BC Geological Survey
Coal Assessment Report
969

COAL ASSESSMENT REPORT TITLE PAGE AND SUMMARY

TITLE OF REPORT: Assessment Report for 2013 - Arctos Anthracite Project

TOTAL COST:

AUTHOR(S): Robin E. Goad, M.Sc., P. Geo. - President & CEO, Fortune Coal Limited (Qualified Person)
SIGNATURE(S):

NOTICE OF WORK PERMIT NUMBER(S)/DATE(S): C-160 (5 YR term, expires March 31, 2018)
Approval number: 13-0200025-0604, CX-1-004: 2013 (expires April 30, 2018)

YEAR OF WORK: 2013

PROPERTY NAME: Arctos Anthracite Project

COAL LICENSE(S) AND/OR LEASES ON WHICH PHYSICAL WORK WAS DONE:

417191, 417194-96, 417200-01, 417204-05, 417214-16, 417219-21, 417225-26, 417230-31, 417160-61, 417180-99 & 417200-38

MINERAL INVENTORY MINFILE NUMBER(S), IF KNOWN: 0200025
MINING DIVISION: Liard
NTS / BCGS: 104H02 and 104H07
LATITUDE: 57.2410° N
LONGITUDE: 128.8923° W

OWNER(S): Fortune Coal Limited (Managing Partner), POSCO Klappan Coal; parties to the Arctos Anthracite Joint Venture

MAILING ADDRESS: 148 Fullarton Street, Suite 1600, London, Ontario N6A 5P3

OPERATOR(S) [who paid for the work]: Fortune Coal Limited
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REPORT KEYWORDS (lithology, age, stratigraphy, structure, alteration, mineralization, size and attitude. **Do not use abbreviations or codes**)

REFERENCES TO PREVIOUS ASSESSMENT WORK AND ASSESSMENT REPORT NUMBERS:

Fortune Coal Limited completed its exploration work of the Arctos Anthracite project in 2005. The exploration work undertaken is described in detail in our assessment report “Assessment Report for 2005 - Mount Klappan Anthracite Coal Project (Liard Mining Division)” which is on file with the BC Government.

SUMMARY OF TYPES OF WORK IN THIS REPORT		EXTENT OF WORK (in metric units)	ON WHICH TENURES
GEOLOGICAL (scale, area)			
	Ground, mapping	Not applicable	
	Photo interpretation	Not applicable	
GEOPHYSICAL (line-kilometres)			
	Ground (Specify types)	Not applicable	
		Not applicable	
	Airborne (Specify types)	Not applicable	
	Borehole	Not applicable	
	Gamma, Resistivity,	Not applicable	
	Resistivity	Not applicable	
	Caliper	Not applicable	
	Deviation	Not applicable	
	Dip	Not applicable	
	Others (specify)		
	Core	*Please refer to report prepared by Terracon Geotechnique on the 2013 Drilling Program*	
	Non-core	Not applicable	
SAMPLING AND ANALYSES			
Total # of Samples			
	Proximate	Not applicable	
	Ultimate	Not applicable	
	Petrographic	Not applicable	
	Vitrinite reflectance	Not applicable	
	Coking	Not applicable	
	Wash tests	Not applicable	
PROSPECTING (scale/area)		Not applicable	
PREPARATORY/PHYSICAL			
Line/grid (km)		Not applicable	
Trench (number, metres)		Not applicable	
Bulk sample(s)		Not applicable	

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1.0 - INTRODUCTION

This report is provided in fulfilment of the Coal Mine Regulations regarding the filing of an Assessment Report for exploration work conducted in 2013. The project has not had any exploration work performed since 2005. All work performed since 2005 has been in fulfillment of securing an EA certificate from the BC EAO. The project is currently in the pre-application stage of the BC EA process and has completed a formal Project Description Report, as well as a draft Application Information Requirements document.

The only work that was performed in 2013 was EA related baseline data acquisition work. No exploration work was performed in 2013 that changed the scope and extent of known coal mineralization. The 43-101 compliant coal resource and reserve estimate, provided to the BC Government in our Coal Assessment report dated Feb. 2013, remains unchanged.

2.0 - SITE DESCRIPTION AND LOCATION

The site is located in northwestern British Columbia, approximately 160 kilometres (km) northeast of Stewart and 300 km northwest of Smithers, as shown on Figure 1, in the Liard Mining District and Bulkley-Cassiar Forest District between 57°06'N and 57°23'N latitude and 128°37'W and 129°15'W longitude, NTS Map Reference 104H 020-022.

Ground access to the property is via a connector road from Stewart-Cassiar Highway 37 to the BC Railway sub-grade, which functions as a road and passes through the coal license area. The site is accessible by air to via 1,000-metre gravel airstrip built on the railway sub-grade, which is suitable for landing fixed-wing aircraft.

The mineral rights comprise 61 contiguous coal licenses, listed in Table 1, with a combined area of 16,411 hectares located on and around the north side of Mount Klappan as shown on Figure 2.

Table 1 Coal Licenses

License No.	Mapsheet	Area (ha)	License No.	Mapsheet	Area (ha)
417160	104H026	281	417209	104H027	280
417161	104H026	491	417210	104H027	280
417180	104H017	281	417211	104H027	211
417181	104H017	281	417212	104H027	280
417182	104H027	276	417213	104H026	280
417183	104H027	281	417214	104H026	280
417184	104H027	281	417215	104H026	280
417185	104H027	205	417216	104H026	280
417186	104H027	280	417217	104H027	247
417187	104H027	280	417218	104H026	279
417188	104H017	281	417219	104H026	280
417189	104H027	281	417220	104H026	280
417190	104H026	281	417221	104H026	280
417191	104H026	281	417222	104H026	58
417192	104H027	280	417223	104H026	104
417193	104H026	280	417224	104H026	149
417194	104H026	280	417225	104H026	280
417195	104H026	280	417226	104H026	280
417196	104H026	280	417227	104H026	280
417197	104H016	281	417228	104H026	280
417198	104H016	281	417229	104H025	280
417199	104H016	281	417230	104H026	280
417200	104H026	281	417231	104H026	280
417201	104H026	281	417232	104H026	280
417202	104H026	281	417233	104H026	280
417203	104H026	281	417234	104H025	280
417204	104H026	280	417235	104H026	202
417205	104H026	280	417236	104H026	280
417206	104H026	280	417237	104H026	280
417207	104H026	280	417238	104H025	280
417208	104H027	173			

Note: Mapsheet references are to BC Geographic Survey.

3.0 - PROJECT HISTORY

In 1901, V.H. Dupont reported a coal outcrop near Mount Klappan in a Canadian government railway survey report. The Geological Survey of Canada (GSC) issued reports on the area in 1912 and 1914, based on work conducted in 1911 and 1912 by G.S. Malloch. Malloch's work was subsequently followed by GSC Reports by Buckham and Latour (1950) and Richards and Gilchrist (1979). The GSC's C.A. Evenchick, G.M. Green, and others have performed numerous studies and mapping of the Bowser Basin from 1985 to the present. In 1978, Esso Resources Ltd. and Petrofina Ltd. acquired the first coal licenses at the current project location but allowed the licenses to lapse in 1980. Based on Esso's report from a summer geological mapping program, Gulf acquired its licenses between 1981 and 1987 covering an area much greater than the current license area.

Between 1981 and 1988, Gulf conducted annual exploration programs to refine its knowledge of the regional geology, seam occurrences, and physical characteristics, and quality attributes of the anthracite resources. These programs were comprehensive and included rotary and core drilling, adits, trenching and outcrop sampling, and quality testing. In 1985 and 1986, Gulf developed a trial cargo pit on top of Lost Ridge and constructed a pilot processing plant near the railway bed access road for bulk testing and to produce sample shipments for potential customers. Anthracite mined from the trial cargo pit (was hauled to the pilot plant where it was processed in a heavy media bath and water-only cyclones to separate coal from the rock. The clean coal products were then trucked to the Port of Stewart and shipped via ocean vessels to potential overseas customers. In February 1992, Gulf surrendered several coal licenses north (in the Little Klappan Valley), south (in the Skeena/Spatsizi Valley) and west (in the Nass/Klappan Valley) of the current license block. In 1994, Gulf performed its last major technical study, which was an analysis of producing a single anthracite product for use in steelmaking.

A summary of Gulf's exploration work is as follows. Gulf's exploration work commenced in all areas with geologic mapping at 1:10,000 scale. In the Lost-Fox Area, ground control surveys established control points in 1984 and 1985, and aerial photography, orthophotographs, and topographic mapping were produced at 1:5,000 and 1:2,000 scales. All geologic mapping, drilling, sampling, and other exploration work was tied into a local system of survey control, which was later translated to the UTM coordinate system (North American Datum of 1983, Zone 9).

Gulf's exploration drilling programs included the compilation of detailed drillers' logs of lithology and geophysical logging of nearly all drill holes. Geophysical logs included gamma ray, neutron, sidewall density, caliper, focused beam resistivity, and directional deviation in some angled drill holes.

In July 2001, Conoco acquired Gulf's remaining coal licenses through acquisition of the company. In 2002, Fortune Coal Limited acquired these coal licenses and Gulf's comprehensive technical database, and archives of supporting documents from Conoco Canada Ltd.

Fortune Coal Limited conducted a drilling exploration program in 2005 and specific details of the work performed are described in detail in our assessment report "Assessment Report for 2005 - Mount Klappan Anthracite Coal Project (Liard Mining Division)" which is on file with the BC Government. All drill core samples are stored off-site in a locked shipping container in Smithers, BC. Table 2 is a summary of intrusive exploration by Gulf in the 1980s and Fortune in 2005:

Table 2 Summary of Intrusive Exploration

Exploration Program	1980-1988 (Historical, Gulf)	2005 (Fortune)	Total
Adits	4	None	4
Diamond Drill Holes	159 (22,752 m)	12 (2,109 m)	171 (24,861 m)
Rotary Drill Holes	23 (1517 m)	None	23 (1517 m)
Mechanical Trenches	210 (2304 m)	None	210 (2304 m)
Hand Trenches	357 (1999 m)	None	357 (1999 m)
Measured Sections	64 (8818 m)	None	64 (8818 m)

4.0 - 2013 EXPLORATION WORK

The Arctos Anthracite project entered the BC EA process in 2012 and is currently in the pre-application stage. All recent work at the project site has involved the acquisition of baseline data in support of an EA application. In 2013, the project was granted a Notice of Work (NOW) permit for 5 years, and a summer base camp was erected at the project site from July to September 2013. Unfortunately, the EA baseline work was terminated prematurely due to the presence of FN and NGO protestors at the project site, and therefore the full scope of EA work was not completed.

The majority of the baseline EA work consisted of a drill program for geotechnical, geochemical and hydrogeological assessment. Other work consisted of archaeological assessments, water flow measurements and water sampling. Fortune's 2013 drill program consisted of 19 drill holes ranging in depth from 70 to 100 metres, and two of these holes were not drilled to planned depth due to interruptions from protestors; these holes will re-drilled at a future date. As these holes are relatively shallow, they are not expected to provide information that would increase the size of our coal resource. Drilling was performed by Driftwood Drilling (Smithers), the geotechnical analysis was performed by Terracon Geotechnique Consulting, the hydrogeological analysis was performed by Stantec Consulting, and the Geochemical analysis was performed by Lorax Environmental. All the sites occupied and drilled by the company have been cleaned of debris and left in a stable condition.

The environmental data collected in 2013 will be added to data collected in previous years, and collectively this information will be used in support of an application for a BC Environmental Assessment Certificate. To date, none of this data has been used to prepare any final technical reports or has been summarized for review by external parties. More baseline data must be acquired at the site before our primary environmental consultants (Stantec, Lorax and Knight Piésold) can prepare their final reports.

5.0 - SUMMARY OF COSTS

Table 3 provides a summary of costs associated with the completion of the 2013 work.

Exploration Work type	Comment	Days			Totals
Personnel (Name)* / Position	**Field Days (list actual days)**	**Days**	**Rate**	**Subtotal***	
Labourers (employees)			$0.00	$136,791.77	
Contract Labourer			$0.00	$101,991.33	
Project Management (Jul-Mid Oct)			$0.00	$81,245.00	
Corporate Management			$0.00	$33,430.00	
				$353,458.10	**$353,458.10**
Office Studies	**List Personnel (note - Office only, do not include field days**				
				$0.00	**$0.00**
Airborne Exploration Surveys	**Line Kilometres / Enter total invoiced amount**				
				$0.00	**$0.00**
Remote Sensing	**Area in Hectares / Enter total invoiced amount or list personnel**				
				$0.00	**$0.00**
Ground Exploration Surveys	**Area in Hectares/List Personnel**				
Ground geophysics	**Line Kilometres / Enter total amount invoiced list personnel**				
Other (specify)	Terracon geotechnical assessment			$359,158.00	
				$359,158.00	**$359,158.00**
Geochemical Surveying	**Number of Samples**	**No.**	**Rate**	**Subtotal**	
Other (specify)	Environmental (Lorax, Stantec)		$0.00	2,793,829.62	
				$2,793,829.62	**$2,793,829.62**
Drilling	**No. of Holes, Size of Core and Metres**	**No.**	**Rate**	**Subtotal**	
Diamond	See attached geotechnical report		$0.00	$814,937.53	
				$814,937.53	**$814,937.53**
Other Operations	**Clarify**	**No.**	**Rate**	**Subtotal**	
				$0.00	**$0.00**
Reclamation	**Clarify**	**No.**	**Rate**	**Subtotal**	
Transportation		**No.**	**Rate**	**Subtotal**	
Airfare			$0.00	$7,814.00	
Helicopter (hours)			$0.00	$1,437,188.61	
Fuel (litres/hour)			$0.00	$27,086.14	
Other				$55,320.92	
				$1,527,409.67	**$1,527,409.67**
Accommodation & Food	**Rates per day**				
Camp			$0.00	$462,094.14	
Meals	day rate or actual costs-specify		$0.00	$62,379.00	
				$524,473.14	**$524,473.14**
Miscellaneous					
				$0.00	**$0.00**
Equipment Rentals					
				$0.00	**$0.00**
Freight, rock samples					
				$0.00	**$0.00**
TOTAL Expenditures					**$6,373,266.06**

Table 3 – Fieldwork Expenses

FIGURES

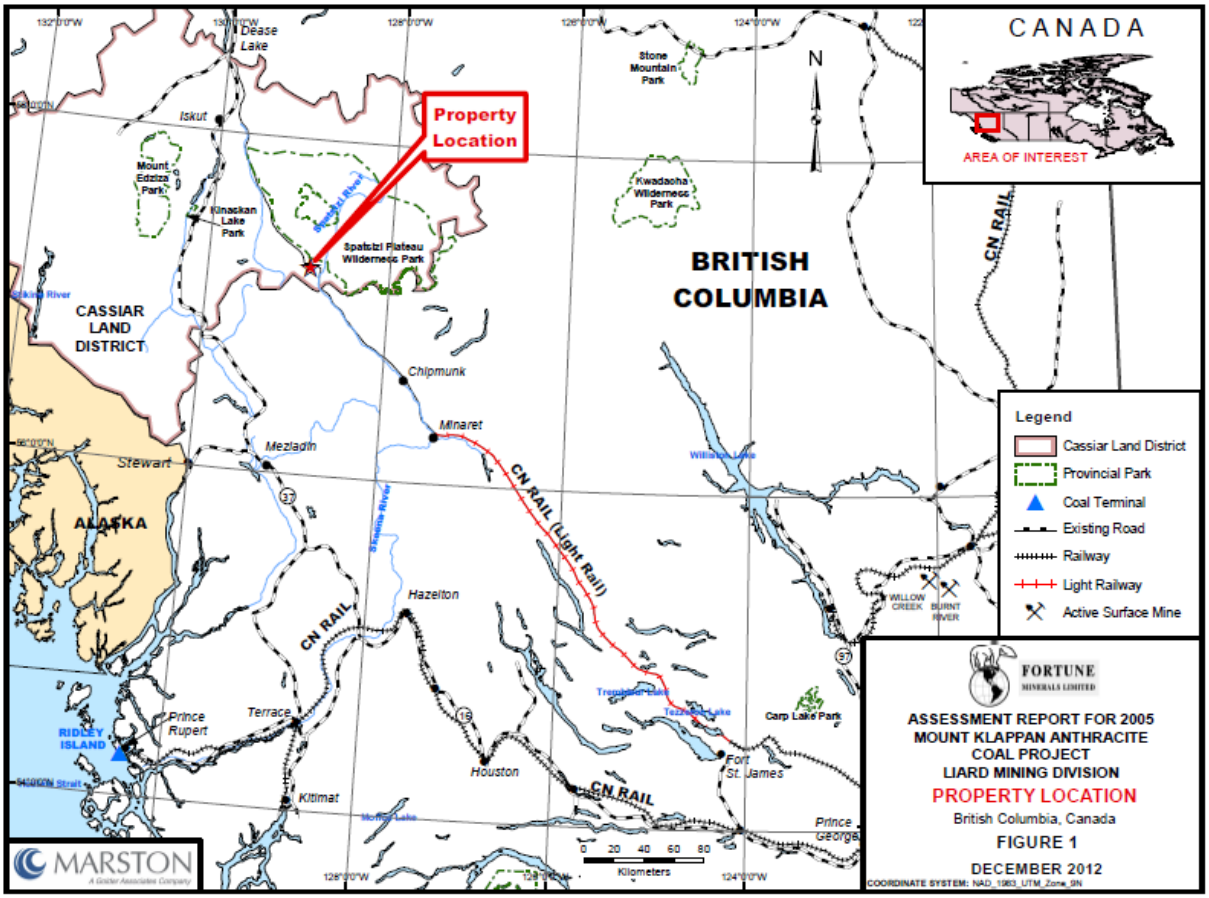

Figure 1 - Property Location

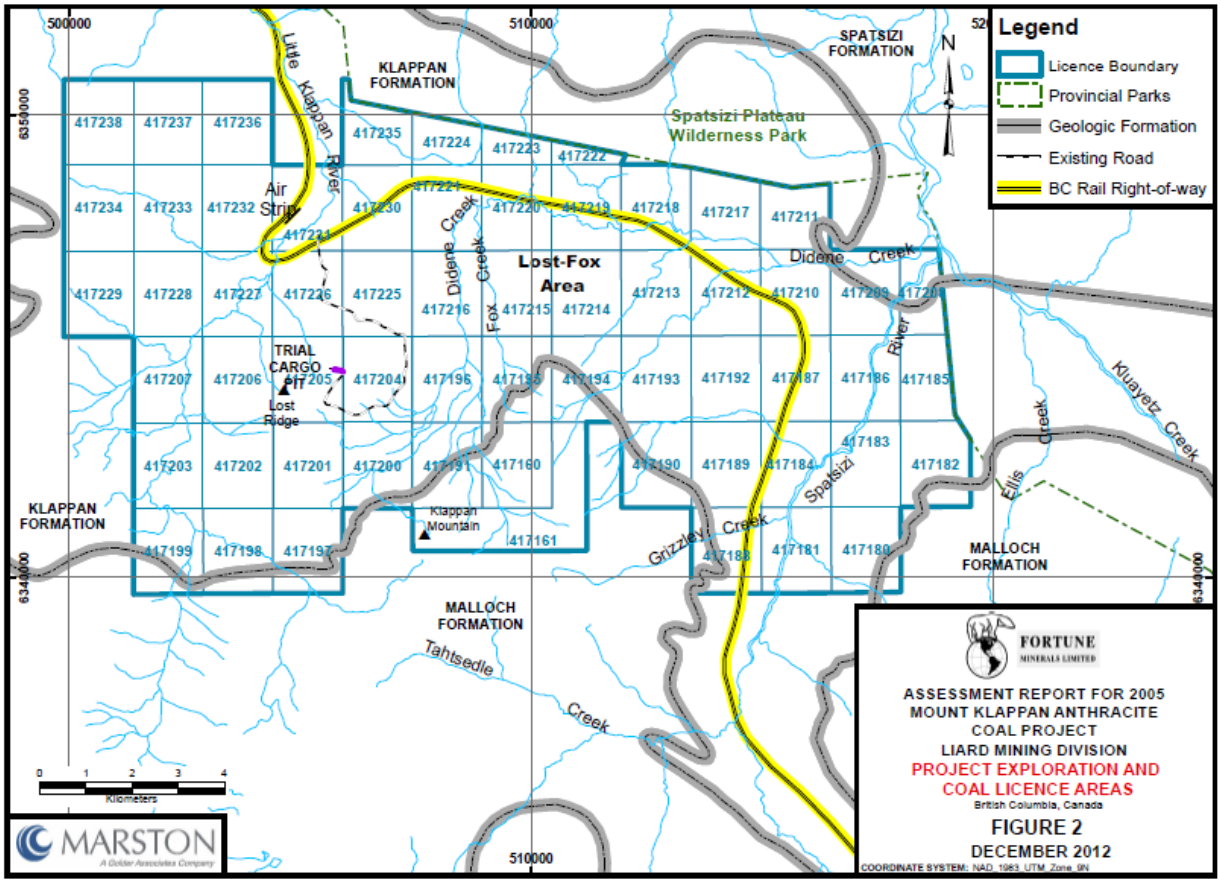

Figure 2 - Project Exploration and Coal License Areas

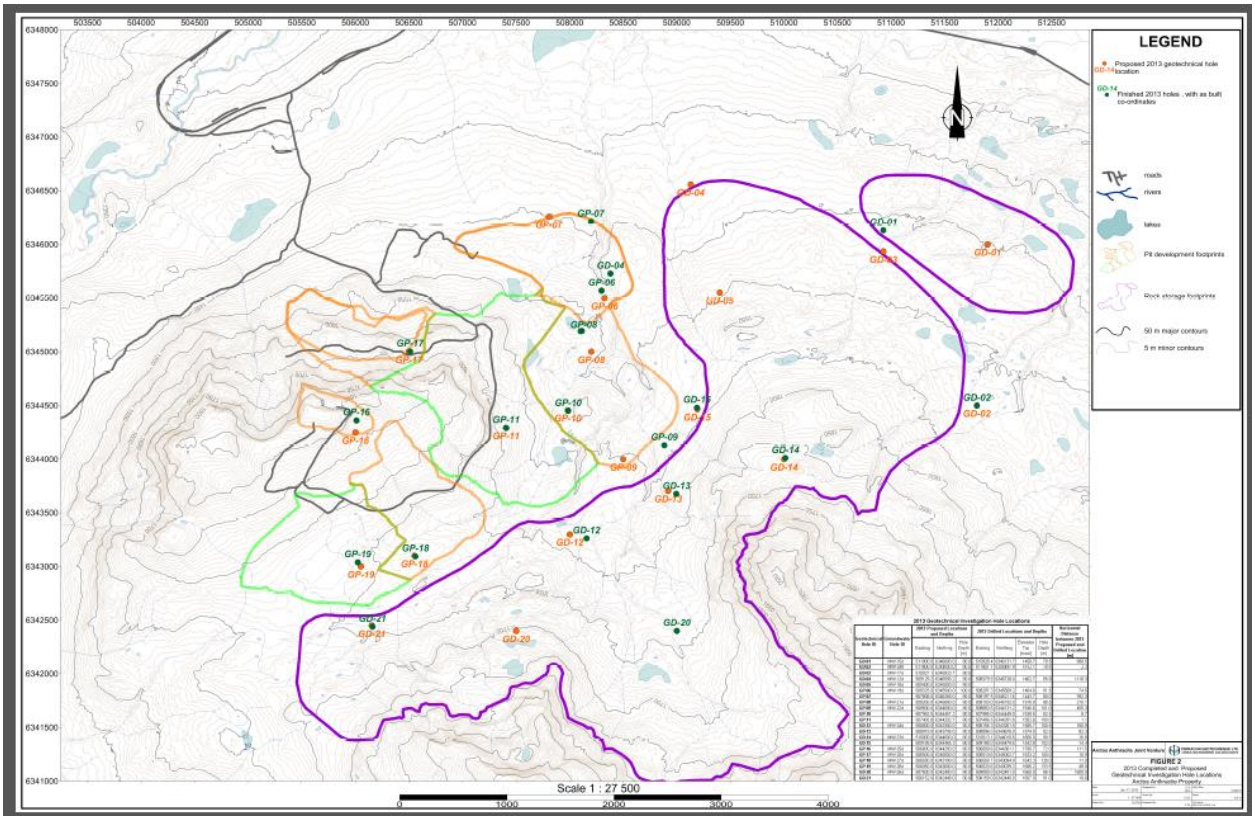

Figure 3 – Drillhole Locations

ARCTOS ANTHRACITE PROJECT
GEOTECHNICAL FIELD PROGRAM AND STUDY OF THE PIT SLOPES AND WASTE STORAGE STRUCTURES

Submitted To: Arctos Anthracite Joint Venture

Project Number: 122781

Date Issued: April 01, 2014

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Appendix I References

EXECUTIVE SUMMARY

The Arctos Anthracite Mount Klappan Drilling Program was initiated in early July 2013. The camp equipment and drill were mobilized in mid-June and the drill crew groundwater personnel from Stantec and Geotechnical/Geological personnel from Terracon mobilized onto the site on July 2nd 2013.

The core drilling and water instrumentation program was conducted by Driftwood Drilling. The core was 3 inch (HQ) using five and ten foot core barrels; the shorter barrel was used in the overburden where core recoveries were more difficult. A SPT hammer assembly was also used to obtain blow count data in the overburden. This blow count information provided some guidance and variability of material types in the overburden which consist of glacial debris and scree with large boulders mixed with silty clay and sand tills. The large boulders which often amounted to 50% of the material required frequent coring in the overburden.

The total number of boreholes drilled was 19. Two planned boreholes were not drilled due to operational constraints. An additional 2 overburden holes were drilled for instrumentation installations. These holes were collared within the proposed pit limits and within the proposed out of pit waste rock/soil storage footprints.

The boreholes were designed to provide basic lithology profiles, structural geology data and physical property data for the shallow bedrock units and the glacial overburden sediments. Core samples were selected for laboratory testing to provide density, strength and other related physical characterization data. The secondary purpose of the holes was to provide hydrogeological data for the initial pit area and the initial area for construction of the out-of-pit waste dump structures for mine stripping disposal.

The report also includes a brief review of the relevant lease geological elements, seismicity, and a brief summary of the extensive and relevant geotechnical research and learnings on waste dump structure failures in Western Canada and Wales.

Slope stability sensitivities and guidelines are provided for the dump structures and the initial pit slopes with recommendations for the next stage of the lease development and design study.

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1.0 INTRODUCTION

Terracon Geotechnique Ltd. (Terracon) was retained by Arctos Anthracite Joint Venture (AAJV or the Client) to examine the rock storage areas (waste dumps) and ultimate pit walls for the initial pit with respect to geotechnical conditions for the proposed open pit anthracite coal mine project in northwestern British Columbia. A project location plan is shown in Figure 1 in Appendix A.

1.1 Purpose

This report summarizes the results of the geotechnical field program and the subsequent analysis. The geotechnical field program, executed in the summer of 2013, had two components - a core drilling campaign and limited geological structural mapping. The 2013 core drilling program was fully coordinated with the hydrogeological field program completed by Stantec.

The purpose of the geotechnical field program was to gather additional data for the analysis of the rock storage areas and ultimate pit walls with respect to geotechnical conditions with the focus on the first 5 to 10 years of the mine life. The key objective was to assess the static and dynamic slope stability conditions of these rock structures, (pitwalls and external dump).

1.2 Scope of Work

Elements of the program scope, as outlined in Terracon's scoping study, included the following:

- A geotechnical drilling program for the pit and waste storage areas (to include in-situ testing);
- A laboratory testing program;
- Analysis of slope designs for the ultimate pit wall slopes:
  - Including sensitivities to fracture families, seismic loading, pore pressure;
- Analysis of slope designs for the waste rock structures:
  - Including sensitivities to seismic loading, pore pressure, foundation conditions, construction methods;
  - Recognition of historical performance of coal waste rock structures under similar conditions;

- Provide advice related to dewatering, pit and waste rock geotechnical monitoring, setbacks, geotechnical database and future geotechnical studies;

- A report to summarize the program and initial findings.

1.3 History

The project site has been explored and developed by various owners, including Gulf Canada Resources Inc. and Fortune Minerals Limited, since the early 1980s. Terracon has participated and collaborated with programs on this site since the late 1990s. Specific programs have included a 2005 geotechnical analysis and hydrogeological evaluation and a 2012 geotechnical review. The scoping document for this latest program was formally accepted by the Client in June 2013.

2.0 FIELD PROGRAM

In alignment with Terracon's Scoping Study (April 11, 2013), the field program was designed to obtain better ground control data to aid in geotechnical evaluation of pitwall and rock storage areas on the Arctos property. Primary activities included a drilling program, core description, sample collection, field testing and structural mapping. The field portion occurred between July and October 2013, during which time Terracon geotechnical/geological personnel were responsible for the following duties:

- Field mapping;

- Supervision of Standard Penetration Tests (SPTs) in the overburden;

- Core measurement and core recovery documentation, Rock Quality Designation (RQD) data recording, geological core description, geology and structural discontinuity description, and Schmidt Hammer testing;

- Selection of samples for geotechnical testing; sample preparation, packaging and shipping samples to Calgary for laboratory testing;

- Assist Stantec Ltd. with supervision of piezometer installation for the hydrogeological program.

2.1 Drilling Program

The drilling component involved moving drill rigs, drill supplies and core by helicopter sling methods to each of the proposed drill hole locations. See Figure 2, Appendix A, for borehole locations relative to the proposed ultimate pit and the ultimate rock waste storage structure limits. Temporary field tent camps for all of the required drilling technical and support personnel were also relocated in this manner. It should also be noted that all drill sites required construction of wooden platforms to accommodate the drill rigs.

For the duration of the project, field personnel on site at various times included two to three geology/geotechnical personnel from Terracon; two to three hydrogeologists from Stantec Ltd.; two to four man drill crews from Driftwood Diamond Drilling operating on a 24 hour basis; as well as other camp and drill support, archeologists and technical staff. Terracon field personnel accommodated a rotation schedule throughout the drilling program consisting of 12 hour days, 21 days per month.

The camp location had a short landing strip for supplies and personnel which were flown in by a Cessna Grand Caravan operated by NT Air. The helicopters utilized in the program were supplied by Lakelse Air and consisted of an A-Star and a Bell 204. ATV's were also available for personnel and transport of some supplies.

Core drills were supplied by Driftwood Diamond Drilling of Smithers, BC and consisted of HQ (3 inch) coring systems using 5 and 10 foot barrels. An SPT hammer assembly was also used to obtain blow count data in the overburden, which consisted primarily of glacial debris and scree; primarily large boulders, silty clays, and sandy tills.

Three categories of boreholes were labelled according to the following functionality:

- GP (Geotechnical Pit) – data collection for pit analysis;
- GD (Geotechnical Dump) – data collection for dump analysis;
- MW (Monitoring Well) – groundwater information collection plus data for geotechnical analysis.

Total depths of the 19 core holes drilled were in the order of 70 m to 130 m. Nine boreholes were drilled to test the foundation conditions in the proposed rock storage area and 10 boreholes were drilled within the footprint of the proposed pit area.

A change in the number of planned core holes and some of their proposed locations were due to a number of factors. Site factors included archeological investigations introduced prior to drilling in some borehole locations; access to water was constrained to 500 m; boreholes for groundwater instrument installations often took priority; and site changes due to preferred hydrogeological conditions for well placement. Consequently, data deficiencies resulted. As outlined in the report recommendations, such deficiencies in the geotechnical data, as well as additional information required for ground control, can be obtained in the next field program which is planned for this year.

Locations of the originally proposed 2013 drill holes and actually completed 2013 drill holes are presented in Table 1 in Appendix B. Spatial representation of 2013 proposed and drilled core holes are illustrated in Figure 2 in Appendix A.

2.2 Core Description

Drill core was transported by helicopter from the borehole location to a designated core description site on the Arctos property. Terracon field personnel logged the core, performing the following operations:

- Core was measured and adjusted to the core run numbers. Lost core intervals were documented for each run; core recoveries were noted;
- RQD data was recorded for each core run;
- Geological units and structural features were described;
- Schmidt Hammer tests were performed at chosen intervals;
- Core samples for laboratory tests were selected;
- Core was photographed and stacked on site.

Detailed geological – geotechnical logs were prepared from the logging of the core and recording of field data such as Standard Penetration Test numbers and RQD values. The core was tested for hardness by using a Schmidt Hammer system systematically on whole core specimens. The lithologies were recorded along with structural data and these included coal seams, sandstones, mudstones, siltstone, plastic clay, muds and bentonite seams.

The structural data included recording bedding plane dips and fracture plane dips. Fractures were primarily tension fractures (joints) but also included shear or fault features in the core. The fracture planes were also characterized (open, healed, slicken sided, rough, etc.). Because the geological model for the mine does not extend into the out-of-pit dump areas, the strike direction of the primary bedding in the new core holes is unknown: consequently the strikes of the fracture data in the core can not be computed until the geological model is completed for the dump areas. When that task is completed the fracture data from the 2013 program can be oriented and included in the analysis.

Detailed field core description logs are presented in Appendix C and core photographs are presented in Appendix D. The core (except for the sample intervals selected for laboraty testing) remain catalogued in boxes for easy access and future inspection at site.

2.3 Field Tests

To obtain relative strength and compressibility indices of the overburden, SPTs in proposed pit and rock storage areas were conducted. Rebound hardness of the bedrock core surfaces were obtained when selected core sections were subjected to Schmidt Hammer tests. RQD's were measured and recorded in the geological logs. It is often applied as a component of a general rock mass rating system (RMR) identified as Bieniawski's Geomechanics Classification.

2.3.1 Standard Penetration Tests

The SPT equipment was provided by Driftwood Drilling. The SPT apparatus consisted of a one piece hammer-anvil assembly with 61" (154.9 cm) compact length, 96" (243.8 cm) extended length, and 162 lb (73.5 kg) gross weight with a hammer weight of 140 lb (63.5 kg).

The SPTs were performed by the drilling crews under Terracon field personnel supervision. The equipment utilized and the testing and sampling procedures were consistent with ASTM D 1586. SPT results are summarized in Table 2 in Appendix B.

2.3.2 Schmidt Hammer Tests

For estimating the uniaxial compressive strength of the bedrock units, core sections were subjected to Schmidt Hammer tests. Bedrock core surface rebound hardness data

were recorded in the core description logs (Appendix C). An L-type (0.735 Nm impact energy) Schmidt Hammer was used in this exercise.

2.3.3 RQD Index Measurements

Rock quality designation is an index property that measures the percentage of core recovery in lengths greater than twice its diameter. These data were recorded were measured in the filed on the geological logs. These data are also a component of Bieniawski's RMR.

2.4 Structural Geology Mapping

Field mapping exercises were completed primarily to collect structural data from rock exposures in the area. The structural data included strike/dip of planar features including bedding planes, joint planes, and other fracture types. Successful data collection was achieved in outcrop areas along the access road. Thirty six outcrop locations were mapped during the field program. Also, an excavation was attempted but with limited success. Field mapping exercises were severely hindered due to an unplanned field program interruption. This interruption occurred towards the end of the program when Terracon had hoped to accomplish field mapping with extra personnel.

It is recommended that additional outcrop mapping of bedding and joint sets as well as field observations on the surficial geology be accomplished during the 2014 field program. Structural data obtained are presented in Figure 3 in Appendix A and Table 3 in Appendix B.

Dip data are recorded for the bedding angles and fracture planes in the borehole logs. Azimuth data are not available until the structural models for these areas are completed and the bedding azimuths are known from these models.

Historical structural data are known to exist from earlier reports. It is recommended that these data be retrieved.

3.0 LABORATORY PROGRAM

Selected core samples were collected as the core description was completed in the field. These samples were shipped to Calgary for further screening, assessment and testing.

The laboratory test results are presented in Appendix E and summarized in Table 4 in Appendix B.

3.1 Laboratory Test Program Scheduling Overview

Given the scope and extent of the 2013 geotechnical field program, the laboratory test program was primarily designed to provide basic soil/rock material properties for the purposes of stability analyses of pit wall and waste dump structures as outlined in the feasibility study. The test program, however, was limited by the fact that high quality samples were not always obtainable. For instance, no rock core samples were found to contain discontinuities that were deemed suitable for testing to characterize strength properties of the discontinuities inherent in the rock mass.

The main objectives of this laboratory test program were: (1) to conduct a variety of index tests and strength tests in an attempt to characterize the soil material properties; and (2) to perform tests to gain insight into the strength and deformation of rock material in order to predict its behaviour during the mining process. The factors considered when planning this test program included: sample locations (pit and rock storage areas); type of materials (soil and rock); environment (weathering-related rock behavior); weak rock/seam (bentonite), etc.

Selected core and overburden samples were shipped to Calgary and delivered to the Golder laboratory for testing in accordance with relevant ASTM standards.

3.2 Soil Index and Strength Laboratory Test Results

The geotechnical field program identified and confirmed that the majority of the unconsolidated overburden is a glacial horizon of till typically 10 m thick. The actual thickness of the surficial soil varies depending on borehole locations. Because all soil samples were disturbed in nature, typically only index tests were conducted on the samples. The laboratory tests for the mineral soil samples included moisture content, Atterberg limits, unit weight, specific gravity, particle size distribution, and direct shear tests.

The laboratory tests and findings are summarized below.

3.2.1 Moisture Content

A total of 42 soil samples were tested for moisture content. The measured moisture contents range from 9.8% to 51.3%. The average moisture contents from the rock storage areas and the pits were 20.0% and 21.1%, respectively. These soil moisture content data suggests the overburden profile appears to be saturated in most of the footprint of the waste rock structures. These data support the observation that the water table probably follows and mimics the existing topographic surface in the rock waste storage area. This observation also explains the numerous small water filled kettles that pock mark the waste dump footprint.

3.2.2 Atterberg Limits and Activity

Atterberg Limits tests were conducted on 38 soil samples. The results suggest that the glacially derived soils have low to intermediate plasticity.

Associated liquidity indices of the samples were calculated as ranging from -0.8 to 1.1. Approximately half of the values are less than zero, which indicates the respective soils were subjected to past consolidation pressures. This finding is generally consistent with glaciated till material found in this region. It is not uncommon that soil at some locations shows over-consolidation, where soil at other locations does not. This applies particularly to surficial soils. The indication coincides with a general trend for the surficial soils in the project area: the deeper the soil is buried, the more likely it experienced pre-consolidation, probably from ice re-advances.

Soil activity, defined as the ratio of plasticity index to the percentage of clay-sized particles (less than 2 µm) present, generally reflects the potential of soil volume change at wetting and drying. A total of 28 soil samples were analyzed and their activity values scatter from 0.5 to 1.2. The results indicate that more than two thirds of the samples represent inactive mudstone lithologies. This characterization suggests these lithologies will be reasonably resistant to weathering in a mine life context.

3.2.3 Unit Weight and Specific Gravity

Soil samples collected at approximately 6 m and 8 m depths were tested for unit weight. The measured unit weight values were 1761 kg/m^3 and 2014 kg/m^3, respectively. The values are consistent with design data employed for coal mine operations. Three samples were tested for specific gravity. The samples were collected in the interval from 1.5 m to 2.0 m below surface. The average mineral specific gravity value was approximately 2.64.

3.2.4 Particle Size Distribution

The particle size distributions of a total of 42 soil samples were analyzed in the laboratory test program. The soil gradations varied widely, from clay rich to gravel soils. Of the 42 samples tested, the majority of soil samples contained more fines than the coarser portions.

3.2.5 Direct Shear Strength

Two soil samples collected at 6 m to 9 m depths in the overburden profile from 2 boreholes were deemed suitable for strength tests. The samples were identified as being clay. Direct shear test results revealed that under normal pressures in the orders of 1000 kPa and 600 kPa, peak strengths were 660 kPa and 370 kPa. Correspondingly, residual strengths were 250 kPa and 270 kPa, respectively. Unfortunately, the limited test results were not sufficient to interpret reliable Mohr-Coulomb shear strength parameters, i.e., cohesion and angle of internal friction of the material because of data scatter. Further testing is required. The sandstone unconfined compressive strengths can be classified as moderate at best. The mudstone/calstone classified as weak.

3.3 Rock Index and Strength Laboratory Test Results

Strength and index tests were conducted on rock core samples representing the two major rock types, sandstone and mudstone/siltstone. The tests carried out in this program included unconfined compression, direct shear, durability, water content, and unit weight tests. For the weak mudstone/siltstone, frequently it was found that the rock is sufficiently soil-like such that tests were scheduled and carried out to measure their particle size distributions. The tests and findings are summarized in the following sections.

3.3.1 Unconfined Compressive Strength

Five core samples were tested for unconfined compressive strengths. The 3 sandstone samples, when subjected to unconfined uniaxial loading, failed at 17.5MPa, 24.1 MPa and 32.0 MPa. For the 2 mudstone/siltstone samples, the ultimate unconfined compressive strengths were 1.2 MPa and 7.4 MPa. The sandstone unconfined compressive strengths can be classed as moderate at best. The mudstone/siltstone results can be classed as representative of a weak rock.

In terms of rock deformation characteristics, the average elastic modulus (E) of sandstone was calculated to be approximately 980 MPa; whereas the E values for mudstone/siltstone lithology were 44 MPa to 400 MPa, showing significant differences in its stiffness.

3.3.2 Direct Shear Strength

A total of 11 rock samples were tested in direct shear under various normal loadings. Of the tests, 2 were tested on sandstone samples, and the rest were carried out on mudstone/siltstone samples, including a few identified as predominantly bentonite. The depths at which the samples were collected ranged from approximately 29 m to 74 m below surface.

For sandstone samples, under normal stresses ranging from 0.88 MPa to 1.75 MPa, the peak shear strengths were 2.12 MPa, 1.55 MPa and 2.34 MPa, respectively. One residual shear strength under 0.91 MPa normal stress (corresponding to the 1.55 MPa normal stress in peak strength testing) resulted in a value of 0.75 MPa.

For the weak mudstone/siltstone samples excluding the bentonite samples, the peak shear strengths were in the range of 0.64 MPa to 2.40 MPa under the normal loading from 0.53 MPa to 2.25 MPa. Their corresponding residual shear strengths ranged from 0.29 MPa to 0.50 MPa, with the vertical pressures from 0.44 MPa to 1.90 MPa.

Two samples were identified as bentonite because of their high water contents averaging 13.0% in comparison with the 1.2% to 5.0% range for other mudstone/siltstone samples. Even under normal loading as high as 1.12 MPa, the peak shear strength was only 0.68 MPa. When the vertical pressure was reduced to 0.53 MPa, the peak strength reduced to 0.20 MPa. Corresponding residual shear strengths ranged from 0.13 MPa to 0.43 MPa. These low strength values are consistent with a bentonite clay mineralogy.

3.3.3 Slake Durability Index

Slake durability tests were used in this test program to estimate quantitatively the durability of the rock, such as the identified mudstone/siltstone, in the expected mining environment (exposure to air). The slake durability index measured in the test refers to the percentage by dry mass of the rock pieces retained on a 2 mm sieve after two cycles of over drying and 10 minutes of soaking in water with a standard device.

A total of 4 mudstone/siltstone samples representing rocks at different depths and locations were tested for their durability. Three samples collected at shallow depth (16 m to 20 m below surface) from one borehole (GD-14) had an average slake durability index of 68.7%, which is generally considered as medium durability. Another sample showed very high durability and had only about 4% mass lost in the durability test. This sampling depth was at approximately 67 m below surface. Therefore, the high slake durability index may reflect to some degree the extra strength and dense structure augmented by deeper burial. These data suggest that these materials are reasonably resistant to weathering in the context of a mine life time span.

3.3.4 Water Content and Unit Weight

Water content results were obtained from a total of 25 rock samples. Of the 25 samples, 6 of them were sandstone and the others were mudstone/siltstone. For sandstone, the water contents ranged from 0.7% to 3.0% with a mean of 1.5%. For the mudstone/siltstone, the water contents covered a spectrum from 0.2% to 7.2%. The average value was approximately 3.3%.

A total of 11 unit weight data were retrieved from the test results. Five represent sandstone and the other five are deemed to be valid for rocks of mudstone/siltstone in nature. For sandstone, the mean unit weight value was 2550 kg/m^3, whereas for mudstone/siltstone the unit weight averaged approximately 2560 kg/m^3. The water contents and unit weights suggest relatively low porosities.

3.4 Comments on Soil and Rock Properties

In general, there is no significant difference in terms of material properties between overburden soils from the pit and the waste dump areas. Depending on locations, the surficial soil was found to consist of a variety of grain sized particles, to contain sufficient fines to exhibit plasticity, to have experienced pre-consolidation, and to be mostly inactive when subjected to a wetting and drying environment.

For rock formations, two major types were identified in the project area: sandstone and mudstone/siltstone. Both unconfined compression and direct shear test results indicate that, though sandstone is generally stronger, these data vary depending on factors including depth and location. Some of the weak rocks can be significantly affected by the environment once exposed at various mining stages. The bentonite seams can exhibit soil like properties and may eventually compromise the pit wall stability.

For pit wall stability analyses that use Mohr-Coulomb failure criterion, cohesions and angles of internal friction of rocks were estimated primarily using the unconfined compressive strength data. They are given as follows:

- For mudstone/siltstone, the strength parameters were estimated based on the maximum unconfined compressive strength (the minimum one was excluded due to invalid value calculated). Cohesion and angle of internal friction are estimated to be 1.8 MPa and 19°, respectively.

- For sandstone, it is reasonable to assume the cohesions can be from 4.0 MPa to 9.0 MPa and their corresponding angles of internal friction are 16° to 15°, respectively.

It should be noted that the above Mohr-Coulomb strength parameters are indirectly derived and calculated and that caution should be made when applying them. Further testing to develop Mohr-Coulomb strength envelopes especially for fracture surfaces is required for the main lithologies.

4.0 GEOLOGY

The geology of Mount Klappan area is described by Koo (1985), Hardy (1987), Gulf (1988), Marston (2012) and other authors. Part of these descriptions are quoted or paraphrased in this report. The contribution of the authors, Hardy, Gulf and Marston is acknowledged.

4.1 Regional Geology

The Klappan Coalfield is located in the northern part of the Groundhog Coalfield, within the northeastern portion of the Bowser Basin. The Upper Jurassic and Lower Cretaceous sedimentary rocks were formed from peat bogs in a coastal delta system with cyclic fluvio-deltaic to marine depositional environments.

Successive layers of peat were periodically covered with sediments. Heat and pressure transformed the peat layers into anthracite coal seams.

Tectonic activity in the vicinity of the Bowser Basin uplifted and compressed the sedimentary rocks, which resulted in NW-SE parallel folds and thrusts. A secondary N-S compression superimposed NE-SW trending folds across the region.

The Klappan Coalfield sediments are grouped into four stratigraphic units. Starting with the oldest, these units are the Spatsizi Formation, the Klappan Formation, the Malloch Formation and the Rhonda Formation.

Klappan Formation is nearly 1100 m thick and is composed of interbedded sandstones, siltstones, mudstones and coal seams. It also contains bentonite layers and discontinuous conglomerates. Klappan Formation is the main coal bearing formation. Thirty-three coal horizons in the Klappan Formation were identified by Gulf.

It's important to note that the major structures which this study is focused, namely the pit and out of pit rock storage structures, lie within or on the Klappan Formation. A generalized stratigraphic column (Marston, 2012) is shown in Figure 4 and the local geology is presented in Figure 5.

4.2 Arctos Anthracite Coal Property Geology

Arctos Anthracite Coal Property is located almost entirely over the outcropping Klappan Formation sediments, which, to the South of the property, are overlain by the younger Malloch Formation (see Figure 5, Appendix A).

The fine to coarse grained sandstone layers of the Klappan Sequence are often rippled, with unknown direction of the rippled bedding. Siltstone and mudstone layers are associated with individual coal seams. According to Koo, the upper part of the formation, which contains the potentially economic coal seams, contains twice as much mudstone and siltstone as sandstone. This ratio corresponds to Terracon's observations and estimates. During the 2013 field program, some plastic clay and conglomerate interbeds were also encountered.

The surficial geology units in the Arctos Anthracite Property are 0 to > 15 m thick silt and clay tills; slopewash or glacial outwash relatively shallow deposits, including silty sands and gravels; colluvium and fen or bog organic rich, shallow, relatively thin, discontinuous

deposits. The coarser portions of the clay tills are composed of sedimentary rocks, primarily local in provenance.

In general, the glacial till may be overlain by fen or bog deposits or by the slopewash and glacial outwash deposits. The colluvial deposits frequently overlay the bedrock, although sometimes they overrun onto the glacial till. Recent gravels and sands (Holocene) occur along the Little Klappan River valley bottom and along small streams draining the area.

4.3 Structures

The overall structure of the Klappan area is that of the Mt. Beirnes Synclinorium (Figure 5, Appendix A), trending NW - SE (Gulf, 1982).

The Klappan Sequence has been deformed into a number of folds, which are upright to overturned to the northeast on the northeast limb of the synclinorium, and overturned to the southwest on the southwest limb. Arctos Anthracite Property covers mostly the northeast limb of the synclinorium.

Folding is the dominant deformational mechanism on the property and is demonstrated by broad upright folds to overturned megascopic Z-folds with axes inclined 45° to the northeast. A periodic fluctuation in the plunge of the fold axes (alternately NW and SE) is superimposed on the above described fold pattern. The magnitude of the plunge is around 10°, and rarely more than 20°. Alternating plunge changes keep the Middle Klappan Sequence relatively close to the surface in the eastern portion of the property.

Faulting has a relatively minor role in the deformation of the Klappan sediments. Four SW dipping thrust faults are recognized on the Mount Klappan property with only 2, the Klappan and B.H.G. (Broatch, Hobbit, Grizzley) being continuous over the property.

Thrusts subdivide the property into 3 structural blocks. The upper (SW) structural block is bounded to the NE by the Klappan Thrust and encompasses all of the western portion of the property, including Klappan Mountain. The structure of the block is characterized by open upright folds of 200 m - 300 m wavelength. Fold axes are parallel and are oriented with the regional NW-SE trend.

Deformation is not intense with the exception of a recumbent isoclinal fold of several hundred metres amplitude on the NW face of Mount Klappan.

The middle structural block lies between the Klappan and B.H.G. Thrusts. The structural style of the southern portion of the block is similar to that of the south-westerly structural block but, towards the northwest, the folds become progressively overturned to the northeast.

The tendency toward overturned folds is even more pronounced in the structural block beneath the B.H.G. Thrust. The folds are characterized by long, gently dipping southwest limbs, which tend to flatten out near the hinge area, and by shorter, vertical or overturned northeast limbs. While the limbs are free of secondary structural complications, fracturing and structural thickening of the strata, including coal, are common in the hinges of the folds. Quartz filling of the fractures in the hinge area of folds was noted. The structures in the Mount Klappan area are relatively broad and can be traced over large areas. This suggests that strike and dip structural domains for the pit and rock storage areas should be possible to define for purpose of fracture mapping in core.

4.4 Natural Talus Slopes

The natural geology along the slopes of Mount Klappan can be used to estimate the angle of repose for structures built using materials from the same geological formation. The talus material below a natural cliff will come to rest at the highest angle of repose that is sustainable based on the material's physical properties and conditions.

A series of natural slopes were observed around the Mount Klappan mine site and the angle of repose was recorded. From the natural slopes that were analysed, an average angle of repose of 35° was observed.

4.5 Seismicity

Canada's Earthquake Database website was used to determine seismicity parameters for the analyses. According to the data presented in Section 1 of Appendix F, gathered from the Seismic Hazard Calculator, a dynamic load of 0.1g is conservative compared to all dynamic loads presented by the Hazard Calculator. It is for this reason that a dynamic load of 0.1 g is used in the slope stability analyses.

According to the information available in the database, the largest magnitude seismic event recorded within a 250 km radius of Mount Klappan had a magnitude of 4.4ML with an epicentre located 168 km west-southwest of Fort Nelson and occurred on June 7, 2012. The second largest seismic event to have been recorded within a 250 km radius of Mount Klappan occurred on April 29, 2013, had a magnitude of 4.2Mw and had an

epicentre located 88 km west-northwest of Stewart. A history of the seismic activity for the area surrounding Mount Klappan from January 1985 to December 2013 is presented in Section 2 of Appendix F.

4.6 Groundwater

In this assessment, the pitwalls are inferred to be drained by active or passive eductor systems. For the out-of-pit waste structure storage area the foundation soils are recognized to be saturated but not subject to pore pressure increases due to loading.

5.0 PITWALL PARAMETERS

5.1 Structural Data

The structural data utilized for the pit slope stability analyses (Table 5 in Appendix B) encompasses structural interpretations from previous studies on the Arctos Anthracite Property and data obtained from the 2013 Arctos Anthracite Property field investigation program. Structural data point locations are shown on Figure 6, Appendix A. The structural data set used in the present study consists of 2013 field program bedding and joint measurements and interpretations from 1987 Hardy's report.

5.2 Rock Strength Parameters

Bedrock on the Arctos Anthracite Coal Property is composed of interbedded sandstones, mudstones/siltstones, coal seams and bentonite layers. The rock strength parameters, derived from the 2013 laboratory tests of selected core samples, are as follows:

- For mudstone/siltstone the angle of internal friction ϕ' is estimated to be 19°
- For the sandstone a ϕ' value of 15° is inferred. This value is unusually low and needs to be examined with further data. However, smooth fracture planes in the sandstone cores were observed during logging to be slickensided with carbonaceous infillings. By observation, these surfaces are intuitively rated as having low friction values in the 15° to 20° range which is typical for some coals or carbonaceous materials.

The unit weight (γ) averages approximately 2560 kg/m^3 for the mudstone and 2550 kg/m^3 for the sandstone. These unit weights suggest that ϕ' values in the vicinity of 40°

might be the typical ones for the unfractured sandstone strata. Additional laboratory tests are necessary to be conducted in the next programs, to examine this possibility.

The pit wall slope stability may be controlled by weaker bentonite and carbonaceous layers, with ϕ' values of ~8° for the bentonite (2013 laboratory test program) and ~13° for the "carbonaceous natural surfaces" (Hardy, 1987). These strengths values are not considered unreasonable for these lithologies.

5.3 Pit Design Parameters

As outlined in the 2012 Update to the Arctos Anthracite Project Mine Feasibility Study, by Golder – Marston (and as provided in part by Terracon), the pit design parameters (Figure 7) are as follows:

- Bench Height: 20 m
- Highwall Slope: 45° (recommended double benched with 70° face angle and 13 m catch bench every 20 m for overall angle 45°)
- Footwall Slope: Equal to dip of seam up to a maximum of 45°
- Haul Road Width: 30 m to allow for the use of 177-tonne haul trucks (minimum 25-m running width with 1.5 m high berm at 1.5:1 cross slope)
- Haul Road Grade (In-Pit): 10 %

5.4 Pit Wall Stability Analyses

5.4.1 Kinematic Analyses for Planar and Wedge Failures

The kinematic analyses are based on structural data and rock strength parameters using stereographic methods. This technique utilises a kinematic feasibility approach whereby blocks created by discontinuities are assessed on the basis of their angular relationships to move, rather than analysing the forces that may cause them to move. The analyses consider the angular relationships of discontinuities, but they do not consider their volume. When there is no 'freedom' for a block to move, normally due to the presence of intact rock, a cut slope may remain stable even if it is steep and contains discontinuities with low strength. The orientation of the discontinuities relative to one

another and the orientation of the excavated face is therefore of primary importance (Goodman, 1980).

Software used for the pit wall kinematic analyses was Dips 6.0, by Rocscience Inc. The software input parameters were the strike and the dip of the pit wall and the friction angles along the discontinuities. The analysis employs stereographic projection methods after K. John.

The following assumptions and limitations were applied in the analyses:

- Pit walls are fully drained;
- Discontinuities have friction angles of 8° or 13°. These values are strongly conservative and represent the worst case scenarios such as: failures along bentonite or carbonaceous seams;
- The analyses yield relative risk of failure results rather than safety factors.

The kinematic tests were performed for pit wall slope azimuths from 45° to 360^0 at 45° increments and for pit wall slope dips from 45° to 30° on 5° increments.

The lateral "acceleration" force representing pseudoseismic conditions was incorporated in the analyses by the friction cone concept. Application of this lateral force in connection with the gravity force resulted in a cone about the origin. Inferring a seismic acceleration coefficient of 0.1, $\varphi'_{seismic} = 6^o$.

To assess the risk of failure, a classification system based on the amount of defects within the danger zone was established. Those that did not display any of the contoured defect sets identified as significant within the danger zone are deemed to be not feasible failures.

If less than 25% of the contoured cluster was within the danger zone, then there was low possibility of failure occurring. Failures are classed as possible if between 25% and 50% of the contoured group is within the danger zone. If greater than 50% of the contoured set is within the danger zone, there is high possibility of failure occurring. The criterion does not take into account persistence or volume of potential failures.

5.4.1.1 Planar Sliding

The geometrical conditions that allow sliding along a single planar failure are as follows:

- Dip direction of the planar discontinuity must be within ±20° of the dip direction of the slope face;
- Dip of the planar discontinuity must be less than dip of the slope face and will therefore "daylight" in the face;
- Dip of the planar discontinuity must be greater than the angle of friction of the surface;
- The lateral extent of the potential failure mass must be defined by lateral release surfaces, which provide negligible resistance to sliding or by a convex slope shape.

A planar sliding test stereographic plot example is shown in Figure 8 below. The results of the planar sliding tests are summarized in Table 5.

Figure 8: Planar Sliding Stereographic Plot

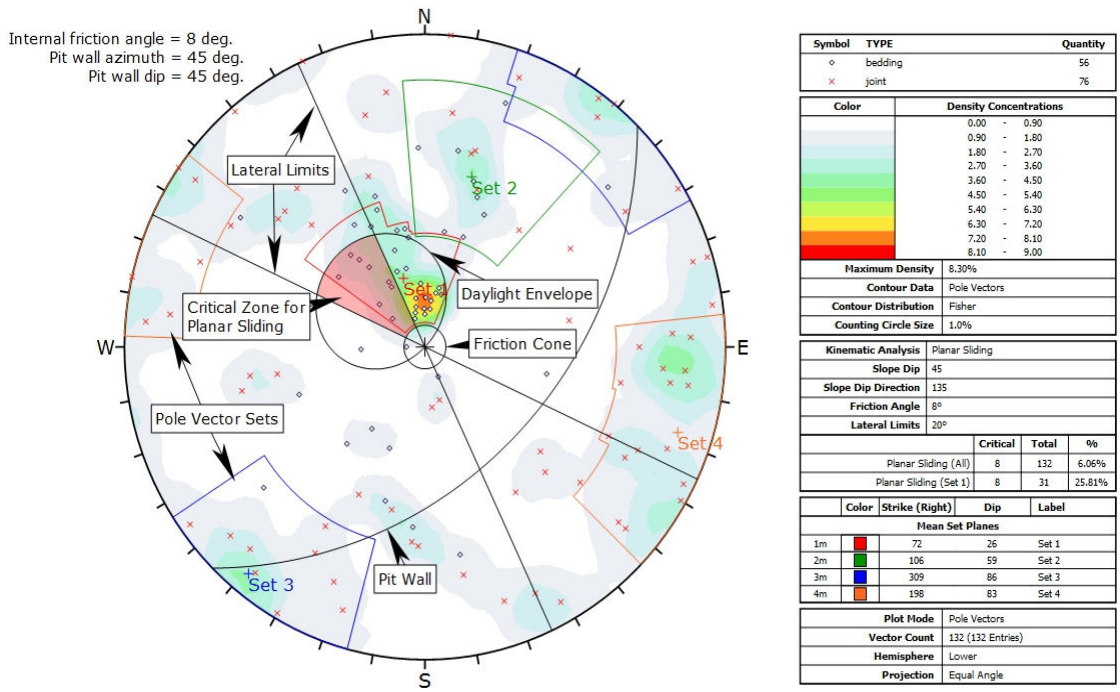


Table 6: Percentage of significant pole vectors in the planar sliding danger zone.

	φ = 8 deg.				φ = 13 deg.				φseismic = 6 deg.			
Pit Slope Azimuth (deg) \ Pit Slope Dip (deg)	45	40	35	30	45	40	35	30	45	40	35	30
45	26	19	13	13	26	19	13	13	26	19	13	13
90	58	52	45	45	52	45	39	39	58	52	45	45
135	0	0	0	0	0	0	0	0	0	0	0	0
180	0	0	0	0	0	0	0	0	0	0	0	0
225	0	0	0	0	0	0	0	0	0	0	0	0
270	0	0	0	0	0	0	0	0	0	0	0	0
315	0	0	0	0	0	0	0	0	0	0	0	0
360	0	0	0	0	0	0	0	0	0	0	0	0

1 - 25	- low possibility of failure
25 - 50	- possible failure
> 50	- high possibility of failure

5.4.1.2 Wedge Sliding

Results demonstrate that pit walls that strike at 45° to 90° North Eastern to Easterly have measurable risk of planar failure and need more geotechnical study after pit wall orientation.

The structural requirements necessary for wedge failure to occur are as follows:

- The trend of the line of intersection must be approximately the same as the dip direction of the slope face;
- The plunge of the line of intersection must be less than dip of the slope face and the line of intersection can therefore daylight on the face;
- The plunge of the line of intersection must be greater than the angle of friction for the surface. If the angle of friction for each plane is significantly different from one another, an average friction angle is applicable;
- The line of intersection must lie between the dip vectors of the bounding planes.

A wedge sliding test stereographic plot example is shown in Figure 9 below. The results of the wedge sliding kinematic tests are summarized in Table 6.

Figure 9: Wedge Sliding Stereographic Plot

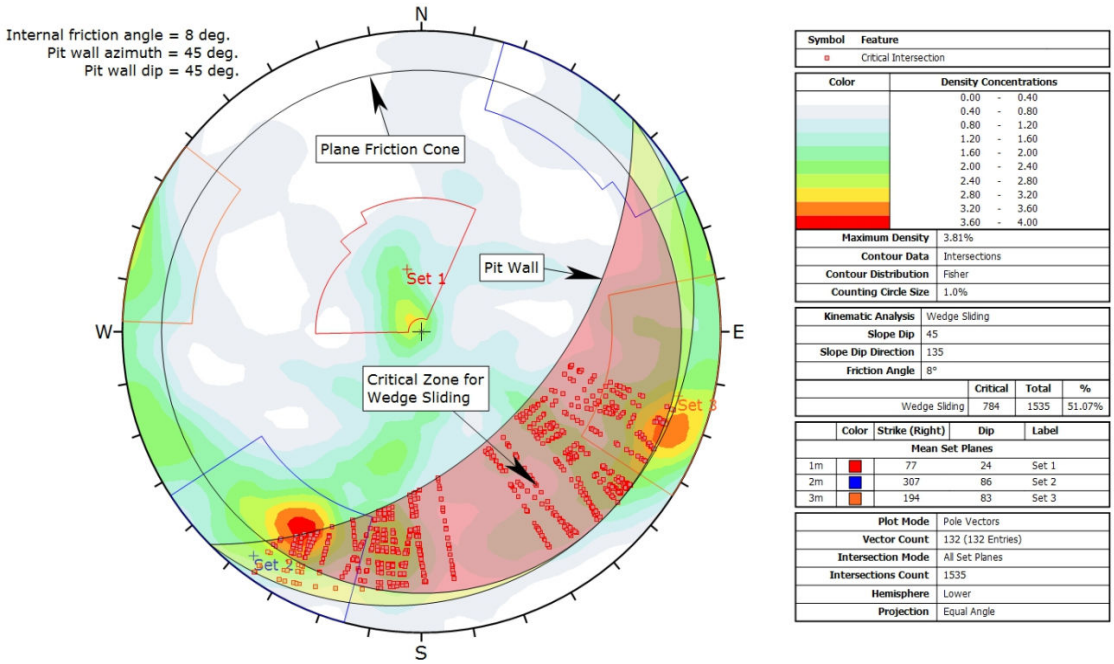


Table 7: Percentage of significant plane intersections in the wedge sliding danger zone.

	φ = 8 deg.				φ = 13 deg.				$\varphi_{seismic}$ = 6 deg.			
Pit Slope Azimuth (deg) \ Pit Slope Dip (deg)	45	40	35	30	45	40	35	30	45	40	35	30
45	41	35	31	25	32	27	22	17	43	37	33	27
90	56	50	45	40	47	41	35	30	57	52	46	41
135	36	32	29	25	30	26	23	19	37	33	30	26
180	15	13	11	8	10	8	7	4	16	14	12	9
225	0	0	0	0	0	0	0	0	0	0	0	0
270	0	0	0	0	0	0	0	0	0	0	0	0
315	4	3	2	1	2	1	1	0	6	4	3	3
360	18	16	14	12	13	11	9	7	22	20	18	16

1 - 25	- low possibility of failure
25 - 50	- possible failure
> 50	- high possibility of failure

These findings are similar to those for planar failures, but also extend to pit walls with southeasterly and northerly bearings.

5.4.1.3 Flexural Toppling

The structural conditions necessary for toppling failure to occur are as follows:

- The strike of the slabs must be approximately parallel to the slope face. The deviation in orientations used varies between 15° and 30°;
- The dip of the layers must be into the slope face;
- The normal to the toppling plane must have a plunge less than the inclination of the slope face, minus the friction angle for interlayer slip to occur;
- The lateral extent of the toppling failure is limited by zero-strength lateral release surfaces or a convex slope shape.

A flexural toppling test stereographic plot example is shown in Figure 10 below. The results of the flexural toppling kinematic tests are summarized in Table 7.

Figure 10: Flexural Toppling Stereographic Plot

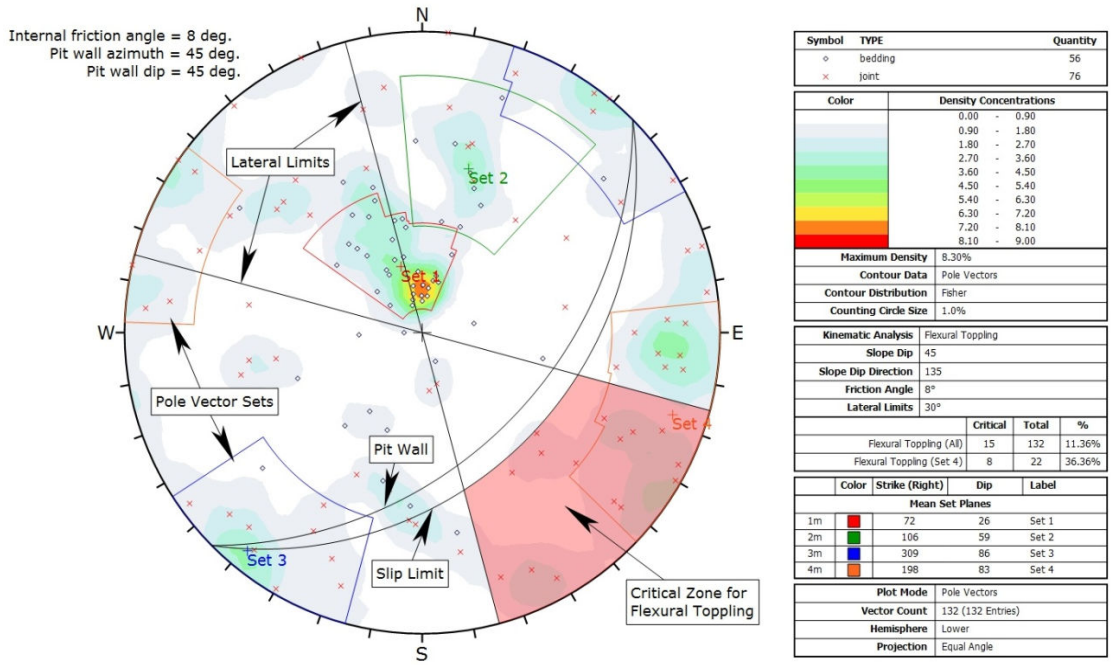


Table 8: Percentage of significant pole vectors in the flexural toppling danger zone.

	φ = 8 deg.				φ = 13 deg.				$\varphi_{seismic}$ = 6 deg.			
Pit Slope Azimuth (deg) \ Pit Slope Dip (deg)	45	40	35	30	45	40	35	30	45	40	35	30
45	36	36	36	32	36	36	32	32	36	36	36	32
90	29	29	29	24	29	29	24	18	29	29	29	24
135	59	59	59	53	59	59	53	47	59	59	59	53
180	18	18	18	18	18	18	18	18	18	18	18	18
225	14	14	14	14	14	14	14	14	14	14	14	14
270	62	46	46	15	46	46	15	15	69	54	46	15
315	41	41	41	41	41	41	41	41	46	41	41	41
360	64	64	64	55	64	64	55	45	64	64	64	55

1 - 25	- low possibility of failure
25 - 50	- possible failure
> 50	- high possibility of failure

Most pit wall and bench wall west zones will have same risks of flexural toppling. This hazard can be mitigated with catchment benches.

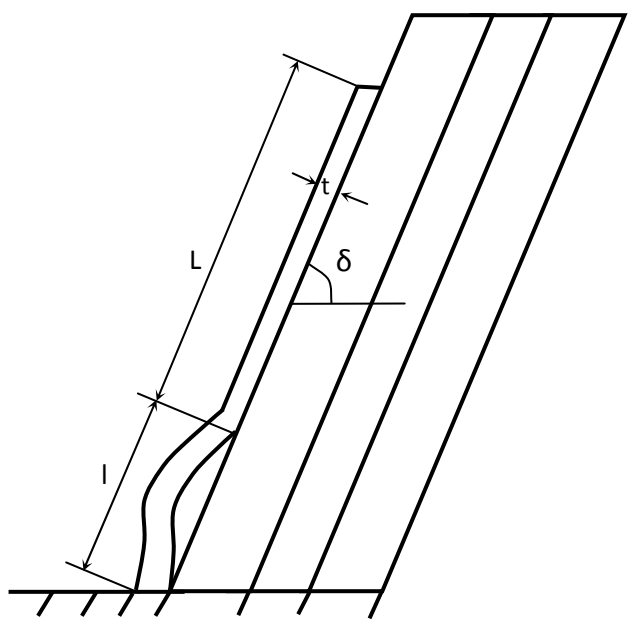
5.4.2 Buckling Analysis

Buckling analysis is applicable for open pit slopes that are congruent with footwall structures, especially footwall structures with angles measured from the horizontal that exceed 45°. Ultimate pit wall slopes that follow dipping structures in the range of 45° to 70° are especially sensitive to this type of failure mechanism.

5.4.2.1 Buckling Theory

Figure 11 below shows a mode of failure in high dip slopes. In open cut mines, this behaviour is sometimes called a "footwall failure".

Figure 11: Footwall Failure



Buckling may occur on rock slopes in which one or more slabs are approximately parallel with the rock face. In general, the failure mechanism requires that the slope dips more steeply than the angle of internal friction along the discontinuity forming the slabs involved. Failure usually involves buckling of the slab near the toe of the slope followed by translational failure of the slab above the buckle.

To express the maximum length of slope L_{max} above the top of the buckling section such that failure does not occur the following assumptions are made:

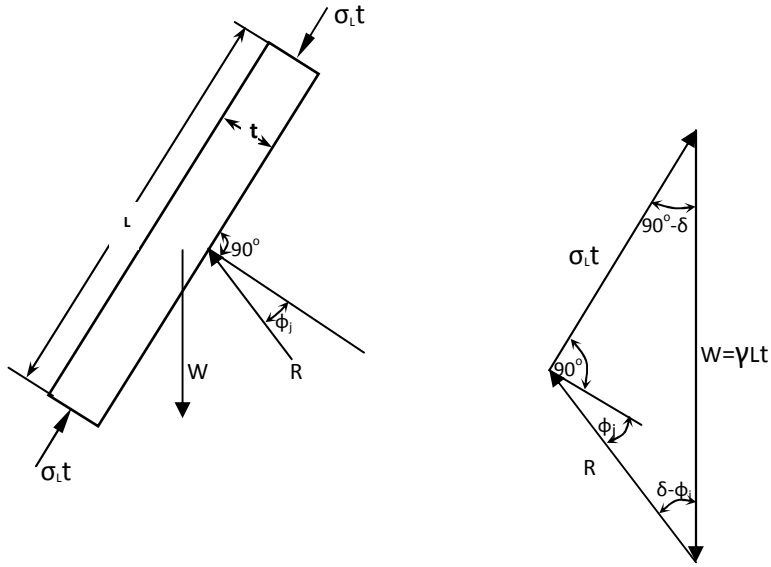
- Toe of slope is fully drained;
- Weight of the portion of the buckled column, represented by length **l** is negligible;
- Column is elastic and obeys Hook's Law;
- Column is straight.

According to the theory discussed in most books on strength of materials, buckling occurs when σ_L, the stress parallel to the axis of a column, reaches Euler's critical stress for buckling σ_E:

$$\sigma_E = \frac{\pi^2 E t}{3 l^2} \qquad (1)$$

The free body diagram defines the force polygon, which yields

$$\sigma_L = \frac{\gamma L \sin(\delta - \varphi_j)}{\sin(90 + \varphi_j)} \qquad (2)$$



The condition for initiation of failure is met if $\sigma_L = \sigma_E$, giving

$$L_{\max} = \frac{\pi^2 Et}{3l^2} \frac{\sin(90+\varphi_j)}{\gamma \sin(\delta - \varphi_j)} \qquad (3)$$

where:

- L_{max} [m] is the maximum length of slope above the top of the buckling section;
- l [m] is the length of the buckling section;
- t [m] is the thickness of the buckling section;
- E [MPa] is the Young's modulus;
- γ [MN/m^3] is the unit weight;
- φ_j [deg] is the discontinuities angle of internal friction;
- δ [deg] is the slope angle.

Application of Euler's Formula requires certain additional assumptions:

The ratio of the length of slope subject to buckling ***l*** to the total slope length L_{max}+***l*** must be assumed. Base friction model tests on a material with modulus-strength ratios much lower than rock, have given the following results:

1) ***l***/(L_{max}+***l***)= 0.46 for a slab slightly too thick to buckle.

2) ***l***/(L_{max}+***l***)= 0.36 for a slab thinner than that required for buckling.

These results should form upper and lower bounds on ***l***/(L_{max}+***l***) for the conditions and materials used. It will be assumed that ***l***/(L_{max}+***l***) in rock is 0.50, or, ***l*** = L_{max}.

Substituting ***l*** with L_{max} in (3), yields

$$L_{\max}^3 = \frac{\pi^2 E t^2}{3} \frac{\sin(90+\varphi_j)}{\gamma \sin(\delta - \varphi_j)} \quad (4)$$

5.4.2.2 Buckling Sensitivity Theory Application to Arctos Open Pit

The following model parameters were used in the analysis:

- Bedding was represented by 0.25 m to 3.75 m thick beds;
- Internal friction angle varied from 20° to 40°;
- Unit weight ranged from 0.0250 MN/m^3 for the sandstone to 0.0251 MN/m^3 for the mudstone;
- Young's modulus was 980 MPa for the sandstone and 222 MPa for the mudstone;
- The maximum pit wall slope length at the 10th year of pit development was approximately 400 m.

The total length of slope (2L_{max}) for the Arctos 10 year open pit development was calculated for φ_j varying from 20^0 to 40^0 and ***t*** varying from 0.25 m to 3.75 m. The factors of safety (**FOS**) for mudstone and sandstone pit walls were also derived from the ratio of calculated slope lengths and designed slope length.

The results are shown in Table 9 and Table 10. Sensitivity charts for mudstone and sandstone pit walls are created from equation (4) calculations and are presented in Figure 12 and Figure 13 as shown below.

Factors of safety against buckling failure are smaller for the mudstone pit walls and higher for the sandstone pit walls because of more unfavourable mudstone physical parameters.

These sensitivity analyses also show that the factors of safety are sensitive to thinly bedded strata.

Table 9: Mudstone Pit Wall Sensitivity Calculations

Constants:

E, *MPa*	222	Sandstone Young's modulus
γ, *MN/m³*	0.0251	Sandstone Unit Weight
δ, *deg*	45	Designed Slope Angle
L_{design} , *m*	400.0	Designed Slope Length

Variables:

φ_j, *deg*	20 - 40	Discontinuities angle of internal friction
t, *m*	0.25 - 3.75	Thickness of the buckling section

φ_j, *deg*	20			30			40		
t, *m*	L_{max}, *m*	**L**, *m*	**FOS**	L_{max}, *m*	**L**, *m*	**FOS**	L_{max}, *m*	**L**, *m*	**FOS**
0.25	15.9	31.9	0.1	18.3	36.5	0.1	25.2	50.4	0.1
0.75	33.1	66.3	0.2	38.0	76.0	0.2	52.4	104.8	0.3
1.25	46.6	93.2	0.2	53.4	106.8	0.3	73.7	147.3	0.4
1.75	58.3	116.6	0.3	66.8	133.6	0.3	92.2	184.4	0.5
2.25	68.9	137.9	0.3	79.0	158.0	0.4	109.0	218.0	0.5
2.75	78.8	157.6	0.4	90.3	180.6	0.5	124.6	249.2	0.6
3.25	88.1	176.2	0.4	100.9	201.9	0.5	139.3	278.5	0.7
3.75	96.9	193.8	0.5	111.0	222.1	0.6	153.2	306.4	0.8

Calculated Values:

L_{max} Maximum length of slope above the buckling section (equation 4)

$$L_{max}^3 = \frac{\pi^2 E t^2}{3} \frac{\sin(90+\varphi_j)}{\gamma \sin(\delta - \varphi_j)}$$

L, *m* Calculated slope length for FOS = 1 (***L*** = 2***L***$_{max}$)

FOS Calculated Factor of Safety (FOS = ***L*** / ***L***$_{design}$)

Table 10: Sandstone Pit Wall Sensitivity Calculations

Constants:

E, *MPa*	980	Sandstone Young's modulus
γ, *MN/m³*	0.0250	Sandstone Unit Weight
δ, *deg*	45	Designed Slope Angle
L_{design} , *m*	400.0	Designed Slope Length

Variables:

φ_j, *deg*	20 - 40	Discontinuities angle of internal friction
t, *m*	0.25 - 3.75	Thickness of the buckling section

φ_j, *deg*	20			30			40		
t, *m*	L_{max}, *m*	**L**, *m*	**FOS**	L_{max}, *m*	**L**, *m*	**FOS**	L_{max}, *m*	**L**, *m*	**FOS**
0.25	26.2	52.3	0.1	30.0	60.0	0.1	41.4	82.8	0.2
0.75	54.4	108.9	0.3	62.4	124.8	0.3	86.1	172.1	0.4
1.25	76.5	153.0	0.4	87.7	175.4	0.4	121.0	242.0	0.6
1.75	95.8	191.5	0.5	109.7	219.5	0.5	151.4	302.8	0.8
2.25	113.2	226.5	0.6	129.8	259.5	0.6	179.0	358.1	0.9
2.75	129.4	258.9	0.6	148.3	296.7	0.7	204.7	409.3	1.0
3.25	144.7	289.4	0.7	165.8	331.6	0.8	228.8	457.5	1.1
3.75	159.2	318.3	0.8	182.4	364.8	0.9	251.7	503.3	1.3

Calculated Values:

L_{max} Maximum length of slope above the buckling section (equation 4)

$$L_{max}^3 = \frac{\pi^2 E t^2}{3} \frac{\sin(90+\varphi_j)}{\gamma \sin(\delta - \varphi_j)}$$

L, *m* Calculated slope length for FOS = 1 (***L*** = 2L_{max})

FOS Calculated Factor of Safety (FOS = ***L*** / L_{design})

Figure 12

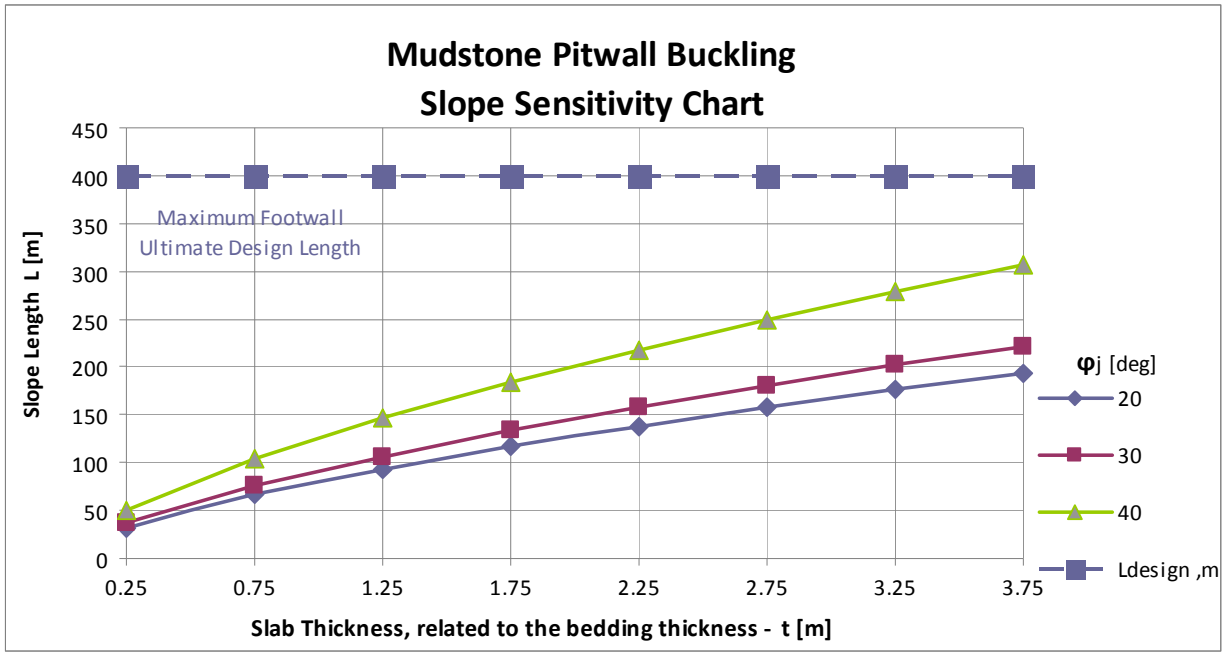
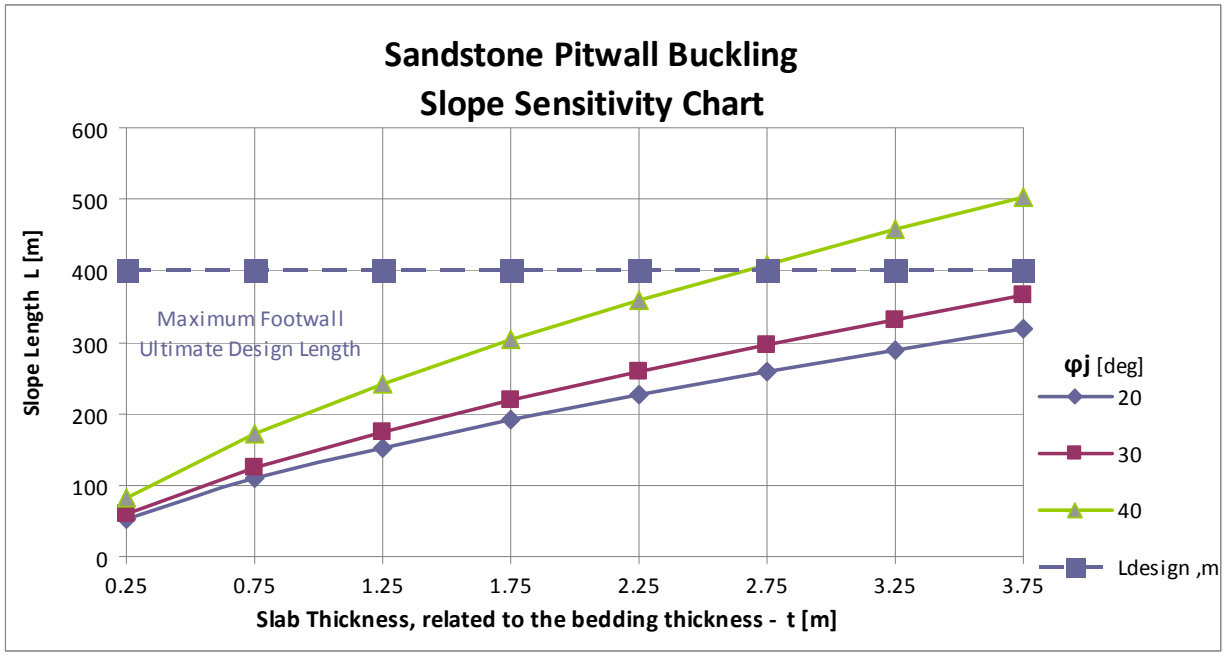


Figure 13



Note: The sensitivity curves present the slab thickness versus the length of the pit wall slope for a factor of safety of one.

5.5 Discussion

The results of the kinematic and buckling analyses indicate that:

- The most unfavourable pit wall azimuths are from 60° to 105° due to the relatively high risk of planar and wedge sliding. Risk of flexural toppling is shown by pit walls with orientation from 355° to 35°.

- Depending on the slab thicknesses, pit wall mudstone and sandstone slabs are sensitive to buckling if the exposed footwall has a length exceeding 50 m and 80 m respectively.

This preliminary sensitivity study demonstrates that the risk of planar and wedge failure, given the pit wall orientation and fracture data, is moderate to high. Further fracture data from outcrops and oriented core is needed to better assess the stability conditions. The analyses are based on data sufficient for sensitivity assessment only. More detailed analyses based on supplemental field and laboratory test data should follow. There is also a need to ensure catchment bench designs, pit mapping, performance evaluation protocols and instrumentation protocols (strain and pore pressure monitoring systems) are established as design and development proceed. Further recommendations are discussed in Section 7.0.

6.0 EXTERNAL WASTE STRUCTURES

6.1 Background and Approach

All soil and rock waste generated by open pit operations is to be stored in an environmentally sound, safe and secure manner in permanent storage facilities located externally and internally to the ultimate pit. A waste characterization program was completed by Hardy Associates to predict the reactivity of waste rock and overburden materials from the open pit. A total of approximately 1,131 million bcm of waste material will be produced over the mine life.

Subsurface investigations have been carried out at the waste rock storage structure areas in order to provide geotechnical information on the subsurface, ie foundation conditions for the waste structures. Those subsurface investigations included initial drilling of 9 boreholes in the waste rock storage area and conducting SPTs in those holes. Laboratory testing on selected overburden samples was completed subsequent to the drilling. The out of pit structure footprints are displayed in Figure 2, Appendix A.

Stability analyses have been carried out for the waste rock storage structures south and east of the proposed pit locations. Analyzed profiles are shown in Figure 14 in Appendix A. These test profiles were selected to provide the most critical geometric conditions for stable slopes. These geometries are represented by maximum topographic slopes, (ie foundation slopes), and maximum storage structure relief.

6.2 Geologic Setting

6.2.1 Location and Topography

The waste rock structures are proposed to be located immediately across the valley to the south and east of the proposed pits. A plan showing the locations of the waste rock structure footprints is included as Figure 2 in Appendix A. Natural slopes of the proposed waste rock area range from flat to 8% with relief up to 110 m. There are numerous ponds (probably kettles) and drainage creeks within the footprints, some of which may be ephemeral. The topography of the footprint area on the south side of the pit generally slopes towards the pit.

6.2.2 Surficial Geology

The surficial geology of the AAJV project area is characterized by glacial deposits and rock outcrops (Geologic Survey of Canada, Surficial Materials of Canada). The glacial deposits consist of sandy, silty, clayey till ranging from thick and continuous to thin and discontinuous. The alpine complexes (abundant rock outcrop) consist of rock, alluvium and till characterized by alpine and glacial landforms. In spite of the elevation and northern latitude there are no obvious displayed characteristics supportive of periglacial and/or discontinuous permafrost such as solifluction lobes, stoney circles or pingos in the mine area. Initial reference suggest the area may contain discontinuous permafrost.

Table 11 in Appendix B summarizes the surficial geology encountered in the 2013 boreholes.

6.2.3 Groundwater/Meteorological Conditions

Based on the drilling completed in the summer of 2013, groundwater within the waste rock structures footprint may be encountered between 0.8 m and 38.9 m below ground surface (Stantec). Groundwater level data are only available for 5 out of the 9 boreholes that are located within the footprints of the waste rock structures.

Based on the numerous streams/creeks and ponds (kettles) that are found within the waste structure footprints (see Figure 2), it appears that the soil column is essentially saturated in these areas.

Accessible precipitation data for the region was limited, but a brief discussion of local meteorological data can be found in Appendix G. Based on the available data, it is believed that the low-moderate amount of local precipitation does not pose a significant threat to stability of the waste structures provided appropriate criteria to encourage run-off are incorporated into the dump designs and construction protocols.

6.3 Slope Stability Analysis

Should the rock structures be constructed using conventional methods of the mountain coal mines, it is highly expected that segregation of the waste rock would occur due to placement mechanism from end dumping.

Weaker zones within the pit contain portions of sand and gravel rather than rock. These zones will control the strength properties of the waste rock materials in the waste structure therefore a conservative friction angle of 30° was used in the slope stability analysis. This strength value is reasonably consistent with research studies on waste rock failures associated with mountain coal mines in Western Canada. See Appendix H for further elaboration.

Subsurface investigations have been carried out at the waste rock storage structure locations in 2013 and the stability analyses were recalculated in order to include the new information obtained from these investigations. The location of the waste rock structures is shown in Figure 2 in Appendix A, and is based on the latest waste rock dump design from Golder.

6.3.1 Foundation Conditions and Waste Material Properties

A total of 9 boreholes have been drilled in the waste rock storage structure areas by Driftwood Drilling Ltd. All the boreholes were drilled between July and October of 2013 and no permafrost was identified in the overburden. The thickness of overburden ranged from 0.5 m to 15 m and consisted of sand, clay and organics in different portions. Table 11 presents the depth and description of the lithology in the overburden observed in these 9 boreholes.

6.3.2 Design Criteria

The slope stability analyses were conducted for the design criteria reported in the Golder 2012 Mine Feasibility Study update:

- Overall effective slopes 4H:1V;
- Individual bench angle 37°;
- Bench width: 54 m;
- Bench height: 20 m.

Several industry guidelines were examined for acceptable factors of safety under static and dynamic conditions.

The Canadian Dam Association's Dam Safety Guidelines were used to establish the criteria for the calculated slope stability analysis. For dams and embankments, the minimum long term factor of safety should be 1.5, and the minimum earthquake factor of safety should be 1.1.

The investigation and design manual/interim guidelines prepared by British Columbia Mine Waste Rock Pile Research Committee, suggests 1.5 for static factor of safety and 1.1-1.3 for earthquake factor of safety to be used for long term stability.

Finally, several intensive geotechnical research studies conducted over many years on coal mine waste rock failures in Wales (Aberfan) and Western Canada, support factors of safety of 1.3 to 1.5 for static conditions. These studies are discussed in Appendix H.

Based on these guidelines, a 1.5 minimum acceptable value for long term factor of safety and a minimum value 1.1 for earthquake factor of safety, were used in the analyses conducted in this study.

6.3.3 Potential Failure Modes

Rotational failure of the foundation and waste rock storage slopes, which is a mass failure of the foundation or waste embankments along a circular or curvilinear failure surface, has been addressed in this report. Weak or fine grained materials excavated

from the overburden or the weak layers, commonly cause this type of failure due to the low friction angle of those materials.

Also those materials have a low permeability which increase the pore water pressure; therefore, it is highly recommended to place weak and fine materials in the core of the dump and coarse materials in the dump perimeter to ensure that the rock structures are as free draining as possible.

The following are other slope failure modes that were not included in Terracon's current scope of work but should be addressed in the future:

- Edge Slumping
- Plane failure
- Flows

Potential foundation failure modes that were not included in Terracon's current scope of work but that should be addressed in the future:

- Non-rotational failure
- Wedge failure
- Base translation
- Liquefaction
- Toe failure

6.3.4 Analysis Methodology

Slope stability analyses were conducted using Geo-Studio SLOPE/W software to determine the factor of safety against slope failure of the waste rock storage structures. The Morgenstern-Price method was used in the analysis. A total of 6 profiles were selected through the waste rock structure to represent the steepest ground slope and design line of the dump. For pore water pressure, it was inferred that the piezometric surface be at the top of the overburden layer and that the waste rock material was fully drained.

The slope stability analyses were modeled by considering the bedrock as impenetrable for all 6 profiles. Another model considered the bedrock to be fractured with a friction angle of 38° and a unit weight of 24 kN/m³ in order to check the design performance in a worst case scenario.

The material properties used for slope stability analyses are presented in Table 12 in Appendix B. These are based on historical properties reported by Hardy as well as the 2013 laboratory testing program conducted by Terracon.

Figure 15 in Appendix A presents a typical model profile for the waste rock storage structures.

6.3.5 Results

Slope stability analyses were executed for the overall waste rock storage structures using the circular failure mode. Index testing and engineering judgement have been used in estimating the friction angle for waste materials and the bedrock.

The stability analyses were modeled using ϕ-value of 30° for the waste rock materials and ϕ-value of 38° for the in-situ overburden foundation materials. These values are consistent with values used in previous analyses and with values employed in Western Canadian mountain coal operations. See Appendix H.

The factors of safety calculated were consistently greater than 1.7 and indicate long term slope stability. When earthquake loading was applied to the profiles, a lower factor of safety of 1.5 was obtained.

7.0 CONCLUSIONS AND RECOMMENDATIONS

Based on the available historical data, research studies at other similar mountain coal properties and the data gathered during the 2013 field and laboratory programs, slope stability was modelled using the proposed pit wall and waste structure designs.

Based on the preliminary analysis of the pit wall slope stability, the risk of potential structural failures ranges from low to moderate to high for certain slopes when applied to the current design. There are measured risks of failures of a structural nature and this risk protocol needs to be followed up for better pit wall definition. Therefore the current pit wall design should not be altered at this point until further data are acquired.

It is recommended that:

- Systematic surface structural mapping of joints and fractures be performed;
- Oriented core be used to identify structural patterns in the core in selected pit walls;
- Data input from oriented core and outcrop structure mapping be used to further refine pit slope and pit catchment bench designs;
- Pointload and uniaxial tests be performed for the units in the pit walls;
- Triple tube coring should be used to collect bentonite and carbonaceous samples;
- Existing historical structural data be recovered in digital format - as current format cannot be manipulated;
- Classical observational and performance monitoring of pit walls during operation be instituted to refine the pit wall design and bench designs as mining progresses.

The analyses of the overall slopes of the waste rock structures indicate the slopes are stable in the long term (factor of safety greater than 1.5). In order to conduct more detailed analysis and incorporate footprints of all the waste structures, the proposed 2014 field and laboratory program includes the waste storage areas.

The construction protocols of the waste storage areas have a significant impact on achieving stable waste structures. It is recommended that waste construction protocols

be formulated that focus on creating stable structures such as are followed in the oil sand mining and other mining sectors.

Waste structure construction should avoid end dumping and recognize that waste structures with steep natural foundation slopes require a controlled and documented density construction method. One best practice is to deposit weaker waste materials within the centre of the waste structure. Water and snow management controls should be a key element in waste structure design.

Foundation and groundwater conditions need further definition for the waste structure footprints. Recommendations for additional boreholes in these areas include those presented in Table 13 in Appendix B and Figure 16 in Appendix A. A waste storage structure foundation drainage and surface water control system should be incorporated into the final design.

8.0 CLOSURE

We trust this draft report meets your present requirements and would appreciate your comments. If you have any questions, please do not hesitate contact the undersigned.

Yours Sincerely,
TERRACON GEOTECHNIQUE LTD.

Partnerships IN HEALTH AND SAFETY

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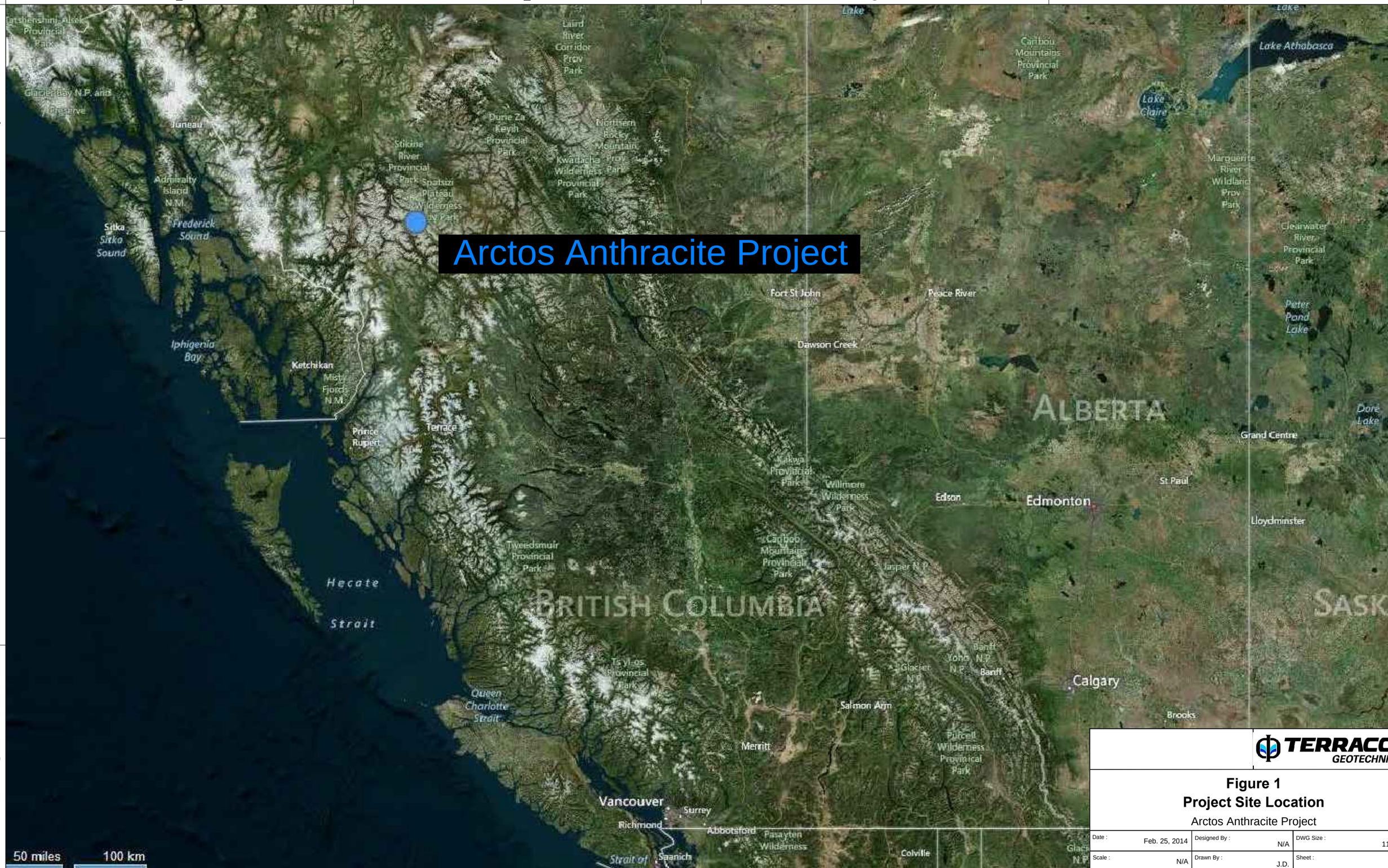
APPENDIX A

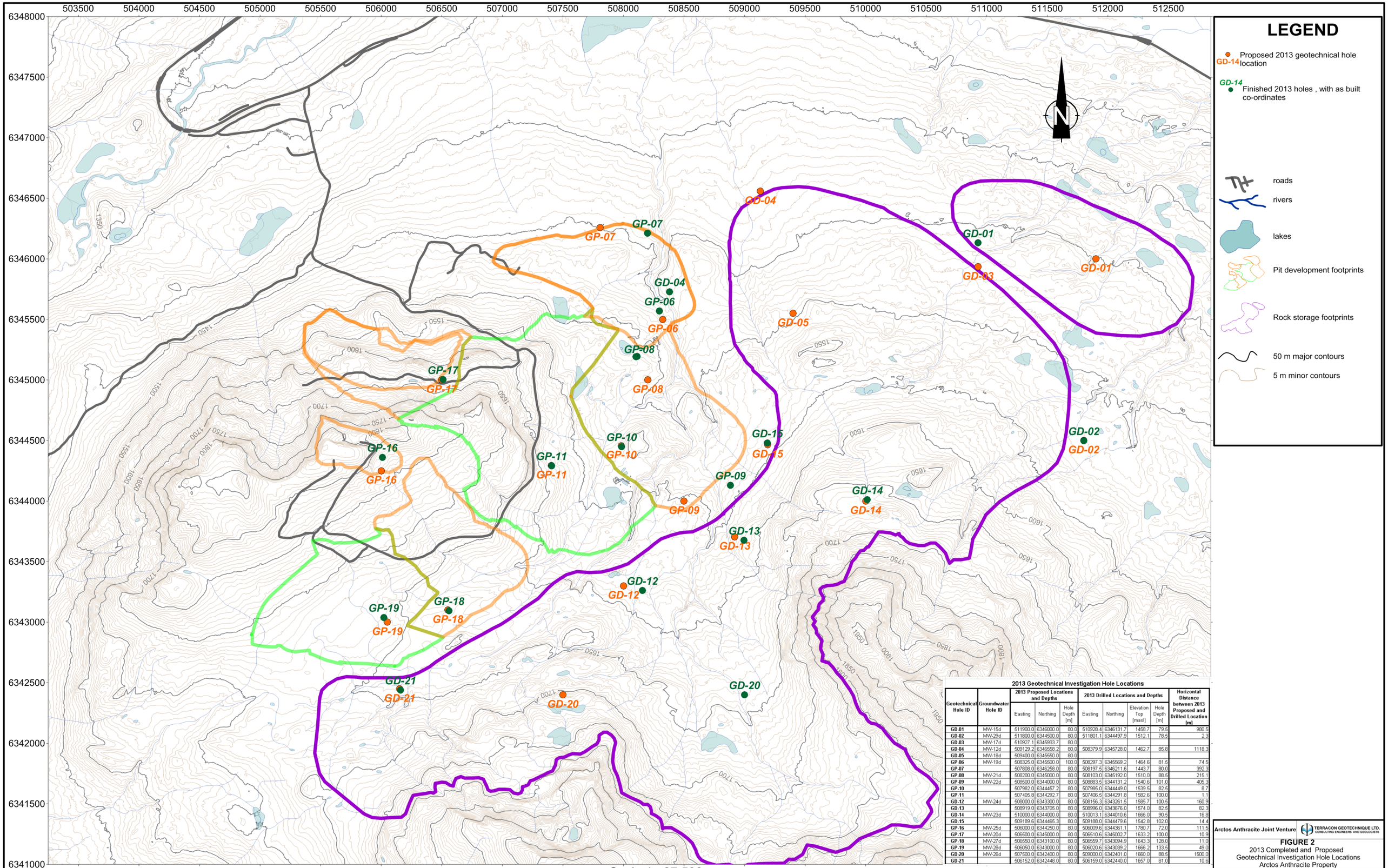
Figures



TERRACON GEOTECHNIQUE

Figure 1
Project Site Location
Arctos Anthracite Project

Date : Feb. 25, 2014	Designed By : N/A	DWG Size : 11 x 17in
Scale : N/A	Drawn By : J.D.	Sheet : 1 OF 1
Project No. : 122781	Reviewed By : B.K.	File Name : Figure 1.pdf



2013 Geotechnical Investigation Hole Locations

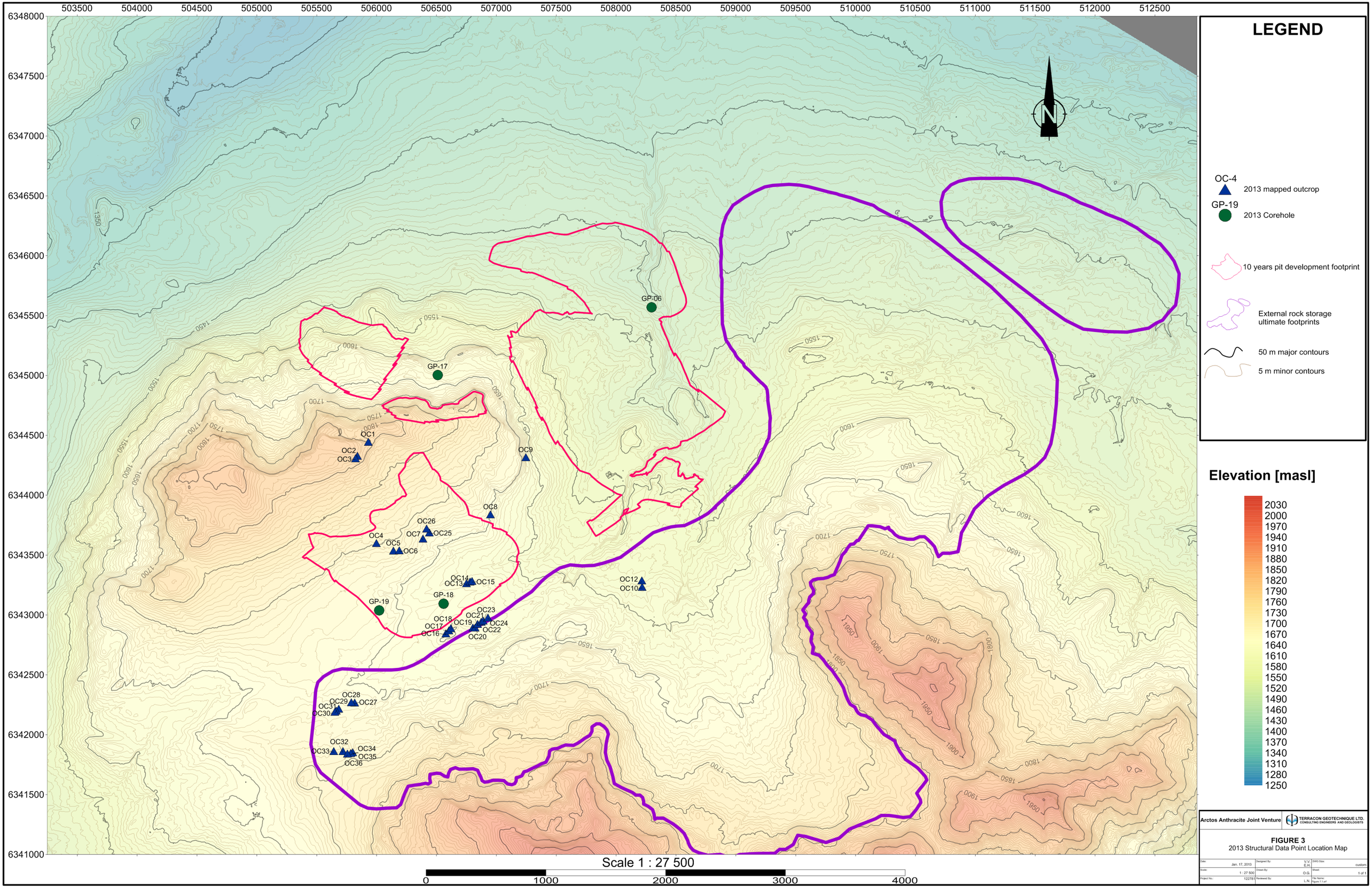
Geotechnical Hole ID	Groundwater Hole ID	2013 Proposed Locations and Depths			2013 Drilled Locations and Depths				Horizontal Distance between 2013 Proposed and Drilled Location [m]
		Easting	Northing	Hole Depth [m]	Easting	Northing	Elevation Top [masl]	Hole Depth [m]	
GD-01	MW-15d	511900.0	6346000.0	80.0	510928.4	6346131.7	1458.7	79.5	980.5
GD-02	MW-29d	511800.0	6344500.0	80.0	511801.1	6344497.9	1512.1	78.5	2.3
GD-03	MW-17d	510927.1	6345933.7	80.0					
GD-04	MW-12d	509129.2	6346658.2	80.0	508379.9	6345728.0	1462.7	85.6	1118.3
GD-05	MW-18d	509400.0	6345550.0	80.0					
GP-06	MW-19d	508325.0	6345500.0	100.0	508297.3	6345569.2	1464.6	81.5	74.5
GP-07		507808.0	6346258.0	80.0	508197.5	6346211.6	1443.7	80.0	392.3
GP-08	MW-21d	508200.0	6345000.0	80.0	508103.0	6345192.0	1510.0	88.5	215.1
GP-09	MW-22d	508500.0	6344000.0	80.0	508883.5	6344131.2	1540.6	101.0	405.3
GP-10		507982.0	6344457.2	80.0	507985.0	6344449.0	1539.5	82.5	8.7
GP-11		507405.8	6344292.7	80.0	507406.5	6344291.8	1582.6	100.0	1.1
GD-12	MW-24d	508000.0	6343900.0	80.0	508156.3	6343261.5	1585.7	100.5	660.9
GD-13		508919.0	6343705.0	80.0	508996.0	6343676.0	1574.0	82.5	82.3
GD-14	MW-23d	510000.0	6344000.0	80.0	510013.1	6344010.6	1666.0	90.5	16.8
GD-15		509189.6	6344465.3	80.0	509188.0	6344479.6	1542.8	102.0	14.4
GP-16	MW-25d	506000.0	6344250.0	80.0	506009.6	6344361.1	1780.7	72.0	111.5
GP-17	MW-20d	506500.0	6345000.0	80.0	506510.6	6345002.7	1633.2	100.0	10.9
GP-18	MW-27d	506550.0	6343100.0	80.0	506559.7	6343094.9	1643.3	126.0	11.0
GP-19	MW-28d	506050.0	6343000.0	80.0	506020.6	6343039.2	1666.2	133.5	49.0
GD-20	MW-26d	507500.0	6342400.0	80.0	509000.0	6342401.0	1660.0	88.5	1500.0
GD-21		506152.0	6342448.0	80.0	506159.0	6342440.0	1657.0	81.0	10.6

Arctos Anthracite Joint Venture

TERRACON GEOTECHNIQUE LTD.
CONSULTING ENGINEERS AND GEOLOGISTS

FIGURE 2
2013 Completed and Proposed
Geotechnical Investigation Hole Locations
Arctos Anthracite Property

Date:	Jan. 17, 2013	Designed By:	V.V. E.H.	DWG Size:	custom
Scale:	1 : 27 500	Drawn By:	O.G.	Sheet:	1 of 1
Project No.:	122781	Reviewed By:	L.N.	File Name:	ARCTOS FIGURE 2.wf

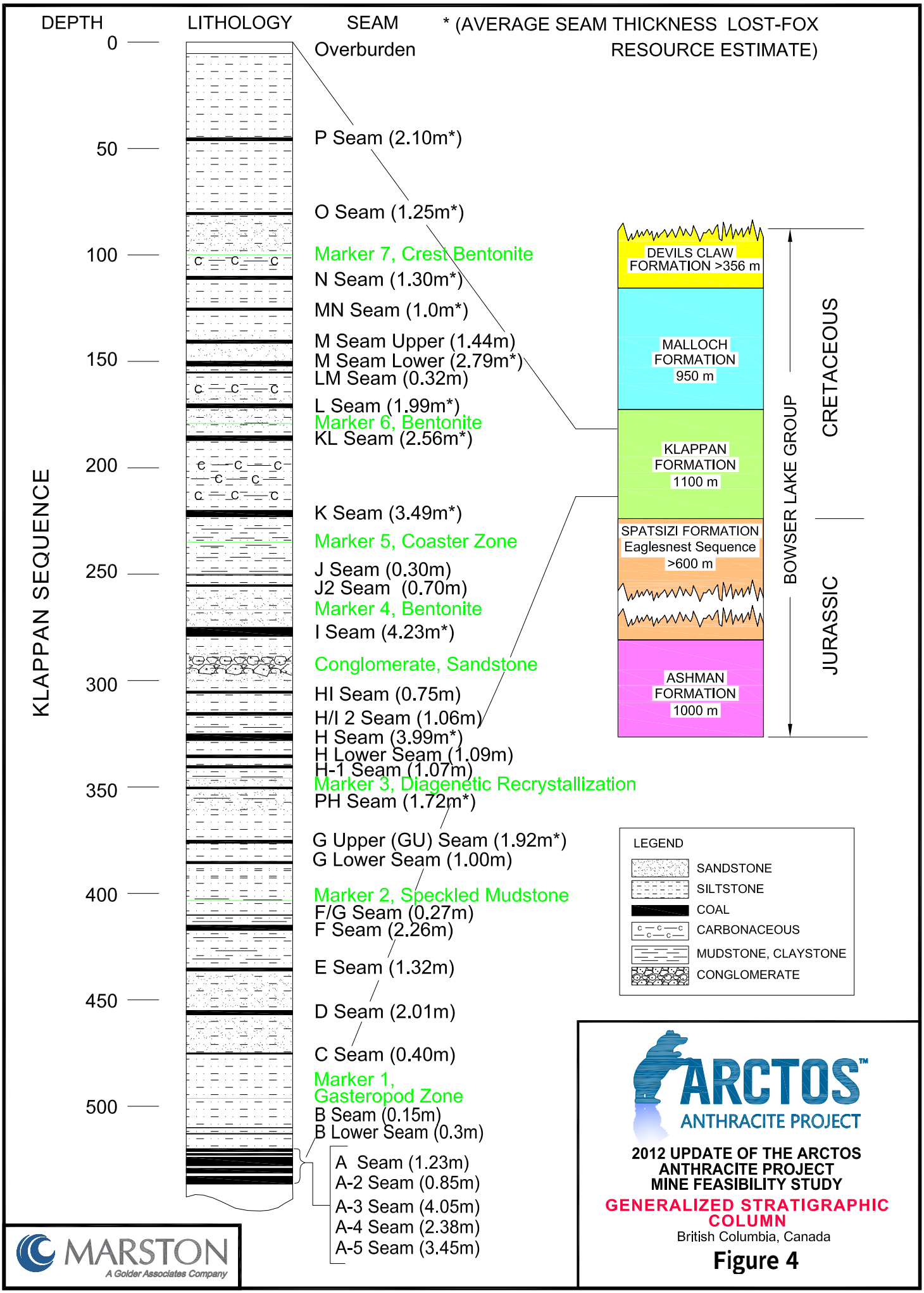


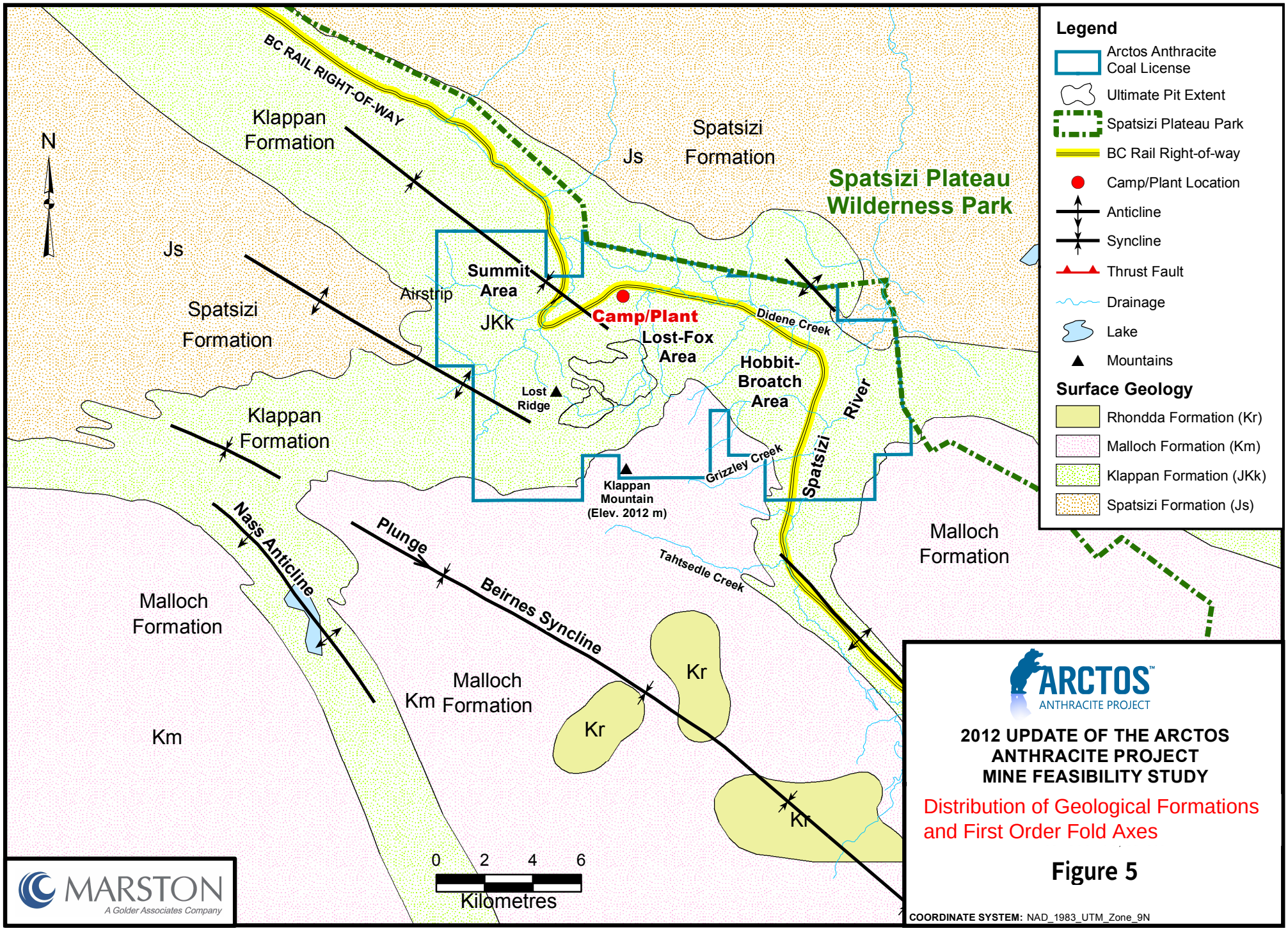
Arctos Anthracite Joint Venture

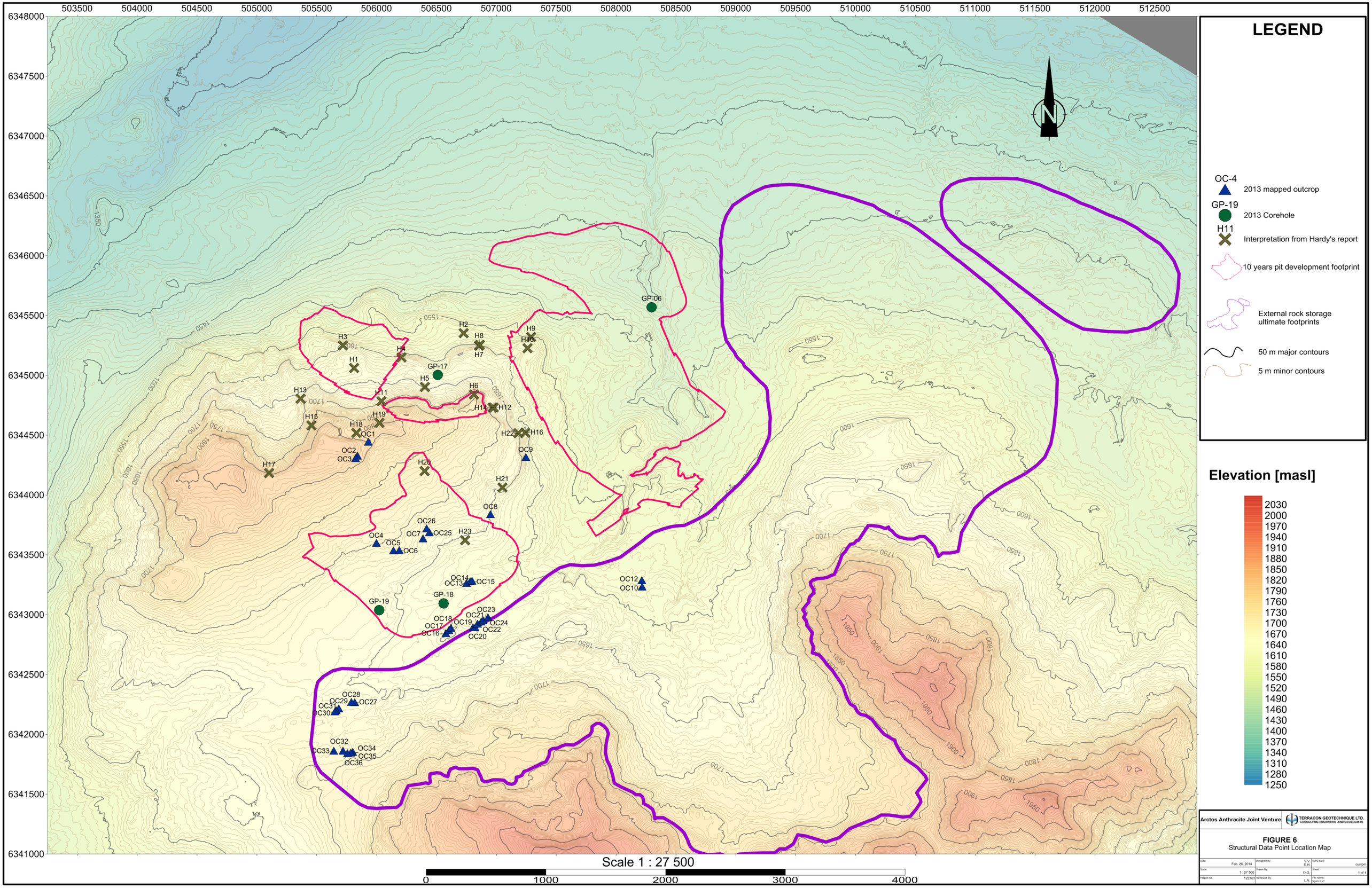
TERRACON GEOTECHNIQUE LTD.
CONSULTING ENGINEERS AND GEOLOGISTS

FIGURE 3
2013 Structural Data Point Location Map

Date:	Jan. 17, 2013	Designed By:	V.V. E.H.	DWG Size:	custom
Scale:	1 : 27 500	Drawn By:	O.G.	Sheet:	1 of 1
Project No.:	122781	Reviewed By:	L.N.	File Name:	Figure F1.1.wf


DEPTH
LITHOLOGY
SEAM
* (AVERAGE SEAM THICKNESS LOST-FOX RESOURCE ESTIMATE)
0
50
100
150
200
250
300
350
400
450
500
KLAPPAN SEQUENCE
Overburden
P Seam (2.10m*)
O Seam (1.25m*)
Marker 7, Crest Bentonite
N Seam (1.30m*)
MN Seam (1.0m*)
M Seam Upper (1.44m)
M Seam Lower (2.79m*)
LM Seam (0.32m)
L Seam (1.99m*)
Marker 6, Bentonite
KL Seam (2.56m*)
K Seam (3.49m*)
Marker 5, Coaster Zone
J Seam (0.30m)
J2 Seam (0.70m)
Marker 4, Bentonite
I Seam (4.23m*)
Conglomerate, Sandstone
HI Seam (0.75m)
H/I 2 Seam (1.06m)
H Seam (3.99m*)
H Lower Seam (1.09m)
H-1 Seam (1.07m)
Marker 3, Diagenetic Recrystallization
PH Seam (1.72m*)
G Upper (GU) Seam (1.92m*)
G Lower Seam (1.00m)
Marker 2, Speckled Mudstone
F/G Seam (0.27m)
F Seam (2.26m)
E Seam (1.32m)
D Seam (2.01m)
C Seam (0.40m)
Marker 1, Gasteropod Zone
B Seam (0.15m)
B Lower Seam (0.3m)
A Seam (1.23m)
A-2 Seam (0.85m)
A-3 Seam (4.05m)
A-4 Seam (2.38m)
A-5 Seam (3.45m)
DEVILS CLAW FORMATION >356 m
MALLOCH FORMATION 950 m
KLAPPAN FORMATION 1100 m
SPATSIZI FORMATION Eaglesnest Sequence >600 m
ASHMAN FORMATION 1000 m
BOWSER LAKE GROUP
CRETACEOUS
JURASSIC
LEGEND
SANDSTONE
SILTSTONE
COAL
CARBONACEOUS
MUDSTONE, CLAYSTONE
CONGLOMERATE
ARCTOS™
ANTHRACITE PROJECT
2012 UPDATE OF THE ARCTOS ANTHRACITE PROJECT MINE FEASIBILITY STUDY
GENERALIZED STRATIGRAPHIC COLUMN
British Columbia, Canada
Figure 4
MARSTON
A Golder Associates Company


Legend
Arctos Anthracite Coal License
Ultimate Pit Extent
Spatsizi Plateau Park
BC Rail Right-of-way
Camp/Plant Location
Anticline
Syncline
Thrust Fault
Drainage
Lake
Mountains
Surface Geology
Rhondda Formation (Kr)
Malloch Formation (Km)
Klappan Formation (JKk)
Spatsizi Formation (Js)
N
BC RAIL RIGHT-OF-WAY
Klappan Formation
Spatsizi Formation
Js
Spatsizi Plateau Wilderness Park
Summit Area
Airstrip
JKk
Camp/Plant
Lost-Fox Area
Didene Creek
Hobbit-Broatch Area
Lost Ridge
Klappan Mountain (Elev. 2012 m)
Grizzley Creek
Spatsizi River
Tahtsedle Creek
Nass Anticline
Plunge
Beirnes Syncline
Malloch Formation
Km
Kr
0 2 4 6
Kilometres
ARCTOS ANTHRACITE PROJECT
2012 UPDATE OF THE ARCTOS ANTHRACITE PROJECT MINE FEASIBILITY STUDY
Distribution of Geological Formations and First Order Fold Axes
Figure 5
COORDINATE SYSTEM: NAD_1983_UTM_Zone_9N
MARSTON
A Golder Associates Company


LEGEND
OC-4
2013 mapped outcrop
GP-19
2013 Corehole
H11
Interpretation from Hardy's report
10 years pit development footprint
External rock storage ultimate footprints
50 m major contours
5 m minor contours
Elevation [masl]
2030
2000
1970
1940
1910
1880
1850
1820
1790
1760
1730
1700
1670
1640
1610
1580
1550
1520
1490
1460
1430
1400
1370
1340
1310
1280
1250
N
Scale 1 : 27 500
0
1000
2000
3000
4000
503500
504000
504500
505000
505500
506000
506500
507000
507500
508000
508500
509000
509500
510000
510500
511000
511500
512000
512500
6348000
6347500
6347000
6346500
6346000
6345500
6345000
6344500
6344000
6343500
6343000
6342500
6342000
6341500
6341000
GP-06
GP-17
GP-18
GP-19
H1
H2
H3
H4
H5
H6
H7
H8
H9
H10
H11
H12
H13
H14
H15
H16
H17
H18
H19
H20
H21
H22
H23
OC1
OC2
OC3
OC4
OC5
OC6
OC7
OC8
OC9
OC10
OC12
OC13
OC14
OC15
OC16
OC17
OC18
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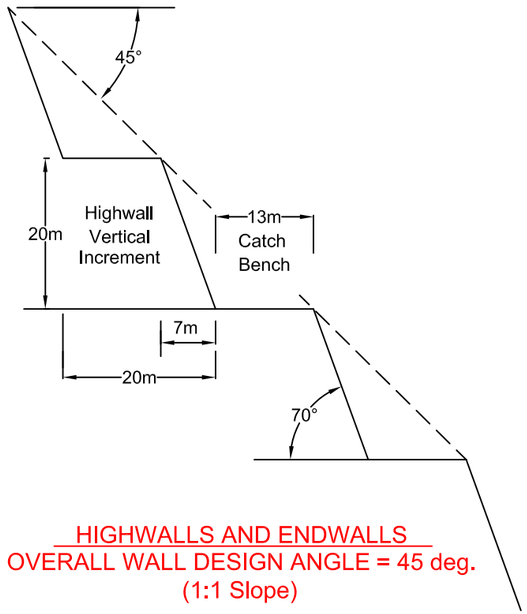
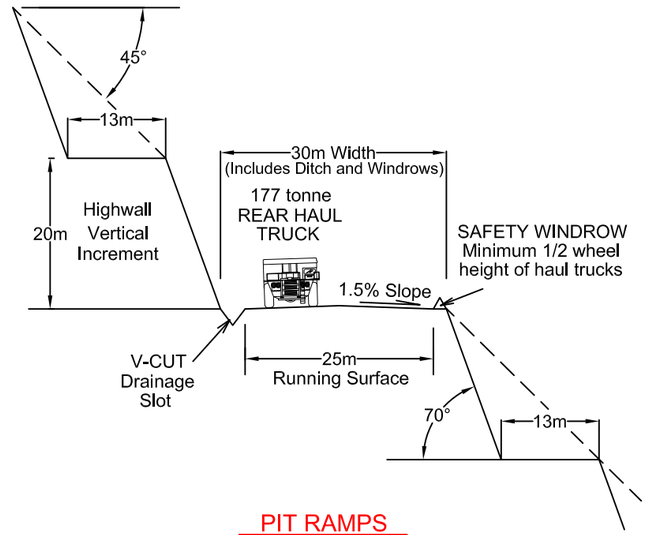
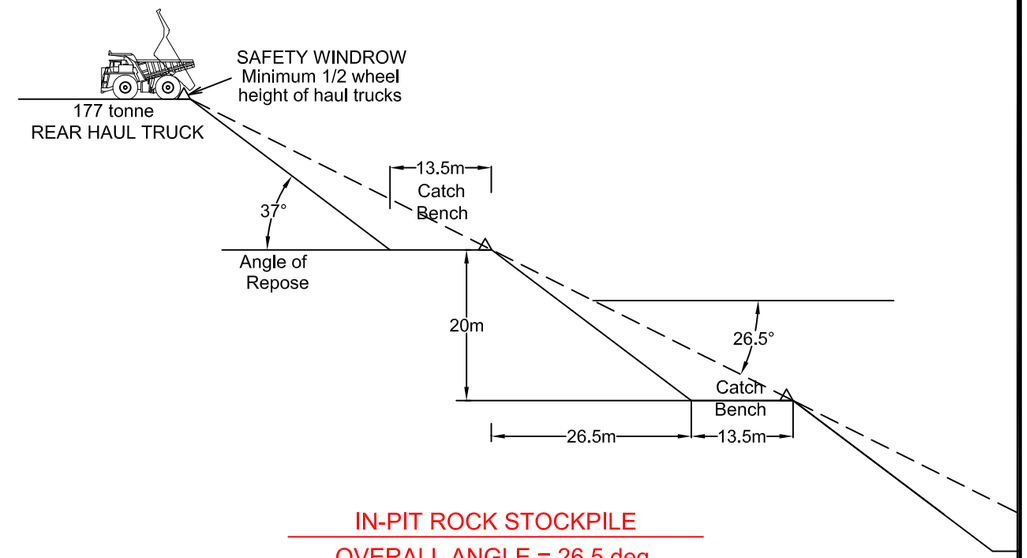
OC20
OC21
OC22
OC23
OC24
OC25
OC26
OC27
OC28
OC29
OC30
OC31
OC32
OC33
OC34
OC35
OC36
Arctos Anthracite Joint Venture
TERRACON GEOTECHNIQUE LTD.
CONSULTING ENGINEERS AND GEOLOGISTS
FIGURE 6
Structural Data Point Location Map
Date: Feb. 26, 2014
Designed By: V.V. E.H.
DWG Size: custom
Scale: 1 : 27 500
Drawn By: O.G.
Sheet: 1 of 1
Project No.: 12278
Reviewed By: L.N.
File Name: Figure 6.wf



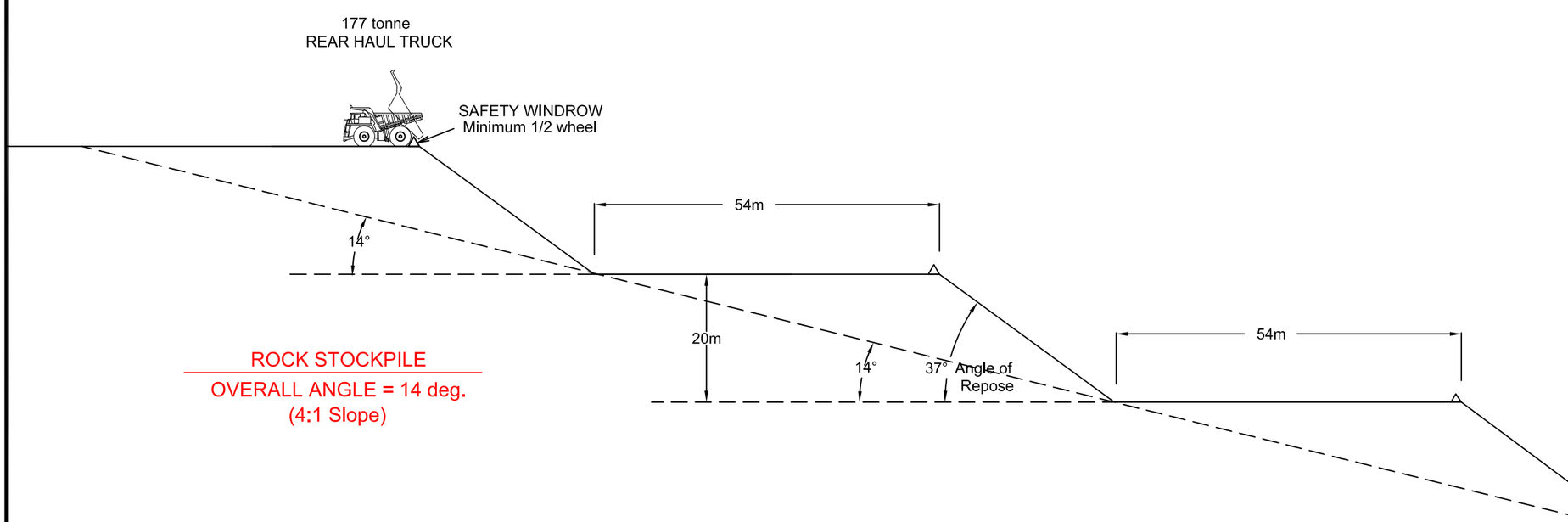
HIGHWALLS AND ENDWALLS
OVERALL WALL DESIGN ANGLE = 45 deg.
(1:1 Slope)



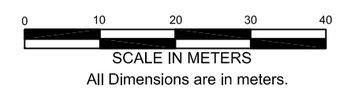
PIT RAMPS
OVERALL WALL DESIGN ANGLE = 45 deg.
(1:1 Slope)



IN-PIT ROCK STOCKPILE
OVERALL ANGLE = 26.5 deg.
(2:1 Slope)



ROCK STOCKPILE
OVERALL ANGLE = 14 deg.
(4:1 Slope)



MARSTON
A Golder Associates Company

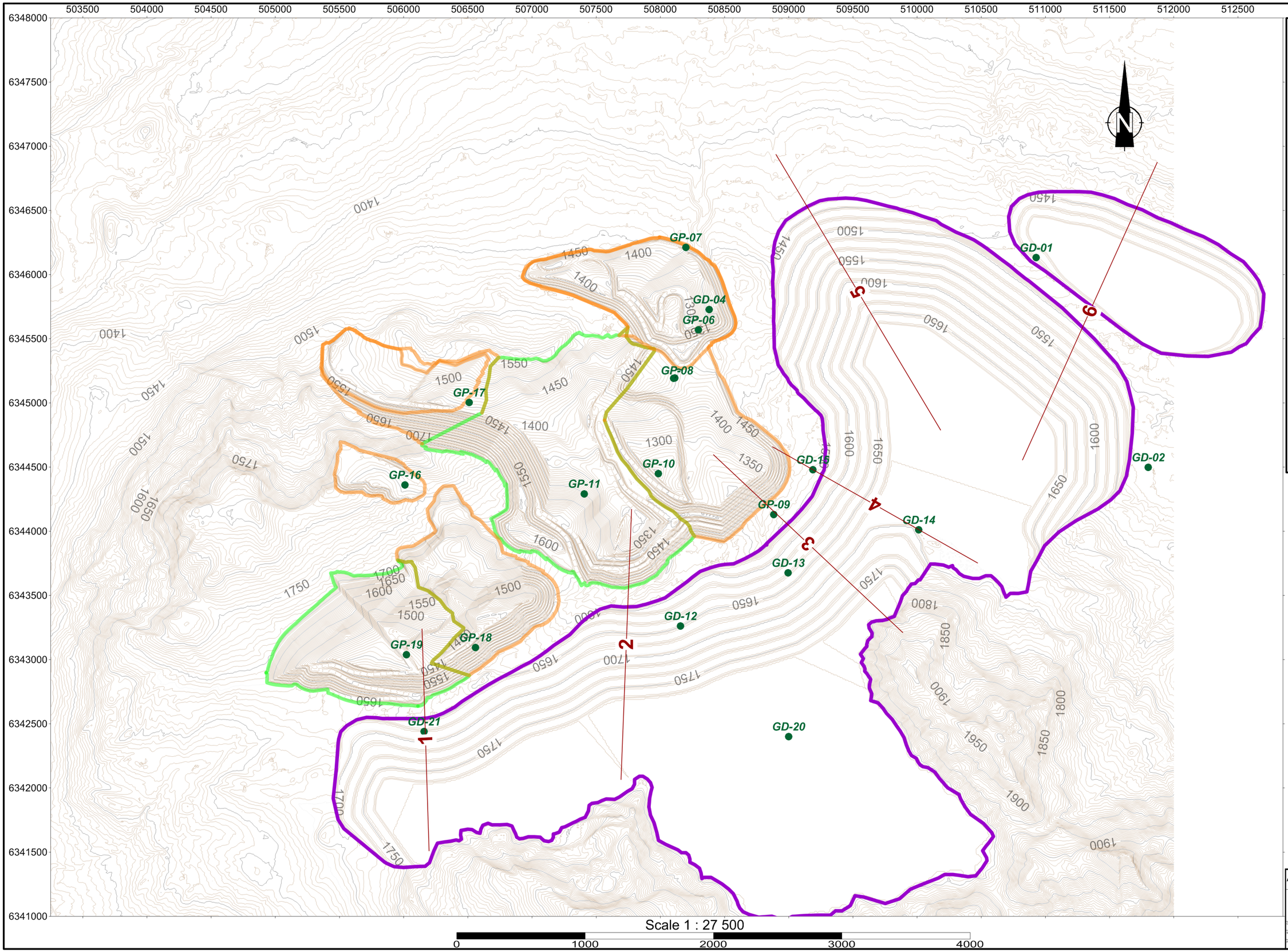
ARCTOS™
ANTHRACITE PROJECT

2012 UPDATE OF THE ARCTOS
ANTHRACITE PROJECT
MINE FEASIBILITY STUDY

PIT WALL AND ROCK STOCKPILE DESIGN

British Columbia, Canada

Figure 7



LEGEND

GD-14 Finished 2013 holes , with as built co-ordinates

Pit development footprints

Rock storage footprints

50 m major contours

5 m minor contours

4 Profile line

Scale 1 : 27 500

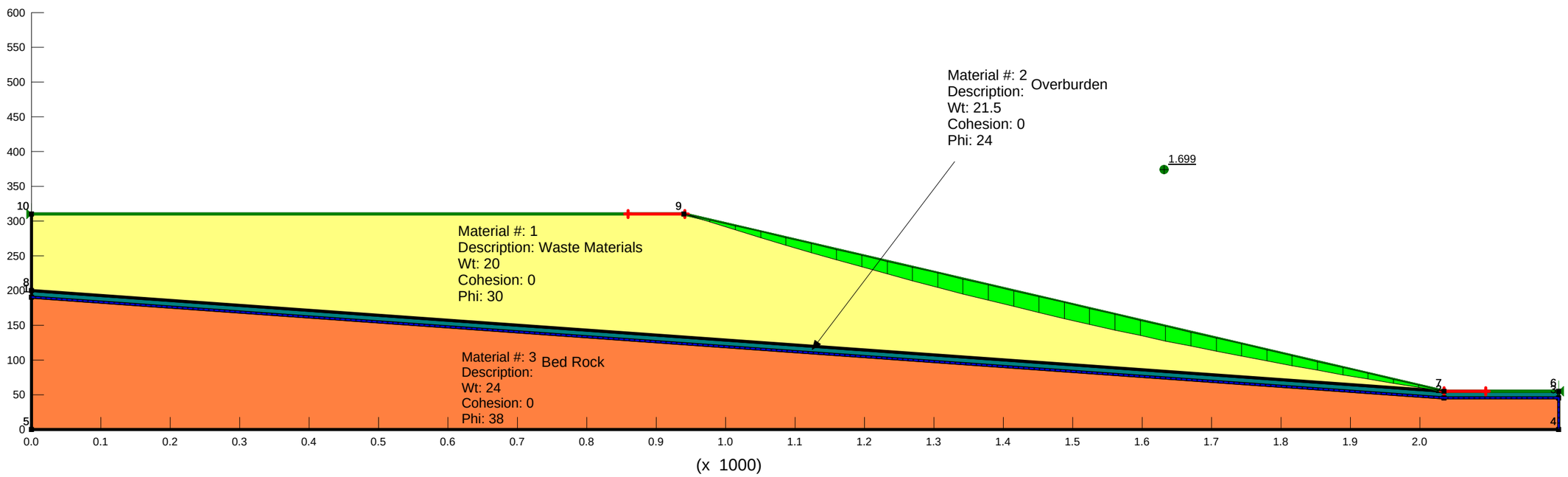
0 1000 2000 3000 4000

Arctos Anthracite Joint Venture

TERRACON GEOTECHNIQUE LTD.
CONSULTING ENGINEERS AND GEOLOGISTS

FIGURE 14
Plan of Rock Stockpile Profile Locations
Arctos Anthracite Property

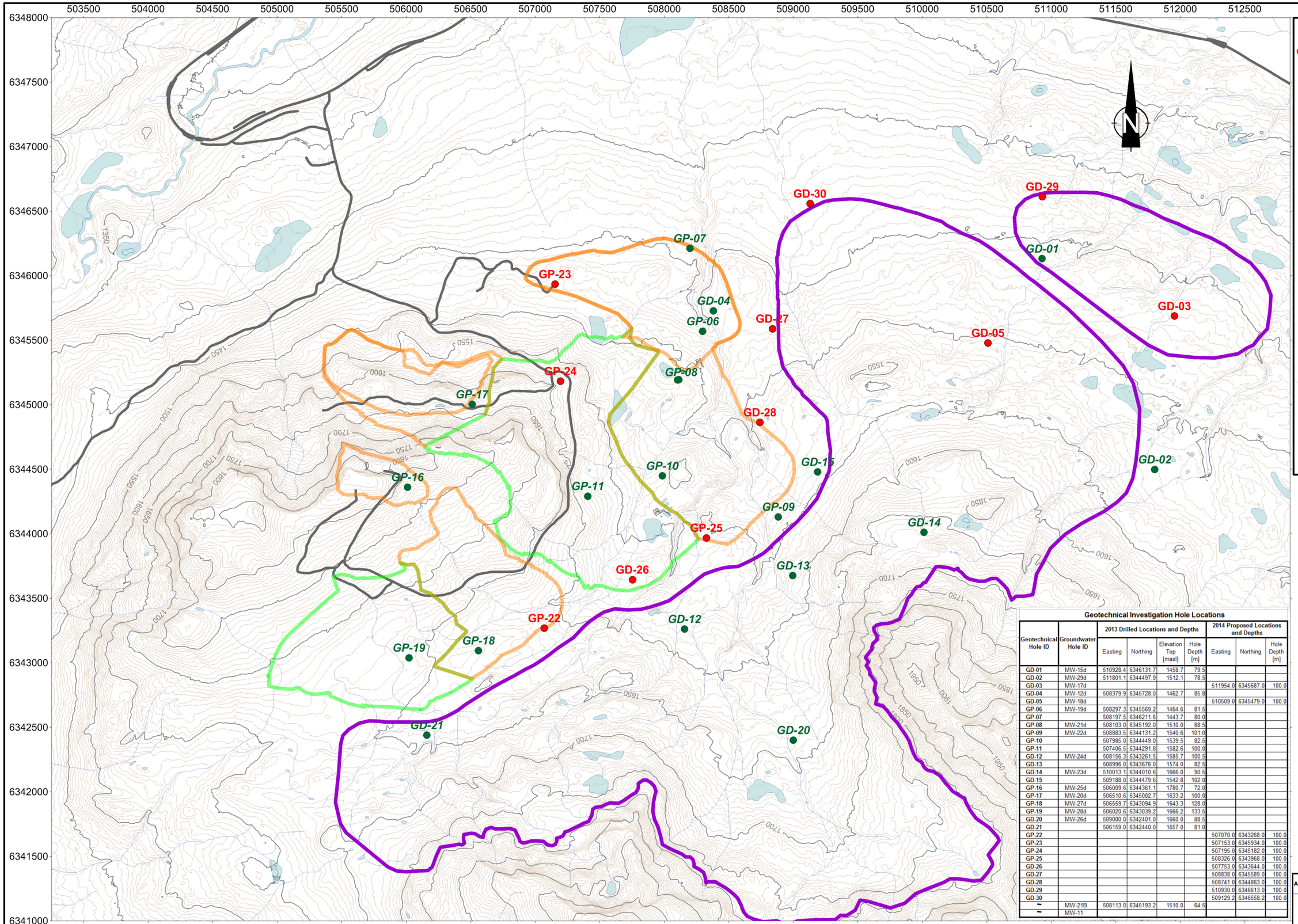
Date:	Feb. 26, 2014	Designed By:	V.V. E.H.	DWG Size:	custom
Scale:	1 : 27 500	Drawn By:	O.G.	Sheet:	1 of 1
Project No.:	122781	Reviewed By:	L.N.	File Name:	Figure 14.wl



TERRACON GEOTECHNIQUE

Figure 15
Typical Slope Stability Model
Waste Rock Storage Structure

Date :	Feb. 25, 2014	Designed By :	Client	DWG Size :	11 x 17in
Scale :	NTS	Drawn By :	A.H.	Sheet :	1 OF 1
Project No. :	122781	Reviewed By :	B.K.	File Name :	Figure 15.pdf



Geotechnical Investigation Hole Locations

Geotechnical Hole ID	Groundwater Hole ID	2013 Drilled Locations and Depths				2014 Proposed Locations and Depths		
		Easting	Northing	Elevation Top [masl]	Hole Depth [m]	Easting	Northing	Hole Depth [m]
GD-01	MW-15d	510928.4	6346131.7	1458.7	79.5			
GD-02	MW-29d	511801.1	6344497.9	1512.1	78.5			
GD-03	MW-17d					511954.0	6345687.0	100.0
GD-04	MW-12d	508379.9	6345728.0	1462.7	85.8			
GD-05	MW-18d					510509.0	6345479.0	100.0
GP-06	MW-19d	508297.3	6345569.2	1464.6	81.5			
GP-07		508197.5	6346211.6	1443.7	80.0			
GP-08	MW-21d	508103.0	6345192.0	1510.0	88.5			
GP-09	MW-22d	508883.5	6344131.2	1540.6	101.0			
GP-10		507985.0	6344449.0	1539.5	82.5			
GP-11		507406.5	6344291.8	1582.6	100.0			
GD-12	MW-24d	508156.3	6343261.5	1585.7	100.5			
GD-13		508996.0	6343676.0	1574.0	82.5			
GD-14	MW-23d	510013.1	6344010.6	1666.0	90.5			
GD-15		509188.0	6344479.6	1542.8	102.0			
GP-16	MW-25d	506009.6	6344361.1	1780.7	72.0			
GP-17	MW-20d	506510.6	6345002.7	1633.2	100.0			
GP-18	MW-27d	506559.7	6343094.9	1643.3	128.0			
GP-19	MW-28d	506020.6	6343039.2	1666.2	133.5			
GD-20	MW-26d	509000.0	6342401.0	1660.0	88.5			
GD-21		506159.0	6342440.0	1657.0	81.0			
GP-22						507070.0	6343268.0	100.0
GP-23						507153.0	6345934.0	100.0
GP-24						507195.0	6345182.0	100.0
GP-25						508326.0	6343968.0	100.0
GD-26						507753.0	6343644.0	100.0
GD-27						508838.0	6345589.0	100.0
GD-28						508741.0	6344863.0	100.0
GD-29						510930.0	6346613.0	100.0
GD-30						509129.2	6346558.2	100.0
~	MW-21B	508113.0	6345193.2	1510.0	64.5			
~	MW-11							

Arctos Anthracite Joint Venture

TERRACON GEOTECHNIQUE LTD.
CONSULTING ENGINEERS AND GEOLOGISTS

FIGURE 16
2013 Completed and 2014 Proposed
Geotechnical Investigation Hole Locations
Arctos Anthracite Property

Date:	Feb. 26, 2014	Designed By:	V.V. E.H.	DWG Size:	custom
Scale:	1 : 27 500	Drawn By:	O.G.	Sheet:	1 of 1
Project No.:	122781	Reviewed By:	L.N.	File Name:	Figure 16.wf

APPENDIX B

Tables

Table 1: Geotechnical Investigation Drill Hole Locations

Geotechnical Hole ID	Groundwater Hole ID	2013 Proposed Locations and Depths			2013 Drilled Locations and Depths				Horizontal Distance between 2013 Proposed and Drilled Locations [m]
		Easting	Northing	Hole Depth [m]	Easting	Northing	Elevation Top [masl]	Hole Depth [m]	
GD-01	MW-15d	511900	6346000	80	510928.4	6346132	1458.7	79.5	980.5
GD-02	MW-29d	511800	6344500	80	511801.1	6344498	1512.1	78.5	2.3
GD-03	MW-17d	510927.1	6345934	80					
GD-04	MW-12d	509129.2	6346558	80	508379.9	6345728	1462.7	85.8	1118.3
GD-05	MW-18d	509400	6345550	80					
GP-06	MW-19d	508325	6345500	100	508297.3	6345569	1464.6	81.5	74.5
GP-07		507808	6346258	80	508197.5	6346212	1443.7	80	392.3
GP-08	MW-21d	508200	6345000	80	508103	6345192	1510	88.5	215.1
GP-09	MW-22d	508500	6344000	80	508883.5	6344131	1540.6	101	405.3
GP-10		507982	6344457	80	507985	6344449	1539.5	82.5	8.7
GP-11		507405.8	6344293	80	507406.5	6344292	1582.6	100	1.1
GD-12	MW-24d	508000	6343300	80	508156.3	6343262	1585.7	100.5	160.9
GD-13		508919	6343705	80	508996	6343676	1574	82.5	82.3
GD-14	MW-23d	510000	6344000	80	510013.1	6344011	1666	90.5	16.8
GD-15		509189.6	6344465	80	509188	6344480	1542.8	102	14.4
GP-16	MW-25d	506000	6344250	80	506009.6	6344361	1780.7	72	111.5
GP-17	MW-20d	506500	6345000	80	506510.6	6345003	1633.2	100	10.9
GP-18	MW-27d	506550	6343100	80	506559.7	6343095	1643.3	128	11
GP-19	MW-28d	506050	6343000	80	506020.6	6343039	1666.2	133.5	49
GD-20	MW-26d	507500	6342400	80	509000	6342401	1660	88.5	1500
GD-21		506152	6342448	80	506159	6342440	1657	81	10.6
GP-22									
GP-23									
GP-24									
GP-25									
GD-26									
GD-27									
GD-28									
GD-29									
GD-30									
~	MW-21B				508113	6345193	1510	64.5	
~	MW-11								

Table 2: SPT Results

HOLE ID	Northing	Easting	From	To	Blows	N
Hole ID: GD-01 (MW-15d)	N: 6346130	E: 510927	1.5	1.96	3/7/11	18
Hole ID: GD-02 (MW-29d)	N: 6344500	E: 511797	2.00m	2.46m	4/6/9	15
			5.00m	5.46m	1/1/2	3
			6.50m	6.96	6/9/21	30
			9.50m	9.96m	5/7/15	22
Hole ID: GD-04 (MW-12d)	N: 6345727	E: 508379	NO CLAY, NO SPT SAMPLES			
Hole ID:MW-24-GD-12	N:6343261	E:5081581	3	3.25	7 /7 /8	15
			4.5	4.7	4 / 7 /5	12
			7.5	7.83	14/35/50	85
			9	9.22	29/31 /49	80
			10.5	10.8	6 /15 /23	38
Hole ID: GD-14	N:6344006	E:510012	2	2.1	1 /1 /2	3
			3.5	3.73	12 /23 /30	53
Hole ID: GD-15	N: 6344479	E: 509185	0	7.5	10/19 /42	61
Hole ID:MW-26/GD-20	N:6342401	E:509000	1.5	1.64	8 /18 /10	28
			3	3.14	16 /11 / 07	18
Hole ID: GD-21	N: 6342432	E: 506159	2.00	2.46	2 / 2 / 2	
			3.50	3.96	2/9/6	
Hole ID: GP-09 (MW-22D)	N: 6344129	E: 508890	1.5	1.55	5/ 17/12	29
			4.5	4.83	7/11/28	39
			6	6.26	10/13/19	32
Hole ID: GP-17/MW-20	N: 6344998	E: 506503	0	3	4 / 5 /7	13
HOLE ID: GP-19/MW-28	6343036	506019	1.5	1.81		

Table 3: Field Mapping Structural Data

Field Mapping Structural Data					
Location ID	**Easting**	**Northing**	**Strike (Right)**	**Dip**	**Type**
OC1	505930	6344436	70	11	Bedding
OC1	505930	6344436	163	86	Joint
OC2	505841	6344320	310	44	Bedding
OC2	505841	6344320	50	67	Joint
OC3	505823	6344298	115	50	Bedding
OC3	505823	6344298	5	86	Joint
OC4	505998	6343590	60	25	Bedding
OC4	505998	6343590	185	82	Joint
OC4	505998	6343590	260	73	Joint
OC5	506140	6343527	111	31	Bedding
OC6	506190	6343529	128	86	Joint
OC7	506388	6343627	90	12	Bedding
OC7	506388	6343627	110	85	Joint
OC7	506388	6343627	150	70	Joint
OC7	506388	6343627	150	90	Joint
OC7	506388	6343627	140	70	Joint
OC7	506388	6343627	350	53	Joint
OC7	506388	6343627	40	65	Joint
OC8	506951	6343830	225	59	Joint
OC8	506951	6343830	43	65	Joint
OC8	506951	6343830	10	72	Joint
OC8	506951	6343830	7	50	Joint
OC9	507246	6344307	245	12	Bedding
OC9	507246	6344307	185	77	Joint
OC9	507246	6344307	30	90	Joint

Table 3: Field Mapping Structural Data

Location ID	Easting	Northing	Strike (Right)	Dip	Type
OC9	507246	6344307	40	83	Joint
OC9	507246	6344307	75	75	Joint
OC9	507246	6344307	340	80	Joint
OC10	508218	6343225	284	52	bedding
OC10	508218	6343225	286	56	bedding
OC12	508214	6343277	140	77	bedding
OC13	506751	6343255	50	48	bedding
OC13	506751	6343255	80	46	bedding
OC14	506780	6343268	82	58	bedding
OC14	506780	6343268	60	52	bedding
OC15	506797	6343274	68	44	bedding
OC15	506797	6343274	74	44	bedding
OC15	506797	6343274	88	40	bedding
OC16	506578	6342836	50	45	bedding
OC16	506578	6342836	54	34	bedding
OC17	506604	6342861	50	42	bedding
OC18	506621	6342881	34	73	bedding
OC19	506805	6342884	94	52	bedding
OC19	506805	6342884	110	30	bedding
OC20	506822	6342884	104	22	bedding
OC21	506844	6342915	88	50	bedding
OC21	506844	6342915	82	42	bedding
OC21	506844	6342915	78	34	bedding
OC21	506844	6342915	74	30	bedding
OC22	506873	6342934	72	36	bedding
OC23	506890	6342942	68	15	bedding

Table 3: Field Mapping Structural Data

Location ID	Easting	Northing	Strike (Right)	Dip	Type
OC23	506890	6342942	94	32	bedding
OC24	506929	6342969	52	26	bedding
OC24	506929	6342969	94	36	bedding
OC25	506441	6343678	304	35	bedding
OC26	506417	6343711	340	48	bedding
OC27	505816	6342258	320	70	bedding
OC28	505789	6342260	38	40	bedding
OC29	505684	6342206	82	40	bedding
OC29	505684	6342206	78	44	bedding
OC30	505664	6342191	54	35	bedding
OC31	505652	6342181	70	50	bedding
OC32	505718	6341853	170	20	bedding
OC33	505641	6341854	260	68	bedding
OC34	505801	6341844	108	20	bedding
OC35	505784	6341836	274	60	bedding
OC36	505756	6341831	100	65	bedding

Table 4: Laboratory Test Summary

Laboratory Test Summary - Arctos (As of Jan. 16, 2014)

BH ID	Sample ID	Sample Depth (m)		Major Lithology	WC (%)	Plasticity					Unit Weight (kg/m3)	Specific Gravity	Particle Size Distr (%)				Slake Durability Index (%)	Strength (Mpa)		
																		Unconfined Compression	Direct Shear	
		From	To			LL	PL	PI	Liquidity Index	Activity			Graval	Sand	Silt	Clay			Peak/N Stress	Residual/N Stress
GD-01	127751	1.50	1.96	Till	16.5	NP	NP	NP					36	56	11	7				
	130449	6.00	6.14	Clay	32.4	48	19	29	0.5	0.6			0	13	24	63				
	130449-core	6.00	6.14		33.0	49	19	30	0.5											
GD-02	130440-SPT	2.00	2.46	Till	18.7	39	22	17	-0.2											
	130441-SPT	5.00	5.46	Clay	27.2	32	17	15	0.7	0.6			0	19	37	44				
	130442-SPT	6.50	6.96	Till	14.3	26	15	11	-0.1	0.6			7	33	35	25				
	130443-SPT	9.50	9.96	Till	16.5	33	19	14	-0.2	1.2			13	44	26	17				
GD-12	130454	3.00	3.25	Till	20.8	33	21	12	0.0											
	130459	0.15	0.35		30.2	45	30	15	0.0	0.5			0	12	50	38				
	130460	0.35	0.50	Till	20.7	32	21	11	0.0	0.9			7	45	30	18				
	130461	0.55	0.65		39.8	52	40	12	0.0	0.7			1	34	40	25				
	130462	3.15	3.29	Till									36	31	14	19				
	130455	4.50	4.70										35	40	13	12				
	130456	7.50	7.83	Sandstone									32	40	18	10				
	130457	9.00	9.22	Sandstone									21	41	25	13				
	130458	10.50	10.80	Mudstone									20	15	40	25				
	130495	52.45	52.71	Sandstone	0.7						2204								1.55/1.20	0.75/0.91
GD-13	127752-SPT	1.50	1.96		20.9	38	21	17	0.0											
GD-14	130433	2.00	2.10	Mudstone	18.4	29	19	10	-0.1											
	130434	3.50	3.73	Mudstone	9.8	26	14	12					0	8	65	27				
	130436	16.22	16.44	Mud/ Sandstone	2.2												79.3			
	130437-core	16.44	16.71	Bentonite	3.2												60.7			
	130438-core	20.16	20.59		4.8												66.1			

Table 4: Laboratory Test Summary

GD-15	130124	6.98	7.20	Clay	13.7	35	20	15	-0.4	0.5			0	11	40	49			
	130125	7.20	7.40		10.0	32	18	14	-0.6	0.7			0	6	62	32			
	130123	7.50	7.72		18.8	32	18	14	0.1	0.6			0	1	60	39			
	130126-1	8.30	8.70		17.2	31	18	13	-0.1	0.5			0	2	60	38			
	130126-2	8.30	8.70		11.5						2014							0.37/0.61	0.27/0.49
	130127	8.70	8.85		9.8	31	19	12	-0.8	0.5			0	1	65	34			
	130130	28.65	28.90	Mudstone	1.0	16	13	3			2594							2.01/2.05	
	130135-1	64.75	65.25	Mudstone	5.0	62	17	45					0	32	32	36			
	130135-2	64.75	65.25		5.0						2731							0.88/0.53	0.29/0.44
	130135-3	64.75	65.25		3.7						2450							0.64/1.06	0.43/0.88
GD-20	130473	1.50	1.64	Till									15	33	24	28			
	130486	1.25	1.50	Till	9.4	30	20	19	-0.6	1.0			13	29	31	27			
	130474	3.00	3.14	Sandstone	13.2	19	13	16											
GD-21	130117												9	36	42	13			
	130119	2.00	2.15	Clay									30	25	21	24			
	130118	3.50	3.60	Siltstone	22.1	27	18	9	0.5	0.8			1	17	61	21			
	130120	3.60	3.70		17.8	27	18	9	0.0	0.7			0	15	60	25			
GP-06	130424	46.40	46.60	Mudstone	1.0	NP	NP	NP											
GP-08		81.45	81.60	Sandstone	1.8						2660						32.0		
		83.40	83.55	Mudstone	2.5						2514						7.4		
		88.17	88.40	Sandstone	2.1						2564						17.5		
	1	0.00	1.40	Till	17.6								57	23	11	9			
	2	3.00	3.90	Till	11.5								65	16	11	8			
GP-09	130428	0.15	0.30	Clay	32.1	39	28	11	0.4	0.4			0	6	39	55			
	130425	1.50	1.55		15.9								25	56	19				
	130426	4.50	4.83	Till															
	130427	6.00	6.26		13.7	32	18	14	-0.3	1.0			6	31	41	22			
	130429	33.78	33.95	Siltstone	6.1	55	19	36											
	130430	51.63	51.91	Sandstone	0.5						3146							2.12/0.88	
	130131	73.25	73.58	Sandstone	0.4						2654							2.34/1.75	
GP-09B	130432	0.00	1.50	Till	51.3	49	31	18	1.1										

Table 4: Laboratory Test Summary

GP-10	1	1.50	3.00		11.1								50	24	15	11			
	2	3.00	4.50	Sandstone	8.1								54	18	18	10			
	3	4.50	6.00		11.0								34	24	17	25			
	4	9.00	10.50	Sand/ Mudstone	7.2								26	16	43	15			
	7	22.50	24.00	Siltstone	11.0	38	12	25					5	49	24	22			
	8	57.00	58.50	Sandstone	3.0														
	5	63.00	63.30		1.9						2672						24.1		
	6	67.20	67.45	Mudstone	2.9						2530					96.9	1.2		
GP-11	SA1	1.40	1.50	Till	22.1	38	18	20	0.2	0.5		2.68	10	20	24	46			
	SA2	1.50	1.95	Till	22.2	40	16	24	0.3	0.8		2.63	2	28	28	42			
	SA3	1.80	1.95		14.1	40	17	23	-0.1	0.9		2.60	15	22	29	34			
GP-16	130411	4.55	4.76	Clay	18.1	60	16	14	0.2										
	130412	6.05	6.19		18.1	35	20	15	-0.1										
	130415-1	6.52	6.70		17.3	35	21	14	-0.3										
	130415-2	6.52	6.70		16.8						1761							0.66/1.07	0.25/0.97
	130416	66.50	66.71	Mudstone	1.3	19	14	5			2988							0.62/0.58	0.40/0.53
GP-17	130487	3.00	3.12	Sandstone	13.4	42	15	27	-0.1										
	130491	32.20	32.37	Mud/ Sandstone	2.1								1	80	19				
	130495	52.45	52.71	Mudstone	0.2	NP	NP	NP					0	61	21	18			
	130498	80.03	80.14	Mudstone	3.0	NP	NP	NP											
	130499	80.40	80.55		2.8	NP	NP	NP											
	130500	82.86	82.93		3.3	26	20	6											
GP-18	130418	0.00	0.15	Till	33.4	40	26	14	0.5	0.6			6	24	35	35			
	130419	0.15	0.30		29.8	52	26	26	0.1	0.6			0	17	23	60			
	130420	0.30	0.50		27.5	55	24	31	0.1	0.8			10	16	26	48			
	130421-1	39.92	40.12	Mudstone	1.2								0	10	41	49			
	130421-2	39.62	40.12	Clay	1.2													2.4/1.19	
	130422-1	43.65	43.90	Clay	14.5	82	24	58					0	7	15	78			
	130422-2	43.65	43.90		4.2													1.19/2.25	0.5/1.90

Table 4: Laboratory Test Summary

GP-19	130144	1.05	1.25		16.7	33	19	14	-0.2	0.5			0	4	56	40			
	130145	1.25	1.50		15.0	31	19	12	-0.3	0.5			0	28	39	33			
	130143	1.50	1.81	Clay	20.6	35	20	15	0.0	0.5			0	15	43	42			
	130146	1.55	1.85		20.0	34	20	14	0.0	0.5			0	14	46	40			
	130147	2.00	2.50		14.9	31	17	14	-0.2	0.5			0	4	53	43			
	130452-1	47.15	47.55	Bentonite	14.2	43	18	25	-0.2		1397		0	36	29	35		0.2/0.53	0.13/0.47
	130452-2	47.15	47.55		11.7						2037							0.68/1.12	0.43/0.89

Table 5: Structural Data for Pit Slope Stability

Location ID	Easting	Northing	Strike(Right)	Dip	Type
GP-06	508297	6345569	300	89	joint
GP-17	506511	6345003	105	66	joint
GP-17	506511	6345003	71	60	joint
GP-18	506560	6343095	104	65	joint
GP-18	506560	6343095	180	71	joint
GP-18	506560	6343095	274	64	joint
GP-19	506021	6343039	81	79	joint
GP-19	506021	6343039	46	57	joint
GP-19	506021	6343039	147	60	joint
OC1	505930	6344436	70	11	bedding
OC1	505930	6344436	163	86	joint
OC2	505841	6344320	310	44	bedding
OC2	505841	6344320	50	67	joint
OC3	505823	6344298	115	50	bedding
OC3	505823	6344298	5	86	joint
OC4	505998	6343590	60	25	bedding
OC4	505998	6343590	185	82	joint
OC4	505998	6343590	260	73	joint
OC5	506140	6343527	111	31	bedding
OC6	506190	6343529	128	86	joint
OC7	506388	6343627	90	12	bedding
OC7	506388	6343627	147	77	joint
OC7	506388	6343627	110	85	joint
OC7	506388	6343627	40	65	joint
OC7	506388	6343627	350	53	joint
OC8	506951	6343830	9	61	joint
OC8	506951	6343830	43	65	joint
OC8	506951	6343830	225	59	joint
OC9	507246	6344307	245	12	bedding
OC9	507246	6344307	35	86	joint
OC9	507246	6344307	75	75	joint
OC9	507246	6344307	172	88	joint
OC10	508218	6343225	285	54	bedding
OC12	508214	6343277	140	77	bedding
OC13	506751	6343255	65	46	bedding
OC14	506780	6343268	71	54	bedding
OC15	506797	6343274	76	42	bedding
OC16	506578	6342836	52	39	bedding
OC17	506604	6342861	50	42	bedding
OC18	506621	6342881	34	73	bedding
OC19	506805	6342884	100	41	bedding
OC20	506822	6342884	104	22	bedding
OC21	506844	6342915	81	39	bedding
OC22	506873	6342934	72	36	bedding
OC23	506890	6342942	86	23	bedding
OC24	506929	6342969	76	29	bedding
OC25	506441	6343678	304	35	bedding

Table 5: Structural Data for Pit Slope Stability

Location ID	Easting	Northing	Strike(Right)	Dip	Type
OC26	506417	6343711	340	48	bedding
OC27	505816	6342258	320	70	bedding
OC28	505789	6342260	38	40	bedding
OC29	505684	6342206	80	42	bedding
OC30	505664	6342191	54	35	bedding
OC31	505652	6342181	70	50	bedding
OC32	505718	6341853	170	20	bedding
OC33	505641	6341854	260	68	bedding
OC34	505801	6341844	108	20	bedding
OC35	505784	6341836	274	60	bedding
OC36	505756	6341831	100	65	bedding
H1	505811	6345061	74	13	bedding
H2	506727.6	6345354	77	15	bedding
H3	505718	6345250	91	18	bedding
H3	505718	6345250	292	78	joint
H3	505718	6345250	50	89	joint
H4	506207	6345149	79	18	bedding
H4	506207	6345149	324	88	joint
H4	506207	6345149	245	82	joint
H4	506207	6345149	221	83	joint
H5	506402.5	6344903	88	65	bedding
H5	506402.5	6344903	170	52	joint
H5	506402.5	6344903	7	81	joint
H5	506402.5	6344903	272	65	joint
H5	506402.5	6344903	178	83	joint
H6	506813	6344841	192	45	bedding
H7	506856	6345249	60	27	bedding
H7	506856	6345249	299	74	joint
H7	506856	6345249	220	68	joint
H8	506862	6345256	69	29	bedding
H8	506862	6345256	308	85	joint
H8	506862	6345256	205	76	joint
H8	506862	6345256	177	79	joint
H8	506862	6345256	252	81	joint
H9	507290	6345320	62	59	bedding
H9	507290	6345320	288	83	joint
H9	507290	6345320	188	79	joint
H9	507290	6345320	237	58	joint
H10	507260.7	6345227	59	49	bedding
H10	507260.7	6345227	254	20	joint
H10	507260.7	6345227	130	52	joint
H10	507260.7	6345227	149	89	joint
H10	507260.7	6345227	347	64	joint
H11	506040	6344784	110	54	bedding
H11	506040	6344784	282	56	joint
H11	506040	6344784	207	88	joint
H12	506966	6344731	98	17	bedding

Table 5: Structural Data for Pit Slope Stability

Location ID	Easting	Northing	Strike(Right)	Dip	Type
H12	506966	6344731	126	89	joint
H12	506966	6344731	210	89	joint
H13	505364	6344805	107	58	bedding
H13	505364	6344805	295	55	joint
H13	505364	6344805	35	90	joint
H13	505364	6344805	221	54	joint
H14	506979	6344731	40	16	bedding
H14	506979	6344731	208	74	joint
H14	506979	6344731	129	90	joint
H15	505457	6344583	358	24	bedding
H15	505457	6344583	190	67	joint
H15	505457	6344583	241	86	joint
H16	507241	6344522	98	14	bedding
H16	507241	6344522	202	82	joint
H16	507241	6344522	312	82	joint
H17	505103	6344183	42	23	bedding
H17	505103	6344183	95	90	joint
H17	505103	6344183	185	77	joint
H18	505831	6344518	89	14	bedding
H18	505831	6344518	66	90	joint
H18	505831	6344518	163	89	joint
H19	506023	6344602	290	38	bedding
H19	506023	6344602	20	77	joint
H19	506023	6344602	109	56	joint
H20	506400.4	6344201	109	79	bedding
H20	506400.4	6344201	31	74	joint
H20	506400.4	6344201	188	83	joint
H20	506400.4	6344201	263	22	joint
H20	506400.4	6344201	205	68	joint
H21	507051	6344063	110	41	bedding
H21	507051	6344063	97	74	joint
H21	507051	6344063	221	81	joint
H21	507051	6344063	300	67	joint
H21	507051	6344063	351	61	joint
H22	507183	6344517	102	20	bedding
H22	507183	6344517	13	90	joint
H22	507183	6344517	317	83	joint
H23	506739.4	6343624	360	7	bedding

GP-18 - Arctos 2013 corehole location
OC9 - Arcctos 2013 outcrop location
H18 - Interpretation from Hardy's report

Table 11: Overburden Depth Based on Boreholes Logs

Borehole ID	Overburden Depth (m)	Major Litheology Description
GD-01/MW-15d	6	Siltstone 5-6cm, orange-brown, weathered.
GD-02	12.5	Brown clayey soil with abundant rootlets and organics.
GD-12	5.7	Sand and clay, some organics, soft
GD-13	15	Weathered/oxidized sandstone and mudstone gravel and cobbles with brown-grey silty clay
GD-14	0.5	Organic silty clay
GD-15	9	Organics, clay, roots, various clasts
GD-20	2.6	Clay-silt, trace fine grain sand, mm angular clasts, some gravel, hard, till.
GD-21	3.5	Brown oxidized organics, clay and silt, soft.
GP-09	9.5	Dark brown muskeg soil with abundant rootlets and organics present, Brown massive silty clay, with angular fine grained sand clasts (up to 2cm).

Table 12: Material Properties Used in Slope Stability Analyses

Material	ɣ (kN/m³)	ϕ (°)	C (kPa)
Waste Rock	20	30	0
Overburden	21.5	24	0
Bed Rock	24	38	0
Mudstone	25.5	19	
Sandstone	25.6	15	
Bentonite		8	
Carbonaceous Natural Surfaces		13	

Table 13: Proposed Geotechnical Investigation Drill Hole Locations

Geotechnical Hole ID	2014 Proposed Locations and Depths		
	Easting	Northing	Hole Depth [m]
GD-03	511954	6345687	100
GD-05	510509	6345479	100
GP-22	507070	6343268	100
GP-23	507153	6345934	100
GP-24	507195	6345182	100
GP-25	508326	6343968	100
GD-26	507753	6343644	100
GD-27	508838	6345589	100
GD-28	508741	6344863	100
GD-29	510930	6346613	100
GD-30	509129.2	6346558	100

APPENDIX C

Core Logs

TERRACON GEOTECHNIQUE

CLIENT: Arctos Anthracite Joint Venture
PROJECT NUMBER: 122781

HOLE ID: GD-01/MW-15d
PROJECT LOCATION: Arctos Anthracite Property

DATE STARTED: Sept. 11, 2013 COMPLETED: Sept. 13, 2013
DRILL CONTRACTOR: Driftwood RIG #:
HOLE SIZE: HQ
DRILLING METHOD: Diamond
LOGGED BY: GJM/MM/SL CHECKED BY:

Ground Elevation [masl] 1455
Easting 510920.0
Northing 6346130.0
Water Table Depth [m]
Total Depth [m] 79.50m

COMMENTS:

Run Depth		Core Recovery		RQD Length (Pieces >10cm) [m]	RQD length /run length x100 [%]	Number of Joints (per run)	Core Depth		Schmidt Hammer Tests		Joint Details				Colour	Major Lithology	Minor Lithology	Bedding Type	Features	Comments
From [m]	To [m]	Rec. [m]	Rec. [%]				From [m]	To [m]	Test 'R' Values	Avg 'R' Value	Geometry	Roughness	Spacing	Joint Angle [°]						
0.00	1.50	0.20	13.33	0.00	0.00	0.00	0	1.30	LOST CORE	LOST CORE	LOST CORE	LOST CORE	LOST CORE	LOST CORE	LOST CORE	LOST CORE	LOST CORE	LOST CORE	LOST CORE	LOST CORE
							1.30	1.5	-	-	-	-	-	-	Brown	Overburden	-	-	Oxidized/Oxidation	Siltstone 5-6cm, orange-brown, weathered.
1.50	1.96	0.24		SPT	SPT	SPT	SPT	SPT	SPT	SPT	SPT	SPT	SPT	SPT	SPT	SPT	SPT	SPT	SPT	Brown fine-coarse grained gravelly sand.
1.50	3.00	0.12	8.00	0.00	0.00	0.00	1.5	1.62	-	-	-	-	-	-	Medium Grey	Overburden	-	-	Oxidized/Oxidation	Sandstone 5-6cm, grey, patches of orange-brown oxidation.
							1.62	3	LOST CORE	LOST CORE	LOST CORE	LOST CORE	LOST CORE	LOST CORE	LOST CORE	LOST CORE	LOST CORE	LOST CORE	LOST CORE	LOST CORE
3.00	4.50	0.20	13.33	0.00	0.00	0.00	3.00	4.30	LOST CORE	LOST CORE	LOST CORE	LOST CORE	LOST CORE	LOST CORE	LOST CORE	LOST CORE	LOST CORE	LOST CORE	LOST CORE	LOST CORE
							4.30	4.50	-	-	-	-	-	-	Brown-Grey	Overburden	-	-	Oxidized/Oxidation	Siltstone and sandstone 2-3cm, orange-brown-grey, weathered.
4.50	6.00	0.15	10.00	0.00	0.00	0.00	4.50	5.85	LOST CORE	LOST CORE	LOST CORE	LOST CORE	LOST CORE	LOST CORE	LOST CORE	LOST CORE	LOST CORE	LOST CORE	LOST CORE	LOST CORE
							5.85	6.00	-	-	-	-	-	-	Brown-Grey	Overburden	-	-	Oxidized/Oxidation	Sandstone 6-7cm, brown-grey, patches of orange-brown oxidation.
6.00	7.50	1.27	84.67	0.51	34.00	0.00	6	6.15			-	-	-	-	Dark Grey-Black	Clay	-	Massive	-	Clay, dark grey-black, trace gravels, soft, weathered.
							6.15	7	0	0	-	-	-	-	Dark Grey	Mudstone	-	Massive	Quartz Vein(s) mm scale	Mudstone, dark grey, massive, trace veins.
							7	7.27			-	-	-	-	Medium-Dark Grey	Sandstone	Siltstone	Interbedded	-	Sand fine grained, siltstone 1-2cm.
							7.27	7.5	LOST CORE	LOST CORE	LOST CORE	LOST CORE	LOST CORE	LOST CORE	LOST CORE	LOST CORE	LOST CORE	LOST CORE	LOST CORE	LOST CORE
7.50	9.00	1.5	100.00	0.85	56.67	0	7.5	9	26,25	25.5	-	-	-	-	Medium Grey	Sandstone	Siltstone	Interbedded	-	Sandstone, fine grained, mm siltstone lamili, trace cm layer of clay.
9.00	10.50	1.37	91.33	1.09	72.67	1.00	9.00	9.13	LOST CORE	LOST CORE	LOST CORE	LOST CORE	LOST CORE	LOST CORE	LOST CORE	LOST CORE	LOST CORE	LOST CORE	LOST CORE	LOST CORE
							9.13	10.50	33,27	30	Planar	Slightly Rough	Isolated (6->12cm)	80°	Medium Grey	Sandstone	Siltstone	Interbedded	-	Sandstone, fine grained, 10% mm siltstone laminae
10.50	12.00	1.47	98.00	0.91	60.67	1	10.5	12	32,31	31.5	Planar	Slightly Rough	Isolated (6->12cm)	75°	Medium Grey	Sandstone	Siltstone	Massive	-	Sandstone, fine grain, massive, trace siltstone interbeds.
12.00	13.50	1.5	100.00	0.82	54.67	0	12	13.5	27,37	32	-	-	-	-	Medium Grey	Sandstone	Siltstone	Interbedded	-	Sandstone, fine grained, 20% siltstone mm layers and 5-6cm siltstone clasts, rounded.
13.50	15.00	1.5	100.00	1.41	94.00	0	13.5	15	39,34	36.5	-	-	-	-	Medium Grey	Sandstone	Siltstone	Massive	Quartz Vein(s) mm scale	Sandstone, fine grain, trace siltstone clasts 1-2cm, mm Quartz 65 deg.
15.00	16.50	1.40	93.33	0.93	62.00	0.00	15.00	15.10	LOST CORE	LOST CORE	LOST CORE	LOST CORE	LOST CORE	LOST CORE	LOST CORE	LOST CORE	LOST CORE	LOST CORE	LOST CORE	LOST CORE
							15.10	16.50	35,34	34.5	-	-	-	-	Medium Grey	Sandstone	Anthracite Coal	Massive	Quartz Vein(s) mm scale	Sandstone, fine grained, trace siltstone, trace coal along quartz veining.
16.50	18.00	1.5	100.00	1.3	86.67	0	16.5	18	32,38	35	-	-	-	-	Medium Grey	Sandstone	-	Massive	-	Sandstone, fine grained, massive.
18.00	19.50	1.48	98.67	1.43	95.33	0	18	19.5	36,30	33	-	-	-	-	Medium Grey	Sandstone	Siltstone	Massive	-	Sandstone fine grained, 10% siltstone, 1-2cm bands.
19.50	21.00	1.46	97.33	1.38	92.00	0	19.5	21	36,30	33	-	-	-	-	Medium Grey	Sandstone	Siltstone	Massive	-	Sandstone, fine grained, 1% mm siltstone wavey laminae.
21.00	22.50	1.5	100.00	1.01	67.33	1	21	22.5	31,30	30.5	Planar	Smooth	Isolated (6->12cm)	70°	Medium Grey	Sandstone	Siltstone	Interbedded	-	Sandstone, fine grain, 20% siltstone mm-7cm clasts
22.50	24.00	1.5	100.00	1.34	89.33	1	22.5	24	31,30	30.5	Planar	Slightly Rough	Isolated (6->12cm)	40°	Medium Grey	Sandstone	Siltstone	Interbedded	-	Sandstone, fine grained, 10% siltstone mm layers.
24.00	25.50	1.5	100.00	1.05	70.00	1	24	25.5	30,30	30	Planar	Slightly Rough	Isolated (6->12cm)	50°	Medium Grey	Sandstone	Siltstone	Interbedded	-	Sandstone, fine grained, 10% siltstone mm layers.
25.50	27.00	1.38	92.00	1.22	81.33	0.00	25.50	25.62	LOST CORE	LOST CORE	LOST CORE	LOST CORE	LOST CORE	LOST CORE	LOST CORE	LOST CORE	LOST CORE	LOST CORE	LOST CORE	LOST CORE
							25.62	27.00	26,25	25.5	-	-	-	-	Medium Grey	Sandstone	Siltstone	Massive	-	Sandstone, fine grained, 5% siltstone mm layers.
27.00	28.50	1.5	100.00	1.09	72.67	1	27	28.5	20,31	25.5	Planar	Slightly Rough	Isolated (6->12cm)	80°	Medium Grey	Sandstone	Siltstone	Massive	-	Sandstone, fine grain, 3% siltstone mm discontinuous layers.

Run Depth		Core Recovery		RQD Length (Pieces >10cm) [m]	RQD length /run length x100 [%]	Number of Joints (per run)	Core Depth		Schmidt Hammer Tests		Joint Details				Colour	Major Lithology	Minor Lithology	Bedding Type	Features	Comments
From [m]	To [m]	Rec. [m]	Rec. [%]				From [m]	To [m]	Test 'R' Values	Avg 'R' Value	Geometry	Roughness	Spacing	Joint Angle [°]						
28.50	30.00	1.45	96.67	0.85	56.67	1.00	28.50	28.55	LOST CORE	LOST CORE	LOST CORE	LOST CORE	LOST CORE	LOST CORE	LOST CORE	LOST CORE	LOST CORE	LOST CORE	LOST CORE	LOST CORE
							28.55	30.00	19,17	18	Planar	Slightly Rough	Isolated (6->12cm)	80°	Medium Grey	Sandstone	Siltstone	Massive	-	Sandstone, fine grained, 3% siltstone mm discontinuous layers.
30.00	31.50	1.38	92.00	0.86	57.33	1.00	30.00	30.12	LOST CORE	LOST CORE	LOST CORE	LOST CORE	LOST CORE	LOST CORE	LOST CORE	LOST CORE	LOST CORE	LOST CORE	LOST CORE	LOST CORE
							30.12	31.50	27,28	27.5	Planar	Slightly Rough	Isolated (6->12cm)	70°	Medium Grey	Sandstone	Siltstone	Interbedded	Quartz Vein(s) mm scale	Sandstone, fine grained, 20% siltstone, 1-2mm, 5mm Qtz vein.
31.50	33.00	1.5	100.00	1.38	92.00	1	31.5	33	0,14	7	Planar	Slightly Rough	Isolated (6->12cm)	60°	Medium Grey	Sandstone	Siltstone	Interbedded	-	Sandstone, fine grained, 20% siltstone, 1-2mm, discountinuous layers.
33.00	34.50	1.50	100.00	0.73	48.67	1.00	33	34.5	12,32	22	Irregular	Slightly Rough	Isolated (6->12cm)	65°	Medium Grey	Sandstone	Siltstone	Interbedded	-	Sandstone, fine grained, 20% siltstone, 1-2mm, discountinuous layers.
34.50	36.00	1.37	91.33	0.14	9.33	0.00	34.50	34.63	LOST CORE	LOST CORE	LOST CORE	LOST CORE	LOST CORE	LOST CORE	LOST CORE	LOST CORE	LOST CORE	LOST CORE	LOST CORE	LOST CORE
							34.63	36.00			-	-	-	-	Medium-Dark Grey	Interbedded Mudstone/Sandstone	Anthracite Coal	Interbedded	-	Sandstone and siltstone, trace coal mm, stringers.
36.00	37.50	1.00	66.67	0.00	0.00	0.00	36.00	36.50	LOST CORE	LOST CORE	LOST CORE	LOST CORE	LOST CORE	LOST CORE	LOST CORE	LOST CORE	LOST CORE	LOST CORE	LOST CORE	LOST CORE
							36.50	37.50	0	0	-	-	-	-	Dark Grey-Black	Anthracite Coal	Mudstone	Interbedded	-	Coal, 10% mudstone, very brittle and broken.
37.50	39.00	0.28	18.67	0.00	0.00	0.00	37.50	38.72	LOST CORE	LOST CORE	LOST CORE	LOST CORE	LOST CORE	LOST CORE	LOST CORE	LOST CORE	LOST CORE	LOST CORE	LOST CORE	LOST CORE
							38.72	39.00	0	0	-	-	-	-	Black	Anthracite Coal	-	Massive	-	Coal, trace mudstone interlayered, <2cm
39.00	40.50	1.30	86.67	0.35	23.33	1.00	39.00	39.20	LOST CORE	LOST CORE	LOST CORE	LOST CORE	LOST CORE	LOST CORE	LOST CORE	LOST CORE	LOST CORE	LOST CORE	LOST CORE	LOST CORE
							39.20	40.50	0	0	Planar	Very Rough	Isolated (6->12cm)	60°	Dark Grey	Mudstone	Anthracite Coal	Massive	Pyrite	Mudstone, dark grey, massive, trace: pyrite, Quartz stringers, coal stringers
40.50	42.00	1.40	93.33	0.26	17.33	1.00	40.50	40.60	LOST CORE	LOST CORE	LOST CORE	LOST CORE	LOST CORE	LOST CORE	LOST CORE	LOST CORE	LOST CORE	LOST CORE	LOST CORE	LOST CORE
							40.60	42.00	0	0	Planar	Slightly Rough	Isolated (6->12cm)	20°	Dark Grey-Black	Mudstone	Anthracite Coal	Massive	-	Mudstone, 3% coal stringers.
42.00	43.50	1.48	98.67	0.45	30.00	1	42	43.15	0	0	Planar	Slightly Rough	Isolated (6->12cm)	30°	Medium-Dark Grey	Interlaminated Mudstone/Siltstone	-	Interbedded	-	Mudstone and siltstone interbedded.
							43.15	43.5							Medium Grey	Sandstone		Massive	Quartz Stringers	Sandstone, fine grained, fractures with Qtz on face.
43.50	45.00	1.46	97.33	0.92	61.33	1	43.5	44.25	0,24	12	Planar	Smooth	Isolated (6->12cm)	30°	Dark Grey	Interbedded Mudstone/Siltstone	-	Interbedded	-	Mudstone and siltstone interbedded.
							44.25	45							Medium Grey	Sandstone	-	Massive	-	Sandstone, fine grained, weak.
45.00	46.50	1.5	100.00	1.24	82.67	1	45	46.5	0,22	11	Planar	Slightly Rough	Isolated (6->12cm)	60°	Medium Grey	Sandstone	Mudstone	Massive	Quartz Vein(s) mm scale	Sandstone, fine grained, 10% mudstone clasts, Quartz veins same as joint angle.
46.50	48.00	1.5	100.00	0.83	55.33	1	46.5	48	0,10	5	Planar	Smooth	Isolated (6->12cm)	40°	Medium Grey	Sandstone	Siltstone	Massive	Quartz Vein(s) mm scale	Sandstone, 10% siltstone, mm, Quartz vein vertical.
48.00	49.50	1.40	93.33	0.46	30.67	1.00	48.00	48.10	LOST CORE	LOST CORE	LOST CORE	LOST CORE	LOST CORE	LOST CORE	LOST CORE	LOST CORE	LOST CORE	LOST CORE	LOST CORE	LOST CORE
							48.10	49.50	18,24	21	Irregular	Slightly Rough	Isolated (6->12cm)	65°	Medium Grey	Sandstone	Siltstone	Interbedded	Quartz Vein(s) cm scale	Sandstone, fine grained, 20% siltstone 5-6mm.
49.50	51.00	1.39	92.67	0.00	0.00	1.00	49.50	49.61	LOST CORE	LOST CORE	LOST CORE	LOST CORE	LOST CORE	LOST CORE	LOST CORE	LOST CORE	LOST CORE	LOST CORE	LOST CORE	LOST CORE
							49.61	51.00	10,0	5	Planar	Slightly Rough	Isolated (6->12cm)	30°	Medium-Dark Grey	Sandstone	Siltstone	Interbedded	Quartz Vein(s) mm scale	Sandstone, fine grain, 20% siltstone 1-2cm bands.
51.00	52.50	1.5	100.00	0.56	37.33	1	51	52.5	20,20	20	Planar	Slightly Rough	Isolated (6->12cm)	70°	Medium Grey	Sandstone	Siltstone	Massive	Quartz Stringers	Sandstone, fine grain, 10% siltstone clasts, trace Quartz stringers vertical.
52.50	54.00	1.5	100.00	0.83	55.33	1	52.5	54	14,16	15	Planar	Smooth	Isolated (6->12cm)	40°	Medium-Dark Grey	Sandstone	Siltstone	Interbedded	-	Sandstone, fine grained, 20% siltstone mm discountinuous layers.
54.00	55.50	1.5	100.00	0.9	60.00	1	54	55.5	22,27	24.5	Planar	Smooth	Isolated (6->12cm)	40°	Medium-Dark Grey	Sandstone	Siltstone	Interbedded	-	Sandstone, fine grained, 40% siltstone mm-cm layers, possible bioturbation 10-15cm.
55.50	57.00	1.5	100.00	1.09	72.67	1	55.5	57	28,25	26.5	Planar	Slightly Rough	Isolated (6->12cm)	80°	Medium Grey	Sandstone	Siltstone	Interbedded	Quartz Stringers	Sandstone, fine grained, 20% siltstone <1cm layers, trace black mm coal or mudstone clasts.
57.00	58.50	1.5	100.00	0.91	60.67	1	57	58.5	0	0	Planar	Smooth	Isolated (6->12cm)	40°	Medium Grey	Sandstone	Siltstone	Interbedded	-	Sandstone, fine grained, 20% siltstone 1-2cm layers, trace black hard mm coal or mudstone clasts, similar to above.
58.50	60.00	1.5	100.00	0.24	16.00	2	58.5	59.3	33,36	34.5	Irregular	Slightly Rough	Occasional (3-6cm)	85°	Medium Grey	Sandstone	Siltstone	Interbedded	Quartz Stringers	Sandstone fine grained, 10% siltstone mm-cm layers, jointing at high angle with Qtz on face and vugs in Qtz veins.

Run Depth		Core Recovery		RQD Length (Pieces >10cm) [m]	RQD length /run length x100 [%]	Number of Joints (per run)	Core Depth		Schmidt Hammer Tests		Joint Details				Colour	Major Lithology	Minor Lithology	Bedding Type	Features	Comments
From [m]	To [m]	Rec. [m]	Rec. [%]				From [m]	To [m]	Test 'R' Values	Avg 'R' Value	Geometry	Roughness	Spacing	Joint Angle [°]						
60.00	61.50	1.5	100.00	1.26	84.00	1	60	60.75	0	0	Planar	Smooth	Isolated (6->12cm)	30°	Medium Grey	Sandstone	Siltstone	Interbedded	-	Sandstone, fine grained, 10% siltstone, <1cm layers.
							60.75	61			-	-	-	-	Dark Grey	Siltstone	Sandstone	Interbedded	Quartz Vein(s) mm scale	Siltstone, trace sands.
							61	61.5			-	-	-	-	Medium Grey	Sandstone	Siltstone	Massive	Quartz Vein(s) mm scale	Sandstone fine grained,trace siltstone mm, trace black mm coal clasts.
61.50	63.00	1.5	100.00	0.81	54.00	1	61.5	63	24,26	25	Planar	Slightly Rough	Isolated (6->12cm)	80°	Medium Grey	Sandstone	Siltstone	Interbedded	Quartz Stringers	Sandstone fine grain, 5% siltstone, <3cm bands.
63.00	64.50	1.5	100.00	1.02	68.00	1	63	64.5	0	0	Planar	Slightly Rough	Isolated (6->12cm)	30°	Medium-Dark Grey	Sandstone	Siltstone	Interbedded	-	Sandstone fine grained, 20% siltstone, <1cm bands.
64.50	66.00	1.43	95.33	0.82	54.67	1.00	64.50	64.57	LOST CORE	LOST CORE	LOST CORE	LOST CORE	LOST CORE	LOST CORE	LOST CORE	LOST CORE	LOST CORE	LOST CORE	LOST CORE	LOST CORE
							64.57	66.00	22,28	25	Planar	Slightly Rough	Isolated (6->12cm)	30°	Medium-Dark Grey	Sandstone	Siltstone	Interbedded	-	Sandstone fine grained, 20% siltstone, 6cm bands, mm coal stringers.
66.00	67.50	1.5	100.00	0.92	61.33	1	66	67.5	0,10,20	10	Irregular	Smooth	Isolated (6->12cm)	80°	Medium-Dark Grey	Sandstone	Siltstone	Interbedded	Quartz Vein(s) mm scale	Sandstone and siltstone cm interbeds, mm coal stringers
67.50	69.00	1.48	98.67	0.71	47.33	1	67.5	69	0	0	Planar	Slightly Rough	Isolated (6->12cm)	20°	Medium-Dark Grey	Siltstone	Sandstone	Interbedded	Quartz Vein(s) mm scale	Siltstone, 30% sandstone fine grained, trace coal stringers.
69.00	70.50	1.5	100.00	1.11	74.00	1	69	70.5	26,26	26	Planar	Slightly Rough	Isolated (6->12cm)	70°	Medium-Dark Grey	Sandstone	Siltstone	Interbedded	-	Sandstone fine grained, 30% siltstone, 1-2cm banding.
70.50	72.00	1.45	96.67	0.64	42.67	1.00	70.50	70.55	LOST CORE	LOST CORE	LOST CORE	LOST CORE	LOST CORE	LOST CORE	LOST CORE	LOST CORE	LOST CORE	LOST CORE	LOST CORE	LOST CORE
							70.55	72.00	0	0	Planar	Slightly Rough	Isolated (6->12cm)	40°	Dark Grey-Black	Interbedded Anthracite/Mudstone	Siltstone	Interbedded	Pyrite	Mudstone 30%, Coal 10%, Siltstone 20%, <1% Pyrite.
72.00	73.50	1.20	80.00	0.11	7.33	1.00	72.00	72.30	LOST CORE	LOST CORE	LOST CORE	LOST CORE	LOST CORE	LOST CORE	LOST CORE	LOST CORE	LOST CORE	LOST CORE	LOST CORE	LOST CORE
							72.30	73.50	27, 21	24	Planar	Smooth	Isolated (6->12cm)	30°	Dark Grey-Black	Interbedded Anthracite/Mudstone	-	Interbedded	Pyrite	20% Coal , <1% Pyrite.
73.50	75.00	1.37	91.33	0.10	6.67	1.00	73.50	73.63	LOST CORE	LOST CORE	LOST CORE	LOST CORE	LOST CORE	LOST CORE	LOST CORE	LOST CORE	LOST CORE	LOST CORE	LOST CORE	LOST CORE
							73.63	75.00	0	0	Planar	Polished	Isolated (6->12cm)	50°	Dark Grey-Black	Interbedded Anthracite/Mudstone	-	Interbedded	-	Mudstone, 20% Coal, 10cm light brown clay.
75.00	76.50	1.02	68.00	0.12	8.00	1.00	75.00	75.48	LOST CORE	LOST CORE	LOST CORE	LOST CORE	LOST CORE	LOST CORE	LOST CORE	LOST CORE	LOST CORE	LOST CORE	LOST CORE	LOST CORE
							75.48	76.50	0	0	Planar	Smooth	Isolated (6->12cm)	40°	Brown-Grey	Interlaminated Mudstone/Siltstone	-	Interbedded	Carbonate	Siltyclay-mudstone, med brown, 1% Coal stringers, carbonate veins.
76.50	78.00	1.40	93.33	0.00	0.00	1.00	76.50	76.60	LOST CORE	LOST CORE	LOST CORE	LOST CORE	LOST CORE	LOST CORE	LOST CORE	LOST CORE	LOST CORE	LOST CORE	LOST CORE	LOST CORE
							76.60	78.00	0	0	Curved	Smooth	Isolated (6->12cm)	50°	Dark Grey-Black	Interbedded Anthracite/Mudstone	-	Interbedded	Quartz Vein(s) mm scale	Mudstone, 3% coal layers, trace chlorite, greenish.
78.00	79.50	1.5	100.00	0.78	52.00	1	78	79.1	43, 50	46.5	Planar	Slightly Rough	Isolated (6->12cm)	50°	Dark Grey	Mudstone	Sandstone	Massive	-	Mudstone, 10% sandstone , fine grained.
							79.1	79.5			-	-	-	-	Medium Grey	Sandstone	-	Massive	Mud clasts	Sandstone fine grained, trace mud clasts.

TERRACON GEOTECHNIQUE

CLIENT: Arctos Anthracite Joint Venture
PROJECT NUMBER: 122781

HOLE ID: GD-02/MW-29d
PROJECT LOCATION: Arctos Anthracite Property

DATE STARTED: Sept 4, 2013 COMPLETED: Sept 7, 2013
DRILL CONTRACTOR: Driftwood RIG #:
HOLE SIZE: HQ
DRILLING METHOD: Diamond
LOGGED BY: Shane Lyons, N CHECKED BY:

Ground Elevation [masl]
Easting
Northing
Water Table Depth [m]
Total Depth [m] 78.5m

COMMENTS:

Run Depth		Core Recovery		RQD Length (Pieces >10cm) [m]	RQD length /run length x100 [%]	Number of Joints (per run)	Core Depth		Schmidt Hammer Tests		Joint Details				Colour	Major Lithology	Minor Lithology	Bedding Type	Features	Comments
From [m]	To [m]	Rec. [m]	Rec. [%]				From [m]	To [m]	Test 'R' Values	Avg 'R' Value	Geometry	Roughness	Spacing	Joint Angle [°]						
0.00	0.50	0.40	80.00	0.00	0.00	n/a	0.00	0.10	LOST CORE	LOST CORE	LOST CORE	LOST CORE	LOST CORE	LOST CORE	LOST CORE	LOST CORE	LOST CORE	LOST CORE	LOST CORE	LOST CORE
							0.10	0.50	0	0	n/a	n/a	n/a	n/a	Brown	Overburden	-	-	Organics	Brown clayey soil with abundant rootlets and organics.
0.50	2.00	0.00	0.00	0.00	0.00	n/a	0.50	2.00	LOST CORE	LOST CORE	LOST CORE	LOST CORE	LOST CORE	LOST CORE	LOST CORE	LOST CORE	LOST CORE	LOST CORE	LOST CORE	LOST CORE
2.00	2.46	0.20	43.48	SPT	SPT	SPT	SPT	SPT	SPT	SPT	SPT	SPT	SPT	SPT	SPT	SPT	SPT	SPT	SPT	Dark grey sandy clay with gravel/till (up to 2cm).
2.46	3.50	0.20	19.23	0.00	0.00	n/a	2.46	3.30	LOST CORE	LOST CORE	LOST CORE	LOST CORE	LOST CORE	LOST CORE	LOST CORE	LOST CORE	LOST CORE	LOST CORE	LOST CORE	LOST CORE
							3.30	3.50	0	0	n/a	n/a	n/a	n/a	Brown-Grey	Glacial Till	Sandstone	-	-	Brown/grey weathered sandstone and siltstone cobbles.
3.50	5.00	0.00	0.00	0.00	0.00	n/a	3.50	5.00	LOST CORE	LOST CORE	LOST CORE	LOST CORE	LOST CORE	LOST CORE	LOST CORE	LOST CORE	LOST CORE	LOST CORE	LOST CORE	LOST CORE
5.00	5.46	0.27	58.70	SPT	SPT	SPT	SPT	SPT	SPT	SPT	SPT	SPT	SPT	SPT	SPT	SPT	SPT	SPT	SPT	Dark grey plastic fine grained sandy clay.
5.46	6.50	0.20	19.23	0.00	0.00	n/a	5.46	6.30	LOST CORE	LOST CORE	LOST CORE	LOST CORE	LOST CORE	LOST CORE	LOST CORE	LOST CORE	LOST CORE	LOST CORE	LOST CORE	LOST CORE
							6.30	6.50	0	0	n/a	n/a	n/a	n/a	Dark Brown	Clay	Till	-	-	Dark brown silty clay with glacial till/cobbles (up to 1cm).
6.50	6.96	0.26	56.52	SPT	SPT	SPT	SPT	SPT	SPT	SPT	SPT	SPT	SPT	SPT	SPT	SPT	SPT	SPT	SPT	Dark grey clayey very fine grained sand w/ siltstone clasts @ base.
6.96	8.00	0.65	62.50	0.00	0.00	n/a	6.96	7.35	LOST CORE	LOST CORE	LOST CORE	LOST CORE	LOST CORE	LOST CORE	LOST CORE	LOST CORE	LOST CORE	LOST CORE	LOST CORE	LOST CORE
							7.35	8.00	0	0	n/a	n/a	n/a	n/a	Dark Brown	Glacial Till	-	-	-	Dark brown clayey silt matrix with common angular clasts of siltstone and glacial till.
8.00	9.50	1.05	70.00	0.00	0.00	n/a	8.00	8.45	LOST CORE	LOST CORE	LOST CORE	LOST CORE	LOST CORE	LOST CORE	LOST CORE	LOST CORE	LOST CORE	LOST CORE	LOST CORE	LOST CORE
							8.45	9.50	0	0	n/a	n/a	n/a	n/a	Dark Brown	Glacial Till	Anthracite Coal	-	-	Dark brown clayey silt matrix with common angular clasts of siltstone, glacial till and coal fragments.
9.50	9.96	0.33	71.74	SPT	SPT	SPT	SPT	SPT	SPT	SPT	SPT	SPT	SPT	SPT	SPT	SPT	SPT	SPT	SPT	Dark grey silty sand matrix with till and coal fragments.
9.96	11.00	0.85	81.73	0.00	0.00	n/a	9.96	10.15	LOST CORE	LOST CORE	LOST CORE	LOST CORE	LOST CORE	LOST CORE	LOST CORE	LOST CORE	LOST CORE	LOST CORE	LOST CORE	LOST CORE
							10.15	11.00	0	0	n/a	n/a	n/a	n/a	Dark Brown	Glacial Till	Anthracite Coal	-	-	Dark brown clayey silt matrix with common angular clasts of siltstone, glacial till and coal fragments.
11.00	12.50	0.50	33.33	0.00	0.00	n/a	11.00	12.00	LOST CORE	LOST CORE	LOST CORE	LOST CORE	LOST CORE	LOST CORE	LOST CORE	LOST CORE	LOST CORE	LOST CORE	LOST CORE	LOST CORE
							12.00	12.50	0	0	n/a	n/a	n/a	n/a	Dark Brown	Glacial Till	Anthracite Coal	-	-	Dark brown clayey silt matrix with common angular clasts of pyritic siltstone, glacial till, and coal fragments.
12.50	14.00	1.50	100.00	0.10	6.67	n/a	12.50	14.00	0	0	n/a	n/a	n/a	n/a	Medium-Dark Grey	Interbedded Siltstone/Coal	-	-	-	Medium to dark grey weathered clayey siltstone with occasional interbeds and inclusions of coal.
14.00	15.50	1.50	100.00	0.10	6.67	8	14.00	15.50	16,10	13	Stepped	Slightly Rough	Isolated (6->12cm)	80°	Medium-Dark Grey	Interbedded Sandstone/Siltstone	-	-	-	Medium grey silty fine to very fine grained sandstone interbedded with dark grey sandy siltstone (mm to cm scale).
15.50	17.00	1.50	100.00	0.54	36.00	6	15.50	17.00	10,12	11	Irregular	Slightly Rough	Isolated (6->12cm)	70°	Medium-Dark Grey	Interbedded Sandstone/Siltstone	-	-	-	Medium grey silty fine to very fine grained sandstone interbedded with dark grey sandy siltstone (cm scale).
17.00	18.50	1.50	100.00	0.88	58.67	2	17.00	18.50	14,26	20	Planar	Slightly Rough	Isolated (6->12cm)	60°	Light-Medium Grey	Sandstone	-	-	-	Grey fine grained bedded (mm to cm scale) sandstone.
18.50	20.00	1.50	100.00	0.72	48.00	7	18.50	20.00	28,24	26	Planar	Slightly Rough	Isolated (6->12cm)	80°	Light-Medium Grey	Sandstone	Mudstone	-	Quartz Stringers	Grey fine grained sandstone with occasional interbeds (cm scale) of carbonaceous mudstone and quartz stringers.
20.00	21.50	1.50	100.00	0.77	51.33	6	20.00	21.50	28,26	27	Irregular	Striated	Isolated (6->12cm)	70°	Light-Medium Grey	Sandstone	-	-	Quartz Stringers	Light grey fine grained sandstone with interbeds of medium grey clayey very fine grained sandstone and rare quartz stringers.

Run Depth		Core Recovery		RQD Length (Pieces >10cm) [m]	RQD length /run length x100 [%]	Number of Joints (per run)	Core Depth		Schmidt Hammer Tests		Joint Details				Colour	Major Lithology	Minor Lithology	Bedding Type	Features	Comments
From [m]	To [m]	Rec. [m]	Rec. [%]				From [m]	To [m]	Test 'R' Values	Avg 'R' Value	Geometry	Roughness	Spacing	Joint Angle [°]						
21.50	23.00	1.50	100.00	0.83	55.33	3.00	21.50	23.00	18,17	17.5	Planar	Slightly Rough	Isolated (6->12cm)	20°	Light-Medium Grey	Sandstone	-	-	Quartz Stringers	Light grey fine grained sandstone with interbeds of medium grey clayey very fine grained sandstone and rare quartz stringers.
23.00	24.50	1.46	97.33	0.94	62.67	3.00	23.00	23.04	LOST CORE	LOST CORE	LOST CORE	LOST CORE	LOST CORE	LOST CORE	LOST CORE	LOST CORE	LOST CORE	LOST CORE	LOST CORE	LOST CORE
							23.04	24.50	24,25	24.5	Irregular	Slightly Rough	Isolated (6->12cm)	50°	Light-Medium Grey	Sandstone	-	-	Quartz Stringers	Light grey fine grained sandstone with interbeds of medium grey clayey very fine grained sandstone and rare quartz stringers.
24.50	26.00	1.50	100.00	1.42	94.67	1	24.50	26.00	12,30	21	Planar	Slightly Rough	Isolated (6->12cm)	25°	Light-Medium Grey	Sandstone	-	-	Quartz Stringers	Light grey fine grained sandstone with interbeds of medium grey clayey very fine grained sandstone and rare quartz stringers.
26.00	27.50	1.50	100.00	1.17	78.00	2	26.00	27.50	24,22	23	Planar	Slightly Rough	Isolated (6->12cm)	20°	Light-Medium Grey	Sandstone	-	-	Quartz Stringers	Light grey fine grained sandstone with thin interbeds and laminations of medium grey sandy mudstone and rare quartz stringers.
27.50	29.00	1.50	100.00	0.88	58.67	2	27.50	29.00	12,12	12	Curved	Slightly Rough	Isolated (6->12cm)	85°	Light Grey	Sandstone	-	-	Mud clasts	Light grey fine grained sandstone with rare mudstone clasts (up to 2cm).
29.00	30.50	1.47	98.00	1.02	68.00	1.00	29.00	29.03	LOST CORE	LOST CORE	LOST CORE	LOST CORE	LOST CORE	LOST CORE	LOST CORE	LOST CORE	LOST CORE	LOST CORE	LOST CORE	LOST CORE
							29.03	30.50	10,10	10	-	-	-	-	Light Grey	Sandstone	-	-	-	Light grey fine grained sandstone with occasional thin interbeds and laminations of medium grey sandy mudstone.
30.50	32.00	1.50	100.00	0.89	59.33	4	30.50	32.00	14,10	12	Curved	Slightly Rough	Isolated (6->12cm)	85°	Light Grey	Sandstone	-	-	Mud clasts	Light grey fine grained sandstone with occasional think interbeds and laminations of medium grey sandy mudstone and rare mudstone clasts (up to 1cm).
32.00	33.50	1.49	99.33	0.77	51.33	4.00	32.00	32.01	LOST CORE	LOST CORE	LOST CORE	LOST CORE	LOST CORE	LOST CORE	LOST CORE	LOST CORE	LOST CORE	LOST CORE	LOST CORE	LOST CORE
							32.01	33.50	34,22	28	Irregular	Slightly Rough	Isolated (6->12cm)	85°	Light Grey	Sandstone	-	-	Mud clasts	Light grey fine grained sandstone with occasional think interbeds and laminations of medium grey sandy mudstone and rare mudstone clasts (up to 0.5cm).
33.50	35.00	1.50	100.00	0.82	54.67	4	33.50	35.00	10,10	10	Irregular	Slightly Rough	Isolated (6->12cm)	80°	Light-Medium Grey	Sandstone	-	-	-	Light grey fine grained sandstone with interbeds of medium grey clayey very fine grained sandstone.
35.00	36.50	1.35	90.00	0.46	30.67	4.00	35.00	35.15	LOST CORE	LOST CORE	LOST CORE	LOST CORE	LOST CORE	LOST CORE	LOST CORE	LOST CORE	LOST CORE	LOST CORE	LOST CORE	LOST CORE
							35.15	36.50	16,14	15	Planar	Slightly Rough	Isolated (6->12cm)	90°	Light-Medium Grey	Sandstone	Siltstone	-	-	Light grey fine grained sandstone with interbeds of medium grey clayey very fine grained sandstone/siltstone.
36.50	38.00	1.50	100.00	0.29	19.33	5	36.50	38.00	16,14	15	Irregular	Slightly Rough	Isolated (6->12cm)	80°	Light-Medium Grey	Interbedded Mudstone/Sandstone	-	-	-	Light grey fine to very fine grained sandstone with interbeds of medium to dark grey silty mudstone.
38.00	39.50	1.50	100.00	0.22	14.67	3	38.00	39.50	0	0	Irregular	Slightly Rough	Isolated (6->12cm)	90°	Medium-Dark Grey	Interbedded Mudstone/Sandstone	-	-	Pyrite	Light to medium grey very fine grained silty sandstone interbedded with medium to dark grey silty mudstone.
39.50	41.00	1.50	100.00	0.00	0.00	6	39.50	41.00	0	0	Irregular	Slightly Rough	Isolated (6->12cm)	90°	Medium-Dark Grey	Interbedded Mudstone/Sandstone	-	-	-	Light to medium grey very fine grained silty sandstone interbedded with medium to dark grey silty mudstone.
41.00	42.50	1.50	100.00	0.00	0.00	3	41.00	42.50	0	0	-	-	-	-	Medium-Dark Grey	Interbedded Mudstone/Siltstone	-	-	-	Dark grey mudstone interbedded with thin (mm scale) medium grey very fine grained silty sandstone.
42.50	44.00	1.50	100.00	0.00	0.00	11	42.50	44.00	0	0	-	-	-	-	Medium-Dark Grey	Mudstone	Siltstone	-	-	Dark grey mudstone with rare laminations of medium grey clayey siltstone.
44.00	45.50	1.50	100.00	0.43	28.67	7	44.00	45.50	0	0	-	-	-	-	Dark Grey-Black	Interbedded Anthracite/Mudstone	-	-	Quartz Stringers	Dark grey to black mudstone interbedded with anthracite with occasional quartz stringers.
45.50	47.00	1.50	100.00	0.15	10.00	9	45.50	47.00	0	0	Irregular	Very Rough	Occasional (3-6cm)	80°	Dark Grey-Black	Interbedded Anthracite/Mudstone	-	-	Quartz Stringers	Dark grey to black mudstone interbedded with anthracite with occasional quartz stringers.
47.00	48.50	1.40	93.33	0.25	16.67	8.00	47.00	47.10	LOST CORE	LOST CORE	LOST CORE	LOST CORE	LOST CORE	LOST CORE	LOST CORE	LOST CORE	LOST CORE	LOST CORE	LOST CORE	LOST CORE
							47.10	48.50	0	0	-	-	-	-	Dark Grey-Black	Interbedded Anthracite/Mudstone	-	-	Quartz Stringers	Dark grey to black mudstone interbedded with anthracite with occasional quartz stringers.
48.50	50.00	1.50	100.00	0.14	9.33	11	48.50	48.75			-	-	-	-	Dark Grey-Black	Interbedded Anthracite/Mudstone	-	-	Quartz Stringers	Dark grey to black mudstone interbedded with anthracite with occasional quartz stringers.
							48.75	50.00	32,32	32					Dark Grey-Black	Interbedded Mudstone/Siltstone	-	-	Quartz Stringers	Dark grey to black carbonaceous mudstone interbedded with dark grey clayey siltstone.
50.00	51.50	1.45	96.67	0.19	12.67	3.00	50.00	50.05	LOST CORE	LOST CORE	LOST CORE	LOST CORE	LOST CORE	LOST CORE	LOST CORE	LOST CORE	LOST CORE	LOST CORE	LOST CORE	LOST CORE
							50.05	51.50	32,18	25	-	-	-	-	Dark Grey-Black	Interlaminated Mudstone/Siltstone	Anthracite Coal	-	Quartz Stringers	Dark grey to black carbonaceous mudstone interbedded with dark grey clayey siltstone and occasional anthracite interbeds (up to cm scale).

Run Depth		Core Recovery		RQD Length (Pieces >10cm) [m]	RQD length /run length x100 [%]	Number of Joints (per run)	Core Depth		Schmidt Hammer Tests		Joint Details				Colour	Major Lithology	Minor Lithology	Bedding Type	Features	Comments
From [m]	To [m]	Rec. [m]	Rec. [%]				From [m]	To [m]	Test 'R' Values	Avg 'R' Value	Geometry	Roughness	Spacing	Joint Angle [°]						
51.50	53.00	1.50	100.00	0.00	0.00	7	51.50	53.00	28,0	14	-	-	-	-	Medium-Dark Grey	Interbedded Mudstone/Siltstone	Sandstone	-	-	Dark grey carbonaceous mudstone interbedded with dark grey clayey siltstone and occasional thin (mm scale) light grey fine to very fine grained silty sandstone interbeds.
53.00	54.50	1.50	100.00	0.00	0.00	8	53.00	54.50	0	0	-	-	-	-	Medium-Dark Grey	Interbedded Mudstone/Siltstone	Sandstone	-	-	Dark grey mudstone with grey clay interbeds and thin (mm scale) interbeds of grey very fine grained silty sand.
54.50	56.00	1.50	100.00	0.00	0.00	13	54.50	56.00	0	0	Irregular	Slightly Rough	Isolated (6->12cm)	75°	Medium-Dark Grey	Interbedded Mudstone/Sandstone	-	-	-	Dark grey mudstone interbedded with grey fine to very fine grained sandstone.
56.00	57.50	1.33	88.67	0.15	10.00	7.00	56.00	56.17	LOST CORE	LOST CORE	LOST CORE	LOST CORE	LOST CORE	LOST CORE	LOST CORE	LOST CORE	LOST CORE	LOST CORE	LOST CORE	LOST CORE
							56.17	57.50	28,29	28.5	Planar	-	-	-	Medium-Dark Grey	Interbedded Mudstone/Sandstone	Siltstone	-	-	Dark grey silty mudstone interbedded with grey fine to very fine grained clayey siltstone and occasional siltstone.
57.50	59.00	1.50	100.00	0.00	0.00	18	57.50	59.00	0	0	Planar	-	-	-	Medium-Dark Grey	Interbedded Mudstone/Sandstone	Siltstone	-	-	Dark grey silty mudstone interbedded with grey fine to very fine grained clayey siltstone and occasional siltstone.
59.00	60.50	1.50	100.00	0.00	0.00	8	59.00	60.50	0	0	Planar	-	-	-	Medium-Dark Grey	Interbedded Mudstone/Sandstone	Siltstone	-	Chlorite	Dark grey silty mudstone interbedded with grey fine to very fine grained clayey siltstone and siltstone with highly disturbed section of siltstone clasts, quartz, and calcareous mud matrix.
60.50	62.00	1.50	100.00	0.00	0.00	7	60.50	62.00	0,10	5	Planar	-	-	-	Medium-Dark Grey	Mudstone	-	-	Quartz Stringers	Medium to dark grey silty carbonaceous mudstone with rare thin quartz stringers.
62.00	63.50	1.50	100.00	0.00	0.00	6	62.00	63.50	0	0	Planar	-	-	-	Light-Medium Grey	Interbedded Mudstone/Sandstone	-	-	Quartz Stringers	Light grey fine to very fine grained sandstone with interbeds of medium to dark grey silty mudstone.
63.50	65.00	1.45	96.67	0.00	0.00	5.00	63.50	63.55	LOST CORE	LOST CORE	LOST CORE	LOST CORE	LOST CORE	LOST CORE	LOST CORE	LOST CORE	LOST CORE	LOST CORE	LOST CORE	LOST CORE
							63.55	65.00	0	0	n/a	n/a	n/a	n/a	Light-Medium Grey	Interbedded Mudstone/Sandstone	-	-	-	Light grey fine to very fine grained sandstone with interbeds of medium to dark grey silty mudstone.
65.00	66.50	1.50	100.00	0.00	0.00	10	65.00	66.50	0	0	n/a	n/a	n/a	n/a	Medium-Dark Grey	Interbedded Mudstone/Siltstone	-	-	Quartz Stringers	Dark grey carbonaceous mudstone interbedded with medium grey siltstone and common thin (mm scale) quartz stringers.
66.50	68.00	1.50	100.00	0.00	0.00	8	66.50	68.00	17,30	23.5	n/a	n/a	n/a	n/a	Medium-Dark Grey	Interbedded Mudstone/Siltstone	-	-	Quartz Stringers	Dark grey silty carbonaceous mudstone with occasional (mm to cm scale) and rare quartz stringers.
68.00	69.50	1.47	98.00	0.00	0.00	5.00	68.00	68.03	LOST CORE	LOST CORE	LOST CORE	LOST CORE	LOST CORE	LOST CORE	LOST CORE	LOST CORE	LOST CORE	LOST CORE	LOST CORE	LOST CORE
							68.03	69.50	21,10	15.5	Planar	Slightly Rough	Isolated (6->12cm)	60°	Medium-Dark Grey	Interbedded Mudstone/Sandstone	-	-	Quartz Stringers	Dark grey silty mudstone interbedded with grey fine to very fine grained silty sandstone and rare quartz stringers.
69.50	71.00	1.49	99.33	0.00	0.00	4.00	69.50	69.51	LOST CORE	LOST CORE	LOST CORE	LOST CORE	LOST CORE	LOST CORE	LOST CORE	LOST CORE	LOST CORE	LOST CORE	LOST CORE	LOST CORE
							69.51	71.00	0	0	n/a	n/a	n/a	n/a	Medium-Dark Grey	Interbedded Mudstone/Sandstone	-	-	Quartz Stringers	Dark grey silty mudstone interbedded with grey fine to very fine grained silty sandstone and rare quartz stringers.
71.00	72.50	1.50	100.00	0.10	6.67	11	71.00	72.50	0	0	n/a	n/a	n/a	n/a	Medium-Dark Grey	Interbedded Mudstone/Sandstone	-	-	-	Dark grey silty mudstone interbedded with grey fine to very fine grained silty sandstone.
72.50	74.00	1.50	100.00	0.00	0.00	8	72.50	74.00	14,18	16	n/a	n/a	n/a	n/a	Medium-Dark Grey	Interbedded Mudstone/Sandstone	-	-	-	Dark grey silty mudstone interbedded with grey fine to very fine grained silty sandstone.
74.00	75.50	1.43	95.33	0.43	58.90	14	74.00	74.73	0,16	8	n/a	n/a	n/a	n/a	Medium-Dark Grey	Interbedded Mudstone/Sandstone	-	-	-	Dark grey silty mudstone interbedded with grey fine to very fine grained sandstone in a clear coursening up sequence.
							74.73	75.50			n/a	n/a	n/a	n/a	Dark Grey-Black	Mudstone	-	-	Quartz Stringers	Dark grey to black carbonaceous mudstone with rare quartz stringers.

Run Depth		Core Recovery		RQD Length (Pieces >10cm) [m]	RQD length /run length x100 [%]	Number of Joints (per run)	Core Depth		Schmidt Hammer Tests		Joint Details				Colour	Major Lithology	Minor Lithology	Bedding Type	Features	Comments
From [m]	To [m]	Rec. [m]	Rec. [%]				From [m]	To [m]	Test 'R' Values	Avg 'R' Value	Geometry	Roughness	Spacing	Joint Angle [°]						
75.50	77.00	1.47	98.00	0.68	45.33	15.00	75.50	75.53	LOST CORE	LOST CORE	LOST CORE	LOST CORE	LOST CORE	LOST CORE	LOST CORE	LOST CORE	LOST CORE	LOST CORE	LOST CORE	LOST CORE
							75.53	77.00	0	0	Planar	Smooth	Isolated (6->12cm)	40°	Dark Grey-Black	Interbedded Anthracite/Mudstone	-	-	Quartz Stringers	Dark grey to black carbonaceous mudstone interbedded with anthracite and common quartz stringers.
77.00	78.50	1.50	100.00	0.85	56.67	11	77.00	77.92			n/a	n/a	n/a	n/a	Dark Grey-Black	Interbedded Anthracite/Mudstone	-	-	Quartz Stringers	Dark grey to black carbonaceous mudstone interbedded with anthracite and common quartz stringers.
							77.92	78.50	18,19	18.5					Light-Medium Grey	Interbedded Sandstone/Siltstone	Mudstone	-	Quartz Stringers	Light to medium grey fine to very fine grained sandstone interbedded with siltstone, thin (mm scale) silty mudstone, and rare quartz stringers.

TERRACON GEOTECHNIQUE	CLIENT: Arctos Anthracite Joint Venture	HOLE ID: GD-04/MW-12d
	PROJECT NUMBER: 122781	PROJECT LOCATION: Arctos Anthracite Property

DATE STARTED: September 05, 2013 COMPLETED: Sept 7, 2013
DRILL CONTRACTOR: Driftwood RIG #:
HOLE SIZE: HQ
DRILLING METHOD: Diamond
LOGGED BY: Mollie McGratl CHECKED BY: OG

Ground Elevation [masl] 1474
Easting 508379.0
Northing 6345727.0
Water Table Depth [m]
Total Depth [m] 85.75m

COMMENTS:

Run Depth		Core Recovery		RQD Length (Pieces >10cm) [m]	RQD length /run length x100 [%]	Number of Joints (per run)	Core Depth		Schmidt Hammer Tests		Joint Details				Colour	Major Lithology	Minor Lithology	Features	Comments
From [m]	To [m]	Rec. [m]	Rec. [%]				From [m]	To [m]	Test 'R' Values	Avg 'R' Value	Geometry	Roughness	Spacing	Joint Angle [°]					
0.00	1.50	0.06	4.00	0.00	0.00	n/a	0.00	0.06	21,31	16.5	n/a	n/a	n/a	n/a	Medium Grey	Sandstone	-	-	Sandstone cobble
							0.06	1.50	LOST CORE	LOST CORE	LOST CORE	LOST CORE	LOST CORE	LOST CORE	LOST CORE	LOST CORE	LOST CORE	LOST CORE	LOST CORE
1.50	3.00	0.15	10.00	0.00	0.00	n/a	1.50	1.65	0	0	n/a	n/a	n/a	n/a	Medium Grey	Overburden	Sandstone	Clasts-Assorted	Silty grey clay, assorted clasts
							1.65	3.00	LOST CORE	LOST CORE	LOST CORE	LOST CORE	LOST CORE	LOST CORE	LOST CORE	LOST CORE	LOST CORE	LOST CORE	LOST CORE
3.00	4.50	0.40	26.67	0.00	0.00	n/a	3.00	3.40	12,24	18	n/a	n/a	n/a	n/a	Medium Grey	Sandstone	-	Clasts-Assorted	Silty grey clay, weathered sandstone
							3.40	4.50	LOST CORE	LOST CORE	LOST CORE	LOST CORE	LOST CORE	LOST CORE	LOST CORE	LOST CORE	LOST CORE	LOST CORE	LOST CORE
4.50	6.00	0.40	26.67	0.00	0.00	n/a	4.50	4.90	40,46	43	n/a	n/a	n/a	n/a	Medium Grey	Sandstone	-	Clasts-Assorted	Silty grey clay, weathered sandstone, sandstone and quartz clasts
							4.90	6.00	LOST CORE	LOST CORE	LOST CORE	LOST CORE	LOST CORE	LOST CORE	LOST CORE	LOST CORE	LOST CORE	LOST CORE	LOST CORE
6.00	7.50	0.40	26.67	0.00	0.00	n/a	6.00	6.40	41,42	41.5	n/a	n/a	n/a	n/a	Medium Grey	Sandstone	-	Clasts-Assorted	Weathered sandstone, silty clay/Fault breccia
							6.40	7.50	LOST CORE	LOST CORE	LOST CORE	LOST CORE	LOST CORE	LOST CORE	LOST CORE	LOST CORE	LOST CORE	LOST CORE	LOST CORE
7.50	9.00	0.25	16.67	0.00	0.00	n/a	7.50	7.75	0	0	n/a	n/a	n/a	n/a	Medium Grey	Sandstone	-	Clasts-Assorted	Weathered sandstone, silty clay/Fault breccia
							7.75	9.00	LOST CORE	LOST CORE	LOST CORE	LOST CORE	LOST CORE	LOST CORE	LOST CORE	LOST CORE	LOST CORE	LOST CORE	LOST CORE
9.00	10.50	1.08	72.00	0.00	0.00	n/a	9.00	10.08	18,32,42	30.66	n/a	n/a	n/a	n/a	Medium Grey	Sandstone	-	Clasts-Assorted	Weathered sandstone, silty clay/Fault breccia
							10.08	10.50	LOST CORE	LOST CORE	LOST CORE	LOST CORE	LOST CORE	LOST CORE	LOST CORE	LOST CORE	LOST CORE	LOST CORE	LOST CORE
10.50	12.00	0.20	13.33	0.00	0.00	n/a	10.50	10.70	0	0	n/a	n/a	n/a	n/a	Medium Grey	Sandstone	-	Clasts-Assorted	Weathered sandstone, silty clay/Fault breccia
							10.70	12.00	LOST CORE	LOST CORE	LOST CORE	LOST CORE	LOST CORE	LOST CORE	LOST CORE	LOST CORE	LOST CORE	LOST CORE	LOST CORE
12.00	13.50	0.45	30.00	0.00	0.00	n/a	12.00	12.45	52,39	45.5	n/a	n/a	n/a	n/a	Medium Grey	Sandstone	-	Clasts-Assorted	Weathered sandstone, silty clay/Fault breccia
							12.45	13.50	LOST CORE	LOST CORE	LOST CORE	LOST CORE	LOST CORE	LOST CORE	LOST CORE	LOST CORE	LOST CORE	LOST CORE	LOST CORE
13.50	15.00	0.40	26.67	0.12	8.00	n/a	13.50	13.90	0	0	n/a	n/a	n/a	n/a	Medium Grey	Sandstone and Mudstone	-	Clasts-Assorted	Weathered sandstone, silty clay/conglomerate, fault breccia
							13.90	15.00	LOST CORE	LOST CORE	LOST CORE	LOST CORE	LOST CORE	LOST CORE	LOST CORE	LOST CORE	LOST CORE	LOST CORE	LOST CORE
15.00	16.50	0.45	30.00	0.00	0.00	n/a	15.00	15.45	0	0	n/a	n/a	n/a	n/a	Medium Grey	Sandstone and Mudstone	-	Clasts-Assorted	Weathered sandstone and mudstone, silty clay, fault breccia
							15.45	16.50	LOST CORE	LOST CORE	LOST CORE	LOST CORE	LOST CORE	LOST CORE	LOST CORE	LOST CORE	LOST CORE	LOST CORE	LOST CORE
16.50	18.00	0.20	13.33	0.00	0.00	n/a	16.50	16.70	44,44	44	n/a	n/a	n/a	n/a	Medium Grey	Sandstone and Mudstone	-	Clasts-Assorted	Weathered sandstone and mudstone pebbles and cobbles, sub-rounded.
							16.70	18.00	LOST CORE	LOST CORE	LOST CORE	LOST CORE	LOST CORE	LOST CORE	LOST CORE	LOST CORE	LOST CORE	LOST CORE	LOST CORE
18.00	19.50	0.25	16.67	0.00	0.00	n/a	18.00	18.25	26,45	35.5	n/a	n/a	n/a	n/a	Medium Grey	Sandstone and Mudstone	-	Clasts-Assorted	Weathered sandstone and mudstone pebbles and cobbles, sub-rounded.
							18.25	19.50	LOST CORE	LOST CORE	LOST CORE	LOST CORE	LOST CORE	LOST CORE	LOST CORE	LOST CORE	LOST CORE	LOST CORE	LOST CORE

Run Depth		Core Recovery		RQD Length (Pieces >10cm) [m]	RQD length /run length x100 [%]	Number of Joints (per run)	Core Depth		Schmidt Hammer Tests		Joint Details				Colour	Major Lithology	Minor Lithology	Features	Comments
From [m]	To [m]	Rec. [m]	Rec. [%]				From [m]	To [m]	Test 'R' Values	Avg 'R' Value	Geometry	Roughness	Spacing	Joint Angle [°]					
19.50	21.00	0.45	30.00	0.00	0.00	n/a	19.50	19.95	42,57	49.5	n/a	n/a	n/a	n/a	Medium Grey	Sandstone and Mudstone	-	Clasts-Assorted	Weathered sandstone and mudstone pebbles and cobbles, sub-rounded.
							19.95	21.00	LOST CORE	LOST CORE	LOST CORE	LOST CORE	LOST CORE	LOST CORE	LOST CORE	LOST CORE	LOST CORE	LOST CORE	LOST CORE
21.00	22.50	0.50	33.33	0.00	0.00	n/a	21.00	21.50	18,33	25.5	n/a	n/a	n/a	n/a	Medium Grey	Sandstone and Mudstone	-	Clasts-Assorted	Weathered sandstone and mudstone pebbles and cobbles, sub-rounded.
							21.50	22.50	LOST CORE	LOST CORE	LOST CORE	LOST CORE	LOST CORE	LOST CORE	LOST CORE	LOST CORE	LOST CORE	LOST CORE	LOST CORE
22.50	24.00	1.25	83.33	0.10	6.67	~6	22.50	23.75	36,24	30	-	-	-	-	Dark Grey	Mudstone	-	Quartz Vein(s) mm scale	Heavily weathered silty mudstone, very minor weathered micro coal seams
							23.75	24.00	LOST CORE	LOST CORE	LOST CORE	LOST CORE	LOST CORE	LOST CORE	LOST CORE	LOST CORE	LOST CORE	LOST CORE	LOST CORE
24.00	25.50	1.45	96.67	0.00	0.00	~7	24.00	25.45	0	0	-	-	-	-	Dark Grey	Mudstone	-		Heavily weathered silty mudstone and fault breccia, minor micro coal seams
							25.45	25.50	LOST CORE	LOST CORE	LOST CORE	LOST CORE	LOST CORE	LOST CORE	LOST CORE	LOST CORE	LOST CORE	LOST CORE	LOST CORE
25.50	27.00	1.45	96.7	0.00	0.00	~3	25.50	26.77	0	0	-	-	-	-	Dark Grey	Mudstone	-		Heavily weathered silty mudstone with micro coal seams
							26.77	27.00	0	0	-	-	-	-	Dark Grey	Interbedded Mudstone/Sandstone	-	Quartz Vein(s) mm scale	Weathered interbedded sandstone and mudstone. Micro coal seams
27.00	28.50	1.45	96.67	0.00	0.00	~5	27.00	28.45	0	0	-	-	-	-	Dark Grey	Interbedded Mudstone/Sandstone	-		Weathered silty mudstone with micro coal seams, minor sandstone interbeds
							28.45	28.50	LOST CORE	LOST CORE	LOST CORE	LOST CORE	LOST CORE	LOST CORE	LOST CORE	LOST CORE	LOST CORE	LOST CORE	LOST CORE
28.50	30.00	1.35	90.0	0.00	0.00	>20	28.50	28.80	0	0	-	-	-	-	Dark Grey	Mudstone	-	Fossils	Weathered mudstone-partially altered to anthracite. Plant fossils present.
							28.80	30.00			-	-	-	-	Dark Grey	Interbedded Anthracite/Mudstone	-	Quartz Stringers	Weathered mudstone interbedded with anthracite.
30.00	31.50	1.15	76.67	0.00	0.00	~4	30.00	31.15	0	0	-	-	-	-	Dark Grey	Mudstone	Anthracite Coal	Quartz Vein(s) mm scale	Weathered mudstone with quartz veins, minor anthracite present
							31.15	31.50	LOST CORE	LOST CORE	LOST CORE	LOST CORE	LOST CORE	LOST CORE	LOST CORE	LOST CORE	LOST CORE	LOST CORE	LOST CORE
31.50	33.00	1.45	96.67	0.00	0.00	~9	31.50	32.95	0	0	-	-	-	-	Dark Grey	Mudstone	Anthracite Coal	Pyrite	Weathered mudstone with pyrite and minor anthracite.
							32.95	33.00	LOST CORE	LOST CORE	LOST CORE	LOST CORE	LOST CORE	LOST CORE	LOST CORE	LOST CORE	LOST CORE	LOST CORE	LOST CORE
33.00	34.50	1.40	93.3	0.11	11.83	~6	33.00	33.93			-	-	-	-	Dark Grey	Mudstone	-	-	Weathered mudstone
							33.93	34.50	17,24	20.5	-	-	-	-	Medium Grey	Sandstone	Mudstone	-	Very fine-fine grained sandstone with mudstone interbedding
34.50	36.00	1.50	100.0	1.11	74.00	~6	34.50	36.00	20,24	22	-	-	-	-	Medium Grey	Interbedded Mudstone/Sandstone	Mudstone	Quartz Stringers	Very fine-fine grained sandstone with occasional mudstone interbeds.
36.00	37.50	1.50	100.0	0.92	61.33	5	36.00	37.50	29,34	31.5	-	-	-	-	Medium Grey	Interbedded Mudstone/Sandstone	Mudstone	Quartz Stringers	Very fine-fine grained sandstone with occasional mudstone interbeds, some mudclasts
37.50	39.00	1.50	100.0	0.93	178.85	6	37.50	38.02	11,18	14.5	Curved	Slightly Rough	Isolated (6->12cm)	40°	Medium Grey	Interbedded Mudstone/Sandstone	Mudstone	Quartz Vein(s) mm scale	Very fine-fine grained sandstone with occasional mudstone interbeds.
							38.02	39.00	11,18	14.5	Curved	Slightly Rough	Isolated (6->12cm)	40°	Dark Grey	Interbedded Mudstone/Sandstone	Sandstone	Quartz Vein(s) mm scale	Weathered mudstone with occasional sandstone interbeds
39.00	40.50	1.50	100.0	1.15	76.67	4	39.00	40.50	16,10	13	-	-	-	-	Dark Grey	Interbedded Mudstone/Siltstone	Siltstone	-	Weathered, interbedded mudstone/siltstone
40.50	42.00	1.45	96.7	0.60	40.00	4	40.50	42.00	5,18	11.5	Curved	Slightly Rough	Isolated (6->12cm)	40°	Dark Grey	Interbedded Mudstone/Siltstone	Siltstone	-	Weathered, interbedded mudstone/siltstone
42.00	43.50	1.48	98.7	0.93	160.34	3	42.00	42.58	22,18	20	Irregular	Slightly Rough	Isolated (6->12cm)	60°	Dark Grey	Interbedded Mudstone/Sandstone	Sandstone	-	Interbedded mudstone and silty very fine-fine grained sandstone
							42.58	43.50	22,18	20	Irregular	Slightly Rough	Isolated (6->12cm)	60°	Medium-Dark Grey	Interbedded Mudstone/Sandstone	Mudstone	Quartz Stringers	Interbedded mudstone and very fine-fine grained sandstone
43.50	45.00	1.50	100.0	0.45	30.00	4	43.50	45.00	10,5	7.5	Planar	Slightly Rough	Isolated (6->12cm)	50°	Medium-Dark Grey	Interbedded Mudstone/Sandstone	Mudstone	Quartz Stringers	Interbedded mudstone and very fine-fine grained sandstone
45.00	46.50	1.50	100.0	0.33	22.00	7	45.00	46.50	11,22	16.5	Planar	Slightly Rough	Isolated (6->12cm)	50°	Medium-Dark Grey	Interbedded Mudstone/Sandstone	Sandstone	-	Interbedded mudstone and very fine-fine grained sandstone
46.50	48.00	1.40	93.33	0.73	48.67	6.00	46.50	47.90	5,19	12	Irregular	Slightly Rough	Isolated (6->12cm)	50°	Medium-Dark Grey	Interbedded Mudstone/Sandstone	Sandstone	Quartz Vein(s) mm scale	Interbedded mudstone and very fine-fine grained silty sandstone. Minor chlorite present in one quartz vein
							47.90	48.00	LOST CORE	LOST CORE	LOST CORE	LOST CORE	LOST CORE	LOST CORE	LOST CORE	LOST CORE	LOST CORE	LOST CORE	LOST CORE
48.00	49.50	1.50	100.0	1.20	80.00	1	48.00	49.50	18,5	11.5	Planar	Slightly Rough	Isolated (6->12cm)	70°	Medium-Dark Grey	Interbedded Mudstone/Sandstone	Sandstone	Pyrite	Interbedded mudstone and very fine-fine grained silty sandstone. Trace pyrite (2 x 1cm nodules)
49.50	51.00	1.50	100.0	0.93	62.00	2	49.50	51.00	23,27	25	Irregular	Striated	Isolated (6->12cm)	80°	Dark Grey	Mudstone	-	Quartz Vein(s) cm scale	Silty mudstone. Minor chlorite in quartz vein.

Run Depth		Core Recovery		RQD Length (Pieces >10cm) [m]	RQD length /run length x100 [%]	Number of Joints (per run)	Core Depth		Schmidt Hammer Tests		Joint Details				Colour	Major Lithology	Minor Lithology	Features	Comments
From [m]	To [m]	Rec. [m]	Rec. [%]				From [m]	To [m]	Test 'R' Values	Avg 'R' Value	Geometry	Roughness	Spacing	Joint Angle [°]					
51.00	52.50	1.40	93.33	0.63	42.00	2.00	51.00	52.40	35,24	29.5	Irregular	Smooth	Isolated (6->12cm)	40°	Dark Grey	Mudstone	-	-	Silty mudstone.
							52.40	52.50	LOST CORE	LOST CORE	LOST CORE	LOST CORE	LOST CORE	LOST CORE	LOST CORE	LOST CORE	LOST CORE	LOST CORE	LOST CORE
52.50	54.00	1.50	100.0	0.32	21.33	8	52.50	54.00	12,14	13	Irregular	Striated	Isolated (6->12cm)	65°	Dark Grey	Mudstone	-	-	Silty mudstone.
54.00	55.50	1.00	66.67	0.00	0.00	~10	54.00	55.00	0	0	-	-	-	-	Dark Grey	Mudstone	-	Quartz Vein(s) mm scale	Weathered silty mudstone
							55.00	55.50	LOST CORE	LOST CORE	LOST CORE	LOST CORE	LOST CORE	LOST CORE	LOST CORE	LOST CORE	LOST CORE	LOST CORE	LOST CORE
55.50	57.00	1.55	103.3	1.00	66.67	5	55.50	57.00	5,28	16.5	Irregular	Slightly Rough	Isolated (6->12cm)	85°	Dark Grey	Mudstone	-	Quartz Vein(s) mm scale	Weathered silty mudstone
57.00	58.50	1.45	96.67	0.99	66.00	2.00	57.00	58.45	13,17	15	-	-	-	-	Dark Grey	Interbedded Mudstone/Siltstone	-	Quartz Stringers	Weathered silty mudstone
							58.45	58.50	LOST CORE	LOST CORE	LOST CORE	LOST CORE	LOST CORE	LOST CORE	LOST CORE	LOST CORE	LOST CORE	LOST CORE	LOST CORE
58.50	60.00	1.45	96.67	0.93	62.00	2.00	58.50	59.95	5,21	13	Irregular	Slightly Rough	Isolated (6->12cm)	50°	Dark Grey	Interbedded Mudstone/Siltstone	-	Quartz Stringers	Weathered silty mudstone
							59.95	60.00	LOST CORE	LOST CORE	LOST CORE	LOST CORE	LOST CORE	LOST CORE	LOST CORE	LOST CORE	LOST CORE	LOST CORE	LOST CORE
60.00	61.50	1.43	95.33	1.15	76.67	4.00	60.00	61.43	10,5	7.5	Planar	Striated	Isolated (6->12cm)	55°	Medium Grey	Interbedded Mudstone/Sandstone	Mudstone	Quartz Stringers	Interbedded very fine-fine grained silty sandstone and mudstone
							61.43	61.50	LOST CORE	LOST CORE	LOST CORE	LOST CORE	LOST CORE	LOST CORE	LOST CORE	LOST CORE	LOST CORE	LOST CORE	LOST CORE
61.50	63.00	1.45	96.67	0.65	43.33	7.00	61.50	62.95	24,16	20	Planar	Slightly Rough	Isolated (6->12cm)	45°	Medium Grey	Interbedded Mudstone/Sandstone	Mudstone	Quartz Stringers	Interbedded very fine-fine grained silty sandstone and mudstone
							62.95	63.00	LOST CORE	LOST CORE	LOST CORE	LOST CORE	LOST CORE	LOST CORE	LOST CORE	LOST CORE	LOST CORE	LOST CORE	LOST CORE
63.00	64.50	1.45	96.67	0.00	0.00	>20	63.00	64.45	0	0	-	-	-	-	Medium-Dark Grey	Interbedded Mudstone/Sandstone	Sandstone	Quartz Vein(s) mm scale	Interbedded very fine-fine grained silty sandstone and mudstone. Weathered.
							64.45	64.50	LOST CORE	LOST CORE	LOST CORE	LOST CORE	LOST CORE	LOST CORE	LOST CORE	LOST CORE	LOST CORE	LOST CORE	LOST CORE
64.50	66.00	0.78	52.00	0.00	0.00	4.00	64.50	65.28	0	0	-	-	-		Medium-Dark Grey	Interbedded Mudstone/Sandstone	Sandstone	Quartz Vein(s) mm scale	Interbedded very fine-fine grained silty sandstone and mudstone. Weathered.
							65.28	66.00	LOST CORE	LOST CORE	LOST CORE	LOST CORE	LOST CORE	LOST CORE	LOST CORE	LOST CORE	LOST CORE	LOST CORE	LOST CORE
66.00	67.50	1.50	100.0	1.07	71.33	3	66.00	67.50	11,12	11.5	Irregular	Striated	Isolated (6->12cm)	40°	Medium-Dark Grey	Interbedded Mudstone/Siltstone	Siltstone	Quartz Vein(s) mm scale	Interbedded mudstone and siltstone
67.50	69.00	1.50	100.0	0.29	19.33	7	67.50	69.00	26,21	23.5	Irregular	Slightly Rough	Isolated (6->12cm)	60°	Medium-Dark Grey	Interbedded Mudstone/Sandstone	Mudstone	Quartz Vein(s) mm scale	Interbedded mudstone and very-fine to fine grained silty sandstone
69.00	70.50	1.50	100.0	0.23	15.33	~6	69.00	70.50	10,0	5	Planar	Slightly Rough	Isolated (6->12cm)	90°	Medium-Dark Grey	Interbedded Mudstone/Sandstone	Sandstone	Quartz Vein(s) mm scale	Interbedded mudstone and very fine-fine grained silty sandstone. Nearly vertical bedding.
70.50	72.00	1.50	100.0	0.00	0.00	8	70.50	72.00	5,22	13.5	Irregular	Striated	Occasional (3-6cm)	50°	Medium-Dark Grey	Interbedded Mudstone/Sandstone	Sandstone	Quartz Vein(s) cm scale	Interbedded mudstone and very fine-fine grained silty sandstone. Nearly vertical bedding.
72.00	73.50	1.50	100.0	0.00	0.00	11	72.00	73.50	12,13	12.5	Irregular	Slightly Rough	Occasional (3-6cm)	80°	Medium-Dark Grey	Interbedded Mudstone/Sandstone	Sandstone	Quartz Vein(s) mm scale	Interbedded mudstone and very fine-fine grained silty sandstone. Nearly vertical bedding.
73.50	75.00	1.45	96.67	0.56	37.33	~6	73.50	74.95	10,12	11	-	-	-	-	Medium-Dark Grey	Interbedded Mudstone/Sandstone	Sandstone	Quartz Vein(s) cm scale	Interbedded mudstone and very fine-fine grained silty sandstone. Nearly vertical bedding. Abundant quartz, with minor chlorite in quartz veins.
							74.95	75.00	LOST CORE	LOST CORE	LOST CORE	LOST CORE	LOST CORE	LOST CORE	LOST CORE	LOST CORE	LOST CORE	LOST CORE	LOST CORE
75.00	76.50	1.48	98.67	0.77	51.33	1.00	75.00	76.48	12,17	14.5	Planar	Smooth	Occasional (3-6cm)	80°	Medium-Dark Grey	Interbedded Mudstone/Sandstone	Sandstone	Quartz Vein(s) cm scale	Interbedded mudstone and very fine-fine grained silty sandstone. Nearly vertical bedding. Abundant quartz, with minor chlorite in quartz veins.
							76.48	76.50	LOST CORE	LOST CORE	LOST CORE	LOST CORE	LOST CORE	LOST CORE	LOST CORE	LOST CORE	LOST CORE	LOST CORE	LOST CORE
76.50	78.00	1.50	100.0	1.43	95.33	1			12,30	21	Planar	Smooth	Isolated (6->12cm)	85°	Medium-Dark Grey	Interbedded Mudstone/Sandstone	Sandstone		Interbedded mudstone and very fine-fine grained sandstone. Nearly vertical bedding.
78.00	79.50	1.40	93.33	0.92	61.33	2.00	78.00	79.40	22,25	23.5	Planar	Smooth	Isolated (6->12cm)	65°	Medium-Dark Grey	Interbedded Mudstone/Sandstone	Sandstone		Interbedded mudstone and very fine-fine grained sandstone. Nearly vertical bedding.
							79.40	79.50	LOST CORE	LOST CORE	LOST CORE	LOST CORE	LOST CORE	LOST CORE	LOST CORE	LOST CORE	LOST CORE	LOST CORE	LOST CORE
79.50	81.00	1.50	100.0	0.47	31.33	2	79.50	81.00	35,31	33	Irregular	Striated	Isolated (6->12cm)	80°	Medium-Dark Grey	Interbedded Mudstone/Sandstone	Sandstone	Quartz Vein(s) cm scale	Interbedded mudstone and very fine-fine grained sandstone. Nearly vertical bedding.

Run Depth		Core Recovery		RQD Length (Pieces >10cm) [m]	RQD length /run length x100 [%]	Number of Joints (per run)	Core Depth		Schmidt Hammer Tests		Joint Details				Colour	Major Lithology	Minor Lithology	Features	Comments
From [m]	To [m]	Rec. [m]	Rec. [%]				From [m]	To [m]	Test 'R' Values	Avg 'R' Value	Geometry	Roughness	Spacing	Joint Angle [°]					
81.00	82.50	1.50	100.0	1.27	84.67	0	81.00	82.50	5,20	12.5	-	-	-	-	Medium Grey	Interbedded Mudstone/Sandstone	Mudstone	Quartz Vein(s) cm scale	Interbedded very fine-fine grained sandstone and mudstone. Nearly vertical bedding.
82.50	84.00	1.50	100.0	0.67	44.67	10	82.50	84.00	10,11	10.5	-	-	-	-	Medium Grey	Interbedded Mudstone/Sandstone	Mudstone	Quartz Vein(s) cm scale	Interbedded very fine-fine grained sandstone and mudstone. Nearly vertical bedding.
84.00	85.50	1.48	98.67	0.19	12.67	2.00	84.00	85.48	0	0	-	-	-	-	Medium Grey	Interbedded Mudstone/Sandstone	Mudstone	Quartz Vein(s) cm scale	Interbedded very fine-fine grained sandstone and mudstone. Nearly vertical bedding.
							85.48	85.50	LOST CORE	LOST CORE	LOST CORE	LOST CORE	LOST CORE	LOST CORE	LOST CORE	LOST CORE	LOST CORE	LOST CORE	LOST CORE
85.50	85.75	0.25	100.00	0.00	0.00	-	85.50	85.75	-	-	-	-	-	-	Medium Grey	Interbedded Mudstone/Sandstone	Mudstone	-	Interbedded very fine-fine grained sandstone and mudstone. Very broken up, rubbly.
							85.75	85.75	LOST CORE	LOST CORE	LOST CORE	LOST CORE	LOST CORE	LOST CORE	LOST CORE	LOST CORE	LOST CORE	LOST CORE	LOST CORE

TERRACON GEOTECHNIQUE

CLIENT: Arctos Anthracite Joint Venture
PROJECT NUMBER: 122781

HOLE ID: MW-24/GD-12
PROJECT LOCATION: Arctos Anthracite Property

DATE STARTED: July 28,2013 COMPLETED: Aug. 1,2
DRILL CONTRACTOR: Driftwood RIG #:
HOLE SIZE: HQ
DRILLING METHOD: Diamond
LOGGED BY: GJM/Zack CHECKED BY:

Ground Elevation [masl] 1585
Easting 508158.0
Northing 6343261.0
Water Table Depth [m]
Total Depth [m] 100.50m

COMMENTS:

Run Depth		Core Recovery		RQD Length (Pieces >10cm) [m]	RQD length /run length x100 [%]	Number of Joints (per run)	Core Depth		Schmidt Hammer Tests		Joint Details				Colour	Major Lithology	Minor Lithology	Bedding Type	Features	Comments
From [m]	To [m]	Rec. [m]	Rec. [%]				From [m]	To [m]	Test 'R' Values	Avg 'R' Value	Geometry	Roughness	Spacing	Joint Angle [°]						
0	1.5	0.8	53.333	0.25	16.66667	NA	0	0.8	NA	NA	n/a	n/a	n/a	n/a	Brown-Grey	Overburden	-	-	-	Sand and clay, some organics, soft, PP:1.5-2
							0.8	1.5	LOST CORE	LOST CORE	LOST CORE	LOST CORE	LOST CORE	LOST CORE	LOST CORE	LOST CORE	LOST CORE	LOST CORE	LOST CORE	LOST CORE
1.5	3	0.5	33.333	0	0	NA	1.5	2	NA	NA	n/a	n/a	Abundant (<1cm)	n/a	-	Glacial Till	-	n/a	Quartz Vein(s) cm scale	Claytill, oxidation orange, highly weathered, some gravel,soft.
							2	3	LOST CORE	LOST CORE	LOST CORE	LOST CORE	LOST CORE	LOST CORE	LOST CORE	LOST CORE	LOST CORE	LOST CORE	LOST CORE	LOST CORE
3	3.25	0.25	100	SPT	SPT	SPT	SPT	SPT	SPT	SPT	SPT	SPT	SPT	SPT	SPT	SPT	SPT	SPT	SPT	
3.25	4.5	1	80	0.13	8.666667	3	3.25	4.25	25,32	28.5	n/a	n/a	Occasional (3-6cm)	n/a	Brown	Glacial Till	-	-	-	Claytill, some sandstone <5cm
							4.25	4.5	LOST CORE	LOST CORE	LOST CORE	LOST CORE	LOST CORE	LOST CORE	LOST CORE	LOST CORE	LOST CORE	LOST CORE	LOST CORE	LOST CORE
4.5	4.7	0.2	100	SPT	SPT	SPT	SPT	SPT	SPT	SPT	SPT	SPT	SPT	SPT	SPT	SPT	SPT	SPT	SPT	Sand and Gravel, trace clay, dark brown.
4.70	6.00	0.55	42.308	0.19	12.67	0	4.7	5.45	LOST CORE	LOST CORE	LOST CORE	LOST CORE	LOST CORE	LOST CORE	LOST CORE	LOST CORE	LOST CORE	LOST CORE	LOST CORE	LOST CORE
							5.45	5.70			n/a	n/a		n/a	-	Glacial Till	-	-	-	Gravel, claytill, 10% clay, cm pieces.
							5.7	6.00	28,40,38	35.3	n/a	n/a	Isolated (6->12cm)	n/a	Medium Grey	Sandstone	-	Massive	-	fine grain, 50 deg contact.
6	7.5	0.6	40	0	0	3	6	6.6	0	0	n/a	n/a	Numerous (1-3cm)	n/a	Medium Grey	Sandstone	-	-	-	within fault gouge, mm-cm angular clasts, hard, very weathered, grey-orange oxidation, high silt-clay content. PP: 4.5
							6.6	7.5	LOST CORE	LOST CORE	LOST CORE	LOST CORE	LOST CORE	LOST CORE	LOST CORE	LOST CORE	LOST CORE	LOST CORE	LOST CORE	LOST CORE
7.5	7.83	0.33	100	SPT	SPT	SPT	SPT	SPT	SPT	SPT	SPT	SPT	SPT	SPT	SPT	SPT	SPT	SPT	SPT	Clay, some angular clasts, dark grey.
7.83	9	0.8	68.376	0.35	23.33333	0	7.83	8.63	0	0	n/a	n/a	Numerous (1-3cm)	n/a	Medium Grey	Sandstone	-	-	-	within fault gouge, sandstone clasts <10cm, high silt clay content, hard, PP: 4.5
							8.63	9	LOST CORE	LOST CORE	LOST CORE	LOST CORE	LOST CORE	LOST CORE	LOST CORE	LOST CORE	LOST CORE	LOST CORE	LOST CORE	LOST CORE
9	9.22	0.22	100	SPT	SPT	SPT	SPT	SPT	SPT	SPT	SPT	SPT	SPT	SPT	SPT	SPT	SPT	SPT	SPT	Clay, trace angular clasts, dark grey, low plast, till.
9.22	10.50	1.10	85.938	0.62	41.33	8	9.22	9.4	LOST CORE	LOST CORE	LOST CORE	LOST CORE	LOST CORE	LOST CORE	LOST CORE	LOST CORE	LOST CORE	LOST CORE	LOST CORE	LOST CORE
							9.4	9.9	0	0	n/a	n/a	Isolated (6->12cm)	n/a	Medium Grey	Sandstone	-	-	Quartz-Carbonate	Within fault gouge,hard, angular clasts <3cm, highly weathered, trace mm Qtz-carbonate veins, PP:4.5
							9.9	10.5	0	0	n/a	n/a	Isolated (6->12cm)	n/a	Medium Grey	Mudstone	-	-	Mud clasts	Hard, very angular clasts, weathered, PP: 4.5
10.5	10.8	0.2	66.667	SPT	SPT	SPT	SPT	SPT	SPT	SPT	SPT	SPT	SPT	SPT	SPT	SPT	SPT	SPT	SPT	Clay, trace gravels, dark grey, mod plast.
10.8	12	0.85	283.33	0.21	14	1	10.8	11.15	LOST CORE	LOST CORE	LOST CORE	LOST CORE	LOST CORE	LOST CORE	LOST CORE	LOST CORE	LOST CORE	LOST CORE	LOST CORE	LOST CORE
							11.15	12	0	0	n/a	n/a	Occasional (3-6cm)	n/a	Dark Grey	Mudstone	Sandstone	Massive	-	Hard, some angular clasts, fine grained sand
12	13.5	1.4	93.333	1.15	76.67	0	12	13.4	0	0	n/a	n/a	Isolated (6->12cm)	n/a	Medium Grey	Mudstone	-	-	Quartz Vein(s) mm scale	within fault gouge, hard, angular mud clasts, weathered, sand and clasts
							13.4	13.5	LOST CORE	LOST CORE	LOST CORE	LOST CORE	LOST CORE	LOST CORE	LOST CORE	LOST CORE	LOST CORE	LOST CORE	LOST CORE	LOST CORE
13.5	15	1.05	70	0	0	1	13.5	14.55	0	0	Planar	Slightly Rough	Isolated (6->12cm)	40°	Dark Grey-Black	Mudstone	Anthracite Coal	Massive	Quartz Vein(s) mm scale	Weathered
							14.55	15	LOST CORE	LOST CORE	LOST CORE	LOST CORE	LOST CORE	LOST CORE	LOST CORE	LOST CORE	LOST CORE	LOST CORE	LOST CORE	LOST CORE
15	16.5	1	66.667	0.12	8	0	15	16	0	0	n/a		Isolated (6->12cm)	n/a	Dark Grey	Mudstone	Anthracite Coal	Massive	-	Hard
							16	16.5	LOST CORE	LOST CORE	LOST CORE	LOST CORE	LOST CORE	LOST CORE	LOST CORE	LOST CORE	LOST CORE	LOST CORE	LOST CORE	LOST CORE
16.5	18	1.40	93.333	0.48	32.00	3	16.5	17.9	0	0	Planar	Smooth	Isolated (6->12cm)	50°	Dark Grey	Mudstone	-	Massive	-	Fine grained sand, hard, qtz on fracture surface
							17.9	18	LOST CORE	LOST CORE	LOST CORE	LOST CORE	LOST CORE	LOST CORE	LOST CORE	LOST CORE	LOST CORE	LOST CORE	LOST CORE	LOST CORE

Run Depth		Core Recovery		RQD Length (Pieces >10cm) [m]	RQD length /run length x100 [%]	Number of Joints (per run)	Core Depth		Schmidt Hammer Tests		Joint Details				Colour	Major Lithology	Minor Lithology	Bedding Type	Features	Comments
From [m]	To [m]	Rec. [m]	Rec. [%]				From [m]	To [m]	Test 'R' Values	Avg 'R' Value	Geometry	Roughness	Spacing	Joint Angle [°]						
18	19.5	1.2	80	0.5	33.33333	4	18	19.2	14	14	Planar	Smooth	Isolated (6->12cm)	40°	Dark Grey	Mudstone	-	Massive	Quartz Stringers	Fine grained sand
							19.2	19.5	LOST CORE	LOST CORE	LOST CORE	LOST CORE	LOST CORE	LOST CORE	LOST CORE	LOST CORE	LOST CORE	LOST CORE	LOST CORE	LOST CORE
19.5	21	1.27	84.667	0.9	60.00	4	19.5	20.77	5	5	Planar	Smooth	Isolated (6->12cm)	n/a	Dark Grey-Black	Mudstone	Anthracite Coal	-	-	Broken quartz cm scale, coal stringers/bands <1cm
							20.77	21	LOST CORE	LOST CORE	LOST CORE	LOST CORE	LOST CORE	LOST CORE	LOST CORE	LOST CORE	LOST CORE	LOST CORE	LOST CORE	LOST CORE
21.00	22.50	1.45	96.667	0.13	61.90		21	21.21	0	0	n/a		Isolated (6->12cm)	n/a	Light Grey	Siltstone	-	Massive	n/a	Soft, weathered
						4	21.21	22.5	0	0	Planar	Polished	Isolated (6->12cm)	30°	Dark Grey-Black	Mudstone	Anthracite Coal	-	Quartz Stringers	Qtz stringers cm scale, coal mm-cm bands and stringers
22.5	24	1.15	76.667	0.48	32	3	22.5	23.65	13	13	Planar	Smooth	Isolated (6->12cm)	60°	Brown-Grey	Mudstone	-	Massive	-	Soft
							23.65	24	LOST CORE	LOST CORE	LOST CORE	LOST CORE	LOST CORE	LOST CORE	LOST CORE	LOST CORE	LOST CORE	LOST CORE	LOST CORE	LOST CORE
24	25.5	1.33	88.667	0.78	52	3	24	24.17	LOST CORE	LOST CORE	LOST CORE	LOST CORE	LOST CORE	LOST CORE	LOST CORE	LOST CORE	LOST CORE	LOST CORE	LOST CORE	LOST CORE
							24.17	25.2					Isolated (6->12cm)	40°	Medium-Dark Grey	Mudstone	Anthracite Coal	Massive	n/a	weathered and soft
							25.2	25.5	14,11	12.5	Planar	Slightly Rough	Occasional (3-6cm)		Dark Grey	Mudstone	-	Massive	n/a	brittle
25.5	27	1.41	94	0.39	26	9	25.5	26.91	17,20	18.5	Planar	Smooth	Occasional (3-6cm)	40°	Dark Grey	Mudstone	Anthracite Coal	Massive	Quartz Vein(s) mm scale	trace sandstone clasts, brittle.
							26.91	27	LOST CORE	LOST CORE	LOST CORE	LOST CORE	LOST CORE	LOST CORE	LOST CORE	LOST CORE	LOST CORE	LOST CORE	LOST CORE	LOST CORE
27	28.5	1.42	94.667	0.42	28	15	27	27.08	LOST CORE	LOST CORE	LOST CORE	LOST CORE	LOST CORE	LOST CORE	LOST CORE	LOST CORE	LOST CORE	LOST CORE	LOST CORE	LOST CORE
							27.08	1.42	0	0	Irregular	Smooth	Isolated (6->12cm)	25	Dark Grey	Mudstone	Anthracite Coal	Interbedded	Quartz Vein(s) mm scale	<1cm coal band.
							1.42	28.5	0	0	Planar	Slightly Rough	Isolated (6->12cm)	50°	Dark Grey	Mudstone				-
28.5	30	1.32	88	0.55	36.66667	8	28.5	28.68	LOST CORE	LOST CORE	LOST CORE	LOST CORE	LOST CORE	LOST CORE	LOST CORE	LOST CORE	LOST CORE	LOST CORE	LOST CORE	LOST CORE
							28.68	30	16,14	15	Planar	Slightly Rough	Isolated (6->12cm)	40°	Medium Grey	Sandstone	Siltstone	Interbedded	-	Siltstone and sandstone, fine grained, 30-40 bedding angle.
30	31.5	1.33	88.667	0.22	14.66667	10	30	30.17	LOST CORE	LOST CORE	LOST CORE	LOST CORE	LOST CORE	LOST CORE	LOST CORE	LOST CORE	LOST CORE	LOST CORE	LOST CORE	LOST CORE
							30.17	31.2	0	0	Planar	Polished	Occasional (3-6cm)	50°	Dark Grey-Black	Mudstone	Anthracite Coal	Interbedded	n/a	<1cm coal
							31.2	31.5	0	0	Planar	Polished		20°	Dark Grey-Black	Mudstone	Anthracite Coal	Interbedded	-	-
31.5	33	0.99	66	0	0	10	31.5	32.49	18,16	17	Curved	Polished	Occasional (3-6cm)	80°	Dark Grey-Black	bedded Mudstone/Sand	Anthracite Coal	Interbedded	Quartz Vein(s) cm scale	20% sandstone
							32.49	33	LOST CORE	LOST CORE	LOST CORE	LOST CORE	LOST CORE	LOST CORE	LOST CORE	LOST CORE	LOST CORE	LOST CORE	LOST CORE	LOST CORE
33	34.5	0.89	59.333	0.26	17.33333	8	33	33.3	LOST CORE	LOST CORE	LOST CORE	LOST CORE	LOST CORE	LOST CORE	LOST CORE	LOST CORE	LOST CORE	LOST CORE	LOST CORE	LOST CORE
							33.3	33.6	12,20	16	Planar	Smooth	Numerous (1-3cm)	30°	Dark Grey-Black	Mudstone	Anthracite Coal	Interbedded	Quartz Vein(s) cm scale	-
							33.6	33.9							Light Grey	Siltstone	-	Massive	-	Hard
							33.9	34.19							Dark Grey	Mudstone	Anthracite Coal	Interbedded	Quartz Vein(s) cm scale	-
							34.19	34.5	LOST CORE	LOST CORE	LOST CORE	LOST CORE	LOST CORE	LOST CORE	LOST CORE	LOST CORE	LOST CORE	LOST CORE	LOST CORE	LOST CORE
34.5	36	1.22	81.333	0.3	20	12	34.5	34.78	LOST CORE	LOST CORE	LOST CORE	LOST CORE	LOST CORE	LOST CORE	LOST CORE	LOST CORE	LOST CORE	LOST CORE	LOST CORE	LOST CORE
							34.78	35.25						50°	Dark Grey	Mudstone	Anthracite Coal	Massive	Quartz Vein(s) mm scale	-
							35.25	35.45	0	0	Planar	Slightly Rough	Isolated (6->12cm)	50°	Medium Grey	Siltstone	-	Massive	-	Hard, lower contact 50 deg.
							35.45	36							Brown	bedded Mudstone/Sand	Anthracite Coal	Interbedded	n/a	Coal 1cm.
36	37.5	1.35	90	0.61	40.66667	7	36	36.15	LOST CORE	LOST CORE	LOST CORE	LOST CORE	LOST CORE	LOST CORE	LOST CORE	LOST CORE	LOST CORE	LOST CORE	LOST CORE	LOST CORE
							36.15	36.6	0	0	Planar	Smooth	Isolated (6->12cm)	60°	Medium Grey	Siltstone	Sandstone	Interbedded	Quartz Stringers	-
							36.6	37.5							Medium Grey	Mudstone	Siltstone	Interbedded	Quartz Stringers	-
37.5	39	1.31	87.333	0.73	48.66667	8	37.5	37.69	LOST CORE	LOST CORE	LOST CORE	LOST CORE	LOST CORE	LOST CORE	LOST CORE	LOST CORE	LOST CORE	LOST CORE	LOST CORE	LOST CORE
							37.5	38.37	34,36	35	Planar	Slightly Rough	Isolated (6->12cm)	30°	Medium Grey	Mudstone	Sandstone	Interbedded	Quartz Vein(s) mm scale	-
							38.37	38.55			Planar	Smooth		30°	Light Grey	Siltstone	n/a	Massive	-	Hard
							38.55	39							Dark Grey-Black	Mudstone	Anthracite Coal	Interbedded	Quartz Vein(s) mm scale	30% Qtz mm

Run Depth		Core Recovery		RQD Length (Pieces >10cm) [m]	RQD length /run length x100 [%]	Number of Joints (per run)	Core Depth		Schmidt Hammer Tests		Joint Details				Colour	Major Lithology	Minor Lithology	Bedding Type	Features	Comments
From [m]	To [m]	Rec. [m]	Rec. [%]				From [m]	To [m]	Test 'R' Values	Avg 'R' Value	Geometry	Roughness	Spacing	Joint Angle [°]						
39	40.5	1.41	94	0.39	26	14	39	39.09	LOST CORE	LOST CORE	LOST CORE	LOST CORE	LOST CORE	LOST CORE	LOST CORE	LOST CORE	LOST CORE	LOST CORE	LOST CORE	LOST CORE
							39.09	39.6	14,16	15	Planar	Slightly Rough	Isolated (6->12cm)	40°	Dark Brown	Mudstone	Anthracite Coal	Massive	Quartz Vein(s) mm scale	Soft
							39.6	40.15			Curved	Smooth		70°	Brown-Grey	Siltstone	-	Massive	n/a	-
							40.15	40.5							Dark Brown	Mudstone	-	Massive	n/a	-
40.5	42	1.37	91.333	0.39	26	12	40.5	40.63	LOST CORE	LOST CORE	LOST CORE	LOST CORE	LOST CORE	LOST CORE	LOST CORE	LOST CORE	LOST CORE	LOST CORE	LOST CORE	LOST CORE
							40.63	41.7	0	0	Planar	Very Rough	Isolated (6->12cm)	60°	Medium-Dark Grey	bedded Mudstone/Sand	Mudstone	Interbedded	n/a	-
							41.7	42			-	-	-	-	Medium Grey	Sandstone	-	Massive	n/a	Final 5cm mudstone
42	43.5	1.42	94.667	1.23	82	6	42.08	43.42	19,21	20	Planar	Slightly Rough	Isolated (6->12cm)	30°	Medium Grey	Sandstone	Siltstone	Interbedded	Quartz Stringers	mm silt layers, similar to above, 5cm at final of run.
							43.42	43.5	LOST CORE	LOST CORE	LOST CORE	LOST CORE	LOST CORE	LOST CORE	LOST CORE	LOST CORE	LOST CORE	LOST CORE	LOST CORE	LOST CORE
43.5	45	1.35	90	0.46	30.66667	4	43.5	44.85	27,26	27.5	-	-	Occasional (3-6cm)	-	Medium Grey	Sandstone	Mudstone	Interbedded	Quartz Vein(s) cm scale	vuggy Qtz vein.
							44.85	45	LOST CORE	LOST CORE	LOST CORE	LOST CORE	LOST CORE	LOST CORE	LOST CORE	LOST CORE	LOST CORE	LOST CORE	LOST CORE	LOST CORE
45	46.5	1.36	90.667	0.86	57.33333	8	45	46.36	31,34	32.5	Planar	Smooth	Occasional (3-6cm)	15°	Light Grey	Sandstone	Mudstone	Interbedded	Quartz Vein(s) mm scale	Mudstone, dm size layer
							46.36	46.5	LOST CORE	LOST CORE	LOST CORE	LOST CORE	LOST CORE	LOST CORE	LOST CORE	LOST CORE	LOST CORE	LOST CORE	LOST CORE	LOST CORE
46.5	48	1.37	91.333	0.67	44.66667	8	46.5	46.63	LOST CORE	LOST CORE	LOST CORE	LOST CORE	LOST CORE	LOST CORE	LOST CORE	LOST CORE	LOST CORE	LOST CORE	LOST CORE	LOST CORE
							46.63	46.9	12,15	13.5	-	-	Isolated (6->12cm)	-	Light Grey	Sandstone	Mudstone	Interbedded	Quartz Vein(s) mm scale	mm mudstone laminae
							46.9	47.65					-	-	Dark Brown	Mudstone	Sandstone	Interbedded	Quartz Stringers	Qtz weathered and vertical.
							47.65	47.9					-	-	Light Grey	Sandstone	Mudstone	Interbedded	n/a	-
							47.9	48					-	-	Dark Grey-Black	Mudstone	Sandstone	Interbedded	Quartz Vein(s) mm scale	-
48	49.5	1.33	88.667	0.93	62	1	48	48.17	LOST CORE	LOST CORE	LOST CORE	LOST CORE	LOST CORE	LOST CORE	LOST CORE	LOST CORE	LOST CORE	LOST CORE	LOST CORE	LOST CORE
							48.17	48.37	28,30	29	Planar	Smooth	Isolated (6->12cm)	40°	Light Grey	Sandstone	Anthracite Coal	Massive	Quartz Stringers	Coal clasts
							48.37	48.95							Light Grey	Sandstone and Mudston	Anthracite Coal	Interbedded	Quartz Vein(s) cm scale	Pebble size-med grain,well sorted, mud:20%
							48.95	49.5							Light Grey	Sandstone	Mudstone	Massive	Clasts-Assorted	vertical fractures, vertical Qtz stringers, coarse grained, well sorted. 5cm Qtz 1-2cm crystals, weathered.
49.5	51	1.43	95.333	1.17	78	4	49.5	50.93	14,14	14	Planar	Slightly Rough	Isolated (6->12cm)	20°	Light Grey	Sandstone	Mudstone	Massive	Quartz Vein(s) mm scale	Mudstone stringers
							50.93	51	LOST CORE	LOST CORE	LOST CORE	LOST CORE	LOST CORE	LOST CORE	LOST CORE	LOST CORE	LOST CORE	LOST CORE	LOST CORE	LOST CORE
51	52.5	1.5	100	1.02	68.00	-	51	52.25	16,15	15.5	Planar	Smooth	Isolated (6->12cm)	40°	Light Grey	Sandstone		Massive	Quartz Vein(s) mm scale	trace light grey clay
							52.25	52.5							Light Grey	Sandstone		Massive	Quartz Vein(s) cm scale	coarse grain sand, fractures 50 deg
52.5	54	0.86	57.333	0.5	33.33333	-	52.5	53.36	0	0	-	-	Occasional (3-6cm)	-	Light Grey	Sandstone	Anthracite Coal	n/a	Quartz Vein(s) cm scale	numerous cm Qtz veins, coarse grained sand.
							53.36	54	LOST CORE	LOST CORE	LOST CORE	LOST CORE	LOST CORE	LOST CORE	LOST CORE	LOST CORE	LOST CORE	LOST CORE	LOST CORE	LOST CORE
54	55.5	1.39	92.667	0.63	42	6	54	54.11	LOST CORE	LOST CORE	LOST CORE	LOST CORE	LOST CORE	LOST CORE	LOST CORE	LOST CORE	LOST CORE	LOST CORE	LOST CORE	LOST CORE
							54.11	54.2	31,34	32.5	Planar	Smooth	Isolated (6->12cm)	30°	Light Grey	Sandstone		Massive	n/a	Coarse grained
							54.2	55.4							Light Grey	Sandstone	Mudstone	Interbedded	Quartz Stringers	Fine grained, trace mm coal.
							55.4	55.5							Dark Grey	Siltstone	-	-	-	-
55.5	57	1.16	77.333	0.12	8	15	55.5	56.66	0	0	Planar	Slightly Rough	Occasional (3-6cm)	20°	Medium-Dark Grey	Siltstone	Sandstone	Interbedded	Quartz Vein(s) mm scale	Coal 1%,
							56.66	57	LOST CORE	LOST CORE	LOST CORE	LOST CORE	LOST CORE	LOST CORE	LOST CORE	LOST CORE	LOST CORE	LOST CORE	LOST CORE	LOST CORE
57	58.5	1.05	70	0.3	20	8	57	57.45	LOST CORE	LOST CORE	LOST CORE	LOST CORE	LOST CORE	LOST CORE	LOST CORE	LOST CORE	LOST CORE	LOST CORE	LOST CORE	LOST CORE
							57.45	58.3	20,14	17	Planar	Polished	Occasional (3-6cm)	20°	Dark Grey	rbedded Mudstone/Silts	Anthracite Coal	Interbedded	Quartz Vein(s) mm scale	-
							58.3	58.5							Black	Anthracite Coal	Mudstone	Massive	Quartz Vein(s) mm scale	-
58.5	60	0.91	60.667	0	0	15	58.5	59.09	LOST CORE	LOST CORE	LOST CORE	LOST CORE	LOST CORE	LOST CORE	LOST CORE	LOST CORE	LOST CORE	LOST CORE	LOST CORE	LOST CORE
							59.09	59.8	0	0	-	-	Numerous (1-3cm)	-	Black	Anthracite Coal	Mudstone	Interbedded	Quartz Vein(s) mm scale	Also 20cm brown clay
							59.8	60			-	-	-	-	Medium Grey	Siltstone	Anthracite Coal	Interbedded	n/a	Hard

Run Depth		Core Recovery		RQD Length (Pieces >10cm) [m]	RQD length /run length x100 [%]	Number of Joints (per run)	Core Depth		Schmidt Hammer Tests		Joint Details				Colour	Major Lithology	Minor Lithology	Bedding Type	Features	Comments
From [m]	To [m]	Rec. [m]	Rec. [%]				From [m]	To [m]	Test 'R' Values	Avg 'R' Value	Geometry	Roughness	Spacing	Joint Angle [°]						
60	61.5	1.25	83.333	0.27	18	-	60	61.25	12,18	15	-	-	-	-	Dark Grey-Black	Siltstone	Mudstone	Interbedded	Quartz Vein(s) cm scale	Coal:10%, mm,<2cm, Dm silt bands.
							61.25	61.5	LOST CORE	LOST CORE	LOST CORE	LOST CORE	LOST CORE	LOST CORE	LOST CORE	LOST CORE	LOST CORE	LOST CORE	LOST CORE	LOST CORE
61.5	63	1.18	78.667	0.67	44.66667	14	61.5	62.68	15,18	16.5	Planar	Slightly Rough	Numerous (1-3cm)	20°	Dark Grey-Black	bedded Anthracite/Mud	Siltstone	Interbedded	Quartz Stringers	
							62.68	63	LOST CORE	LOST CORE	LOST CORE	LOST CORE	LOST CORE	LOST CORE	LOST CORE	LOST CORE	LOST CORE	LOST CORE	LOST CORE	LOST CORE
63	64.5	1.32	88	0	0	12	63	64.32	24,24	24	Curved	Polished	Isolated (6->12cm)	60°	Dark Grey	nterbedded Siltstone/Co	Mudstone	Interbedded	Quartz Vein(s) mm scale	
							64.32	64.5	LOST CORE	LOST CORE	LOST CORE	LOST CORE	LOST CORE	LOST CORE	LOST CORE	LOST CORE	LOST CORE	LOST CORE	LOST CORE	LOST CORE
64.5	66	1.4	93.333	0.33	22	5	64.5	64.6	LOST CORE	LOST CORE	LOST CORE	LOST CORE	LOST CORE	LOST CORE	LOST CORE	LOST CORE	LOST CORE	LOST CORE	LOST CORE	LOST CORE
							64.6	64.95	13,5	9	Planar	Slightly Rough	Isolated (6->12cm)	30°	Medium-Dark Grey	rbedded Mudstone/Silts	Mudstone	Interbedded	Quartz Stringers	
							64.95	66							Brown-Grey	bedded Mudstone/Sand	Mudstone	Interbedded	Quartz Vein(s) mm scale	mm mudstone
66	67.5	1.4	93.333	0.7	46.66667	17	66	67.4	18,25	21.5	Planar	Smooth	Numerous (1-3cm)	50°	Medium-Dark Grey	rbedded Mudstone/Silts	Siltstone	Interbedded	Quartz Stringers	mm coal <1%
							67.4	67.5	LOST CORE	LOST CORE	LOST CORE	LOST CORE	LOST CORE	LOST CORE	LOST CORE	LOST CORE	LOST CORE	LOST CORE	LOST CORE	LOST CORE
67.5	69	1.5	100	0.75	50.00	10	67.5	69	10,16	13	Planar	Smooth	Isolated (6->12cm)	20°	Dark Grey	Mudstone	Siltstone	Massive	n/a	68.25m-68.31m siltstone, hard, fissile mudstone
69	70.5	1.5	100	0.65	43.33	9	69	70.2	10,10	10	Planar	Smooth	Isolated (6->12cm)	30°	Dark Grey	Mudstone	Siltstone	Massive	Quartz Vein(s) cm scale	69.06m-69.24m siltstone, fissile mudstone
							70.2	71.5							Dark Grey-Black	Mudstone	Anthracite Coal	Interbedded	Quartz Stringers	-
70.5	72	1.1	73.333	0.75	50	6	70.5	71.6	0	0	Planar	Polished	Isolated (6->12cm)	20°	Dark Grey-Black	Mudstone	Anthracite Coal	Interbedded	Quartz Stringers	mm coal
							71.6	72	LOST CORE	LOST CORE	LOST CORE	LOST CORE	LOST CORE	LOST CORE	LOST CORE	LOST CORE	LOST CORE	LOST CORE	LOST CORE	LOST CORE
72	73.5	1.45	96.667	0.35	23.33333	10	72	73.45	5,16	10.5	Planar	Polished	Occasional (3-6cm)	40°	Dark Grey-Black	Mudstone	Anthracite Coal	Interbedded	Quartz Stringers	-
							73.45	73.5	LOST CORE	LOST CORE	LOST CORE	LOST CORE	LOST CORE	LOST CORE	LOST CORE	LOST CORE	LOST CORE	LOST CORE	LOST CORE	LOST CORE
73.5	75	1.5	100	0.7	46.67	10	73.5	74.02	22,33	27.5	Planar	Polished	Isolated (6->12cm)	30°	Dark Grey-Black	Mudstone	Sandstone	Interbedded	Quartz Stringers	mm coal <1%
							74.02	75							Medium Grey	Sandstone	Mudstone	Massive	Quartz Stringers	Hard, trace chlorite
75	76.5	1.4	93.333	0.55	36.66667	9	75	75.17	13,22	17.5	Planar	Slightly Rough	Isolated (6->12cm)	50°	Medium Grey	Sandstone	Anthracite Coal	Massive	Quartz Stringers	trace mudstone
							75.17	75.56							Dark Grey-Black	Sandstone	Anthracite Coal	Interbedded	Quartz Stringers	trace mudstone
							75.56	76.4							Medium Grey	Sandstone	Anthracite Coal	Massive	Quartz Stringers	trace mudstone
							76.4	76.5	LOST CORE	LOST CORE	LOST CORE	LOST CORE	LOST CORE	LOST CORE	LOST CORE	LOST CORE	LOST CORE	LOST CORE	LOST CORE	LOST CORE
76.5	78	1.4	93.333	1.15	76.66667	4	76.6	77.9	18,38,36	30.5	Planar	Smooth	Isolated (6->12cm)	40°	Medium Grey	Sandstone	Mudstone	Massive	Quartz Stringers	Fine grained
							77.9	78	LOST CORE	LOST CORE	LOST CORE	LOST CORE	LOST CORE	LOST CORE	LOST CORE	LOST CORE	LOST CORE	LOST CORE	LOST CORE	LOST CORE
78	79.5	1.45	96.667	1.15	76.66667	6	78	79.45	27,16	21.5	Planar	Slightly Rough	Isolated (6->12cm)	30°	Light-Medium Grey	Sandstone	Mudstone	Massive	Quartz Vein(s) mm scale	78.94-79.04m quartz vein, fine grained
							79.45	79.5	LOST CORE	LOST CORE	LOST CORE	LOST CORE	LOST CORE	LOST CORE	LOST CORE	LOST CORE	LOST CORE	LOST CORE	LOST CORE	LOST CORE
79.5	81	1.5	100	0.6	40.00	12	79.5	81	33,46	39.5	Planar	Smooth	Occasional (3-6cm)	20°	Light Grey	Sandstone	Mudstone	Massive	Quartz Vein(s) cm scale	Fine grained
81	82.5	1.45	96.667	0.85	56.66667	5	81	82.45	29,45,46	40	Planar	Smooth	Isolated (6->12cm)	10°	Medium Grey	Sandstone	Mudstone	Massive	Quartz Stringers	Fine grained
							82.45	82.5	LOST CORE	LOST CORE	LOST CORE	LOST CORE	LOST CORE	LOST CORE	LOST CORE	LOST CORE	LOST CORE	LOST CORE	LOST CORE	LOST CORE
82.5	84	1.35	90	0.6	40	9	82.5	83.85	0	0	Stepped	Slightly Rough	Isolated (6->12cm)	60°	Medium Grey	Sandstone	Anthracite Coal	Massive	Quartz Vein(s) cm scale	Fine grained, 83.15-84m highly fractured (horizontally, vertically)
							83.85	84	LOST CORE	LOST CORE	LOST CORE	LOST CORE	LOST CORE	LOST CORE	LOST CORE	LOST CORE	LOST CORE	LOST CORE	LOST CORE	LOST CORE
84	85.5	1.5	100	1.5	100.00	2	83.85	85.5	12,13	12.5	Planar	Slightly Rough	Isolated (6->12cm)	30°	Medium Grey	Sandstone	Mudstone	Massive	Quartz Vein(s) mm scale	Hard
85.5	87	1.45	96.667	0.9	60	3	85.5	86.95	35,30	32.5	Planar	Smooth	Isolated (6->12cm)	60°	Medium Grey	Sandstone	Mudstone	Massive	Quartz Vein(s) mm scale	Hard
							86.95	87	LOST CORE	LOST CORE	LOST CORE	LOST CORE	LOST CORE	LOST CORE	LOST CORE	LOST CORE	LOST CORE	LOST CORE	LOST CORE	LOST CORE
87	88.5	1.45	96.667	0.9	60	3	87	88.45	38,32,32	34	Planar	Smooth	Isolated (6->12cm)	60°	Medium Grey	Sandstone	Anthracite Coal	Massive	Quartz Vein(s) mm scale	trace mudstone
							88.45	88.5	LOST CORE	LOST CORE	LOST CORE	LOST CORE	LOST CORE	LOST CORE	LOST CORE	LOST CORE	LOST CORE	LOST CORE	LOST CORE	LOST CORE
88.5	90	1.41	94	0.95	63.33333	3	88.5	89.91	13,25,20	19	Planar	Smooth	Isolated (6->12cm)	40°	Medium Grey	Sandstone	Mudstone	Interbedded	Quartz Stringers	Fine grained
							89.91	90	LOST CORE	LOST CORE	LOST CORE	LOST CORE	LOST CORE	LOST CORE	LOST CORE	LOST CORE	LOST CORE	LOST CORE	LOST CORE	LOST CORE

Run Depth		Core Recovery		RQD Length (Pieces >10cm) [m]	RQD length /run length x100 [%]	Number of Joints (per run)	Core Depth		Schmidt Hammer Tests		Joint Details				Colour	Major Lithology	Minor Lithology	Bedding Type	Features	Comments
From [m]	To [m]	Rec. [m]	Rec. [%]				From [m]	To [m]	Test 'R' Values	Avg 'R' Value	Geometry	Roughness	Spacing	Joint Angle [°]						
90	91.5	1.5	100	1.2	80.00	5	90	91.25	10,14	12	Planar	Smooth	Isolated (6->12cm)	20°	Medium-Dark Grey	Sandstone	Mudstone	Interbedded	Quartz Vein(s) mm scale	mm coal <1%
							91.25	91.5							Dark Grey-Black	Mudstone	Sandstone	Interbedded	Quartz Vein(s) mm scale	coal 3-5%
91.5	93	1.3	86.667	0.23	15.33333	13	91.5	92.8	0	0	Planar	Smooth	Occasional (3-6cm)	20°	Dark Grey-Black	Mudstone	Anthracite Coal	Interbedded	Quartz Stringers	-
							92.8	93	LOST CORE	LOST CORE	LOST CORE	LOST CORE	LOST CORE	LOST CORE	LOST CORE	LOST CORE	LOST CORE	LOST CORE	LOST CORE	LOST CORE
93	94.5	1.44	96	0.55	36.66667	14	93	94.44	12	12	Planar	Smooth	Occasional (3-6cm)	40°	Dark Grey-Black	Mudstone	Anthracite Coal	Interbedded	Quartz Stringers	trace sandstone laminae
							94.44	94.5	LOST CORE	LOST CORE	LOST CORE	LOST CORE	LOST CORE	LOST CORE	LOST CORE	LOST CORE	LOST CORE	LOST CORE	LOST CORE	LOST CORE
94.5	96	1.43	95.333	0.4	26.66667	12	94.5	95.93	12,18,14	15	Planar	Smooth	Numerous (1-3cm)	60°	Dark Grey-Black	Mudstone	Anthracite Coal	Interbedded	Quartz Vein(s) mm scale	-
							95.93	96	LOST CORE	LOST CORE	LOST CORE	LOST CORE	LOST CORE	LOST CORE	LOST CORE	LOST CORE	LOST CORE	LOST CORE	LOST CORE	LOST CORE
96	97.5	1.4	93.333	0.8	53.33333	8	96	96.3							Dark Grey-Black	Mudstone	Anthracite Coal	Interbedded	Quartz Vein(s) mm scale	mm silt blebs within quartz
							96.3	97.4	20,39,43,46	37	Planar	Smooth	Isolated (6->12cm)	40°	Medium-Dark Grey	Sandstone	Mudstone	Interbedded	Quartz Stringers	97.08-97.17m siltstone, minor silt content throughout
							97.4	97.5	LOST CORE	LOST CORE	LOST CORE	LOST CORE	LOST CORE	LOST CORE	LOST CORE	LOST CORE	LOST CORE	LOST CORE	LOST CORE	LOST CORE
97.5	99	1.16	77.333	0.82	54.66667	7	97.5	98.66	18,22,18	19	Planar	Smooth	Isolated (6->12cm)	40°	Light-Medium Grey	Sandstone	Mudstone	Massive	Quartz Vein(s) mm scale	low silt content, vugs in quartz, hard, fine grained
							98.66	99	LOST CORE	LOST CORE	LOST CORE	LOST CORE	LOST CORE	LOST CORE	LOST CORE	LOST CORE	LOST CORE	LOST CORE	LOST CORE	LOST CORE
99	100.5	1.4	93.333	0.5	33.33333	11	99	99.1	LOST CORE	LOST CORE	LOST CORE	LOST CORE	LOST CORE	LOST CORE	LOST CORE	LOST CORE	LOST CORE	LOST CORE	LOST CORE	LOST CORE
							99.1	99.3	14,27,30	24	Planar	Polished	Occasional (3-6cm)	20°	Medium Grey	Sandstone	Mudstone	Massive	Quartz Stringers	fine grained
							99.3	100.3							Medium-Dark Grey	Mudstone	Siltstone	Interbedded	Quartz Vein(s) mm scale	alternating sandy mudstone and siltstone, moderately soft, coal <1%
							100.3	100.5							Dark Grey-Black	Mudstone	Anthracite Coal	Interbedded	Pyrite	soft

TERRACON GEOTECHNIQUE

CLIENT: Arctos Anthracite Joint Venture
PROJECT NUMBER: 122781

HOLE ID: GD-13
PROJECT LOCATION: Arctos Anthracite Property

DATE STARTED: September 12, 2013 COMPLETED: September 13, 2
DRILL CONTRACTOR: Driftwood RIG #:
HOLE SIZE: HQ
DRILLING METHOD: Diamond
LOGGED BY: M.McGrath/O. CHECKED BY:

Ground Elevation [masl]
Easting 508996.0
Northing 6343676.0
Water Table Depth [m]
Total Depth [m] 82.50m

COMMENTS:

Run Depth		Core Recovery		RQD Length (Pieces >10cm) [m]	RQD length /run length x100 [%]	Number of Joints (per run)	Core Depth		Schmidt Hammer Tests		Joint Details				Colour	Major Lithology	Minor Lithology	Features	Comments
From [m]	To [m]	Rec. [m]	Rec. [%]				From [m]	To [m]	Test 'R' Values	Avg 'R' Value	Geometry	Roughness	Spacing	Joint Angle [°]					
0.00	1.50	0.49	32.67	0.00	0.00	-	0.00	0.49	-	-	-	-	-	-	Brown-Grey	Overburden	-	Clasts-Assorted	Weathered/oxizided sandstone and mudstone gravel and cobbles with brown-grey silty clay
							0.49	1.50	LOST CORE	LOST CORE	LOST CORE	LOST CORE	LOST CORE	LOST CORE	LOST CORE	LOST CORE	LOST CORE	LOST CORE	LOST CORE
1.50	1.96	0.46	100.00	SPT	SPT	SPT	SPT	SPT	SPT	SPT	SPT	SPT	SPT	SPT	SPT	SPT	SPT	SPT	Weathered/oxizided sandstone and mudstone gravel and cobbles with brown-grey silty clay
1.96	3.00	0.15	14.42	0.00	0.00	-	1.96	2.11	-	-	-	-	-	-	Brown-Grey	Overburden	-	Clasts-Assorted	weathered/oxidized sandstone and mudstone clasts.
							2.11	3.00	LOST CORE	LOST CORE	LOST CORE	LOST CORE	LOST CORE	LOST CORE	LOST CORE	LOST CORE	LOST CORE	LOST CORE	LOST CORE
3.00	4.50	0.40	26.67	0.00	0.00	-	3.00	3.40	-	-	-	-	-	-	Brown-Grey	Overburden	-	Clasts-Assorted	weathered/oxidized sandstone and mudstone clasts.
							3.40	4.50	LOST CORE	LOST CORE	LOST CORE	LOST CORE	LOST CORE	LOST CORE	LOST CORE	LOST CORE	LOST CORE	LOST CORE	LOST CORE
4.50	6.00	0.15	10.00	0.00	0.00	-	4.50	4.65	-	-	-	-	-	-	Brown-Grey	Overburden	-	Clasts-Assorted	weathered/oxidized sandstone and mudstone clasts.
							4.65	6.00	LOST CORE	LOST CORE	LOST CORE	LOST CORE	LOST CORE	LOST CORE	LOST CORE	LOST CORE	LOST CORE	LOST CORE	LOST CORE
6.00	7.50	0.00	0.00	0.00	0.00	-	6.00	7.50	LOST CORE	LOST CORE	LOST CORE	LOST CORE	LOST CORE	LOST CORE	LOST CORE	LOST CORE	LOST CORE	LOST CORE	LOST CORE
7.50	9.00	0.35	23.33	0.00	0.00	-	7.50	7.85	-	-	-	-	-	-	Medium Grey	Overburden	-	Clasts-Assorted	Weathered sandstone and mudstone clasts
							7.85	9.00	LOST CORE	LOST CORE	LOST CORE	LOST CORE	LOST CORE	LOST CORE	LOST CORE	LOST CORE	LOST CORE	LOST CORE	LOST CORE
9.00	10.50	0.45	30.00	0.00	0.00	-	9.00	9.45	-	-	-	-	-	-	Medium Grey	Overburden	-	Clasts-Assorted	Weathered sandstone and mudstone clasts (gravel and cobbles)
							9.45	10.50	LOST CORE	LOST CORE	LOST CORE	LOST CORE	LOST CORE	LOST CORE	LOST CORE	LOST CORE	LOST CORE	LOST CORE	LOST CORE
10.50	12.00	0.14	9.33	0.00	0.00	-	10.50	10.64	-	-	-	-	-	-	Medium Grey	Overburden	-	Clasts-Assorted	Weathered sandstone and mudstone clasts
							10.64	12.00	LOST CORE	LOST CORE	LOST CORE	LOST CORE	LOST CORE	LOST CORE	LOST CORE	LOST CORE	LOST CORE	LOST CORE	LOST CORE
12.00	13.50	0.13	8.67	0.00	0.00	-	12.00	12.13	-	-	-	-	-	-	Medium Grey	Overburden	-	Clasts-Assorted	Weathered sandstone and silty mudstone clasts
							12.13	13.50	LOST CORE	LOST CORE	LOST CORE	LOST CORE	LOST CORE	LOST CORE	LOST CORE	LOST CORE	LOST CORE	LOST CORE	LOST CORE
13.50	15.00	0.33	22.00	0.00	0.00	-	13.50	13.83	-	-	-	-	-	-	Medium Grey	Overburden	-	Clasts-Assorted	Weathered sandstone and mudstone clasts
							13.83	15.00	LOST CORE	LOST CORE	LOST CORE	LOST CORE	LOST CORE	LOST CORE	LOST CORE	LOST CORE	LOST CORE	LOST CORE	LOST CORE
15.00	16.50	0.00	0.00	0.00	0.00	-	15.00	16.50	LOST CORE	LOST CORE	LOST CORE	LOST CORE	LOST CORE	LOST CORE	LOST CORE	LOST CORE	LOST CORE	LOST CORE	LOST CORE
16.50	18.00	0.00	0.00	0.00	0.00	-	16.50	18.00	LOST CORE	LOST CORE	LOST CORE	LOST CORE	LOST CORE	LOST CORE	LOST CORE	LOST CORE	LOST CORE	LOST CORE	LOST CORE
18.00	19.50	0.00	0.00	0.00	0.00	-	18.00	19.50	LOST CORE	LOST CORE	LOST CORE	LOST CORE	LOST CORE	LOST CORE	LOST CORE	LOST CORE	LOST CORE	LOST CORE	LOST CORE
19.50	21.00	0.40	26.67	0.00	0.00	-	19.50	19.90	-	-	-	-	-	-	Medium Grey	Sandstone and Mudstone	-	Clasts-Assorted	Weathered sandstone and mudstone clasts/cobbles and medium grey silty clay.
							19.90	21.00	LOST CORE	LOST CORE	LOST CORE	LOST CORE	LOST CORE	LOST CORE	LOST CORE	LOST CORE	LOST CORE	LOST CORE	LOST CORE
21.00	22.50	0.00	0.00	0.00	0.00	-	21.00	22.50	LOST CORE	LOST CORE	LOST CORE	LOST CORE	LOST CORE	LOST CORE	LOST CORE	LOST CORE	LOST CORE	LOST CORE	LOST CORE
22.50	24.00	0.68	45.33	0.00	0.00	-	22.50	23.18	-	-	-	-	-	-	Medium Grey	Sandstone and Mudstone	-	Clasts-Assorted	Weathered sandstone and mudstone
							23.18	24.00	LOST CORE	LOST CORE	LOST CORE	LOST CORE	LOST CORE	LOST CORE	LOST CORE	LOST CORE	LOST CORE	LOST CORE	LOST CORE
24.00	25.50	0.00	0.00	0.00	0.00	-	24.00	25.50	LOST CORE	LOST CORE	LOST CORE	LOST CORE	LOST CORE	LOST CORE	LOST CORE	LOST CORE	LOST CORE	LOST CORE	LOST CORE

Run Depth		Core Recovery		RQD Length (Pieces >10cm) [m]	RQD length /run length x100 [%]	Number of Joints (per run)	Core Depth		Schmidt Hammer Tests		Joint Details				Colour	Major Lithology	Minor Lithology	Features	Comments
From [m]	To [m]	Rec. [m]	Rec. [%]				From [m]	To [m]	Test 'R' Values	Avg 'R' Value	Geometry	Roughness	Spacing	Joint Angle [°]					
25.50	27.00	0.69	46.00	0.00	0.00	-	25.50	26.19	-	-	-	-	-	-	Medium Grey	Clay	-	Clasts-Assorted	Medium grey silty, sandy clay with occasional weathered sandstone clasts. Bentonite at end of run.
							26.19	27.00	LOST CORE	LOST CORE	LOST CORE	LOST CORE	LOST CORE	LOST CORE	LOST CORE	LOST CORE	LOST CORE	LOST CORE	LOST CORE
27.00	28.50	0.15	10.00	0.00	0.00	-	27.00	27.15	-	-	-	-	-	-	Medium-Dark Grey	Clay	-	-	Medium-dark grey clay, very minor weathered anthracite, and a few assorted clasts.
							27.15	28.50	LOST CORE	LOST CORE	LOST CORE	LOST CORE	LOST CORE	LOST CORE	LOST CORE	LOST CORE	LOST CORE	LOST CORE	LOST CORE
28.50	30.00	0.02	1.33	0.00	0.00	-	28.50	28.52	-	-	-	-	-	-	Medium Grey	Sandstone	-	-	Weathered sandstone clasts
							28.52	30.00	LOST CORE	LOST CORE	LOST CORE	LOST CORE	LOST CORE	LOST CORE	LOST CORE	LOST CORE	LOST CORE	LOST CORE	LOST CORE
30.00	31.50	0.00	0.00	0.00	0.00	-	30.00	31.50	LOST CORE	LOST CORE	LOST CORE	LOST CORE	LOST CORE	LOST CORE	LOST CORE	LOST CORE	LOST CORE	LOST CORE	LOST CORE
31.50	33.00	0.10	6.67	0.00	0.00	-	31.50	31.60	-	-	-	-	-	-	Medium Grey	Sandstone	-	Pyrite	Weathered sandstone. Abundant pyrite present
							31.60	33.00	LOST CORE	LOST CORE	LOST CORE	LOST CORE	LOST CORE	LOST CORE	LOST CORE	LOST CORE	LOST CORE	LOST CORE	LOST CORE
33.00	36.00	1.70	56.67	0.00	0.00	-	33.00	34.70	-	-	-	-	-	-	Medium-Dark Grey	Interbedded Mudstone/Sandstone	Anthracite Coal	-	Larger interbeds of sandstone/mudstone with minor anthracite coal
							34.70	36.00	LOST CORE	LOST CORE	LOST CORE	LOST CORE	LOST CORE	LOST CORE	LOST CORE	LOST CORE	LOST CORE	LOST CORE	LOST CORE
36.00	37.50	1.13	75.33	0.00	0.00	-	36.00	37.13	-	-	-	-	-	-	Medium-Dark Grey	Interbedded Mudstone/Sandstone	Anthracite Coal	-	Inrterbedded mudstone and sandstone with minor anthracite.
							37.13	37.50	LOST CORE	LOST CORE	LOST CORE	LOST CORE	LOST CORE	LOST CORE	LOST CORE	LOST CORE	LOST CORE	LOST CORE	LOST CORE
37.50	39.00	1.50	100.00	0.00	0.00	-	37.50	39.00	-	-	-	-	-	-	Medium-Dark Grey	Mudstone	Sandstone	-	Mudstone with minor sandstone and very minor anthracite coal
39.00	40.50	1.15	76.67	0.00	0.00	-	39.00	40.15	-	-	-	-	-	-	Dark Grey-Black	Interbedded Anthracite/Mudstone	Anthracite Coal	-	Interbedded mudstone and minor anthracite and clay
							40.15	40.50	LOST CORE	LOST CORE	LOST CORE	LOST CORE	LOST CORE	LOST CORE	LOST CORE	LOST CORE	LOST CORE	LOST CORE	LOST CORE
40.50	42.00	0.80	53.33	0.00	0.00	-	40.50	41.30	-	-	-	-	-	-	Medium-Dark Grey	Mudstone	-	Quartz Vein(s) mm scale	Mudstone and clay
							41.30	42.00	LOST CORE	LOST CORE	LOST CORE	LOST CORE	LOST CORE	LOST CORE	LOST CORE	LOST CORE	LOST CORE	LOST CORE	LOST CORE
42.00	43.50	1.15	76.67	0.00	0.00	-	42.00	43.15	-	-	-	-	-	-	Medium-Dark Grey	Interbedded Mudstone/Sandstone	-	-	Interbedded sandstone and mudstone, some silty clay
							43.15	43.50	LOST CORE	LOST CORE	LOST CORE	LOST CORE	LOST CORE	LOST CORE	LOST CORE	LOST CORE	LOST CORE	LOST CORE	LOST CORE
43.50	45.00	1.50	100.00	0.00	0.00	-	43.50	45.00	-	-	-	-	-	-	Medium-Dark Grey	Interbedded Mudstone/Sandstone	-	-	Interbedded sandstone and mudstone, some silty clay
45.00	46.50	1.50	100.00	0.00	0.00	-	45.00	46.50	-	-	-	-	-	-	Medium-Dark Grey	Interbedded Mudstone/Sandstone	-	Quartz Vein(s) cm scale	Interbedded very fine-fineg grained sandstone and mudstone
46.50	48.00	1.50	100.00	0.00	0.00	-	46.50	48.00	-	-	-	-	-	-	Medium-Dark Grey	Interbedded Mudstone/Sandstone	-	Quartz Vein(s) mm scale	Interbedded very fine-fine grained sandstone and mudstone some silty clay at end of run
48.00	49.50	1.50	100.00	0.00	0.00	-	48.00	49.50	-	-	-	-	-	-	Dark Grey	Interbedded Mudstone/Sandstone	Sandstone	Quartz Vein(s) mm scale	Mudstone interbedded with occasional/minor sandstone
49.50	51.00	1.50	100.00	0.00	0.00	-	49.50	51.00	-	-	-	-	-	-	Medium-Dark Grey	Mudstone	Sandstone	Quartz Vein(s) mm scale	Mudstone with occasional sandstone laminations. Minor bentonite seam at 50.05m
51.00	52.50	1.40	93.33	0.00	0.00	-	51.00	52.40	-	-	-	-	-	-	Dark Grey	Mudstone	-	-	Mudstone
							52.40	52.50	LOST CORE	LOST CORE	LOST CORE	LOST CORE	LOST CORE	LOST CORE	LOST CORE	LOST CORE	LOST CORE	LOST CORE	LOST CORE
52.50	54.00	1.40	93.33	0.00	0.00	-	52.50	53.90	-	-	-	-	-	-	Dark Grey	Mudstone	-	Quartz Stringers	Mudstone with very minor very fine-fine grained sandstone laminae.
							53.90	54.00	LOST CORE	LOST CORE	LOST CORE	LOST CORE	LOST CORE	LOST CORE	LOST CORE	LOST CORE	LOST CORE	LOST CORE	LOST CORE
54.00	55.50	1.30	86.67	0.00	0.00	-	54.00	55.30	-	-	-	-	-	-	Dark Grey-Black	Mudstone	-	Quartz Stringers	Mudstone with very minor very fine-fine grained sandstone laminae with 2 very minor anthracite seams
							55.30	55.50	LOST CORE	LOST CORE	LOST CORE	LOST CORE	LOST CORE	LOST CORE	LOST CORE	LOST CORE	LOST CORE	LOST CORE	LOST CORE
55.50	57.00	1.20	80.00	0.00	0.00	-	55.50	57.00	-	-	-	-	-	-	Medium-Dark Grey	Mudstone	-	Quartz Stringers	Silty mudstone
							0.00	57.00	-	-	-	-	-	-	Dark Grey-Black	Interbedded Anthracite/Mudstone	-	Quartz Stringers	Interbedded mudstone and anthracite coal.

Run Depth		Core Recovery		RQD Length (Pieces >10cm) [m]	RQD length /run length x100 [%]	Number of Joints (per run)	Core Depth		Schmidt Hammer Tests		Joint Details				Colour	Major Lithology	Minor Lithology	Features	Comments
From [m]	To [m]	Rec. [m]	Rec. [%]				From [m]	To [m]	Test 'R' Values	Avg 'R' Value	Geometry	Roughness	Spacing	Joint Angle [°]					
57.00	58.50	1.10	73.33	0.30	20.00	-	57.00	58.10	-	-	-	-	-	-	Dark Grey-Black	Anthracite Coal	-	Quartz Stringers	Anthracite coal
							58.10	58.50	LOST CORE	LOST CORE	LOST CORE	LOST CORE	LOST CORE	LOST CORE	LOST CORE	LOST CORE	LOST CORE	LOST CORE	LOST CORE
58.50	60.00	1.50	100.00	0.60	40.00	-	58.50	60.00	-	-	-	-	-	-	Dark Grey-Black	Interbedded Anthracite/Mudstone	Mudstone	Quartz Stringers	Anthracite coal with minor mudstone interbeds
60.00	61.50	1.30	86.67	0.10	6.67	-	60.00	61.30	-	-	-	-	-	-	Dark Grey-Black	Interbedded Anthracite/Mudstone	Mudstone	Quartz Stringers	Anthracite coal with minor mudstone interbeds
							61.30	61.50	LOST CORE	LOST CORE	LOST CORE	LOST CORE	LOST CORE	LOST CORE	LOST CORE	LOST CORE	LOST CORE	LOST CORE	LOST CORE
61.50	63.00	1.30	86.67	0.00	0.00	-	61.50	62.80	-	-	-	-	-	-	Dark Grey-Black	Mudstone	Siltstone	Quartz Vein(s) cm scale	Mudstone with minor siltstone interbeds and anthracite coal seams
							62.80	63.00	LOST CORE	LOST CORE	LOST CORE	LOST CORE	LOST CORE	LOST CORE	LOST CORE	LOST CORE	LOST CORE	LOST CORE	LOST CORE
63.00	64.50	1.10	73.33	0.00	0.00	-	63.00	64.10	-	-	-	-	-	-	Medium Grey	Interbedded Mudstone/Siltstone	-	Quartz Stringers	Interbedded mudstone and siltstone
							64.10	64.50	LOST CORE	LOST CORE	LOST CORE	LOST CORE	LOST CORE	LOST CORE	LOST CORE	LOST CORE	LOST CORE	LOST CORE	LOST CORE
64.50	66.00	1.50	100.00	0.00	0.00	-	64.50	66.00	-	-	-	-	-	-	Medium Grey	Interbedded Mudstone/Siltstone	-	Quartz Stringers	Interbedded mudstone and siltstone. Very minor presence of very fine grained sandstone.
66.00	67.50	1.50	100.00	0.00	0.00	-	66.00	67.50	-	-	-	-	-	-	Medium Grey	Interbedded Mudstone/Siltstone	-	Quartz Stringers	Interbedded mudstone and siltstone with minor very fine grained sand laminations
67.50	67.90	0.20	50.00	0.20	13.33	-	67.50	67.70	-	-	-	-	-	-	Medium-Dark Grey	Interbedded Mudstone/Sandstone	Sandstone	Quartz Stringers	Interbedded sandstone and mudstone
							67.70	67.90	LOST CORE	LOST CORE	LOST CORE	LOST CORE	LOST CORE	LOST CORE	LOST CORE	LOST CORE	LOST CORE	LOST CORE	LOST CORE
67.90	69.00	0.20	18.18	0.20	13.33	-	67.90	68.10	-	-	-	-	-	-	Medium Grey	Sandstone	Mudstone	Quartz Stringers	Very fine-fine grained sandstone with minor mudstone laminations and few mud clasts
							68.10	69.00	LOST CORE	LOST CORE	LOST CORE	LOST CORE	LOST CORE	LOST CORE	LOST CORE	LOST CORE	LOST CORE	LOST CORE	LOST CORE
69.00	70.50	1.45	96.67	0.10	6.67	-	69.00	70.45	-	-	-	-	-	-	Medium Grey	Interbedded Mudstone/Sandstone	Mudstone	Quartz Stringers	very fine-fine grained sandstone with mudstone interbeds and few mud clasts
							70.45	70.50	LOST CORE	LOST CORE	LOST CORE	LOST CORE	LOST CORE	LOST CORE	LOST CORE	LOST CORE	LOST CORE	LOST CORE	LOST CORE
70.50	73.50	1.65	55.00	0.00	0.00	-	70.50	72.15	-	-	-	-	-	-	Medium-Dark Grey	Interbedded Mudstone/Sandstone	-	Quartz Stringers	Interbedded sandstone and mudstone with very minor anthracite coal at end of run.
							72.15	73.50	LOST CORE	LOST CORE	LOST CORE	LOST CORE	LOST CORE	LOST CORE	LOST CORE	LOST CORE	LOST CORE	LOST CORE	LOST CORE
73.50	75.00	1.00	66.67	0.00	0.00	-	73.50	74.50	-	-	-	-	-	-	Dark Grey-Black	Interbedded Anthracite/Mudstone	-	Quartz Stringers	Interbedded silty mudstone and anthracite coal
							74.50	75.00	LOST CORE	LOST CORE	LOST CORE	LOST CORE	LOST CORE	LOST CORE	LOST CORE	LOST CORE	LOST CORE	LOST CORE	LOST CORE
75.00	76.50	1.35	90.00	0.00	0.00	-	75.00	76.35	-	-	-	-	-	-	Medium-Dark Grey	Interbedded Mudstone/Siltstone	Sandstone	Quartz Vein(s) mm scale	interbedded siltstone and mudstone with one sandstone interbed and very minor presence of anthracite coal
							76.35	76.50	LOST CORE	LOST CORE	LOST CORE	LOST CORE	LOST CORE	LOST CORE	LOST CORE	LOST CORE	LOST CORE	LOST CORE	LOST CORE
76.50	78.00	1.50	100.00	0.00	0.00	-	76.50	78.00	-	-	-	-	-	-	Medium-Dark Grey	Interbedded Mudstone/Sandstone	-	-	Interbedded mudstone and very fine grained silty sandstone. Very minor siltstone present.
78.00	79.50	0.00	0.00		0.00	-	78.00	79.50	LOST CORE	LOST CORE	LOST CORE	LOST CORE	LOST CORE	LOST CORE	LOST CORE	LOST CORE	LOST CORE	LOST CORE	LOST CORE
79.50	81.00	1.50	100.00	0.00	0.00	-	79.50	81.00	-	-	-	-	-	-	Medium-Dark Grey	Interbedded Mudstone/Sandstone	-	-	Interbedded very fine-fine grained sandstone and mudstone.
81.00	82.50	1.50	100.00	0.00	0.00	-	81.00	82.50	-	-	-	-	-	-	Medium-Dark Grey	Interbedded Mudstone/Sandstone	-	Quartz Stringers	Interbedded very fine-fine grained sandstone and mudstone with two micro coal seams.

TERRACON GEOTECHNIQUE

CLIENT: Arctos Anthracite Joint Venture
PROJECT NUMBER: 122781

HOLE ID: GD-14/MW-23D
PROJECT LOCATION: Arctos Anthracite Property

DATE STARTED: Sept. 1, 2013 COMPLETED: Sept. 2, 2013
DRILL CONTRACTOR: Driftwood RIG #:
HOLE SIZE: HQ
DRILLING METHOD: Diamond
LOGGED BY: M.McGrath/S.Lyo CHECKED BY: OG

Ground Elevation [masl] 1659
Easting 510012.0
Northing 6344006.0
Water Table Depth [m]
Total Depth [m] 90.50m

COMMENTS: No DipAzi Data

Run Depth		Core Recovery		RQD Length (Pieces >10cm) [m]	RQD length /run length x100 [%]	Number of Joints (per run)	Core Depth		Schmidt Hammer Tests		Joint Details				Colour	Major Lithology	Minor Lithology	Features	Comments
From [m]	To [m]	Rec. [m]	Rec. [%]				From [m]	To [m]	Test 'R' Values	Avg 'R' Value	Geometry	Roughness	Spacing	Joint Angle [°]					
0.00	0.50	0.20	40.00	0.00	0.00	n/a	0.00	0.20	n/a	n/a	n/a	n/a	n/a	n/a	Brown-Grey	Overburden	-	Organics	Organic silty clay
							0.20	0.50	LOST CORE	LOST CORE	LOST CORE	LOST CORE	LOST CORE	LOST CORE	LOST CORE	LOST CORE	LOST CORE	LOST CORE	LOST CORE
0.50	2.00	0.60	40.00	0.00	0.00	n/a	0.50	1.10	n/a	n/a	n/a	n/a	n/a	n/a	Brown-Grey	Mudstone	-	-	Very heavily weathered silty mudstone, altering to clay.
							1.10	2.00	LOST CORE	LOST CORE	LOST CORE	LOST CORE	LOST CORE	LOST CORE	LOST CORE	LOST CORE	LOST CORE	LOST CORE	LOST CORE
2.00	2.10	0.10	100.00	SPT	SPT	SPT	SPT	SPT	SPT	SPT	SPT	SPT	SPT	SPT	SPT	SPT	SPT	SPT	Siltstone-gravel, brown, loose, wet, non plastic, interlayed.
2.10	3.50	0.55	39.29	0.00	0.00	n/a	2.10	2.65	n/a	n/a	n/a	n/a	n/a	n/a	Brown-Grey	Mudstone	-	-	Very heavily weathered silty mudstone, altering to clay.
							2.65	3.50	LOST CORE	LOST CORE	LOST CORE	LOST CORE	LOST CORE	LOST CORE	LOST CORE	LOST CORE	LOST CORE	LOST CORE	LOST CORE
3.50	3.73	0.23	100.00	SPT	SPT	SPT	SPT	SPT	SPT	SPT	SPT	SPT	SPT	SPT	SPT	SPT	SPT	SPT	Mudstone, dark grey, moist, mod-high plasticity, stiff.
3.73	5.00	1.00	78.74	0.00	0.00	n/a	3.73	4.73	n/a	n/a	n/a	n/a	n/a	n/a	Dark Grey	Mudstone	-	-	Weathered mudstone
							4.73	5.00	LOST CORE	LOST CORE	LOST CORE	LOST CORE	LOST CORE	LOST CORE	LOST CORE	LOST CORE	LOST CORE	LOST CORE	LOST CORE
5.00	6.50	1.40	93.33	0.00	0.00	~11	5.00	5.25	0	0	n/a	n/a	n/a	n/a	Dark Grey-Black	Interbedded Anthracite/Mudstone	Mudstone	Quartz Stringers	Weathered, interbedded mudstone and anthracite
							5.25	6.40			n/a	n/a	n/a	n/a	Dark Grey	Mudstone	Siltstone	Pyrite	Mudstone with minor siltstone, quartz stringers, pyrite and minor coal seam (~6cm thick @ 6.35m)
							6.40	6.50	LOST CORE	LOST CORE	LOST CORE	LOST CORE	LOST CORE	LOST CORE	LOST CORE	LOST CORE	LOST CORE	LOST CORE	LOST CORE
6.50	8.00	1.40	93.33	0.00	0.00	11.00	6.50	6.70	0	0	n/a	n/a	n/a	n/a	Dark Grey	Mudstone	Siltstone	-	Mudstone with minor siltstone, weathered.
							6.70	7.90	0	0	n/a	n/a	n/a	n/a	Medium Grey	Sandstone	-	Quartz Stringers	Very fine-fine grained sandstone, heavily fractured and jointed
							7.90	8.00	LOST CORE	LOST CORE	LOST CORE	LOST CORE	LOST CORE	LOST CORE	LOST CORE	LOST CORE	LOST CORE	LOST CORE	LOST CORE
8.00	9.50	1.50	100.00	0.00	0.00	~19	8.00	9.50	0	0	n/a	n/a	n/a	n/a	Medium Grey	Sandstone	-	Quartz Stringers	Very fine-fine grained sandstone, heavily fractured and jointed
9.50	11.00	1.50	100.00	0.00	0.00	10	9.50	11.00	41,34	38	n/a	n/a	n/a	n/a	Medium Grey	Sandstone	Mudstone	Quartz Stringers	Sandstone with minor mudstone, transitioning into interbedded very fine-fine grained and mudstone.
11.00	12.50	1.35	90.00	0.00	0.00	>20	11.00	12.00	0	0	-	-	-	-	Dark Grey	Mudstone	-	-	Silty mudstone, heavily fractured/jointed
							12.00	12.35	0	0	-	-	-	-	Dark Grey	Interbedded Mudstone/Sandstone	Mudstone	Quartz Stringers	Very fine-fine grained sandstone, mildly weathered with some displacement (mm scale) bedding nearly vertical.
							12.35	12.50	LOST CORE	LOST CORE	LOST CORE	LOST CORE	LOST CORE	LOST CORE	LOST CORE	LOST CORE	LOST CORE	LOST CORE	LOST CORE
12.50	14.00	1.50	100.00	0.00	0.00	15.00	12.50	12.75	44,35	40	-	-	-	-	Dark Grey	Interbedded Mudstone/Sandstone	-	Quartz Stringers	Very fine-fine grained sandstone interbedded with mudstone, weathered,
							12.75	14.00			-	-	-	-	Dark Grey	Interbedded Mudstone/Siltstone	-	-	Interbedded mudstone and siltstone, weathered.
14.00	15.50	1.50	100.00	0.00	0.00	12	14.00	15.50	0	0	-	-	-	-	Dark Grey	Interbedded Mudstone/Sandstone	-	Quartz Stringers	Very fine-fine grained silty sandstone interbedded with mudstone. Abundant displacement and stress fractures.

Run Depth		Core Recovery		RQD Length (Pieces >10cm) [m]	RQD length /run length x100 [%]	Number of Joints (per run)	Core Depth		Schmidt Hammer Tests		Joint Details				Colour	Major Lithology	Minor Lithology	Features	Comments
From [m]	To [m]	Rec. [m]	Rec. [%]				From [m]	To [m]	Test 'R' Values	Avg 'R' Value	Geometry	Roughness	Spacing	Joint Angle [°]					
15.50	17.00	1.50	100.00	0.00	0.00	11.00	15.50	16.44	0	0	Planar	Smooth	Occasional (3-6cm)	30°	Dark Grey	Interbedded Mudstone/Sandstone	-	Quartz Stringers	Very fine-fine grained silty sandstone interbedded with mudstone. Abundant displacement and stress fractures.
							16.44	16.71			-	-	-	-	Light Grey	Bentonite	-	-	Bentonite bed
							16.71	17.00			-	-	-	-	Medium Grey	Interbedded Mudstone/Sandstone	-	Quartz Stringers	Moderately weathered
17.00	18.50	1.50	100.00	0.00	0.00	13	17.00	18.50	0	0	Planar	Slightly Rough	Occasional (3-6cm)	45°	Dark Grey	Mudstone	-	Quartz Stringers	Silty mudstone, mildly weathered at start of run. Mildly fractured.
18.50	20.00	1.50	100.00	0.10	6.67	12	18.50	20.00	0	0	Planar	Slightly Rough	Isolated (6->12cm)	55°	Dark Grey	Mudstone	-	Quartz Stringers	Silty mudstone, moderately jointed/fractured. Mildly weathered in zones, some mud infilled joints. Fractured.
20.00	21.50	0.90	60.00	0.10	6.67	4.00	20.00	20.16	0	0	n/a	n/a	n/a	n/a	Medium Grey	Interbedded Mudstone/Siltstone	-	-	Interbedded mudstone and siltstone.
							20.16	20.59			-	-	-	-	Light Grey	Bentonite	-	-	Partially lithified bentonite bed.
							20.59	20.90			-	-	-	-	Dark Grey	Mudstone	-	Quartz Stringers	Silty mudstone, heavily weathered at end of run.
							20.90	21.50	LOST CORE	LOST CORE	LOST CORE	LOST CORE	LOST CORE	LOST CORE	LOST CORE	LOST CORE	LOST CORE	LOST CORE	LOST CORE
21.50	23.00	1.50	100.00	0.30	20.00	14	21.50	23.00	0	0	Irregular	Smooth	Occasional (3-6cm)	50°	Dark Grey	Mudstone	-	Quartz Stringers	Silty mudstone, weathered, displacement apparent (mm scale)
23.00	24.50	1.45	96.67	0.00	0.00	>20	23.00	24.45	0	0	n/a	n/a	n/a	n/a	Dark Grey	Mudstone	-	-	Silty mudstone, weathered.
							24.45	24.50	LOST CORE	LOST CORE	LOST CORE	LOST CORE	LOST CORE	LOST CORE	LOST CORE	LOST CORE	LOST CORE	LOST CORE	LOST CORE
24.50	26.00	1.40	93.33	0.11	7.33	>20	24.50	25.90	0	0	Irregular	Slightly Rough	Numerous (1-3cm)	90°	Dark Grey	Mudstone	-	Quartz Vein(s) cm scale	Silty mudstone, heavily fractured/jointed
							25.90	26.00	LOST CORE	LOST CORE	LOST CORE	LOST CORE	LOST CORE	LOST CORE	LOST CORE	LOST CORE	LOST CORE	LOST CORE	LOST CORE
26.00	27.50	1.50	100.00	0.24	16.00	>20	26.00	27.04	0	0	Planar	Smooth	Isolated (6->12cm)	45°	Dark Grey	Mudstone	-	-	Silty mudstone, heavily fractured/jointed
							27.04	27.50							Dark Grey-Black	Anthracite Coal			Anthracite coal
27.50	29.00	1.40	93.33	0.00	0.00	~18	27.50	28.90	0	0	Irregular	Smooth	Occasional (3-6cm)	30°	Dark Grey-Black	Interbedded Anthracite/Mudstone	Mudstone	Quartz Vein(s) mm scale	Interbedded Antracite and mudstone
							28.90	29.00	LOST CORE	LOST CORE	LOST CORE	LOST CORE	LOST CORE	LOST CORE	LOST CORE	LOST CORE	LOST CORE	LOST CORE	LOST CORE
29.00	30.50	1.50	100.00	0.00	0.00	~20	29.00	30.50	0	0	Planar	Striated	Occasional (3-6cm)	40°	Dark Grey-Black	Interbedded Anthracite/Mudstone	Anthracite Coal	Quartz Stringers	Interbedded Mudstone and Anthracite (>Mudstone)
30.50	32.00	1.50	100.00	0.00	0.00	10	30.50	32.00	0	0	Curved	Slightly Rough	Occasional (3-6cm)	35°	Dark Grey	Mudstone	Anthracite Coal	Quartz Stringers	Mudstone with very minor coal seams (mm scale)
32.00	33.50	1.50	100.00	0.10	6.67	11.00	32.00	33.02	0	0	Irregular	Slightly Rough	Occasional (3-6cm)	75°	Dark Grey	Mudstone	Anthracite Coal	-	Silty mudstone with very minor coal seams (mm scale)
							33.02	33.30			-	-	-	-	Dark Grey-Black	Interbedded Anthracite/Mudstone	Mudstone	Pyrite	Anthracite coal interbedded with mudstone, pyrite
							33.30	33.50			-	-	-	-	Dark Grey	Mudstone	-	Quartz Stringers	Mildly weathered towards base of run.
33.50	35.00	1.45	96.67	0.00	0.00	11.00	33.50	34.95	0	0	Irregular	Slightly Rough	Occasional (3-6cm)	45°	Dark Grey	Mudstone	-	Quartz Stringers	Mildly weathered at top of run, minor silty sandstone/mudstone interbedded zone/potential fault zone
							34.95	35.00	LOST CORE	LOST CORE	LOST CORE	LOST CORE	LOST CORE	LOST CORE	LOST CORE	LOST CORE	LOST CORE	LOST CORE	LOST CORE
35.00	35.39	1.50	384.62	0.48	32.00	10	35.00	35.39	0	0	Planar	Slightly Rough	Isolated (6->12cm)	20°	Dark Grey	Interbedded Mudstone/Siltstone	Siltstone	Quartz Stringers	Silty mudstone
35.39	36.50						35.39	36.50			-	-	-	-	Medium Grey	Sandstone	-	Quartz Stringers	Moderately weathered, very silty.
36.50	38.00	1.45	96.67	0.89	59.33	5.00	36.50	37.95	10,0	5	-	-	-	-	Medium Grey	Sandstone	-	Quartz Stringers	Fine-coarse grained sandstone, silty, weathered
							37.95	38.00	LOST CORE	LOST CORE	LOST CORE	LOST CORE	LOST CORE	LOST CORE	LOST CORE	LOST CORE	LOST CORE	LOST CORE	LOST CORE
38.00	39.50	1.50	100.00	1.11	74.00	1	38.00	39.50	0	0	Planar	Slightly Rough	Isolated (6->12cm)	70°	Medium Grey	Sandstone	-	Quartz Stringers	Fine-coarse grained sandstone, mildly weathered.

Run Depth		Core Recovery		RQD Length (Pieces >10cm) [m]	RQD length /run length x100 [%]	Number of Joints (per run)	Core Depth		Schmidt Hammer Tests		Joint Details				Colour	Major Lithology	Minor Lithology	Features	Comments
From [m]	To [m]	Rec. [m]	Rec. [%]				From [m]	To [m]	Test 'R' Values	Avg 'R' Value	Geometry	Roughness	Spacing	Joint Angle [°]					
39.50	41.00	1.50	100.00	1.08	72.00	3	39.50	41.00	10,14	12	-	-	-	-	Light-Medium Grey	Sandstone	Anthracite Coal	Quartz Stringers	Grey to light grey fine to medium grained sandstone with rare quartz stringers and a wedge shaped inclusion of anthracite.
41.00	42.50	1.50	100.00	0.70	46.67	4.00	41.00	41.25	0	0	-	-	-	-	Light-Medium Grey	Sandstone	-	Quartz Stringers	Grey to light grey fine grained sandstone with rare quartz stringers.
							41.25	42.50			Irregular	Slightly Rough	Occasional (3-6cm)	25°	Dark Grey-Black	Interbedded Anthracite/Mudstone	Siltstone	Quartz Stringers	Dark grey to black carbonaceous mudstone interbedded with anthracite with rare siltstone inclusions and quartz stringers.
42.50	44.00	1.50	100.00	0.94	62.67	2.00	42.50	43.50	0	0	-	-	-	-	Dark Grey-Black	Interbedded Anthracite/Mudstone	Siltstone	Quartz Stringers	Dark grey to black carbonaceous mudstone interbedded with anthracite with rare siltstone inclusions and quartz stringers.
							43.50	44.00			Planar	Slightly Rough	Isolated (6->12cm)	45°	Light-Medium Grey	Mudstone	Siltstone	-	Light to medium grey silty mudstone grading into light grey clayey siltstone.
44.00	45.50	1.45	96.67	1.34	89.33	3.00	44.00	45.45	0	0	Planar	Slightly Rough	Isolated (6->12cm)	90°	Light-Medium Grey	Siltstone	-	Quartz Stringers	Light to medium grey siltstone with occasional quartz stringers.
							45.45	45.50	LOST CORE	LOST CORE	LOST CORE	LOST CORE	LOST CORE	LOST CORE	LOST CORE	LOST CORE	LOST CORE	LOST CORE	LOST CORE
45.50	47.00	1.50	100.00	1.14	76.00	3	45.50	47.00	0	0	Planar	Smooth	Isolated (6->12cm)	55°	Light-Medium Grey	Siltstone	-	-	Light to medium grey siltstone with rare medium grey mudstone laminations.
47.00	48.50	1.50	100.00	0.84	56.00	3	47.00	48.50	14,0	7	Stepped	Very Rough	Isolated (6->12cm)	70°	Light-Medium Grey	Siltstone	Sandstone	-	Light to medium grey siltstone interbedded with light grey very fine to fine grained sandstone with rare medium grey mudstone laminations.
48.50	50.00	1.50	100.00	0.90	60.00	7	48.50	50.00	0	0	Planar	Slightly Rough	Isolated (6->12cm)	60°	Light-Medium Grey	Sandstone	Siltstone	-	Light grey fine to very fine grained sandstone interbedded with light to medium grey siltstone with rare medium grey mudstone laminations.
50.00	51.50	1.46	97.33	1.15	76.67	4.00	50.00	51.46	0	0	Planar	Slightly Rough	Isolated (6->12cm)	40°	Light-Medium Grey	Sandstone	Siltstone	-	Light grey fine to very fine grained sandstone interbedded with light to medium grey siltstone with rare medium grey mudstone laminations.
							51.46	51.50	LOST CORE	LOST CORE	LOST CORE	LOST CORE	LOST CORE	LOST CORE	LOST CORE	LOST CORE	LOST CORE	LOST CORE	LOST CORE
51.50	53.00	1.50	100.00	0.40	26.67	7	51.50	53.00	0	0	Planar	Smooth	Isolated (6->12cm)	70°	Light-Medium Grey	Sandstone	Mudstone	Quartz Stringers	Light to medium grey silty fine grained sandstone with thin (mm scale) dark grey mud interbeds and laminations.
53.00	54.50	1.50	100.00	1.20	80.00	3	53.00	54.50	0	0	Planar	Slightly Rough	Isolated (6->12cm)	85°	Light-Medium Grey	Sandstone	-	Quartz Stringers	Light to medium grey silty fine grained sandstone with thin (mm scale) dark grey mudstone laminations and quartz stringers.
54.50	56.00	1.50	100.00	0.98	65.33	11	54.50	56.00	18,16	17	Planar	Slightly Rough	Occasional (3-6cm)	60°	Light-Medium Grey	Sandstone	-	Quartz Stringers	Light to medium grey silty fine grained sandstone with thin (mm scale) dark grey mudstone laminations and quartz stringers.
56.00	57.50	1.39	92.67	0.89	59.33	1.00	56.00	57.39	12,11	11.5	Planar	Slightly Rough	Isolated (6->12cm)	75°	Light-Medium Grey	Sandstone	-	Quartz Stringers	Light to medium grey silty fine grained sandstone with thin (mm scale) dark grey mudstone laminations and quartz stringers.
							57.39	57.50	LOST CORE	LOST CORE	LOST CORE	LOST CORE	LOST CORE	LOST CORE	LOST CORE	LOST CORE	LOST CORE	LOST CORE	LOST CORE
57.50	59.00	1.50	100.00	1.42	94.67	1	57.50	59.00	12,11	11.5	Planar	Striated	Isolated (6->12cm)	45°	Light-Medium Grey	Sandstone	-	Quartz Stringers	Light to medium grey silty fine grained sandstone with thin (mm scale) dark grey mudstone laminations and quartz stringers.
59.00	60.50	1.50	100.00	1.50	100.00	11	59.00	60.50	10,10	10	Planar	Striated	Numerous (1-3cm)	45°	Medium-Dark Grey	Interbedded Mudstone/Sandstone	-	Quartz Stringers	Medium grey fine grained sandstone interbedded with dark grey silty mudstone (both mm to cm scale).
60.50	62.00	1.50	100.00	0.93	62.00	1	60.50	62.00	20,16	18	Planar	Slightly Rough	Isolated (6->12cm)	60°	Medium-Dark Grey	Interbedded Mudstone/Sandstone	-	Quartz Stringers	Medium grey fine grained sandstone interbedded with dark grey silty mudstone (both mm to cm scale).

Run Depth		Core Recovery		RQD Length (Pieces >10cm) [m]	RQD length /run length x100 [%]	Number of Joints (per run)	Core Depth		Schmidt Hammer Tests		Joint Details				Colour	Major Lithology	Minor Lithology	Features	Comments
From [m]	To [m]	Rec. [m]	Rec. [%]				From [m]	To [m]	Test 'R' Values	Avg 'R' Value	Geometry	Roughness	Spacing	Joint Angle [°]					
62.00	63.50	1.50	100.00	1.26	84.00	5	62.00	63.50	16,16	16	Planar	Slightly Rough	Isolated (6->12cm)	70°	Medium-Dark Grey	Interbedded Mudstone/Sandstone	-	Quartz Stringers	Medium grey fine grained sandstone interbedded with dark grey silty mudstone (both mm to cm scale).
63.50	65.00	1.50	100.00	1.03	68.67	9	63.50	65.00	18,16	17	Planar	Slightly Rough	Isolated (6->12cm)	75°	Medium-Dark Grey	Interbedded Mudstone/Sandstone	-	-	Medium grey fine grained sandstone interbedded with dark grey silty mudstone (both mm to cm scale).
65.00	66.50	1.42	94.67	1.18	78.67	6.00	65.00	66.42	14,24	19	Planar	Slightly Rough	Isolated (6->12cm)	65°	Medium-Dark Grey	Interbedded Mudstone/Sandstone	-	Quartz Stringers	Medium grey fine grained sandstone interbedded with dark grey silty mudstone (both mm to cm scale).
							66.42	66.50	LOST CORE	LOST CORE	LOST CORE	LOST CORE	LOST CORE	LOST CORE	LOST CORE	LOST CORE	LOST CORE	LOST CORE	LOST CORE
66.50	68.00	1.43	95.33	1.43	95.33	1.00	66.50	67.93	14,11	12.5	Planar	Slightly Rough	Isolated (6->12cm)	45°	Medium-Dark Grey	Mudstone	Sandstone	-	Dark grey silty mudstone with medium grey thin (mm scale) interbeds and laminations of fine to very fine grained sandstone.
							67.93	68.00	LOST CORE	LOST CORE	LOST CORE	LOST CORE	LOST CORE	LOST CORE	LOST CORE	LOST CORE	LOST CORE	LOST CORE	LOST CORE
68.00	69.50	1.43	95.33	1.19	79.33	4.00	68.00	69.43	11,10	10.5	Planar	Slightly Rough	Occasional (3-6cm)	70°	Medium-Dark Grey	Mudstone	Sandstone	-	Dark grey silty mudstone with medium grey thin (mm scale) interbeds and laminations of fine to very fine grained sandstone.
							69.43	69.50	LOST CORE	LOST CORE	LOST CORE	LOST CORE	LOST CORE	LOST CORE	LOST CORE	LOST CORE	LOST CORE	LOST CORE	LOST CORE
69.50	71.00	1.47	98.00	0.59	39.33	5.00	69.50	70.97	24,24	24	Stepped	Slightly Rough	Isolated (6->12cm)	75°	Medium-Dark Grey	Mudstone	Sandstone	-	Dark grey silty mudstone with medium grey thin (mm scale) interbeds and laminations of fine to very fine grained sandstone.
							70.97	71.00	LOST CORE	LOST CORE	LOST CORE	LOST CORE	LOST CORE	LOST CORE	LOST CORE	LOST CORE	LOST CORE	LOST CORE	LOST CORE
71.00	72.50	1.50	100.00	0.77	51.33	7	71.00	72.50	10,10	10	Planar	Slightly Rough	Isolated (6->12cm)	45°	Medium-Dark Grey	Mudstone	Sandstone	-	Dark grey silty mudstone with medium grey thin (mm scale) interbeds and laminations of fine to very fine grained sandstone.
72.50	74.00	1.50	100.00	0.12	8.00	4	72.50	74.00	0	0	Planar	Slightly Rough	Isolated (6->12cm)	45°	Dark Grey	Mudstone	-	-	Dark grey semi-fractured mudstone with rare laminations of siltstone and very fine grained sandstone.
74.00	75.50	1.44	96.00	0.50	33.33	4.00	74.00	75.44	0	0	Planar	Slightly Rough	Isolated (6->12cm)	40°	Dark Grey	Mudstone	-	-	Dark grey silty mudstone with occasional thin interbeds and laminations of siltstone rare thin lenses and laminations of coal.
							75.44	75.50	LOST CORE	LOST CORE	LOST CORE	LOST CORE	LOST CORE	LOST CORE	LOST CORE	LOST CORE	LOST CORE	LOST CORE	LOST CORE
75.50	77.00	1.50	100.00	0.31	20.67	13.00	75.50	75.60	0	0	-	-	-	-	Light-Medium Grey	Interlaminated Mudstone/Siltstone	-	-	Light grey siltstone with occasional dark grey silty mudstone interbeds.
							75.60	77.00			Planar	Smooth	Occasional (3-6cm)	40°	Dark Grey-Black	Interbedded Anthracite/Mudstone	-	Quartz Stringers	Dark grey to black carbonaceous mudstone interbedded with anthracite and quartz stringers.
77.00	78.50	1.43	95.33	0.00	0.00	10.00	77.00	78.43	0	0	Planar	Smooth	Isolated (6->12cm)	20°	Black	Anthracite Coal	Mudstone	Quartz Stringers	Black anthracite beds (up to dm scale) with thin (mm to cm scale) interbeds of black mudstone and occasional quartz stringers.
							78.43	78.50	LOST CORE	LOST CORE	LOST CORE	LOST CORE	LOST CORE	LOST CORE	LOST CORE	LOST CORE	LOST CORE	LOST CORE	LOST CORE
78.50	80.00	1.45	96.67	0.40	26.67	13.00	78.50	79.95	0	0	Planar	Smooth	Occasional (3-6cm)	45°	Black	Anthracite Coal	Mudstone	Quartz Stringers	Black anthracite beds (up to dm scale) with thin (mm to cm scale) interbeds of black mudstone and occasional quartz stringers.
							79.95	80.00	LOST CORE	LOST CORE	LOST CORE	LOST CORE	LOST CORE	LOST CORE	LOST CORE	LOST CORE	LOST CORE	LOST CORE	LOST CORE
80.00	81.50	1.50	100.00	0.12	8.00	6	80.00	81.50	0	0	n/a	n/a	n/a	n/a	Black	Anthracite Coal	Mudstone	Quartz Stringers	Black anthracite beds (up to dm scale) with thin (mm to cm scale) interbeds of black mudstone and occasional quartz stringers.
81.50	83.00	1.50	100.00	0.00	0.00	11	81.50	83.00	0	0	n/a	n/a	n/a	n/a	Black	Anthracite Coal	Mudstone	Quartz Stringers	Black anthracite beds (up to dm scale) with thin (mm to cm scale) interbeds of black mudstone and occasional quartz stringers.
83.00	84.50	1.50	100.00	0.00	0.00	7.00	83.00	83.80	0	0	n/a	n/a	n/a	n/a	Black	Anthracite Coal	Mudstone	Quartz Stringers	Black anthracite beds (up to dm scale) with thin (mm to cm scale) interbeds of black mudstone and occasional quartz stringers.
							83.80	84.50							Medium-Dark Grey	Interbedded Mudstone/Siltstone	-	-	Grey clayey siltstone grading into black silty mudstone.

Run Depth		Core Recovery		RQD Length (Pieces >10cm) [m]	RQD length /run length x100 [%]	Number of Joints (per run)	Core Depth		Schmidt Hammer Tests		Joint Details				Colour	Major Lithology	Minor Lithology	Features	Comments
From [m]	To [m]	Rec. [m]	Rec. [%]				From [m]	To [m]	Test 'R' Values	Avg 'R' Value	Geometry	Roughness	Spacing	Joint Angle [°]					
84.50	86.00	1.50	100.00	0.20	13.33	7	84.50	86.00	0	0	Planar	Slightly Rough	Isolated (6->12cm)	45°	Dark Grey-Black	Interbedded Anthracite/Mudstone	Siltstone	Quartz Stringers	Dark grey mudstone interbedded with black anthracite
86.00	87.50	1.48	98.67	0.00	0.00	>20	86.00	87.48	0	0	n/a	n/a	n/a	n/a	Black	Anthracite Coal	Siltstone	Quartz Stringers	Black fractured/fissile anthracite with rare thin (mm scale) siltstone interbeds and occasional quartz stringers.
							87.48	87.50	LOST CORE	LOST CORE	LOST CORE	LOST CORE	LOST CORE	LOST CORE	LOST CORE	LOST CORE	LOST CORE	LOST CORE	LOST CORE
87.50	89.00	1.50	100.00	0.56	37.33	5.00	87.50	88.25							Black	Anthracite Coal	Siltstone	Quartz Stringers	Black fractured/fissile anthracite with rare thin (mm scale) siltstone interbeds and occasional quartz stringers.
							88.25	89.00	0	0	Planar	Slightly Rough	Isolated (6->12cm)	45°	Black	Mudstone	-	Pyrite	Black mudstone and dark grey silty mudstone with small (<mm) pyrite grains and grey soft plastic clay veins/fault zones.
89.00	90.50	1.43	95.33	0.71	47.33	8.00	89.00	90.43	20,14	17	Planar	Smooth	Isolated (6->12cm)	45°	Black	Mudstone	Siltstone	Pyrite	Black mudstone and dark grey silty mudstone with pyrite grains and nodules (up to mm scale).
							90.43	90.50	LOST CORE	LOST CORE	LOST CORE	LOST CORE	LOST CORE	LOST CORE	LOST CORE	LOST CORE	LOST CORE	LOST CORE	LOST CORE

TERRACON GEOTECHNIQUE

CLIENT:	Arctos Anthracite Joint Venture
PROJECT NUMBER:	122781
HOLE ID:	GD-15
PROJECT LOCATION:	Arctos Anthracite Property

DATE STARTED: July 15th, 2013 Completed: July 21, 2013
DRILL CONTRACTOR: Driftwood RIG #:
HOLE SIZE: HQ
DRILLING METHOD: Diamond
LOGGED BY: M.McGrath/G.McLe CHECKED BY:

Ground Elevation [masl] 1545
Easting 509189.6
Northing 6344465.3
Water Table Depth [m]
Total Depth [m] 102.00m

COMMENTS:

Run Depth		Core Recovery		RQD Length (Pieces >10cm) [m]	RQD length /run length x100 [%]	Number of Joints (per run)	Core Depth		Schmidt Hammer Tests		Joint Details				Colour	Major Lithology	Minor Lithology	Features	Comments
From [m]	To [m]	Rec. [m]	Rec. [%]				From [m]	To [m]	Test 'R' Values	Avg 'R' Value	Geometry	Roughness	Spacing	Joint Angle [°]					
0.00	1.50	0.30	20.00	0.00	0.00	n/a	0.00	0.30	n/a	n/a	n/a	n/a	n/a	n/a	Brown	Overburden		Organics	Organics, clay, roots, various clasts
							0.30	1.50	LOST CORE	LOST CORE	LOST CORE	LOST CORE	LOST CORE	LOST CORE	LOST CORE	LOST CORE	LOST CORE	LOST CORE	LOST CORE
1.50	3.00	0.50	33.33	0.00	0.00	n/a	1.50	2.00	n/a	n/a	n/a	n/a	n/a	n/a	Medium-Dark Grey	Sandstone and Mudstone		Clasts - Assorted Sizes	Weathered, sub-rounded to angular sandstone and mudstone clasts up to 6cm in size
							2.00	3.00	LOST CORE	LOST CORE	LOST CORE	LOST CORE	LOST CORE	LOST CORE	LOST CORE	LOST CORE	LOST CORE	LOST CORE	LOST CORE
3.00	4.50	0.30	20.00	0.00	0.00	n/a	3.00	3.30	n/a	n/a	n/a	n/a	n/a	n/a	Medium-Dark Grey	Sandstone and Mudstone		Clasts - Assorted Sizes	Weathered, sub-rounded to angular sandstone and mudstone clasts up to 5cm in size. Light grey clays
							3.30	4.50	LOST CORE	LOST CORE	LOST CORE	LOST CORE	LOST CORE	LOST CORE	LOST CORE	LOST CORE	LOST CORE	LOST CORE	LOST CORE
4.50	6.00	0.65	43.33	0.50	33.33	n/a	4.50	5.15	n/a	n/a	n/a	n/a	n/a	n/a	Dark Grey	Glacial Till		Clasts - Assorted Sizes	Assorted angular and sub-rounded clasts
							5.15	6.00	LOST CORE	LOST CORE	LOST CORE	LOST CORE	LOST CORE	LOST CORE	LOST CORE	LOST CORE	LOST CORE	LOST CORE	LOST CORE
6.00	7.50	1.30	86.67	0.50	33.33	n/a	6.00	7.30	n/a	n/a	n/a	n/a	n/a	n/a	Dark Grey	Clay		Clasts - Assorted Sizes	Very stiff clay with weathered mudstone clasts
							7.30	7.50	LOST CORE	LOST CORE	LOST CORE	LOST CORE	LOST CORE	LOST CORE	LOST CORE	LOST CORE	LOST CORE	LOST CORE	LOST CORE
7.50	9.00	0.75	50.00	0.00	0.00	n/a	7.50	8.25	n/a	n/a	n/a	n/a	n/a	n/a	Dark Grey	Clay		Clasts - Assorted Sizes	Very stiff clay with weathered mudstone clasts
							8.25	9.00	LOST CORE	LOST CORE	LOST CORE	LOST CORE	LOST CORE	LOST CORE	LOST CORE	LOST CORE	LOST CORE	LOST CORE	LOST CORE
9.00	10.50	1.20	80.00	0.20	13.33	13.00	9.00	9.30	n/a	n/a	Planar	Smooth	Occasional (3-6cm)	30°	Dark Grey-Black	Interbedded Anthracite/Mudstone		-	Contact between mudstone and coal, very weathered.
							9.30	10.20							Dark Grey-Black	Interbedded Anthracite/Mudstone		-	Minor mudstone interbedding
							10.20	10.50	LOST CORE	LOST CORE	LOST CORE	LOST CORE	LOST CORE	LOST CORE	LOST CORE	LOST CORE	LOST CORE	LOST CORE	LOST CORE
10.50	12.00	1.05	70.00	0.58	38.67	8.00	10.50	10.66	12,38,27	25.67	Planar	Smooth	Isolated (6->12cm)	30°	Dark Grey-Black	Interbedded Anthracite/Mudstone		Quartz Vein(s) mm scale	-
							10.66	11.33							Dark Grey	Mudstone		-	Silty mudstone
							11.33	11.55							Medium Grey	Interbedded Mudstone/Sandstone		Quartz Stringers	-
							11.55	12.00	LOST CORE	LOST CORE	LOST CORE	LOST CORE	LOST CORE	LOST CORE	LOST CORE	LOST CORE	LOST CORE	LOST CORE	LOST CORE
12.00	13.50	1.35	90.00	0.95	63.33	7.00	12.00	12.80	33,30	31.5	Planar	Slightly Rough	-	40°	Dark Grey-Black	Mudstone		Quartz Stringers	-
							12.80	12.97							Medium Grey	Sandstone		Quartz Vein(s) mm scale	Fractured and rubbly, weathered, FAULT.
							12.97	13.35							Medium Grey	Sandstone		-	Fine grained sandstone with minor mudstone laminae.
							13.35	13.50	LOST CORE	LOST CORE	LOST CORE	LOST CORE	LOST CORE	LOST CORE	LOST CORE	LOST CORE	LOST CORE	LOST CORE	LOST CORE
13.50	15.00	1.25	83.33	0.55	36.67	7.00	13.50	14.40	28,30	29	Planar	Slightly Rough	Isolated (6->12cm)	10°	Medium Grey	Sandstone		Quartz Stringers	Fine grained SS, moderately fractured and jointed.
							14.40	14.75							Dark Grey-Black	Interbedded Anthracite/Mudstone		Pyrite	Minor mudstone interbedding, large concentration of pyrite.
							14.75	15.00	LOST CORE	LOST CORE	LOST CORE	LOST CORE	LOST CORE	LOST CORE	LOST CORE	LOST CORE	LOST CORE	LOST CORE	LOST CORE
15.00	16.50	1.10	73.33	0.75	50.00	8.00	15.00	15.20	10	10	Planar	Smooth	Isolated (6->12cm)	60°	Dark Grey-Black	Anthracite Coal		-	Very broken up/crumbly
							15.20	16.10							Medium-Dark Grey	Mudstone			-
							16.10	16.50	LOST CORE	LOST CORE	LOST CORE	LOST CORE	LOST CORE	LOST CORE	LOST CORE	LOST CORE	LOST CORE	LOST CORE	LOST CORE

16.50	18.00	1.45	96.67	0.65	43.33	10.00	16.50	17.38	20,17,18	18.33	Planar	Smooth	Isolated (6->12cm)	60°	Medium-Dark Grey	Mudstone		-	-
							17.38	17.95							Medium Grey	Sandstone		Quartz Stringers	Weathered along joints
							17.95	18.00	LOST CORE	LOST CORE	LOST CORE	LOST CORE	LOST CORE	LOST CORE	LOST CORE	LOST CORE	LOST CORE	LOST CORE	LOST CORE
18.00	19.50	1.50	100.00	0.75	50.00	10	18.00	19.50	26,12,26	21.33	Planar	Slightly Rough	Occasional (3-6cm)	60°	Medium Grey	Sandstone		Quartz Stringers	Some mudstone laminae, weathered along some joints.
19.50	21.00	1.25	83.33	0.67	44.67	7.00	19.50	19.75	LOST CORE	LOST CORE	LOST CORE	LOST CORE	LOST CORE	LOST CORE	LOST CORE	LOST CORE	LOST CORE	LOST CORE	LOST CORE
							19.75	20.75	34,35	34.5	Planar	Slightly Rough	Isolated (6->12cm)	70°	Medium-Dark Grey	Interbedded Mudstone/Sandstone		Quartz Stringers	Very fine grained silty sandstone with mudstone interbeds.
							20.75	21.00	LOST CORE	LOST CORE	LOST CORE	LOST CORE	LOST CORE	LOST CORE	LOST CORE	LOST CORE	LOST CORE	LOST CORE	LOST CORE
21.00	22.50	1.20	80.00	0.68	45.33	7	21.00	22.20	24,10,20	18	Planar	Smooth	Isolated (6->12cm)	70°	Medium-Dark Grey	Interbedded Mudstone/Sandstone		Quartz Vein(s) mm scale	Very fine grained silty sandstone with mudstone interbeds.
							22.20	22.50	LOST CORE	LOST CORE	LOST CORE	LOST CORE	LOST CORE	LOST CORE	LOST CORE	LOST CORE	LOST CORE	LOST CORE	LOST CORE
22.50	24.00	1.50	100.00	1.00	66.67	7	22.50	24.00	28,24	26	Planar	Slightly Rough	Isolated (6->12cm)	50°	Medium-Dark Grey	Interbedded Mudstone/Sandstone		Quartz Vein(s) mm scale	Very fine grained silty sandstone with mudstone interbeds.
24.00	25.50	1.45	96.67	0.97	64.67	7.00	24.00	25.45	24,22	23	Planar	Smooth	Isolated (6->12cm)	30°	Medium-Dark Grey	Interbedded Mudstone/Sandstone		Quartz Vein(s) mm scale	Very fine grained silty sandstone with mudstone interbeds. Some quartz stringers.
							25.45	25.50	LOST CORE	LOST CORE	LOST CORE	LOST CORE	LOST CORE	LOST CORE	LOST CORE	LOST CORE	LOST CORE	LOST CORE	LOST CORE
25.50	27.00	1.40	93.33	0.90	60.00	6.00	25.50	26.90	14,18	16	Planar	Smooth	Occasional (3-6cm)	60°	Dark Grey-Black	Mudstone		-	Highly fractured and jointed mudstone
							26.90	27.00	LOST CORE	LOST CORE	LOST CORE	LOST CORE	LOST CORE	LOST CORE	LOST CORE	LOST CORE	LOST CORE	LOST CORE	LOST CORE
27.00	28.50	1.50	100.00	0.20	13.33	>20	27.00	28.50	12,10	11	Planar	Smooth	Numerous (1-3cm)	50°	Dark Grey-Black	Mudstone		Pyrite	Large amount of heavily concentrated pyrite at beginning and end of run.
28.50	30.00	1.45	96.67	0.85	56.67	6.00	28.50	29.95	30,29	29.5	Planar	Slightly Rough	Isolated (6->12cm)	50°	Dark Grey-Black	Mudstone		Quartz Stringers	Silty mudstone
							29.95	30.00	LOST CORE	LOST CORE	LOST CORE	LOST CORE	LOST CORE	LOST CORE	LOST CORE	LOST CORE	LOST CORE	LOST CORE	LOST CORE
30.00	31.50	1.50	100.00	0.99	66.00	5	30.00	31.50	30,27	28.5	Planar	Smooth	Isolated (6->12cm)	40°	Dark Grey-Black	Mudstone		Quartz Stringers	Silty Mudstone
31.50	33.00	1.45	96.67	0.70	46.67	13.00	31.50	31.75	28,28	28	Planar	Smooth	Isolated (6->12cm)	50°	Dark Grey-Black	Mudstone		-	Silty mudstone
							31.75	32.95			Planar	Smooth	Isolated (6->12cm)	40°	Medium-Dark Grey	Interbedded Mudstone/Sandstone		Quartz Vein(s) mm scale	Very fine grained sandstone with mudstone interbeds. Some flaser bedding.
							32.95	33.00	LOST CORE	LOST CORE	LOST CORE	LOST CORE	LOST CORE	LOST CORE	LOST CORE	LOST CORE	LOST CORE	LOST CORE	LOST CORE
33.00	34.50	1.50	100.00	0.85	56.67	12	33.00	34.50	32,34	33	Planar	Polished	Occasional (3-6cm)	60°	Medium-Dark Grey	Interbedded Mudstone/Sandstone		Quartz Stringers	Very fine grained sandstone with mudstone interbeds. Some flaser bedding.
34.50	36.00	1.35	90.00	0.40	26.67	>20	34.50	35.85	12,18	15	Irregular	Polished	Occasional (3-6cm)	60°	Medium-Dark Grey	Interbedded Mudstone/Sandstone		Quartz Stringers	Very fine grained sandstone with mudstone interbeds. Some flaser bedding Very broken up/rubbly. Lightly weathered on some joints.
							35.85	36.00	LOST CORE	LOST CORE	LOST CORE	LOST CORE	LOST CORE	LOST CORE	LOST CORE	LOST CORE	LOST CORE	LOST CORE	LOST CORE
36.00	37.50	1.30	86.67	0.60	40.00	>20	36.00	37.30	36,32	34	Planar	Smooth	Occasional (3-6cm)	70°	Medium-Dark Grey	Interbedded Mudstone/Sandstone		Quartz Stringers	Very fine grained sandstone with mudstone interbeds. Some flaser bedding Very broken up/rubbly. Lightly weathered on some joints. Rubbly/broken up from 36.00m-36.25m and 36.50m-36.75m.
							37.30	37.50	LOST CORE	LOST CORE	LOST CORE	LOST CORE	LOST CORE	LOST CORE	LOST CORE	LOST CORE	LOST CORE	LOST CORE	LOST CORE
37.50	39.00	1.45	96.67	0.70	46.67	12.00	37.50	38.95	21,28,26	25	Planar	Very Rough	Isolated (6->12cm)	65°	Medium Grey	Sandstone		Quartz Stringers	Fine to medium grained, grain size coarsening towards base of run. Minor mudstone laminations.
							38.95	39.00	LOST CORE	LOST CORE	LOST CORE	LOST CORE	LOST CORE	LOST CORE	LOST CORE	LOST CORE	LOST CORE	LOST CORE	LOST CORE
39.00	40.50	1.40	93.33	0.45	30.00	12.00	39.00	40.40	24,20	22	Planar	Slightly Rough	Occasional (3-6cm)	70°	Light-Medium Grey	Sandstone		Quartz Stringers	Fine to medium grained. Abundance of quartz at base of run.
							40.40	40.50	LOST CORE	LOST CORE	LOST CORE	LOST CORE	LOST CORE	LOST CORE	LOST CORE	LOST CORE	LOST CORE	LOST CORE	LOST CORE
40.50	42.00	1.45	96.67	0.90	60.00	8.00	40.50	41.95	25,30	27.5	Planar	Slightly Rough	Isolated (6->12cm)	70°	Light-Medium Grey	Sandstone		Quartz Stringers	Fine to medium grained.
							41.95	42.00	LOST CORE	LOST CORE	LOST CORE	LOST CORE	LOST CORE	LOST CORE	LOST CORE	LOST CORE	LOST CORE	LOST CORE	LOST CORE

42.00	43.50	1.40	93.33	0.00	0.00	17.00	42.00	43.10	16,28,34	26	Planar	Slightly Rough	Isolated (6->12cm)	60°	Light-Medium Grey	Sandstone		Quartz Stringers	Fine to medium grained.
							43.10	43.40			Planar	Polished	Isolated (6->12cm)	80°	Medium-Dark Grey	Sandstone		Mudclasts	Fine grained, transitioning to mudstone, some mudstone laminae and mud clasts.
							43.40	43.50	LOST CORE	LOST CORE	LOST CORE	LOST CORE	LOST CORE	LOST CORE	LOST CORE	LOST CORE	LOST CORE	LOST CORE	LOST CORE
43.50	45.00	1.34	89.33	0.17	11.33	>20	43.50	43.66	LOST CORE	LOST CORE	LOST CORE	LOST CORE	LOST CORE	LOST CORE	LOST CORE	LOST CORE	LOST CORE	LOST CORE	LOST CORE
							43.66	44.00	18,16	17	Irregular	Smooth	Isolated (6->12cm)	65°	Medium-Dark Grey	Sandstone		Mudclasts	Mud clasts and mudstone laminae.
							44.00	44.30			Planar	Smooth	Numerous (1-3cm)	75°	Medium-Dark Grey	Sandstone			Very broken up, heavily jointed, potential fault.
							44.30	45.00			Planar	Polished	Abundant (<1cm)	75°	Medium-Dark Grey	Sandstone		Quartz Vein(s) cm scale	Very broken up, heavily jointed, potential fault.
45.00	46.50	1.35	90.00	0.53	35.33	>20	45.00	46.35	16	16	Planar	Smooth	Isolated (6->12cm)	55°	Medium-Dark Grey	Interbedded Mudstone/Sandstone		Quartz Vein(s) cm scale	Fine grained sandstone interbedded with mudstone. Weathered on some joint surfaces.
							46.35	46.50	LOST CORE	LOST CORE	LOST CORE	LOST CORE	LOST CORE	LOST CORE	LOST CORE	LOST CORE	LOST CORE	LOST CORE	LOST CORE
46.50	48.00	1.50	100.00	0.00	0.00	>20	46.50	46.80	21,20	20.5	Planar	Slightly Rough	Isolated (6->12cm)	70°	Medium-Dark Grey	Interbedded Mudstone/Siltstone		-	Silty mudstone
							46.80	47.45			Curved	Slightly Rough	Numerous (1-3cm)	40°	Medium-Dark Grey	Interbedded Mudstone/Siltstone			Very broken up, potential fault. Silty mudstone
							47.45	48.00			Planar	Smooth	Isolated (6->12cm)	60°	Medium-Dark Grey	Interbedded Mudstone/Siltstone			Silty mudstone
48.00	49.50	1.50	100.00	0.65	43.33	5	48.00	48.70	16,40	28	Planar	Smooth	Isolated (6->12cm)	60°	Medium-Dark Grey	Interbedded Mudstone/Siltstone		-	-
							48.70	49.50							Dark Grey	Mudstone			Trace siltstone
49.50	51.00	1.45	96.67	1.15	76.67	5.00	49.50	50.95	22,23	22.5	Planar	Polished	Isolated (6->12cm)	60°	Dark Grey	Mudstone		-	Trace siltstone laminae massive
							50.95	51.00	LOST CORE	LOST CORE	LOST CORE	LOST CORE	LOST CORE	LOST CORE	LOST CORE	LOST CORE	LOST CORE	LOST CORE	LOST CORE
51.00	52.50	1.50	100.00	1.50	100.00	4	51.00	52.50	20,18	19	Planar	Smooth	Isolated (6->12cm)	50°	Dark Grey	Mudstone		Pyrite	Trace siltstone bands, <1cm, 50 deg, massive, one Py lamination
52.50	54.00	1.40	93.33	0.85	56.67	11.00	52.50	53.10	13,15	14	Planar	Smooth	Occasional (3-6cm)	70°	Dark Grey	Mudstone		Quartz Stringers	40cm zone of fractured core.
							53.10	53.90			Planar	Smooth		75	Dark Grey	Mudstone			
							53.90	54.00	LOST CORE	LOST CORE	LOST CORE	LOST CORE	LOST CORE	LOST CORE	LOST CORE	LOST CORE	LOST CORE	LOST CORE	LOST CORE
54.00	55.50	1.50	100.00	1.35	90.00	5	54.00	54.80	22,22	22	Planar	Smooth	Isolated (6->12cm)	35	Dark Grey	Mudstone		Pyrite	Trace pyrite <1%, massive
							54.80	54.90			Planar	Smooth		65	Dark Grey	Mudstone			
							54.90	55.50			Planar	Smooth		40°	Dark Grey	Mudstone			
55.50	57.00	1.40	93.33	0.40	26.67	15.00	55.50	55.80	12,12	12	Planar	Slightly Rough	Isolated (6->12cm)	40°	Dark Grey	Mudstone		Pyrite	1% pyrite stringers, <1% Qtz
							55.80	56.00			Planar	Slightly Rough	Isolated (6->12cm)	90°	Dark Grey	Mudstone			
							56.00	56.90			Curved	Smooth		60°	Dark Grey	Mudstone			
							56.90	57	LOST CORE	LOST CORE	LOST CORE	LOST CORE	LOST CORE	LOST CORE	LOST CORE	LOST CORE	LOST CORE	LOST CORE	LOST CORE
57.00	58.50	1.35	90.00	0.65	43.33	19.00	57.00	57.65	11,12	11.5	Planar	Polished	Numerous (1-3cm)	90°	Dark Grey	Mudstone		Pyrite	Pyrite <1cm, massive
							57.65	58.35	11,12	11.5	Curved	Polished	Numerous (1-3cm)	70°	Dark Grey	Mudstone		Pyrite	Pyrite <1cm, massive
							58.35	58.50	LOST CORE	LOST CORE	LOST CORE	LOST CORE	LOST CORE	LOST CORE	LOST CORE	LOST CORE	LOST CORE	LOST CORE	LOST CORE
58.50	60.00	1.50	100.00	0.30	20.00	>20	58.50	59.25	0	0				90°	Black	Anthracite Coal		Quartz Stringers	-
							59.25	59.80	0	0	Planar	Polished	Occasional (3-6cm)	70°	Dark Grey-Black	Interbedded Anthracite/Mudstone		Quartz Stringers	
							59.80	60.00	0	0	Planar	Polished		60°	Dark Grey	Mudstone		Quartz Stringers	
60.00	61.50	1.50	100.00	0.50	33.33	14	60.00	60.20	30,26	28	Irregular	Slightly Rough	Isolated (6->12cm)	60°	Dark Grey	Mudstone		-	Trace fine grained sandstone.
							60.20	60.60			Planar	Polished		85°	Dark Grey	Mudstone			
							60.60	61.50			Planar	Polished		55	Dark Grey	Mudstone			

61.50	63.00	1.50	100.00	0.55	36.67	10	61.50	61.60	10,21,27	19	Planar	Polished	Isolated (6->12cm)	40°	Medium-Dark Grey	Interbedded Mudstone/Sandstone		Quartz Vein(s) mm scale	Sandstone 5-10cm bands, fine grained
							61.60	63.00			Planar	Slightly Rough		40°	Medium-Dark Grey	Interbedded Mudstone/Sandstone		-	-
63.00	64.50	1.50	100.00	0.20	13.33	>20	63.00	63.10	19,10,9	12.5	Planar	Polished	Numerous (1-3cm)	75	Brown-Grey	Mudstone		-	-
							63.10	64.50			Planar	Smooth		50°					
64.50	66.00	1.50	100.00	0.60	40.00	5,4,12	64.50	64.85	30,10	20	Planar	Smooth	Isolated (6->12cm)	45	Dark Brown	Mudstone		-	-
							64.85	65.10			Curved	Smooth	Isolated (6->12cm)	40°	White	Bentonite			contact angle 40, irregular,smooth, Calcareous
							65.10	66.00			Planar	Slightly Rough	Isolated (6->12cm)	60°	Dark Brown	Mudstone		Pyrite	Pyrite nodule,1cm
66.00	67.50	1.40	93.33	0.70	46.67	9.00	66.00	67.10	0	0	Irregular	Slightly Rough	Isolated (6->12cm)	30°	Dark Grey	Mudstone		-	Weathered, massive, dense.
							67.10	67.40			Planar	Polished	Numerous (1-3cm)	80°	Black	Anthracite Coal			Burnt on both edges of coal seam.
							67.40	67.50	LOST CORE	LOST CORE	LOST CORE	LOST CORE	LOST CORE	LOST CORE	LOST CORE	LOST CORE	LOST CORE	LOST CORE	LOST CORE
67.50	69.00	1.40	93.33	0.40	26.67	13.00	67.50	67.60	LOST CORE	LOST CORE	LOST CORE	LOST CORE	LOST CORE	LOST CORE	LOST CORE	LOST CORE	LOST CORE	LOST CORE	LOST CORE
							67.60	68.30	0	0	Planar	Polished	Isolated (6->12cm)	30°	Dark Grey-Black	Interbedded Anthracite/Mudstone		-	-
							68.30	69.00				Polished	Abundant (<1cm)		Black	Anthracite Coal		-	-
69.00	70.50	1.40	93.33	0.80	53.33	11.00	69.00	69.10	LOST CORE	LOST CORE	LOST CORE	LOST CORE	LOST CORE	LOST CORE	LOST CORE	LOST CORE	LOST CORE	LOST CORE	LOST CORE
							69.10	69.50	20,16	18	Irregular	Smooth	Numerous (1-3cm)	20°	Dark Grey-Black	Interbedded Anthracite/Mudstone		-	Fine grained sandstone-siltstone.
							69.50	70.50			Curved	Smooth	Occasional (3-6cm)	40°	Medium-Dark Grey	Interbedded Anthracite/Mudstone			
70.50	72.00	1.43	95.33	1.38	92.00	5.00	70.50	71.93	18,18	18	Curved	Very Rough	Isolated (6->12cm)	20°	Medium-Dark Grey	Interbedded Mudstone/Siltstone		Quartz Stringers	Mudstone interbedded with Siltstone, siltstone becoming sandier towards base of run, flaser bedding present
							71.93	72.00	LOST CORE	LOST CORE	LOST CORE	LOST CORE	LOST CORE	LOST CORE	LOST CORE	LOST CORE	LOST CORE	LOST CORE	LOST CORE
72.00	73.50	1.50	100.00	1.10	73.33	4.00	72.00	72.76	16,16	16	Curved	Very Rough	Isolated (6->12cm)	30°	Light-Medium Grey	Interbedded Mudstone/Sandstone		-	Fine-medium grained sandstone interbedded with mudstone. Flaser bedding present.
							72.76	72.81			Irregular	Slightly Rough	Isolated (6->12cm)	90°	Dark Grey-Black	Mudstone		-	Mudstone with minor siltstone and sandstone. Abundance of bi-valve shells/shell fragments
							72.81	73.50			Planar	Slightly Rough	Isolated (6->12cm)	20°	Dark Grey-Black	Interbedded Mudstone/Siltstone		-	Minor concentration of bi-valve fossils at 73.27m. Flaser bedding present.
73.50	75.00	1.45	96.67	1.10	73.33	7.00	73.50	74.95	20,22	21	Irregular	Very Rough	Isolated (6->12cm)	45°	Medium-Dark Grey	Interbedded Mudstone/Sandstone		Quartz Vein(s) cm scale	-
							74.95	75.00	LOST CORE	LOST CORE	LOST CORE	LOST CORE	LOST CORE	LOST CORE	LOST CORE	LOST CORE	LOST CORE	LOST CORE	LOST CORE
75.00	76.50	1.50	100.00	1.45	96.67	3	75.00	76.50	14,18	16	Curved	Very Rough	Isolated (6->12cm)	50°	Medium-Dark Grey	Sandstone		-	Occasional mudstone interbeds.
76.50	78.00	1.40	93.33	1.20	80.00	3.00	76.50	76.92	20,27	23.5	Planar	Polished	Isolated (6->12cm)	30°	Medium Grey	Sandstone		Quartz Vein(s) mm scale	Fine-medium grained sandstone. Occsional mudstone interlaminae.
							76.92	77.90			Planar	Striated	Isolated (6->12cm)	55°	Medium-Dark Grey	Interbedded Mudstone/Sandstone		Quartz Vein(s) mm scale	Silty mudstone with minor sandstone interbeds. Flaser bedding present
							77.90	78.00	LOST CORE	LOST CORE	LOST CORE	LOST CORE	LOST CORE	LOST CORE	LOST CORE	LOST CORE	LOST CORE	LOST CORE	LOST CORE
78.00	79.50	1.50	100.00	1.40	93.33	3	78.00	79.50	27,16	21.5	Planar	Polished	Isolated (6->12cm)	30°	Medium-Dark Grey	Interbedded Mudstone/Sandstone		-	Silty mudstone with minor sandstone interbeds. Flaser bedding present
79.50	81.00	1.50	100.00	1.30	86.67	5	79.50	81.00			Planar	Striated	Isolated (6->12cm)	80°	Medium-Dark Grey	Interbedded Mudstone/Sandstone		Quartz Vein(s) mm scale	Silty mudstone with flaser bedding
81.00	82.50	1.50	100.00	1.25	83.33	7	81.00	82.50	0	0	Planar	Smooth	Isolated (6->12cm)	20°	Medium-Dark Grey	Interbedded Mudstone/Siltstone		-	Sandy siltstone with mudstone interbedding. Flaser bedding.
82.50	84.00	1.50	100.00	0.65	43.33	9	82.50	83.10	12,0	12	Planar	Smooth	Isolated (6->12cm)	70°	Dark Grey-Black	Mudstone		Quartz Vein(s) mm scale	Massive mudstone
							83.10	83.38			Irregular	Striated	Isolated (6->12cm)	80°	Dark Grey-Black	Mudstone		Quartz Vein(s) mm scale	Mudstone with abundant quartz veins and stringers.
							83.38	84.00			Planar	Striated	Isolated (6->12cm)	50°	Dark Grey-Black	Interbedded Mudstone/Siltstone		Quartz Stringers	Mudstone with siltstone interbeds
84.00	85.50	1.45	96.67	0.75	50.00	11.00	84.00	85.45	20,22	21	Curved	Smooth	Isolated (6->12cm)	70°	Dark Grey-Black	Mudstone		Quartz Vein(s) mm scale	-
							85.45	85.50	LOST CORE	LOST CORE	LOST CORE	LOST CORE	LOST CORE	LOST CORE	LOST CORE	LOST CORE	LOST CORE	LOST CORE	LOST CORE

85.50	87.00	1.50	100.00	0.80	53.33	16	85.50	87.00	0		Planar	Striated	Isolated (6->12cm)	50°	Dark Grey-Black	Mudstone		Quartz Stringers	Massive mudstone. Occasional quartz stringer
87.00	88.50	1.50	100.00	0.30	20.00	>20	87.00	88.00	12,20	16	Irregular	Smooth	Isolated (6->12cm)	30°	Dark Grey-Black	Mudstone		Quartz Vein(s) mm scale	-
							88.00	88.50			Planar	Striated	Isolated (6->12cm)	50°	Dark Grey-Black	Sandstone		Pyrite	Very fine-Coarse grained muddy sandstone. Pyrite present.
88.50	90.00	1.45	96.67	0.85	56.67	8.00	88.50	89.95	14,28	21	Planar	Striated	Isolated (6->12cm)	80°, 50°	Medium-Dark Grey	Sandstone		Quartz Vein(s) mm scale	Very fine-coarse grained sandstone with occasional mudstone interbeds.
							89.95	90.00	LOST CORE	LOST CORE	LOST CORE	LOST CORE	LOST CORE	LOST CORE	LOST CORE	LOST CORE	LOST CORE	LOST CORE	LOST CORE
90.00	91.50	1.45	96.67	1.15	76.67	8.00	90.00	91.45	25,24	24.5	Irregular	Smooth	Isolated (6->12cm)	40°	Medium-Dark Grey	Sandstone		Mudclasts	Very fine-coarse grained sandstone with siltstone and mudstone interbeds.
							91.45	91.50	LOST CORE	LOST CORE	LOST CORE	LOST CORE	LOST CORE	LOST CORE	LOST CORE	LOST CORE	LOST CORE	LOST CORE	LOST CORE
91.50	93.00	1.45	96.67	1.10	73.33		91.50	92.95	30,34	32	Irregular	Very Rough	Isolated (6->12cm)	50°	Medium-Dark Grey	Sandstone		Mudclasts	Very fine-coarse grained sandstone with siltstone and mudstone interbeds.
							92.95	93.00	LOST CORE	LOST CORE	LOST CORE	LOST CORE	LOST CORE	LOST CORE	LOST CORE	LOST CORE	LOST CORE	LOST CORE	LOST CORE
93.00	94.50	1.50	100.00	1.30	86.67	6	93.00	94.50	29,27	28	Planar	Slightly Rough	Isolated (6->12cm)	40°, 60°	Medium-Dark Grey	Sandstone		Mudclasts	Very fine-coarse grained sandstone with siltstone and mudstone interbeds.
94.50	96.00	1.40	93.33	0.80	53.33	16.00	94.50	95.70	10,14	12	Planar	Smooth	Isolated (6->12cm)	50°	Medium-Dark Grey	Sandstone		Quartz Vein(s) cm scale	Very fine-coarse grained sandstone with siltstone and mudstone interbeds.
							95.70	95.90			Irregular	Smooth	Isolated (6->12cm)	20°	Dark Grey-Black	Mudstone		-	Silty mudstone
							95.90	96.00	LOST CORE	LOST CORE	LOST CORE	LOST CORE	LOST CORE	LOST CORE	LOST CORE	LOST CORE	LOST CORE	LOST CORE	LOST CORE
96.00	97.50	1.50	100.00	0.70	46.67	11	96.00	96.50	13,22	17.5	Planar	Polished	Isolated (6->12cm)	30°	Dark Grey-Black	Mudstone		Pyrite	Silty mudstone with cm scale coal seam, Pyrite present.
							96.50	97.50			Irregular	Very Rough	Isolated (6->12cm)	80°	Medium-Dark Grey	Sandstone		Quartz Vein(s) cm scale	Very fine-coarse grained sandstone with siltstone and mudstone interbeds.
97.50	99.00	1.40	93.33	0.60	40.00	10.00	97.50	98.13	11,10	21	Planar	Smooth	Isolated (6->12cm)	50°	Medium-Dark Grey	Sandstone		Quartz Vein(s) cm scale	Very fine-coarse grained sandstone with siltstone and mudstone interbeds.
							98.13	98.53			Planar	Smooth	Isolated (6->12cm)	50°	Dark Grey-Black	Mudstone		Quartz Stringers	-
							98.53	98.90							Dark Grey-Black	Interbedded Anthracite/Mudstone		-	Mudstone with some Anthracite. Moderately weathered, soft and crumbly.
							98.90	99.00	LOST CORE	LOST CORE	LOST CORE	LOST CORE	LOST CORE	LOST CORE	LOST CORE	LOST CORE	LOST CORE	LOST CORE	LOST CORE
99.00	100.50	1.40	93.33	0.93	62.00	9.00	99.00	99.05							Dark Grey-Black	Interbedded Anthracite/Mudstone		-	Mudstone with some Anthracite. Moderately weathered, soft and crumbly.
							99.05	100.40	14,18	16	Planar	Smooth	Isolated (6->12cm)	60°	Dark Grey-Black	Mudstone		-	Mudstone with minor siltstone interbeds.
							100.40	100.50	LOST CORE	LOST CORE	LOST CORE	LOST CORE	LOST CORE	LOST CORE	LOST CORE	LOST CORE	LOST CORE	LOST CORE	LOST CORE
100.50	102.00	1.50	100.00	1.05	70.00	3	100.50	102.00	26,24	25	Planar	Very Rough	Isolated (6->12cm)	70°	Dark Grey-Black	Interbedded Mudstone/Sandstone		Quartz Vein(s) mm scale	Mudstone with silty sandstone interbeds.

TERRACON GEOTECHNIQUE

CLIENT:	Arctos Anthracite Joint Venture
PROJECT NUMBER:	122781
HOLE ID:	GD-20/MW-26D
PROJECT LOCATION:	Arctos Anthracite Property

DATE STARTED: Aug 2, 2013 COMPLETED: Aug 4, 2013
DRILL CONTRACTOR: Driftwood RIG #:
HOLE SIZE: HQ
DRILLING METHOD: Diamond
LOGGED BY: GM/Zack CHECKED BY:

Ground Elevation [masl] 1644
Easting 509000.0
Northing 6342401.0
Water Table Depth [m]
Total Depth [m] 85.5

COMMENTS:

Run Depth		Core Recovery		RQD Length (Pieces >10cm) [m]	RQD length /run length x100 [%]	Number of Joints (per run)	Core Depth		Schmidt Hammer Tests		Joint Details				Colour	Major Lithology	Minor Lithology	% (Minor Lithology)	Bedding Type	Features	Comments
From [m]	To [m]	Rec. [m]	Rec. [%]				From [m]	To [m]	Test 'R' Values	Avg 'R' Value	Geometry	Roughness	Spacing	Joint Angle [°]							
0	1.5	0.72	48	0.59	39.33333	n/a	0	0.78	LOST CORE	LOST CORE	LOST CORE	LOST CORE	LOST CORE	LOST CORE	LOST CORE	LOST CORE	LOST CORE	LOST CORE	LOST CORE	LOST CORE	LOST CORE
							0.78	1.05	1,1	1	n/a	n/a	n/a	n/a	Brown	Overburden	n/a	n/a	Massive	n/a	Soil, organics, soft, PP=0
							1.05	1.50	1,1	1	n/a	n/a	n/a	n/a	Brown	Glacial Till	n/a	n/a	Massive	n/a	Clay-silt, trace fine grain sand, mm angular clasts,some gravel,hard,PP=4.5, till.
1.5	1.64	0.1	71.429	SPT	SPT	SPT	SPT	SPT	SPT	SPT	SPT	SPT	SPT	SPT	SPT	SPT	SPT	SPT	SPT	SPT	Clay, some sand, dark brown, till
1.64	3	0.55	40.44	0.44	32.35	1	1.64	2.45	LOST CORE	LOST CORE	LOST CORE	LOST CORE	LOST CORE	LOST CORE	LOST CORE	LOST CORE	LOST CORE	LOST CORE	LOST CORE	LOST CORE	LOST CORE
							2.45	2.60	32,32	32	Planar	Smooth	Isolated (6->12cm)	40°	Dark Brown	Glacial Till	n/a	n/a	Massive	Clasts-Assorted	Clay-silt, trace fine grain sand, some cm angular clasts of gravel, hard, till.
							2.6	3.00							Dark Brown	Sandstone	Mudstone	3-5%	Interbedded	Clasts-Assorted	10cm layer of mud and sandstone clast, Dark grey-brown
3	3.14	0.1	71.43	SPT	SPT	SPT	SPT	SPT	SPT	SPT	SPT	SPT	SPT	SPT	SPT	SPT	SPT	SPT	SPT	SPT	Sandstone and clay, dark grey, 1-2cm clasts.
3.14	4.5	0.15	11.029	0.15	11.02941	0	3.14	4.35	LOST CORE	LOST CORE	LOST CORE	LOST CORE	LOST CORE	LOST CORE	LOST CORE	LOST CORE	LOST CORE	LOST CORE	LOST CORE	LOST CORE	LOST CORE
							4.35	4.5	0	0	n/a	n/a	n/a	n/a	Medium-Dark Grey	Sandstone	-	n/a	Massive	n/a	cored half the diameter of core
4.5	6	0.26	17.333	0.23	15.33333	2	4.5	5.74	LOST CORE	LOST CORE	LOST CORE	LOST CORE	LOST CORE	LOST CORE	LOST CORE	LOST CORE	LOST CORE	LOST CORE	LOST CORE	LOST CORE	LOST CORE
							5.74	6	0	0	n/a	n/a	Isolated (6->12cm)	n/a	Medium-Dark Grey	Sandstone	-	n/a	Interbedded	Clasts-Assorted	fractured core, trace clay and sandstone clasts, brown-light grey.
6	7.5	1.09	72.667	0.74	49.33333	6	6	6.41	LOST CORE	LOST CORE	LOST CORE	LOST CORE	LOST CORE	LOST CORE	LOST CORE	LOST CORE	LOST CORE	LOST CORE	LOST CORE	LOST CORE	LOST CORE
							6.41	7.5	22,32,30	28	Planar	Smooth	Isolated (6->12cm)	70°	Medium Grey	Sandstone	Mudstone	3-5%	Interbedded	Quartz Vein(s) cm scale	2.5cm Qtz vein.
7.5	9	0.14	9.3333	0.1	6.666667	1	7.5	8.86	LOST CORE	LOST CORE	LOST CORE	LOST CORE	LOST CORE	LOST CORE	LOST CORE	LOST CORE	LOST CORE	LOST CORE	LOST CORE	LOST CORE	LOST CORE
							8.86	9	0	0	n/a		Isolated (6->12cm)		Medium-Dark Grey	Sandstone and Mudstone	-	-	Interbedded	n/a	Sandstone a 6cm clast.
9	10.5	0.1	6.6667	0	0	0	9	10.4	LOST CORE	LOST CORE	LOST CORE	LOST CORE	LOST CORE	LOST CORE	LOST CORE	LOST CORE	LOST CORE	LOST CORE	LOST CORE	LOST CORE	LOST CORE
							10.4	10.5	0	0	n/a	n/a	n/a	n/a	Medium Grey	Sandstone	-	n/a	n/a	n/a	2cm sandstone pebbles.
10.5	12	0.18	12	0	0	1	10.5	11.82	LOST CORE	LOST CORE	LOST CORE	LOST CORE	LOST CORE	LOST CORE	LOST CORE	LOST CORE	LOST CORE	LOST CORE	LOST CORE	LOST CORE	LOST CORE
							11.82	12	0	0	n/a	-	n/a	-	Medium Grey	Mudstone	-	n/a	Massive	n/a	Fractured, PP=3.5
12	13.5	1.28	85.333	0.99	66	7	12	12.22	LOST CORE	LOST CORE	LOST CORE	LOST CORE	LOST CORE	LOST CORE	LOST CORE	LOST CORE	LOST CORE	LOST CORE	LOST CORE	LOST CORE	LOST CORE
							12.22	13.5	0	0	n/a	-	Isolated (6->12cm)	-	Medium-Dark Grey	Mudstone	Siltstone	3-5%	Massive	n/a	Mudstone, some silt, trace fine grain sand, hard 4.5 on PP.
13.5	15	1.5	100	1.18	78.66667	6	13.5	15	0	0	n/a	-	Isolated (6->12cm)	-	Medium-Dark Grey	Mudstone	-	n/a	Massive	Clasts-Assorted	trace sand and gravel clasts.
15	16.5	1.19	79.333	1.05	70	2	15	15.31	LOST CORE	LOST CORE	LOST CORE	LOST CORE	LOST CORE	LOST CORE	LOST CORE	LOST CORE	LOST CORE	LOST CORE	LOST CORE	LOST CORE	LOST CORE
							15.31	16	0	0	n/a	-	Isolated (6->12cm)	-	Dark Grey	Mudstone	n/a	n/a	Massive	Clasts-Assorted	Clasts <1cm
							16	16.5	0	0	n/a				Light-Medium Grey	Mudstone			Massive	Clasts-Assorted	Clasts <2cm
16.5	18	0.9	60	0.49	32.66667	6	16.5	17.1	LOST CORE	LOST CORE	LOST CORE	LOST CORE	LOST CORE	LOST CORE	LOST CORE	LOST CORE	LOST CORE	LOST CORE	LOST CORE	LOST CORE	LOST CORE
							17.1	17.55	14,16	15	Planar	Smooth	Isolated (6->12cm)	20°	Light Grey	Siltstone	n/a	n/a	Massive	n/a	-
							17.55	18			Planar	Smooth		20°	Light Grey	Sandstone	Mudstone	0.10	Interbedded	n/a	mm mudstone layers ~20 deg.

TERRACON GEOTECHNIQUE

CLIENT:	Arctos Anthracite Joint Venture	HOLE ID:	GD-20/MW-26D
PROJECT NUMBER:	122781	PROJECT LOCATION:	Arctos Anthracite Property

DATE STARTED: Aug 2, 2013 COMPLETED: Aug 4, 2013
DRILL CONTRACTOR: Driftwood RIG #:
HOLE SIZE: HQ
DRILLING METHOD: Diamond
LOGGED BY: GM/Zack CHECKED BY:

Ground Elevation [masl] 1644
Easting 509000.0
Northing 6342401.0
Water Table Depth [m]
Total Depth [m] 85.5

COMMENTS:

Run Depth		Core Recovery		RQD Length (Pieces >10cm) [m]	RQD length /run length x100 [%]	Number of Joints (per run)	Core Depth		Schmidt Hammer Tests		Joint Details				Colour	Major Lithology	Minor Lithology	% (Minor Lithology)	Bedding Type	Features	Comments
From [m]	To [m]	Rec. [m]	Rec. [%]				From [m]	To [m]	Test 'R' Values	Avg 'R' Value	Geometry	Roughness	Spacing	Joint Angle [°]							
18.00	19.50	1.42	94.667	1.13	75.33333	2	18	18.08	LOST CORE	LOST CORE	LOST CORE	LOST CORE	LOST CORE	LOST CORE	LOST CORE	LOST CORE	LOST CORE	LOST CORE	LOST CORE	LOST CORE	LOST CORE
							18.08	19.5	12,26,29	22	Planar	Slighty Rough	Isolated (6->12cm)	70°	Light Grey	Sandstone	Mudstone	< 1%	Massive	n/a	mm mudstone layers.
19.5	21	1.45	96.667	1.28	85.33333	3	19.5	19.55	LOST CORE	LOST CORE	LOST CORE	LOST CORE	LOST CORE	LOST CORE	LOST CORE	LOST CORE	LOST CORE	LOST CORE	LOST CORE	LOST CORE	LOST CORE
							19.55	20.5	24,28,34	29	Irregular	Slighty Rough	Isolated (6->12cm)	30°	Light Grey	Sandstone	Mudstone	3-5%	Interbedded	n/a	-
							20.5	21			Planar	Slighty Rough		45							-
21.00	22.50	1.46	97.33	1.15	76.67	5.00	21	21.04	LOST CORE	LOST CORE	LOST CORE	LOST CORE	LOST CORE	LOST CORE	LOST CORE	LOST CORE	LOST CORE	LOST CORE	LOST CORE	LOST CORE	LOST CORE
							21.04	22.5	24,18,20	21	Planar	Smooth	Isolated (6->12cm)	30°	Light Grey	Sandstone	Mudstone	0.20	Interbedded	n/a	-
22.50	24.00	1.09	72.67	0.87	58.00	4.00	22.5	22.91	LOST CORE	LOST CORE	LOST CORE	LOST CORE	LOST CORE	LOST CORE	LOST CORE	LOST CORE	LOST CORE	LOST CORE	LOST CORE	LOST CORE	LOST CORE
							22.91	24	16,19	17.5	Planar	Slighty Rough	Isolated (6->12cm)	60°	Light Grey	Sandstone	Mudstone	0.10	Interbedded	n/a	-
24	25.5	1.45	96.667	1.15	76.66667	3	24.00	24.05	LOST CORE	LOST CORE	LOST CORE	LOST CORE	LOST CORE	LOST CORE	LOST CORE	LOST CORE	LOST CORE	LOST CORE	LOST CORE	LOST CORE	LOST CORE
							24.05	24.92	18,23	20.5	Planar	Slighty Rough	Isolated (6->12cm)	20°	Light Grey	Sandstone	Mudstone	3-5%	Interbedded	n/a	-
							24.92	25.50			Planar	Smooth	Isolated (6->12cm)	30°	Medium-Dark Grey	Sandstone and Mudstone		n/a	Interbedded	n/a	5mm interbedded, fine grain sand.
25.50	27.00	1.25	83.33	0.71	47.33	7.00	25.5	25.75	LOST CORE	LOST CORE	LOST CORE	LOST CORE	LOST CORE	LOST CORE	LOST CORE	LOST CORE	LOST CORE	LOST CORE	LOST CORE	LOST CORE	LOST CORE
							25.75	27	0	0	Planar	Smooth	Isolated (6->12cm)	20°	Dark Grey	Mudstone	Anthracite Coal	0.01	Interbedded	Quartz Vein(s) cm scale	-
27.00	28.50	0.75	50.00	0.00	0.00	15.00	27	27.75	LOST CORE	LOST CORE	LOST CORE	LOST CORE	LOST CORE	LOST CORE	LOST CORE	LOST CORE	LOST CORE	LOST CORE	LOST CORE	LOST CORE	LOST CORE
							27.75	28.5	10,18	14	n/a	n/a	Numerous (1-3cm)	-	Dark Grey-Black	Interbedded Anthracite/Mudstone			Interbedded	n/a	20-30% Coal
28.50	30.00	1.31	87.33	0.64	42.67	10.00	28.5	28.69	LOST CORE	LOST CORE	LOST CORE	LOST CORE	LOST CORE	LOST CORE	LOST CORE	LOST CORE	LOST CORE	LOST CORE	LOST CORE	LOST CORE	LOST CORE
							28.69	30	8,16	12	Curved	Polished	Isolated (6->12cm)	70°	Dark Grey-Black	Mudstone	Anthracite Coal	0.10	Interbedded	Pyrite	5mm pyrite nodule.
30.00	31.50	1.29	86.00	0.66	44.00	14.00	30	30.21	LOST CORE	LOST CORE	LOST CORE	LOST CORE	LOST CORE	LOST CORE	LOST CORE	LOST CORE	LOST CORE	LOST CORE	LOST CORE	LOST CORE	LOST CORE
							30.21	31.5	0	0	Irregular	Slighty Rough	Occasional (3-6cm)	30°	Dark Grey-Black	Mudstone	Anthracite Coal	0.20	Interbedded	Quartz Stringers	-
31.5	33	1.27	84.667	0.68	45.33333	16	31.5	31.65	24,22	23	Planar	Smooth	Occasional (3-6cm)	20°	Dark Grey-Black	Interbedded Mudstone/Siltstone	Anthracite Coal	3-5%	Interbedded	Quartz Vein(s) mm scale	-
							31.65	32.45	24,22	23	Planar	Slighty Rough	Occasional (3-6cm)	80°	Dark Grey-Black	Interbedded Mudstone/Siltstone	Anthracite Coal	3-5%	Interbedded		-
							32.45	32.77	24,22	23	Planar	Smooth	Occasional (3-6cm)	35	Dark Grey-Black	Interbedded Mudstone/Siltstone	Anthracite Coal	3-5%	Interbedded		-
							32.77	33	LOST CORE	LOST CORE	LOST CORE	LOST CORE	LOST CORE	LOST CORE	LOST CORE	LOST CORE	LOST CORE	LOST CORE	LOST CORE	LOST CORE	LOST CORE
33	34.5	1.5	100	1.42	94.66667	1	33	34	16,16	16	Planar	Slighty Rough	Isolated (6->12cm)	15°	Dark Grey	Interbedded Mudstone/Sandstone		n/a	Interbedded	Quartz Stringers	-
							34	34.5	16,16	16	Planar	Slighty Rough	Isolated (6->12cm)	15°	Dark Grey	Sandstone	Mudstone	0.20	Interbedded	Quartz Vein(s) mm scale	-
34.5	36	1.45	96.667	1.45	96.66667	1	34.5	34.55	LOST CORE	LOST CORE	LOST CORE	LOST CORE	LOST CORE	LOST CORE	LOST CORE	LOST CORE	LOST CORE	LOST CORE	LOST CORE	LOST CORE	LOST CORE
							34.55	36.00	18,24,27	23	Planar	Smooth	Isolated (6->12cm)	20°	Medium-Dark Grey	Sandstone	Mudstone	3-5%	Interbedded	Quartz Vein(s) mm scale	-
36	37.5	1.42	94.667	0.67	44.66667	5	36.00	36.65	33,36	34.5	Planar	Slighty Rough	Isolated (6->12cm)	50°	Medium-Dark Grey	Sandstone	Mudstone	0.10	Interbedded	Quartz Vein(s) mm scale	-
							36.65	37.42	33,36	34.5	Planar	Smooth	Isolated (6->12cm)	30°	Medium-Dark Grey	Sandstone	Mudstone	0.10	Interbedded	Quartz Vein(s) mm scale	-
							37.42	37.50	LOST CORE	LOST CORE	LOST CORE	LOST CORE	LOST CORE	LOST CORE	LOST CORE	LOST CORE	LOST CORE	LOST CORE	LOST CORE	LOST CORE	LOST CORE
37.5	39	1.41	94	1.25	83.33333	4	37.50	38.91	18,13,16	15.66	Planar	Slighty Rough	Isolated (6->12cm)	35	Medium-Dark Grey	Sandstone	Mudstone	0.10	Interbedded	n/a	metal from bit noticed.
							38.91	39.00	LOST CORE	LOST CORE	LOST CORE	LOST CORE	LOST CORE	LOST CORE	LOST CORE	LOST CORE	LOST CORE	LOST CORE	LOST CORE	LOST CORE	LOST CORE
39	40.5	1.5	100	1.05	70	5	39.00	40.48	24,21,23	22.66	Planar	Very Rough	Isolated (6->12cm)	55°	Dark Grey	Sandstone	Mudstone	3-5%	Interbedded	Quartz Vein(s) mm scale	<1% Coal
40.5	42	1.25	83.333	0.63	42	5	40.50	41.75	28,33	30.5	Planar	Slighty Rough	Isolated (6->12cm)	30°	Dark Grey	Sandstone	Mudstone	0.10	Interbedded	Quartz Stringers	Qtz vugs carbonate
							41.75	42.00	LOST CORE	LOST CORE	LOST CORE	LOST CORE	LOST CORE	LOST CORE	LOST CORE	LOST CORE	LOST CORE	LOST CORE	LOST CORE	LOST CORE	LOST CORE
42	43.5	1.45	96.667	1.3	86.66667	2	40.50	41.95	40,40, 34	38	Stepped	Smooth	Isolated (6->12cm)	45	Medium-Dark Grey	Sandstone	Mudstone	0.20	Interbedded	Quartz Stringers	Qtz vugs carbonate, mm interbedded mud.
							41.95	42.00	LOST CORE	LOST CORE	LOST CORE	LOST CORE	LOST CORE	LOST CORE	LOST CORE	LOST CORE	LOST CORE	LOST CORE	LOST CORE	LOST CORE	LOST CORE

TERRACON GEOTECHNIQUE

CLIENT:	Arctos Anthracite Joint Venture
PROJECT NUMBER:	122781
HOLE ID:	GD-20/MW-26D
PROJECT LOCATION:	Arctos Anthracite Property

DATE STARTED: Aug 2, 2013 COMPLETED: Aug 4, 2013
DRILL CONTRACTOR: Driftwood RIG #:
HOLE SIZE: HQ
DRILLING METHOD: Diamond
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Ground Elevation [masl] 1644
Easting 509000.0
Northing 6342401.0
Water Table Depth [m]
Total Depth [m] 85.5

COMMENTS:

Run Depth		Core Recovery		RQD Length (Pieces >10cm) [m]	RQD length /run length x100 [%]	Number of Joints (per run)	Core Depth		Schmidt Hammer Tests		Joint Details				Colour	Major Lithology	Minor Lithology	% (Minor Lithology)	Bedding Type	Features	Comments
From [m]	To [m]	Rec. [m]	Rec. [%]				From [m]	To [m]	Test 'R' Values	Avg 'R' Value	Geometry	Roughness	Spacing	Joint Angle [°]							
43.5	45	1.43	95.333	1.43	95.33333	1	43.5	43.57	LOST CORE	LOST CORE	LOST CORE	LOST CORE	LOST CORE	LOST CORE	LOST CORE	LOST CORE	LOST CORE	LOST CORE	LOST CORE	LOST CORE	LOST CORE
							43.57	44	46,48,48	47.33	Stepped	Smooth	Isolated (6->12cm)	50°	Medium-Dark Grey	Sandstone	Mudstone	0.20	Interbedded	Quartz Stringers	-
							44	45	46,48,48	47.33	Stepped	Smooth	Isolated (6->12cm)	50°	Light-Medium Grey	Sandstone		n/a	Massive	Quartz Stringers	trace mud stone clasts <1%
45	46.5	1.34	89.333	0.99	66	4	45	46.34	26,27,25	26	Planar	Slighty Rough	Isolated (6->12cm)	60°	Light-Medium Grey	Sandstone		n/a	Massive	Quartz Stringers	Sandstone fine-very coarse.
							46.34	46.5	LOST CORE	LOST CORE	LOST CORE	LOST CORE	LOST CORE	LOST CORE	LOST CORE	LOST CORE	LOST CORE	LOST CORE	LOST CORE	LOST CORE	LOST CORE
46.5	48	1.33	88.667	0.96	64	0	46.5	47.83	36,37	36.5	n/a	-	n/a	-	Light-Medium Grey	Sandstone		n/a	Massive	Quartz Stringers	46.50m-46.88m: Possible fault
							47.83	48	LOST CORE	LOST CORE	LOST CORE	LOST CORE	LOST CORE	LOST CORE	LOST CORE	LOST CORE	LOST CORE	LOST CORE	LOST CORE	LOST CORE	LOST CORE
48	49.5	1.42	94.667	1.07	71.33333	3	48	49.42	32,36	34	Planar	Slighty Rough	Isolated (6->12cm)	80°	Medium Grey	Sandstone		n/a	Massive	Quartz Vein(s) mm scale	Sandstone fine-med grain.
							49.42	49.5	LOST CORE	LOST CORE	LOST CORE	LOST CORE	LOST CORE	LOST CORE	LOST CORE	LOST CORE	LOST CORE	LOST CORE	LOST CORE	LOST CORE	LOST CORE
49.5	51.00	1.5	100.00	1.44	96	1	49.5	51	38,39,39	38.66	Curved	Slighty Rough	Isolated (6->12cm)	20°	Medium Grey	Sandstone		n/a	Massive	Quartz Vein(s) mm scale	Sandstone fine-med grain.
51.00	52.50	1.5	100.00	1.50	100	1	51	52.5	18,22,23	63	Planar	Smooth	Isolated (6->12cm)	20°	Medium Grey	Sandstone		n/a	Massive	Quartz Vein(s) cm scale	Trace mudstone clast 1.5cm
52.5	54	1.5	100	1.5	100	1	52.5	54	44,39	41.5	Irregular	Slighty Rough	Isolated (6->12cm)	20°	Medium Grey	Sandstone	Mudstone	< 1%	Massive	Quartz Vein(s) mm scale	Mudstone laminae, mm scale
54	55.5	1.45	96.667	0.79	52.66667	5	54	55.45	36,37	36.5	Planar	Smooth	Isolated (6->12cm)	40°	Medium Grey	Sandstone	Mudstone	< 1%	Massive	Quartz Vein(s) cm scale	Mudstone laminae, mm scale and clasts
							55.45	55.5	LOST CORE	LOST CORE	LOST CORE	LOST CORE	LOST CORE	LOST CORE	LOST CORE	LOST CORE	LOST CORE	LOST CORE	LOST CORE	LOST CORE	LOST CORE
55.5	57	1.37	91.333	1.37	91.33333	3	55.5	56.87	28,34	31	Planar	Smooth	Isolated (6->12cm)	40°	Medium-Dark Grey	Sandstone	Mudstone	0.20	Interbedded	Quartz Vein(s) mm scale	Mudstone cm scale.
							56.87	57	LOST CORE	LOST CORE	LOST CORE	LOST CORE	LOST CORE	LOST CORE	LOST CORE	LOST CORE	LOST CORE	LOST CORE	LOST CORE	LOST CORE	LOST CORE
57	58.5	1.36	90.667	1.09	72.66667	6	57	58.36	24,20	22	Planar	Smooth	Isolated (6->12cm)	40°	Medium-Dark Grey	Mudstone	Sandstone	0.40	Interbedded	Quartz Stringers	
							58.36	58.5	LOST CORE	LOST CORE	LOST CORE	LOST CORE	LOST CORE	LOST CORE	LOST CORE	LOST CORE	LOST CORE	LOST CORE	LOST CORE	LOST CORE	LOST CORE
58.5	60	1.41	94	0.95	63.33333	6	58.5	59.91	10	10	Planar	Smooth	Isolated (6->12cm)	20°	Medium-Dark Grey	Sandstone	Mudstone	3-5%	Interbedded	Quartz Vein(s) mm scale	
							59.91	60	LOST CORE	LOST CORE	LOST CORE	LOST CORE	LOST CORE	LOST CORE	LOST CORE	LOST CORE	LOST CORE	LOST CORE	LOST CORE	LOST CORE	LOST CORE
60	61.5	1.37	91.333	1	66.66667	4	60	61.37	16,20	18	Stepped	Smooth	Isolated (6->12cm)	20°	Medium-Dark Grey	Sandstone	Mudstone	0.10	Interbedded	Quartz Vein(s) mm scale	
							61.37	61.5	LOST CORE	LOST CORE	LOST CORE	LOST CORE	LOST CORE	LOST CORE	LOST CORE	LOST CORE	LOST CORE	LOST CORE	LOST CORE	LOST CORE	LOST CORE
61.5	63	1.4	93.333	1.08	72	5	61.5	62.9	16,22,28	22	Planar	Smooth	Isolated (6->12cm)	15	Medium Grey	Sandstone	Anthracite Coal	< 1%	Massive	Mud clasts	med grain sandstone, with few coarse grained
							62.9	63	LOST CORE	LOST CORE	LOST CORE	LOST CORE	LOST CORE	LOST CORE	LOST CORE	LOST CORE	LOST CORE	LOST CORE	LOST CORE	LOST CORE	LOST CORE
63	64.5	1.39	92.667	0.68	45.33333	6	63	64.39	25,25	25	Planar	Smooth	Isolated (6->12cm)	20°	Medium Grey	Sandstone	Anthracite Coal	< 1%	Massive	Mud clasts	med-coarse grained, moderately sorted
							64.39	64.5	LOST CORE	LOST CORE	LOST CORE	LOST CORE	LOST CORE	LOST CORE	LOST CORE	LOST CORE	LOST CORE	LOST CORE	LOST CORE	LOST CORE	LOST CORE
64.5	66	1.4	93.333	1.21	80.66667	1	64.5	64.60	LOST CORE	LOST CORE	LOST CORE	LOST CORE	LOST CORE	LOST CORE	LOST CORE	LOST CORE	LOST CORE	LOST CORE	LOST CORE	LOST CORE	LOST CORE
							64.60	66	26,25	25.5	Planar	Slighty Rough	Isolated (6->12cm)	65°	Medium Grey	Sandstone	Mudstone	< 1%	Massive	Quartz Vein(s) mm scale	med grain sandstone, with few coal stringers.
66	67.50	1.5	100.00	1.33	88.67	4	66	67.5	30,24	27	Planar	Smooth	Isolated (6->12cm)	30°	Light-Medium Grey	Sandstone	Mudstone	< 1%	Massive	Quartz Vein(s) mm scale	med-coarse grained, trace mm coal; 66.45-66.55m matrix supported conglomerate, subangular clasts (<1cm), med grained sand
67.5	69	1.4	93.333	1.04	69.33333	7	67.5	67.6	LOST CORE	LOST CORE	LOST CORE	LOST CORE	LOST CORE	LOST CORE	LOST CORE	LOST CORE	LOST CORE	LOST CORE	LOST CORE	LOST CORE	LOST CORE
							67.6	69	26,33	29.5	Planar	Smooth	Isolated (6->12cm)	40°	Medium-Dark Grey	Sandstone	Anthracite Coal	< 1%	Massive	Mud clasts	med grained; trace mm mud
69	70.5	1.45	96.667	0.8	53.33333	5	69	69.05	LOST CORE	LOST CORE	LOST CORE	LOST CORE	LOST CORE	LOST CORE	LOST CORE	LOST CORE	LOST CORE	LOST CORE	LOST CORE	LOST CORE	LOST CORE
							69.05	70.5	15,14	14.5	Curved	Polished	Isolated (6->12cm)	40°	Medium Grey	Sandstone	Mudstone	< 1%	Massive	Mud clasts	med grained; trace mm coal, rounded clasts
70.5	72	1.45	96.667	1.25	83.33333	5	70.5	70.55	LOST CORE	LOST CORE	LOST CORE	LOST CORE	LOST CORE	LOST CORE	LOST CORE	LOST CORE	LOST CORE	LOST CORE	LOST CORE	LOST CORE	LOST CORE
							70.55	72	23,18	20.5	Planar	Polished	Isolated (6->12cm)	30°	Medium Grey	Sandstone	Anthracite Coal	< 1%	Massive	Quartz Vein(s) cm scale	71.21m-71.32m matrix supported congl. 2-3cm mud clasts

TERRACON GEOTECHNIQUE

CLIENT:	Arctos Anthracite Joint Venture
PROJECT NUMBER:	122781
HOLE ID:	GD-20/MW-26D
PROJECT LOCATION:	Arctos Anthracite Property

DATE STARTED: Aug 2, 2013 COMPLETED: Aug 4, 2013
DRILL CONTRACTOR: Driftwood RIG #:
HOLE SIZE: HQ
DRILLING METHOD: Diamond
LOGGED BY: GM/Zack CHECKED BY:

Ground Elevation [masl] 1644
Easting 509000.0
Northing 6342401.0
Water Table Depth [m]
Total Depth [m] 85.5

COMMENTS:

Run Depth		Core Recovery		RQD Length (Pieces >10cm) [m]	RQD length /run length x100 [%]	Number of Joints (per run)	Core Depth		Schmidt Hammer Tests		Joint Details				Colour	Major Lithology	Minor Lithology	% (Minor Lithology)	Bedding Type	Features	Comments
From [m]	To [m]	Rec. [m]	Rec. [%]				From [m]	To [m]	Test 'R' Values	Avg 'R' Value	Geometry	Roughness	Spacing	Joint Angle [°]							
72	73.5	1.4	93.333	1.1	73.33333	4	72	72.1	LOST CORE	LOST CORE	LOST CORE	LOST CORE	LOST CORE	LOST CORE	LOST CORE	LOST CORE	LOST CORE	LOST CORE	LOST CORE	LOST CORE	LOST CORE
							72.1	73.5	13,29,16	19.3	Planar	Smooth	Isolated (6->12cm)	60°	Medium Grey	Sandstone	Mudstone	3-5%	Interbedded	Mud clasts	trace mm coal, subrounded mud clasts
73.5	75	1	66.667	0.12	8	8	73.5	74	LOST CORE	LOST CORE	LOST CORE	LOST CORE	LOST CORE	LOST CORE	LOST CORE	LOST CORE	LOST CORE	LOST CORE	LOST CORE	LOST CORE	LOST CORE
							74	75	24,29	26.5	Planar	Smooth	Isolated (6->12cm)	30°	Dark Grey-Black	Mudstone	Anthracite Coal	0.20	Interbedded	Quartz Vein(s) cm scale	74.65-74.75m claystone
75	76.5	1.3	86.667	0.83	55.33333	8	75	75.2	LOST CORE	LOST CORE	LOST CORE	LOST CORE	LOST CORE	LOST CORE	LOST CORE	LOST CORE	LOST CORE	LOST CORE	LOST CORE	LOST CORE	LOST CORE
							75.2	76.5	10	10	Planar	Polished	Isolated (6->12cm)	70°	Dark Grey-Black	Mudstone	Anthracite Coal	3-5%	Interbedded	Pyrite	3cm siltstone at base
76.5	78	1.5	100.00	0.70	46.67	14	76.50	77.00	22,12	17	Planar	Smooth	Occasional (3-6cm)	20°	Dark Grey-Black	Mudstone	Siltstone	0.20	Massive	Quartz Vein(s) mm scale	76.5-76.59 siltstone; fissile, soft, weathered
							77.00	78.00	22,12	17	Planar	Smooth	Occasional (3-6cm)	20°	Medium-Dark Grey	Interbedded Mudstone/Siltstone	Siltstone	0.20	Interbedded	Quartz Vein(s) mm scale	cm clay lens, trace mm coal
78	79.5	1.45	96.667	1.1	73.33333	5	78	78.05	LOST CORE	LOST CORE	LOST CORE	LOST CORE	LOST CORE	LOST CORE	LOST CORE	LOST CORE	LOST CORE	LOST CORE	LOST CORE	LOST CORE	LOST CORE
							78.05	79.5	18,12	15	Planar	Smooth	Isolated (6->12cm)	50°	Dark Grey	Mudstone	Anthracite Coal	< 1%	Massive	Quartz Stringers	trace fine grained sand throughout
79.5	81	1.5	100.00	1.34	89.33	6	79.50	79.94	13,20	16.5	Planar	Smooth	Isolated (6->12cm)	40°	Dark Grey	Mudstone			Interbedded	Quartz Stringers	interbedded mm soft clay 3-5%
							79.94	81.00	13,20	16.5	Planar	Smooth	Isolated (6->12cm)	40°	Medium-Dark Grey	Mudstone	Sandstone	0.30	Interbedded	Quartz Stringers	increased sandstone with depth, trace clay
81	82.5	1.47	98	1.2	80	6	81	81.03	LOST CORE	LOST CORE	LOST CORE	LOST CORE	LOST CORE	LOST CORE	LOST CORE	LOST CORE	LOST CORE	LOST CORE	LOST CORE	LOST CORE	LOST CORE
							81.03	82.5	24,24	24	Planar	Slighty Rough	Occasional (3-6cm)	50°	Medium-Dark Grey	Mudstone	Sandstone	0.30	Interbedded	Quartz Vein(s) cm scale	mm soft clay at 81.75m
82.5	84	1.4	93.333	1.3	86.66667	2	82.5	82.6	LOST CORE	LOST CORE	LOST CORE	LOST CORE	LOST CORE	LOST CORE	LOST CORE	LOST CORE	LOST CORE	LOST CORE	LOST CORE	LOST CORE	LOST CORE
							82.6	84	24,26	25	Planar	Slighty Rough	Isolated (6->12cm)	50°	Medium-Dark Grey	Sandstone	Mudstone	0.40	Interbedded	Quartz Vein(s) mm scale	fine grained
84	85.5	1.45	96.667	0.93	62	10	84	84.05	LOST CORE	LOST CORE	LOST CORE	LOST CORE	LOST CORE	LOST CORE	LOST CORE	LOST CORE	LOST CORE	LOST CORE	LOST CORE	LOST CORE	LOST CORE
							84.05	85.5	22,22	22	Planar	Smooth	Occasional (3-6cm)	40°	Brown-Grey	Mudstone	Sandstone	0.40	Interbedded	Quartz Vein(s) mm scale	siltstones at 84.16m-84.37m and 84.95m-85.10m

TERRACON GEOTECHNIQUE

CLIENT: Arctos Anthracite Joint Venture
PROJECT NUMBER: 122781

HOLE ID: GD-21
PROJECT LOCATION: Arctos Anthracite Property

DATE STARTED: July 16, 2013 COMPLETED: July 17, 2013
DRILL CONTRACTOR: Driftwood RIG #:
HOLE SIZE: HQ
DRILLING METHOD: Diamond
LOGGED BY: G.McLearn CHECKED BY:

Ground Elevation [masl] 1640
Easting 506159.0
Northing 6342432.0
Water Table Depth [m]
Total Depth [m] 81.00m

COMMENTS:

Run Depth		Core Recovery		RQD Length (Pieces >10cm) [m]	RQD length /run length x100 [%]	Number of Joints (per run)	Core Depth		Schmidt Hammer Tests		Joint Details				Colour	Major Lithology	Minor Lithology	Bedding Type	Features	Comments
From [m]	To [m]	Rec. [m]	Rec. [%]				From [m]	To [m]	Test 'R' Values	Avg 'R' Value	Geometry	Roughness	Spacing	Joint Angle [°]						
0.00	1.50	0.75	50.00	0.25	16.67	1.00	0.00	0.75	LOST CORE	LOST CORE	LOST CORE	LOST CORE	LOST CORE	LOST CORE	LOST CORE	LOST CORE	LOST CORE	LOST CORE	LOST CORE	LOST CORE
							0.75	1.50	38,40	39	Planar	n/a	n/a	70°	Brown	Overburden	Sandstone	n/a	Organics	Brown organics and then 25cm of SST
1.50	2.00	0.10	20.00	0.00	0.00	0.00	1.50	1.60	0	0	n/a	n/a	n/a	n/a	Brown	Clay	n/a	n/a	Organics	Brown oxidized organics, clay and silt, soft.
							1.60	2.00	LOST CORE	LOST CORE	LOST CORE	LOST CORE	LOST CORE	LOST CORE	LOST CORE	LOST CORE	LOST CORE	LOST CORE	LOST CORE	LOST CORE
2.00	3.50	0.26	17.33	0.00	0.00	0.00	2.00	2.26	0	0	n/a	n/a	n/a	n/a	Brown-Grey	Clay	Sandstone	n/a	n/a	Clay and SST, dark brown-grey, **sample 0130119 2-2.15m** clay and gravel.
							2.26	3.50	LOST CORE	LOST CORE	LOST CORE	LOST CORE	LOST CORE	LOST CORE	LOST CORE	LOST CORE	LOST CORE	LOST CORE	LOST CORE	LOST CORE
3.50	6.00	1.20	48.00	0.30	12.00	n/a	3.50	4.70	24,20	22	n/a	n/a	n/a	n/a	Dark Grey	Siltstone	Sandstone	n/a	Fault/Faulted	Trace SST, Faults 3.9-4.20m and 5.3-6.0m, **Sample 0130120**: 3.6-3.7: clay-gravels
							4.70	6.00	LOST CORE	LOST CORE	LOST CORE	LOST CORE	LOST CORE	LOST CORE	LOST CORE	LOST CORE	LOST CORE	LOST CORE	LOST CORE	LOST CORE
6.00	7.50	1.30	86.67	0.20	13.33	n/a	6.00	7.30	0	0	n/a	n/a	n/a	n/a	Medium-Dark Grey	Sandstone	Mudstone	n/a	Fault/Faulted	faulted 55° at 6-6.2 and 6.3-7.5 fractures-faulted along the core axis and 10°
							7.30	7.50	LOST CORE	LOST CORE	LOST CORE	LOST CORE	LOST CORE	LOST CORE	LOST CORE	LOST CORE	LOST CORE	LOST CORE	LOST CORE	LOST CORE
7.50	9.00	0.25	16.67	0.00	0.00	n/a	7.50	7.75	38	38	n/a	n/a	n/a	n/a	Dark Grey	Mudstone	n/a	n/a	n/a	cm pieces
							7.75	9.00	LOST CORE	LOST CORE	LOST CORE	LOST CORE	LOST CORE	LOST CORE	LOST CORE	LOST CORE	LOST CORE	LOST CORE	LOST CORE	LOST CORE
9.00	10.50	1.15	76.67	0.45	30.00	n/a	9.00	10.15	0	0	n/a	n/a	n/a	n/a	Dark Grey-Black	Claystone	n/a	n/a	Fault/Faulted	moist, soft, fractured-faulted 9.65-10.40m
							10.15	10.50	LOST CORE	LOST CORE	LOST CORE	LOST CORE	LOST CORE	LOST CORE	LOST CORE	LOST CORE	LOST CORE	LOST CORE	LOST CORE	LOST CORE
10.50	12.00	0.90	60.00	0.12	8.00	n/a	10.50	11.40	0	0	n/a	n/a	n/a	n/a	Dark Grey	Claystone	Anthracite Coal	n/a	Fault/Faulted	coal <2cm
							11.40	12.00	LOST CORE	LOST CORE	LOST CORE	LOST CORE	LOST CORE	LOST CORE	LOST CORE	LOST CORE	LOST CORE	LOST CORE	LOST CORE	LOST CORE
12.00	13.50	0.60	40.00	0.00	0.00	n/a	12.00	12.60	0	0	n/a	n/a	n/a	n/a	Dark Grey-Black	Claystone	Anthracite Coal	n/a	n/a	soft
							12.60	13.50	LOST CORE	LOST CORE	LOST CORE	LOST CORE	LOST CORE	LOST CORE	LOST CORE	LOST CORE	LOST CORE	LOST CORE	LOST CORE	LOST CORE
13.50	15.00	0.70	46.67	0.28	18.67	2.00	13.50	14.30	LOST CORE	LOST CORE	LOST CORE	LOST CORE	LOST CORE	LOST CORE	LOST CORE	LOST CORE	LOST CORE	LOST CORE	LOST CORE	LOST CORE
							14.30	15.00	26	26	n/a	Smooth	n/a	60°	Medium-Dark Grey	Claystone	Anthracite Coal	n/a	Quartz Stringers	Fault 14.75-15.10m
15.00	16.50	0.65	43.33	0.11	7.33	3.00	15	15.85	LOST CORE	LOST CORE	LOST CORE	LOST CORE	LOST CORE	LOST CORE	LOST CORE	LOST CORE	LOST CORE	LOST CORE	LOST CORE	LOST CORE
							15.85	16.50	24,24	24	Planar	n/a	n/a	35°	n/a	Claystone	n/a	n/a	n/a	some mm coal, fault 15.40-16.40m
16.50	18.00	1.45	96.67	1.05	70.00	3.00	16.50	16.55	LOST CORE	LOST CORE	LOST CORE	LOST CORE	LOST CORE	LOST CORE	LOST CORE	LOST CORE	LOST CORE	LOST CORE	LOST CORE	LOST CORE
							16.55	18.00	11,13	12	Planar	n/a	n/a	65°, 30°	Dark Grey	Claystone	n/a	n/a	Quartz Vein(s) mm scal	mm-cm broken coal 17.4-17.75m, 5mm quartz veins 55-60°
18.00	19.50	0.70	46.67	0.22	14.67	2.00	18.00	18.80	LOST CORE	LOST CORE	LOST CORE	LOST CORE	LOST CORE	LOST CORE	LOST CORE	LOST CORE	LOST CORE	LOST CORE	LOST CORE	LOST CORE
							18.80	19.50	22,22	22	n/a	Polished	n/a	10°, 60°	n/a	Claystone	n/a	n/a	Quartz Vein(s) mm scal	some dull fractured coal pieces <10cm
19.50	21.00	1.00	66.67	0.21	14.00	2.00	19.50	20.00	LOST CORE	LOST CORE	LOST CORE	LOST CORE	LOST CORE	LOST CORE	LOST CORE	LOST CORE	LOST CORE	LOST CORE	LOST CORE	LOST CORE
							20.00	21.00	0	0	Planar	n/a	n/a	40°	Dark Grey	Mudstone	n/a	n/a	Fault/Faulted	dull, fault 19.5-20.05m, fractured 20.05-20.5m, fault 20.7-21m
21.00	22.50	0.65	43.33	0.00	0.00	2.00	21.00	21.85	LOST CORE	LOST CORE	LOST CORE	LOST CORE	LOST CORE	LOST CORE	LOST CORE	LOST CORE	LOST CORE	LOST CORE	LOST CORE	LOST CORE
							21.85	22.50	0	0	Stepped	n/a	n/a	65°	n/a	Mudstone	Anthracite Coal	Interbedded	Fault/Faulted	coal <1cm, 65° bands, faulted 22.1-22.5m with 30% cm coal pieces

Run Depth		Core Recovery		RQD Length (Pieces >10cm) [m]	RQD length /run length x100 [%]	Number of Joints (per run)	Core Depth		Schmidt Hammer Tests		Joint Details				Colour	Major Lithology	Minor Lithology	Bedding Type	Features	Comments
From [m]	To [m]	Rec. [m]	Rec. [%]				From [m]	To [m]	Test 'R' Values	Avg 'R' Value	Geometry	Roughness	Spacing	Joint Angle [°]						
22.50	24.00	1.20	80.00	0.11	7.33	2.00	22.50	22.80	LOST CORE	LOST CORE	LOST CORE	LOST CORE	LOST CORE	LOST CORE	LOST CORE	LOST CORE	LOST CORE	LOST CORE	LOST CORE	LOST CORE
							22.80	24.00	14,14,14	14	n/a	Polished	n/a	55°, 70°	Medium-Dark Grey	Interbedded Anthracite/Mudstone	Claystone	Interbedded	Fault/Faulted	Mudstone interlayers along core axis, faulted 22.5-22.8m, fractured till 24.0m
24.00	25.50	0.95	63.33	0.11	7.33	2.00	24.00	24.95	10,12	11	n/a	Smooth	n/a	60°	Dark Grey	Mudstone	Anthracite Coal	Interbedded	Fault/Faulted	fault 24.0-24.4m
							24.95	25.50	LOST CORE	LOST CORE	LOST CORE	LOST CORE	LOST CORE	LOST CORE	LOST CORE	LOST CORE	LOST CORE	LOST CORE	LOST CORE	LOST CORE
25.50	27.00	1.40	93.33	0.80	53.33	3.00	25.5	25.6	LOST CORE	LOST CORE	LOST CORE	LOST CORE	LOST CORE	LOST CORE	LOST CORE	LOST CORE	LOST CORE	LOST CORE	LOST CORE	LOST CORE
							25.6	26.6			n/a	Slightly Rough	n/a	70°	Dark Grey	Mudstone	Anthracite Coal	Interbedded	Quartz Stringers	-
							26.6	27	28,27	27.5	Planar	Slightly Rough	n/a	70°	Medium Grey	Interbedded Mudstone/Sandstone	n/a	Interbedded	n/a	fine grained
27.00	28.50	1.45	96.67	1.23	82.00	3.00	27.00	27.05	LOST CORE	LOST CORE	LOST CORE	LOST CORE	LOST CORE	LOST CORE	LOST CORE	LOST CORE	LOST CORE	LOST CORE	LOST CORE	LOST CORE
							27.05	28.50	24,30	27	Stepped	n/a	n/a	25°	n/a	Mudstone	Sandstone	Interbedded	Pyrite	trace coal laminae, dirty
28.50	30.00	1.40	93.33	1.20	80.00	3.00	28.50	28.60	LOST CORE	LOST CORE	LOST CORE	LOST CORE	LOST CORE	LOST CORE	LOST CORE	LOST CORE	LOST CORE	LOST CORE	LOST CORE	LOST CORE
							28.60	29.00	14,12	13	Planar	n/a	n/a	40°	Dark Grey	Mudstone	n/a	Massive	n/a	**Sample 0130121** 28.8-29m
							29.00	30.00			Stepped	n/a	n/a	60°, 80°	n/a	Interbedded Mudstone/Sandstone	n/a	Interbedded	Pyrite	cm-dm interlayers
30.00	31.50	1.50	100.00	1.4	93.33	2	30.00	31.50	27,38	32.5	n/a	n/a	n/a	40°, 70°	n/a	Sandstone	Mudstone	Interbedded	Pyrite	mudstone layers 75°
31.50	33.00	1.50	100.00	1.25	83.33	3	31.50	33.00	18,13	15.5	Planar	n/a	n/a	70°	n/a	Sandstone	Mudstone	Interbedded	Quartz Vein(s) mm scal	-
33.00	34.50	1.50	100.00	1	66.67	2	33.00	34.50	n/a	n/a	Planar	n/a	n/a	75°, 50°	Dark Grey	Sandstone	Mudstone	Interbedded	Quartz-Carbonate	cm layers, trace vuggy carbonate and quartz stringers
34.50	36.00	1.40	93.33	1.20	80.00	3.00	34.50	34.60	LOST CORE	LOST CORE	LOST CORE	LOST CORE	LOST CORE	LOST CORE	LOST CORE	LOST CORE	LOST CORE	LOST CORE	LOST CORE	LOST CORE
							34.60	36.00	n/a	n/a	n/a	Slightly Rough	n/a	0°, 60°, 85°	Medium-Dark Grey	Interbedded Mudstone/Sandstone	Mudstone	Interbedded	n/a	mudstone 60°
36.00	37.50	1.25	83.33	0.62	41.33	2	36.00	37.50	28,32	30	Planar	n/a	n/a	70°	n/a	Sandstone	Anthracite Coal	Interbedded	Mud clasts	fracture area 36.35-36.6m, trace coal 1cm at 36.18m, quartz-carbonate 36.25-36.31m
37.50	39.00	1.50	100.00	0.65	43.33	2	37.50	39.00	14,19	16.5	Stepped	n/a	n/a	30°, 65°	Medium-Dark Grey	Sandstone and Mudstone	n/a	Interbedded	n/a	sandstone and mudstone clasts/bands, 80-85° mudstone, some vertical fractures 30cm
39.00	40.50	1.50	100.00	1.20	80.00	3.00	39.00	39.70	21,20	20.5	n/a	Smooth	n/a	75°	Dark Grey	Mudstone	Sandstone	Interbedded	Mud clasts	mudstone bands 65-70°
							39.70	40.50			n/a	Slightly Rough	n/a	30°, 75°	n/a	Sandstone	Mudstone	Massive	Mud clasts	sandstone mm grains, mudstone mm bands 80°
40.50	42.00	1.45	96.67	1.45	96.67	1.00	40.50	41.95	LOST CORE	LOST CORE	LOST CORE	LOST CORE	LOST CORE	LOST CORE	LOST CORE	LOST CORE	LOST CORE	LOST CORE	LOST CORE	LOST CORE
							41.95	42.00	21,24	22.5	Planar	n/a	n/a	60°	n/a	Sandstone	Mudstone	Interbedded	Quartz Vein(s) mm scal	quartz veins vuggy
42.00	43.50	1.50	100.00	1.3	86.67	2	42.00	43.50	18,36,26	26.66	Planar	n/a	n/a	75°	n/a	Sandstone	Mudstone	Interbedded	Quartz Vein(s) mm scal	angular mud clasts
43.50	45.00	1.30	86.67	0.70	46.67	2.00	43.50	43.70	LOST CORE	LOST CORE	LOST CORE	LOST CORE	LOST CORE	LOST CORE	LOST CORE	LOST CORE	LOST CORE	LOST CORE	LOST CORE	LOST CORE
							43.70	45.00	10,22	16	Planar	n/a	n/a	70°	n/a	Sandstone	Mudstone	Interbedded	Quartz Vein(s) cm scale	mudstone bands 75° <4cm, faults 43.65-43.8m, 44.25-44.9m
45.00	46.50	1.50	100.00	1.45	96.67	2	45.00	46.50	18,10	14	n/a	Smooth	n/a	90°, 80°	Light Grey	Sandstone	n/a	Massive	Quartz Vein(s) mm scal	-
46.50	48.00	1.45	96.67	1.30	86.67	0.00	46.50	47.95	LOST CORE	LOST CORE	LOST CORE	LOST CORE	LOST CORE	LOST CORE	LOST CORE	LOST CORE	LOST CORE	LOST CORE	LOST CORE	LOST CORE
							47.95	48.00	14,24	19	n/a	n/a	n/a	-	Light Grey	Sandstone	Mudstone	Massive	n/a	trace mudstone laminae
48.00	49.50	1.50	100.00	1.1	73.33	1	48.00	49.50	18,22	20	Planar	n/a	n/a	75°	Light Grey	Sandstone	Mudstone	Massive	n/a	trace mudstone laminae 1mm
49.50	51.00	1.50	100.00	1.2	80.00	2	49.50	51.00	22,22	22	n/a	Slightly Rough	n/a	85°, 75°	Light Grey	Sandstone	Mudstone	Massive	n/a	trace mudstone laminae and nodules
51.00	52.50	1.50	100.00	1.4	93.33	3			20,24	22	Curved	Slightly Rough	n/a	75°, 65°	-	Sandstone	Mudstone	Interbedded		mudstone 70° laminae and nodules
52.50	54.00	1.42	94.67	1.26	84.00		52.50	52.58	LOST CORE	LOST CORE	LOST CORE	LOST CORE	LOST CORE	LOST CORE	LOST CORE	LOST CORE	LOST CORE	LOST CORE	LOST CORE	LOST CORE
							52.58	53.75	13,25	19	n/a	Smooth	n/a	80°	n/a	Sandstone	n/a	n/a	n/a	trace MDST laminae, fractures along core axis
							53.75	54.00			n/a	n/a	n/a	-	Light-Medium Grey	Sandstone	Conglomerate	n/a	n/a	trace MDST, trace coal laminae

Run Depth		Core Recovery		RQD Length (Pieces >10cm) [m]	RQD length /run length x100 [%]	Number of Joints (per run)	Core Depth		Schmidt Hammer Tests		Joint Details				Colour	Major Lithology	Minor Lithology	Bedding Type	Features	Comments
From [m]	To [m]	Rec. [m]	Rec. [%]				From [m]	To [m]	Test 'R' Values	Avg 'R' Value	Geometry	Roughness	Spacing	Joint Angle [°]						
54.00	55.50	1.45	96.67	0.64	42.67	3.00	54.00	54.05	LOST CORE	LOST CORE	LOST CORE	LOST CORE	LOST CORE	LOST CORE	LOST CORE	LOST CORE	LOST CORE	LOST CORE	LOST CORE	LOST CORE
							54.05	54.33	14,20	17	n/a	n/a	n/a	80°	n/a	Sandstone	Conglomerate	n/a	n/a	trace MDST, trace coal 4-5mm, <5mm CONG clasts
							54.33	54.85			n/a	n/a	n/a	75°	n/a	Anthracite Coal	Mudstone	n/a	Pyrite	
							54.85	55.50			n/a	n/a	n/a	65°	Black	Sandstone	n/a	Massive	n/a	soft, 15cm vertical fractures
55.50	57.00	1.45	96.67	0.95	63.33	3.00	55.50	55.55	LOST CORE	LOST CORE	LOST CORE	LOST CORE	LOST CORE	LOST CORE	LOST CORE	LOST CORE	LOST CORE	LOST CORE	LOST CORE	LOST CORE
							55.55	57.00	17,19	18	Curved	n/a	n/a	30°, 70°	n/a	Sandstone	Sandstone	n/a	Quartz Vein(s) mm scal	-
57.00	58.50	1.40	93.33	0.85	56.67	2.00	57.00	57.10	LOST CORE	LOST CORE	LOST CORE	LOST CORE	LOST CORE	LOST CORE	LOST CORE	LOST CORE	LOST CORE	LOST CORE	LOST CORE	LOST CORE
							57.10	57.45	12,17	14.5	n/a	Smooth	n/a	80°	Dark Grey	Mudstone	n/a	Massive	Quartz Stringers	-
							57.45	58.50			Stepped	n/a	n/a	65°	n/a	Mudstone	Anthracite Coal	Interbedded	n/a	
58.50	60.00	1.35	90.00	0.40	26.67	2.00	58.50	58.65	LOST CORE	LOST CORE	LOST CORE	LOST CORE	LOST CORE	LOST CORE	LOST CORE	LOST CORE	LOST CORE	LOST CORE	LOST CORE	LOST CORE
							58.65	60.00	24,25	24.5	Curved	n/a	n/a	55°, 40°	n/a	Mudstone	Anthracite Coal	Interbedded	Quartz Vein(s) mm scal	-
60.00	61.50	1.40	93.33	1.05	70.00	1.00	60.00	60.10	LOST CORE	LOST CORE	LOST CORE	LOST CORE	LOST CORE	LOST CORE	LOST CORE	LOST CORE	LOST CORE	LOST CORE	LOST CORE	LOST CORE
							60.10	61.50	32,33	32.5	Curved	n/a	n/a	40°	Dark Grey	Mudstone	Anthracite Coal	Massive	n/a	vertical fractures
61.50	63.00	1.50	100.00	0.75	50.00	2	61.50	62.65	25,18	21.5	n/a	Polished	n/a	80°	n/a	Mudstone	Anthracite Coal	Interbedded	n/a	coal bands and laminae <1cm thick, 85-90 deg orientation
							62.65	63.00			Stepped	n/a	n/a	60°	Medium Grey	Claystone	Anthracite Coal	Interbedded	Quartz Stringers	-
63.00	64.50	1.50	100.00	1.15	76.67	2	63.00	63.50	20,10	15	n/a	Slightly Rough	n/a	80°	Dark Grey	Mudstone	Anthracite Coal	Interbedded	Quartz Vein(s) mm scal	-
							63.50	63.90			Stepped	n/a	n/a	60°	n/a	Mudstone	Anthracite Coal	Interbedded	n/a	coal <2cm pods, ~80°
							63.90	64.10			n/a	n/a	n/a	-	Black	Anthracite Coal	Mudstone	Interbedded	Quartz-Carbonate	light, porous
							64.10	64.50			n/a	n/a	n/a	-	Dark Grey	Mudstone	Anthracite Coal	Interbedded	n/a	Coal 80°, decreasing with depth
64.50	66.00	1.40	93.33	0.95	63.33	2.00	64.50	64.60	LOST CORE	LOST CORE	LOST CORE	LOST CORE	LOST CORE	LOST CORE	LOST CORE	LOST CORE	LOST CORE	LOST CORE	LOST CORE	LOST CORE
							64.60	66.00	20,16	18	Planar	Smooth	n/a	25°	Dark Grey	Mudstone	Siltstone	Massive	n/a	soft, siltstone layers <5mm
66.00	67.50	1.50	100.00	1.45	96.67	2	66.00	67.50	22,20	21	n/a	Smooth	n/a	85°	n/a	Interbedded Mudstone/Siltstone	Sandstone	Interbedded	n/a	Siltstone-Fine grain sandstone and MDST interlayered, 66.15 1cm coal layer, 1% elsewhere
67.50	69.00	1.45	96.67	0.80	53.33	2.00	67.50	67.55	LOST CORE	LOST CORE	LOST CORE	LOST CORE	LOST CORE	LOST CORE	LOST CORE	LOST CORE	LOST CORE	LOST CORE	LOST CORE	LOST CORE
							67.55	69.00	10,18	14	Curved	n/a	n/a	70°, 55°	n/a	Mudstone	Anthracite Coal	Interbedded	n/a	patchy siltstone, coal in bands <1cm and disseminated
69.00	70.50	1.50	100.00	0.8	53.33	3	69.00	70.50	37,42	39.5	Stepped	Smooth	n/a	85°, 70°, 50°	Brown-Grey	Mudstone	Anthracite Coal	Massive	n/a	coal in discontinuous vein ~3mm
70.50	72.00	1.30	86.67	0.95	63.33	1.00	70.50	70.70	LOST CORE	LOST CORE	LOST CORE	LOST CORE	LOST CORE	LOST CORE	LOST CORE	LOST CORE	LOST CORE	LOST CORE	LOST CORE	LOST CORE
							70.70	72.00	20,22	21	Planar	n/a	n/a	40°	n/a	Mudstone	Anthracite Coal	Interbedded	Quartz Vein(s) mm scal	Qtz vein with chlorite along edge, fossilization of fern at 70.8m
72.00	73.50	1.50	100.00	1.5	100.00	2	72.00	73.50	15,19	17	n/a	Smooth	n/a	85°	Dark Grey	Mudstone	Anthracite Coal	Massive	n/a	-
73.50	75.00	1.50	100.00	1	66.67	2	73.50	75.00	10,28,16	18	Planar	n/a	n/a	60°, 50°	Medium-Dark Grey	Mudstone	Anthracite Coal	Massive	n/a	-
75.00	76.50	1.50	100.00	1.4	93.33	2	75.00	76.50	17,23	20	Stepped	n/a	n/a	70°, 80°	n/a	Mudstone	Anthracite Coal	Massive	Quartz Vein(s) mm scal	soft
76.50	78.00	1.45	96.67	1.25	83.33	2.00	76.50	76.55	LOST CORE	LOST CORE	LOST CORE	LOST CORE	LOST CORE	LOST CORE	LOST CORE	LOST CORE	LOST CORE	LOST CORE	LOST CORE	LOST CORE
							76.55	78.00	20,16	18	n/a	Smooth	n/a	50°, 30°	Dark Grey-Black	Mudstone	n/a	Massive	n/a	no coal
78.00	79.50	1.50	100.00	0.95	63.33	2	78.00	79.50	25,20	22.5	n/a	Smooth	n/a	20°	Dark Grey-Black	Mudstone	n/a	Massive	Fossils	no coal, fossilization of fern, core vertical fractured 78-78.9m
79.50	81.00	1.45	96.67	1.35	90.00	4.00	79.50	79.55	LOST CORE	LOST CORE	LOST CORE	LOST CORE	LOST CORE	LOST CORE	LOST CORE	LOST CORE	LOST CORE	LOST CORE	LOST CORE	LOST CORE
							79.55	81.00	12,12	12	n/a	Slightly Rough to Polished	n/a	80°	Dark Grey	Mudstone	Anthracite Coal	Massive	n/a	trace carbonaceous debris, possible trace fossil

TERRACON GEOTECHNIQUE

CLIENT: Arctos Anthracite Joint Venture
PROJECT NUMBER: 122781

HOLE ID: GP-06/MW-19d
PROJECT LOCATION: Arctos Anthracite Property

DATE STARTED: August 24, 2013 COMPLETED: August 26, 2013
DRILL CONTRACTOR: Driftwood RIG #:
HOLE SIZE: HQ
DRILLING METHOD: Diamond
LOGGED BY: GM/MM CHECKED BY:

Ground Elevation [masl] 1464
Easting 508294.0
Northing 6345567.0
Water Table Depth [m]
Total Depth [m] 81.5m

COMMENTS:

Run Depth		Core Recovery		RQD Length (Pieces >10cm) [m]	RQD length /run length x100 [%]	Number of Joints (per run)	Core Depth		Schmidt Hammer Tests		Joint Details				Colour	Major Lithology	Minor Lithology	Bedding Type	Features	Comments
From [m]	To [m]	Rec. [m]	Rec. [%]				From [m]	To [m]	Test 'R' Values	Avg 'R' Value	Geometry	Roughness	Spacing	Joint Angle [°]						
0.00	1.50	0.06	4.00	0.00	0.00	0.00	0.00	1.44	LOST CORE	LOST CORE	LOST CORE	LOST CORE	LOST CORE	LOST CORE	LOST CORE	LOST CORE	LOST CORE	LOST CORE	LOST CORE	LOST CORE
							1.44	1.50	0	0	-	-	-	-	Medium Grey	Overburden	n/a	Massive	n/a	Sandstone boulder, fine-med grained.
1.50	5.00	0.60	17.14	0.00	0.00	0.00	1.50	2.40	LOST CORE	LOST CORE	LOST CORE	LOST CORE	LOST CORE	LOST CORE	LOST CORE	LOST CORE	LOST CORE	LOST CORE	LOST CORE	LOST CORE
							2.40	5.00	0	0	-	-	-	-	Medium Grey	Overburden	n/a	n/a	n/a	Sandstone boulders, fine grained, trace clay, <6cm pieces.
5.00	6.50	0.35	23.33	0.00	0.00	0.00	5.00	6.15	LOST CORE	LOST CORE	LOST CORE	LOST CORE	LOST CORE	LOST CORE	LOST CORE	LOST CORE	LOST CORE	LOST CORE	LOST CORE	LOST CORE
							6.15	6.50	0	0	-	-	-	-	Medium Grey	Glacial Till	n/a	Interbedded	n/a	Possible fault gouge, Silty-clay, some fine sand, and clasts of mudstone and mm quartz pieces, soft, weathered, pp=1.5-0.25
6.50	8.00	0.85	56.67	0.00	0.00	0.00	6.50	7.15	LOST CORE	LOST CORE	LOST CORE	LOST CORE	LOST CORE	LOST CORE	LOST CORE	LOST CORE	LOST CORE	LOST CORE	LOST CORE	LOST CORE
							7.15	8.00	0	0	-	-	-	-	Light-Medium Grey	Glacial Till	n/a	Interbedded	n/a	Possible fault gouge, Silty-clay, trace mudstone clasts, trace fine grained sand, soft, strongly weathered, pp=1.5-4.5
8.00	9.50	1.40	93.33	0.00	0.00	0.00	8.00	8.10	LOST CORE	LOST CORE	LOST CORE	LOST CORE	LOST CORE	LOST CORE	LOST CORE	LOST CORE	LOST CORE	LOST CORE	LOST CORE	LOST CORE
							8.10	9.50	38,40	39	-	-	-	-	Medium-Dark Grey	Mudstone	n/a	Massive	n/a	Mudstone clasts 10-20cm, with soft clay matrix. Fault induced, highly weathered.
9.50	11.00	1.20	80.00	0.10	6.67	1.00	9.50	9.80	LOST CORE	LOST CORE	LOST CORE	LOST CORE	LOST CORE	LOST CORE	LOST CORE	LOST CORE	LOST CORE	LOST CORE	LOST CORE	LOST CORE
							9.80	10.70	0	0	Irregular	Slightly Rough	Isolated (6->12cm)	90°	Dark Grey	Mudstone	n/a	Massive	n/a	very soft, weathered and gouge like, trace mudstone pieces and trace coal fragments.
							10.70	11.00							Medium Grey	Sandstone	n/a	Massive	Quartz Vein(s) mm scale	Sandstone, fine-med grained, irregular Qtz veins.
11.00	12.50	1.30	86.67	1.10	73.33	1.00	11.00	11.20	LOST CORE	LOST CORE	LOST CORE	LOST CORE	LOST CORE	LOST CORE	LOST CORE	LOST CORE	LOST CORE	LOST CORE	LOST CORE	LOST CORE
							11.20	12.50	32,32	32	Irregular	Very Rough	Isolated (6->12cm)	75°	Medium Grey	Sandstone	n/a	Massive	Quartz Vein(s) mm scale	Sandstone, fine-med grained, Qtz veins along joint surfaces.
12.50	14.00	1.35	90.00	1.15	76.67	1.00	12.50	12.65	LOST CORE	LOST CORE	LOST CORE	LOST CORE	LOST CORE	LOST CORE	LOST CORE	LOST CORE	LOST CORE	LOST CORE	LOST CORE	LOST CORE
							12.65	14.00	38,30	34	Planar	Slightly Rough	Isolated (6->12cm)	30°	Medium Grey	Sandstone	n/a	Massive	Quartz Vein(s) cm scale	Sandstone, fine-med grain, Qtz veins <3cm.
14.00	15.50	1.49	99.33	0.90	60.00	1.00	14.00	14.01	LOST CORE	LOST CORE	LOST CORE	LOST CORE	LOST CORE	LOST CORE	LOST CORE	LOST CORE	LOST CORE	LOST CORE	LOST CORE	LOST CORE
							14.01	15.50	33,34	33.5	Planar	Slightly Rough	Isolated (6->12cm)	75°	Medium Grey	Sandstone	n/a	Massive	Quartz Vein(s) cm scale	Sandstone, fine-med grained, trace coarse grains (white 1mm sized grains), some irregular Qtz veins.
15.50	17.00	1.23	82.00	0.85	56.67	2.00	15.50	15.77	LOST CORE	LOST CORE	LOST CORE	LOST CORE	LOST CORE	LOST CORE	LOST CORE	LOST CORE	LOST CORE	LOST CORE	LOST CORE	LOST CORE
							15.77	15.80	18,28	23	Planar	Smooth	Isolated (6->12cm)	80°	Medium Grey	Sandstone	n/a	Massive	Quartz Vein(s) mm scale	Sandstone, fine-coarse grained, white mm grains, high angle joints present with Quartz filling.
17.00	18.50	1.50	100.00	0.7	46.67	2	17.00	17.40	49,43	46	Irregular	Rough	Isolated (6->12cm)	70°	Medium Grey	Sandstone	n/a	Massive	Quartz Vein(s) mm scale	Sandstone, fine-med grained, trace coarse grained, trace quartz veins.
18.50	20.00	1.50	100.00	1.41	94.00	1	18.50	20.00	26,28	27	Planar	Very Rough	Isolated (6->12cm)	70°	Medium Grey	Sandstone	n/a	Massive	Quartz Stringers	Sandstone fine-coarse grained, trace mudstone laminae
20.00	21.50	0.90	60.00	0.71	47.33	1.00	20.00	20.60	LOST CORE	LOST CORE	LOST CORE	LOST CORE	LOST CORE	LOST CORE	LOST CORE	LOST CORE	LOST CORE	LOST CORE	LOST CORE	LOST CORE
							20.60	21.50	48,46	47	Planar	Slightly Rough	Isolated (6->12cm)	40°	Medium Grey	Sandstone	n/a	Massive	Quartz Stringers	Sandstone, fine-coarse grain, trace mudstone laminae, and abundant quartz veining.
21.50	23.00	1.20	80.00	0.00	0.00	0.00	21.50	21.59	LOST CORE	LOST CORE	LOST CORE	LOST CORE	LOST CORE	LOST CORE	LOST CORE	LOST CORE	LOST CORE	LOST CORE	LOST CORE	LOST CORE
							21.59	22.70	0	0	n/a	n/a	n/a	n/a	Medium Grey	Sandstone	n/a	Massive	n/a	Sandstone,fine-med grained.
							22.70	23.00			n/a	n/a	n/a	n/a	Dark Grey	Mudstone	n/a	Massive	n/a	Mudstone, very fissile, mechanically broken, 10-20 deg polished and planner.

Run Depth		Core Recovery		RQD Length (Pieces >10cm) [m]	RQD length /run length x100 [%]	Number of Joints (per run)	Core Depth		Schmidt Hammer Tests		Joint Details				Colour	Major Lithology	Minor Lithology	Bedding Type	Features	Comments
From [m]	To [m]	Rec. [m]	Rec. [%]				From [m]	To [m]	Test 'R' Values	Avg 'R' Value	Geometry	Roughness	Spacing	Joint Angle [°]						
23.00	24.50	1.30	86.67	0.36	24.00	1.00	23.00	23.20	LOST CORE	LOST CORE	LOST CORE	LOST CORE	LOST CORE	LOST CORE	LOST CORE	LOST CORE	LOST CORE	LOST CORE	LOST CORE	LOST CORE
							23.20	24.50	0	0	Irregular	Smooth	Isolated (6->12cm)	40°	Dark Grey	Mudstone	n/a	Massive	Quartz Vein(s) mm scale	Mudstone, very fisile, machanically broken, polished-smooth and planner.
24.50	26.00	1.31	87.33	1.05	70.00	1.00	24.50	24.69	LOST CORE	LOST CORE	LOST CORE	LOST CORE	LOST CORE	LOST CORE	LOST CORE	LOST CORE	LOST CORE	LOST CORE	LOST CORE	LOST CORE
							24.69	26.00	12,0	6	Planar	Smooth	Isolated (6->12cm)	80°	Dark Grey	Mudstone	n/a	Massive	Quartz Vein(s) mm scale	Mudstone, massive, increase in joint angles.
26.00	27.50	1.25	83.33	1.07	71.33	1.00	26.00	26.25	LOST CORE	LOST CORE	LOST CORE	LOST CORE	LOST CORE	LOST CORE	LOST CORE	LOST CORE	LOST CORE	LOST CORE	LOST CORE	LOST CORE
							26.25	27.50	28,28	28	Planar	Smooth	Isolated (6->12cm)	80°	Dark Grey	Mudstone	n/a	Massive	n/a	Mudstone, drilling down dip.
27.50	29.00	1.42	94.67	0.95	63.33	0.00	27.50	27.58	LOST CORE	LOST CORE	LOST CORE	LOST CORE	LOST CORE	LOST CORE	LOST CORE	LOST CORE	LOST CORE	LOST CORE	LOST CORE	LOST CORE
							27.58	29.00	19,18	18.5	n/a	n/a	n/a	n/a	Dark Grey	Mudstone	n/a	Massive	n/a	Mudstone, bedding 85-90 deg.
29.00	30.50	1.41	94.00	1.16	77.33	1.00	29.00	29.09	LOST CORE	LOST CORE	LOST CORE	LOST CORE	LOST CORE	LOST CORE	LOST CORE	LOST CORE	LOST CORE	LOST CORE	LOST CORE	LOST CORE
							29.09	30.50	19,40	29.5	Planar	Smooth	Isolated (6->12cm)	80°	Dark Grey	Mudstone	n/a	Massive	n/a	-
30.50	32.00	1.45	96.67	1.27	84.67	0.00	30.50	30.55	LOST CORE	LOST CORE	LOST CORE	LOST CORE	LOST CORE	LOST CORE	LOST CORE	LOST CORE	LOST CORE	LOST CORE	LOST CORE	LOST CORE
							30.55	32.00	25,30	27.5	n/a	n/a	n/a	n/a	Dark Grey	Mudstone	n/a	Massive	n/a	-
32.00	33.50	1.40	93.33	1.35	90.00	0.00	32.00	32.10	LOST CORE	LOST CORE	LOST CORE	LOST CORE	LOST CORE	LOST CORE	LOST CORE	LOST CORE	LOST CORE	LOST CORE	LOST CORE	LOST CORE
							32.10	33.50	19,14	16.5	n/a	n/a	n/a	n/a	Dark Grey	Mudstone	n/a	Massive	n/a	-
33.50	35.00	1.45	96.67	0.68	45.33	0.00	33.50	33.55	LOST CORE	LOST CORE	LOST CORE	LOST CORE	LOST CORE	LOST CORE	LOST CORE	LOST CORE	LOST CORE	LOST CORE	LOST CORE	LOST CORE
							33.55	35.00	25,20	22.5	n/a	n/a	n/a	n/a	Dark Grey	Mudstone	n/a	Massive	n/a	-
35.00	36.50	1.30	86.67	1.15	76.67	1.00	35.00	35.20	LOST CORE	LOST CORE	LOST CORE	LOST CORE	LOST CORE	LOST CORE	LOST CORE	LOST CORE	LOST CORE	LOST CORE	LOST CORE	LOST CORE
							35.20	36.50	14,19	16.5	Stepped	Smooth	Isolated (6->12cm)	85°	Dark Grey	Mudstone	n/a	Massive	Quartz Vein(s) mm scale	-
36.50	38.00	1.40	93.33	1.10	73.33	0.00	36.50	36.60	LOST CORE	LOST CORE	LOST CORE	LOST CORE	LOST CORE	LOST CORE	LOST CORE	LOST CORE	LOST CORE	LOST CORE	LOST CORE	LOST CORE
							36.60	38.00	24,24	24	n/a	n/a	n/a	n/a	Dark Grey	Mudstone	n/a	Massive	Quartz Vein(s) mm scale	Trace coal stringers, and Qtz patch.
38.00	39.50	1.40	93.33	1.25	83.33	1.00	38.00	38.10	LOST CORE	LOST CORE	LOST CORE	LOST CORE	LOST CORE	LOST CORE	LOST CORE	LOST CORE	LOST CORE	LOST CORE	LOST CORE	LOST CORE
							38.10	39.50	16,12	14	Planar	Smooth	Isolated (6->12cm)	80°	Dark Grey	Mudstone	n/a	Massive	n/a	Increased silt content.
39.50	41.00	1.48	98.67	1.40	93.33	1.00	39.50	39.52	LOST CORE	LOST CORE	LOST CORE	LOST CORE	LOST CORE	LOST CORE	LOST CORE	LOST CORE	LOST CORE	LOST CORE	LOST CORE	LOST CORE
							39.52	41.00	20,31	25.5	Planar	Smooth	Isolated (6->12cm)	85°	Dark Grey	Mudstone	n/a	Massive	n/a	-
41.00	42.50	1.50	100.00	1.1	73.33	0	41.00	42.50	18,47	32.5	n/a	n/a	n/a	n/a	Dark Grey	Mudstone	n/a	Massive	Quartz Vein(s) mm scale	-
42.50	44.00	1.50	100.00	1.2	80.00	0	42.50	44.00	25,22	23.5	n/a	n/a	n/a	n/a	Dark Grey	Mudstone	n/a	Massive	n/a	-
44.00	45.50	1.40	93.33	1.10	73.33	0.00	44.00	44.10	LOST CORE	LOST CORE	LOST CORE	LOST CORE	LOST CORE	LOST CORE	LOST CORE	LOST CORE	LOST CORE	LOST CORE	LOST CORE	LOST CORE
							44.10	45.50	22,20	21	n/a	n/a	n/a	n/a	Dark Grey	Mudstone	n/a	Massive	Quartz-Carbonate	Vuggy cm Quartz-Carbonate.
45.50	47.00	1.50	100.00	0.75	50.00	0	45.50	47.00	22,24	23	n/a	n/a	n/a	n/a	Dark Grey	Mudstone	n/a	Massive	Quartz Stringers	Micro faults and folding , showing 1.5cm and 4mm displacemnt.
47.00	48.50	1.42	94.67	1.20	80.00	0.00	47.00	47.08	LOST CORE	LOST CORE	LOST CORE	LOST CORE	LOST CORE	LOST CORE	LOST CORE	LOST CORE	LOST CORE	LOST CORE	LOST CORE	LOST CORE
							47.08	48.50	30,32	31	n/a	n/a	n/a	n/a	Dark Grey	Mudstone	n/a	Massive	Quartz Stringers	Similar to above micro veins showing displacement.
48.50	50.00	1.48	98.67	1.30	86.67	1.00	48.50	48.52	LOST CORE	LOST CORE	LOST CORE	LOST CORE	LOST CORE	LOST CORE	LOST CORE	LOST CORE	LOST CORE	LOST CORE	LOST CORE	LOST CORE
							48.52	50.00	13,26	19.5	Irregular	Very Rough	Isolated (6->12cm)	60°	Dark Grey	Mudstone	n/a	Massive	Quartz Stringers	-
50.00	51.50	1.40	93.33	0.60	40.00	0.00	50.00	50.10	LOST CORE	LOST CORE	LOST CORE	LOST CORE	LOST CORE	LOST CORE	LOST CORE	LOST CORE	LOST CORE	LOST CORE	LOST CORE	LOST CORE
							50.10	51.50	34,41	37.5	n/a	n/a	n/a	n/a	Dark Grey	Mudstone	n/a	Massive	Quartz Vein(s) cm scale	Vuggy mm Quartz-Carbonate.

Run Depth		Core Recovery		RQD Length (Pieces >10cm) [m]	RQD length /run length x100 [%]	Number of Joints (per run)	Core Depth		Schmidt Hammer Tests		Joint Details				Colour	Major Lithology	Minor Lithology	Bedding Type	Features	Comments
From [m]	To [m]	Rec. [m]	Rec. [%]				From [m]	To [m]	Test 'R' Values	Avg 'R' Value	Geometry	Roughness	Spacing	Joint Angle [°]						
51.50	53.00	1.50	100.00	1.45	96.67	0	51.50	53.00	33,34	33.5	n/a	n/a	n/a	n/a	Dark Grey	Mudstone	n/a	Massive	Quartz Stringers	-
53.00	54.50	1.47	98.00	1.47	98.00	2.00	53.00	53.03	LOST CORE	LOST CORE	LOST CORE	LOST CORE	LOST CORE	LOST CORE	LOST CORE	LOST CORE	LOST CORE	LOST CORE	LOST CORE	LOST CORE
							53.03	54.50	26,34	30	Planar	Smooth	Isolated (6->12cm)	50°	Dark Grey	Interbedded Mudstone/Siltstone	Siltstone	Interbedded	-	-
54.50	56.00	1.40	93.33	0.90	60.00	0.00	54.50	54.60	LOST CORE	LOST CORE	LOST CORE	LOST CORE	LOST CORE	LOST CORE	LOST CORE	LOST CORE	LOST CORE	LOST CORE	LOST CORE	LOST CORE
							54.60	56.00	23,25	24	n/a	n/a	n/a	n/a	Dark Grey	Interbedded Mudstone/Siltstone	Siltstone	Interbedded	Quartz Stringers	-
56.00	57.50	1.50	100.00	1.04	69.33	1	56.00	57.50	18,16	17	Planar	Smooth	Isolated (6->12cm)	50°	Dark Grey	Interbedded Mudstone/Siltstone	Siltstone	Interbedded	Quartz Stringers	-
57.50	59.00	0.90	60.00	0.70	46.67	1.00	57.50	58.10	LOST CORE	LOST CORE	LOST CORE	LOST CORE	LOST CORE	LOST CORE	LOST CORE	LOST CORE	LOST CORE	LOST CORE	LOST CORE	LOST CORE
							58.10	58.80	11,19	15	n/a	n/a	n/a	n/a	Dark Grey	Interbedded Mudstone/Siltstone	Siltstone	Interbedded	-	-
							58.80	59.00							Dark Grey	Interbedded Anthracite/Mudstone	Siltstone	Interbedded	-	Heavily weathered, interbedded anthracite and mudstone
59.00	60.50	0.90	60.00	0.20	13.33	~16	59.00	59.30							Dark Grey-Black	Interbedded Anthracite/Mudstone	Siltstone	Interbedded	-	Weathered anthracite and mudstone
							59.30	59.50	29,22	25.5	Planar	Slightly Rough	Isolated (6->12cm)	30°	Dark Grey	Siltstone	-	-	-	-
							59.50	59.63							Dark Grey	Mudstone	-	-	Quartz Stringers	-
							59.63	59.90							Dark Grey-Black	Interbedded Anthracite/Mudstone	Mudstone	Interbedded	Quartz Stringers	-
							59.90	60.50	LOST CORE	LOST CORE	LOST CORE	LOST CORE	LOST CORE	LOST CORE	LOST CORE	LOST CORE	LOST CORE	LOST CORE	LOST CORE	LOST CORE
60.50	62.00	1.43	95.33	1.35	90.00	3.00	60.50	60.63							Dark Grey-Black	Interbedded Anthracite/Mudstone	Mudstone	Interbedded	-	Weathered, interbedded mudstone and anthracite.
							60.63	61.65	19,15	17	n/a	n/a	n/a	n/a	Dark Grey	Mudstone	Siltstone	Interbedded	Quartz Stringers	Mudstone and siltstone with minor coal seams (mm scale)
							61.65	61.93							Dark Grey	Mudstone	-	Massive	Quartz Stringers	-
							61.93	62.00	LOST CORE	LOST CORE	LOST CORE	LOST CORE	LOST CORE	LOST CORE	LOST CORE	LOST CORE	LOST CORE	LOST CORE	LOST CORE	LOST CORE
62.00	63.50	1.45	96.67	1.45	96.67	0.00	62.00	62.05	LOST CORE	LOST CORE	LOST CORE	LOST CORE	LOST CORE	LOST CORE	LOST CORE	LOST CORE	LOST CORE	LOST CORE	LOST CORE	LOST CORE
							62.05	63.50	30,26	28	n/a	n/a	n/a	n/a	Dark Grey	Mudstone	-	-	Quartz Stringers	Silty Mudstone
63.50	65.00	1.45	96.67	0.90	60.00	~20	63.50	63.67			n/a	n/a	n/a	n/a	Dark Grey	Mudstone	Anthracite Coal	-	Quartz Stringers	Weathered anthracite and mudstone
							63.67	64.95	17,26	21.5	n/a	n/a	n/a	n/a	Medium-Dark Grey	Interbedded Mudstone/Sandstone	Mudstone	Interbedded	Quartz Stringers	Very fine-fine grained sandstone interbedded with mudstone.
							64.95	65.00	LOST CORE	LOST CORE	LOST CORE	LOST CORE	LOST CORE	LOST CORE	LOST CORE	LOST CORE	LOST CORE	LOST CORE	LOST CORE	LOST CORE
65.00	66.50	1.50	100.00	1.25	83.33	1	65.00	66.50	30,28	29	Irregular	Very Rough	Isolated (6->12cm)	50°	Medium-Dark Grey	Interbedded Mudstone/Sandstone	Mudstone	Interbedded	Quartz Vein(s) mm scale	Very fine-fine grained sandstone interbedded with mudstone.
66.50	68.00	1.50	100.00	1.22	81.33	2	66.50	68.00	28,22	25	Planar	Slightly Rough	Isolated (6->12cm)	20°	Medium Grey	Sandstone	Mudstone	Interbedded	Quartz Vein(s) mm scale	Sandstone fine-med grained, 10% mudstone mm interlayer.
68.00	69.50	1.47	98.00	1.39	92.67	1.00	68.00	68.03	LOST CORE	LOST CORE	LOST CORE	LOST CORE	LOST CORE	LOST CORE	LOST CORE	LOST CORE	LOST CORE	LOST CORE	LOST CORE	LOST CORE
							68.03	69.50	34,26	30	Irregular	Slightly Rough	Isolated (6->12cm)	75°	Medium-Dark Grey	Sandstone	Mudstone	Interbedded	Quartz Vein(s) mm scale	Sandstone fine-med grain, 30% mudstone interlayered.
69.50	71.00	1.50	100.00	1.4	93.33	0	69.50	71.00	32,35	33.5	n/a	n/a	n/a	n/a	Medium Grey	Sandstone	Mudstone	Interbedded	Quartz Vein(s) mm scale	Sandstone fine-med grained, 5% mudstone interlayered.
71.00	72.50	1.40	93.33	1.12	74.67	1.00	71.00	71.10	LOST CORE	LOST CORE	LOST CORE	LOST CORE	LOST CORE	LOST CORE	LOST CORE	LOST CORE	LOST CORE	LOST CORE	LOST CORE	LOST CORE
							71.10	72.50	13,30	21.5	Planar	Very Rough	Isolated (6->12cm)	85°	Medium Grey	Sandstone	Mudstone	Massive	Quartz Vein(s) mm scale	Sandstone fine-med grain, 1% mudstone .
72.50	74.00	1.45	96.67	1.21	80.67	2.00	72.50	72.55	LOST CORE	LOST CORE	LOST CORE	LOST CORE	LOST CORE	LOST CORE	LOST CORE	LOST CORE	LOST CORE	LOST CORE	LOST CORE	LOST CORE
							72.55	73.10	11,17	14	Irregular	Rough	Isolated (6->12cm)	75°	Medium Grey	Sandstone	Mudstone	Massive	Quartz Vein(s) mm scale	Sandstone fine-med grained, 1% mudstone .
74.00	75.50	1.45	96.67	0.70	46.67	1.00	74.00	74.05	LOST CORE	LOST CORE	LOST CORE	LOST CORE	LOST CORE	LOST CORE	LOST CORE	LOST CORE	LOST CORE	LOST CORE	LOST CORE	LOST CORE
							74.05	74.50	14,20	17	Planar	Polished	Isolated (6->12cm)	70°	Medium Grey	Sandstone	-	Massive	Quartz Stringers	Sandstone, fine-med grained, some quartz stringers.
							74.50	75.50			-	-	-	-	Dark Grey	Mudstone	-	Massive	Quartz Stringers	Mudstone, trace quartz stringers.
75.50	77.00	1.48	98.67	0.70	46.67	1.00	75.50	75.52	LOST CORE	LOST CORE	LOST CORE	LOST CORE	LOST CORE	LOST CORE	LOST CORE	LOST CORE	LOST CORE	LOST CORE	LOST CORE	LOST CORE
							75.52	77.00	20,24	22	Irregular	Smooth	Isolated (6->12cm)	60°	Dark Grey	Mudstone	-	Massive	Quartz Stringers	-

Run Depth		Core Recovery		RQD Length (Pieces >10cm) [m]	RQD length /run length x100 [%]	Number of Joints (per run)	Core Depth		Schmidt Hammer Tests		Joint Details				Colour	Major Lithology	Minor Lithology	Bedding Type	Features	Comments
From [m]	To [m]	Rec. [m]	Rec. [%]				From [m]	To [m]	Test 'R' Values	Avg 'R' Value	Geometry	Roughness	Spacing	Joint Angle [°]						
77.00	78.50	1.25	83.33	0.30	20.00	0.00	77.00	77.25	LOST CORE	LOST CORE	LOST CORE	LOST CORE	LOST CORE	LOST CORE	LOST CORE	LOST CORE	LOST CORE	LOST CORE	LOST CORE	LOST CORE
							77.25	78.50	0	0	-	-	Numerous (1-3cm)	-	Black	Anthracite Coal	n/a	Massive	Quartz Stringers	Coal, dull, trace mudstone, brittle.
78.50	80.00	1.25	83.33	0.00	0.00	0.00	78.50	78.75	LOST CORE	LOST CORE	LOST CORE	LOST CORE	LOST CORE	LOST CORE	LOST CORE	LOST CORE	LOST CORE	LOST CORE	LOST CORE	LOST CORE
							78.75	80.00	0	0	-	-	-	-	Black	Anthracite Coal	Mudstone	Massive	-	Coal, 10% mudstone, very fractured.
80.00	81.50	1.40	93.33	0.30	20.00	1	80.00	80.10	LOST CORE	LOST CORE	LOST CORE	LOST CORE	LOST CORE	LOST CORE	LOST CORE	LOST CORE	LOST CORE	LOST CORE	LOST CORE	LOST CORE
							80.10	80.55	33,11	22	-	-	-	-	Black	Anthracite Coal	-	Massive	-	-
							80.55	81.50			Planar	Smooth	Isolated (6->12cm)	30°	Dark Grey	Mudstone		Massive	Quartz Vein(s) mm scale	EOH

TERRACON GEOTECHNIQUE

CLIENT: Arctos Anthracite Joint Venture
PROJECT NUMBER: 122781

HOLE ID: GP-07
PROJECT LOCATION: Arctos Anthracite Property

DATE STARTED: August 10, 2013 COMPLETED: August 12, 2013
DRILL CONTRACTOR: Driftwood RIG #:
HOLE SIZE: HQ
DRILLING METHOD: Diamond
LOGGED BY: Z.Hodgson/M.I CHECKED BY:

Ground Elevation [masl] 1455
Easting 508200.0
Northing 6346185.0
Water Table Depth [m]
Total Depth [m] 80.0M

COMMENTS:

Run Depth		Core Recovery		RQD Length (Pieces >10cm) [m]	RQD length /run length x100 [%]	Number of Joints (per run)	Core Depth		Schmidt Hammer Tests		Joint Details				Colour	Major Lithology	Minor Lithology	Features	Comments
From [m]	To [m]	Rec. [m]	Rec. [%]				From [m]	To [m]	Test 'R' Values	Avg 'R' Value	Geometry	Roughness	Spacing	Joint Angle [°]					
0.00	0.50	0.18	36.00	0.00	0.00	n/a	0.00	1.32	LOST CORE	LOST CORE	LOST CORE	LOST CORE	LOST CORE	LOST CORE	LOST CORE	LOST CORE	LOST CORE	LOST CORE	LOST CORE
							1.32	0.50	n/a	n/a	n/a	n/a	n/a	n/a	Brown	Soil	n/a	Organics	USCS: PT
0.50	2.00	0.38	25.33	0.10	6.67	n/a	0.50	1.62	LOST CORE	LOST CORE	LOST CORE	LOST CORE	LOST CORE	LOST CORE	LOST CORE	LOST CORE	LOST CORE	LOST CORE	LOST CORE
							1.62	2.00	n/a	n/a	n/a	n/a	n/a	n/a	Brown	Glacial Till	n/a	Organics	n/a
2.00	3.50	0.30	20.00	0.00	0.00	n/a	2.00	3.20	LOST CORE	LOST CORE	LOST CORE	LOST CORE	LOST CORE	LOST CORE	LOST CORE	LOST CORE	LOST CORE	LOST CORE	LOST CORE
							3.20	3.50	n/a	n/a	n/a	n/a	n/a	n/a	Light Grey	Glacial Till	n/a	n/a	n/a
3.50	5.00	1.02	68.00	0.61	40.67	2.00	3.50	3.98	LOST CORE	LOST CORE	LOST CORE	LOST CORE	LOST CORE	LOST CORE	LOST CORE	LOST CORE	LOST CORE	LOST CORE	LOST CORE
							3.98	5.00	30,32	31	Planar	Smooth	Isolated (6->12cm)	60°	Light Grey	Sandstone	n/a	n/a	30,33
5.00	6.50	0.26	17.33	0.00	0.00	n/a	5.00	6.24	LOST CORE	LOST CORE	LOST CORE	LOST CORE	LOST CORE	LOST CORE	LOST CORE	LOST CORE	LOST CORE	LOST CORE	LOST CORE
							6.24	6.50	n/a	n/a	n/a	n/a	n/a	n/a	Light Grey	Glacial Till	n/a	n/a	n/a
6.50	8.00	0.12	8.00	0.00	0.00	n/a	6.50	7.88	LOST CORE	LOST CORE	LOST CORE	LOST CORE	LOST CORE	LOST CORE	LOST CORE	LOST CORE	LOST CORE	LOST CORE	LOST CORE
							7.88	8.00	n/a	n/a	n/a	n/a	n/a	n/a	Light-Medium Grey	Sandstone	n/a	n/a	n/a
8.00	9.50	0.22	14.67	0.00	0.00	n/a	8.00	9.28	LOST CORE	LOST CORE	LOST CORE	LOST CORE	LOST CORE	LOST CORE	LOST CORE	LOST CORE	LOST CORE	LOST CORE	LOST CORE
							9.28	9.50	n/a	n/a	n/a	n/a	n/a	n/a	Light-Medium Grey	Sandstone	n/a	n/a	n/a
9.50	11.00	0.30	20.00	0.21	14.00	n/a	9.50	10.70	LOST CORE	LOST CORE	LOST CORE	LOST CORE	LOST CORE	LOST CORE	LOST CORE	LOST CORE	LOST CORE	LOST CORE	LOST CORE
							10.70	11.00	n/a	n/a	n/a	n/a	n/a	n/a	Light-Medium Grey	Glacial Till	Sandstone	n/a	n/a
11.00	12.50	0.21	14.00	0.00	0.00	n/a	11.00	12.29	LOST CORE	LOST CORE	LOST CORE	LOST CORE	LOST CORE	LOST CORE	LOST CORE	LOST CORE	LOST CORE	LOST CORE	LOST CORE
							12.29	12.50	n/a	n/a	n/a	n/a	n/a	n/a	Light-Medium Grey	Glacial Till	Sandstone	n/a	n/a
12.50	14.00	0.23	15.33	0.00	0.00	n/a	12.50	13.77	LOST CORE	LOST CORE	LOST CORE	LOST CORE	LOST CORE	LOST CORE	LOST CORE	LOST CORE	LOST CORE	LOST CORE	LOST CORE
							13.77	14.00	n/a	n/a	n/a	n/a	n/a	n/a	Light-Medium Grey	Glacial Till	Sandstone	n/a	n/a
14.00	15.50	0.25	16.67	0.00	0.00	n/a	14.00	15.25	LOST CORE	LOST CORE	LOST CORE	LOST CORE	LOST CORE	LOST CORE	LOST CORE	LOST CORE	LOST CORE	LOST CORE	LOST CORE
							15.25	15.50	42,44	43	n/a	n/a	n/a	n/a	Light-Medium Grey	Sandstone	n/a	n/a	42,45
15.50	17.00	0.26	17.33	0.00	0.00	n/a	15.50	16.74	LOST CORE	LOST CORE	LOST CORE	LOST CORE	LOST CORE	LOST CORE	LOST CORE	LOST CORE	LOST CORE	LOST CORE	LOST CORE
							16.74	17.00	n/a	n/a	n/a	n/a	n/a	n/a	Light-Medium Grey	Sandstone	n/a	n/a	n/a
17.00	18.50	1.10	73.33	0.97	64.67	2.00	17.00	17.40	LOST CORE	LOST CORE	LOST CORE	LOST CORE	LOST CORE	LOST CORE	LOST CORE	LOST CORE	LOST CORE	LOST CORE	LOST CORE
							17.40	18.50	20,24	22	Irregular	Very Rough	Isolated (6->12cm)	70°	Light Grey	Sandstone	n/a	Quartz Vein(s) mm scale	20,25
18.50	20.00	1.45	96.67	1.05	70.00	1.00	18.50	18.55	LOST CORE	LOST CORE	LOST CORE	LOST CORE	LOST CORE	LOST CORE	LOST CORE	LOST CORE	LOST CORE	LOST CORE	LOST CORE
							18.55	20.00	30,30	30	Planar	Very Rough	Isolated (6->12cm)	80°	Light-Medium Grey	Sandstone	Mudstone	Quartz Vein(s) cm scale	30,31
20.00	21.50	1.50	100.00	0.86	57.33	4	20.00	21.50	11	11	Planar	Slightly Rough	Isolated (6->12cm)	20°	Medium Grey	Sandstone	Mudstone	Quartz Stringers	dm interbeds, coarse gained sandstone
21.50	23.00	1.50	100.00	1.01	67.33	5	21.50	22.35	15,16	15.5	Planar	Very Rough	Isolated (6->12cm)	65°	Medium Grey	Mudstone	n/a	n/a	soft, silty, sharp contact at bottom
							22.35	23.00							Light Grey	Sandstone	n/a	Quartz Vein(s) mm scale	hard, course grained

Run Depth		Core Recovery		RQD Length (Pieces >10cm) [m]	RQD length /run length x100 [%]	Number of Joints (per run)	Core Depth		Schmidt Hammer Tests		Joint Details				Colour	Major Lithology	Minor Lithology	Features	Comments
From [m]	To [m]	Rec. [m]	Rec. [%]				From [m]	To [m]	Test 'R' Values	Avg 'R' Value	Geometry	Roughness	Spacing	Joint Angle [°]					
23.00	24.50	1.25	83.33	0.28	18.67	4.00	23.00	24.25	28,44,46	39.3	Planar	Very Rough	Isolated (6->12cm)	70°	Light Grey	Sandstone	n/a	Quartz Stringers	course grained, trace mudstone
							24.25	24.50	LOST CORE	LOST CORE	LOST CORE	LOST CORE	LOST CORE	LOST CORE	LOST CORE	LOST CORE	LOST CORE	LOST CORE	LOST CORE
24.50	26.00	1.50	100.00	0.56	37.33	5	24.50	26.00	n/a	n/a	Planar	Very Rough	Isolated (6->12cm)	70°	Light Grey	Sandstone	n/a	Quartz Vein(s) mm scale	trace mudstone
26.00	27.50	1.45	96.67	0.75	50.00	5.00	26.00	27.45	16,20,22	19.33333333	Planar	Very Rough	Isolated (6->12cm)	70°	Medium Grey	Sandstone	Mudstone	Quartz Vein(s) cm scale	fine-very couarse grained sandstone/conglomerate, mm-cm mudstone
							27.45	27.50	LOST CORE	LOST CORE	LOST CORE	LOST CORE	LOST CORE	LOST CORE	LOST CORE	LOST CORE	LOST CORE	LOST CORE	LOST CORE
27.50	29.00	1.42	94.67	0.92	61.33	7.00	27.50	27.58	LOST CORE	LOST CORE	LOST CORE	LOST CORE	LOST CORE	LOST CORE	LOST CORE	LOST CORE	LOST CORE	LOST CORE	LOST CORE
							27.58	28.70	18,18	18	Planar	Very Rough	Isolated (6->12cm)	40°	Medium Grey	Sandstone	Mudstone	Quartz Vein(s) mm scale	very couarse grained/conglomerate, mudstone stringers
							28.70	29.00							Dark Grey-Black	Mudstone	Anthracite Coal	Quartz Vein(s) cm scale	-
29	30.5	1.43	95.333333	0.87	58	6	29.00	29.30	26,30,32	29.3	Planar	Smooth	Isolated (6->12cm)	30°	Dark Grey-Black	Mudstone	Siltstone	Quartz Vein(s) mm scale	trace coal
							29.30	30.43							Light-Medium Grey	Sandstone	n/a	Quartz Vein(s) mm scale	quartz rich 29.3-29.4m cm veins, trace mudstone
							30.43	30.50	LOST CORE	LOST CORE	LOST CORE	LOST CORE	LOST CORE	LOST CORE	LOST CORE	LOST CORE	LOST CORE	LOST CORE	LOST CORE
30.50	32.00	1.50	100.00	1.06	70.67	6	30.50	32.00	22,24	23	Planar	Very Rough	Isolated (6->12cm)	70°	Medium Grey	Sandstone	n/a	Quartz Vein(s) mm scale	med-very coarse grained sandstone, trace mudstone
32.00	33.50	1.36	90.67	0.85	56.67	7.00	32.00	33.36	22,25	23.5	Planar	Slightly Rough	Isolated (6->12cm)	75°	Light-Medium Grey	Sandstone	Mudstone	Quartz Stringers	mudstone bed 32.0-32.10m, med-very coarse grained sandstone
							33.36	33.50	LOST CORE	LOST CORE	LOST CORE	LOST CORE	LOST CORE	LOST CORE	LOST CORE	LOST CORE	LOST CORE	LOST CORE	LOST CORE
33.5	35	1.12	74.666667	0.34	22.66666667	8	33.50	33.75							Light Grey	Sandstone	n/a	n/a	interbedded med and coarse grained sandstone, sharp contact at bottom
							33.75	34.62	0	0	Planar	Polished	Occasional (3-6cm)	65°	Dark Grey-Black	Mudstone	Anthracite Coal	Quartz Vein(s) mm scale	mm coal
							34.62	35.00	LOST CORE	LOST CORE	LOST CORE	LOST CORE	LOST CORE	LOST CORE	LOST CORE	LOST CORE	LOST CORE	LOST CORE	LOST CORE
35.00	36.50	1.03	68.67	0.12	8.00	12.00	35.00	35.47	LOST CORE	LOST CORE	LOST CORE	LOST CORE	LOST CORE	LOST CORE	LOST CORE	LOST CORE	LOST CORE	LOST CORE	LOST CORE
							35.47	36.50	22	22	Planar	Polished	Numerous (1-3cm)	20°	Dark Grey-Black	Mudstone	Anthracite Coal	Quartz Vein(s) mm scale	**sample 0130406**, pyrite at 36.3m
36.50	38.00	1.25	83.33	0.30	20.00	8.00	36.50	36.75	LOST CORE	LOST CORE	LOST CORE	LOST CORE	LOST CORE	LOST CORE	LOST CORE	LOST CORE	LOST CORE	LOST CORE	LOST CORE
							36.75	38.00	10	10	Planar	Polished	Occasional (3-6cm)	50°	Dark Grey-Black	Mudstone	Anthracite Coal	Quartz Stringers	-
38.00	39.50	1.13	75.33	0.00	0.00	2.00	38.00	38.37	LOST CORE	LOST CORE	LOST CORE	LOST CORE	LOST CORE	LOST CORE	LOST CORE	LOST CORE	LOST CORE	LOST CORE	LOST CORE
							38.37	39.50	0	0	Planar	Polished	Isolated (6->12cm)	30°	Black	Anthracite Coal	Mudstone	Quartz Stringers	40-50% mudstone
39.50	41.00	1.40	93.33	0.42	28.00	5.00	39.50	39.60	LOST CORE	LOST CORE	LOST CORE	LOST CORE	LOST CORE	LOST CORE	LOST CORE	LOST CORE	LOST CORE	LOST CORE	LOST CORE
							39.60	41.00	0	0	Planar	Polished	Isolated (6->12cm)	30°	Dark Grey-Black	Mudstone	Anthracite Coal	n/a	35% coal
41.00	42.50	1.35	90.00	1.02	68.00	5.00	41.00	41.15	LOST CORE	LOST CORE	LOST CORE	LOST CORE	LOST CORE	LOST CORE	LOST CORE	LOST CORE	LOST CORE	LOST CORE	LOST CORE
							41.15	42.50	24,28,36	29.3	Planar	Smooth	Isolated (6->12cm)	20°	Dark Grey-Black	Mudstone	Anthracite Coal	Quartz Vein(s) mm scale	**sample 0130407**, organic mudstone, trace anthracite coal
42.50	44.00	1.42	94.67	1.36	90.67	2.00	42.50	42.58	LOST CORE	LOST CORE	LOST CORE	LOST CORE	LOST CORE	LOST CORE	LOST CORE	LOST CORE	LOST CORE	LOST CORE	LOST CORE
							42.58	44.00	12,13	12.5	Planar	Smooth	Isolated (6->12cm)	50°	Dark Grey	Mudstone	n/a	n/a	sandstone starting at 43.85m
44.00	45.50	1.50	100.00	1.38	92.00	1.00	44.00	45.50	LOST CORE	LOST CORE	LOST CORE	LOST CORE	LOST CORE	LOST CORE	LOST CORE	LOST CORE	LOST CORE	LOST CORE	LOST CORE
45.50	47.00	1.43	95.33	1.12	74.67	6.00	45.50	45.57	16,17,20	17.7	Planar	Smooth	Isolated (6->12cm)	50°	Light-Medium Grey	Sandstone	Mudstone	Quartz Stringers	mm-cm mudstone beds, 20% mudstone
							45.57	46.50	26,28	27	Irregular	Slightly Rough	Isolated (6->12cm)	90°	Medium Grey	Sandstone	Mudstone	Quartz Vein(s) mm scale	-
							46.50	47.00			Irregular	Slightly Rough	Isolated (6->12cm)	50°	Medium-Dark Grey	Interbedded Mudstone/Siltstone	n/a	n/a	-
							47.00	47.05	LOST CORE	LOST CORE	LOST CORE	LOST CORE	LOST CORE	LOST CORE	LOST CORE	LOST CORE	LOST CORE	LOST CORE	LOST CORE

Run Depth		Core Recovery		RQD Length (Pieces >10cm) [m]	RQD length /run length x100 [%]	Number of Joints (per run)	Core Depth		Schmidt Hammer Tests		Joint Details				Colour	Major Lithology	Minor Lithology	Features	Comments
From [m]	To [m]	Rec. [m]	Rec. [%]				From [m]	To [m]	Test 'R' Values	Avg 'R' Value	Geometry	Roughness	Spacing	Joint Angle [°]					
47.00	48.50	1.45	96.67	0.88	58.67	>20	47.05	48.15	15,12	13.5	Irregular	Slightly Rough	Isolated (6->12cm)	70°	Medium-Dark Grey	Interbedded Mudstone/Siltstone	Siltstone	Quartz Stringers	Silty mudstone interbedded with siltstone
							48.15	48.50			Curved	Slightly Rough	Isolated (6->12cm)	55°	Medium Grey	Sandstone	n/a	Quartz Stringers	Heavily jointed/fractured at base of run
48.50	50.00	1.47	98.00	1.12	74.67	11.00	48.50	48.53	LOST CORE	LOST CORE	LOST CORE	LOST CORE	LOST CORE	LOST CORE	LOST CORE	LOST CORE	LOST CORE	LOST CORE	LOST CORE
							48.53	50.00	0	0	Irregular	Slightly Rough	Isolated (6->12cm)	50°	Medium Grey	Sandstone	n/a	Quartz Stringers	-
50.00	51.50	1.34	89.33	0.85	56.67	7.00	50.00	50.16	LOST CORE	LOST CORE	LOST CORE	LOST CORE	LOST CORE	LOST CORE	LOST CORE	LOST CORE	LOST CORE	LOST CORE	LOST CORE
							50.16	51.04	14,16	15	Planar	Smooth	Isolated (6->12cm)	40°	Medium Grey	Sandstone	n/a	Quartz Stringers	-
							51.04	51.50			Planar	Slightly Rough	Isolated (6->12cm)	60°	Medium Grey	Sandstone	n/a	Quartz Stringers	Very fine grained silty sandstone
51.50	53.00	1.50	100.00	1.20	80.00	9	51.50	53.00	10	10	Irregular	Slightly Rough	Isolated (6->12cm)	80°, 50°	Medium Grey	Interbedded Mudstone/Sandstone	Mudstone	Quartz Stringers	Interbedded very fine grained sandstone and silty mudstone.
53.00	54.50	1.39	92.67	0.50	33.33	16.00	53.00	53.11	LOST CORE	LOST CORE	LOST CORE	LOST CORE	LOST CORE	LOST CORE	LOST CORE	LOST CORE	LOST CORE	LOST CORE	LOST CORE
							53.11	54.50	\		Irregular	Striated	Isolated (6->12cm)	50°	Medium Grey	Interbedded Mudstone/Siltstone	Sandstone	n/a	Mudstone interbedded with siltstone, occasional very fine grained sandstone interbeds.
54.50	56.00	1.20	80.00	0.39	26.00	>20	54.5	54.94	0	0	Planar	Polished	Isolated (6->12cm)	50°	Dark Grey-Black	Interbedded Anthracite/Mudstone	Anthracite Coal	n/a	Interbedded silty mudstone and anthracite, weathered and heavily jointed/fractured.
							54.94	55.70							Medium-Dark Grey	Interbedded Mudstone/Sandstone	Mudstone	Quartz Stringers	Fractured.
							55.70	56.00	LOST CORE	LOST CORE	LOST CORE	LOST CORE	LOST CORE	LOST CORE	LOST CORE	LOST CORE	LOST CORE	LOST CORE	LOST CORE
56.00	57.50	1.50	100.00	0.44	29.33	>20	56.00	56.70	0	0	-	-	-	-	Medium Grey	Sandstone	n/a	n/a	Sandstone with minor mudstone interbed
							56.70	57.50			Irregular	Slightly Rough	Isolated (6->12cm)	20°, 70°, 65°	Dark Grey-Black	Interbedded Mudstone/Sandstone	Sandstone	n/a	Very fine grained silty sandstone interbedded with mudstone
57.50	59.00	1.50	100.00	0.22	14.67	>20	57.50	59.00	0	0	Planar	Slightly Rough	Isolated (6->12cm)	15°	Dark Grey-Black	Interbedded Mudstone/Sandstone	n/a	Quartz Stringers	Very fine grained silty sandstone interbedded with mudstone
59.00	60.50	1.30	86.67	0.00	0.00	15.00	59.00	59.20	LOST CORE	LOST CORE	LOST CORE	LOST CORE	LOST CORE	LOST CORE	LOST CORE	LOST CORE	LOST CORE	LOST CORE	LOST CORE
							59.20	60.50	n/a	n/a	Irregular	Slightly Rough	Isolated (6->12cm)	90°	Dark Grey-Black	Mudstone	Siltstone	n/a	Mudstone with very minor siltstone
60.50	62.00	1.37	91.33	0.24	16.00	>20	60.50	61.02			-	-	-	-	Dark Grey-Black	Mudstone	n/a	n/a	-
							61.02	61.33	24,27	26	Irregular	Polished	Isolated (6->12cm)	40°	Light-Medium Grey	Sandstone	n/a	Pyrite	Very fine-medium grained sandstone with an abundance of pyrite from 70.22m-70.34m
							61.33	61.57			-	-	-	-	Dark Grey-Black	Mudstone	n/a	n/a	Weak, heavily fractured
							61.57	61.87			Planar	Polished	Isolated (6->12cm)	15°	Medium-Dark Grey	Interbedded Mudstone/Sandstone	Mudstone	Quartz Stringers	Very fine-medium grained sandstone with occasional mudstone interbeds. Very weathered towards base of run.
							61.87	62.00	LOST CORE	LOST CORE	LOST CORE	LOST CORE	LOST CORE	LOST CORE	LOST CORE	LOST CORE	LOST CORE	LOST CORE	LOST CORE
62.00	63.50	1.50	100.00	0.53	35.33	8	62.00	63.50	10,17	13.5	-	-	-	-	Medium Grey	Sandstone	Mudstone	Quartz Stringers	-
63.50	65.00	1.40	93.33	0.22	14.67	13.00	63.50	63.76	0	0	Irregular	Striated	Isolated (6->12cm)	50°	Medium Grey	Sandstone	n/a	Quartz Stringers	Fine-medium grained sandstone with very minor mudstone
							63.76	64.39			-	-	-	-	Dark Grey-Black	Anthracite Coal	n/a	Quartz Stringers	Weathered anthracite, minor mudstone, trace pyrite
							64.39	64.90			-	-	-	-	Dark Grey-Black	Interbedded Anthracite/Mudstone	n/a	n/a	Heavily weathered anthracite interbedded with mudstone
							64.90	65.00	LOST CORE	LOST CORE	LOST CORE	LOST CORE	LOST CORE	LOST CORE	LOST CORE	LOST CORE	LOST CORE	LOST CORE	LOST CORE
65.00	66.50	1.50	100.00	0.30	20.00	19	65.00	65.64	19,20	19.5	-	-	-	-	Dark Grey-Black	Interbedded Anthracite/Mudstone	Anthracite Coal	n/a	Mudstone with very minor coal seams
							65.64	65.92			-	-	-	-	Medium-Dark Grey	Interbedded Mudstone/Sandstone	n/a	n/a	-
							65.92	66.50			-	-	-	-	Medium Grey	Sandstone	n/a	Quartz Stringers	Fine grained sandstone
66.50	68.00	1.50	100.00	0.53	35.33	11	66.50	68.00	20,30		Planar	Polished	Isolated (6->12cm)	45°	Medium-Dark Grey	Interbedded Mudstone/Sandstone	n/a	Quartz Stringers	Moderately fractured, weathered at top of run.

Run Depth		Core Recovery		RQD Length (Pieces >10cm) [m]	RQD length /run length x100 [%]	Number of Joints (per run)	Core Depth		Schmidt Hammer Tests		Joint Details				Colour	Major Lithology	Minor Lithology	Features	Comments
From [m]	To [m]	Rec. [m]	Rec. [%]				From [m]	To [m]	Test 'R' Values	Avg 'R' Value	Geometry	Roughness	Spacing	Joint Angle [°]					
68.00	69.50	1.39	92.67	0.66	44.00	~10	68.00	68.70	34,35	34.5	Irregular	Slightly Rough	Isolated (6->12cm)	50°	Medium-Dark Grey	Sandstone	Mudstone	Mud clasts	Fine grained sandstone
							68.70	69.39							Medium-Dark Grey	Interbedded Mudstone/Sandstone	n/a	n/a	Interbedded sandstone and mudstone, fault gouge/heavily weathered
							69.39	69.50	LOST CORE	LOST CORE	LOST CORE	LOST CORE	LOST CORE	LOST CORE	LOST CORE	LOST CORE	LOST CORE	LOST CORE	LOST CORE
69.50	71.00	1.50	100.00	0.10	6.67	20	69.50	71.00	0,0	0	Planar	Slightly Rough	Isolated (6->12cm)	60°	Medium-Dark Grey	Interbedded Mudstone/Sandstone	n/a	n/a	Mildly weathered
71.00	72.50	0.92	61.33	0.13	8.67	~12	71.00	71.38	0,0	0	Irregular	Slightly Rough	Isolated (6->12cm)	50°	Medium Grey	Sandstone	Mudstone	Quartz Stringers	Fine grained sandstone with trace mudstone laminae.
							71.38	71.92			Planar	Polished	Isolated (6->12cm)	15°	Dark Grey-Black	Interbedded Anthracite/Mudstone	Mudstone	Quartz Stringers	Anthracite coal with minor mudstone interbeds.
							71.92	72.50	LOST CORE	LOST CORE	LOST CORE	LOST CORE	LOST CORE	LOST CORE	LOST CORE	LOST CORE	LOST CORE	LOST CORE	LOST CORE
72.50	74.00	1.47	98.00	0.00	0.00	~20	72.50	72.73	11,10	10.5	Planar	Polished	Occasional (3-6cm)	20°	Dark Grey-Black	Interbedded Anthracite/Mudstone	Anthracite Coal	n/a	Heavily jointed/fractured mudstone with minor amount of anthracite.
							72.73	73.97			Irregular	Slightly Rough	Isolated (6->12cm)	65°	Medium-Dark Grey	Interbedded Mudstone/Siltstone	Siltstone	Quartz Stringers	Interbedded sandstone and mudstone, very minor amounts of very fine grained sand. Heavily jointed/fractured.
							73.97	74.00	LOST CORE	LOST CORE	LOST CORE	LOST CORE	LOST CORE	LOST CORE	LOST CORE	LOST CORE	LOST CORE	LOST CORE	LOST CORE
74.00	75.50	1.50	100.00	0.15	10.00	13	74.00	74.93	27,22	24.5	Planar	Slightly Rough	Isolated (6->12cm)	60°	Medium-Dark Grey	Interbedded Mudstone/Sandstone	n/a	n/a	-
							74.93	75.50			Irregular	Polished	Isolated (6->12cm)	80°	Medium Grey	Sandstone	n/a	n/a	-
75.50	77.00	1.50	100.00	0.26	17.33	16	75.50	77.00	0	0	Planar	Polished	Isolated (6->12cm)	15°	Medium Grey	Interbedded Mudstone/Sandstone	Mudstone	Quartz Stringers	Very fine grained sandstone interbedded with minor mudstone
77.00	78.50	1.50	100.00	0.25	16.67	>20	77.00	78.50	19,20	19.5	Planar	Slightly Rough	Isolated (6->12cm)	50°	Medium Grey	Interbedded Mudstone/Sandstone	Mudstone	Quartz Stringers	-
78.50	80.00	1.50	100.00	0.98	65.33	9	78.50	80.00	16,14	15	Planar	Slightly Rough	Isolated (6->12cm)	30°	Medium Grey	Interbedded Mudstone/Sandstone	n/a	Quartz Stringers	Interbedded fine grained sandstone and mudstone.

TERRACON GEOTECHNIQUE

CLIENT: Arctos Anthracite Joint Venture
PROJECT NUMBER: 122781

HOLE ID: GP-08/MW-21
PROJECT LOCATION: Arctos Anthracite Property

DATE STARTED: July 4, 2013 COMPLETED: July 7, 2013
DRILL CONTRACTOR: Driftwood RIG #:
HOLE SIZE: HQ
DRILLING METHOD: Diamond
LOGGED BY: O.Gubev CHECKED BY: OG

Ground Elevation [masl] 1510
Easting 508103.0
Northing 6345192.0
Water Table Depth [m]
Total Depth [m] 88.5

COMMENTS:

Run Depth		Core Recovery		RQD Length (Pieces >10cm) [m]	RQD length /run length x100 [%]	Number of Joints (per run)	Core Depth		Schmidt Hammer Tests		Joint Details				Colour	Major Lithology	Minor Lithology	Bedding Type	Features	Comments
From [m]	To [m]	Rec. [m]	Rec. [%]				From [m]	To [m]	Test 'R' Values	Avg 'R' Value	Geometry	Roughness	Spacing	Joint Angle [°]						
0	3	1.4	46.667	0	0	4	0	1.4								Glacial Till				silt, clay, soft
							1.4	3	LOST CORE	LOST CORE	LOST CORE	LOST CORE	LOST CORE	LOST CORE	LOST CORE	LOST CORE	LOST CORE	LOST CORE	LOST CORE	LOST CORE
3	4.5	0.9	60	0	0	5	3	3.9								Glacial Till				silt, clay, soft
							3.9	4.5	LOST CORE	LOST CORE	LOST CORE	LOST CORE	LOST CORE	LOST CORE	LOST CORE	LOST CORE	LOST CORE	LOST CORE	LOST CORE	LOST CORE
4.5	6	1.2	80	0.9	60	1	4.5	5.7	22,18,26	22						Siltstone	Sandstone	Interlaminated		some interbeds, massive, fractured at bottom 0.3 m
							5.7	6	LOST CORE	LOST CORE	LOST CORE	LOST CORE	LOST CORE	LOST CORE	LOST CORE	LOST CORE	LOST CORE	LOST CORE	LOST CORE	
6	7.5	1.15	76.667	0	0	11	6	7.15	18	18				56,75,84	Medium-Dark Grey	Mudstone				mudstone, mud filled joints
							7.15	7.5	LOST CORE	LOST CORE	LOST CORE	LOST CORE	LOST CORE	LOST CORE	LOST CORE	LOST CORE	LOST CORE	LOST CORE	LOST CORE	
7.5	10.5	3	100	0.9	30	15	7.5	10.5	18,18,14	17					Medium-Dark Grey	Mudstone				silty, flat dips rippled, fractures mud filled as above.
10.5	13.5	3	100	2.1	70.00	3	10.5	13.5	14,17,21,26,24	20					Medium-Dark Grey	Mudstone				silty, flat dips 3-5 deg, micro fractures, blockey
13.5	16.5	3	100	1.1	36.67	1	13.5	14.2	16,17	16					Medium-Dark Grey	Mudstone				
							14.2	16							Dark Grey-Black	Anthracite Coal	Mudstone	Interbedded		mud laminae, filled in fractures
							16	16.5		16.5					Dark Grey	Mudstone				organic, rippled, flat dipping
16.5	19.5	3	100	2.5	83.33	3	16.5	19.5	34,22,24,36	29					Dark Grey	Mudstone	Sandstone	Massive		trace sandstone laminae, flat dipping
19.5	22.5	3	100	2.3	76.67	5	19.5	22				Polished		76	Dark Grey	Mudstone				
							22	22.5							Medium-Dark Grey	Interlaminated Mudstone/Siltstone		Interbedded		gradual mudstone-siltstone-sandstone, rippled, flat dipping.
22.5	25.5	3	100	2.2	73.33	4	22.5	25.5	28,28,22	26					Light Grey	Interbedded Mudstone/Sandstone	Anthracite Coal	Interbedded		30% mudstone, 3% Coal
25.5	28.5	3	100	1.3	43.33	10	25.5	28.5	38,36,28,29	32.75					Light Grey	Sandstone	Mudstone	Interbedded		20% mudstone laminae, joints 85-90 deg
28.5	31.5	3	100	2.3	76.67	5	28.5	31.5	42,38,26,34	35					Light Grey	Interbedded Mudstone/Sandstone				silty mudstone, 3-5, 5-10 dips, joints slickensided 79, 77 deg
31.5	34.5	3	100	2.2	73.33	7	31.5	34.5	37,30,38,39	36					Light Grey	Interbedded Mudstone/Sandstone				Joints 85, 50, 75 deg
34.5	37.5	3	100	2.6	86.67	6	34.5	37.5	40,40,38	39.3					Light Grey	Interbedded Mudstone/Sandstone				
37.5	40.5	3	100	2.7	90.00	2	37.5	40.5	28,28,34,30	30					Light Grey	Interbedded Mudstone/Sandstone				Joint 50
40.5	43.5	3	100	2.7	90.00	4	40.5	43.5	34,28,36,38	34					Light Grey	Interbedded Mudstone/Sandstone				Joint 80
43.5	46.5	3	100	2.9	96.67	1	43.5	46.5	34,34,38,32	34.5					Light Grey	Interbedded Mudstone/Sandstone				Irregular joint 75-85
46.5	49.5	2.9	96.667	2.1	70	6	46.5	49.4	44,42,50	45.3					Dark Grey	Mudstone	Sandstone	Massive		trace sandstone vfg, joints 88-89, 55-60, minor carbonate fill 49.40m-49.50m
							49.4	49.5	LOST CORE	LOST CORE	LOST CORE	LOST CORE	LOST CORE	LOST CORE	LOST CORE	LOST CORE	LOST CORE	LOST CORE	LOST CORE	
49.5	52.5	3	100	2.3	76.67	7	49.5	52.5	44,48,46,38	44					Dark Grey	Mudstone				
52.5	55.5	3	100	1.4	46.67	10	52.5	55.5	42,38	40				60°	Dark Grey	Mudstone				fractures, faults at 60 to subvertical
55.5	58.5	3	100	1	33.33	21	55.5	58	20,24,34,26	26					Dark Grey	Mudstone				
							58	58.5							Black	Anthracite Coal				
58.5	61.5	3	100	0.2	6.67	10	58.5	61.5	0	0					Black	Anthracite Coal				
61.5	64.5	3	100	1.5	50.00	15	61.5	63.3	0	0					Black	Anthracite Coal				
							63.3	64.5							Dark Grey	Mudstone				organic, rippled,hard, irregular, sub vertical fractures and joints.

Run Depth		Core Recovery		RQD Length (Pieces >10cm) [m]	RQD length /run length x100 [%]	Number of Joints (per run)	Core Depth		Schmidt Hammer Tests		Joint Details				Colour	Major Lithology	Minor Lithology	Bedding Type	Features	Comments
From [m]	To [m]	Rec. [m]	Rec. [%]				From [m]	To [m]	Test 'R' Values	Avg 'R' Value	Geometry	Roughness	Spacing	Joint Angle [°]						
64.5	67.5	3	100	2.6	86.67	8	64.5	67	28,39,32	33					Dark Grey	Mudstone				
							67	67.5	36,36	36					Light Grey	Sandstone	Mudstone			minor dark grey mud, some faulting irregular sub vertical joints.
67.5	70.5	3	100	1.7	56.67	10	67.5	70.5	37,35,34,24	32.5					Light Grey	Sandstone				Hard, subvertical joints, with silaceous -carbonaceous secoundary mineralization infill.
70.5	73.5	3	100	1.7	56.67	15	70.5	71.2	20,28,32,30	27.5					Light Grey	Sandstone				
							71.2	73.5							Dark Grey	Mudstone	Sandstone	n/a		trace sandstone vfgrain, silty, some fractures and sub-vertical joints with mud, some slickensides.
73.5	76.5	3	100	2	66.67	6	73.5	76.5	30,24,24,24	25.5					Dark Grey	Mudstone				sub vertical irregular joints filled with Quart.
76.5	79.5	3	100	2.1	70.00	5	76.5	77.7	24,24	24					Dark Grey	Mudstone				Faulted zone 76.20m-77.30m , slickensided, some silicious mineralization infill.
							77.7	79.5	20,30	25					Light Grey	Sandstone				vfg silty, hard, laminated, trace dark grey mudstone, some fractures and subvertical irregular joints, some quartize
79.5	82.5	3	100	2.6	86.67	4	79.5	82.5	28,24,20,26	24.5					Light Grey	Sandstone				
82.5	85.5	2.6	86.667	2.4	80.00	1	82.5	82.9	LOST CORE	LOST CORE	LOST CORE	LOST CORE	LOST CORE	LOST CORE	LOST CORE	LOST CORE	LOST CORE	LOST CORE	LOST CORE	LOST CORE
							82.9	83.65	22,14,14,12	15.5					Dark Grey	Mudstone	Sandstone			common sandstone, then mm interbeds, hard
							83.65	85.4	22,23,26	23.6					Light Grey	Sandstone	Mudstone			silty, vfgrain, with common mud stone, coarser sandstone at bottom, hard, joint with rough surfaces.
							85.4	85.5	16,10,14	13.3					Light Grey	Sandstone				silty vfg, with mudstone, hard.
85.5	88.5	3	100	2.95	98.33	2	85.5	87.5	16,13,11,25	16.25					Light Grey	Sandstone				
							87.5	87.9	12,14	13					Dark Grey	Mudstone		Interbedded		
							87.9	88.5	19,22	20.5					Light Grey	Sandstone				silty, occasional dark grey mud, hard

TERRACON GEOTECHNIQUE

CLIENT: Arctos Anthracite Joint Venture

PROJECT NUMBER: 122781

HOLE ID: GP-09/MW-22d

PROJECT LOCATION: Arctos Anthracite Property

STARTED: August 26, 2013 COMPLETED: August 28, 2013

DRILL CONTRACTOR: Driftwood RIG #:

HOLE SIZE: HQ

DRILLING METHOD: Diamond

LOGGED BY: Shane Lyons/G: CHECKED BY:

Ground Elevation [masl] 1520

Easting 508890.0

Northing 6344129.0

Water Table Depth [m]

Total Depth [m] 101.00m

COMMENTS:

Run Depth		Core Recovery		RQD Length (Pieces >10cm) [m]	RQD length /run length x100 [%]	Number of Joints (per run)	Core Depth		Schmidt Hammer Tests		Joint Details				Colour	Major Lithology	Minor Lithology	Bedding Type	Features	Comments
From [m]	To [m]	Rec. [m]	Rec. [%]				From [m]	To [m]	Test 'R' Values	Avg 'R' Value	Geometry	Roughness	Spacing	Joint Angle [°]						
0.00	2.00	0.35	17.50	0.00	0.00	0.00	0.00	0.15	0	0	-	-	-	-	Dark Brown	Overburden	n/a	n/a	Organics	Dark brown muskeg soil with abundant rootlets and organics present. (PT)
							0.15	0.35							Brown	Clay	n/a	Massive	-	Brown massive silty clay. (CL) SAMPLE # 130428
							0.35	2.00	LOST CORE	LOST CORE	LOST CORE	LOST CORE	LOST CORE	LOST CORE	LOST CORE	LOST CORE	LOST CORE	LOST CORE	LOST CORE	LOST CORE
2.00	3.50	0.30	20.00	0.00	0.00	0.00	2.00	2.30	0	0	-	-	-	-	Brown-Grey	Glacial Till	n/a	n/a	Clasts-Assorted	Oxidized brownish grey clasts of fine grained sandstone. (GP)
							2.30	3.50	LOST CORE	LOST CORE	LOST CORE	LOST CORE	LOST CORE	LOST CORE	LOST CORE	LOST CORE	LOST CORE	LOST CORE	LOST CORE	LOST CORE
3.50	5.00	0.50	33.33	0.00	0.00	0.00	3.50	4.50	LOST CORE	LOST CORE	LOST CORE	LOST CORE	LOST CORE	LOST CORE	LOST CORE	LOST CORE	LOST CORE	LOST CORE	LOST CORE	LOST CORE
							4.50	5.00	0	0	-	-	-	-	Dark Grey	Glacial Till	n/a	n/a	Clasts-Assorted	Dark grey clayey sand matrix with angular fine grained sand clasts (up to 2cm). (GC)
5.00	6.50	0.65	43.33	0.00	0.00	0.00	5.00	5.85	LOST CORE	LOST CORE	LOST CORE	LOST CORE	LOST CORE	LOST CORE	LOST CORE	LOST CORE	LOST CORE	LOST CORE	LOST CORE	LOST CORE
							5.85	6.50	5, 15	10	-	-	-	-	Dark Grey	Glacial Till	n/a	n/a	Clasts-Assorted	Dark grey clayey sand and sandy clay matrix with assorted sandstone and mudstone clasts (up to 5cm). (GC)
6.50	8.00	0.20	13.33	0.00	0.00	0.00	6.50	6.70	0	0	-	-	-	-	Dark Grey	Glacial Till	n/a	n/a	Clasts-Assorted	Dark grey clayey sand and sandy clay matrix with assorted sandstone and mudstone clasts (up to 5cm). (GC)
							6.70	8.00	LOST CORE	LOST CORE	LOST CORE	LOST CORE	LOST CORE	LOST CORE	LOST CORE	LOST CORE	LOST CORE	LOST CORE	LOST CORE	LOST CORE
8.00	9.50	0.30	20.00	0.00	0.00	0.00	8.00	8.30	0	0	-	-	-	-	Brown-Grey	Glacial Till	n/a	n/a	Clasts-Assorted	Oxidized brownish grey clasts of fine grained sandstone and siltstone. (GP)
							8.30	9.50	LOST CORE	LOST CORE	LOST CORE	LOST CORE	LOST CORE	LOST CORE	LOST CORE	LOST CORE	LOST CORE	LOST CORE	LOST CORE	LOST CORE
9.50	11.00	0.75	50.00	0.12	8.00	1.00	9.50	9.55							Brown-Grey	Glacial Till	n/a	n/a	Clasts-Assorted	Oxidized brownish grey clasts of fine grained sandstone and siltstone. (GP)
							9.55	10.25	14, 5	9.5	Planar	Slightly Rough	Isolated (6->12cm)	30°	Black	Interbedded Anthracite/Mudstone	n/a	Interbedded	Pyrite	Black interbedded anthracite and silty mudstone with occasional pyrite and rare quartz veins (mm scale)
							10.25	11.00	LOST CORE	LOST CORE	LOST CORE	LOST CORE	LOST CORE	LOST CORE	LOST CORE	LOST CORE	LOST CORE	LOST CORE	LOST CORE	LOST CORE
11.00	12.50	0.60	40.00	0.00	0.00	1.00	11.00	11.60	0	0	Irregular	Smooth	Isolated (6->12cm)	50°	Black	Interbedded Siltstone/Coal	n/a	Interbedded	Quartz Stringers	Black interbedded siltstone and coal with occasional quartz stringers and rare pyrite nodules.
							11.60	12.50	LOST CORE	LOST CORE	LOST CORE	LOST CORE	LOST CORE	LOST CORE	LOST CORE	LOST CORE	LOST CORE	LOST CORE	LOST CORE	LOST CORE
12.50	14.00	0.70	46.67	0.00	0.00	0.00	12.50	13.20	0	0	-	-	-	-	Black	Interbedded Siltstone/Coal	n/a	Interbedded	Quartz Stringers	Black interbedded siltstone and coal with common quartz stringers and rare pyrite nodules.
							13.20	14.00	LOST CORE	LOST CORE	LOST CORE	LOST CORE	LOST CORE	LOST CORE	LOST CORE	LOST CORE	LOST CORE	LOST CORE	LOST CORE	LOST CORE
14.00	15.50	1.35	90.00	0.40	26.67	0.00	14.00	15.35	19, 18	18.5	-	-	-	-	Black	Interbedded Anthracite/Mudstone	Siltstone	Flaser Bedding	Quartz Stringers	Black interbedded mudstone and anthracite with a minor siltstone bed (10cm) and occasional quartz stringers.
							15.35	15.50	LOST CORE	LOST CORE	LOST CORE	LOST CORE	LOST CORE	LOST CORE	LOST CORE	LOST CORE	LOST CORE	LOST CORE	LOST CORE	LOST CORE
15.50	17.00	1.10	73.33	0.00	0.00	1.00	15.50	16.60	0	0	Irregular	Smooth	Isolated (6->12cm)	50°	Black	Interbedded Anthracite/Mudstone	Siltstone	Interbedded	Quartz Stringers	Black anthracite/graphite with common interbeds and occasional clasts of siltstone and common quartz stringers. High angle easily fractured cleavage planes (up to 90 degrees) with highly polished cleavage surfaces.
							16.60	17.00	LOST CORE	LOST CORE	LOST CORE	LOST CORE	LOST CORE	LOST CORE	LOST CORE	LOST CORE	LOST CORE	LOST CORE	LOST CORE	LOST CORE

Run Depth		Core Recovery		RQD Length (Pieces >10cm) [m]	RQD length /run length x100 [%]	Number of Joints (per run)	Core Depth		Schmidt Hammer Tests		Joint Details				Colour	Major Lithology	Minor Lithology	Bedding Type	Features	Comments
From [m]	To [m]	Rec. [m]	Rec. [%]				From [m]	To [m]	Test 'R' Values	Avg 'R' Value	Geometry	Roughness	Spacing	Joint Angle [°]						
17.00	18.50	1.35	90.00	0.12	8.00	0.00	17.00	17.75	10, 13	11.5	-	-	-	-	Black	Anthracite Coal	Mudstone	Interbedded	Quartz Stringers	Black unconsolidated anthracite with common dissemintated carbonaceous mud throughout, occasional quartz stringers, and rare pyrite nodules.
							17.75	18.35							Black	Anthracite Coal	n/a	Massive	Quartz Stringers	Black massive anthracite with occasional quartz stringers and occasional pyrite.
							18.35	18.50	LOST CORE	LOST CORE	LOST CORE	LOST CORE	LOST CORE	LOST CORE	LOST CORE	LOST CORE	LOST CORE	LOST CORE	LOST CORE	LOST CORE
18.50	20.00	1.35	90.00	0.95	63.33	2.00	18.50	19.85	14, 11	12.5	Planar	Smooth	Isolated (6->12cm)	50°, 20°	Black	Siltstone	n/a	Massive	Quartz Vein(s) mm scale	Black massive carbonaceous foliated siltstone with occasional quartz veins (mm scale).
							19.85	20.00	LOST CORE	LOST CORE	LOST CORE	LOST CORE	LOST CORE	LOST CORE	LOST CORE	LOST CORE	LOST CORE	LOST CORE	LOST CORE	LOST CORE
20.00	21.50	1.50	100.0	0.95	63.3	0	20.00	21.50	26, 24	25	-	-	-	-	Black	Siltstone	n/a	Massive	Quartz Vein(s) mm scale	Black massive carbonaceous siltstone with rare quartz veins (mm scale)
21.50	23.00	1.40	93.33	0.65	43.33	1.00	21.50	22.90	20, 18	19	Curved	Striated	Isolated (6->12cm)	30°	Black	Siltstone	n/a	Massive	Quartz Vein(s) mm scale	Black massive carbonaceous siltstone with rare quartz veins (mm scale).
							22.90	23.00	LOST CORE	LOST CORE	LOST CORE	LOST CORE	LOST CORE	LOST CORE	LOST CORE	LOST CORE	LOST CORE	LOST CORE	LOST CORE	LOST CORE
23.00	24.50	1.50	100.0	1.08	72.0	1	23.00	24.50	10, 10	10	Planar	Striated	Isolated (6->12cm)	10°	Black	Siltstone	n/a	Massive	Quartz Stringers	Black massive carbonaceous siltstone with rare quartz stringers (mm scale).
24.50	26.00	1.50	100.0	1.46	97.3	0	24.50	26.00	26, 26	26	-	-	-	-	Black	Siltstone	n/a	Massive	Quartz Stringers	Black massive carbonaceous siltstone with rare quartz stringers (mm scale).
26.00	27.50	1.50	100.0	1.35	90.0	0	26.00	27.50	12, 11	11.5	-	-	-	-	Dark Grey	Siltstone	n/a	Massive	-	Dark grey massive siltstone.
27.50	29.00	1.15	76.67	1.15	76.67	0.00	27.50	28.65	28, 33	30.5	-	-	-	-	Dark Grey	Siltstone	n/a	Massive	-	Dark grey massive siltstone.
							28.65	29.00	LOST CORE	LOST CORE	LOST CORE	LOST CORE	LOST CORE	LOST CORE	LOST CORE	LOST CORE	LOST CORE	LOST CORE	LOST CORE	LOST CORE
29.00	30.50	1.41	94.00	1.41	94.00	0.00	29.00	30.41	38,43	40.5	-	-	-	-	Dark Grey	Siltstone	Sandstone	Interlaminated	-	Dark grey siltstone beds (cm to dm scale) with occasional light grey very fine grained sandstone laminations (lamination to mm scale).
							30.41	30.50	LOST CORE	LOST CORE	LOST CORE	LOST CORE	LOST CORE	LOST CORE	LOST CORE	LOST CORE	LOST CORE	LOST CORE	LOST CORE	LOST CORE
30.50	32.00	1.48	98.67	1.48	98.67	0.00	30.50	31.98	28,27	27.5	-	-	-	-	Dark Grey	Siltstone	Sandstone	Interbedded	-	Dark grey siltstone (cm scale) interbedded with light grey fine to very fine sandstone (mm scale).
							31.98	32.00	LOST CORE	LOST CORE	LOST CORE	LOST CORE	LOST CORE	LOST CORE	LOST CORE	LOST CORE	LOST CORE	LOST CORE	LOST CORE	LOST CORE
32.00	33.50	1.43	95.33	1.41	94.00	1.00	32.00	33.43	22,36	29	Planar	Striated	Isolated (6->12cm)	50°	Dark Grey	Siltstone	Sandstone	Interbedded	-	Dark grey siltstone (cm scale) interbedded with often irregular/deformed light grey fine to very fine sandstone interbeds and laminations (mm scale).
							33.43	33.50	LOST CORE	LOST CORE	LOST CORE	LOST CORE	LOST CORE	LOST CORE	LOST CORE	LOST CORE	LOST CORE	LOST CORE	LOST CORE	LOST CORE
33.50	35.00	1.50	100.0	0.87	58.0	3	33.50	35.00	28,25	26.5	Irregular	Slightly Rough	Isolated (6->12cm)	50°	Dark Grey	Siltstone	Sandstone	Interlaminated	-	Dark grey siltstone beds (cm to dm scale) with occasional light grey very fine grained sandstone laminations (lamination to mm scale).
											Stepped	Slightly Rough	Isolated (6->12cm)	40°	Light Grey	Clay	n/a	Massive	Carbonate	Light grey silty clay with occasional white calcareous stringers.
											Planar	Slightly Rough	Occasional (3-6cm)	50°	Medium Grey	Siltstone	Sandstone	Interlaminated	-	Grey siltstone with laminations of grey very fine grained sandstone.
35.00	36.50	1.39	92.67	1.35	90.00	1.00	35.00	36.39	22,36	29	Curved	Polished	Occasional (3-6cm)	10°	Medium Grey	Siltstone	Sandstone	Interbedded	Quartz Stringers	Grey sandy siltstone interbedded with grey silty sandstone and occasional quarzt stringers.
							36.39	36.50	LOST CORE	LOST CORE	LOST CORE	LOST CORE	LOST CORE	LOST CORE	LOST CORE	LOST CORE	LOST CORE	LOST CORE	LOST CORE	LOST CORE
36.50	38.00	1.48	98.67	1.34	89.33	1.00	36.50	37.98	13,34	23.5	Planar	Striated	Isolated (6->12cm)	10°	Medium Grey	Siltstone	n/a	Interbedded	Quartz Stringers	Grey siltstone with rare quartz stringers.
							37.98	38.00	LOST CORE	LOST CORE	LOST CORE	LOST CORE	LOST CORE	LOST CORE	LOST CORE	LOST CORE	LOST CORE	LOST CORE	LOST CORE	LOST CORE
38.00	39.50	1.48	98.67	1.48	98.67	1.00	38.00	39.48	21,29	25	Irregular	Very Rough	Isolated (6->12cm)	10°	Medium-Dark Grey	Siltstone	n/a	Massive	Quartz Stringers	Dark grey siltstone with rare quartz stringers.
							39.48	39.50	LOST CORE	LOST CORE	LOST CORE	LOST CORE	LOST CORE	LOST CORE	LOST CORE	LOST CORE	LOST CORE	LOST CORE	LOST CORE	LOST CORE
39.50	41.00	1.45	96.67	1.23	82.00	1.00	39.50	40.95	40,22	31	Planar	Striated	Isolated (6->12cm)	30°	Light-Medium Grey	Siltstone	Sandstone	Interbedded	Quartz Stringers	Medium grey sandy siltstone grading into light grey silty sandstone with rare quartz stringers.
							40.95	41.00	LOST CORE	LOST CORE	LOST CORE	LOST CORE	LOST CORE	LOST CORE	LOST CORE	LOST CORE	LOST CORE	LOST CORE	LOST CORE	LOST CORE
41.00	42.50	1.44	96.00	1.42	94.67	0.00	41.00	42.44	26,40	33	-	-	-	-	Light-Medium Grey	Siltstone	Sandstone	Interbedded	Quartz Vein(s) mm scale	Light grey siltstone and sandstone interbedded in deformed beds and rare quartz veins, grading into medium to dark grey massive siltstone.
							42.44	42.50	LOST CORE	LOST CORE	LOST CORE	LOST CORE	LOST CORE	LOST CORE	LOST CORE	LOST CORE	LOST CORE	LOST CORE	LOST CORE	LOST CORE

Run Depth		Core Recovery		RQD Length (Pieces >10cm) [m]	RQD length /run length x100 [%]	Number of Joints (per run)	Core Depth		Schmidt Hammer Tests		Joint Details				Colour	Major Lithology	Minor Lithology	Bedding Type	Features	Comments
From [m]	To [m]	Rec. [m]	Rec. [%]				From [m]	To [m]	Test 'R' Values	Avg 'R' Value	Geometry	Roughness	Spacing	Joint Angle [°]						
42.50	44.00	1.45	96.67	0.85	56.67	2.00	42.50	43.95	19,16	17.5	Planar	Slightly Rough	Occasional (3-6cm)	10°, 85°	Medium-Dark Grey	Siltstone	Mudstone	Massive	Quartz Vein(s) mm scale	Medium grey massive siltstone grading into dark grey fissile carbonaceous mudstone with occasional quartz stringers/veins.
							43.95	44.00	LOST CORE	LOST CORE	LOST CORE	LOST CORE	LOST CORE	LOST CORE	LOST CORE	LOST CORE	LOST CORE	LOST CORE	LOST CORE	LOST CORE
44.00	45.50	1.10	73.33	0.35	23.33	0.00	44.00	45.10	20,14	17	-	-	-	-	Dark Grey-Black	Interbedded Siltstone/Coal	n/a	Interbedded	Quartz Stringers	Dark grey siltstone grading into black fissile coal with occasional quartz stringers.
							45.10	45.50	LOST CORE	LOST CORE	LOST CORE	LOST CORE	LOST CORE	LOST CORE	LOST CORE	LOST CORE	LOST CORE	LOST CORE	LOST CORE	LOST CORE
45.50	47.00	1.43	95.33	0.82	54.67	2.00	45.50	46.93	17,12	14.5	Planar	Smooth	Isolated (6->12cm)	40°, 30°	Medium Grey	Interbedded Siltstone/Coal	Mudstone	Massive	Quartz Stringers	Black coal interbedded with medium grey siltstone grading into medium grey to dark grey massive mudstone.
							46.93	47.00	LOST CORE	LOST CORE	LOST CORE	LOST CORE	LOST CORE	LOST CORE	LOST CORE	LOST CORE	LOST CORE	LOST CORE	LOST CORE	LOST CORE
47.00	48.50	1.26	84.00	0.91	60.67	1.00	47.00	48.26	10,16	13	Planar	Smooth	Occasional (3-6cm)	40°	Medium Grey	Siltstone	Mudstone	Massive	Quartz Stringers	Medium grey siltstone and mudstone with rare quartz stringers.
							48.26	48.50	LOST CORE	LOST CORE	LOST CORE	LOST CORE	LOST CORE	LOST CORE	LOST CORE	LOST CORE	LOST CORE	LOST CORE	LOST CORE	LOST CORE
48.50	50.00	1.40	93.33	0.85	56.67	0.00	48.50	49.90	12,12	12	-	-	-	-	Light-Medium Grey	Siltstone	Sandstone	Massive	Quartz Stringers	Medium grey massive siltstone grading into interbedded dark grey siltstone and light grey sandstone (both mm scale) with rare pyrite nodules and common quartz stringers.
							49.90	50.00	LOST CORE	LOST CORE	LOST CORE	LOST CORE	LOST CORE	LOST CORE	LOST CORE	LOST CORE	LOST CORE	LOST CORE	LOST CORE	LOST CORE
50.00	51.50	1.49	99.33	0.92	61.33	0.00	50.00	51.49	49,28	77	-	-	-	-	Light-Medium Grey	Sandstone	Siltstone	Interbedded	Quartz Stringers	Light grey silty fine grained sandstone interbedded with medium grey sandy siltstone (both mm to cm scale) with occasional quartz stringers.
							51.49	51.50	LOST CORE	LOST CORE	LOST CORE	LOST CORE	LOST CORE	LOST CORE	LOST CORE	LOST CORE	LOST CORE	LOST CORE	LOST CORE	LOST CORE
51.50	53.00	1.50	100.0	1.35	90.0	1	51.50	53.00	28,34	31	Irregular	Smooth	Isolated (6->12cm)	10°	Light-Medium Grey	Sandstone	Siltstone	Interbedded	Quartz Vein(s) mm scale	Light grey fine grained sandstone with rare interbeds and clasts of medium grey siltstone and occasional quartz veins. Vertical fractures 52.5-53m. Also 15cm siltstone/mudstone
53.00	54.50	1.35	90.00	1.10	73.33	0.00	53.00	54.35	28,26	27	-	-	-	-	Light Grey	Sandstone	n/a	Massive	Quartz Stringers	Light grey fine grained sandstone with occasional medium to dark grey silty mud filled fractures and occasional quartz stringers
							54.35	54.50	LOST CORE	LOST CORE	LOST CORE	LOST CORE	LOST CORE	LOST CORE	LOST CORE	LOST CORE	LOST CORE	LOST CORE	LOST CORE	LOST CORE
54.50	56.00	1.50	100.0	1.4	93.3	1	54.50	56.00	36,32	34	Planar	Slightly Rough	Isolated (6->12cm)	85°	Light Grey	Sandstone	n/a	Massive	Quartz Stringers	Light grey fine grained sandstone with occasional quartz stringers.
56.00	57.50	1.30	86.67	0.42	28.00	0.00	56.00	57.30	19,28	23.5	-	-	-	-	Light Grey	Sandstone	n/a	Massive	Quartz Stringers	Light grey fine grained heavly fractured sandstone with common quartz stringers and quartz veins. Possible fault zone.
							57.30	57.50	LOST CORE	LOST CORE	LOST CORE	LOST CORE	LOST CORE	LOST CORE	LOST CORE	LOST CORE	LOST CORE	LOST CORE	LOST CORE	LOST CORE
57.50	59.00	1.50	100.0	1	66.7	0	57.50	59.00	40,41	40.5	-	-	-	-	Light Grey	Sandstone	n/a	Massive	Quartz Stringers	Light grey fine grained sandstone with occasional quartz stringers.
59.00	60.50	1.40	93.33	1.02	68.00	0.00	59.00	60.40	20,16	18	-	-	-	-	Light-Medium Grey	Sandstone	Siltstone	Interbedded	Quartz Stringers	Light grey fine grained sandstone (cm to dm scale) interbedded with medium grey siltstone (mm to cm scale) with a potential bentonite layer at 59.3m and occasional quartz stringers throughout.
							60.40	60.50	LOST CORE	LOST CORE	LOST CORE	LOST CORE	LOST CORE	LOST CORE	LOST CORE	LOST CORE	LOST CORE	LOST CORE	LOST CORE	LOST CORE
60.50	62.00	1.45	96.67	1.00	66.67	0.00	60.50	61.95	24,20	22	-	-	-	-	Light-Medium Grey	Siltstone	Sandstone	Interbedded	Quartz Stringers	Medium grey siltstone interbedded with light grey fine to very fine grained sandstone with rare quartz stringers.
							61.95	62.00	LOST CORE	LOST CORE	LOST CORE	LOST CORE	LOST CORE	LOST CORE	LOST CORE	LOST CORE	LOST CORE	LOST CORE	LOST CORE	LOST CORE
62.00	63.50	1.50	100.0	1.5	100.0	1	62.00	63.50	22,26	24	Irregular	Very Rough	Isolated (6->12cm)	60°	Light-Medium Grey	Siltstone	Sandstone	Interbedded	Quartz Stringers	Medium grey siltstone interbedded with occasional light grey fine to very fine grained sandstone beds/lenses (mm scale) and rare quartz stringers.
63.50	65.00	1.50	100.0	1.5	100.0	0	63.50	65.00	26,22	24	-	-	-	-	Medium-Dark Grey	Siltstone	n/a	Massive	-	Medium to dark grey massive siltstone.
65.00	66.50	1.33	88.67	1.33	88.67	1.00	65.00	66.33	22,28	25	Planar	Polished	Isolated (6->12cm)	10°	Medium-Dark Grey	Siltstone	n/a	Massive	Quartz Stringers	Medium to dark grey massive siltstone with occasional quartz stringers.
							66.33	66.50	LOST CORE	LOST CORE	LOST CORE	LOST CORE	LOST CORE	LOST CORE	LOST CORE	LOST CORE	LOST CORE	LOST CORE	LOST CORE	LOST CORE
66.50	68.00	1.50	100.00	1.37	91.33	0.00	66.50	68.00	18,14	16	-	-	-	-	Medium-Dark Grey	Mudstone	Siltstone	Massive	Quartz Stringers	Medium to dark grey silty mudstone with occasional quartz stringers.
							68.00	68.00	LOST CORE	LOST CORE	LOST CORE	LOST CORE	LOST CORE	LOST CORE	LOST CORE	LOST CORE	LOST CORE	LOST CORE	LOST CORE	LOST CORE

Run Depth		Core Recovery		RQD Length (Pieces >10cm) [m]	RQD length /run length x100 [%]	Number of Joints (per run)	Core Depth		Schmidt Hammer Tests		Joint Details				Colour	Major Lithology	Minor Lithology	Bedding Type	Features	Comments
From [m]	To [m]	Rec. [m]	Rec. [%]				From [m]	To [m]	Test 'R' Values	Avg 'R' Value	Geometry	Roughness	Spacing	Joint Angle [°]						
68.00	69.50	1.41	94.00	1.32	88.00	2.00	68.00	69.41	19,14	16.5	Planar	Smooth	Isolated (6->12cm)	30°, 20°	Dark Grey	Mudstone	n/a	Massive	n/a	-
							69.41	69.50	LOST CORE	LOST CORE	LOST CORE	LOST CORE	LOST CORE	LOST CORE	LOST CORE	LOST CORE	LOST CORE	LOST CORE	LOST CORE	LOST CORE
69.50	71.00	1.50	100.0	1.54	102.7	1	69.50	71.00	16,14	15	Planar	Slightly Rough	Isolated (6->12cm)	30°	Dark Grey	Mudstone	Sandstone	Interbedded	n/a	Mudstone, 30% sandstone very fine grained, 1-2cm, over 40cm.
71.00	72.50	1.46	97.33	1.40	93.33	2.00	71.00	71.70	21,21	21	Planar	Smooth	Isolated (6->12cm)	40°	Medium-Dark Grey	Interbedded Mudstone/Sandstone	n/a	Interbedded	Quartz Stringers	Mudstone interlayered with 40% sandstone fine grained.
							71.70	72.46			Planar	Slightly Rough		80°						
							72.46	72.50	LOST CORE	LOST CORE	LOST CORE	LOST CORE	LOST CORE	LOST CORE	LOST CORE	LOST CORE	LOST CORE	LOST CORE	LOST CORE	LOST CORE
72.50	74.00	1.45	96.67	1.30	86.67	2.00	72.50	73.95	28,44	36	Planar	Smooth	Isolated (6->12cm)	30°, 70°	Medium-Dark Grey	Sandstone	Mudstone	Interbedded	Quartz Vein(s) mm scale	Sandstone, very fine- fine grain, 30% mudstone <1cm layers. Quartz along fracture surfaces.
							73.95	74.00	LOST CORE	LOST CORE	LOST CORE	LOST CORE	LOST CORE	LOST CORE	LOST CORE	LOST CORE	LOST CORE	LOST CORE	LOST CORE	LOST CORE
74.00	75.50	1.35	90.00	1.10	73.33	1.00	74.00	75.35	33,23	28	Planar	Smooth	Isolated (6->12cm)	40°	Medium-Dark Grey	Sandstone	Mudstone	Interbedded	Quartz Vein(s) mm scale	Sandstone, fine grained, trace med grained 20% mudstone <1 cm layers, vuggy Qtz carbonate veins <1cm.
							75.35	75.50	LOST CORE	LOST CORE	LOST CORE	LOST CORE	LOST CORE	LOST CORE	LOST CORE	LOST CORE	LOST CORE	LOST CORE	LOST CORE	LOST CORE
75.50	77.00	1.50	100.0	1.32	88.0	2	75.50	76.35	25,19	22	Planar	Slightly Rough	Isolated (6->12cm)	80°	Medium Grey	Sandstone	Mudstone	Interbedded	Quartz Vein(s) mm scale	Sandstone, fine grained, 5% mudstone mm.
							76.35	77.00			n/a	n/a	n/a	n/a	Dark Grey	Mudstone	Sandstone	Massive	Quartz Vein(s) mm scale	Mudstone, trace sandstone interlayered initially, then massive.
77.00	78.50	1.40	93.33	0.60	40.00	0.00	77.00	77.32	16,18	17	Planar	Smooth	Occasional (3-6cm)	50°	Dark Grey	Mudstone	-	Massive	Quartz Stringers	-
							77.32	78.20			Planar	Smooth		60°	Black	Anthracite Coal	-	Massive	Quartz Stringers	Upper coal contactact 30 deg, trace Qtz stringers
							78.20	78.40			n/a	n/a	n/a	n/a	Dark Grey	Mudstone	-	Massive	-	Lower coal contact 30 deg
							78.40	78.50	LOST CORE	LOST CORE	LOST CORE	LOST CORE	LOST CORE	LOST CORE	LOST CORE	LOST CORE	LOST CORE	LOST CORE	LOST CORE	LOST CORE
78.50	80.00	1.50	100.0	1.5	100.0	2	78.50	79.75	19,22	20.5	Planar	Slightly Rough to Polished	Isolated (6->12cm)	20°, 50°	Dark Grey	Mudstone	Siltstone	Massive	-	Mudstone, 30% siltstone nodules, light grey.
80.00	81.50	1.50	100.0	1.5	100.0	0	80.00	81.50	25,22	23.5	-	-	-	-	Dark Grey	Interbedded Mudstone/Sandstone	-	Interbedded	Quartz Stringers	Mudstone and sandstone, very fine grain, trace coal stringers.
81.50	83.00	1.45	96.67	1.45	96.67	0.00	81.50	82.95	28,24	26	-	-	-	-	Medium-Dark Grey	Sandstone	Mudstone	Interbedded	-	Sandstone, fine grained, 20% wavey mudstone, mm thickness.
							82.95	83.00	LOST CORE	LOST CORE	LOST CORE	LOST CORE	LOST CORE	LOST CORE	LOST CORE	LOST CORE	LOST CORE	LOST CORE	LOST CORE	LOST CORE
83.00	84.50	1.46	97.33	1.46	97.33	0.00	83.00	84.46	24,26	25	-	-	-	-	Medium-Dark Grey	Sandstone	Mudstone	Interbedded	Quartz Vein(s) mm scale	Sandstone, fine grain, 40% wavey mudstone/siltstone, mm thickness.
							84.46	84.50	LOST CORE	LOST CORE	LOST CORE	LOST CORE	LOST CORE	LOST CORE	LOST CORE	LOST CORE	LOST CORE	LOST CORE	LOST CORE	LOST CORE
84.50	86.00	1.45	96.67	1.30	86.67	1.00	84.50	85.95	33,32	32.5	Planar	Slightly Rough	Isolated (6->12cm)	40°	Medium-Dark Grey	Sandstone	Mudstone	Interbedded	-	Sandstone fine grained, 30% mudstone,
							85.95	86.00	LOST CORE	LOST CORE	LOST CORE	LOST CORE	LOST CORE	LOST CORE	LOST CORE	LOST CORE	LOST CORE	LOST CORE	LOST CORE	LOST CORE
86.00	87.50	1.42	94.67	1.42	94.67	0.00	86.00	87.42	28,22	25	-	-	-	-	Medium-Dark Grey	Sandstone	Mudstone	Massive	Pyrite	Sandstone fine grained, 20% mudstone,<5cm bands, 2cm pyrite nodule.
							87.42	87.50	LOST CORE	LOST CORE	LOST CORE	LOST CORE	LOST CORE	LOST CORE	LOST CORE	LOST CORE	LOST CORE	LOST CORE	LOST CORE	LOST CORE
87.50	89.00	1.50	100.0	0.71	47.3	0	87.50	88.15	28,24	26	-	-	-	-	Dark Grey	Mudstone	-	Massive	Quartz Vein(s) mm scale	-
							88.15	89.00			-	-	-	-	Dark Grey-Black	Interbedded Anthracite/Mudstone	-	Interbedded	Quartz Vein(s) mm scale	Mudstone, 3% coal bands <1cm.
89.00	90.50	1.40	93.33	1.40	93.33	0.00	89.00	90.40	16,24	20	-	-	-	-	Dark Grey	Mudstone	Sandstone	Interbedded	Quartz Vein(s) cm scale	Mudstone, 1% sandstone fine grained layers.
							90.40	90.50	LOST CORE	LOST CORE	LOST CORE	LOST CORE	LOST CORE	LOST CORE	LOST CORE	LOST CORE	LOST CORE	LOST CORE	LOST CORE	LOST CORE
90.50	92.00	0.95	63.33	0.15	10.00	6.00	90.50	91.45	0	0	Planar	Polished	Occasional (3-6cm)	30°	Black	Anthracite Coal	-	Massive	Quartz Stringers	Coal with trace Qtz stringers.
							91.45	92.00	LOST CORE	LOST CORE	LOST CORE	LOST CORE	LOST CORE	LOST CORE	LOST CORE	LOST CORE	LOST CORE	LOST CORE	LOST CORE	LOST CORE
92.00	93.50	1.25	83.33	0.20	13.33	3.00	92.00	93.25	0	0	Planar	Polished	Isolated (6->12cm)	30°	Dark Grey-Black	Interbedded Anthracite/Mudstone	-	Interbedded	Quartz Vein(s) mm scale	Coal, 30% mudstone
							93.25	93.50	LOST CORE	LOST CORE	LOST CORE	LOST CORE	LOST CORE	LOST CORE	LOST CORE	LOST CORE	LOST CORE	LOST CORE	LOST CORE	LOST CORE
93.50	95.00	1.5	100.0	1.37	91.3	0	93.50	95.00	26,26	26	-	-	-	-	Medium-Dark Grey	Interbedded Mudstone/Siltstone	Anthracite Coal	Interbedded	Pyrite	Mudstone with 40% siltstone interlayered, trace coal <1cm, and two 2cm Pyrite bands.
95.00	96.50	1.5	100.0	1.4	93.3	1	95.00	96.50	15,30	22.5	Planar	Smooth	Isolated (6->12cm)	85°	Medium-Dark Grey	Interbedded Mudstone/Sandstone	-	Interbedded	Quartz Vein(s) mm scale	Sandstone fine grain, 30% mudstone, 5mm bands.
96.50	98.00	1.5	100.0	1.5	100.0	0	96.50	98.00	22,27	24.5	-	-	-	-	Medium-Dark Grey	Interbedded Mudstone/Sandstone	-	Interbedded	-	Sandstone fine grain, 40% mudstone, <5mm bands.

Run Depth		Core Recovery		RQD Length (Pieces >10cm) [m]	RQD length /run length x100 [%]	Number of Joints (per run)	Core Depth		Schmidt Hammer Tests		Joint Details				Colour	Major Lithology	Minor Lithology	Bedding Type	Features	Comments
From [m]	To [m]	Rec. [m]	Rec. [%]				From [m]	To [m]	Test 'R' Values	Avg 'R' Value	Geometry	Roughness	Spacing	Joint Angle [°]						
98.00	99.50	1.46	97.33	1.46	97.33	1.00	98.00	99.46	30,32	31	Planar	Smooth	Isolated (6->12cm)	65°	Medium-Dark Grey	Interbedded Mudstone/Sandstone	-	Interbedded	-	Sandstone fine grain, 40% mudstone, <1cm bands.
							99.46	99.50	LOST CORE	LOST CORE	LOST CORE	LOST CORE	LOST CORE	LOST CORE	LOST CORE	LOST CORE	LOST CORE	LOST CORE	LOST CORE	LOST CORE
99.50	101.00	1.45	96.67	0.80	53.33	1.00	99.50	100.10	26,34	30	Irregular	Polished	Isolated (6->12cm)	50°	Medium-Dark Grey	Sandstone	-	Interbedded	-	Sandstone, fine grain, 20% mudstone <5mm.
							100.10	100.95							Dark Grey	Mudstone	-	Massive	Quartz Stringers	Mudstone, numerous Quartz stringers.
							100.95	101.00	LOST CORE	LOST CORE	LOST CORE	LOST CORE	LOST CORE	LOST CORE	LOST CORE	LOST CORE	LOST CORE	LOST CORE	LOST CORE	LOST CORE

TERRACON GEOTECHNIQUE

CLIENT:	Arctos Anthracite Joint Venture
PROJECT NUMBER:	122781
HOLE ID:	GP-10
PROJECT LOCATION:	Arctos Anthracite Property

DATE STARTED: July 15th, 2013 Completed: July 21, 2013

DRILL CONTRACTOR: Driftwood RIG #:

HOLE SIZE: HQ

DRILLING METHOD: Diamond

LOGGED BY: M.McGrath/G.McL CHECKED BY:

Ground Elevation [masl] 1545

Easting 509189.6

Northing 6344465.3

Water Table Depth [m]

Total Depth [m] 102.00m

COMMENTS:

Run Depth		Core Recovery		RQD Length (Pieces >10cm) [m]	RQD length /run length x100 [%]	Number of Joints (per run)	Core Depth		Schmidt Hammer Tests		Joint Details				Colour	Major Lithology	Minor Lithology	Features	Comments
From [m]	To [m]	Rec. [m]	Rec. [%]				From [m]	To [m]	Test 'R' Values	Avg 'R' Value	Geometry	Roughness	Spacing	Joint Angle [°]					
0.00	1.50	0.00	0.00	0.00	0.00		0.00	1.50	LOST CORE	LOST CORE	LOST CORE	LOST CORE	LOST CORE	LOST CORE	LOST CORE	LOST CORE	LOST CORE	LOST CORE	LOST CORE
1.50	3.00	0.80	53.33	0.00	0.00		1.50	2.20	LOST CORE	LOST CORE	LOST CORE	LOST CORE	LOST CORE	LOST CORE	LOST CORE	LOST CORE	LOST CORE	LOST CORE	LOST CORE
							2.20	2.60							Brown-Grey	Glacial Till		Clasts-Assorted	Glacial material: damp, silty mud and angular to rounded pebble to cobble sized clasts
							2.60	3.00							Light grey - Grey	Glacial Till		Clasts-Assorted	Weathered bedrock: grey silty mud, very fine-fine grained, sub-angular to angular sandstone clasts. Some grey-dark grey laminated silty mud clasts.
3.00	4.50	0.70	46.67	0.00	0.00		3.00	3.80	LOST CORE	LOST CORE	LOST CORE	LOST CORE	LOST CORE	LOST CORE	LOST CORE	LOST CORE	LOST CORE	LOST CORE	LOST CORE
							3.80	4.50							Light Grey	Glacial Till		Clasts-Assorted	Weathered bedrock: grey silty mud, very fine-fine grained, sub-angular to angular sandstone clasts. Some grey-dark grey laminated silty mud clasts.
4.50	6.00	0.25	16.67	0.00	0.00		4.50	4.75							Light Grey	Glacial Till		Clasts-Assorted	Weathered bedrock: grey silty mud, very fine-fine grained, sub-angular to angular sandstone clasts. Some grey-dark grey laminated silty mud clasts.
							4.75	6.00	LOST CORE	LOST CORE	LOST CORE	LOST CORE	LOST CORE	LOST CORE	LOST CORE	LOST CORE	LOST CORE	LOST CORE	LOST CORE
6.00	7.50	1.30	86.67	0.00	0.00		6.00	6.20	LOST CORE	LOST CORE	LOST CORE	LOST CORE	LOST CORE	LOST CORE	LOST CORE	LOST CORE	LOST CORE	LOST CORE	LOST CORE
							6.20	6.80							Light Grey	Sandstone		Clasts-Assorted	Weathered bedrock: grey silty mud, very fine-fine grained, sub-angular to angular sandstone clasts. Some grey-dark grey laminated silty mud clasts.
							6.80	7.50							Dark Grey	Sandstone and Mudstone	Anthracite Coal	Clasts-Assorted	Dark grey organic mud, with abundant coal, sandstone and mudstone fragments/clasts. Some quartz infilled fractures in the clasts. Probable shear zone
7.50	9.00	0.60	40.00	0.00	0.00		7.50	7.90							Dark Grey	Sandstone and Mudstone	Anthracite Coal	Clasts-Assorted	Dark grey organic mud, with abundant coal, sandstone and mudstone fragments/clasts. Some quartz infilled fractures in the clasts. Probable shear zone
							7.90	8.10							Medium Grey	Sandstone and Mudstone	Anthracite Coal	Clasts-Assorted	Grey, silty mud with abundant mudstone/siltstone. Fractured, angular to sub-angular to subrounded clasts and occasional coal fragments. Probable shear zone, some quartz infilled fractures in clasts.
							8.10	9.00	LOST CORE	LOST CORE	LOST CORE	LOST CORE	LOST CORE	LOST CORE	LOST CORE	LOST CORE	LOST CORE	LOST CORE	LOST CORE
9.00	10.50	1.50	100.00	0.00	0.00		9.00	10.50							Dark Grey	Sandstone and Mudstone	Anthracite Coal	Clasts-Assorted	Dark grey mudstone clasts, light grey siltstone and very fine grained sandstone clasts. Some soft grey mud and trace coal fragments. Very broken material with lots of slickensides. Probable shear zone.

Run Depth		Core Recovery		RQD Length (Pieces >10cm) [m]	RQD length /run length x100 [%]	Number of Joints (per run)	Core Depth		Schmidt Hammer Tests		Joint Details				Colour	Major Lithology	Minor Lithology	Features	Comments
From [m]	To [m]	Rec. [m]	Rec. [%]				From [m]	To [m]	Test 'R' Values	Avg 'R' Value	Geometry	Roughness	Spacing	Joint Angle [°]					
10.50	12.00	0.40	26.67	0.00	0.00		10.50	10.90							Dark Grey	Sandstone and Mudstone	Anthracite Coal	Clasts-Assorted	Dark grey mudstone clasts, light grey siltstone and very fine grained sandstone clasts. Some soft grey mud and trace coal fragments. Very broken material with lots of slickensides; Mud infilled joints, Qz infilled fractures. Probable shear zone.
							10.90	12.00	LOST CORE	LOST CORE	LOST CORE	LOST CORE	LOST CORE	LOST CORE	LOST CORE	LOST CORE	LOST CORE	LOST CORE	LOST CORE
12.00	15.00	1.10	36.67	0.00	0.00	5.00	12.00	13.90	LOST CORE	LOST CORE	LOST CORE	LOST CORE	LOST CORE	LOST CORE	LOST CORE	LOST CORE	LOST CORE	LOST CORE	LOST CORE
							13.90	15.00			Irregular	Smooth		25°, 60° - 90°	Dark Grey	Sandstone and Mudstone	Anthracite Coal	Clasts-Assorted	Dark grey mudstone clasts, light grey siltstone and very fine grained sandstone clasts. Some soft grey mud and trace coal fragments. Very broken material with lots of slickensides. Probable shear zone.
15.00	18.00	0.30	10.00	0.00	0.00		15.00	15.30							Dark Grey	Sandstone and Mudstone	Anthracite Coal	Clasts-Assorted	Dark grey mudstone clasts, light grey siltstone and very fine grained sandstone clasts. Some soft grey mud and trace coal fragments. Very broken material with lots of slickensides. Probable shear zone.
							15.30	18.00	LOST CORE	LOST CORE	LOST CORE	LOST CORE	LOST CORE	LOST CORE	LOST CORE	LOST CORE	LOST CORE	LOST CORE	LOST CORE
18.00	19.50	0.90	60.00	0.00	0.00		18.00	18.60	LOST CORE	LOST CORE	LOST CORE	LOST CORE	LOST CORE	LOST CORE	LOST CORE	LOST CORE	LOST CORE	LOST CORE	LOST CORE
							18.60	19.50							Dark Grey	Sandstone and Mudstone	Anthracite Coal	Clasts-Assorted	Dark grey mudstone clasts, light grey siltstone and very fine grained sandstone clasts. Some soft grey mud and trace coal fragments. Very broken material with lots of slickensides. Probable shear zone. Stiff to hard.
19.50	21.00	1.50	100.00	0.25	16.67	2.00	19.50	21.00	0, 0	0	Irregular	Smooth		Irregular joint at 40° , one sub vertical quartz infilled joint	Dark Grey-Black	Mudstone			Dark grey-black mudstone, fractured. Some secondary mineralization (infills) broken, slickensided, disturbed. Stiff to hard.
21.00	22.50	1.50	100.00	0.70	46.67	7.00	21.00	22.50	0	0	Irregular	Smooth		Subvertical to 70° joints, quartz infills	Medium-Dark Grey	Mudstone			Grey-dark grey, laminated mudstone, stiff to hard, fractured, mud infilled fractures. Some siltstone clasts, probable shear zone. 2.5cm displacements.
22.50	24.00	1.50	100.00	0.20	13.33	7.00	22.50	24.00	0, 10	5	Irregular	Slightly Rough		Joints at 37° and ~ subvertical	Medium Grey	Siltstone			Grey laminated siltstone, fractured, hard, some soft mud, quartz infilled fractures
24.00	25.50	1.50	100.00	0.80	53.33	7.00	24.00	24.85	14, 10, 1	8	Irregular	Rough		Irregular rough surfaces, 45°-50°	Medium Grey	Siltstone			Some light grey very fine grained sandstone interbeds/laminae, fractured, joints with irregular rough surfaces, some slickensides.
							24.85	25.50	0, 0	0	Irregular	Rough		36° and sub-vertical	Light Grey	Siltstone			Light grey siltstone with occasional dark grey mudstone laminae. Some fractures with mud and quartz infill. Slickensides along mud laminae, rough irregular joint surfaces. Some sandstone laminae, weak.
25.50	27.00	1.50	100.00	0.55	36.67	10.00	25.50	27.00	24, 14, 24	21	Irregular	Rough		34°- 40° and sub-vertical joints	Light Grey	Sandstone	Siltstone	Quartz Stringers	Light grey, silty, laminated very fine grained sandstone, some quartz infilled fractures and quartz stringers. Some dark grey mud laminae.

Run Depth		Core Recovery		RQD Length (Pieces >10cm) [m]	RQD length /run length x100 [%]	Number of Joints (per run)	Core Depth		Schmidt Hammer Tests		Joint Details				Colour	Major Lithology	Minor Lithology	Features	Comments
From [m]	To [m]	Rec. [m]	Rec. [%]				From [m]	To [m]	Test 'R' Values	Avg 'R' Value	Geometry	Roughness	Spacing	Joint Angle [°]					
27.00	28.50	1.50	100.00	0.30	20.00	10.00	27.00	28.50	38, 32, 32, 26	32	Irregular	Rough to slickensided		Sub-vertical , 42°	Light Grey	Sandstone	Siltstone	Quartz Stringers	Light grey, silty, laminated very fine grained sandstone, some quartz infilled fractures and quartz stringers. Some dark grey mud laminae. Rough to slickensided irregular surfaces.
28.50	30.00	1.20	80.00	0.10	6.67	10.00	28.50	28.80	26, 26	26	Irregular	Rough to slickensided			Light Grey	Sandstone	Siltstone	Quartz Stringers	Light grey, silty, laminated very fine grained sandstone, some quartz infilled fractures and quartz stringers. Some dark grey mud laminae. Rough to slickensided irregular surfaces.
							28.80	29.70			Irregular	Rough		Sub-vertical, 55°,75°	Light Grey	Interbedded Mudstone/Sandstone	Siltstone		Interbeded, on mm-cm scale, light grey, fine grained sandstone, light grey to grey siltstone and grey to dark grey mudstone; Fractured; Hard
							29.70	30.00	LOST CORE	LOST CORE	LOST CORE	LOST CORE	LOST CORE	LOST CORE	LOST CORE	LOST CORE	LOST CORE	LOST CORE	LOST CORE
30.00	31.50	1.50	100.00	0.80	53.33	11.00	30.00	31.50	20, 19, 16, 14	17	irregular to planar	smooth		42°,60°,70°	Dark Grey	Interbedded Mudstone/Sandstone		Quartz stringers: mud clasts	Light grey, laminated, fine grained sandstone with dark grey mud laminae and clasts, fractured, high angle bedding.
31.50	33.00	1.50	100.00	0.75	50.00	8.00	31.50	33.00	0, 0	0	irregular to planar	smooth		70°	Dark Grey	Interbedded Mudstone/Sandstone		Quartz stringers: mud clasts	Light grey, laminated, fine grained sandstone with dark grey mud laminae and clasts, fractured, high angle bedding.
33.00	34.50	1.50	100.00	1.00	66.67	10.00	33.00	34.50	18, 18	18	Irregular	Rough		70°, 40°	Dark Grey	Interbedded Mudstone/Sandstone		Quartz stringers: mud clasts	Light grey, laminated, fine grained sandstone with dark grey mud laminae and clasts, fractured, high angle bedding.
34.50	36.00	1.50	100.00	0.80	53.33	13.00	34.50	36.00	14, 19	17	irregular to planar	rough-smooth surfaces, some slickensides		70°, 40°	Dark Grey	Interbedded Mudstone/Sandstone		Quartz stringers: mud clasts	Light grey, laminated, fine grained sandstone with dark grey mud laminae and clasts, fractured, high angle bedding.
36.00	37.50	1.50	100.00	0.50	33.33	14.00	36.00	37.50	13, 7	10	irregular to planar	rough-smooth surfaces, some slickensides		70°, 40°	Dark Grey	Interbedded Mudstone/Sandstone		Quartz stringers: mud clasts	Light grey, laminated, fine grained sandstone with dark grey mud laminae and clasts, fractured, high angle bedding.
37.50	39.00	1.50	100.00	0.50	33.33	8.00	37.50	38.50	33, 26	25	irregular to planar	rough-smooth surfaces, some slickensides		70°, 40°	Dark Grey	Interbedded Mudstone/Sandstone		Quartz stringers: mud clasts	Light grey, laminated, fine grained sandstone with dark grey mud laminae and clasts, fractured, high angle bedding.
							38.50	39.00							Dark Grey	Sandstone			Dark grey soft to stiff organic mud, sandstone clasts, quartz mineralization. Probable shear zone. High angle bedding/dips.
39.00	40.50	1.50	100.00	1.20	80.00	13.00	39.00	40.50	14, 18	16	irregular	rough surfaces, some filled/healed with mud.		70° to sub-vertical	Light Grey	Sandstone	Mudstone	Quartz stringers: mud clasts	Light grey, silty, fine grained sandstone, high angle bedding, some dark grey mudstone laminae, fractured, jointed. Small displacements at bottom of interval, fractured, hard.
40.50	42.00	1.50	100.00	1.25	83.33	1	40.50	42.00	10,26	18					Medium Grey	Interbedded Mudstone/Sandstone		Quartz stringers: mud clasts	Fractured and jointed, grain size decreasing with depth, core is weak, breaks appear to be mechanical
42.00	43.50	1.50	100.00	1.50	100.00	0	42.00	43.50	20,22	21					Medium Grey	Interbedded Mudstone/Sandstone		Quartz stringers: mud clasts	Fractured and jointed, grain size decreasing with depth, core is weak, breaks appear to be mechanical
43.50	45.00	1.50	100.00	1.50	100.00	2	43.50	45.00	14,16	15				65°,79°	Medium Grey	Interbedded Mudstone/Sandstone		Quartz stringers: mud clasts	Fractured and jointed with slickensided joint surfaces.
45.00	46.50	1.50	100.00	0.82	54.67	1	45.00	46.50	14,18	16				Subvertical	Medium Grey	Sandstone	Mudstone	Mud clasts	Minor presence of mudstone clasts and laminations throughout. Subvertical fractures.
46.50	48.00	1.50	100.00	0.82	54.67	2	46.50	48.00	16,16	16	irregular	smooth to slickensided		75°	Medium Grey	Sandstone		Quartz Stringers	Minor fracturing
48.00	49.50	1.50	100.00	1.50	100.00	0	48.00	49.50	24,26	25					Medium Grey	Sandstone	Mudstone		Minor fracturing and minor presence of mudstone interbeds.
49.50	51.00	1.50	100.00	1.30	86.67	0	49.50	51.00	16,22	19					Medium Grey	Sandstone	Mudstone		Fractured

Run Depth		Core Recovery		RQD Length (Pieces >10cm) [m]	RQD length /run length x100 [%]	Number of Joints (per run)	Core Depth		Schmidt Hammer Tests		Joint Details				Colour	Major Lithology	Minor Lithology	Features	Comments
From [m]	To [m]	Rec. [m]	Rec. [%]				From [m]	To [m]	Test 'R' Values	Avg 'R' Value	Geometry	Roughness	Spacing	Joint Angle [°]					
51.00	52.50	1.50	100.00	0.88	58.67	0	51.00	52.50	0,10	5					Medium Grey	Sandstone	Mudstone		Fractured
52.50	54.00	1.50	100.00	0.96	64.00	1	52.50	54.00	24,26	25				75°	Medium Grey	Sandstone	Mudstone		Fractured, one slickensided face, smooth
54.00	55.50	1.50	100.00	1.30	86.67	0	54.00	55.50	20,14	17					Medium Grey	Sandstone	Mudstone		Minor fracturing, breaks in core, potentially mechanical (weakly cemented sandstone?)
55.50	57.00	1.50	100.00	1.17	78.00	0	55.50	57.00	10,14	12					Medium Grey	Sandstone			Very minor presence of mud. Calcite present along fracture at about 56.5m. Sub-vertical to vertical fractures.
57.00	58.50	1.50	100.00	1.14	76.00	3	57.00	58.50	0	0				74°	Medium Grey	Sandstone			Subvertical to horizontal fractures
58.50	60.00	1.50	100.00	1.30	86.67	2	58.50	60.00	12,14	13	Irregular	smooth to slickensided		65°	Medium Grey	Sandstone	Mudstone	Quartz Stringers	Very minor high angle mud laminae. Minor subvertical and horizontal fractures
60.00	61.50	1.50	100.00	1.18	78.67	3	60.00	61.50	12,12	12				75°	Medium Grey	Sandstone	Mudstone		Minor high angle mud laminae, 90, 0 and subvertical fractures
61.50	63.00	1.50	100.00	1.40	93.33	2	61.50	63.00	10,10	10				79°	Medium Grey	Sandstone	Mudstone		Mudstone interbeds/laminae. Fractured at 90, 0 and sub-vertically
63.00	64.50	1.25	83.33	1.15	76.67	1.00	63.00	64.25	16,16	16		smooth to slickensided		70°	Medium Grey	Sandstone	Mudstone		Medium grey, fine to medium grained sandstone with mudstone intereds and laminae. Smooth slickensided joint measured at 70
							64.25	64.50	LOST CORE	LOST CORE	LOST CORE	LOST CORE	LOST CORE	lost core	LOST CORE	LOST CORE	LOST CORE	LOST CORE	LOST CORE
64.50	66.00	1.50	100.00	1.50	100.00	2	64.50	66.00	0,18	9				68°	Medium Grey	Sandstone	Mudstone	Quartz Stringers	Potential shear zone, fault gouge @ 64.5m-64.7m. Fractured mostly in mudstone area. Slickensided joints near/in mudstone zones, Transitions back into a medium grey, fine-medium grained sandstone with mudstone interbeds and laminae. Minor fractures in sandstone, some filled with quartz.
66.00	67.50	1.25	83.33	1.00	66.67	5.00	66.00	66.25	LOST CORE	LOST CORE	LOST CORE	LOST CORE	LOST CORE	LOST CORE	LOST CORE	LOST CORE	LOST CORE	LOST CORE	LOST CORE
							66.25	66.88	14,18	16					Medium Grey	Sandstone	Mudstone		Fine-medium grained sandstone with mud laminae. Healed joint, quartz infilled. Very minor displacement evident (mm scale) . 1 Rough joint
							66.88	67.50	0,12	6				65°	Medium-Dark Grey	Mudstone	Sandstone		Minor sandstone interbedding. Joints along bedding planes, minor horizontal and subvertical fractures
67.50	69.00	1.50	100.00	0.78	52.00	7	67.50	69.00	0	0				75°	Medium-Dark Grey	Mudstone	Sandstone		Flaser bedding present. Fractured and jointed. Grain size decreasing with depth. Fractures subvertical.
69.00	70.50	1.50	100.00	0.80	53.33	13	69.00	70.50	0	0				45°, 60°	Medium-Dark Grey	Mudstone	Sandstone		Heavily fractured, sub-vertical to horizontal fractures.
70.50	72.00	1.50	100.00	0.83	55.33	9	70.50	72.00	0	0				40°	Medium-Dark Grey	Mudstone	Siltstone		Massive mudstone, very minor occasional siltstone interbeds. Very weak, breakable by hand, highly fractured (vertical and subvertical fractures) Quartz vein ~ 1cm thick @ 71.5m appears to contain trace chlorite. Most fractures appear healed.

Run Depth		Core Recovery		RQD Length (Pieces >10cm) [m]	RQD length /run length x100 [%]	Number of Joints (per run)	Core Depth		Schmidt Hammer Tests		Joint Details				Colour	Major Lithology	Minor Lithology	Features	Comments
From [m]	To [m]	Rec. [m]	Rec. [%]				From [m]	To [m]	Test 'R' Values	Avg 'R' Value	Geometry	Roughness	Spacing	Joint Angle [°]					
72.00	73.50	1.50	100.00	0.50	33.33	2	72.00	72.15	0	0					Dark Grey-Black	Mudstone	Anthracite Coal		Mudstone with very small coal seams.
							72.15	73.50	0	0				70°-80°	Dark Grey-Black	Mudstone	Anthracite Coal	Quartz Stringers	Mudstone with abundant coal seams (mm up to 1cm thick seams) Quite dense due to mudstone content. Abundant quartz stringers, generally cross-cutting coal seams. Becomes less dense towards base of run.
73.50	75.00	1.50	100.00	0.00	0.00	8	73.50	75.00	0	0				80°-90°	Dark Grey-Black	Mudstone	Anthracite Coal	Quartz Stringers, Pyrite	Quartz stringers cross-cutting coal, some displaying "window pane" texture. Generally cubic pyrite present in mud matrix towards base of run.
75.00	76.50	1.50	100.00	0.15	10.00	15	75.00	76.50	0	0					Dark Grey-Black	Mudstone	Siltstone	Quartz Stringers, Pyrite	Minor siltstone laminae, window-pane textured quartz, cross-cutting quartz stringers. Stringy, globular pyrite in mud matrix. Minor coal present. Nearly vertical siltstone laminae within mudstone.
76.50	78.00	1.50	100.00	0.60	40.00	12	76.50	78.00	0	0		rough to smooth		40°,55°,70°	Dark Grey-Black	Interbedded Mudstone/Siltstone		Quartz Vein(s) mm scale	Thick quartz vein @ 76.95m, trace chlorite on edges of contact.
78.00	79.50	1.50	100.00	0.10	6.67	11	78.00	79.50	14,0	7					Dark Grey-Black	Interbedded Mudstone/Siltstone		Quartz Stringers	Very soft, fractured and broken. Nearly vertical joint. Joint surfaces rough-smooth. Some horizontal fractures. Minor presence of quartz.
79.50	81.00	1.50	100.00	0.90	60.00	11	79.50	81.00	0	0				80°	Dark Grey-Black	Interbedded Mudstone/Siltstone		Quartz Stringers	Siltier zones more competent that muddier zones. Fractured and jointed.
81.00	82.50	1.50	100.00	0.60	40.00	11	81.00	82.50	0	0				40°, 60°	Dark Grey-Black	Interbedded Mudstone/Siltstone		Quartz Stringers	Abundant siltstone. Bedding related quartz veins, and cross-cutting quartz veins. One vein with geode type crystal behaviour, some nodular crystals as well. Fractured subvertical.

TERRACON GEOTECHNIQUE

CLIENT: Arctos Anthracite Joint Venture
PROJECT NUMBER: 122781
HOLE ID: GP-11
PROJECT LOCATION: Arctos Anthracite Property

DATE STARTED: July 14, 2013 COMPLETED: July 15, 2013
DRILL CONTRACTOR: Driftwood RIG #:
HOLE SIZE: HQ
DRILLING METHOD: Diamond
LOGGED BY: O.Gubev/M.Mc CHECKED BY:

Ground Elevation [masl] 1585
Easting 506159.0
Northing 6344291.0
Water Table Depth [m]
Total Depth [m] 100.50m

COMMENTS:

Run Depth		Core Recovery		RQD Length (Pieces >10cm) [m]	RQD length /run length x100 [%]	Number of Joints (per run)	Core Depth		Schmidt Hammer Tests		Joint Details				Colour	Major Lithology	Minor Lithology	Bedding Type	Features	Comments
From [m]	To [m]	Rec. [m]	Rec. [%]				From [m]	To [m]	Test 'R' Values	Avg 'R' Value	Geometry	Roughness	Spacing	Joint Angle [°]						
0.00	1.50	0.50	33.33	0.00	0.00		0	1	LOST CORE	LOST CORE	LOST CORE	LOST CORE	LOST CORE	LOST CORE	LOST CORE	LOST CORE	LOST CORE	LOST CORE	LOST CORE	LOST CORE
							1	1.2	n/a	n/a	n/a	n/a	n/a	n/a	Brown	Overburden			Organics	Brown-dark brown organic soil, some rootlets, pebble to gravel sized clasts, vegetation debris; damp and soft
							1.2	1.5	n/a	n/a	n/a	n/a	n/a	n/a	Brown-Grey	Overburden			Clasts-Assorted	Brownish-grey silty clay with rock fragments. Glacial material. ***Sample from 1.4-1.5m : SPT :Sample Tag # 0130111***
1.50	3.00	0.50	33.33	0.00	0.00		1.5	2	n/a	n/a	n/a	n/a	n/a	n/a	Medium Grey	Overburden			Clasts-Assorted	Grey silty mud with angular to sub-rounded, cm-dm sized clasts; damp; soft, weathered bedrock ***Samples: SPT Sample Tag # 0130112, Core Sample from 1.80-1.95m Tag # 0130113***
							2	3	LOST CORE	LOST CORE	LOST CORE	LOST CORE	LOST CORE	LOST CORE	LOST CORE	LOST CORE	LOST CORE	LOST CORE	LOST CORE	LOST CORE
3.00	4.50	1.10	73.33	0.00	0.00	1	3	3.4	LOST CORE	LOST CORE	LOST CORE	LOST CORE	LOST CORE	LOST CORE	LOST CORE	LOST CORE	LOST CORE	LOST CORE	LOST CORE	LOST CORE
							3.4	3.7	0	0	n/a	n/a	n/a	25°,80°	Medium-Dark Grey	Overburden			Clasts-Assorted	Grey-dark grey, silty mud with pebble-gravel sized angular to sub-rounded rock fragments; damp; soft weathered bedrock
							3.7	4.5	0	0	n/a	n/a	n/a	25°	Dark Grey	Interlaminated Mudstone/Siltstone			-	Dark grey organic, laminated, silty mudstone with common cm-dm sized black coal interbeds and fragments; damp to moist; soft to hard; bed dips @ 25°, Joint @ 80°
4.50	6.00	1.20	80.00	0.00	0.00		4.5	5.7	0	0	n/a	n/a	n/a	25°	Dark Grey	Interlaminated Mudstone/Siltstone			-	Dark grey organic, laminated, silty mudstone with common cm-dm sized black coal interbeds and fragments; moist; hard; bed dips @ 25°
							5.7	6	LOST CORE	LOST CORE	LOST CORE	LOST CORE	LOST CORE	LOST CORE	LOST CORE	LOST CORE	LOST CORE	LOST CORE	LOST CORE	LOST CORE
6.00	7.50	1.50	100.00	0.00	0.00		6	7.5	0	0	n/a	n/a	n/a	n/a	Dark Grey	Interlaminated Mudstone/Siltstone			-	Dark grey organic, laminated, silty mudstone, dm-cm sized black coal; damp to moist; fractured; soft to hard
7.50	9.00	1.20	80.00	0.00	0.00	3	7.5	7.8	LOST CORE	LOST CORE	LOST CORE	LOST CORE	LOST CORE	LOST CORE	LOST CORE	LOST CORE	LOST CORE	LOST CORE	LOST CORE	LOST CORE
							7.8	8.1			n/a	n/a	n/a	n/a	Dark Grey	Interlaminated Mudstone/Siltstone			-	Dark grey organic, laminated, silty mudstone, dm-cm sized black coal; damp to moist; fractured; soft to hard
							8.1	9	0,10	5	n/a	n/a	n/a	5°,45°	Medium-Dark Grey	Interlaminated Mudstone/Siltstone			-	Grey-dark grey laminated siltstone, with grey very fine grained silty sandstone laminae, some quartz stringers and laminae; hard; 5° to planar bedding, joints at 45°; irregular, rough surfaces
9.00	10.50	1.50	100.00	1.00	66.67	1	9	10.5	10,14,17,17	14.5	n/a	n/a	n/a	13°	Medium-Dark Grey	Interlaminated Mudstone/Siltstone			-	Interlaminated grey siltstone and grey-dark grey mudstone, some fractures, trace quartz stringers; hard; bed dips ~13°; one subvertical joint
10.50	12.00	1.50	100.00	1.10	73.33	2	10.5	12	0,20,12,15	11.75	n/a	n/a	n/a	13°,15°,45°	Medium-Dark Grey	Interlaminated Mudstone/Siltstone			-	Interlaminated grey siltstone and grey-dark grey mudstone, some fractures, trace quartz stringers; hard; occasional light grey very fine grained silty laminated sandstone interbeds; bed dips ~13°-15°. Subvertical joints and fractures
12.00	13.50	1.50	100.00	1.40	93.33		12	13	16,17	16.5	n/a	n/a	n/a	5°-25°,80°	Medium-Dark Grey	Interlaminated Mudstone/Siltstone			-	Interlaminated grey siltstone and grey-dark grey mudstone; hard; 5°-25° dips, 80° subvertical joints.
							13	13.5	14,13	13.5	n/a	n/a	n/a	~25°	Light Grey	Interlaminated Mudstone/Siltstone			-	Light grey, laminated, very fine grained silty sandstone with occasional dark grey mudstone laminae; fractured, weak, shallow to 25° dips
13.50	15.00	1.50	100.00	0.30	20.00	2	13.5	15	0,0	0	n/a	n/a	n/a	~25°	Light Grey	Interlaminated Mudstone/Siltstone			-	Light grey, laminated, very fine grained silty sandstone with occasional dark grey mudstone laminae; fractured, weak to hard, some mudstone/siltstone fragments; subvertical irregular joint; with rough surfaces, ~25° dip
15.00	16.50	1.50	100.00	0.50	33.33	4	15	16.5	19,21	20	n/a	n/a	n/a	~25°	Light Grey	Interlaminated Mudstone/Siltstone			-	Light grey, laminated, very fine grained silty sandstone with occasional dark grey mudstone laminae; fractured, weak to hard, some mudstone/siltstone fragments; subvertical irregular joints with rough surfaces @ 67° subvertical joints
16.50	18.00	1.50	100.00	0.00	0.00	4	16.5	18	11,12	11.5	n/a	n/a	n/a	~5°	Light Grey	Interlaminated Mudstone/Siltstone			-	Light grey, laminated, very fine grained silty sandstone with occasional dark grey mudstone laminae; very fractured and broken, shallow dips ~5°. Mainly subvertical joints often with quartz stringers/veins; trace dark grey mudstone clasts
18.00	19.50	1.50	100.00				18	19	0	0	n/a	n/a	n/a	75°	Light Grey	Interlaminated Mudstone/Siltstone			-	Light grey, laminated, very fine grained silty sandstone very fractured and broken; 75° and subvertical joints
							19	19.5	12, 0	6	n/a	n/a	n/a	~5°,75°	Light Grey	Interlaminated Mudstone/Siltstone			-	Interlaminated light grey silty sandstone and grey-dark grey mudstone; shallow joints (~5° dip, 75° and subvertical joints)

Run Depth		Core Recovery		RQD Length (Pieces >10cm) [m]	RQD length /run length x100 [%]	Number of Joints (per run)	Core Depth		Schmidt Hammer Tests		Joint Details				Colour	Major Lithology	Minor Lithology	Bedding Type	Features	Comments
From [m]	To [m]	Rec. [m]	Rec. [%]				From [m]	To [m]	Test 'R' Values	Avg 'R' Value	Geometry	Roughness	Spacing	Joint Angle [°]						
19.50	21.00	1.50	100.00	0.90	60.00	5	19.5	21	0,20	10	n/a	n/a	n/a	~5°	Light Grey	Interlaminated Mudstone/Siltstone			Fault/Faulted	Interlaminated light grey silty sandstone and dark grey-black mudstone. Fault gouge from 19.6-19.7m. Fractured and jointed, some fractures seem bedding related @ ~5°. Joints subvertical
21.00	22.50	1.50	100.00	1.15	76.67	12	21	22.5	0	0	n/a	n/a	n/a	15°,20°,85°	Light Grey	Interlaminated Mudstone/Siltstone			-	Interlaminated light grey silty sandstone and dark grey-black mudstone. Mudstone content increases with depth. Slickensided face @ ~ 21.3m @ 85°. ~15°-20° dips along fractures/joints
22.50	24.00	0.60	40.00	0.00	0.00		22.5	23.1	n/a	n/a	n/a	n/a	n/a	20°,25°,50°	-	Mudstone			-	Highly fractured/jointed mudstone, 2 smooth slickensided faces. Minor siltstone interbedding with increasing depth. Very weathered @ 23.0m; wet, clayey gouge material. 20°-25°, 50° dips
							23.1	24	LOST CORE	LOST CORE	LOST CORE	LOST CORE	LOST CORE	LOST CORE	LOST CORE	LOST CORE	LOST CORE	LOST CORE	LOST CORE	LOST CORE
24.00	25.50	1.50	100.00	0.40	26.67	>20	24	24.3	0	0	n/a	n/a	n/a	-	Dark Grey-Black	Anthracite Coal			-	Broken up Anthracite
							24.3	25.5	0	0	n/a	n/a	n/a	~5°	Dark Grey-Black	Interbedded Anthracite/Mudstone			-	Interbedded Anthracite and mudstone, quartz stringers increasing in abundance towards the base of the run. ~5° dip
25.50	27.00	1.50	100.00	0.15	10.00	12	25.5	25.8	0	0	n/a	n/a	n/a	-	Dark Grey-Black	Interbedded Anthracite/Mudstone			-	Coal/weathered mudstone rubble (pebble sized) "Cave" marker at ~25.8m
							25.8	27	0	0	n/a	n/a	n/a	35°,40°	Dark Grey-Black	Mudstone			Quartz Stringers	Dark grey-black mudstone, fractured and jointed @ 35°-40°. 2 slickensided faces, one rough, one smooth. Coal interbedded with mudstone towards the end of the run. Quartz stringers present with coal interbeds
27.00	28.50	1.50	100.00	0.85	56.67	19	27	28.5	24,24	24	n/a	n/a	n/a	15°,25°	Dark Grey-Black	Mudstone			-	Dark grey-black mudstone. Random, sparse micro coal seams (mm scale) 27.15-27.30m - soft weathered, moist mudstone. 27.60-27.70m- soft weathered, moist mudstone. Transitioning into medium dark grey mudstone at base of
28.50	30.00	1.50	100.00	1.35	90.00	5	28.5	30	16,24,24	21.3	n/a	n/a	n/a	25°,30°,65°,70°	Medium Grey	Interbedded Mudstone/Sandstone			-	Medium grey silty sandstone with mudstone laminae. Bedding related joints dipping between 25°-30°. 1 subvertical joint measured between 65°-70°. Weathered muddy joint at 29.4m. Speckled with dark grey mud grains
30.00	31.50	1.50	100.00	1.00	66.67	11	30	31.5	14, 12	13	n/a	n/a	n/a	-	Medium Grey	Interbedded Mudstone/Sandstone			-	Medium grey silty sandstone with mudstone laminae. Sand coarsening with depth (in section 31.2-31.5m) Some flaser bedding present in finer grained sand sections with mudstone laminae. Joints generally rough, 1 very smooth
31.50	33.00	1.50	100.00	1.05	70.00	9	31.5	33	14	14	n/a	n/a	n/a	20°,70°	Medium Grey	Interbedded Mudstone/Sandstone			Mud clasts	Medium grey, fine to medium grained sandstone. A few scattered mud clasts (mm-cm scale). Joints measured at 20° and 70°. Fractures subvertical, vertical and nearly horizontal
33.00	34.50	1.50	100.00	1.30	86.67	13	33	34.5	0	0	n/a	n/a	n/a	30°	Medium Grey	Sandstone			Quartz Stringers	Medium grey, fine to medium grained sandstone; weathered joints, 3 slickensided faces measured @ 30° (rough to smooth faces). Quartz stringers present, additional joints measured @ 80°
34.50	36.00	1.50	100.00	0.13	8.67	4	34.5	36	0	0	n/a	n/a	n/a	30°	Dark Grey	Sandstone			-	Dark grey, fine-medium grained sandstone, transitions into coarse sandstone, then very coarse conglomerate, and back to fine-medium grained sandstone.
36.00	37.50	1.50	100.00	0.10	6.67	4	36	37.5	0	0	n/a	n/a	n/a	30°,70°	Dark Grey	Sandstone			-	Dark grey fine to medium grained sandstone transitioning into a very coarse grained sandstone, then into a pebbly conglomerate. Very broken up. Joints generally @ 30° and 70°. Very rough faces
37.50	39.00	1.00	66.67	0.00	0.00	5.00	37.50	38.00	LOST CORE	LOST CORE	LOST CORE	LOST CORE	LOST CORE	LOST CORE	LOST CORE	LOST CORE	LOST CORE	LOST CORE	LOST CORE	LOST CORE
							38.00	39.00	0	0	n/a	n/a	n/a	30°,70°	Dark Grey	Conglomerate			-	Dark grey pebbly conglomerate, quite weathered and broken up. Transitions into a muddy sandstone near base of run. Broken up and rubbly through transition zone. 3 slickensided faces, rough to smooth, measured @ 30° and
39.00	40.50	1.50	100.00	0.95	63.33	5	39	40.5	0	0	n/a	n/a	n/a	30°,40°,60°	Medium-Dark Grey	Sandstone		Quartz Vein(s) mm scale		Medium-dark grey sandstone, few quartz veins (mm scale). Joints measured at 30°,40° and 60°. 3 slickensided faces, smooth. Some subvertical fractures/joints
40.50	42.00	1.50	100.00	1.00	66.67	15	40.5	42	0	0	n/a	n/a	n/a	-	Medium Grey	Sandstone		Quartz Vein(s) mm scale		Medium grey fine-medium grained sandstone. Cross cutting quartz veins (mm scale), some quartz stringers. Minor mudstone laminae @ ~40.7-40.8m. Weathered at joints. Subvertical fractures and joints
42.00	43.50	1.50	100.00	1.15	76.67	11	42	43.5	0	0	n/a	n/a	n/a	30°,50°	Dark Grey	Sandstone			Quartz Stringers	Dark grey sandstone, fine-medium grained, quartz stringers throughout. Mildly weathered in sections/along joints measured at 30° and 50°. 1 smooth slickensided face measured at 50°
43.50	45.00	1.50	100.00	1.10	73.33	12	43.5	45	22,28	25	n/a	n/a	n/a	30°,50°,70°	Dark Grey	Sandstone			Quartz Stringers	Dark grey sandstone, fine-medium grained, quartz stringers throughout. Mildly weathered in sections. Some horizontal joints and a very continuous smoothly slickensided face, nearly vertical. One joint measured at 70°
45.00	46.50	1.50	100.00	1.10	73.33	15	45	46.5	26,0	13	n/a	n/a	n/a	10°,20°,40°	Dark Grey	Sandstone			Quartz Stringers	Dark grey sandstone, fine-medium grained, quartz stringers, less weathered than runs above. 2 smooth slickensided faces at 20° and 40°. Joints measured at 10°, 40° and subvertical
46.50	48.00	1.25	83.33	0.95	63.33	8.00	46.50	47.75	12,18	15	n/a	n/a	n/a	-	Dark Grey	Sandstone			Quartz Stringers	Dark grey sandstone, fine-medium grained, quartz stringers, transitions to a lighter grey fine-medium grained sandstone at around 47.6m. Subvertical joints. Some joints healed. * **Sample taken for Triaxial test from 47.6-47.8m; Sample**
							47.75	48.00	LOST CORE	LOST CORE	LOST CORE	LOST CORE	LOST CORE	LOST CORE	LOST CORE	LOST CORE	LOST CORE	LOST CORE	LOST CORE	LOST CORE
48.00	49.50	1.50	100.00	1.10	73.33	12	48	49.5	0	0	n/a	n/a	n/a	20°,40°,60°	Medium Grey	Interbedded Mudstone/Sandstone			Quartz Stringers	Medium grey fine grained sandstone, some healed joints. Transitions into a mudstone at base of run. 5 slickensided faces, 3 smooth and 2 striated with quartz present on striated surfaces
49.50	51.00	1.50	100.00	0.65	43.33	18	49.5	51	0	0	n/a	n/a	n/a	20°,30°, 40°,80°	Medium Grey	Interbedded Mudstone/Sandstone			Quartz Stringers	Medium grey fine grained sandstone interbedded/interlaminated with mudstone bedding/laminations at 20° and 30°. 10 slickensided faces, smooth to very smooth, measured at 20°,30°, 40°,80°
51.00	52.50	1.50	100.00	0.63	42.00	17	51	52.5	0	0	n/a	n/a	n/a	20°,30°	Dark Grey-Black	Interlaminated Mudstone/Siltstone			-	Dark grey-black silty mudstone (interbedded/interlaminated). Some joints are bedding related. Other joints are subvertical. Bedding related joints measured @ 20° and 30°. 12 slickensided faces, rough to

Run Depth		Core Recovery		RQD Length (Pieces >10cm) [m]	RQD length /run length x100 [%]	Number of Joints (per run)	Core Depth		Schmidt Hammer Tests		Joint Details				Colour	Major Lithology	Minor Lithology	Bedding Type	Features	Comments
From [m]	To [m]	Rec. [m]	Rec. [%]				From [m]	To [m]	Test 'R' Values	Avg 'R' Value	Geometry	Roughness	Spacing	Joint Angle [°]						
52.50	54.00	1.50	100.00	0.60	40.00	15	52.5	53	0	0	n/a	n/a	n/a		Black	Interbedded Anthracite/Mudstone			-	Black mudstone interbedded with Anthracite.
							53	53.2	0	0	n/a	n/a	n/a		Dark Grey	Sandstone			Quartz Vein(s) cm scale	Very fine-fine grained dark grey sandstone, heavily intruded by quartz veins.
							53.2	54	0	0	n/a	n/a	n/a	30°	Dark Grey-Black	Mudstone			Quartz Stringers	Dark grey-black mudstone. A few quartz stringers, and quartz veins (mm scale) present. Bedding related joints measured at 30°
54.00	55.50	0.90	60.00			8.00	54.00	54.90	0	0	n/a	n/a	n/a	-	Dark Grey-Black	Mudstone			Quartz Stringers	Dark grey-black mudstone. Numerous quartz veins (mm scale) and stringers. Very broken up, about 50cm of lost core. Weathered in areas. 5cm section heavily intruded by quartz
							54.90	55.50	LOST CORE	LOST CORE	LOST CORE	LOST CORE	LOST CORE	LOST CORE	LOST CORE	LOST CORE	LOST CORE	LOST CORE	LOST CORE	LOST CORE
55.50	57.00	1.50	100.00	0.20	13.33	12	55.5	56.3	0	0	n/a	n/a	n/a	-	Dark Grey	Mudstone			Quartz Stringers	Rubbly weathered dark grey mudstone, quartz intrusions showing window pane texture, quartz veins and stringers also present.
							56.3	57	n/a	n/a	n/a	n/a	n/a	20°,50°	Dark Grey	Mudstone			-	Dark grey mudstone with many quartz veins and stringers. 4 slickensided faces measured @ 20°, 50° and subvertical.
57.00	58.50	1.50	100.00	0.75	50.00		57	58.5	0	0	n/a	n/a	n/a	40°,60°,80°	Dark Grey	Mudstone			Quartz Stringers	Dark grey mudstone with many quartz veins and stringers. Joints measured @ 40°,60°,80° and subvertical
58.50	60.00	1.50	100.00	0.71	47.33		58.5	60	0	0	n/a	n/a	n/a	-	Dark Grey	Mudstone			Quartz Stringers	Dark grey mudstone, quartz intrusion more predominant at the beginning of the run, quartz stringers present throughout run. Interbedded Anthracite and mudstone. Joints measured @ 25°,30°,40° and subvertical. 7
60.00	61.50	1.50	100.00	0.00	0.00	>20	60	61.5	0	0	n/a	n/a	n/a	30°,60°,70°	Dark Grey-Black	Interbedded Anthracite/Mudstone			Quartz Stringers	Anthracite with minor mudstone interbeds. Quartz stringers. Very broken up, multiple slickensided faces measured @ 30°,60°,70°
61.50	63.00	1.50	100.00	0.15	10.00	15	61.5	63	0	0	n/a	n/a	n/a	30°,55°	Dark Grey-Black	Anthracite Coal			-	Anthracite. Multiple slickensided faces, measured at 30°, 55° and subvertical.
63.00	64.50	1.50	100.00	0.00	0.00	28	63	64.5	18,20	19	n/a	n/a	n/a	30°,55°	Dark Grey-Black	Anthracite Coal			-	Anthracite. Multiple slickensided faces, measured at 30°, 55° and subvertical.
64.50	66.00	1.50	100.00	0.30	20.00	28	64.5	66	26,26	26	n/a	n/a	n/a	30°,55°	Dark Grey-Black	Anthracite Coal			-	Anthracite Multiple slickensided faces, measured at 30°, 55° and subvertical.
66.00	67.50	1.20	80.00	0.70	46.67	11.00	66.00	67.20	0	0	n/a	n/a	n/a	30°,55°	Dark Grey-Black	Anthracite Coal			-	Anthracite. Multiple slickensided faces, smooth to rough, measured at 30°, 55° and subvertical.
							67.20	67.50	LOST CORE	LOST CORE	LOST CORE	LOST CORE	LOST CORE	LOST CORE	LOST CORE	LOST CORE	LOST CORE	LOST CORE	LOST CORE	LOST CORE
67.50	69.00	1.20	80.00	0.15	10.00	>20	67.50	68.70	0	0	n/a	n/a	n/a	30°,55°	Dark Grey-Black	Anthracite Coal			-	Anthracite with increasing mudstone content. Multiple slickensided faces, generally smooth, measured at 30°, 55° and subvertical.
							68.70	69.00	LOST CORE	LOST CORE	LOST CORE	LOST CORE	LOST CORE	LOST CORE	LOST CORE	LOST CORE	LOST CORE	LOST CORE	LOST CORE	LOST CORE
69.00	70.50	1.50	100.00	0.40	26.67	23	69	69.7	0	0	n/a	n/a	n/a	30°,55°	Dark Grey-Black	Anthracite Coal			-	Anthracite with increasing mudstone content. Multiple slickensided faces, generally smooth, measured at 30°, 55° and subvertical.
							69.7	70.2	0	0	n/a	n/a	n/a	-	Medium Grey	Interbedded Mudstone/Sandstone			-	Weathered contact @ 69.7m. Medium grey, fine-medium grained sanstone with mudstone interlaminae and clasts.
							70.2	70.5	0	0	n/a	n/a	n/a	20°,30°,40°	-	Interlaminated Mudstone/Siltstone			-	Interlaminated siltstone and mudstone. Some subvertical joints/fractures measured at 20°, 30° and 40°
70.50	72.00	1.50	100.00	0.71	47.33	18	70.5	72	28,28	28	n/a	n/a	n/a	30°	Dark Grey	Interbedded Mudstone/Siltstone			Quartz Stringers	Interbedded siltstone and mudstone, dark grey in colour. Rough-smooth slickensided faces. Joints at 30°. Minor quartz stringers. Microfractures throughout, generally subvertical in orientation
72.00	73.50	1.50	100.00	0.85	56.67	17	72	73.5	0	0	n/a	n/a	n/a	30°	Dark Grey	Interbedded Mudstone/Siltstone			Quartz Stringers	Interbedded siltstone and mudstone, dark grey in colour. 12 Rough-smooth slickensided faces. Joints at 30°. Minor quartz stringers. Microfractures throughout, generally subvertical in orientation. Bedding related joints
73.50	75.00	1.50	100.00	0.33	22.00	18	73.5	75	0	0	n/a	n/a	n/a	30°	Dark Grey	Interbedded Mudstone/Siltstone			Quartz Stringers	Interbedded siltstone and mudstone, dark grey in colour. 14 Rough-smooth slickensided faces. Joints at 30°. Minor quartz stringers. Microfractures throughout, generally subvertical in orientation. Bedding related joints. Broken up
75.00	76.50	1.50	100.00	0.62	41.33	20	75	76.5	0	0	n/a	n/a	n/a	30°	Dark Grey	Interbedded Mudstone/Siltstone			-	Interbedded siltstone and mudstone, dark grey in colour. 3 slickensided faces, 1 striated, 2 smooth. Joints at 30°. Minor quartz stringers. Microfractures throughout, generally subvertical in orientation. Bedding related joints. 2
76.50	78.00	1.50	100.00	0.33	22.00	20	76.5	78	20,24	22	n/a	n/a	n/a	30°	Dark Grey	Interbedded Mudstone/Siltstone			-	Interbedded siltstone and mudstone, dark grey in colour. 16 slickensided faces, some rough-smooth, a few striated. Joints at 30°. Minor quartz stringers. Microfractures throughout, generally subvertical in orientation. Bedding
78.00	79.50	1.50	100.00	0.10	6.67	20	78	78.3	n/a	n/a	n/a	n/a	n/a	30°	Dark Grey	Interbedded Mudstone/Siltstone			-	Interbedded siltstone and mudstone, dark grey in colour.
							78.3	79.5	0	0	n/a	n/a	n/a	20°,30°	Dark Grey-Black	Interbedded Anthracite/Mudstone			Quartz Vein(s) cm scale	Transition from highly quartz intruded mudstone into Anthracite. Coal is very broken up, many slickensided faces present measured at 20°-30°.
79.50	81.00	1.50	100.00	0.11	7.33	27	79.5	81	0	0	n/a	n/a	n/a	15°,20°	Dark Grey-Black	Interbedded Anthracite/Mudstone			Quartz Stringers	Anthracite interbedded with dark grey-black mudstone. Quartz stringers and 15°-20° joints.

Run Depth		Core Recovery		RQD Length (Pieces >10cm) [m]	RQD length /run length x100 [%]	Number of Joints (per run)	Core Depth		Schmidt Hammer Tests		Joint Details				Colour	Major Lithology	Minor Lithology	Bedding Type	Features	Comments
From [m]	To [m]	Rec. [m]	Rec. [%]				From [m]	To [m]	Test 'R' Values	Avg 'R' Value	Geometry	Roughness	Spacing	Joint Angle [°]						
81.00	82.50	1.50	100.00	0.85	56.67	9	81	82.5	0	0	n/a	n/a	n/a	30°,80°	Dark Grey-Black	Mudstone			Pyrite	Dark grey-black mudstone, pyrite present @ ~ 82.0m. Subvertical joint @ 80°. Other joints mostly bedding related @ ~ 30°
82.50	84.00	1.50	100.00	0.45	30.00	19	82.5	84	12,20	16	n/a	n/a	n/a	20°,30°	Dark Grey-Black	Mudstone			Quartz Stringers	Dark grey-black mudstone with siltstone interlaminae, a few quartz stringers. Some bedding related joints @ 20°-30°. Increasing siltstone content with depth. Subvertical microfractures
84.00	85.50	1.50	100.00	1.45	96.67	6	84	85.5	0	0	n/a	n/a	n/a	20,50	Medium Grey	Interbedded Mudstone/Siltstone			-	Medium grey siltstone interbedded with mudstone. Joints appear bedding related @ ~20°. One joint @ 50°. 2 rough, weathered slickensided faces.
85.50	87.00	1.50	100.00	1.32	88.00	3	85.5	87	18,24	21	n/a	n/a	n/a	20°,50°	Medium Grey	Interbedded Mudstone/Siltstone			-	Medium grey siltstone interbedded with mudstone. Joints appear bedding related @ ~20°. One joint @ 50°. 2 rough, weathered slickensided faces.
87.00	88.50	1.50	100.00	1.45	96.67	5	87	87.45	18,17	17.5	n/a	n/a	n/a		Medium-Dark Grey	Interbedded Mudstone/Sandstone			Mud clasts	Interbedded fine grained sandstone and mudstone with mud clasts and flaser bedding present.
							87.45	88.5	24,26	25	n/a	n/a	n/a		Medium Grey	Interbedded Mudstone/Sandstone			-	Medium grey sandstone, fine-medium grained, very few mudstone laminae.
88.50	90.00	1.50	100.00	0.97	64.67	3	88.5	90	14,31	22.5	n/a	n/a	n/a	25°	Medium Grey	Interbedded Mudstone/Sandstone			-	Medium grey, fine-medium grained sandstone. Minor mudstone interlaminae. Joint @ 25°
90.00	91.50	1.50	100.00	1.10	73.33	12	90	90.8	-	-	n/a	n/a	n/a	25°	Medium Grey	Interbedded Mudstone/Sandstone			-	Medium grey, fine-medium grained sandstone. Minor mudstone interlaminae. Joint @ 25°. Weathered along joints
							90.8	91.4			n/a	n/a	n/a	-		Conglomerate			-	Pebbly conglomerate, minor seams of anthracite within (mm scale)
							91.4	91.5			n/a	n/a	n/a	-	Medium Grey	Sandstone			-	Medium grey, fine-medium grained sandstone. Subvertical microfractures.
91.50	93.00	1.35	90.00	0.84	56.00	3.00	91.50	91.65	LOST CORE	LOST CORE	LOST CORE	LOST CORE	LOST CORE	LOST CORE	LOST CORE	LOST CORE	LOST CORE	LOST CORE	LOST CORE	LOST CORE
							91.65	93.00	32,46	39	Stepped	n/a	n/a	65°		Sandstone			-	SST, interlayered with cong, <20cm, <1cm, mm coal-clay laminae
93.00	94.50	1.50	100.00	0.95	63.33	4	93	94.5	24,28	26	Planar	n/a	n/a	75°		Sandstone			-	SST 1-2mm interlayered CONG <7mm with fracture, trace coal and mudstone laminae 1-2mm
94.50	96.00	1.50	100.00	1.04	69.33	5	94.50	96.00	17,14	15.5	Planar	n/a	n/a	55°, 65°, 70°	-	Sandstone			-	SST <1mm, trace coal laminae, trace MDST
96.00	97.50	1.50	100.00	1.48	98.67		96	97.5	-	-	Curved	-	n/a	85°	-	Sandstone			-	SST <1mm, trace discont. Coal and MDST, trace stress fractures along core axis <4cm <1mm wide.
97.50	99.00	1.50	100.00	0.58	38.67	10	97.5	97.87	11	11	-	-	n/a	-	-	Sandstone and Mudstone			-	SST, some MDST, fault 25cm
							97.87	99	14	14	Planar	Smooth	n/a	65°	-	Mudstone			-	MDST 75 degree contact, black
99.00	100.50	1.50	100.00	0.56	37.33	6	99	99.95	-	-	Planar	Smooth	n/a	65°, 55°	-	Mudstone			-	MDST, trace coal <.5cm
							99.95	100.5					n/a			Anthracite Coal				Faulted coal, some MDST

TERRACON GEOTECHNIQUE

CLIENT: Arctos Anthracite Joint Venture
PROJECT NUMBER: 122781

HOLE ID: GP-16/MW-25d
PROJECT LOCATION: Arctos Anthracite Property

DATE STARTED: Aug. 19, 2013 COMPLETED: August 21, 2013
DRILL CONTRACTOR: Driftwood RIG #:
HOLE SIZE: HQ
DRILLING METHOD: Diamond
LOGGED BY: G.McLearn/M. CHECKED BY:

Ground Elevation [masl] 1771
Easting 506011.0
Northing 6344355.0
Water Table Depth [m]
Total Depth [m] 72.00m

COMMENTS:

Run Depth		Core Recovery		RQD Length (Pieces >10cm) [m]	RQD length /run length x100 [%]	Number of Joints (per run)	Core Depth		Schmidt Hammer Tests		Joint Details				Colour	Major Lithology	Minor Lithology	Bedding Type	Features	Comments
From [m]	To [m]	Rec. [m]	Rec. [%]				From [m]	To [m]	Test 'R' Values	Avg 'R' Value	Geometry	Roughness	Spacing	Joint Angle [°]						
0.00	1.50	0.20	13.33	0.00	0.00		0.00	1.30	LOST CORE	LOST CORE	LOST CORE	LOST CORE	LOST CORE	LOST CORE	LOST CORE	LOST CORE	LOST CORE	LOST CORE	LOST CORE	LOST CORE
							1.30	1.50	0	0	n/a	n/a	n/a	n/a	Brown	Overburden	n/a	n/a	n/a	SM: Sandstone and siltstone pebbles.
1.50	3.00	0.25	16.67	0.00	0.00		1.50	2.75	LOST CORE	LOST CORE	LOST CORE	LOST CORE	LOST CORE	LOST CORE	LOST CORE	LOST CORE	LOST CORE	LOST CORE	LOST CORE	LOST CORE
							2.75	3.00	0	0	n/a	n/a	n/a	n/a	Brown	Overburden	n/a	Massive	n/a	SM: Sandstone, weathered, orange coloured oxidation,<8cm, hard.
3.00	4.50	0.45	30.00	0.00	0.00		3.00	4.05	LOST CORE	LOST CORE	LOST CORE	LOST CORE	LOST CORE	LOST CORE	LOST CORE	LOST CORE	LOST CORE	LOST CORE	LOST CORE	LOST CORE
							4.05	4.50	0	0	n/a	n/a	n/a	n/a	Brown-Grey	Overburden	n/a	n/a	n/a	CL: Clay, silty, trace sands, soft
4.50	6.00	0.70	46.67	0.00	0.00		4.50	5.20	0	0	n/a	n/a	n/a	n/a	Brown-Grey	Clay	n/a	Interbedded	n/a	Clay, silty, trace pebles, soft-hard, PP=1.5-4.5
							5.20	6.00	LOST CORE	LOST CORE	LOST CORE	LOST CORE	LOST CORE	LOST CORE	LOST CORE	LOST CORE	LOST CORE	LOST CORE	LOST CORE	LOST CORE
6.00	7.50	0.98	65.33	0.00	0.00		6.00	6.98	0	0	n/a	n/a	n/a	n/a	Brown-Grey	Clay	n/a	Massive	n/a	Clay,silty, trace sands, soft, weathered trace orange oxidation, pp=2.5, trace clasts pp=4.
							6.98	7.50	LOST CORE	LOST CORE	LOST CORE	LOST CORE	LOST CORE	LOST CORE	LOST CORE	LOST CORE	LOST CORE	LOST CORE	LOST CORE	LOST CORE
7.50	9.00	0.12	8.00	0.00	0.00		7.50	8.88	LOST CORE	LOST CORE	LOST CORE	LOST CORE	LOST CORE	LOST CORE	LOST CORE	LOST CORE	LOST CORE	LOST CORE	LOST CORE	LOST CORE
							8.88	9.00	0	0	n/a	n/a	n/a	n/a	Brown	Clay	n/a	Massive	n/a	Clay, silty, trace pebbles, weathered, trace orange oxidation, soft.
9.00	10.50	0.59	39.33	0.00	0.00	1.00	9.00	9.30						80°	Brown-Grey	Clay	n/a	Massive	n/a	Clay, silty, hard, pp=4.5
							9.30	9.59	0	0	Irregular	Slightly Rough	Isolated (6->12cm)		Light-Medium Grey	Sandstone	n/a	Massive	n/a	fine grain, trace clay, weathered, orange oxidation.
							9.59	10.50	LOST CORE	LOST CORE	LOST CORE	LOST CORE	LOST CORE	LOST CORE	LOST CORE	LOST CORE	LOST CORE	LOST CORE	LOST CORE	LOST CORE
10.50	12.00	1.30	86.67	0.28	18.67	2.00	10.50	10.95	15,20	17.5	Planar	Slightly Rough	Isolated (6->12cm)	60°	Medium Grey	Interbedded Mudstone/Sandstone	n/a	Interbedded	n/a	Mudstone and sandstone inter bedded, hard.
							10.95	11.80							Light-Medium Grey	Interbedded Mudstone/Sandstone	Mudstone	Interbedded	Quartz Vein(s) mm scale	Sandstone, some mudstone, bottom 10cm mudstone, massive, hard.
							11.80	12.00	LOST CORE	LOST CORE	LOST CORE	LOST CORE	LOST CORE	LOST CORE	LOST CORE	LOST CORE	LOST CORE	LOST CORE	LOST CORE	LOST CORE
12.00	13.50	1.35	90.00	0.00	0.00	3.00	12.00	12.15	LOST CORE	LOST CORE	LOST CORE	LOST CORE	LOST CORE	LOST CORE	LOST CORE	LOST CORE	LOST CORE	LOST CORE	LOST CORE	LOST CORE
							12.15	13.50	16,16	16	Planar	Slightly Rough	Isolated (6->12cm)	30°	Medium-Dark Grey	Mudstone	n/a	Massive	Quartz Vein(s) mm scale	Mudstone and sandstone inter bedded, hard, pp=4.5.
13.50	15.00	1.50	100.00	0.46	30.67	4.00	13.50	14.50	16,22	19	Curved	Smooth	Isolated (6->12cm)	50°, 30°	Dark Grey	Mudstone	n/a	Massive	Pyrite	Trace: pyrite nodule.
							14.50	15.00	LOST CORE	LOST CORE	LOST CORE	LOST CORE	LOST CORE	LOST CORE	LOST CORE	LOST CORE	LOST CORE	LOST CORE	LOST CORE	LOST CORE
15.00	16.50	1.40	93.33	0.17	11.33	4.00	15.00	16.40	22,20	21	Curved	Smooth	Isolated (6->12cm)	50°, 45°	Dark Grey	Mudstone	n/a	Massive	n/a	Hard, PP=4.5
							16.40	16.50	LOST CORE	LOST CORE	LOST CORE	LOST CORE	LOST CORE	LOST CORE	LOST CORE	LOST CORE	LOST CORE	LOST CORE	LOST CORE	LOST CORE
16.50	18.00	1.45	96.67	0.20	13.33	2.00	16.50	17.60	27,25	26	Planar	Smooth	Isolated (6->12cm)	35	Dark Grey	Mudstone	n/a	Massive	n/a	-
							17.60	17.95					Numerous (1-3cm)	n/a	Dark Grey-Black	Interbedded Anthracite/Mudstone	n/a	Interbedded	Quartz Vein(s) mm scale	Highly fractured, possible fault, trace coal in 5cm bands.
							17.95	18.00	LOST CORE	LOST CORE	LOST CORE	LOST CORE	LOST CORE	LOST CORE	LOST CORE	LOST CORE	LOST CORE	LOST CORE	LOST CORE	LOST CORE
18.00	19.50	0.35	23.33	0.00	0.00	2.00	18.00	19.15	LOST CORE	LOST CORE	LOST CORE	LOST CORE	LOST CORE	LOST CORE	LOST CORE	LOST CORE	LOST CORE	LOST CORE	LOST CORE	LOST CORE
							19.15	19.50	0	0	n/a	n/a	Isolated (6->12cm)	n/a	Dark Grey-Black	Interbedded Anthracite/Mudstone	n/a	Interbedded	Quartz Vein(s) mm scale	Mudstone, with 3-5cm coal band, fractured and poor recovery in area.
19.50	21.00	0.51	34.00	0.00	0.00	3.00	19.50	20.49	LOST CORE	LOST CORE	LOST CORE	LOST CORE	LOST CORE	LOST CORE	LOST CORE	LOST CORE	LOST CORE	LOST CORE	LOST CORE	LOST CORE
							20.49	21.00	0	0	Planar	Smooth	Isolated (6->12cm)	25	Dark Grey-Black	Mudstone	Anthracite Coal	Interbedded	n/a	19.5m-19.8m: highly fractured, coal 5%, cm layers.

Run Depth		Core Recovery		RQD Length (Pieces >10cm) [m]	RQD length /run length x100 [%]	Number of Joints (per run)	Core Depth		Schmidt Hammer Tests		Joint Details				Colour	Major Lithology	Minor Lithology	Bedding Type	Features	Comments
From [m]	To [m]	Rec. [m]	Rec. [%]				From [m]	To [m]	Test 'R' Values	Avg 'R' Value	Geometry	Roughness	Spacing	Joint Angle [°]						
21.00	22.50	1.28	85.33	0.71	47.33	2.00	21.00	21.22	LOST CORE	LOST CORE	LOST CORE	LOST CORE	LOST CORE	LOST CORE	LOST CORE	LOST CORE	LOST CORE	LOST CORE	LOST CORE	LOST CORE
							21.22	22.50	12,12	12	Planar	Slightly Rough	Isolated (6->12cm)	20°	Dark Grey	Mudstone	Sandstone	Massive	Quartz Stringers	Sandstone 10%, stringers-mm qtz , <1% coal stringers
22.50	24.00	1.14	76.00	0.54	36.00	3.00	22.50	22.86	LOST CORE	LOST CORE	LOST CORE	LOST CORE	LOST CORE	LOST CORE	LOST CORE	LOST CORE	LOST CORE	LOST CORE	LOST CORE	LOST CORE
							22.86	24.00	15,0	7.5	Irregular	Smooth	Isolated (6->12cm)	60°	Dark Grey	Mudstone	Siltstone	Massive	Pyrite	Mudstone, 5% siltstone/vfgrain sandstone, <1% coal mm beds, cm pyrite bands.
24.00	25.50	1.45	96.67	0.53	35.33	1.00	24.00	24.75	10,10	10	Irregular	Slightly Rough	Isolated (6->12cm)	70°	Dark Grey	Mudstone	n/a	Massive	Quartz Stringers	-
							24.75	25.45							Light-Medium Grey	Sandstone	n/a	Massive	Mud clasts	fine grain, trace mud clasts <2cm
							25.45	25.50	LOST CORE	LOST CORE	LOST CORE	LOST CORE	LOST CORE	LOST CORE	LOST CORE	LOST CORE	LOST CORE	LOST CORE	LOST CORE	LOST CORE
25.50	27.00	1.50	100.00	0.97	64.67	2	25.50	26.50	12,12	12	Planar	Slightly Rough	Isolated (6->12cm)	75°,60°	Light-Medium Grey	Sandstone	Mudstone	Massive	Mud clasts	Trace mm mudstone layers, dm mudstone clasts 1-2cm
27.00	28.50	1.35	90.00	0.70	46.67	1.00	27.00	27.40	24,30	27	n/a	n/a	n/a	n/a	Light Grey	Sandstone	Mudstone	Interbedded	Mud clasts	fine grain, some mudstone interlayered with depth, trace mud clasts.
							27.40	28.35			Curved	Smooth	Isolated (6->12cm)	50°	Dark Grey	Mudstone	n/a	Massive	Quartz-Carbonate	Planar-curved joint
							28.35	28.50	LOST CORE	LOST CORE	LOST CORE	LOST CORE	LOST CORE	LOST CORE	LOST CORE	LOST CORE	LOST CORE	LOST CORE	LOST CORE	LOST CORE
28.50	30.00	1.35	90.00	0.35	23.33	3.00	28.50	28.65	LOST CORE	LOST CORE	LOST CORE	LOST CORE	LOST CORE	LOST CORE	LOST CORE	LOST CORE	LOST CORE	LOST CORE	LOST CORE	LOST CORE
							28.65	30.00	0,0	0	Planar	Striated	Isolated (6->12cm)	40°	Dark Grey	Mudstone	Sandstone	Interbedded	Quartz Vein(s) mm scale	Some fine grain sandstone interbedded.
30.00	31.50	1.25	83.33	0.91	60.67	3.00	30.00	31.25	42,37	39.5	Planar	Slightly Rough	Isolated (6->12cm)	60°, 20°	Light-Medium Grey	Sandstone	Mudstone	Interbedded	Fossils	Fine grain sand, 20-30% mm mud lamili, trace qtz stingers.
							31.25	31.50	LOST CORE	LOST CORE	LOST CORE	LOST CORE	LOST CORE	LOST CORE	LOST CORE	LOST CORE	LOST CORE	LOST CORE	LOST CORE	LOST CORE
31.50	33.00	1.35	90.00	0.75	50.00	2.00	31.50	31.65	LOST CORE	LOST CORE	LOST CORE	LOST CORE	LOST CORE	LOST CORE	LOST CORE	LOST CORE	LOST CORE	LOST CORE	LOST CORE	LOST CORE
							31.65	33.00	0,0	n/a	Planar	Slightly Rough	Isolated (6->12cm)	50°	Medium-Dark Grey	Interbedded Mudstone/Sandstone		Interbedded	Quartz Vein(s) mm scale	Sandstone dm, 40% mudstone.
33.00	34.50	1.35	90.00	0.40	26.67	1.00	33.00	33.15	LOST CORE	LOST CORE	LOST CORE	LOST CORE	LOST CORE	LOST CORE	LOST CORE	LOST CORE	LOST CORE	LOST CORE	LOST CORE	LOST CORE
							33.15	34.50	0,21	21	Planar	Slightly Rough	Isolated (6->12cm)	10°	Dark Grey	Mudstone	Siltstone	Massive	Pyrite	Mudstone, 10% silts/finegrain sandstone.
34.50	36.00	1.35	90.00	0.85	56.67	1.00	34.50	34.65	LOST CORE	LOST CORE	LOST CORE	LOST CORE	LOST CORE	LOST CORE	LOST CORE	LOST CORE	LOST CORE	LOST CORE	LOST CORE	LOST CORE
							34.65	36.00	0	n/a	Irregular	Smooth	Isolated (6->12cm)	30°	Dark Grey	Mudstone	n/a	Massive	Pyrite	Mudstone, trace silts.
36.00	37.50	1.50	100.00	1	66.67	3	36.00	37.50	16,22	19	Planar	Smooth	Isolated (6->12cm)	70°, 35°	Dark Grey	Mudstone	n/a	Massive	n/a	-
37.50	39.00	1.30	86.67	0.43	28.67	12.00	37.50	37.70	LOST CORE	LOST CORE	LOST CORE	LOST CORE	LOST CORE	LOST CORE	LOST CORE	LOST CORE	LOST CORE	LOST CORE	LOST CORE	LOST CORE
							37.70	39.00	12,15	n/a	Irregular	Slightly Rough	Isolated (6->12cm)	90°	Dark Grey	Mudstone	Siltstone	-	Quartz Stringers	Minor siltstone interbedding
39.00	40.50	1.40	93.33	0.11	7.33	>20	39.00	39.40	0	0	Irregular	Striated	Abundant (<1cm)	90°	Dark Grey	Mudstone		-	n/a	-
							39.40	39.72							Dark Grey-Black	Interbedded Anthracite/Mudstone	Mudstone		Quartz Vein(s) cm scale	-
							39.72	40.05							Dark Grey	Mudstone			Quartz Stringers	-
							40.05	40.40							Dark Grey-Black	Interbedded Anthracite/Mudstone	Anthracite Coal		n/a	Massive mudstone with minor coal seams (cm scale) Quartz present in coal seams.
							40.40	40.50	LOST CORE	LOST CORE	LOST CORE	LOST CORE	LOST CORE	LOST CORE	LOST CORE	LOST CORE	LOST CORE	LOST CORE	LOST CORE	LOST CORE
40.50	42.00	1.44	96.00	1.40	93.33	2.00	40.50	40.56	LOST CORE	LOST CORE	LOST CORE	LOST CORE	LOST CORE	LOST CORE	LOST CORE	LOST CORE	LOST CORE	LOST CORE	LOST CORE	LOST CORE
							40.56	42.00	34,32	33	Irregular	Slightly Rough	Isolated (6->12cm)	60°	Dark Grey	Mudstone	Anthracite Coal	-	Quartz Stringers	Massive mudstone with trace coal seams. 5 seams (mm-cm scale). Quartz present in seams. Minor siltstone present.
42.00	43.50	1.50	100.00	0.75	50.00	10	42.00	43.07	26,39	32.5	Irregular	Slightly Rough	Isolated (6->12cm)	75°	Dark Grey	Mudstone		-	Quartz Stringers	Mudstone with minor siltstone.
							43.07	43.50							Medium Grey	Sandstone	Mudstone		Quartz Vein(s) cm scale	Very fine-fine grained sandstone with trace mudstone laminations. Large quartz vein (10cm thick)
43.50	45.00	1.40	93.33	0.80	53.33	17.00	43.50	43.60	LOST CORE	LOST CORE	LOST CORE	LOST CORE	LOST CORE	LOST CORE	LOST CORE	LOST CORE	LOST CORE	LOST CORE	LOST CORE	LOST CORE
							43.60	45.00	29,28	28.5	Irregular	Slightly Rough	Isolated (6->12cm)	10°	Medium Grey	Sandstone	Mudstone	-	Quartz Vein(s) mm scale	Very fine-fine grained sandstone with trace mudstone laminations.

Run Depth		Core Recovery		RQD Length (Pieces >10cm) [m]	RQD length /run length x100 [%]	Number of Joints (per run)	Core Depth		Schmidt Hammer Tests		Joint Details				Colour	Major Lithology	Minor Lithology	Bedding Type	Features	Comments
From [m]	To [m]	Rec. [m]	Rec. [%]				From [m]	To [m]	Test 'R' Values	Avg 'R' Value	Geometry	Roughness	Spacing	Joint Angle [°]						
45.00	46.50	1.40	93.33	0.90	60.00	6.00	45.00	45.10	LOST CORE	LOST CORE	LOST CORE	LOST CORE	LOST CORE	LOST CORE	LOST CORE	LOST CORE	LOST CORE	LOST CORE	LOST CORE	LOST CORE
							45.10	46.50	16,12	14	n/a	n/a	n/a	n/a	Medium Grey	Sandstone	Mudstone	-	Quartz Vein(s) cm scale	Very fine-fine grained sandstone with trace mudstone laminations.
46.50	48.00	1.05	70.00	0.00	0.00	>20	46.50	46.95	LOST CORE	LOST CORE	LOST CORE	LOST CORE	LOST CORE	LOST CORE	LOST CORE	LOST CORE	LOST CORE	LOST CORE	LOST CORE	LOST CORE
							46.95	48.00	0	0	Irregular	Slightly Rough	Occasional (3-6cm)	50°	Medium Grey	Sandstone	Mudstone	-	Quartz Stringers	Very fine-fine grained sandstone with trace mudstone laminations.
48.00	49.50	1.40	93.33	0.35	23.33	~20	48.00	48.10	LOST CORE	LOST CORE	LOST CORE	LOST CORE	LOST CORE	LOST CORE	LOST CORE	LOST CORE	LOST CORE	LOST CORE	LOST CORE	LOST CORE
							48.10	49.50	11,20	15.5	Planar	Slightly Rough	Isolated (6->12cm)	80°	Medium Grey	Interbedded Mudstone/Sandstone	Mudstone	-	Quartz Vein(s) cm scale	Very fine- fine grained sandstone with abundant mudstone laminations. Large quartz vein (7cm thick) at start of run.
49.50	51.00	1.40	93.33	0.90	60.00	~10	49.50	49.60	LOST CORE	LOST CORE	LOST CORE	LOST CORE	LOST CORE	LOST CORE	LOST CORE	LOST CORE	LOST CORE	LOST CORE	LOST CORE	LOST CORE
							49.60	51.00	24,28	26	Curved	Slightly Rough	Isolated (6->12cm)	60°	Medium Grey	Sandstone	Mudstone	-	Quartz Vein(s) mm scale	Very fine-fine grained sandstone, some mud clasts. Sub-vertical fractures.
51.00	52.50	1.45	96.67	1.25	83.33	6.00	51.00	51.05	LOST CORE	LOST CORE	LOST CORE	LOST CORE	LOST CORE	LOST CORE	LOST CORE	LOST CORE	LOST CORE	LOST CORE	LOST CORE	LOST CORE
							51.05	52.50	28,27	27.5	Planar	Slightly Rough	Isolated (6->12cm)	20°	Medium Grey	Sandstone	-	-	Quartz Vein(s) cm scale	Very fine-fine grained sandstone, trace mudstone laminae. Mud clasts present in some localized areas. Minor interbed of very coarse grained conglomerate from 51.26m-51.29m.
52.50	54.00	1.45	96.67	0.95	63.33	4.00	52.50	53.95	17,19	18	Planar	Slightly Rough	Isolated (6->12cm)	50°, 80°	Medium Grey	Sandstone	n/a	Massive	Mud clasts	Numerous, mm quartz sub vertical 1-2mm, trace mud clasts 1cm.
							53.95	54.00	LOST CORE	LOST CORE	LOST CORE	LOST CORE	LOST CORE	LOST CORE	LOST CORE	LOST CORE	LOST CORE	LOST CORE	LOST CORE	LOST CORE
54.00	55.50	1.42	94.67	0.35	23.33	1.00	54.00	54.08	LOST CORE	LOST CORE	LOST CORE	LOST CORE	LOST CORE	LOST CORE	LOST CORE	LOST CORE	LOST CORE	LOST CORE	LOST CORE	LOST CORE
							54.08	55.50	32,42	37	n/a	Slightly Rough	Isolated (6->12cm)	90°	Medium Grey	Sandstone	n/a	Massive	Quartz Vein(s) cm scale	Qtz vein <5cm, trace mud clast <1cm
55.50	57.00	1.32	88.00	1.20	80.00	1.00	55.50	55.68	LOST CORE	LOST CORE	LOST CORE	LOST CORE	LOST CORE	LOST CORE	LOST CORE	LOST CORE	LOST CORE	LOST CORE	LOST CORE	LOST CORE
							55.68	57.00	26,28	27	Planar	Slightly Rough	Isolated (6->12cm)	85°	Medium Grey	Sandstone	n/a	Massive	Mud clasts	Sandstone, fine grain, trace <5cm cobbles of <8mm, of sand and mud, conglomerate.
57.00	58.50	1.50	100.00	1.3	86.67	2	57.00	58.50	28,30	29	Planar	Very Rough	Isolated (6->12cm)	80°, 70°	Medium Grey	Sandstone	Conglomerate	Massive	n/a	Sandstone with 30% conglomerate <3cm clasts of mudstone and sandstone.
58.50	60.00	1.47	98.00	0.75	50.00	2.00	58.50	58.53	LOST CORE	LOST CORE	LOST CORE	LOST CORE	LOST CORE	LOST CORE	LOST CORE	LOST CORE	LOST CORE	LOST CORE	LOST CORE	LOST CORE
							58.53	60.00	30,32	31	Planar	Slightly Rough	Isolated (6->12cm)	70°	Medium Grey	Sandstone	n/a	Massive	Quartz Vein(s) mm scale	Trace mud clasts forming conglomerate <8cm band.
60.00	61.50	1.43	95.33	1.05	70.00	2.00	60.00	60.07	LOST CORE	LOST CORE	LOST CORE	LOST CORE	LOST CORE	LOST CORE	LOST CORE	LOST CORE	LOST CORE	LOST CORE	LOST CORE	LOST CORE
							60.07	61.50	20,38	29	Planar	Slightly Rough	Isolated (6->12cm)	80°	Medium Grey	Sandstone	Conglomerate	Massive	Quartz Vein(s) cm scale	also subvertical fractures
61.50	63.00	1.42	94.67	0.95	63.33	1.00	61.50	62.30	34,27	30.5	n/a	n/a	n/a	n/a	Medium-Dark Grey	Conglomerate	n/a	Massive	Quartz Vein(s) cm scale	Sandstone matrix, clasts 1-2, rounded, moderately sorted.
							62.30	62.92			Planar	Smooth	Isolated (6->12cm)	10°	Medium-Dark Grey	Sandstone	Mudstone	Interbedded	Pyrite	Sandstone-mudstone, trace conglomerate <10cm, fine grain pyrite along mudstone.
							62.92	63.00	LOST CORE	LOST CORE	LOST CORE	LOST CORE	LOST CORE	LOST CORE	LOST CORE	LOST CORE	LOST CORE	LOST CORE	LOST CORE	LOST CORE
63.00	64.50	1.25	83.33	0.15	10.00	0.00	63.00	63.25	LOST CORE	LOST CORE	LOST CORE	LOST CORE	LOST CORE	LOST CORE	LOST CORE	LOST CORE	LOST CORE	LOST CORE	LOST CORE	LOST CORE
							63.25	64.50	0	0	n/a	n/a	n/a	n/a	Dark Grey	Mudstone	n/a	Massive	Fault/Faulted	-
64.50	66.00	1.41	94.00	0.95	63.33	3.00	64.50	65.91	0	0	Planar	Smooth	Isolated (6->12cm)	20°, 70°, 55°	Dark Grey	Mudstone	n/a	Massive	Quartz Stringers	-
							65.91	66.00	LOST CORE	LOST CORE	LOST CORE	LOST CORE	LOST CORE	LOST CORE	LOST CORE	LOST CORE	LOST CORE	LOST CORE	LOST CORE	LOST CORE
66.00	67.50	1.50	100.00	1.1	73.33	1	66.00	67.50	0	0	Curved	Smooth	Isolated (6->12cm)	40°	Dark Grey	Mudstone	n/a	Massive	Quartz Stringers	-
67.50	69.00	1.15	76.67	0.20	13.33	2.00	67.50	67.80	12,23	17.5	Planar	Smooth	Isolated (6->12cm)	20°	Medium-Dark Grey	Mudstone	Siltstone	Massive	Quartz Vein(s) mm scale	20% siltstone (10cm band), 1% coal.
							67.80	68.65	12,23	17.5	Curved	Smooth	Isolated (6->12cm)	20°	Medium-Dark Grey	Mudstone	Siltstone	Massive	Quartz Vein(s) mm scale	20% siltstone (10cm band), 1% coal.
							68.65	69.00	LOST CORE	LOST CORE	LOST CORE	LOST CORE	LOST CORE	LOST CORE	LOST CORE	LOST CORE	LOST CORE	LOST CORE	LOST CORE	LOST CORE
69.00	70.50	1.40	93.33	0.25	16.67	4.00	69.00	69.10	LOST CORE	LOST CORE	LOST CORE	LOST CORE	LOST CORE	LOST CORE	LOST CORE	LOST CORE	LOST CORE	LOST CORE	LOST CORE	LOST CORE
							69.10	70.50	0	0	n/a	n/a	Occasional (3-6cm)	n/a	Dark Grey-Black	Interbedded Anthracite/Mudstone	n/a	Interbedded	Fault/Faulted	30% mudstone, mm-cm coal, possible fault.
70.50	72.00	1.43	95.33	0.65	43.33	3.00	70.50	71.93	0	0	Curved	Smooth	Isolated (6->12cm)	55°, 70°	Dark Grey-Black	Interbedded Anthracite/Mudstone	n/a	Massive	n/a	Mudstone , 10% coal stringers and bands.
							71.93	72.00	LOST CORE	LOST CORE	LOST CORE	LOST CORE	LOST CORE	LOST CORE	LOST CORE	LOST CORE	LOST CORE	LOST CORE	LOST CORE	LOST CORE

TERRACON GEOTECHNIQUE

CLIENT: Arctos Anthracite Joint Venture
PROJECT NUMBER: 122781

HOLE ID: GP-17/MW-20d
PROJECT LOCATION: Arctos Anthracite Property

DATE STARTED: August 6, 2013 COMPLETED: August 9, 2013
DRILL CONTRACTOR: Driftwood RIG #:
HOLE SIZE: HQ
DRILLING METHOD: Diamond
LOGGED BY: M.McGrath/Z.I CHECKED BY:

Ground Elevation [masl] 1637
Easting 506503.0
Northing 6344998.0
Water Table Depth [m]
Total Depth [m] 100.00m

COMMENTS:

Run Depth		Core Recovery		RQD Length (Pieces >10cm) [m]	RQD length /run length x100 [%]	Number of Joints (per run)	Core Depth		Schmidt Hammer Tests		Joint Details				Colour	Major Lithology	Minor Lithology	Bedding Type	Features	Comments
From [m]	To [m]	Rec. [m]	Rec. [%]				From [m]	To [m]	Test 'R' Values	Avg 'R' Value	Geometry	Roughness	Spacing	Joint Angle [°]						
0.00	1.50	0.30	20.00	0.11	7.33		0.00	1.20	LOST CORE	LOST CORE	LOST CORE	LOST CORE	LOST CORE	LOST CORE	LOST CORE	LOST CORE	LOST CORE	LOST CORE	LOST CORE	LOST CORE
							1.20	1.50							Brown	Overburden			Clasts-Assorted	Medium brown organic rich clay, assorted clasts
1.50	3.00	0.48	32.00	0.15	10.00		1.50	2.52	LOST CORE	LOST CORE	LOST CORE	LOST CORE	LOST CORE	LOST CORE	LOST CORE	LOST CORE	LOST CORE	LOST CORE	LOST CORE	LOST CORE
							2.52	3.00							Brown	Overburden			Clasts-Assorted	Medium brown organic rich clay, assorted clasts
3.00	4.50	0.50	33.33	0.39	26.00	2.00	3.00	3.50							Medium-Dark Grey	Sandstone			Clasts-Assorted	Medium-dark grey clay (weathered sandstone) transitioning into competent sandstone
							3.50	4.50	LOST CORE	LOST CORE	LOST CORE	LOST CORE	LOST CORE	LOST CORE	LOST CORE	LOST CORE	LOST CORE	LOST CORE	LOST CORE	LOST CORE
4.50	6.00	0.72	48.00	0.60	40.00		4.50	5.28	LOST CORE	LOST CORE	LOST CORE	LOST CORE	LOST CORE	LOST CORE	LOST CORE	LOST CORE	LOST CORE	LOST CORE	LOST CORE	LOST CORE
							5.28	6.00							Medium-Dark Grey	Clay	Sandstone		Clasts-Assorted	Clay rich, weathered sandstone (fault gouge?)
6.00	7.50	0.25	16.67	0.11	7.33		6.00	7.25	LOST CORE	LOST CORE	LOST CORE	LOST CORE	LOST CORE	LOST CORE	LOST CORE	LOST CORE	LOST CORE	LOST CORE	LOST CORE	LOST CORE
							7.25	7.50							Medium-Dark Grey	Clay	Sandstone		Clasts-Assorted	Clay rich, weathered sandstone (fault gouge?)
7.50	9.00	0.35	23.33	0.00	0.00		7.50	8.65	LOST CORE	LOST CORE	LOST CORE	LOST CORE	LOST CORE	LOST CORE	LOST CORE	LOST CORE	LOST CORE	LOST CORE	LOST CORE	LOST CORE
							8.65	9.00	18,31,35	28					Medium-Dark Grey	Clay	Sandstone		Clasts-Assorted	Clay rich, weathered sandstone (fault gouge?)
9.00	10.50	0.35	23.33	0.00	0.00	1.00	9.00	10.15	LOST CORE	LOST CORE	LOST CORE	LOST CORE	LOST CORE	LOST CORE	LOST CORE	LOST CORE	LOST CORE	LOST CORE	LOST CORE	LOST CORE
							10.15	10.50	52,53	52.5	Planar			90°	Medium-Dark Grey	Sandstone			Clasts-Assorted	Weathered rubbly sandstone
10.50	12.00	0.17	11.33	0.00	0.00		10.50	11.83	LOST CORE	LOST CORE	LOST CORE	LOST CORE	LOST CORE	LOST CORE	LOST CORE	LOST CORE	LOST CORE	LOST CORE	LOST CORE	LOST CORE
							11.83	12.00							Medium-Dark Grey	Sandstone			Clasts-Assorted	Weathered rubbly sandstone
12.00	13.50	0.52	34.67	0.00	0.00	1.00	12.00	13.25							Medium-Dark Grey	Sandstone				Weathered rubbly sandstone
							13.25	12.52			Planar	Slighty Rough	Numerous (1-3cm)	30°	Dark Grey-Black	Mudstone	Siltstone	Interbedded		Mudstone with siltstone interbeds
							12.52	13.50	LOST CORE	LOST CORE	LOST CORE	LOST CORE	LOST CORE	LOST CORE	LOST CORE	LOST CORE	LOST CORE	LOST CORE	LOST CORE	LOST CORE
13.50	15.00	1.30	86.67	0.28	18.67	>20	13.50	13.70	LOST CORE	LOST CORE	LOST CORE	LOST CORE	LOST CORE	LOST CORE	LOST CORE	LOST CORE	LOST CORE	LOST CORE	LOST CORE	LOST CORE
							13.70	15.00	0	0	Planar	Slighty Rough	Numerous (1-3cm)	20°	Dark Grey-Black	Mudstone	Siltstone	Interbedded	Oxidized/Oxidation	Heavily jointed and weathered mudstone with oxidized clays along some joints. Bedding planes almost vertical.
15.00	16.50	1.50	100.00	0.47	31.33	>20	15.00	16.50	0	0	Planar	Striated	Occasional (3-6cm)	30°	Dark Grey-Black	Mudstone	Siltstone	Interbedded		Interbedded mudstone and siltstone, bedding planes almost vertical. A few weathered joints
16.50	18.00	1.30	86.67	0.48	32.00	17.00	16.50	17.80	0	0	Planar	Slighty Rough	Isolated (6->12cm)	20°, 30°	Dark Grey-Black	Mudstone	Siltstone	Interbedded		Interbedded mudstone and siltstone, bedding planes vertical. A few weathered joints
							17.80	18	LOST CORE	LOST CORE	LOST CORE	LOST CORE	LOST CORE	LOST CORE	LOST CORE	LOST CORE	LOST CORE	LOST CORE	LOST CORE	LOST CORE
18.00	19.50	1.50	100.00	0.45	30.00	>20	18.00	19.50			Irregular	Slighty Rough	Occasional (3-6cm)	20°	Dark Grey-Black	Mudstone	Siltstone	Interbedded		Interbedded mudstone and siltstone, bedding planes vertical. A few weathered joints
19.50	21.50	1.50	75.00	0.42	21.00	>20	19.50	21.50	0	0	Planar	Slighty Rough	Occasional (3-6cm)	60°, 10°	Dark Grey-Black	Mudstone	Siltstone	Interbedded	Quartz Stringers	Interbedded mudstone and siltstone, bedding planes @ ~70°. A few weathered joints
21.50	23.00	1.50	100.00	0.27	18.00	>20	21.50	23.00	0	0	Planar	Smooth	Occasional (3-6cm)	60°, 50°	Dark Grey-Black	Mudstone	Siltstone	Interbedded	Quartz Stringers	Interbedded mudstone and siltstone, bedding planes 50°-60°.
23.00	24.50	1.45	96.67	0.62	41.33	>20	23.00	24.45	0	0	Planar	Smooth	Isolated (6->12cm)	50°	Dark Grey-Black	Mudstone	Siltstone	Interbedded		Interbedded mudstone and siltstone, a few weathered joints.
							24.45	24.5	LOST CORE	LOST CORE	LOST CORE	LOST CORE	LOST CORE	LOST CORE	LOST CORE	LOST CORE	LOST CORE	LOST CORE	LOST CORE	LOST CORE
24.50	26.00	1.35	90.00	0.47	31.33	>20	24.50	24.65	LOST CORE	LOST CORE	LOST CORE	LOST CORE	LOST CORE	LOST CORE	LOST CORE	LOST CORE	LOST CORE	LOST CORE	LOST CORE	LOST CORE
							24.65	26.00	10	10	Planar	Slighty Rough	Isolated (6->12cm)	50°	Dark Grey-Black	Mudstone	Siltstone	Interbedded	Quartz Stringers	Interbedded mudstone and siltstone, a few weathered joints.

Run Depth		Core Recovery		RQD Length (Pieces >10cm) [m]	RQD length /run length x100 [%]	Number of Joints (per run)	Core Depth		Schmidt Hammer Tests		Joint Details				Colour	Major Lithology	Minor Lithology	Bedding Type	Features	Comments
From [m]	To [m]	Rec. [m]	Rec. [%]				From [m]	To [m]	Test 'R' Values	Avg 'R' Value	Geometry	Roughness	Spacing	Joint Angle [°]						
26.00	27.50	0.72	48.00	0.15	10.00	~15	26.00	26.78	LOST CORE	LOST CORE	LOST CORE	LOST CORE	LOST CORE	LOST CORE	LOST CORE	LOST CORE	LOST CORE	LOST CORE	LOST CORE	LOST CORE
							26.78	27.50	26,26	26	Planar	Polished	Occasional (3-6cm)	60°	Dark Grey-Black	Mudstone		Massive	Quartz Stringers	Massive silty mudstone, heavily weathered.
27.50	29.00	1.25	83.33	0.25	16.67	~15	27.50	28.75			Irregular	Slighty Rough	Isolated (6->12cm)	55°	Dark Grey-Black	bedded Anthracite/Mud	Anthracite Coal	Interlaminated	Quartz Vein(s) mm scal	Mudstone with siltstone interbeds
							28.75	29.00	LOST CORE	LOST CORE	LOST CORE	LOST CORE	LOST CORE	LOST CORE	LOST CORE	LOST CORE	LOST CORE	LOST CORE	LOST CORE	LOST CORE
29.00	30.50	1.25	83.33	0.55	36.67	>20	29.00	29.40	16	16	Irregular	Slighty Rough	Isolated (6->12cm)	60°	Dark Grey-Black	bedded Anthracite/Mud	Anthracite Coal	Interlaminated	Quartz Stringers	Mudstone with micro coal seams (mm scale)
							29.40	30.25			Irregular	Slighty Rough	Occasional (3-6cm)	90°	Dark Grey-Black	Mudstone	Siltstone		Quartz Stringers	Silty mudstone (minor interbedding). Heavily jointed and weathered.
							30.25	30.50	LOST CORE	LOST CORE	LOST CORE	LOST CORE	LOST CORE	LOST CORE	LOST CORE	LOST CORE	LOST CORE	LOST CORE	LOST CORE	LOST CORE
30.50	32.00	1.45	96.67	0.69	46.00	>20	30.50	31.95	5	5	Planar	Slighty Rough	Occasional (3-6cm)	30°, 70°	Dark Grey-Black	bedded Mudstone/Sand	Sandstone	Interbedded		Mudstone with very fine grained interbedded sandstone.
							31.95	32	LOST CORE	LOST CORE	LOST CORE	LOST CORE	LOST CORE	LOST CORE	LOST CORE	LOST CORE	LOST CORE	LOST CORE	LOST CORE	LOST CORE
32.00	33.50	1.50	100.00	0.90	60.00	~6	32.00	33.50	14,10	12	Planar	Slighty Rough	Isolated (6->12cm)	70°	Dark Grey-Black	bedded Mudstone/Sand	Sandstone	Interbedded	Quartz Stringers	Silty mudstone with very fine grained interbedded sandstone.
33.50	35.00	1.50	100.00	1.14	76.00	8	33.50	35.00	5	5	Planar	Slighty Rough	Isolated (6->12cm)	70°	Dark Grey-Black	Mudstone	Sandstone	Interbedded	Quartz Stringers	Silty mudstone with occasional very fine grained interbedded sandstone.
35.00	36.50	1.40	93.33	0.53	35.33	11.00	35.00	36.40			Irregular	Slighty Rough	Isolated (6->12cm)	90°, 60°	Dark Grey-Black	Mudstone	Siltstone	Interbedded	Quartz Stringers	Silty mudstone, bedding subvertical to vertical and wavy in areas.
							36.40	36.5	LOST CORE	LOST CORE	LOST CORE	LOST CORE	LOST CORE	LOST CORE	LOST CORE	LOST CORE	LOST CORE	LOST CORE	LOST CORE	LOST CORE
36.50	38.00	1.47	98.00	1.16	77.33	3.00	36.50	36.53	LOST CORE	LOST CORE	LOST CORE	LOST CORE	LOST CORE	LOST CORE	LOST CORE	LOST CORE	LOST CORE	LOST CORE	LOST CORE	LOST CORE
							36.53	38.00	20,23	21.5	Planar	Slighty Rough	Isolated (6->12cm)	80°	Medium-Dark Grey	Siltstone	Mudstone	Massive		-
38.00	39.50	1.50	100.00	0.40	26.67	6	38.00	39.50			Planar	Polished	Occasional (3-6cm)	75°	Dark Grey	Mudstone	Siltstone	Interbedded	Quartz Vein(s) mm scal	trace coal
39.50	41.00	1.42	94.67	0.48	32.00	4.00	39.50	39.58	LOST CORE	LOST CORE	LOST CORE	LOST CORE	LOST CORE	LOST CORE	LOST CORE	LOST CORE	LOST CORE	LOST CORE	LOST CORE	LOST CORE
							39.58	41.00	18	18	Planar	Very Rough	Isolated (6->12cm)	75°	Dark Grey-Black	Siltstone	Mudstone	Interbedded	Quartz Vein(s) mm scal	40.15-40.30m coal/mud interbedded
41.00	42.50	1.30	86.67	0.99	66.00	5.00	41.00	41.20	LOST CORE	LOST CORE	LOST CORE	LOST CORE	LOST CORE	LOST CORE	LOST CORE	LOST CORE	LOST CORE	LOST CORE	LOST CORE	LOST CORE
							41.20	42.50	0	0	Planar	Very Rough	Isolated (6->12cm)	80°	Medium-Dark Grey	Sandstone	Mudstone	Interbedded	Quartz Vein(s) mm scal	siltstone 42.40-42.50m
42.50	44.00	1.50	100.00	0.48	32.00	8	42.50	44.00	n/a	n/a	Planar	Slighty Rough	Occasional (3-6cm)	60°	Medium-Dark Grey	Siltstone	Mudstone	Interbedded	Quartz Vein(s) mm scal	trace sandstone
44.00	45.50	1.50	100.00	1.18	78.67	4	44.00	45.50	24,24	24	Planar	Very Rough	Isolated (6->12cm)	60°	Medium-Dark Grey	Siltstone	Mudstone	Interbedded	Quartz Stringers	trace mudstone
45.50	46.00	0.50	100.00	0.44	88.00	2.00	45.50	46.50	LOST CORE	LOST CORE	LOST CORE	LOST CORE	LOST CORE	LOST CORE	LOST CORE	LOST CORE	LOST CORE	LOST CORE	LOST CORE	LOST CORE
							46.50	46.00	23,20	21.5	Planar	Slighty Rough	Isolated (6->12cm)	55°	Medium Grey	Siltstone	Mudstone	Interbedded	Quartz Vein(s) mm scal	soft mud 47.30m
46.00	47.50	1.50	100.00	1.31	87.33	6	46.00	47.50	13,12	12.5	Planar	Smooth	Isolated (6->12cm)	65°	Medium-Dark Grey	Siltstone	Mudstone	Interbedded	Quartz Stringers	-
47.50	49.00	1.50	100.00	1.16	77.33	5	47.50	49.00	5,12	8.5	Planar	Very Rough	Isolated (6->12cm)	60°	Medium-Dark Grey	Siltstone	Mudstone	Massive	Quartz Vein(s) mm scal	-
49.00	50.50	1.50	100.00	1.17	78.00	4	49.00	50.50	19	19	Planar	Polished	Isolated (6->12cm)	60°	Dark Grey	Mudstone	Siltstone	Interbedded	Quartz Vein(s) mm scal	interbedded mm-cm coal bands
50.50	52.00	1.50	100.00	1.00	66.67	6	50.50	52.00	22,20	21	Planar	Very Rough	Isolated (6->12cm)	60°	Medium-Dark Grey	Siltstone	Mudstone	Interbedded	Quartz Vein(s) mm scal	mm coal bands
52.00	53.50	1.50	100.00	0.80	53.33	3	52.00	53.50	35,34	34.5	Planar	Slighty Rough	Isolated (6->12cm)	70°	Medium-Dark Grey	Mudstone	Siltstone	Interbedded	Quartz Vein(s) mm scal	coal 3-5%
53.50	55.00	1.50	100.00	0.16	10.67	6	53.50	55.00			Planar	Smooth	Isolated (6->12cm)	50°	Dark Grey	Mudstone	Anthracite Coal	Interbedded	Pyrite	bentonite 53.86-53.90m, quartz stringers
55.00	56.50	1.35	90.00	0.30	20.00	13.00	55.00	55.15	LOST CORE	LOST CORE	LOST CORE	LOST CORE	LOST CORE	LOST CORE	LOST CORE	LOST CORE	LOST CORE	LOST CORE	LOST CORE	LOST CORE
							55.15	56.50			Planar	Polished	Numerous (1-3cm)	75°	Dark Grey	Mudstone	Siltstone	Interbedded		Fissile
56.50	58.00	1.25	83.33	0.20	13.33	16.00	56.50	56.75	LOST CORE	LOST CORE	LOST CORE	LOST CORE	LOST CORE	LOST CORE	LOST CORE	LOST CORE	LOST CORE	LOST CORE	LOST CORE	LOST CORE
							56.75	58.00			Planar	Polished	Numerous (1-3cm)	75°	Dark Grey	Mudstone	Siltstone	Interlaminated		Fissile, potentially Coaster Zone top
58.00	59.50	0.94	62.67	0.12	8.00	11.00	58.00	58.56	LOST CORE	LOST CORE	LOST CORE	LOST CORE	LOST CORE	LOST CORE	LOST CORE	LOST CORE	LOST CORE	LOST CORE	LOST CORE	LOST CORE
							58.56	59.50			Planar	Polished	Numerous (1-3cm)	80°	Dark Grey	Mudstone	Siltstone	Interlaminated		potentially Coaster Zone
59.50	61.00	1.50	100.00	0.35	23.33	16	59.50	61.00			Planar	Polished	Numerous (1-3cm)	75°	Medium-Dark Grey	Mudstone	Siltstone	Interlaminated		potentially Coaster Zone
61.00	62.50	1.45	96.67	0.34	22.67	11.00	61.00	61.05	LOST CORE	LOST CORE	LOST CORE	LOST CORE	LOST CORE	LOST CORE	LOST CORE	LOST CORE	LOST CORE	LOST CORE	LOST CORE	LOST CORE
							61.05	62.50			Planar	Polished	Numerous (1-3cm)	75°	Medium-Dark Grey	Mudstone	Siltstone	Interlaminated		potentially Coaster Zone

Run Depth		Core Recovery		RQD Length (Pieces >10cm) [m]	RQD length /run length x100 [%]	Number of Joints (per run)	Core Depth		Schmidt Hammer Tests		Joint Details				Colour	Major Lithology	Minor Lithology	Bedding Type	Features	Comments
From [m]	To [m]	Rec. [m]	Rec. [%]				From [m]	To [m]	Test 'R' Values	Avg 'R' Value	Geometry	Roughness	Spacing	Joint Angle [°]						
62.50	64.00	1.46	97.33	0.68	45.33	5.00	62.50	62.54	LOST CORE	LOST CORE	LOST CORE	LOST CORE	LOST CORE	LOST CORE	LOST CORE	LOST CORE	LOST CORE	LOST CORE	LOST CORE	LOST CORE
							62.54	64.00	5	5	Planar	Polished	Isolated (6->12cm)	75°	Medium-Dark Grey	Mudstone	Siltstone	Interlaminated		potentially Coaster Zone
64.00	65.50	1.50	100.00	0.74	49.33	6	64.00	65.50			Planar	Polished	Occasional (3-6cm)	75°	Medium-Dark Grey	Mudstone	Siltstone	Interlaminated		potentially Coaster Zone
65.50	67.00	1.45	96.67	0.31	20.67	6.00	65.50	65.55	LOST CORE	LOST CORE	LOST CORE	LOST CORE	LOST CORE	LOST CORE	LOST CORE	LOST CORE	LOST CORE	LOST CORE	LOST CORE	LOST CORE
							65.55	67.00	18,16	17	Planar	Polished	Occasional (3-6cm)	75°	Medium-Dark Grey	Mudstone	Siltstone	Interlaminated		potentially Coaster Zone
67.00	68.50	1.44	96.00	0.26	17.33	7.00	67.00	67.06	LOST CORE	LOST CORE	LOST CORE	LOST CORE	LOST CORE	LOST CORE	LOST CORE	LOST CORE	LOST CORE	LOST CORE	LOST CORE	LOST CORE
							67.06	68.50			Planar	Polished	Isolated (6->12cm)	80°	Medium-Dark Grey	Mudstone	Siltstone	Interlaminated		potentially Coaster Zone
68.50	70.00	1.31	87.33	0.17	11.33	6.00	68.50	68.69	LOST CORE	LOST CORE	LOST CORE	LOST CORE	LOST CORE	LOST CORE	LOST CORE	LOST CORE	LOST CORE	LOST CORE	LOST CORE	LOST CORE
							68.69	70.00			Planar	Polished	Isolated (6->12cm)	70°	Medium-Dark Grey	Mudstone	Siltstone	Interlaminated		potentially Coaster Zone
70.00	71.50	1.36	90.67	0.24	16.00	10.00	70.00	70.14	LOST CORE	LOST CORE	LOST CORE	LOST CORE	LOST CORE	LOST CORE	LOST CORE	LOST CORE	LOST CORE	LOST CORE	LOST CORE	LOST CORE
							70.14	71.50			Planar	Polished	Isolated (6->12cm)	80°	Medium-Dark Grey	Mudstone	Siltstone	Interlaminated		potentially Coaster Zone
71.50	73.00	1.40	93.33	0.00	0.00	13.00	71.50	71.60	LOST CORE	LOST CORE	LOST CORE	LOST CORE	LOST CORE	LOST CORE	LOST CORE	LOST CORE	LOST CORE	LOST CORE	LOST CORE	LOST CORE
							71.60	73.00			Planar	Polished	Numerous (1-3cm)	75°	Medium-Dark Grey	Mudstone	Siltstone	Interlaminated		potentially Coaster Zone
73.00	74.50	1.28	85.33	0.10	6.67	14.00	73.00	73.22	LOST CORE	LOST CORE	LOST CORE	LOST CORE	LOST CORE	LOST CORE	LOST CORE	LOST CORE	LOST CORE	LOST CORE	LOST CORE	LOST CORE
							73.22	74.50			Planar	Polished	Numerous (1-3cm)	65°	Medium-Dark Grey	Mudstone	Siltstone	Interlaminated		potentially Coaster Zone
74.50	76.00	1.50	100.00	0.00	0.00	18	74.50	76.00			Planar	Polished	Numerous (1-3cm)	65°	Medium-Dark Grey	Mudstone	Siltstone	Interlaminated		potentially Coaster Zone
76.00	77.50	1.50	100.00	0.20	13.33	21	76.00	77.50			Planar	Polished	Numerous (1-3cm)	60°	Medium-Dark Grey	Mudstone	Siltstone	Interlaminated		potentially Coaster Zone
77.50	79.00	1.30	86.67	0.00	0.00	20.00	77.50	77.70	LOST CORE	LOST CORE	LOST CORE	LOST CORE	LOST CORE	LOST CORE	LOST CORE	LOST CORE	LOST CORE	LOST CORE	LOST CORE	LOST CORE
							77.70	79.00			Planar	Polished	Numerous (1-3cm)	60°	Medium-Dark Grey	Mudstone	Siltstone	Interlaminated		potentially Coaster Zone botton
79.00	80.50	1.34	89.33	0.00	0.00	8.00	79.00	79.16	LOST CORE	LOST CORE	LOST CORE	LOST CORE	LOST CORE	LOST CORE	LOST CORE	LOST CORE	LOST CORE	LOST CORE	LOST CORE	LOST CORE
							79.16	80.50			Planar	Polished	Occasional (3-6cm)	55°	Dark Grey	Mudstone	Siltstone	Interbedded	Quartz Vein(s) cm scale	trace coal
80.50	82.00	1.25	83.33	0.24	16.00	12.00	80.50	81.75	0	0	Planar	Polished	Occasional (3-6cm)	40°	Dark Grey	Mudstone	Anthracite Coal	Interbedded	Quartz Vein(s) cm scale	-
							81.75	82.00	LOST CORE	LOST CORE	LOST CORE	LOST CORE	LOST CORE	LOST CORE	LOST CORE	LOST CORE	LOST CORE	LOST CORE	LOST CORE	LOST CORE
82.00	83.50	1.32	88.00	0.00	0.00	12.00	82.00	82.18	LOST CORE	LOST CORE	LOST CORE	LOST CORE	LOST CORE	LOST CORE	LOST CORE	LOST CORE	LOST CORE	LOST CORE	LOST CORE	LOST CORE
							82.18	83.50			Planar	Polished	Occasional (3-6cm)	65°	Dark Grey	Mudstone	Anthracite Coal	Interbedded	Quartz Vein(s) mm scal	mm clay layers, trace siltstone
83.50	85.00	1.50	100.00	0.36	24.00	13	83.50	85.00			Planar	Polished	Occasional (3-6cm)	40°	Dark Grey	Mudstone	Siltstone	Interbedded	Quartz Vein(s) mm scal	trace coal
85.00	86.50	1.45	96.67	0.33	22.00	14.00	85.00	85.05	LOST CORE	LOST CORE	LOST CORE	LOST CORE	LOST CORE	LOST CORE	LOST CORE	LOST CORE	LOST CORE	LOST CORE	LOST CORE	LOST CORE
							85.05	86.50			Planar	Smooth	Occasional (3-6cm)	40°	Dark Grey	Mudstone	Siltstone	Interbedded	Quartz Vein(s) mm scal	trace coal
86.50	88.00	1.44	96.00	0.10	6.67	11.00	86.50	86.56	LOST CORE	LOST CORE	LOST CORE	LOST CORE	LOST CORE	LOST CORE	LOST CORE	LOST CORE	LOST CORE	LOST CORE	LOST CORE	LOST CORE
							86.56	88.00			Planar	Smooth	Isolated (6->12cm)	30°	Dark Grey	Mudstone	Siltstone	Interbedded	Quartz Vein(s) mm scal	trace coal
88.00	89.50	1.29	86.00	0.24	16.00	16.00	88.00	88.21	LOST CORE	LOST CORE	LOST CORE	LOST CORE	LOST CORE	LOST CORE	LOST CORE	LOST CORE	LOST CORE	LOST CORE	LOST CORE	LOST CORE
							88.21	89.50	0	0	Planar	Polished	Occasional (3-6cm)	30°	Medium-Dark Grey	Siltstone	Mudstone	Interbedded		-
89.50	91.00	1.37	91.33	0.10	6.67	9.00	89.50	89.63	LOST CORE	LOST CORE	LOST CORE	LOST CORE	LOST CORE	LOST CORE	LOST CORE	LOST CORE	LOST CORE	LOST CORE	LOST CORE	LOST CORE
							89.63	91.00	0	0	Planar	Polished	Occasional (3-6cm)	30°	Medium-Dark Grey	Siltstone	Mudstone	Interbedded	Quartz Vein(s) mm scal	-
91.00	92.50	1.45	96.67	0.63	42.00	10.00	91.00	91.05	LOST CORE	LOST CORE	LOST CORE	LOST CORE	LOST CORE	LOST CORE	LOST CORE	LOST CORE	LOST CORE	LOST CORE	LOST CORE	LOST CORE
							91.05	92.50	34,31	32.5	Planar	Smooth	Occasional (3-6cm)	40°	Medium-Dark Grey	Siltstone	Mudstone	Interbedded	Quartz Vein(s) cm scale	-
92.50	94.00	1.45	96.67	0.37	24.67	8.00	92.50	92.55	LOST CORE	LOST CORE	LOST CORE	LOST CORE	LOST CORE	LOST CORE	LOST CORE	LOST CORE	LOST CORE	LOST CORE	LOST CORE	LOST CORE
							92.55	94.00	14,16	15	Planar	Smooth	Isolated (6->12cm)	65°	Medium Grey	Siltstone	Mudstone	Massive	Quartz Stringers	-

Run Depth		Core Recovery		RQD Length (Pieces >10cm) [m]	RQD length /run length x100 [%]	Number of Joints (per run)	Core Depth		Schmidt Hammer Tests		Joint Details				Colour	Major Lithology	Minor Lithology	Bedding Type	Features	Comments
From [m]	To [m]	Rec. [m]	Rec. [%]				From [m]	To [m]	Test 'R' Values	Avg 'R' Value	Geometry	Roughness	Spacing	Joint Angle [°]						
94.00	95.50	1.48	98.67	1.44	96.00	2.00	94.00	94.02	LOST CORE	LOST CORE	LOST CORE	LOST CORE	LOST CORE	LOST CORE	LOST CORE	LOST CORE	LOST CORE	LOST CORE	LOST CORE	LOST CORE
							94.02	95.50	24,18	21	Planar	Smooth	Isolated (6->12cm)	50°	Medium Grey	Siltstone	Mudstone	Massive	Quartz Vein(s) mm scal	-
95.50	97.00	1.50	100.00	0.15	10.00	8	95.50	97.00	29,26	27.5	Planar	Polished	Occasional (3-6cm)	60°	Medium Grey	Siltstone		Massive	Quartz Vein(s) mm scal	-
97.00	98.50	1.50	100.00	0.85	56.67	3	97.00	98.50	34,30	32	Curved	Smooth	Isolated (6->12cm)	30°	Medium Grey	Siltstone	Sandstone	Interbedded	Quartz Vein(s) mm scal	trace mudstone
98.50	100.00	1.45	96.67	0.57	38.00	3.00	98.50	98.55	LOST CORE	LOST CORE	LOST CORE	LOST CORE	LOST CORE	LOST CORE	LOST CORE	LOST CORE	LOST CORE	LOST CORE	LOST CORE	LOST CORE
							98.55	100.00	14,26	20	Planar	Smooth	Isolated (6->12cm)	20°	Medium Grey	Sandstone	Siltstone	Interbedded	Quartz Vein(s) mm scal	trace mudstone

TERRACON GEOTECHNIQUE

CLIENT: Arctos Anthracite Joint Venture
PROJECT NUMBER: 122781

HOLE ID: GP-18_MW-27
PROJECT LOCATION: Arctos Anthracite Property

DATE STARTED: Aug.22, 2013 COMPLETED: August 24, 2013
DRILL CONTRACTOR: Driftwood RIG #:
HOLE SIZE: HQ
DRILLING METHOD: Diamond
LOGGED BY: GM CHECKED BY:

Ground Elevation [masl] 1643
Easting 506562.0
Northing 6343093.0
Water Table Depth [m]
Total Depth [m] 128.0m

COMMENTS:

Run Depth		Core Recovery		RQD Length (Pieces >10cm) [m]	RQD length /run length x100 [%]	Number of Joints (per run)	Core Depth		Schmidt Hammer Tests		Joint Details				Colour	Major Lithology	Minor Lithology	Bedding Type	Features	Comments
From [m]	To [m]	Rec. [m]	Rec. [%]				From [m]	To [m]	Test 'R' Values	Avg 'R' Value	Geometry	Roughness	Spacing	Joint Angle [°]						
0.00	0.50	0.45	90.00	0.00	0.00		0.00	0.45	0	0					Brown	Overburden		Massive		PT/CL, Top 2cm organics, with silty clay, trace fine grain sand, soft, PP=0.25.
							0.45	0.50	LOST CORE	LOST CORE	LOST CORE	LOST CORE	LOST CORE	LOST CORE	LOST CORE	LOST CORE	LOST CORE	LOST CORE	LOST CORE	LOST CORE
0.50	2.00	0.35	23.33	0.12	8.00		0.50	1.65	LOST CORE	LOST CORE	LOST CORE	LOST CORE	LOST CORE	LOST CORE	LOST CORE	LOST CORE	LOST CORE	LOST CORE	LOST CORE	LOST CORE
							1.65	2.00	19,38	28.5					Dark Grey-Black	Overburden	Anthracite Coal	Interbedded		CL, Soft unconsolidated mud and 6cm sandstone (boulder),4cm dark grey mudstone with coal stringer mm.
2.00	3.50	1.03	68.67	0.21	14.00	1.00	2.00	2.47	LOST CORE	LOST CORE	LOST CORE	LOST CORE	LOST CORE	LOST CORE	LOST CORE	LOST CORE	LOST CORE	LOST CORE	LOST CORE	LOST CORE
							2.47	3.50	30,35	32.5	Irregular	Slightly Rough	Occasional (3-6cm)	70°	Dark Grey	Mudstone		Massive		sud-vertical fractures with orange oxidation/weathering.
3.50	5.00	1.40	93.33	0.65	43.33	4.00	3.50	4.22	18,14	16	Planar	Very Rough	Occasional (3-6cm)	85°	Dark Grey	Mudstone		Massive		weathered with orange oxidation along fractures..
							4.22	4.90			Planar	Slightly Rough	Occasional (3-6cm)	85°	Medium Grey	Sandstone	Mudstone	Flaser Bedding	Quartz Stringers	trace mm mudstone interlayered in fine grained sand.
							4.90	5.00	LOST CORE	LOST CORE	LOST CORE	LOST CORE	LOST CORE	LOST CORE	LOST CORE	LOST CORE	LOST CORE	LOST CORE	LOST CORE	LOST CORE
5.00	6.50	1.50	100.00	0.79	52.67	1	5.00	6.50	40,36	38	Planar	Slightly Rough	Isolated (6->12cm)	40°	Medium Grey	Sandstone		Massive	Mud clasts	10% mudsclasts 1-2cm, weathering-orange staining on fracture surfaces.
6.50	8.00	1.45	96.67	1.00	66.67	1.00	6.50	6.55	30,31	30.5	Planar	Very Rough	Isolated (6->12cm)	80°	Medium Grey	Sandstone		Massive	Quartz Vein(s) cm scale	fine-med grained sandstone, qtz vein at 80-90 deg.
							6.55	8.00	LOST CORE	LOST CORE	LOST CORE	LOST CORE	LOST CORE	LOST CORE	LOST CORE	LOST CORE	LOST CORE	LOST CORE	LOST CORE	LOST CORE
8.00	9.50	1.35	90.00	0.85	56.67	3.00	8.00	9.35	18,28	23	Irregular	Rough	Occasional (3-6cm)	85°, 70	Medium Grey	Sandstone		Massive	Quartz Stringers	fine-med grained sandstone.
							9.35	9.50	LOST CORE	LOST CORE	LOST CORE	LOST CORE	LOST CORE	LOST CORE	LOST CORE	LOST CORE	LOST CORE	LOST CORE	LOST CORE	LOST CORE
9.50	11.00	1.50	100.00	0.82	54.67	1	9.50	11.00	22,22	22	Irregular	Slightly Rough	Isolated (6->12cm)	85°	Medium Grey	Sandstone		Massive	Quartz Vein(s) mm scale	fine-med grained sandstone. Large subvertical fracture running along core.
11.00	12.50	1.45	96.67	0.30	20.00	1.00	11.00	11.05	LOST CORE	LOST CORE	LOST CORE	LOST CORE	LOST CORE	LOST CORE	LOST CORE	LOST CORE	LOST CORE	LOST CORE	LOST CORE	LOST CORE
							11.05	12.50	31,30	30.5	Planar	Smooth	Isolated (6->12cm)	20°	Medium-Dark Grey	Sandstone	Mudstone	Massive		40cm mudstone layer
12.50	14.00	1.40	93.33	0.67	44.67	3.00	12.50	13.90	22,20	21	Planar	Slightly Rough	Isolated (6->12cm)	40°, 75°	Medium-Dark Grey	Interbedded Mudstone/Sandstone	Anthracite Coal	Interbedded	Quartz Stringers	Sandstone fine grained, dm layers of mudstone, <1% mm of coal.
							13.90	14.00	LOST CORE	LOST CORE	LOST CORE	LOST CORE	LOST CORE	LOST CORE	LOST CORE	LOST CORE	LOST CORE	LOST CORE	LOST CORE	LOST CORE
14.00	15.50	1.40	93.33	0.50	33.33	2.00	14.00	15.40	11,20	15.5	Planar	Slightly Rough	Isolated (6->12cm)	30°, 80°	Medium-Dark Grey	Interbedded Mudstone/Sandstone		Interbedded	Quartz Vein(s) mm scale	Sandstone, fine grained, 20% mud interlayered mm scale
							15.40	15.50	LOST CORE	LOST CORE	LOST CORE	LOST CORE	LOST CORE	LOST CORE	LOST CORE	LOST CORE	LOST CORE	LOST CORE	LOST CORE	LOST CORE
15.50	17.00	1.45	96.67	0.65	43.33	3.00	15.50	15.55	LOST CORE	LOST CORE	LOST CORE	LOST CORE	LOST CORE	LOST CORE	LOST CORE	LOST CORE	LOST CORE	LOST CORE	LOST CORE	LOST CORE
							15.55	17.00	28,26	27	Planar	Slightly Rough	Occasional (3-6cm)	30°	Medium-Dark Grey	Sandstone	Mudstone	Interbedded	Quartz Vein(s) mm scale	Sandstone fine-med grained, 10% mudstone interlayered mm scale.
17.00	18.50	1.25	83.33	0.75	50.00	1.00	17.00	17.25	LOST CORE	LOST CORE	LOST CORE	LOST CORE	LOST CORE	LOST CORE	LOST CORE	LOST CORE	LOST CORE	LOST CORE	LOST CORE	LOST CORE
							17.25	18.50	24,26	25	Planar	Slightly Rough	Isolated (6->12cm)	75°	Medium Grey	Sandstone	Mudstone	Interbedded		Sandstone fine-med grain, 20% mudstone interlayered cm scale.
18.50	20.00	1.40	93.33	0.61	40.67	2.00	18.50	19.90	10,10	10	Planar	Slightly Rough	Isolated (6->12cm)	75°, 40°	Medium-Dark Grey	Interbedded Mudstone/Sandstone		Interbedded	Quartz Vein(s) mm scale	Sandstone, fine grained, 30% cm mud interlayered.
							19.90	20.00	LOST CORE	LOST CORE	LOST CORE	LOST CORE	LOST CORE	LOST CORE	LOST CORE	LOST CORE	LOST CORE	LOST CORE	LOST CORE	LOST CORE
20.00	21.50	1.50	100.00	0.10	6.67	>20	20.00	20.85			Irregular	Slightly Rough	Isolated (6->12cm)	70°	Medium-Dark Grey	Interbedded Mudstone/Sandstone	Mudstone			very fine-fine grained sandstone with occasional mudstone interbeds
							20.85	21.50			Planar	Slightly Rough	Occasional (3-6cm)	80°	Medium Grey	Sandstone				very fine-fine grained sandstone.
21.50	23.00	1.50	100.00	0.53	35.33	20	21.50	23.00	31,30	30.5	Planar	Slightly Rough	Occasional (3-6cm)	90°	Medium Grey	Sandstone				very fine-fine grained sandstone.
23.00	24.50	1.50	100.00	1.07	71.33	8	23.00	24.50	19,21	20	Irregular	Slightly Rough	Isolated (6->12cm)	70°	Medium-Dark Grey	Interbedded Mudstone/Sandstone	Mudstone		Quartz Stringers	

Run Depth		Core Recovery		RQD Length (Pieces >10cm) [m]	RQD length /run length x100 [%]	Number of Joints (per run)	Core Depth		Schmidt Hammer Tests		Joint Details				Colour	Major Lithology	Minor Lithology	Bedding Type	Features	Comments
From [m]	To [m]	Rec. [m]	Rec. [%]				From [m]	To [m]	Test 'R' Values	Avg 'R' Value	Geometry	Roughness	Spacing	Joint Angle [°]						
24.50	26.00	1.50	100.00	0.57	38.00	~20	24.50	26.00	31,33	32	Irregular	Slightly Rough	Isolated (6->12cm)	20°	Medium-Dark Grey	Interbedded Mudstone/Sandstone	Mudstone		-	Strongly weathered from 25.13m-25.40m and 25.87m-26.00m
26.00	27.50	1.30	86.67	0.00	0.00	8.00	26.00	26.20	LOST CORE	LOST CORE	LOST CORE	LOST CORE	LOST CORE	LOST CORE	LOST CORE	LOST CORE	LOST CORE	LOST CORE	LOST CORE	LOST CORE
							26.20	27.50			Irregular	Slightly Rough	Isolated (6->12cm)	50°	Dark Grey	Mudstone				Strongly weathered
27.50	29.00	1.39	92.67	0.86	57.33	6.00	27.50	27.61	LOST CORE	LOST CORE	LOST CORE	LOST CORE	LOST CORE	LOST CORE	LOST CORE	LOST CORE	LOST CORE	LOST CORE	LOST CORE	LOST CORE
							27.61	29.00	0	0	Curved	Smooth	Isolated (6->12cm)	40°	Dark Grey	Mudstone	Siltstone		Pyrite	Mudstone with occasional silt laminae
29.00	30.50	1.23	82.00	0.73	48.67	10.00	29.00	29.27	LOST CORE	LOST CORE	LOST CORE	LOST CORE	LOST CORE	LOST CORE	LOST CORE	LOST CORE	LOST CORE	LOST CORE	LOST CORE	LOST CORE
							29.27	30.50	25,27	26	Irregular	Smooth	Isolated (6->12cm)	25°	Dark Grey	Mudstone			Pyrite	Pyrite stringers throughout
30.50	32.00	1.44	96.00	0.75	50.00	8.00	30.50	30.56	LOST CORE	LOST CORE	LOST CORE	LOST CORE	LOST CORE	LOST CORE	LOST CORE	LOST CORE	LOST CORE	LOST CORE	LOST CORE	LOST CORE
							30.56	32.00	19,25	22	Curved	Slightly Rough	Isolated (6->12cm)	65°	Dark Grey	Mudstone			Pyrite	Pyrite stringers throughout, becoming sandy towards end of run.
32.00	33.50	1.50	100.00	0.39	26.00	6	32.00	32.44			Irregular	Striated	Isolated (6->12cm)	90°	Dark Grey	Mudstone			Pyrite	Concentration of pyrite grains at 32.40m-32.46m.
							32.44	33.50							Dark Grey-Black	Interbedded Anthracite/Mudstone	Mudstone		Pyrite	Interbedded mudstone and coal. Quartz stringers present, pyrite throughout run.
33.50	35.00	1.46	97.33	0.10	6.67	3.00	33.50	34.16			Irregular	Slightly Rough	Isolated (6->12cm)	90°	Dark Grey-Black	Interbedded Anthracite/Mudstone	Mudstone		Quartz Stringers	
							34.16	34.96							Medium-Dark Grey	Interbedded Mudstone/Sandstone			Quartz Stringers	Silty mudstone interbedded with very fine grained sandstone
							34.96	35.00	LOST CORE	LOST CORE	LOST CORE	LOST CORE	LOST CORE	LOST CORE	LOST CORE	LOST CORE	LOST CORE	LOST CORE	LOST CORE	LOST CORE
35.00	36.50	1.50	100.00	0.60	40.00	8	35.00	36.28	16,16	16	Irregular	Slightly Rough	Isolated (6->12cm)	85°	Medium-Dark Grey	Interbedded Mudstone/Siltstone			Quartz Stringers	Mudstone interbedded with siltstone
							36.28	36.50			Curved	Smooth	Isolated (6->12cm)	65°	Medium-Dark Grey	Interbedded Mudstone/Sandstone				Very fine grained sandstone interbedded with mudstone
36.50	38.00	1.50	100.00	0.54	36.00	11	36.50	38.00	33,38	35.5	Irregular	Slightly Rough	Isolated (6->12cm)	90°	Medium-Dark Grey	Interbedded Mudstone/Sandstone				Very fine grained sandstone interbedded with mudstone
38.00	39.50	1.48	98.67	1.24	82.67	5.00	38.00	38.02	LOST CORE	LOST CORE	LOST CORE	LOST CORE	LOST CORE	LOST CORE	LOST CORE	LOST CORE	LOST CORE	LOST CORE	LOST CORE	LOST CORE
							38.02	39.50	19,17	18	Curved	Slightly Rough	Isolated (6->12cm)	20°	Medium-Dark Grey	Interbedded Mudstone/Sandstone				Very fine-fine grained sandstone interbedded with mudstone. Flaser bedding present.
39.50	41.00	1.50	100.00	0.89	59.33	4	39.50	39.92	18,16	17	Planar	Slightly Rough	Isolated (6->12cm)	90°	Medium-Dark Grey	Interbedded Mudstone/Sandstone				Very fine-fine grained sandstone interbedded with mudstone. Flaser bedding present.
							39.92	39.99			Planar	Slightly Rough	Isolated (6->12cm)	90°	Light Grey	Clay				Potential bentonite seam *Sampled*
							39.99	41.00							Dark Grey	Mudstone				Mudstone with very minor sandstone
41.00	42.50	1.50	100.00	1.50	100.00	0	41.00	42.50	22,24	23					Dark Grey	Mudstone			Pyrite	Sandy mudstone with trace amounts of pyrite
42.50	44.00	1.44	96.00	0.89	59.33	1.00	42.50	43.65	21,26	23.5	Curved	Slightly Rough	Isolated (6->12cm)	90°	Dark Grey	Mudstone				Sandy mudstone
							43.65	43.90							Light Grey	Clay				Potential bentonite seam *Sampled*
							43.90	43.94							Dark Grey	Mudstone				
							43.94	44.00	LOST CORE	LOST CORE	LOST CORE	LOST CORE	LOST CORE	LOST CORE	LOST CORE	LOST CORE	LOST CORE	LOST CORE	LOST CORE	LOST CORE
44.00	45.50	1.48	98.67	0.67	44.67	5.00	44.00	44.02	LOST CORE	LOST CORE	LOST CORE	LOST CORE	LOST CORE	LOST CORE	LOST CORE	LOST CORE	LOST CORE	LOST CORE	LOST CORE	LOST CORE
							44.02	45.50	0	0	Irregular	Slightly Rough	Isolated (6->12cm)	65°	Dark Grey	Mudstone			Pyrite	Trace pyrite
45.50	47.00	1.48	98.67	1.34	89.33	1.00	45.50	46.10	0	0	Irregular	Slightly Rough	Isolated (6->12cm)	75°	Dark Grey	Mudstone				Sandy mudstone
							46.10	46.98							Dark Grey	Sandstone				Muddy sandstone, transitioning into interbedded sandstone and mudstone. Some flaser bedding present.
							46.98	47.00	LOST CORE	LOST CORE	LOST CORE	LOST CORE	LOST CORE	LOST CORE	LOST CORE	LOST CORE	LOST CORE	LOST CORE	LOST CORE	LOST CORE
47.00	48.50	1.45	96.67	1.10	73.33	1.00	47.00	47.05	LOST CORE	LOST CORE	LOST CORE	LOST CORE	LOST CORE	LOST CORE	LOST CORE	LOST CORE	LOST CORE	LOST CORE	LOST CORE	LOST CORE
							47.05	48.50	20,19	19.5	Planar	Slightly Rough	Isolated (6->12cm)	30°	Medium-Dark Grey	Sandstone	Mudstone	Interbedded		Sandstone fine grain, 20% mudstone cm interlayers.
48.50	50.00	1.40	93.33	1.11	74.00	2.00	48.50	49.20	22,18	20	Irregular	Slightly Rough	Isolated (6->12cm)	60°, 85°	Medium Grey	Sandstone	Mudstone	Interbedded		Sandstone, fine-med grain, 10% mudstone bands cm.
							#REF!	50.00	LOST CORE	LOST CORE	LOST CORE	LOST CORE	LOST CORE	LOST CORE	LOST CORE	LOST CORE	LOST CORE	LOST CORE	LOST CORE	LOST CORE
50.00	51.50	1.45	96.67	1.45	96.67	0.00	50.00	50.05	LOST CORE	LOST CORE	LOST CORE	LOST CORE	LOST CORE	LOST CORE	LOST CORE	LOST CORE	LOST CORE	LOST CORE	LOST CORE	LOST CORE
							50.05	51.50	19,23	21					Medium-Dark Grey	Sandstone	Mudstone	Interbedded		Sandstone, fine-med grain, 20% mudstone bands cm.

Run Depth		Core Recovery		RQD Length (Pieces >10cm) [m]	RQD length /run length x100 [%]	Number of Joints (per run)	Core Depth		Schmidt Hammer Tests		Joint Details				Colour	Major Lithology	Minor Lithology	Bedding Type	Features	Comments
From [m]	To [m]	Rec. [m]	Rec. [%]				From [m]	To [m]	Test 'R' Values	Avg 'R' Value	Geometry	Roughness	Spacing	Joint Angle [°]						
51.50	53.00	1.47	98.00	1.30	86.67	1.00	51.50	51.53	LOST CORE	LOST CORE	LOST CORE	LOST CORE	LOST CORE	LOST CORE	LOST CORE	LOST CORE	LOST CORE	LOST CORE	LOST CORE	LOST CORE
							51.53	53.00	12,15	13.5	Irregular	Very Rough	Isolated (6->12cm)	65°	Medium Grey	Sandstone	Mudstone	Interbedded	Quartz Stringers	Sandstone, fine-med grain, 10% mudstone bands mm.
53.00	54.50	1.45	96.67	1.45	96.67	1.00	53.00	53.05	LOST CORE	LOST CORE	LOST CORE	LOST CORE	LOST CORE	LOST CORE	LOST CORE	LOST CORE	LOST CORE	LOST CORE	LOST CORE	LOST CORE
							53.05	54.50	20,21	20.5	Irregular	Slightly Rough	Isolated (6->12cm)	20°	Medium Grey	Sandstone	Mudstone	Interbedded	Quartz Stringers	Sandstone, fine-med grain, 20% mudstone bands mm-cm.
54.50	56.00	1.50	100.00	1.50	100.00	1	54.50	56.00	24,18	21	Planar	Slightly Rough	Isolated (6->12cm)	20°	Medium Grey	Sandstone	Mudstone	Interbedded	Mud clasts	Sandstone, fine-med grain, 20% mudstone bands mm-cm.
56.00	57.50	1.48	98.67	1.48	98.67	0.00	56.00	56.02	LOST CORE	LOST CORE	LOST CORE	LOST CORE	LOST CORE	LOST CORE	LOST CORE	LOST CORE	LOST CORE	LOST CORE	LOST CORE	LOST CORE
							56.02	57.50	27,22	24.5					Medium Grey	Sandstone	Mudstone	Interbedded	Mud clasts	Sandstone, fine-med grain, 10% mudstone bands mm, trace mud clasts <2cm.
57.50	59.00	1.50	100.00	1.46	97.33	1	57.50	59.00	34,34	34	Irregular	Slightly Rough	Isolated (6->12cm)	65°	Medium Grey	Sandstone	Mudstone	Interbedded	Mud clasts	Sandstone, fine-med grain, 10% mudstone bands mm, trace mud clasts <1cm.
59.00	60.50	1.50	100.00	1.50	100.00	0	59.00	60.50	21,21	21					Medium Grey	Sandstone	Mudstone	Interbedded	Mud clasts	Sandstone, fine-med grain, 10-20% mudstone bands mm, trace mud clasts <1cm.
60.50	62.00	1.50	100.00	1.37	91.33	1	60.50	62.00	23,21	22	Irregular	Slightly Rough	Isolated (6->12cm)	70°	Medium Grey	Sandstone	Mudstone	Interbedded		Sandstone, fine-med grain, 10% mudstone bands mm, and lamili.
62.00	63.50	1.48	98.67	1.48	98.67	2.00	62.00	63.48	20,19	19.5	Planar	Slightly Rough	Isolated (6->12cm)	10°, 20°	Medium Grey	Sandstone	Mudstone	Interbedded	Mud clasts	Sandstone, fine-med grain, 10% mudstone bands mm-cm bands and lamili, trace mud clasts.
							63.48	63.50	LOST CORE	LOST CORE	LOST CORE	LOST CORE	LOST CORE	LOST CORE	LOST CORE	LOST CORE	LOST CORE	LOST CORE	LOST CORE	LOST CORE
63.50	65.00	1.33	88.67	1.15	76.67	2.00	63.50	64.65	23,24	23.5	Planar	Smooth	Occasional (3-6cm)	20°	Medium Grey	Sandstone	Mudstone	Interbedded	Mud clasts	Sandstone, fine-med grain, 20% mudstone bands mm, trace clasts, 4cm pyrite cap at mudstone-coal contact.
							64.65	64.83							Dark Grey-Black	Mudstone	Anthracite Coal	Interbedded		30% coal interlayered, <2cm coal bands.
							64.83	65.00	LOST CORE	LOST CORE	LOST CORE	LOST CORE	LOST CORE	LOST CORE	LOST CORE	LOST CORE	LOST CORE	LOST CORE	LOST CORE	LOST CORE
65.00	66.50	1.35	90.00	0.11	7.33	15.00	65.00	66.35	0	0	Planar	Smooth	Occasional (3-6cm)	30°, 40°	Dark Grey-Black	Mudstone	Anthracite Coal	Interbedded		Mudstone, 30% coal, mm-cm layers, massive mudstone 20cm
							66.35	66.50	LOST CORE	LOST CORE	LOST CORE	LOST CORE	LOST CORE	LOST CORE	LOST CORE	LOST CORE	LOST CORE	LOST CORE	LOST CORE	LOST CORE
66.50	68.00	1.50	100.00		0.00	2	66.50	67.10			Irregular	Smooth	Isolated (6->12cm)	40°, 50°	Dark Grey-Black	Mudstone	Anthracite Coal	Interbedded	Quartz Vein(s) mm scale	Mudstone, 10% coal, mm layers
68.00	69.50	1.42	94.67	0.72	48.00	4.00	68.00	69.42	20,21	20.5	Irregular	Polished	Isolated (6->12cm)	30°, 90°	Dark Grey-Black	Mudstone	Anthracite Coal	Interbedded	Pyrite	Mudstone, 30% coal, mm layers,pyrite 2-3cm along bedding 30 deg.
							69.42	69.50	LOST CORE	LOST CORE	LOST CORE	LOST CORE	LOST CORE	LOST CORE	LOST CORE	LOST CORE	LOST CORE	LOST CORE	LOST CORE	LOST CORE
69.50	71.00	1.41	94.00	0.86	57.33	2.00	69.50	70.91	16,10	13	Planar	Smooth	Isolated (6->12cm)	50°, 40°	Dark Grey	Mudstone	Anthracite Coal	Massive		Mudstone, <1% coal mm.
							70.91	71.00	LOST CORE	LOST CORE	LOST CORE	LOST CORE	LOST CORE	LOST CORE	LOST CORE	LOST CORE	LOST CORE	LOST CORE	LOST CORE	LOST CORE
71.00	72.50	1.48	98.67	1.13	75.33	1.00	71.00	71.02	LOST CORE	LOST CORE	LOST CORE	LOST CORE	LOST CORE	LOST CORE	LOST CORE	LOST CORE	LOST CORE	LOST CORE	LOST CORE	LOST CORE
							71.02	72.50	21,17	19	Irregular	Slightly Rough	Isolated (6->12cm)	20°	Dark Grey	Mudstone	Anthracite Coal	Massive		Mudstone, <1% coal mm.
72.50	74.00	1.50	100.00	1.49	99.33	2	72.50	74.00	18,28	14.5	Planar	Slightly Rough	Isolated (6->12cm)	40°	Dark Grey	Mudstone		Massive		Mudstone, trace silts.
74.00	75.50	1.46	97.33	0.90	60.00	1.00	74.00	74.04	LOST CORE	LOST CORE	LOST CORE	LOST CORE	LOST CORE	LOST CORE	LOST CORE	LOST CORE	LOST CORE	LOST CORE	LOST CORE	LOST CORE
							74.04	75.50	13,21	17	Planar	Smooth	Isolated (6->12cm)	30°	Dark Grey	Mudstone	Anthracite Coal	Interbedded	Pyrite	5% coal, mm-cm bands, 1% pyrite bands.
75.50	77.00	1.34	89.33	0.30	20.00	2.00	75.50	76.84	17,14	15.5	Planar	Polished		40°, 70°	Dark Grey	Mudstone		Interbedded	Quartz Stringers	-
							76.84	77.00	LOST CORE	LOST CORE	LOST CORE	LOST CORE	LOST CORE	LOST CORE	LOST CORE	LOST CORE	LOST CORE	LOST CORE	LOST CORE	LOST CORE
77.00	78.50	1.25	83.33	0.57	38.00	6.00	77.00	77.25	LOST CORE	LOST CORE	LOST CORE	LOST CORE	LOST CORE	LOST CORE	LOST CORE	LOST CORE	LOST CORE	LOST CORE	LOST CORE	LOST CORE
							77.25	78.50	20,10	15	Irregular	Slightly Rough	Isolated (6->12cm)	65°	Dark Grey	Interbedded Mudstone/Siltstone	Siltstone	Interbedded		-
78.50	80.00	1.50	100.00	1.19	79.33	5	78.50	80.00	14,18	16	Irregular	Slightly Rough	Isolated (6->12cm)	20°	Dark Grey	Interbedded Mudstone/Siltstone	Siltstone	Interbedded		-
80.00	81.50	1.50	100.00	1.46	97.33	5	80.00	81.50	10,30	20	Planar	Smooth	Isolated (6->12cm)	20°	Dark Grey	Interbedded Mudstone/Siltstone	Siltstone	Interbedded		-
81.50	83.00	1.50	100.00	1.50	100.00	1	81.50	83.00	18,19	18.5	Planar	Smooth	Isolated (6->12cm)	25°	Dark Grey	Interbedded Mudstone/Siltstone	Siltstone	Interbedded		-
83.00	84.50	1.46	97.33	1.40	93.33	0.00	83.00	83.04	LOST CORE	LOST CORE	LOST CORE	LOST CORE	LOST CORE	LOST CORE	LOST CORE	LOST CORE	LOST CORE	LOST CORE	LOST CORE	LOST CORE
							83.04	84.50	24,35	29.5	n/a	n/a	n/a	n/a	Dark Grey	Interbedded Mudstone/Siltstone	Siltstone	Interbedded		-
84.50	86.00	1.50	100.00	1.20	80.00	2	84.50	86.00	21,23	22	Irregular	Slightly Rough	Isolated (6->12cm)	70°	Dark Grey	Interbedded Mudstone/Siltstone	Siltstone	Interbedded		-

Run Depth		Core Recovery		RQD Length (Pieces >10cm) [m]	RQD length /run length x100 [%]	Number of Joints (per run)	Core Depth		Schmidt Hammer Tests		Joint Details				Colour	Major Lithology	Minor Lithology	Bedding Type	Features	Comments
From [m]	To [m]	Rec. [m]	Rec. [%]				From [m]	To [m]	Test 'R' Values	Avg 'R' Value	Geometry	Roughness	Spacing	Joint Angle [°]						
86.00	87.50	1.42	94.67	1.42	94.67	1.00	86.00	86.08	LOST CORE	LOST CORE	LOST CORE	LOST CORE	LOST CORE	LOST CORE	LOST CORE	LOST CORE	LOST CORE	LOST CORE	LOST CORE	LOST CORE
							86.08	87.50	18,17	17.5	Irregular	Slightly Rough	Isolated (6->12cm)	55°	Dark Grey	Interbedded Mudstone/Siltstone	Siltstone	Interbedded		-
87.50	89.00	1.50	100.00	1.25	83.33	4.00	87.50	88.03	12,50,51	34.33	Irregular	Slightly Rough	Isolated (6->12cm)	80°	Dark Grey	Interbedded Mudstone/Siltstone	Siltstone	Interbedded		-
							88.03	89.00			Irregular	Slightly Rough	Isolated (6->12cm)	70°	Dark Grey	Interbedded Mudstone/Sandstone	Sandstone	Interbedded		Interbedded mudstone and very fine grained sandstone
89.00	90.50	1.44	96.00	1.13	75.33	3.00	89.00	90.44	34,36	35	Irregular	Slightly Rough	Isolated (6->12cm)	55°, 65°	Dark Grey	Interbedded Mudstone/Sandstone	Sandstone	Interbedded		Interbedded mudstone and very fine grained sandstone
							90.44	90.50	LOST CORE	LOST CORE	LOST CORE	LOST CORE	LOST CORE	LOST CORE	LOST CORE	LOST CORE	LOST CORE	LOST CORE	LOST CORE	LOST CORE
90.50	92.00	1.50	100.00	1.30	86.67	0	90.50	92.00	16,39,46	33.66				n/a	Dark Grey	Interbedded Mudstone/Sandstone	Sandstone	Interbedded	-	Interbedded mudstone and very fine grained sandstone
92.00	93.50	1.40	93.33	0.96	64.00	6.00	92.00	92.10	LOST CORE	LOST CORE	LOST CORE	LOST CORE	LOST CORE	LOST CORE	LOST CORE	LOST CORE	LOST CORE	LOST CORE	LOST CORE	LOST CORE
							92.10	93.50	18,12	15	Irregular	Slightly Rough	Isolated (6->12cm)	70°	Dark Grey	Interbedded Mudstone/Sandstone	Sandstone	Interbedded		Interbedded mudstone and very fine grained sandstone
93.50	95.00	1.50	100.00	1.40	93.33	2	93.50	95.00	16,22	19	Irregular	Slightly Rough	Isolated (6->12cm)	80°	Dark Grey	Interbedded Mudstone/Sandstone	Sandstone	Interbedded		Interbedded mudstone and very fine grained sandstone
95.00	96.50	1.50	100.00	0.51	34.00	2	95.00	96.50	27,33	30					Dark Grey	Interbedded Mudstone/Sandstone	Sandstone	Interbedded		Interbedded mudstone and very fine grained sandstone
96.50	98.00	1.46	97.33	0.86	57.33	8.00	96.50	96.54	LOST CORE	LOST CORE	LOST CORE	LOST CORE	LOST CORE	LOST CORE	LOST CORE	LOST CORE	LOST CORE	LOST CORE	LOST CORE	LOST CORE
							96.54	98.00	20,31	25.5	Irregular	Slightly Rough	Isolated (6->12cm)	40°	Dark Grey	Interbedded Mudstone/Sandstone	Sandstone	Interbedded		Interbedded mudstone and very fine grained sandstone
98.00	99.50	1.47	98.00	1.39	92.67	4.00	98.00	98.03	LOST CORE	LOST CORE	LOST CORE	LOST CORE	LOST CORE	LOST CORE	LOST CORE	LOST CORE	LOST CORE	LOST CORE	LOST CORE	LOST CORE
							98.03	99.50	31,33	32	Planar	Smooth	Isolated (6->12cm)	30°	Dark Grey	Interbedded Mudstone/Sandstone	Sandstone	Interbedded		Interbedded mudstone and very fine grained sandstone
99.50	101.00	1.50	100.00	1.50	100.00	1	99.50	101.00	16,14	15	Irregular	Slightly Rough	Isolated (6->12cm)	10°	Dark Grey	Interbedded Mudstone/Sandstone	Siltstone	Interbedded		Interbedded mudstone and very fine grained sandstone with some siltstone.
101.00	102.50	1.41	94.00	1.41	94.00	3.00	101.00	101.09	LOST CORE	LOST CORE	LOST CORE	LOST CORE	LOST CORE	LOST CORE	LOST CORE	LOST CORE	LOST CORE	LOST CORE	LOST CORE	LOST CORE
							101.09	102.50	18,30	24	Irregular	Slightly Rough	Isolated (6->12cm)	60°	Dark Grey	Interbedded Mudstone/Sandstone	Siltstone	Interbedded		Interbedded mudstone and very fine grained sandstone with some siltstone.
102.50	104.00	1.50	100.00	1.50	100.00	0	102.50	104.00	11,35	23					Dark Grey	Interbedded Mudstone/Sandstone	Siltstone	Interbedded		Interbedded mudstone and very fine grained sandstone with some siltstone.
104.00	105.50	1.38	92.00	1.19	79.33	4.00	104.00	104.12	LOST CORE	LOST CORE	LOST CORE	LOST CORE	LOST CORE	LOST CORE	LOST CORE	LOST CORE	LOST CORE	LOST CORE	LOST CORE	LOST CORE
							104.12	105.50	21,42,44	35.66	Planar	Smooth	Isolated (6->12cm)	50°	Dark Grey	Interbedded Mudstone/Sandstone	Siltstone	Interbedded		Interbedded mudstone and very fine grained sandstone with some siltstone.
105.50	107.00	1.50	100.00	1.34	89.33	3	105.50	107.00	36,34	35	Irregular	Slightly Rough	Isolated (6->12cm)	15°	Dark Grey	Interbedded Mudstone/Sandstone	Siltstone	Interbedded		Interbedded mudstone and very fine grained sandstone with some siltstone.
107.00	108.50	1.48	98.67	1.34	89.33	3.00	107.00	107.02	LOST CORE	LOST CORE	LOST CORE	LOST CORE	LOST CORE	LOST CORE	LOST CORE	LOST CORE	LOST CORE	LOST CORE	LOST CORE	LOST CORE
							107.02	108.50	10,26,31	22.33	Planar	Slightly Rough	Isolated (6->12cm)	50°	Dark Grey	Interbedded Mudstone/Sandstone	Siltstone	Interbedded	Quartz Vein(s) cm scale	Interbedded mudstone and very fine grained sandstone with some siltstone.
108.50	110.00	1.50	100.00	0.53	35.33	6	108.50	110.00	14,34,13	20.33	Irregular	Slightly Rough	Isolated (6->12cm)	90°	Dark Grey	Interbedded Mudstone/Sandstone	Siltstone	Interbedded	Quartz Stringers	Interbedded mudstone and very fine grained sandstone with some siltstone.
110.00	111.50	1.30	86.67	0.49	32.67	1.00	110.00	110.20	LOST CORE	LOST CORE	LOST CORE	LOST CORE	LOST CORE	LOST CORE	LOST CORE	LOST CORE	LOST CORE	LOST CORE	LOST CORE	LOST CORE
							110.20	111.50	10,11	10.5	Irregular	Smooth	Isolated (6->12cm)	50°	Dark Grey	Interbedded Mudstone/Sandstone	Siltstone	Interbedded	Quartz Stringers	Interbedded mudstone and very fine grained sandstone with some siltstone.
111.50	113.00	1.43	95.33	0.10	6.67	10.00	111.50	111.57	LOST CORE	LOST CORE	LOST CORE	LOST CORE	LOST CORE	LOST CORE	LOST CORE	LOST CORE	LOST CORE	LOST CORE	LOST CORE	LOST CORE
							111.57	113.00	14,32	23	Planar	Striated	Isolated (6->12cm)	15°	Dark Grey	Interbedded Mudstone/Sandstone	Siltstone	Interbedded	Quartz Stringers	Interbedded mudstone and very fine grained sandstone with some siltstone.
113.00	114.50	1.44	96.00	1.11	74.00	2.00	113.00	113.06	LOST CORE	LOST CORE	LOST CORE	LOST CORE	LOST CORE	LOST CORE	LOST CORE	LOST CORE	LOST CORE	LOST CORE	LOST CORE	LOST CORE
							113.06	114.50	18,30	24	Planar	Slightly Rough	Isolated (6->12cm)	12°	Dark Grey	Interbedded Mudstone/Sandstone	Siltstone	Interbedded	Quartz Stringers	Interbedded mudstone and very fine grained sandstone with some siltstone.
114.50	116.00	1.55	103.33	1.55	103.33	1	114.50	116.00	21,39,44	34.66	Planar	Smooth	Isolated (6->12cm)	12°	Dark Grey	Interbedded Mudstone/Siltstone	Siltstone	Interbedded		Interbedded mudstone and siltstone, very minor very fine grained sandstone content.
116.00	117.50	1.43	95.33	1.42	94.67	2.00	116.00	116.07	LOST CORE	LOST CORE	LOST CORE	LOST CORE	LOST CORE	LOST CORE	LOST CORE	LOST CORE	LOST CORE	LOST CORE	LOST CORE	LOST CORE
							116.07	117.50	16,28	22	Planar	Smooth	Isolated (6->12cm)	10°	Dark Grey	Interbedded Mudstone/Siltstone	Siltstone	Interbedded		Interbedded mudstone and siltstone, very minor very fine grained sandstone content.

Run Depth		Core Recovery		RQD Length (Pieces >10cm) [m]	RQD length /run length x100 [%]	Number of Joints (per run)	Core Depth		Schmidt Hammer Tests		Joint Details				Colour	Major Lithology	Minor Lithology	Bedding Type	Features	Comments
From [m]	To [m]	Rec. [m]	Rec. [%]				From [m]	To [m]	Test 'R' Values	Avg 'R' Value	Geometry	Roughness	Spacing	Joint Angle [°]						
117.50	119.00	1.55	103.33	1.55	103.33	0	117.50	119.00	18,16	17					Dark Grey	Interbedded Mudstone/Siltstone	Siltstone	Interbedded		Interbedded mudstone and siltstone, very minor very fine grained sandstone content.
119.00	120.50	1.49	99.33	1.49	99.33	0.00	119.00	119.01	LOST CORE	LOST CORE	LOST CORE	LOST CORE	LOST CORE	LOST CORE	LOST CORE	LOST CORE	LOST CORE	LOST CORE	LOST CORE	LOST CORE
							119.01	120.50	16,34,36	28.66					Dark Grey	Interbedded Mudstone/Siltstone	Siltstone	Interbedded		Interbedded mudstone and siltstone, very minor very fine grained sandstone content.
120.50	122.00	1.50	100.00	1.50	100.00	2	120.50	122.00	38,35	36.5	Irregular	Slightly Rough	Isolated (6->12cm)	15°	Dark Grey	Interbedded Mudstone/Siltstone	Siltstone	Interbedded		Interbedded mudstone and siltstone, very minor very fine grained sandstone content.
122.00	123.50	1.41	94.00	1.41	94.00	3.00	122.00	122.09	LOST CORE	LOST CORE	LOST CORE	LOST CORE	LOST CORE	LOST CORE	LOST CORE	LOST CORE	LOST CORE	LOST CORE	LOST CORE	LOST CORE
							122.09	123.50	38,34	36	Irregular	Smooth	Isolated (6->12cm)	10°	Dark Grey	Interbedded Mudstone/Siltstone	Siltstone	Interbedded		Interbedded mudstone and siltstone, very minor very fine grained sandstone content.
123.50	125.00	1.41	94.00	0.95	63.33	9.00	123.50	124.20	11,22,30	21	Planar	Smooth	Isolated (6->12cm)	15°	Dark Grey	Interbedded Mudstone/Siltstone	Siltstone	Interbedded		Interbedded mudstone and siltstone, very minor very fine grained sandstone content.
							124.20	124.91							Dark Grey-Black	Anthracite Coal	Mudstone		Quartz Stringers	Anthracite coal with very minor mudstone content.
							124.91	125.00	LOST CORE	LOST CORE	LOST CORE	LOST CORE	LOST CORE	LOST CORE	LOST CORE	LOST CORE	LOST CORE	LOST CORE	LOST CORE	LOST CORE
125.00	126.50	1.45	96.67	0.55	36.67	~20	125.00	125.72	10,5	7.5	Planar	Smooth	Occasional (3-6cm)	10°	Dark Grey-Black	Interbedded Anthracite/Mudstone	Mudstone	Interbedded	Quartz Stringers	Interbedded mudstone and anthracite coal.
							125.72	126.45							Dark Grey	Interbedded Mudstone/Sandstone	Siltstone			Heavily weathered from 125.82m-125.92m
							126.45	126.50	LOST CORE	LOST CORE	LOST CORE	LOST CORE	LOST CORE	LOST CORE	LOST CORE	LOST CORE	LOST CORE	LOST CORE	LOST CORE	LOST CORE
126.50	128.00	1.42	94.67	0.58	38.67	13.00	126.50	126.58	LOST CORE	LOST CORE	LOST CORE	LOST CORE	LOST CORE	LOST CORE	LOST CORE	LOST CORE	LOST CORE	LOST CORE	LOST CORE	LOST CORE
							126.58	128.00	10,22	16	Irregular	Slightly Rough	Isolated (6->12cm)	20°	Dark Grey-Black	Interbedded Anthracite/Mudstone	Anthracite Coal	Interbedded		Mudstone with minor coal interbeds

TERRACON GEOTECHNIQUE

CLIENT: Arctos Anthracite Joint Venture
PROJECT NUMBER: 122781

HOLE ID: GP-19/MW-28d
PROJECT LOCATION: Arctos Anthracite Property

DATE STARTED: July 23rd, 2013 COMPLETED: July 27th, 2013
DRILL CONTRACTOR: Driftwood RIG #:
HOLE SIZE: HQ
DRILLING METHOD: Diamond
LOGGED BY: G.McLearn/M. CHECKED BY:

Ground Elevation [masl] 1663
Easting 506019.0
Northing 6343036.0
Water Table Depth [m]
Total Depth [m] 133.5m

COMMENTS:

Run Depth		Core Recovery		RQD Length (Pieces >10cm) [m]	RQD length /run length x100 [%]	Number of Joints (per run)	Core Depth		Schmidt Hammer Tests		Joint Details				Colour	Major Lithology	Minor Lithology	Features	Comments
From [m]	To [m]	Rec. [m]	Rec. [%]				From [m]	To [m]	Test 'R' Values	Avg 'R' Value	Geometry	Roughness	Spacing	Joint Angle [°]					
0.00	1.50	0.70	46.67	0.00	0.00	0.00	0.00	0.80	LOST CORE	LOST CORE	LOST CORE	LOST CORE	LOST CORE	LOST CORE	LOST CORE	LOST CORE	LOST CORE	LOST CORE	LOST CORE
							0.80	1.50	n/a	n/a	n/a	n/a	n/a			Overburden		Clasts-Assorted	
1.50	3.00	1.10	73.33	0.33	22.00	4.00	1.50	2.60	n/a	n/a	Planar	Smooth	Occasional (3-6cm)	40°	Dark Grey	Clay			
							2.60	3.00	LOST CORE	LOST CORE	LOST CORE	LOST CORE	LOST CORE	LOST CORE	LOST CORE	LOST CORE	LOST CORE	LOST CORE	LOST CORE
3.00	4.50	1.45	96.67	0.55	36.67	11.00	3.00	4.45	10	10	Planar	Slighty Rough	Isolated (6->12cm)	50°	Dark Grey	Mudstone			Hard
							4.45	4.50	LOST CORE	LOST CORE	LOST CORE	LOST CORE	LOST CORE	LOST CORE	LOST CORE	LOST CORE	LOST CORE	LOST CORE	LOST CORE
4.50	6.00	1.40	93.33	0.71	47.33	6.00	4.50	5.90	27,26	26.5	Planar	Slighty Rough	Isolated (6->12cm)	85°, 40°	Dark Grey	Mudstone			
							5.90	6.00	LOST CORE	LOST CORE	LOST CORE	LOST CORE	LOST CORE	LOST CORE	LOST CORE	LOST CORE	LOST CORE	LOST CORE	LOST CORE
6.00	7.50	1.40	93.33	0.45	30.00	8.00	6.00	6.10	LOST CORE	LOST CORE	LOST CORE	LOST CORE	LOST CORE	LOST CORE	LOST CORE	LOST CORE	LOST CORE	LOST CORE	LOST CORE
							6.10	7.50	44,26	35	Planar	Slighty Rough	Isolated (6->12cm)	50°, 30°	Dark Grey	Mudstone			contact at 6.2m
7.50	9.00	1.50	100.00	0.2	13.33	15	7.50	9.00			Planar	Smooth	Occasional (3-6cm)	85°	Medium Grey	Sandstone		Quartz Vein(s) cm scale	
9.00	10.50	1.32	88.00	0.28	18.67	14.00	9.00	9.19	0	0	Planar	Slighty Rough	Occasional (3-6cm)	55°	Medium-Dark Grey	Interbedded Mudstone/Sandstone			Very weathered, fine grained sandstone with mudstone laminae.
							9.19	10.32			Planar	Slighty Rough	Isolated (6->12cm)	30°	Medium-Dark Grey	Interbedded Mudstone/Sandstone			Heavily fractured/jointed fine grained sandstone with mudstone laminae.
							10.32	10.50	LOST CORE	LOST CORE	LOST CORE	LOST CORE	LOST CORE	LOST CORE	LOST CORE	LOST CORE	LOST CORE	LOST CORE	LOST CORE
10.50	12.00	1.50	100.00	1.02	68.00	6	10.50	12.00	14,0	7	Irregular	Slighty Rough	Isolated (6->12cm)	40°, 30°	Medium Grey	Sandstone		Quartz Stringers	Very fine grained silty sandstone with occasional mudstone interlaminations.
12.00	13.50	1.40	93.33	0.65	43.33	16.00	12.00	12.10	LOST CORE	LOST CORE	LOST CORE	LOST CORE	LOST CORE	LOST CORE	LOST CORE	LOST CORE	LOST CORE	LOST CORE	LOST CORE
							12.10	13.50	0	0	Planar	Slighty Rough	Isolated (6->12cm)	55°	Medium Grey	Sandstone			Heavily fractured/jointed, Very fine grained silty sandstone with occasional mudstone interlaminations.
13.50	15.00	1.32	88.00	0.71	47.33	18.00	13.50	13.68	LOST CORE	LOST CORE	LOST CORE	LOST CORE	LOST CORE	LOST CORE	LOST CORE	LOST CORE	LOST CORE	LOST CORE	LOST CORE
							13.68	15.00	35,36	35.5	Planar	Slighty Rough	Occasional (3-6cm)	60°, 40°	Medium Grey	Sandstone			Heavily fractured/jointed at start and end of run, Very fine grained silty sandstone with occasional mudstone interlaminations.
15.00	16.50	1.50	100.00	1.22	81.33	7	15.00	16.50	0	0	Planar	Slighty Rough	Isolated (6->12cm)	30°	Medium Grey	Sandstone		Quartz Vein(s) cm scale	Very fine-fine grained sandstone with trace mudstone laminae.
16.50	18.00	1.50	100.00	1.22	81.33	6	16.50	18.00	33,36	34.5	Planar	Slighty Rough	Isolated (6->12cm)	50°, 30°	Medium Grey	Sandstone		Quartz Vein(s) mm scale	Very fine-fine grained sandstone with occasional mudstone laminae.
18.00	19.50	1.40	93.33	0.79	52.67	11.00	18.00	19.40	0	0	Irregular	Slighty Rough	Isolated (6->12cm)	65°, 30°, 70°	Medium-Dark Grey	Interbedded Mudstone/Sandstone		Quartz Vein(s) mm scale	Very fine-fine grained sandstone with mudstone interlaminae.
							19.40	19.50	LOST CORE	LOST CORE	LOST CORE	LOST CORE	LOST CORE	LOST CORE	LOST CORE	LOST CORE	LOST CORE	LOST CORE	LOST CORE
19.50	21.00	1.45	96.67	1.15	76.67	5.00	19.50	20.95	30,30	30	Irregular	Slighty Rough	Isolated (6->12cm)	60°, 20°	Medium-Dark Grey	Sandstone		Quartz Vein(s) mm scale	Very fine-fine grained silty sandstone, trace mud clasts
							20.95	21.00	LOST CORE	LOST CORE	LOST CORE	LOST CORE	LOST CORE	LOST CORE	LOST CORE	LOST CORE	LOST CORE	LOST CORE	LOST CORE
21.00	22.50	1.43	95.33	0.35	23.33	11.00	21.00	22.43	38,42	40	Irregular	Slighty Rough	Isolated (6->12cm)	75°, 30°	Medium-Dark Grey	Sandstone		Quartz Vein(s) mm scale	Very fine-fine grained silty sandstone, with trace mudstone interlaminae
							22.43	22.50	LOST CORE	LOST CORE	LOST CORE	LOST CORE	LOST CORE	LOST CORE	LOST CORE	LOST CORE	LOST CORE	LOST CORE	LOST CORE

Run Depth		Core Recovery		RQD Length (Pieces >10cm) [m]	RQD length /run length x100 [%]	Number of Joints (per run)	Core Depth		Schmidt Hammer Tests		Joint Details				Colour	Major Lithology	Minor Lithology	Features	Comments
From [m]	To [m]	Rec. [m]	Rec. [%]				From [m]	To [m]	Test 'R' Values	Avg 'R' Value	Geometry	Roughness	Spacing	Joint Angle [°]					
22.50	24.00	1.40	93.33	1.23	82.00	11.00	22.50	23.90	28,24	26	Planar	Smooth	Isolated (6->12cm)	30°	Medium-Dark Grey	Interbedded Mudstone/Sandstone			Very fine-fine grained silty sandstone, with mudstone interlaminae
							23.90	24.00	LOST CORE	LOST CORE	LOST CORE	LOST CORE	LOST CORE	LOST CORE	LOST CORE	LOST CORE	LOST CORE	LOST CORE	LOST CORE
24.00	25.50	1.50	100.00	1.15	76.67	8	24.00	25.12	30,30	30	Planar	Smooth	Isolated (6->12cm)	30°	Medium-Dark Grey	Interbedded Mudstone/Sandstone			Very fine-fine grained silty sandstone with mudstone interbeds.
							25.12	25.50			Planar	Smooth	Isolated (6->12cm)	30°	Dark grey-Black	Mudstone			Mudstone with silty sandstone interlaminae.
25.50	27.00	1.40	93.33	0.70	46.67	10.00	25.50	25.60	LOST CORE	LOST CORE	LOST CORE	LOST CORE	LOST CORE	LOST CORE	LOST CORE	LOST CORE	LOST CORE	LOST CORE	LOST CORE
							25.60	27.00	0	0	Irregular	Slighty Rough	Isolated (6->12cm)	40°, 30°	Dark Grey-Black	Mudstone			Silty mudstone with occasional very fine grained sandstone interlaminae.
27.00	28.50	1.50	100.00	1.5	100.00	1	27.00	28.50	16,16	16	Planar	Smooth	Isolated (6->12cm)	30°	Dark Grey-Black	Mudstone		Pyrite	Silty mudstone with occasional very fine grained sandstone interlaminae.Numerous window pane type micro-fractures. Pyrite present.
28.50	30.00	1.50	100.00	1.33	88.67	5	28.50	30.00	0	0	Planar	Slighty Rough	Isolated (6->12cm)	20°	Dark Grey-Black	Mudstone			Silty mudstone with occasional very fine grained sandstone interlaminae.
30.00	31.50	1.43	95.33	1.25	83.33	3.00	30.00	31.43	0	0	Irregular	Smooth	Isolated (6->12cm)	20°, 90°	Dark Grey-Black	Mudstone			Silty mudstone with occasional very fine grained sandstone interlaminae.
							31.43	31.50	LOST CORE	LOST CORE	LOST CORE	LOST CORE	LOST CORE	LOST CORE	LOST CORE	LOST CORE	LOST CORE	LOST CORE	LOST CORE
31.50	33.00	1.39	92.67	1.35	90.00	4	31.50	33.00	18,33	25.5	Irregular	Slighty Rough	Isolated (6->12cm)	40°, 30°	Dark Grey-Black	Mudstone		Pyrite	Silty mudstone with occasional very fine grained sandstone interlaminae. Numerous window pane type micro-fractures. Pyrite present.
33.00	34.50	1.50	100.00	1.5	100.00	2	33.00	34.50	0	0	Irregular	Smooth	Isolated (6->12cm)	20°	Dark Grey-Black	Mudstone		Pyrite	Silty mudstone with occasional very fine grained sandstone interlaminae. Numerous window pane type micro-fractures. Pyrite present.
34.50	36.00	1.50	100.00	1.35	90.00	~5	34.50	34.86	0	0	Irregular	Slighty Rough	Isolated (6->12cm)	30°	Dark Grey-Black	Mudstone		Pyrite	Silty mudstone with occasional very fine grained sandstone interlaminae. Numerous window pane type micro-fractures. Pyrite present.
							34.86	36.00	0	0	Irregular	Slighty Rough	Isolated (6->12cm)	30°	Dark Grey-Black	Mudstone		Pyrite	Silty mudstone, very weathered and jointed/ fractured. Cm scale quartz veins, quartz stringers, and pyrite present
36.00	37.50	1.20	80.00	0.09	6.00	13.00	36.00	36.19	12,10	11	Planar	Smooth	Numerous (1-3cm)	75	Dark Grey	Mudstone		Quartz Vein(s) cm scale	Trace coal lamili, Qtz at 90 deg.
							36.19	36.55			Planar	Polished		85°	Dark Grey-Black	Interbedded Anthracite/Mudstone			36.45-36.55: siltsone, light grey, soft
							36.55	37.20							Black	Anthracite Coal		Quartz Stringers	
							37.20	37.50	LOST CORE	LOST CORE	LOST CORE	LOST CORE	LOST CORE	LOST CORE	LOST CORE	LOST CORE	LOST CORE	LOST CORE	LOST CORE
37.50	39.00	1.40	93.33	0.90	60.00	5.00	37.50	38.90	0	0	Planar	Slighty Rough	Isolated (6->12cm)	60°, 80°	Dark Grey	Mudstone		Quartz Stringers	20% sandstone, <1cm thickness, Qtz has carbonate.
							38.90	39.00	LOST CORE	LOST CORE	LOST CORE	LOST CORE	LOST CORE	LOST CORE	LOST CORE	LOST CORE	LOST CORE	LOST CORE	LOST CORE
39.00	40.50	1.50	100.00	0.41	27.33	6	39.00	40.50	19,17	18	Planar	Slighty Rough	Isolated (6->12cm)	65, 40°		Mudstone		Quartz Vein(s) cm scale	20% sandstone, very fine grain, <1cm, quartz vuggy
40.50	42.00	1.35	90.00	0.63	42.00	9.00	40.50	40.65	28,18,26	24	Planar	Smooth		25	Dark Grey	Mudstone			30% sandstone very fine grain.
							40.65	41.85			Planar	Smooth	Abundant (<1cm)	40°		Mudstone			
							41.85	42.00	LOST CORE	LOST CORE	LOST CORE	LOST CORE	LOST CORE	LOST CORE	LOST CORE	LOST CORE	LOST CORE	LOST CORE	LOST CORE
42.00	43.50	1.43	95.33	0.63	42.00	3.00	42.00	42.07	LOST CORE	LOST CORE	LOST CORE	LOST CORE	LOST CORE	LOST CORE	LOST CORE	LOST CORE	LOST CORE	LOST CORE	LOST CORE
							42.07	43.50	42,42	42	Planar	Slighty Rough	Isolated (6->12cm)	50°	Dark Grey	Mudstone			20% sandstone fine grain, 6cm bentonite-clay:joint fill, white at 70 deg.
43.50	45.00	1.50	100.00	0.98	65.33	2	43.50	45.00	12,18	15	Planar	Slighty Rough	Isolated (6->12cm)	60°	Medium-Dark Grey	Interbedded Mudstone/Sandstone			30% sandstone disseminated throughout.
45.00	46.50	1.50	100.00	1.49	99.33	2	45.00	46.50	25,36	30.5	Planar	Slighty Rough	Isolated (6->12cm)	50°	Dark Grey	Mudstone			20% sandstone fine grain, massive.
46.50	48.00	1.34	89.33	1.05	70.00	6.00	46.50	46.66	LOST CORE	LOST CORE	LOST CORE	LOST CORE	LOST CORE	LOST CORE	LOST CORE	LOST CORE	LOST CORE	LOST CORE	LOST CORE
							46.66	47.15	36,34	35	Planar	Smooth	Isolated (6->12cm)	40°	Dark Grey	Mudstone			massive
							47.15	47.84			Curved	Smooth		50°	White	Bentonite			contact ~50 deg, massive
							47.84	48.00	LOST CORE	LOST CORE	LOST CORE	LOST CORE	LOST CORE	LOST CORE	LOST CORE	LOST CORE	LOST CORE	LOST CORE	LOST CORE

Run Depth		Core Recovery		RQD Length (Pieces >10cm) [m]	RQD length /run length x100 [%]	Number of Joints (per run)	Core Depth		Schmidt Hammer Tests		Joint Details				Colour	Major Lithology	Minor Lithology	Features	Comments
From [m]	To [m]	Rec. [m]	Rec. [%]				From [m]	To [m]	Test 'R' Values	Avg 'R' Value	Geometry	Roughness	Spacing	Joint Angle [°]					
48.00	49.50	1.41	94.00	0.72	48.00	4.00	48.00	49.41	15,15	15	Planar	Smooth	Isolated (6->12cm)	40°, 50°	Dark Grey	Mudstone			10% disseminated sandstone fine grain, massive.
							49.41	49.50	LOST CORE	LOST CORE	LOST CORE	LOST CORE	LOST CORE	LOST CORE	LOST CORE	LOST CORE	LOST CORE	LOST CORE	LOST CORE
49.50	51.00	1.50	100.00	1.04	69.33	2	49.50	50.10	33,22,28	27.5	Planar	Slighty Rough	Isolated (6->12cm)	30°	Medium-Dark Grey	Interbedded Mudstone/Sandstone			30% sandstone
							50.10	51.00							Medium Grey	Sandstone			10% mudstone clasts
51.00	52.50	1.50	100.00	0.82	54.67	9	51.00	52.50	22,32,35	29.5	Planar	Smooth	Isolated (6->12cm)	70°, 50°	Medium Grey	Sandstone		Mudclasts	Clasts and bands, <1cm
52.50	54.00	1.27	84.67	0.48	32.00	5.00	52.50	52.73	LOST CORE	LOST CORE	LOST CORE	LOST CORE	LOST CORE	LOST CORE	LOST CORE	LOST CORE	LOST CORE	LOST CORE	LOST CORE
							52.73	54.00	15,22	18.5	Planar	Slighty Rough	Isolated (6->12cm)	70°	Medium Grey	Sandstone			30% Mudstone bands <1cm wide
54.00	55.50	0.98	65.33	0.16	10.67	2.00	54.00	54.52	LOST CORE	LOST CORE	LOST CORE	LOST CORE	LOST CORE	LOST CORE	LOST CORE	LOST CORE	LOST CORE	LOST CORE	LOST CORE
							54.52	55.50		0	Irregular	Slighty Rough	Isolated (6->12cm)	70°	Medium Grey	Sandstone		Quartz Vein(s) mm scale	10% Mudstone bands <1cm
55.50	57.00	1.30	86.67	0.70	46.67	4.00	55.50	56.80	14,34,28	25.3	Planar	Slighty Rough	Isolated (6->12cm)	60°, 80°	Medium Grey	Sandstone			20% Mudstone, bands and clasts.
							56.80	57.00	LOST CORE	LOST CORE	LOST CORE	LOST CORE	LOST CORE	LOST CORE	LOST CORE	LOST CORE	LOST CORE	LOST CORE	LOST CORE
57.00	58.50	1.50	100.00	1.17	78.00	8	57.00	58.50	30,36	33	Planar	Smooth	Isolated (6->12cm)	80°, 30°	Medium Grey	Sandstone			20% Mudstone mm-cm
58.50	60.00	1.20	80.00	0.42	28.00	5.00	58.50	58.80	LOST CORE	LOST CORE	LOST CORE	LOST CORE	LOST CORE	LOST CORE	LOST CORE	LOST CORE	LOST CORE	LOST CORE	LOST CORE
							58.80	60.00	30,40	35	Irregular	Slighty Rough	Isolated (6->12cm)	60°	Medium Grey	Sandstone			10% Mudstone <cm
60.00	61.50	1.33	88.67	0.91	60.67	5.00	60.00	61.33	18,19	18.5	Planar	Smooth	Isolated (6->12cm)	30°	Medium Grey	Sandstone			10% Mudstone bands <2cm
							61.33	61.50	LOST CORE	LOST CORE	LOST CORE	LOST CORE	LOST CORE	LOST CORE	LOST CORE	LOST CORE	LOST CORE	LOST CORE	LOST CORE
61.50	63.00	1.50	100.00	0.77	51.33	8	61.50	63.00	35,34	34.5	Planar	Smooth	Isolated (6->12cm)	30°, 80°, 90°	Medium Grey	Sandstone			5% Mudstone mm bands
63.00	64.50	1.50	100.00	1.5	100.00	3	63.00	64.50	31,45,31	35.5	Planar	Slighty Rough	Isolated (6->12cm)	20°, 30°	Medium Grey	Sandstone			1% Mudstone continuous bands, <1cm
64.50	66.00	1.43	95.33	0.66	44.00	3.00	64.50	64.57	LOST CORE	LOST CORE	LOST CORE	LOST CORE	LOST CORE	LOST CORE	LOST CORE	LOST CORE	LOST CORE	LOST CORE	LOST CORE
							64.57	66.00	18,14	16	Planar	Smooth	Isolated (6->12cm)	25	Medium Grey	Sandstone			1% Mudstone bands
66.00	67.50	1.50	100.00	0.91	60.67	3	66.00	67.39	25,28	26.5	Planar	Slighty Rough	Isolated (6->12cm)	30°	Medium Grey	Sandstone			
							67.39	67.50			Planar	Smooth		30°	Dark Grey-Black	Mudstone			Sharp contact with massive mudstone.
67.50	69.00	1.16	77.33	0.50	33.33	7.00	67.50	67.70	20	20	Planar	Smooth	Occasional (3-6cm)	30°	Dark Grey-Black	Mudstone		Pyrite	<1% pyrite structure related 30 deg.
							67.70	68.66							Black	Anthracite Coal		Pyrite	<1% Pyrite nodules and mm bands
							68.66	69.00	LOST CORE	LOST CORE	LOST CORE	LOST CORE	LOST CORE	LOST CORE	LOST CORE	LOST CORE	LOST CORE	LOST CORE	LOST CORE
69.00	70.50	1.34	89.33	0.29	19.33	8.00	69.00	69.75	0	0					Black	Anthracite Coal			
							69.75	70.34			Planar	Slighty Rough	Isolated (6->12cm)	70°	Dull Grey	Interbedded Siltstone/Coal		Quartz Vein(s) mm scale	dull grey, 1% coal,bands, <1cm, siltstone
							70.34	70.50	LOST CORE	LOST CORE	LOST CORE	LOST CORE	LOST CORE	LOST CORE	LOST CORE	LOST CORE	LOST CORE	LOST CORE	LOST CORE
70.50	72.00	1.50	100.00	0.23	15.33	5	70.50	72.00	10,16	13	Planar	Slighty Rough	Numerous (1-3cm)	70°	Dull Grey	Siltstone			massive
72.00	73.50	1.50	100.00	0.91	60.67	4	72.00	72.65	25,24	24.5	Planar	Smooth	Isolated (6->12cm)	30°	Dull Grey	Siltstone			
							72.65	73.15							Dark Grey-Black	Interbedded Anthracite/Mudstone			30% Mudstone, fractured and possible faulted.
							73.15	73.50	37,30	33.5					Dark Grey-Black	Mudstone			1% coal stringers, massive.
73.50	75.00	1.35	90.00	1.35	90.00	3.00	73.50	73.65	30,17,30	25.5	Planar	Slighty Rough	Isolated (6->12cm)	35	Dark Grey-Black	Mudstone		Quartz Vein(s) mm scale	<1% coal stringers, massive
							73.65	75.00	LOST CORE	LOST CORE	LOST CORE	LOST CORE	LOST CORE	LOST CORE	LOST CORE	LOST CORE	LOST CORE	LOST CORE	LOST CORE
75.00	76.50	1.44	96.00	0.63	42.00	6.00	75.00	76.44	42,46	44	Stepped	Smooth	Isolated (6->12cm)	70°	Dark Grey-Black	Mudstone		Quartz Stringers	<1% coal stringers, massive
							76.44	76.50	LOST CORE	LOST CORE	LOST CORE	LOST CORE	LOST CORE	LOST CORE	LOST CORE	LOST CORE	LOST CORE	LOST CORE	LOST CORE

Run Depth		Core Recovery		RQD Length (Pieces >10cm) [m]	RQD length /run length x100 [%]	Number of Joints (per run)	Core Depth		Schmidt Hammer Tests		Joint Details				Colour	Major Lithology	Minor Lithology	Features	Comments
From [m]	To [m]	Rec. [m]	Rec. [%]				From [m]	To [m]	Test 'R' Values	Avg 'R' Value	Geometry	Roughness	Spacing	Joint Angle [°]					
76.50	78.00	1.50	100.00	0.48	32.00	4	76.50	78.00	14,16	15	Planar	Smooth	Isolated (6->12cm)	30°, 70°	Dark Grey-Black	Interbedded Anthracite/Mudstone		Quartz Stringers	15cm Coal interlayered with Mud
78.00	79.50	1.50	100.00	0.43	28.67	3	78.00	79.50	25,30	27.5	Planar	Slighty Rough	Occasional (3-6cm)	80°, 50°	Dark Grey-Black	Mudstone			<1% coal, massive
79.50	81.00	1.50	100.00	1.27	84.67	2	79.50	81.00	28,33	30.5	Planar	Smooth	Isolated (6->12cm)	30°	Dark Grey-Black	Interbedded Mudstone/Siltstone			30% silt mm layers
81.00	82.50	1.50	100.00	1.23	82.00	2	81.00	82.50	28,42,42	37.3	Planar	Smooth	Isolated (6->12cm)	40°	Dark Grey	Interbedded Mudstone/Siltstone		Quartz Stringers	Siltstone-mud stone in equal amounts.
82.50	84.00	1.33	88.67	0.53	35.33	2.00	82.50	82.67	LOST CORE	LOST CORE	LOST CORE	LOST CORE	LOST CORE	LOST CORE	LOST CORE	LOST CORE	LOST CORE	LOST CORE	LOST CORE
							82.67	84.00	13,26	19.5	Planar	Slighty Rough	Isolated (6->12cm)	20°	Dark Grey-Black	Interbedded Mudstone/Siltstone		Quartz Vein(s) mm scale	40% Silt lamina, <1% Coal
84.00	85.50	1.50	100.00	1.03	68.67	1	84.00	85.50	15,12	13.5	Irregular	Slighty Rough	Isolated (6->12cm)	70°	Dark Grey-Black	Interbedded Mudstone/Siltstone			
85.50	87.00	1.50	100.00	1.08	72.00	2	85.50	87.00	21,28	24.5	Irregular	Striated	Isolated (6->12cm)	90°	Dark Grey-Black	Interbedded Mudstone/Siltstone		Quartz Vein(s) cm scale	
87.00	88.50	1.50	100.00	1.5	100.00	1	87.00	88.50	0	0	Planar	Slighty Rough	Isolated (6->12cm)	20°	Dark Grey-Black	Interbedded Mudstone/Siltstone			
88.50	90.00	1.43	95.33	1.43	95.33	2.00	88.50	89.93	0	0	Planar	Slighty Rough	Isolated (6->12cm)	70°, 30°	Dark Grey-Black	Interbedded Mudstone/Siltstone			
							89.93	90.00	LOST CORE	LOST CORE	LOST CORE	LOST CORE	LOST CORE	LOST CORE	LOST CORE	LOST CORE	LOST CORE	LOST CORE	LOST CORE
90.00	91.50	1.42	94.67	1.42	94.67	2.00	90.00	91.42	0	0	Planar	Slighty Rough	Isolated (6->12cm)	20°, 90°	Dark Grey-Black	Interbedded Mudstone/Siltstone			
							91.42	91.50	LOST CORE	LOST CORE	LOST CORE	LOST CORE	LOST CORE	LOST CORE	LOST CORE	LOST CORE	LOST CORE	LOST CORE	LOST CORE
91.50	93.00	1.50	100.00	1.5	100.00	0	91.50	93.00	0	0	n/a	n/a	n/a	n/a	Dark Grey-Black	Interbedded Mudstone/Siltstone		Pyrite	minor pyrite grains within sandy laminations.
93.00	94.50	1.50	100.00	1.5	100.00	0	93.00	94.50	32,34	33	n/a	n/a	n/a	n/a	Dark Grey-Black	Interbedded Mudstone/Siltstone			Interbedded mudstone/siltstone with sandy interlaminae, some containing pyrite grains, flaser bedding.
94.50	96.00	1.44	96.00	1.44	96.00	0.00	94.50	94.56	LOST CORE	LOST CORE	LOST CORE	LOST CORE	LOST CORE	LOST CORE	LOST CORE	LOST CORE	LOST CORE	LOST CORE	LOST CORE
							94.56	96.00	0	0	n/a	n/a	n/a	n/a	Dark Grey-Black	Interbedded Mudstone/Siltstone		Pyrite	Interbedded mudstone/siltstone with sandy interlaminae, some containing pyrite grains.
96.00	97.50	1.35	90.00	1.00	66.67	1.00	96.00	96.15	LOST CORE	LOST CORE	LOST CORE	LOST CORE	LOST CORE	LOST CORE	LOST CORE	LOST CORE	LOST CORE	LOST CORE	LOST CORE
							96.15	97.50	20,24	22	Irregular	Slighty Rough	Isolated (6->12cm)	90°	Dark Grey-Black	Interbedded Mudstone/Siltstone		Pyrite	Interbedded mudstone/siltstone with sandy interlaminae, some containing pyrite grains.
97.50	99.00	1.44	96.00	1.20	80.00	3.00	97.50	97.56	LOST CORE	LOST CORE	LOST CORE	LOST CORE	LOST CORE	LOST CORE	LOST CORE	LOST CORE	LOST CORE	LOST CORE	LOST CORE
							97.56	99.00	30,35	32.5	Planar	Smooth	Isolated (6->12cm)	20°	Dark Grey-Black	Interbedded Mudstone/Siltstone			
99.00	100.50	1.50	100.00	1.16	77.33	2	99.00	100.50	27,26	26.5	Irregular	Slighty Rough	Isolated (6->12cm)	70°	Dark Grey-Black	Interbedded Mudstone/Siltstone			Interbedded mudstone/siltstone with sandy interlaminae, flaser bedding.
100.50	102.00	1.45	96.67	1.45	96.67	1.00	100.50	100.55	LOST CORE	LOST CORE	LOST CORE	LOST CORE	LOST CORE	LOST CORE	LOST CORE	LOST CORE	LOST CORE	LOST CORE	LOST CORE
							100.55	102.00	17,17	17	Planar	Slighty Rough	Isolated (6->12cm)	20°	Dark Grey-Black	Interbedded Mudstone/Siltstone			Interbedded mudstone/siltstone with sandy interlaminae, flaser bedding.
102.00	103.50	1.50	100.00	1.06	70.67	3	102.00	103.50	0	0	Planar	Smooth	Isolated (6->12cm)	20°, 60°	Dark Grey-Black	Interbedded Mudstone/Siltstone			
103.50	105.00	1.40	93.33	1.25	83.33	1.00	103.50	103.60	LOST CORE	LOST CORE	LOST CORE	LOST CORE	LOST CORE	LOST CORE	LOST CORE	LOST CORE	LOST CORE	LOST CORE	LOST CORE
							103.60	105.00	0	0	Irregular	Smooth	Isolated (6->12cm)	50°	Dark Grey-Black	Interbedded Mudstone/Siltstone		Quartz Stringers	microfractures present
105.00	106.50	1.50	100.00	0.65	43.33	6	105.00	106.50	0	0	Irregular	Striated	Isolated (6->12cm)	70°, 20°	Dark Grey-Black	Interbedded Mudstone/Siltstone		Quartz Vein(s) cm scale	Weathered along some joints, heavily fractured/jointed near quartz veins
106.50	108.00	1.50	100.00	1.2	80.00	6	106.50	107.50	0	0	Planar	Slighty Rough	Isolated (6->12cm)	90°	Dark Grey-Black	Interbedded Mudstone/Siltstone			
							107.50	108.00			Planar	Slighty Rough	Isolated (6->12cm)	25°	Dark Grey-Black	Interbedded Mudstone/Sandstone			Interbedded fine grained sandstone/mudstone,weathered along contacts between sandstone/mudstone. Fractured.
108.00	109.50	1.50	100.00	0.73	48.67	13	108.00	109.05	23,28	25.5	Irregular	Slighty Rough	Isolated (6->12cm)	70°	Dark Grey-Black	Interbedded Mudstone/Sandstone		Quartz Stringers	Interbedded fine grained sandstone/mudstone,weathered along most contacts between sandstone/mudstone.
							109.05	109.50			Irregular	Slighty Rough	Isolated (6->12cm)	50°	Dark Grey-Black	Interbedded Mudstone/Siltstone			Silty mudstone with occasional fine grained sandstone laminations. Fractured.

Run Depth		Core Recovery		RQD Length (Pieces >10cm) [m]	RQD length /run length x100 [%]	Number of Joints (per run)	Core Depth		Schmidt Hammer Tests		Joint Details				Colour	Major Lithology	Minor Lithology	Features	Comments
From [m]	To [m]	Rec. [m]	Rec. [%]				From [m]	To [m]	Test 'R' Values	Avg 'R' Value	Geometry	Roughness	Spacing	Joint Angle [°]					
109.50	111.00	1.45	96.67	1.03	68.67	2.00	109.50	110.95	LOST CORE	LOST CORE	LOST CORE	LOST CORE	LOST CORE	LOST CORE	LOST CORE	LOST CORE	LOST CORE	LOST CORE	LOST CORE
							110.95	111.00	0	0	Irregular	Slighty Rough	Isolated (6->12cm)	70°	Dark Grey-Black	Interbedded Mudstone/Siltstone		Quartz Stringers	Silty mudstone with occasional fine grained sandstone laminations, flaser bedding.
111.00	112.50	1.45	96.67	1.45	96.67	1.00	111.00	112.45	LOST CORE	LOST CORE	LOST CORE	LOST CORE	LOST CORE	LOST CORE	LOST CORE	LOST CORE	LOST CORE	LOST CORE	LOST CORE
							112.45	112.50	13,36	24.5	Planar	Smooth	Isolated (6->12cm)	20°	Dark Grey-Black	Interbedded Mudstone/Sandstone			Silty mudstone with occasional fine grained sandstone interbeds, flaser bedding.
112.50	114.00	1.50	100.00	1.4	93.33	1	112.50	114.00	34,33	33.5	Planar	Slighty Rough	Isolated (6->12cm)	20°	Dark Grey-Black	Interbedded Mudstone/Sandstone			Silty mudstone with occasional fine grained sandstone interbeds, flaser bedding.
114.00	115.50	1.45	96.67	1.28	85.33	7.00	114.00	115.45	LOST CORE	LOST CORE	LOST CORE	LOST CORE	LOST CORE	LOST CORE	LOST CORE	LOST CORE	LOST CORE	LOST CORE	LOST CORE
							115.45	115.50	0	0	Planar	Smooth	Isolated (6->12cm)	10°	Dark Grey-Black	Interbedded Mudstone/Sandstone			Silty mudstone with occasional fine grained sandstone interbeds, flaser bedding.
115.50	117.00	1.50	100.00	0.5	33.33	8	115.50	117.00	45,42	43.5	Irregular	Slighty Rough	Isolated (6->12cm)	70°, 80°	Dark Grey-Black	Interbedded Mudstone/Sandstone			Silty mudstone with occasional fine grained sandstone interbeds, flaser bedding. Weathered along some sand interbeds, fractured.
117.00	118.50	1.40	93.33	1.25	83.33	1.00	117.00	118.40	LOST CORE	LOST CORE	LOST CORE	LOST CORE	LOST CORE	LOST CORE	LOST CORE	LOST CORE	LOST CORE	LOST CORE	LOST CORE
							118.40	118.50	32,29	30.5	Irregular	Slighty Rough	Isolated (6->12cm)	50°	Dark Grey-Black	Interbedded Mudstone/Sandstone			Silty mudstone with occasional fine grained sandstone interbeds, flaser bedding.
118.50	120.00	1.50	100.00	1.21	80.67	4	118.50	120.00	28,27	27.5	Irregular	Slighty Rough	Isolated (6->12cm)	70°, 50°	Dark Grey-Black	Interbedded Mudstone/Sandstone			Silty mudstone with occasional fine grained sandstone interbeds, flaser bedding.
120.00	121.50	1.50	100.00	1.32	88.00	3	120.00	121.50	30,30	30	Irregular	Slighty Rough	Isolated (6->12cm)	60°, 70°	Dark Grey-Black	Interbedded Mudstone/Sandstone			Silty mudstone with occasional fine grained sandstone interbeds, flaser bedding.
121.50	123.00	1.50	100.00	1.46	97.33	0	121.50	123.00	46,44	45	n/a	n/a	n/a	n/a	Dark Grey-Black	Interbedded Mudstone/Sandstone			Silty mudstone with occasional very fine- fine grained sandstone interbeds, flaser bedding.
123.00	124.50	1.50	100.00	1.45	96.67	0	123.00	124.50	32,37	34.5	n/a	n/a	n/a	n/a	Dark Grey-Black	Interbedded Mudstone/Siltstone			Silty mudstone with occasional very fine- fine grained sandstone interbeds
124.50	126.00	1.38	92.00	0.85	56.67	2.00	124.50	125.50	0	0	Irregular	Slighty Rough	Numerous (1-3cm)	<10	Dark Grey-Black	Interlaminated Mudstone/Siltstone		Quartz Stringers	Silty mudstone with occasional very fine- fine grained sandstone interbeds
							125.50	125.88							Dark Grey-Black	Anthracite Coal		Quartz Stringers	occasional mudstone interbeds
							125.88	126.00	LOST CORE	LOST CORE	LOST CORE	LOST CORE	LOST CORE	LOST CORE	LOST CORE	LOST CORE	LOST CORE	LOST CORE	LOST CORE
126.00	127.50	1.40	93.33	0.30	20.00	>20	126.00	126.10	LOST CORE	LOST CORE	LOST CORE	LOST CORE	LOST CORE	LOST CORE	LOST CORE	LOST CORE	LOST CORE	LOST CORE	LOST CORE
							126.10	127.50	n/a	n/a	Planar	Slighty Rough	Numerous (1-3cm)	30°	Dark Grey-Black	Anthracite Coal		Quartz Stringers	occasional mudstone interbeds
127.50	129.00	1.40	93.33	0.30	20.00	>20	127.50	127.60	LOST CORE	LOST CORE	LOST CORE	LOST CORE	LOST CORE	LOST CORE	LOST CORE	LOST CORE	LOST CORE	LOST CORE	LOST CORE
							127.60	129.00	n/a	n/a	Planar	Slighty Rough	Occasional (3-6cm)	40°	Dark Grey-Black	Anthracite Coal		Quartz Stringers	occasional mudstone interbeds
129.00	130.50	1.40	93.33	0.85	56.67	13.00	129.00	129.33	n/a	n/a					Dark Grey-Black	Anthracite Coal		Quartz Stringers	occasional mudstone interbeds
							129.33	129.67	n/a	n/a	Planar	Polished	Isolated (6->12cm)	20°	Dark Grey-Black	Interbedded Mudstone/Siltstone			Silty mudstone with mm scale coal seams
							129.67	130.40	n/a	n/a					Dark Grey-Black	Anthracite Coal		Quartz Vein(s) mm scale	
							130.40	130.50	LOST CORE	LOST CORE	LOST CORE	LOST CORE	LOST CORE	LOST CORE	LOST CORE	LOST CORE	LOST CORE	LOST CORE	LOST CORE
130.50	132.00	1.50	100.00	0.2	13.33	>20	130.50	132.00	n/a	n/a	Planar	Polished	Occasional (3-6cm)	20°	Dark Grey-Black	Interbedded Anthracite/Mudstone		Quartz Vein(s) mm scale	Interbedded anthracite and mudstone. Some cubic pyrite
132.00	133.50	1.50	100.00	0.15	10.00	>20	132.00	133.50	0	0	Planar	Polished	Isolated (6->12cm)	40°	Dark Grey-Black	Interbedded Mudstone/Siltstone			Interbedded mudstone and siltstone with occasional mm scale coal seams.

APPENDIX D

Photographs

CORE LOG
GD-01

MW15 0.0-8.5m
BX1
1.5
3.0
4.5
6.0
7.5
8.5m
BX2 MW15 8.5 - 11.80m
9.0
10.5
11.80m
MW15 BX3 11.8 — 15.00m
13.5
15.0
15.00m

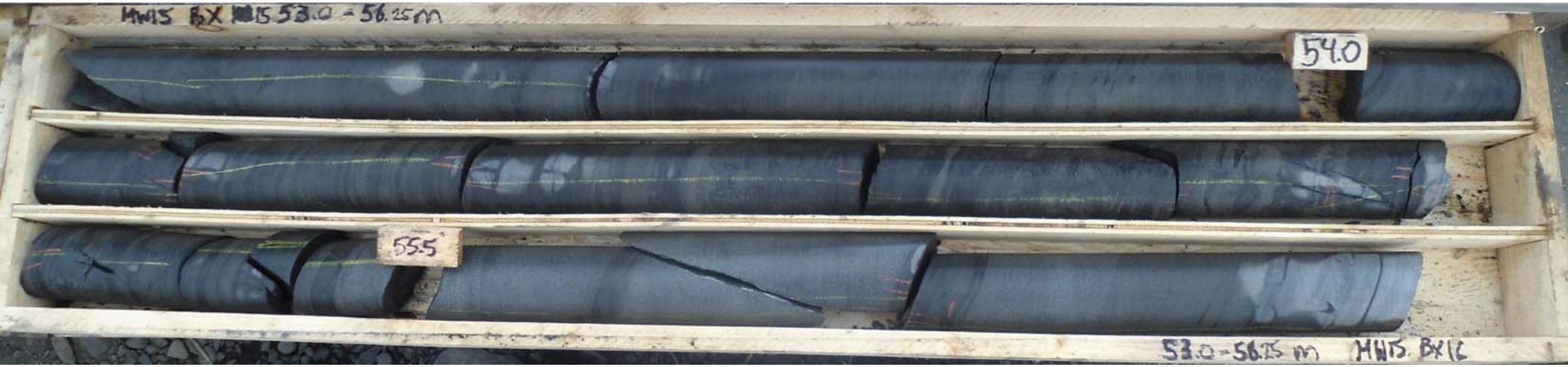
MW15 BX4 15.0-18.2 m
16.5
18.0
18.2
MW15 BX5 18.2 - 21.4m
19.5
21.0
21.4 m
MW15 BX6 21.4 - 24.8 m
22.5
24.0
24.8 m

MW15 BX7 24.8 - 28.0 m
26.5
27.0
27.0 m
MW15 BX8 28.0 - 31.35 m
28.5
30.0
MW15 BX9 28.0 - 31.35 m
MW15 BX10 31.35 - 34.9 m
31.5
33.0
34.5

TOP HW15 BX10 34.9-40.0 m TOP
36.0
37.5
39.0
HW15 BX11 34.9-40.0m
TOP HW15 BX11 40.0-43.5 m
40.5
42.0
40.0-43.5 m

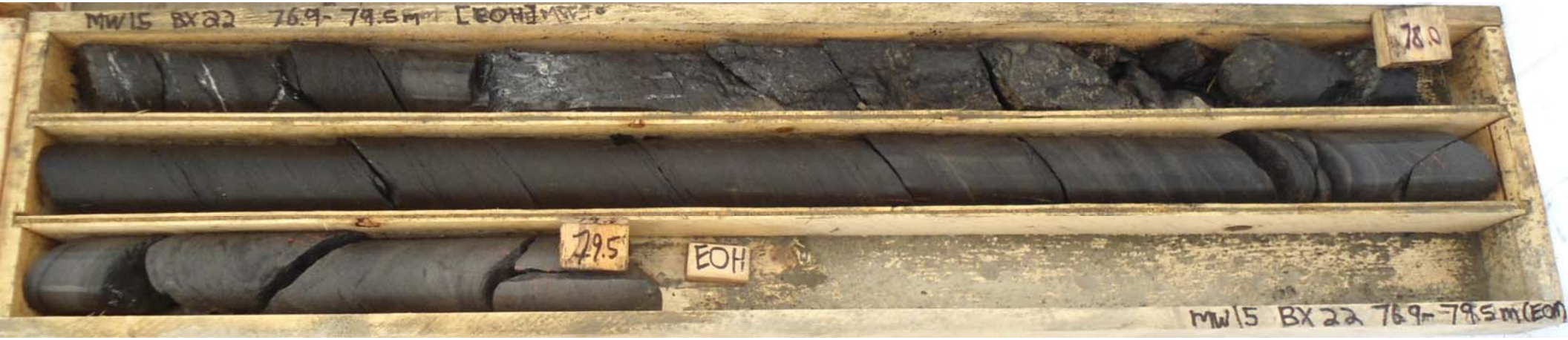
MW15 Ox13 43.5 – 46.7 m
43.5
45.0
46.5
MW15 Ox13 43.5 – 46.7m

MW15 BX 13 46.7-49.7 m
48.0
49.5
MW15 BX 14 49.7 -58.0m
51.0
52.5
49.7-53.0m MW5Bx15


MW15 BX 15 53.0 - 56.25m
54.0
55.5
53.0-56.25 m MW15 BX16

MW15 BX18 58.25 - 59.7m
57.0
58.5
58.25 59.7m MW15 BX18
MW15 BX18 59.70 - 63.00m
60.0
61.5
59.70-63.0 MW15 BX18
MW15 BX18 63.0-66.2
63.0
64.5
66.0
63.0-66.2m MW15 BX18

MW15 Bx 19 68.2 – 69.4m
67.5
69.0
MW15 Bx 19 68.2 – 69.4m
MW15 Bx 20 69.4m – 73.0m
72.0
69.4 – 73.0m MW15 Bx 20
MW15 Bx 21 73.0 – 76.9m
73.5
75.0
76.5
MW15 Bx 21 73.0 – 76.9m

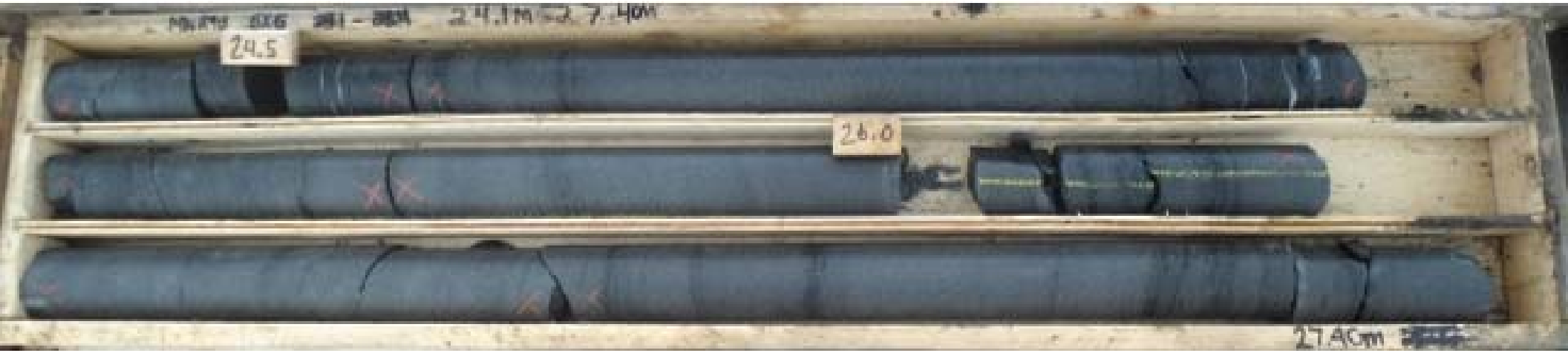

MW15 BX22 76.9-79.5m [EOH]
78.0
79.5
EOH
MW15 BX22 76.9-79.5m (EOH)

CORE LOG
GD-02

0.5
3.0m
2.5
6.5
8.0
9.5
11.0
12.5
13.0
14.90m

15.5
17.0

17.4M - 21.00M
18.5
20.0
21.0M - 24.0M
21.5
23.0


24.5
26.0
27.40m

27.5
29.0
30.5
MW29d BX2 30.5m – 33.5m
32.0
33.5
MW29d BX9 33.5 – 36.9m
35.0
36.5

38.0
39.5
41.0
42.5
44.0
45.5

48.0
48.5
50.0
51.5
53.0
59.5
56.0

57.5
59.0
60.5
62.0

62.90A–66.15M
63.5
65
66.15M

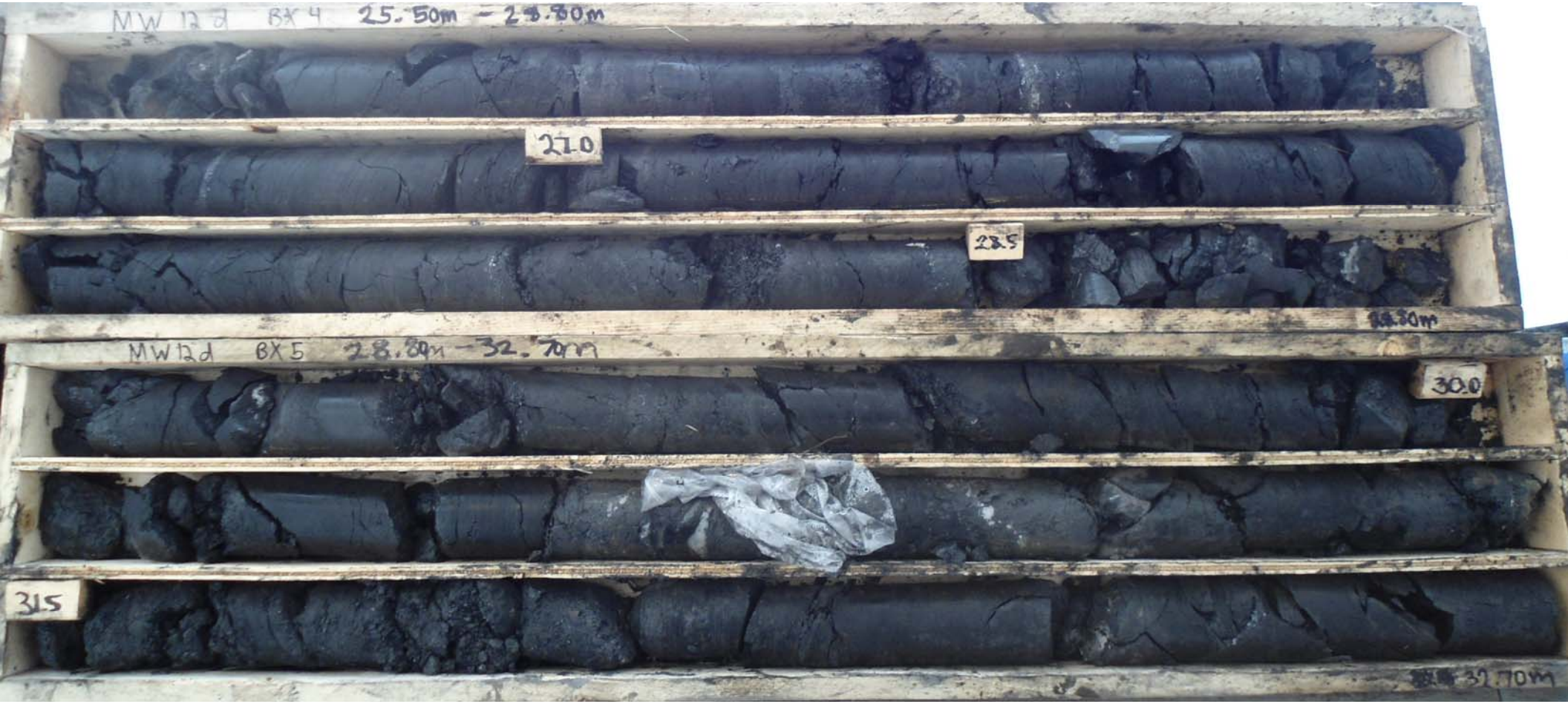
66.5
68.0
69.5
71.0
72.5

78.0
75.5
78.5
EOH
78.5m EOH

CORE LOG
GD-04

MW 12d BX 1 0.09m-10.50m
1.5m
3.0m
4.5m
6.0m
7.5
9.0m
10.5m
MW 12d BX 2 10.50m-21.00m
12.0m
13.5 m
15.0m
16.5m
18.0m
19.5m
21.0m

MW12d BX3 21.00m – 25.50m
22.5
24.0
25.5
25.50m

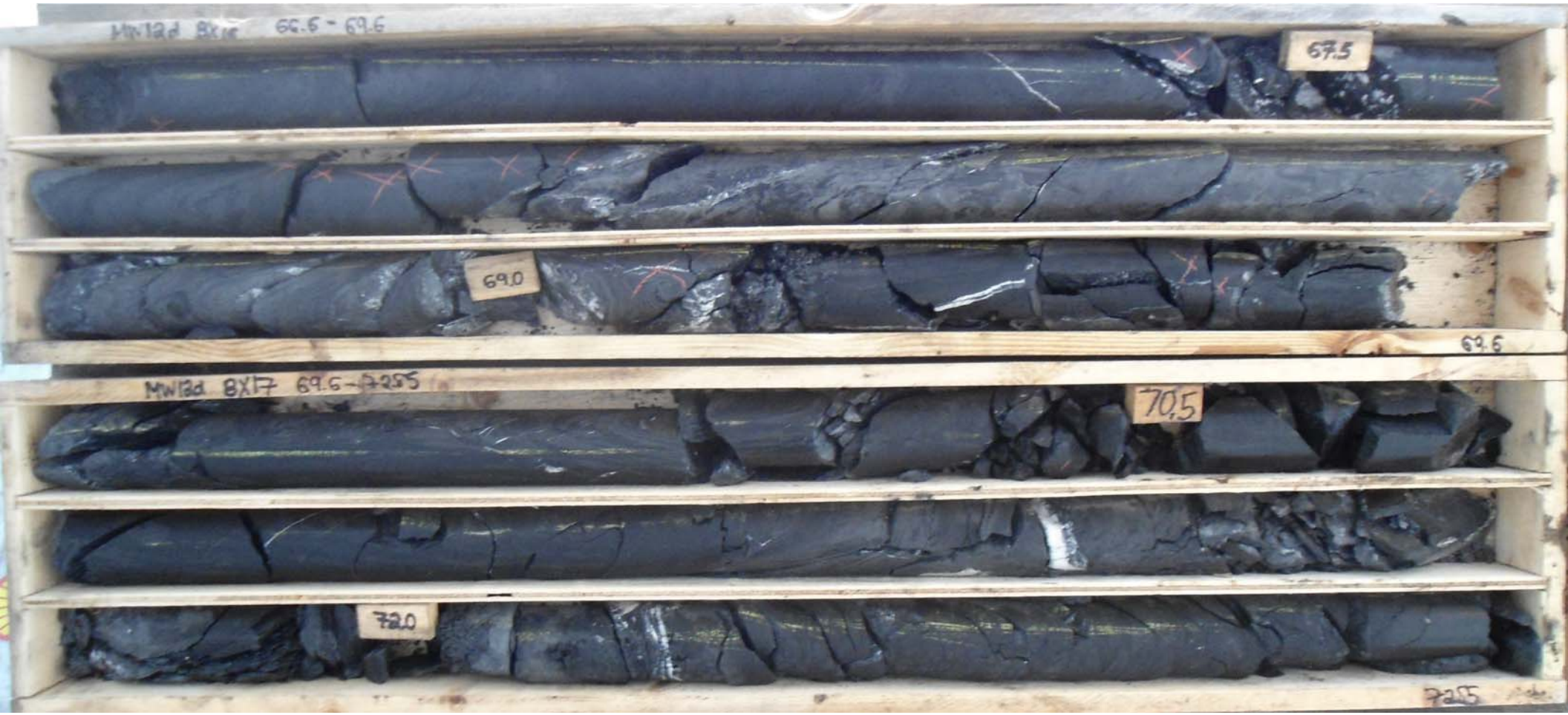

MW 12d BX 4 25.50m - 28.80m
27.0
28.5
MW12d BX 5 28.80m - 32.70m
30.0
31.5

MW12d 32.70-36.00m
33.0
34.5
36.0
36.00m

MW 12 BX-7 36.00m-39.20m
37.5
40 CURVED SR
39.0
40 PL SR
39.20m
MW12d BX8 39.20-42.60m
40.5
42.0
40 CURVED SR
42.60m
MW12d BX9 42.60-45.90m
43.5
45.0
50 PL SR
45.90m

MW18d BX10 45.20-49.20m
46.5
48.0
49.20m
MW18d BX11 49.20-52.50m
51.0
52.50m
MW18d BX12 52.50-56.20m
54.0
55.5
56.20m

MWRd BX13 56.20- 59.30m
57.0
58.5
59.30m
MWRd BX14 59.30- 62.60m
60.0
61.5
62.60m
MWRd BX15 62.60- 66.60m
63.0
64.5
65.0
66.60m


MW12d 8X16 66.6 - 69.6
67.5
69.0
69.6
MW12d 8X17 69.6 - 72.85
70.5
72.0
72.85

MNI2d BXII 72.35 - 76.1
75.5
75.0
76.1

MW13d BX19 76.1 - 79.5
76.5
78.0
79.5
79.5
MW13d BX20 79.5 - 82.5
81.0
82.5
82.5

MWTdd BX21 82.5- 85.5
84.0
85.5
85.5

MW 12d BX22 85.5m - 85.75m
85.75m
EOH
85.75M (EOH)

CORE LOG
GD-12

130459
130460
130461
130462
6
MW-24-DA2 6.0M-10.69M
7.5
9
10.5
10.69

MW-24-1A3 10.69m – 14.71m
12
13.5
14.71

14.74m – 18.08m
130463
SAMPLE
18m
18.08m – 21.85m
21.0

MN24 Box 6 21.85m - 25.32m
83
84
130464
SAMPLE

MW-24-Bx7 25.32M - 28.50M
25.5
27
28.50M
MW-24-Bx10
MW-24-Bx8 28.50M - 31.67M
28.5
30
31.5
0130465
31.67M

31.67M - 35.30 M
33
0130466
345
35.30M

MW-24-BX10 35.30 M — 38.60M
30
0130467
32.6
38.60M
MW-24-BX11 38.60 M — 41.72 M
39.
0130467
40.5
41.72M

MW-24-B212 41.72M – 45.00 m
42
43.5
45
45m

MW-24-Bx 13 45.00m - 48.17m
46.5
48
48.17M
MW-24-Bx 14 48.17m - 51.35m
49.5
51 M
51.35M
MW-24-Bx 15 51.35m - 54.78m
52.5M
54 M
54.78M

58.36M – 61.5
60
61.5
61.5M – 64.9
63
64.5
64.9

MW-24-Bx19 69.9 M
66
67.5
68.2
MW-24-Bx20 68.2
69
130471
70.5
71.57

MW-24-BX21 71.57 M - 74.42 m
72
130 472
73.5
74.42

MW-24-Bx22 74.92m - 78.05m
75
76.5
78
78.05
MW 24 Bx 23 78.05m - 81.15m
79.5 M
81 M
81.15

MW24 BX24 81.15m - 84.42m
82.5
84 M
84.42

MW24 BX 25 84.42m - 87.50m
85.5
87 M
87.50 M
MW 24 BX 26 87.50m - 90.77m
88.5M
90 M
90.77M
MW24 BX 27 90.77m - 94.27m
91.5 M
93 M
94.27M

MW24 Bx28 94.27m - 97.5m
94.5
96
97.5
97.5m
MW-24 Bx29 97.5M - 100.47M
99
100.5
SND-MUD
RYD-COAL
EOH
100.47M

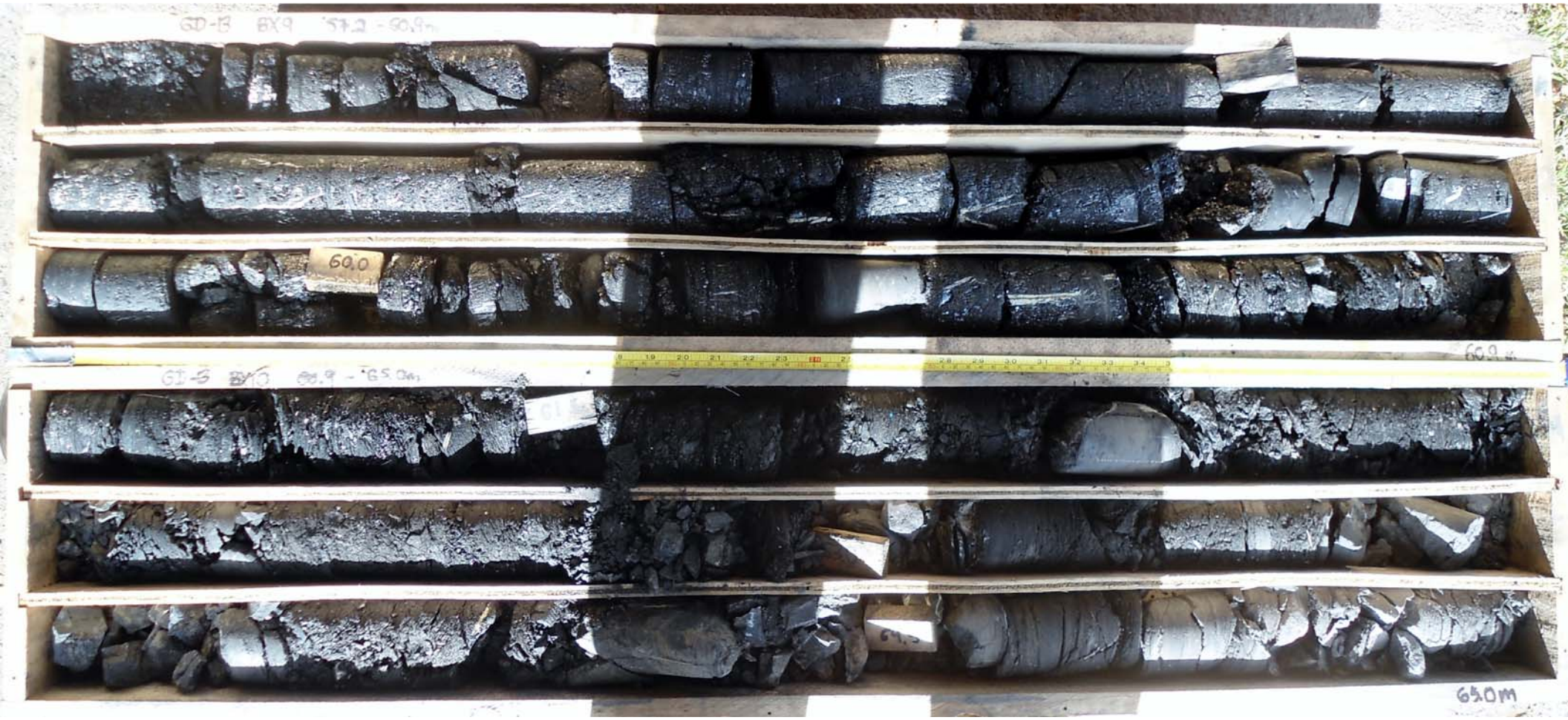
CORE LOG
GD-13

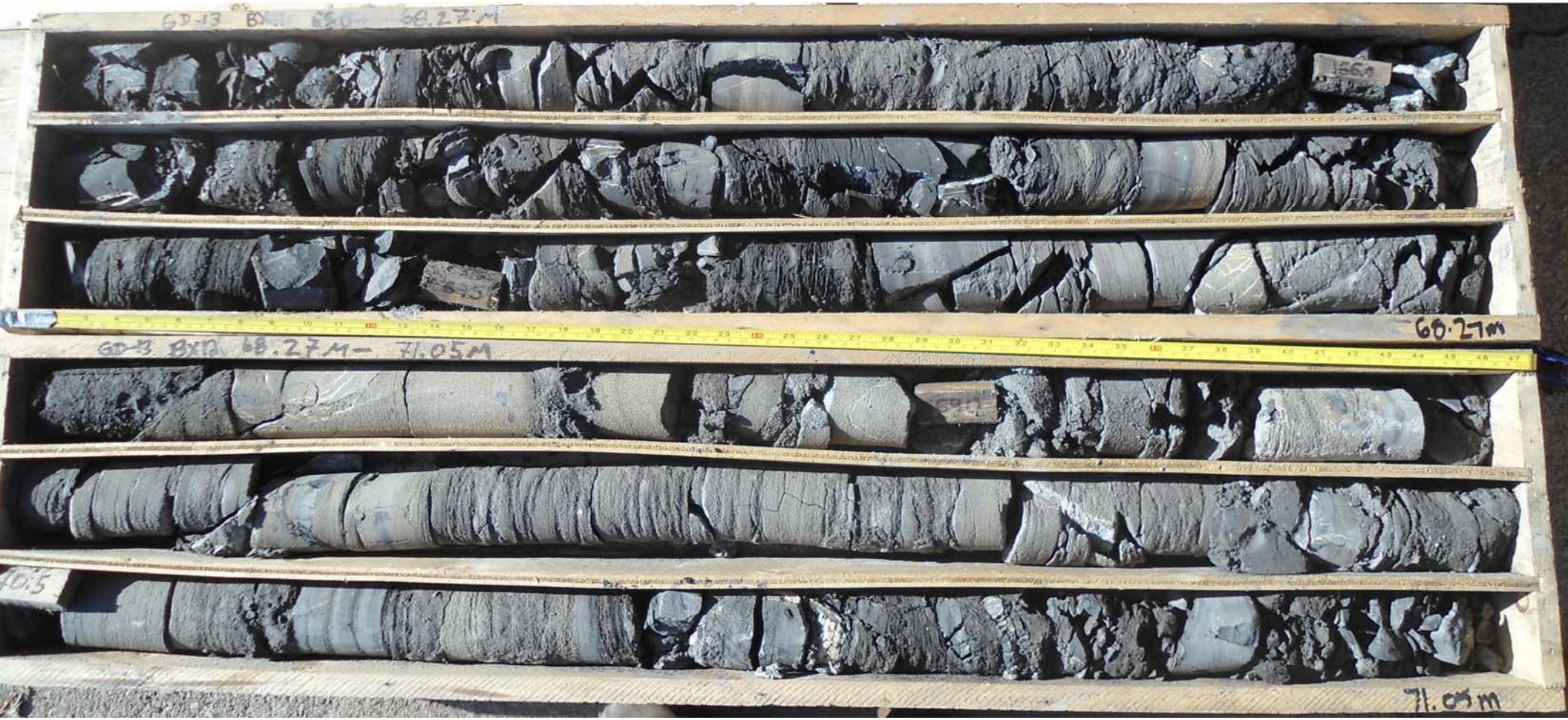
30
60
75
105
12.0
15.0
16.5
18.0
21.0
22.5
24.0
27.0
35.4

38.5m

GD-13 BX5 43.5-46.3m
43.0
46.3
GD-13 BX6 46.3-50.0m
49.5
50.0

53.4 m - 57.2 m
52.5
55.5
57.2 m


60.0
65.0m


GD-13 BX
68.27M
68.27m
GD-13 BX
68.27M – 71.05M
71.05m

GD13 BX 13 71.05M – 76.89 M
75.0
76.89m
GD13 BX14 76.84 M – 81.44 M
81.44m
GD13 Box# 15 81.44M – 82.5M
82.50m EOH

CORE LOG
GD-14

0.5
2.0
3.5
5.0
5.40m
MW23d BX 2 5.60m-5.90m
6.5
8.0
8.40m

MW23d BX 3
9.5
11.0
12.15m

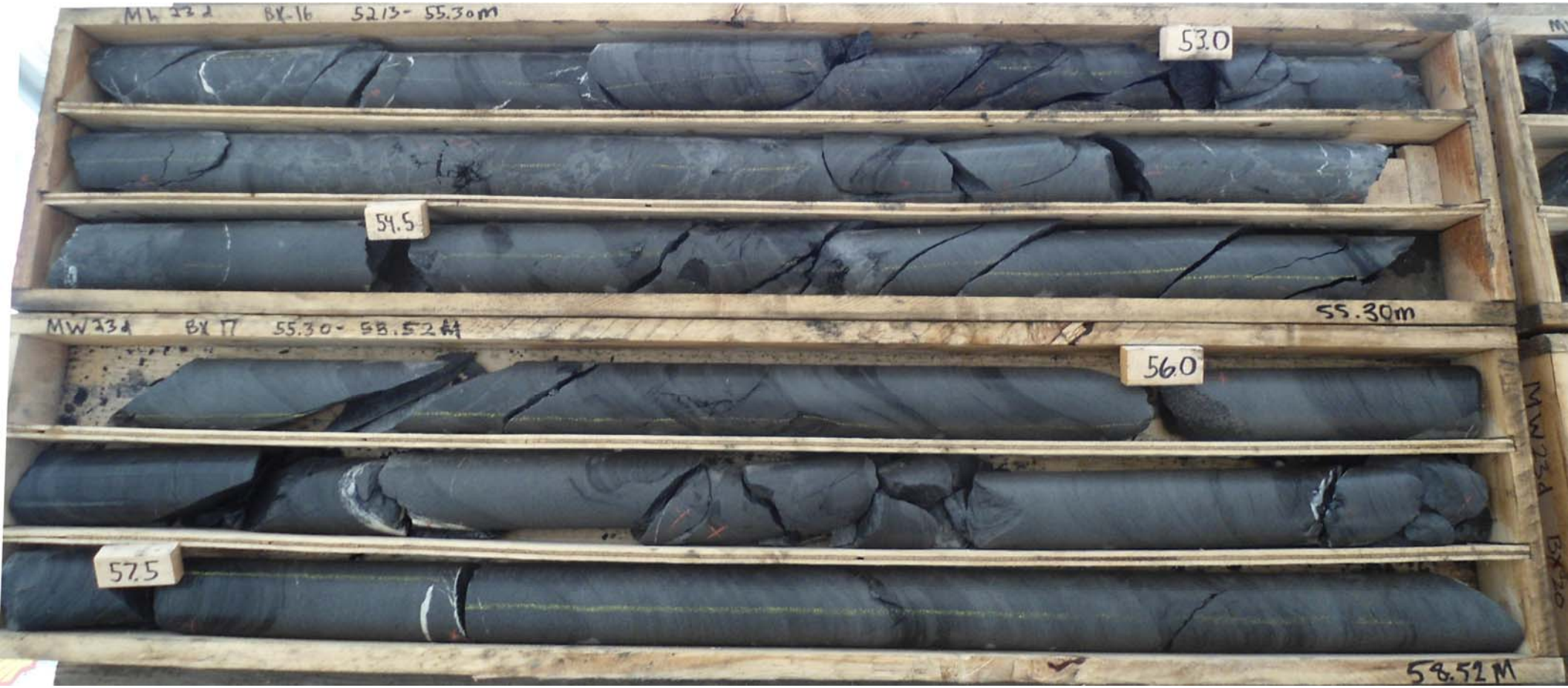
MW 23d BX 4 12.16 - 15.42m
SAMPLE
15.42m
MW 23d BX 5 15.42 - 18.75m
SAMPLE (Bentonite)
18.75mW

MW23d Bx. 6 18.75 - 22.60m
SAMPLE
20.0
SAMPLE
21.5
22.60m

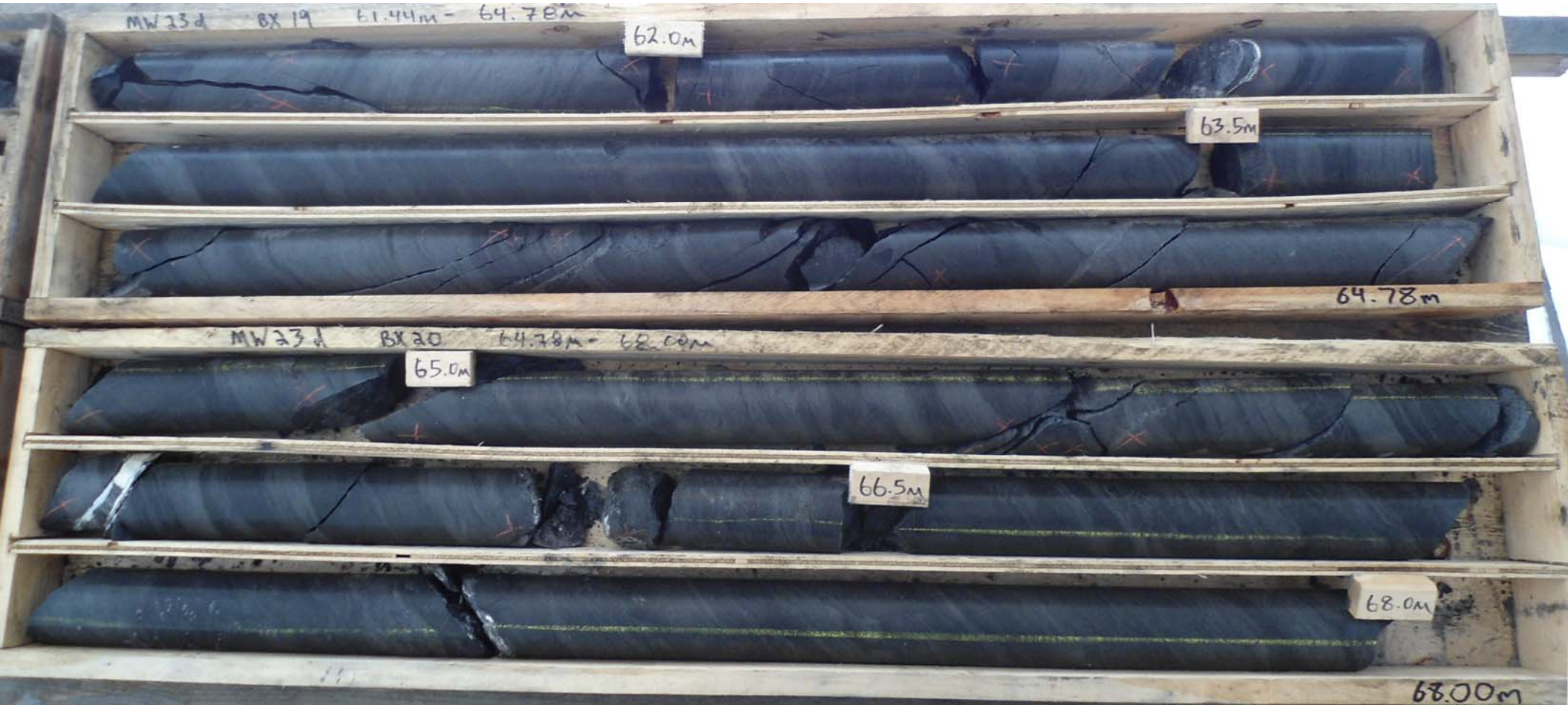
MW23d BX8 26m 29.43m
26.00m
MW23d BX 9
29.43m
30.5
32.58m

MW23d BX 10 32.58-35.80m
33.5
35
35.80m
MW 23d BX 11 35.80-39.15m
36.5
38
39.15m
MW23d BX 12 39.15-42.37
39.5
41
42.37m

MW23d BX 13 42.37-45.73M
42.5
44
45.5
45.72m
MW 23 d BX 14 45.72-48.92m
SAMPLE
47
48.5
48.92m
MW23d BX15 48.92 - 52.13m SAMPLE
50
51.5
52.13m


MW 23d BX-16 52.13- 55.30m
53.0
54.5
55.30m
MW 23d BX 17 55.30- 58.52m
56.0
57.5
58.52M

MW23d Bx 13 58.52m – 61.44m
59.0m
60.5m
61.99m


MW23d BX19 61.44m - 64.78m
62.0m
63.5m
64.78m
MW23d BX20 64.78m - 68.00m
65.0m
66.5m
68.0m
68.00m

MW23d BX21 68.00m - 71.00m
69.5M
71.0M
71.00m

MW23d BX22 71.0m - 74.00m
72.5
74.0
74.00m
MW23d BX 23 74m - 77.24m
75.5
77.0
77.24m
MW23d BX 24 77.24m - 80.70m
78.5
80.0
80.70m

MW 23d BX 25
80.70m - 83.80m
81.5
83.0
83.80m
MW 23d BX 26
83.80m - 87.04m
84.5
86.0
87.04m

MW23d BX 27 87.04- 90.20m
87.5
89.0
90.20m
MW23d BX 28 90.20 - 90.50m
90.5
EOH
WEST FRASER QUEFLY
90.50m

CORE LOG
GD-15

1.20
1.5
3
4.5
6
7.6
7.6
9
10.5
12

135
15.15

15.15
16.5
18
18.1
19.5
20.7

GD-15 Bx 6 20.7
21
22.5
23.5

25
25.5
26.5
27
28.5
28.65
GD-15
28.9
SAMPLE
29.25
30
31.5
32.15

GD-15-Bx 10 32.15
GD-15-Bx 13 40.5
GD-15-Bx 11 34.95
GD-15-Bx 14
GD-15-Bx 12 37.5
37.5
40.5

GD-15-Bx 14 43.3
43.5
46m
46.5m
48m
48.7m

GD-15-Bx 16
49.5m
51m
51.8
GD-15-Bx 17
51.8
52.5m
54m
54.8

GD-15-Bx18 54.8
55.5m
57
57.65
GD 15 Bx 1

GD-15-Bx 19 57.65
58.5
60
60.3 m
GD-15-Bx 20, 60.3
61.5
63
63m

66
69
70.5
72
73.5
75
75.9

GD-15-Bx25
75.9
78
GD-15-Bx26
79.25
79.2
81
GD-15-Bx27
82.25
825
82.35
85.25

85.5
87
88.5
90
91.5
92
94.5

GD-15-Bx31 94-5
96
97.5
97.55
GD-15-Bx32 97.55
99
100.5
100.5

GD-15-Bx33 100.5
102
EOH

CORE LOG
GD-20

MW-26
0- 7.42 M
1.5
3
4.5
0130475
7.42M
MW26 BX2 7.42 m- 14.55m
7.5
9
10.5
12
13.5
14.55M

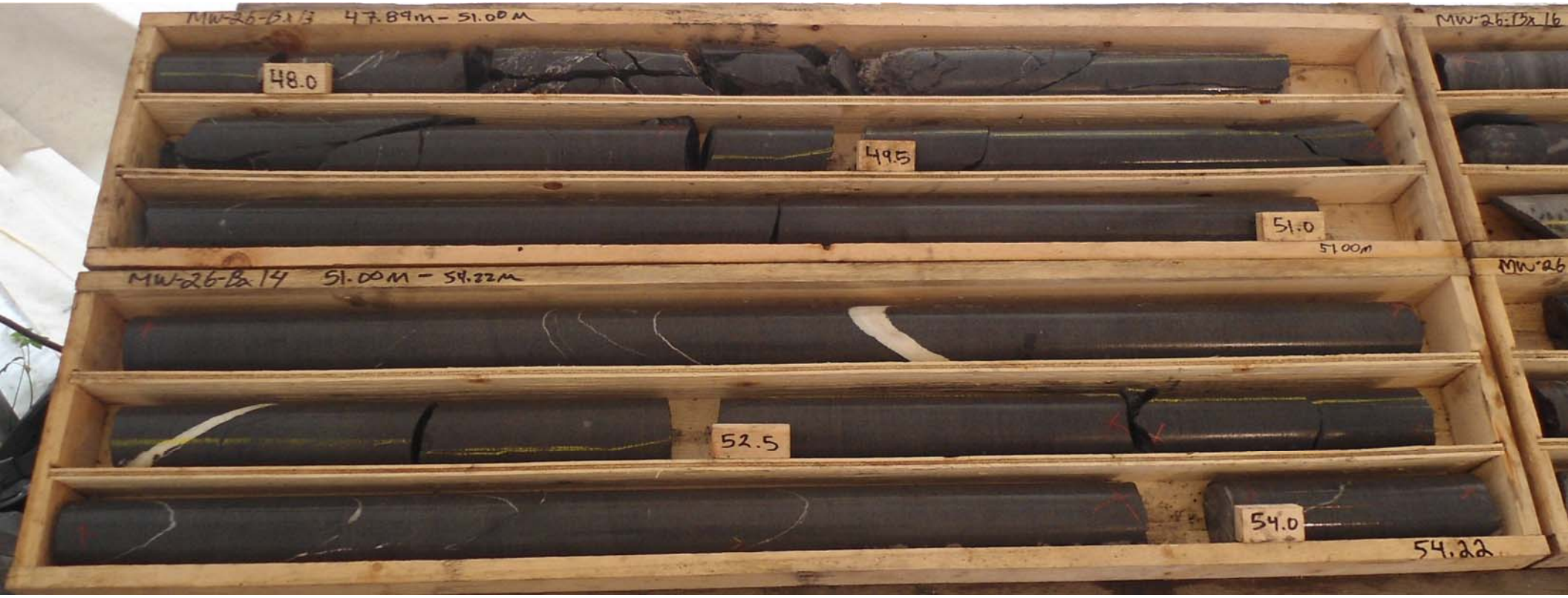
MW26 5X3 14.55m - 18.34m
15.0
18.5
18.0
18.34m

MW26 Bx 4 18.34m – 21.37m
MW-26 Bx1
19.5
0130476
21.0
21.37m
MW26 Bx 5 21.37m – 24.94 M
22.5
0130477
24.0
24.94m

MW26 BxB 24.94M – 28.34M
0130478
0130478
25.5
0130479
0130479
27
28.34m

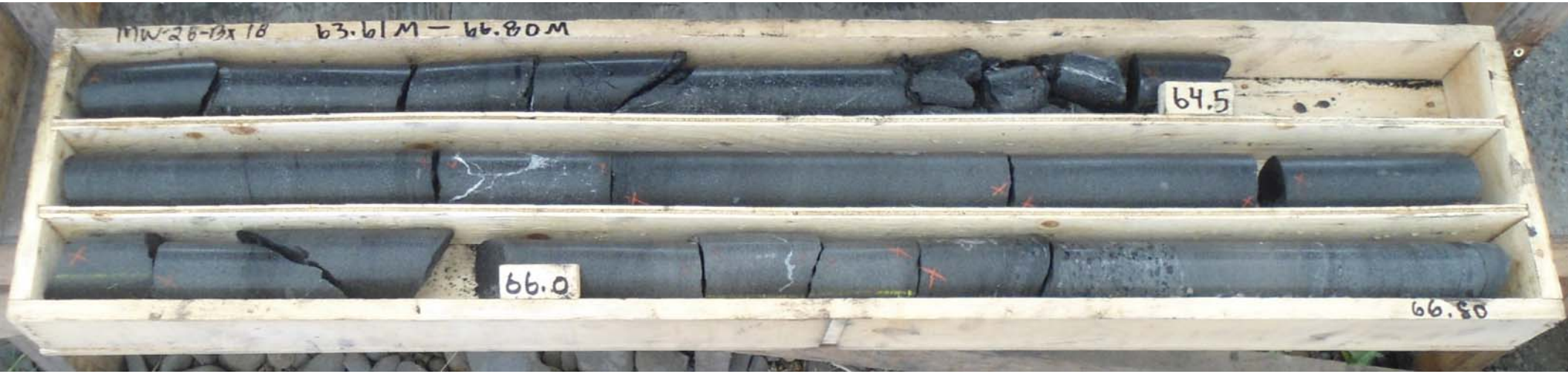
MW 26 Bx7 28.34M – 31.86M
30
31.5
31.86m
MW-26 Bx8 31.86M – 35.1M
33
34.5
35.10m
MW 26 Bx9 35.1M – 38.32M
0130480
36
37.5
38.32m
MW 26 Bx10

MW 26 BX10 38.82 M – 41.23m
39
40.5
0130481
41.23m
MW-26-BX11 41.23m – 44.60m
42
43.5
44.60m
MW-26-BX12 44.60m – 47.89m
45.0
46.5
0130482
0130482
47.89m


MW-26-Bx 13 47.89m - 51.00m
48.0
49.5
51.0
51.00m
MW-26-Bx 14 51.00m - 54.22m
52.5
54.0
54.22
MW-26-Bx 16
MW-26

MW-26-Dx15 54.22M- 57.19m
55.5
0130483
57.0
0130483
57.19

MW-26-Bx16 57.19m – 60.31 M
58.5
60.0
60.31
MW-26-Bx17 60.31 M – 63.61
61.5
63.0
63.61


MW-28-13x 18 63.61M — 66.80M
64.5
66.0
66.80

MW26 BX19 70.15M
67.5
69.0
70.15
MW26 BX20 70.15M — 73.5M
0130434
70.5
72.0
73.5
73.50M — 76.97M
73.5
75.0
76.5
76.97

MW-26 BR22 76.97 M — 79.90 M
78.0
79.5
0130485
79.90
MW-26 BR23 79.90 M – 82.96 M
81.0
82.5
82.96
MW-26 BR24 82.96 M – 85.5M
84.0
EOH
85.5
85.5

CORE LOG
GD-21

34.5m

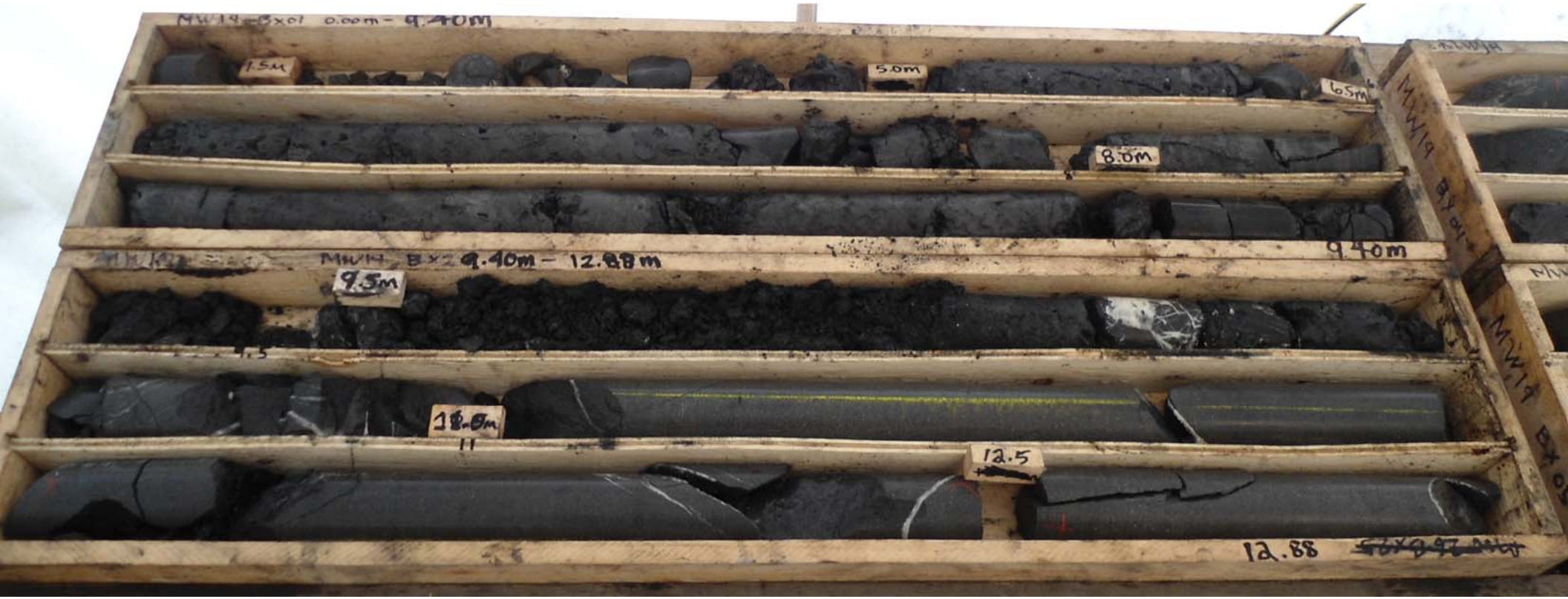
52.5 m
53.6

57 m
58,5 m

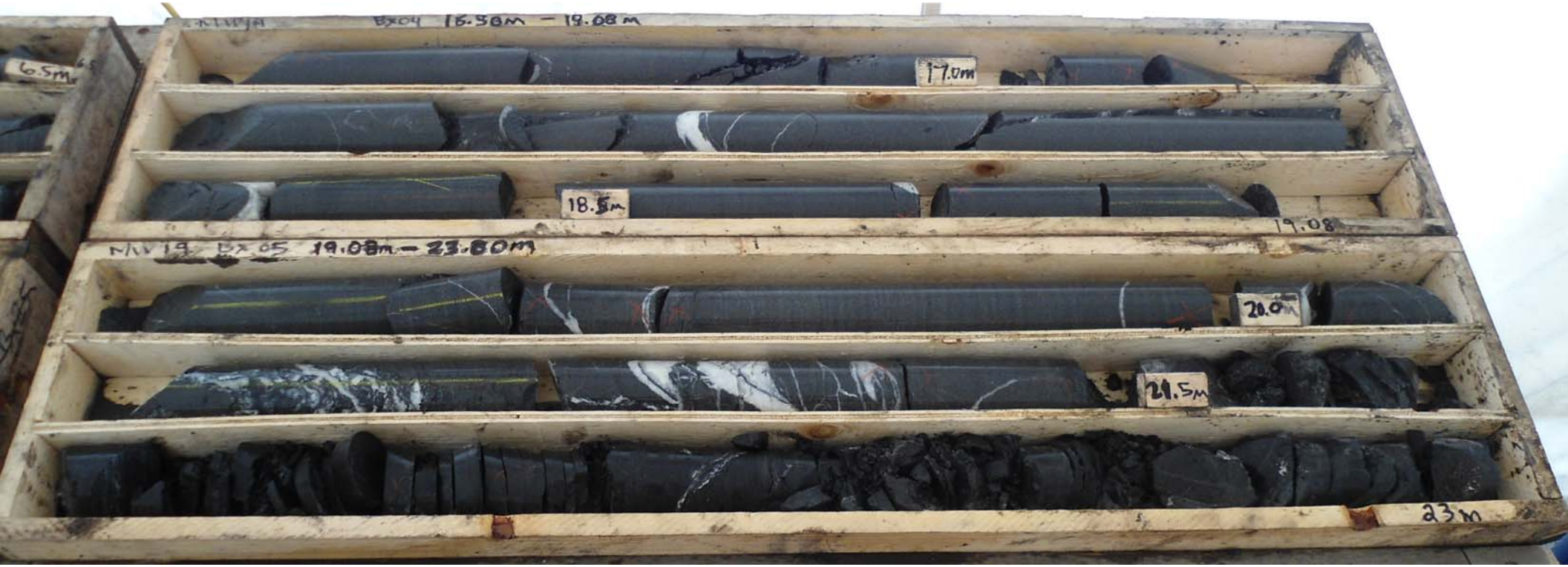
63 M
64.5 M
66 M
66
67.5 M
69 M

78.5
79.5
B1

CORE LOG
GP-06


MW19 BX01 0.00m - 9.40M
1.5M
5.0m
6.5m
8.0m
9.40m
MW19 BX02 9.40m - 12.88m
9.5m
12.5
12.88
MW19 BX01

12.88M – 16.30M
14.0M
15.5
16.08m


BX04 15.58M - 19.08M
17.0m
18.5m
19.08
N/V 19 BX 05 19.08m - 23.80m
20.0m
21.5m
23m

MW19 BX06 23.00m-26.0M
23
24.5m
26.0m
26m

27.5m
29.0m
29.00m - 30.00m
130423
30.5m
32.0m
MW19 BX09 32.0m - 35.0m
33.5m
35.0m

36.5m
38.0m
MW19 BX8 38.0M - 41.00M
39.5m
41.0m
41m
BX12 41.00M - 43.75 M
42.5m
43.75m

45

43.75m
45.5m
47
43.5m
50.0m
50.30
50.30m
53.0m
53.6m

53.60M
56.68M
56.0m
56.68M
MW-19 BX17 56.68M - 60.50M
57.5m
59.0m
60.50M

MW19 BX18
60.50M - 63.67
62.0m
63.67m
MW19-BX21

MW19 BX19 63.67m - 66.69m
65.0m
66.5m
66.69m
MW19 BX20 66.69m - 69.79m
68.0m
69.5m
69.79m

MW19 BX21 69.79 M - 72.87 M
72.5M
72.87M

MW19 BX 22 72.87M - 75.91M
75.5M
75.91M
MW19 BX 23 75.91m - 79.24m
79.24m
MW19 BX 24 79.24m - 81.50M (EOH)
80.0M
81.5M EOH
81.50m EOH.

CORE LOG
GP-07

GP07 Bx1 0m - 11.0 M
0.5m
8.0
5.0m
6.5m
8.0
11.0
GP07 Bx1
GP07 Bx2 11.0M — 19.50M
12.5
14.0
15.5
17.0
18.5
19.50m

20.0
21.51
22.80m

23.0
24.0
26.00m
27.5
29.0
29.30m

30.5m
32.0
32.33m

GP07 BX8
40.33M
GP07 BX9 40.33M — 43.70M
41.0
42.5
43.70m

45.5
46.78m
47.0
48.5
50.0
50.00m

GP 07 BX 15 59.61M – 63.03M
60.5
62.0
63.03m

66.5
68.0
69.5
71.0
72.5

GP-07 Bx 20 75.95m - 78.85m
78.5m
78.85m
GP-07 Bx 21 78.85m - 80.0m
80.0
40.00 EAH

CORE LOG
GP-08

MW-21-Bx 6
22.5m
0.0
RBURDEN MW-21
LL
1.40-3.0
(1.6m)
LL
39.45
(120m)

MW-21-Bx1
6m
7.5m
7.15-7.50
(0.35m)
MW-21-Bx2
10.5m
10.5
MW-21-Bx3
13.5
14.20

MW-21-Bx4
16.5m
MW-21-Bx5
19.5 m.
MW-21-Bx6
22.5m

MW-21-Bx 7
25.5m
MW-21-Bx 8
28.5m
MW-21-Bx 9
31.5m
34.5m
MW-21-Bx 10

MW-21-Bx10
37.5m
MW-21-Bx11
40.5m
MW-21-Bx12
43.5m
82.5

MW-21-Bx 13
46.5m
NW-21-Bx 14
49.5m
NW-21-Bx 15
52.5
NW-21-Bx 16
55.5

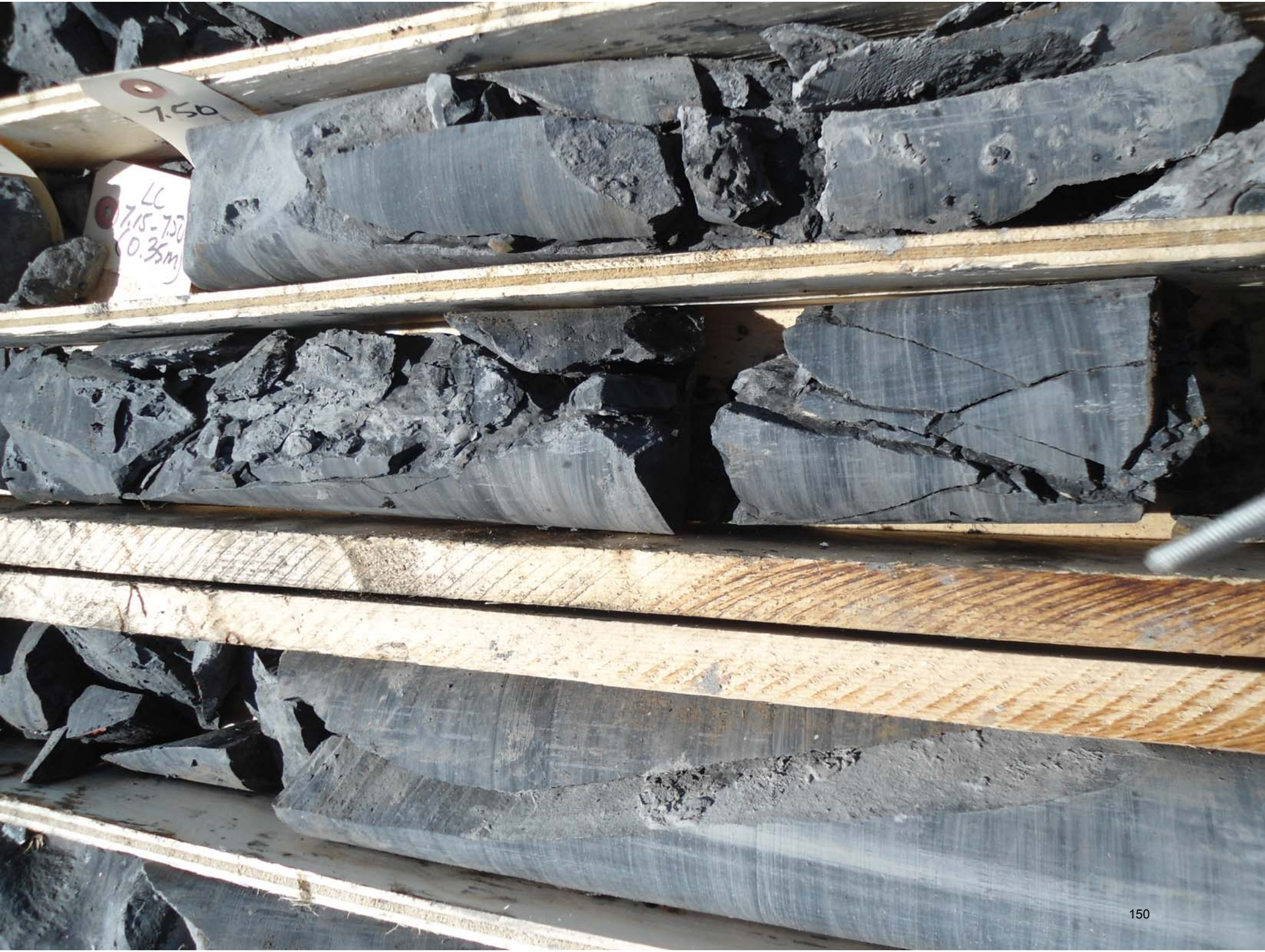
NW-21-Bx 16
55.9
NW-21-Bx 17
58.5
NW-21-Bx 18
61.5
NW-21-Bx 25
82.5

NW-21-Bx19
63.3
64.5
NW-21-Bx20
67.5
NW-21-Bx21
70.5
NW-21-Bx22
73.5

NW-21-Bx22
73.5
NW-21-Bx23
76.5
NW-21-Bx24

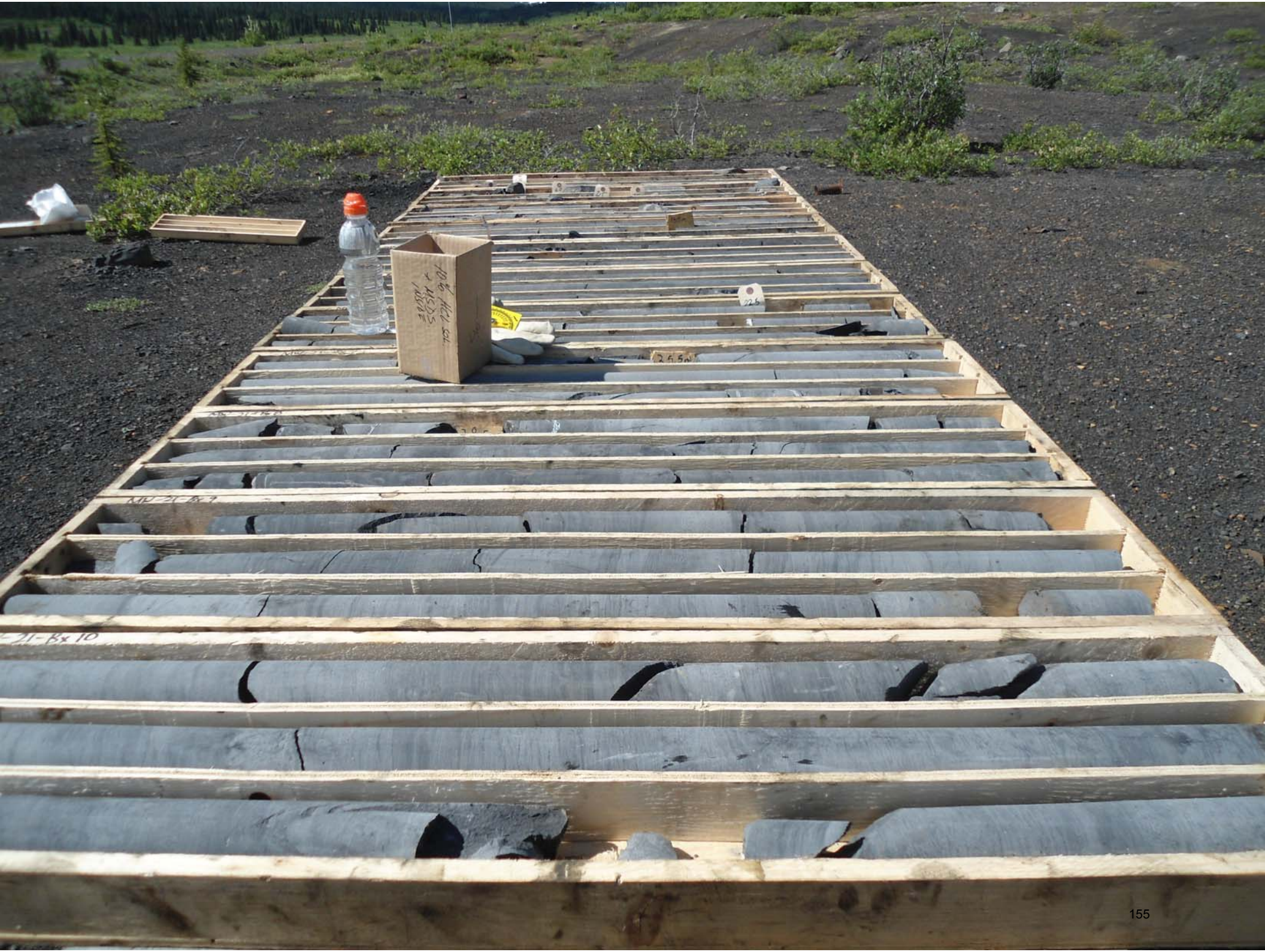
MW-21-Bx 27
82.5
83.65
85.4
87.5
87.9

0.35m


7.50
LC
7.15-7.50
0.35m

14.20

MW-21-B&H
14.20


10% HCL SOL.
+ MSDS
ISSUE
255N

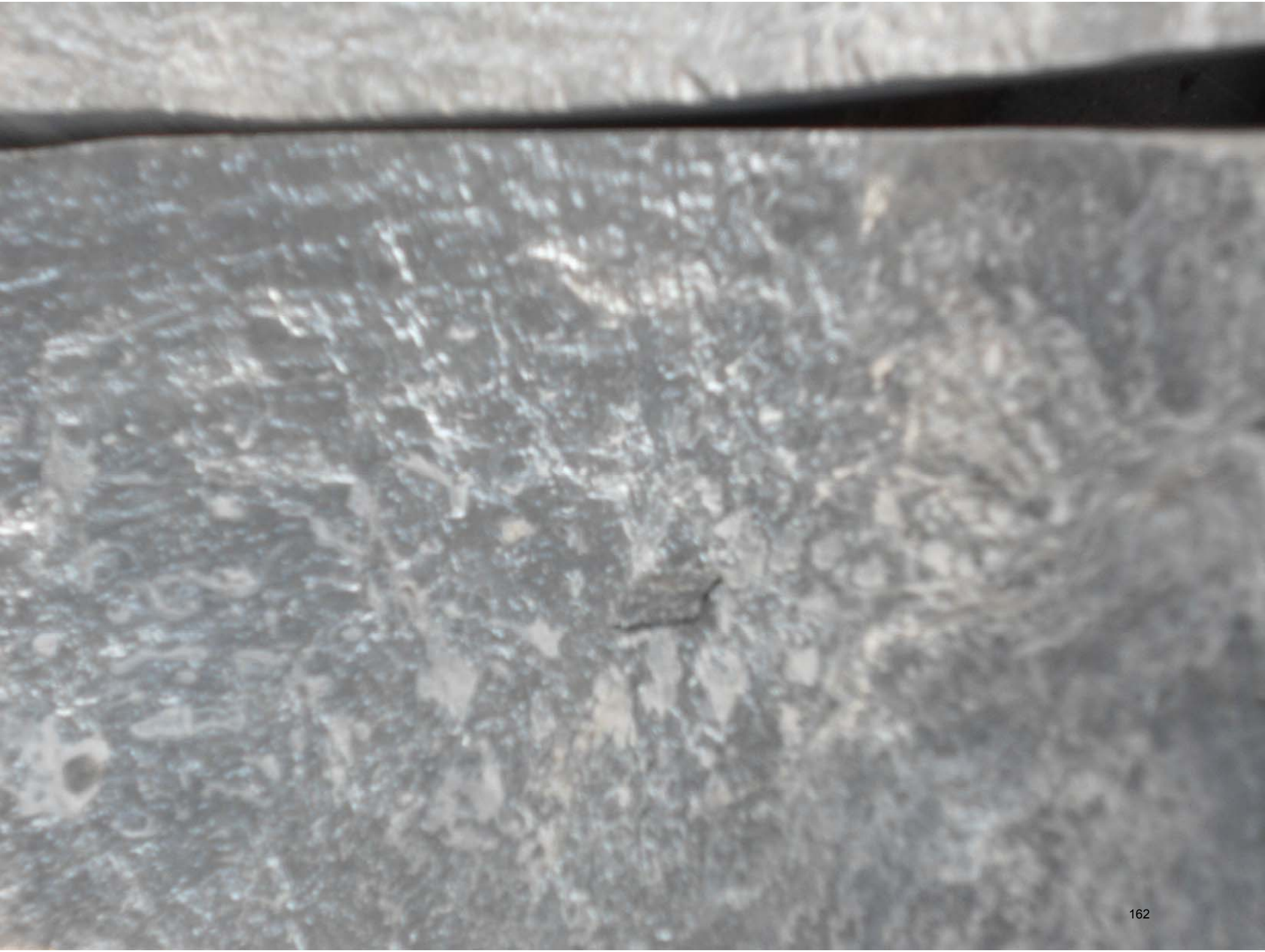
10% HCL SOL.
+ MISCS.
INSIDE
25.5m
28.5m

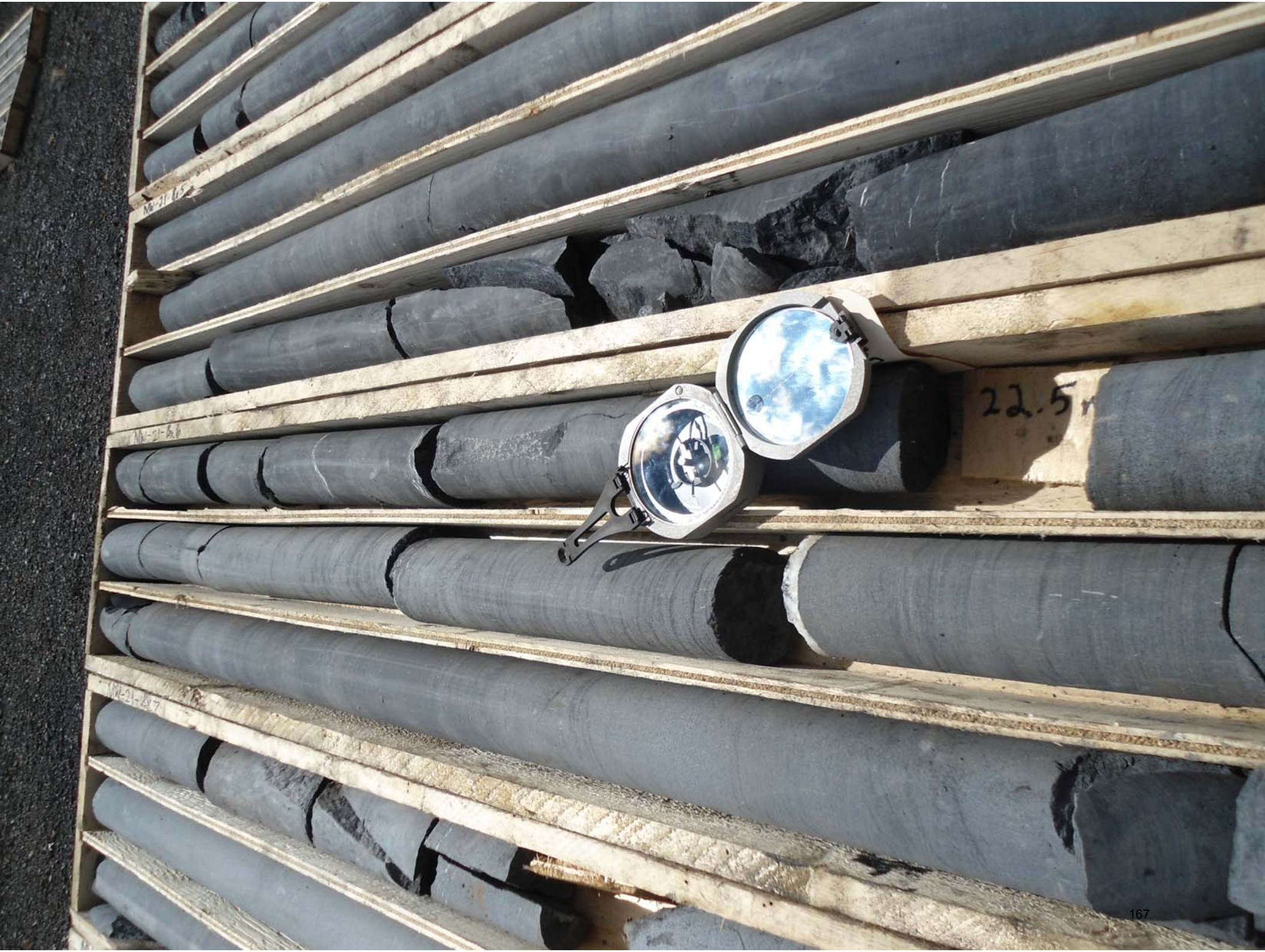
6.0
7.15
7.50
MW-21-Bx3
13.5m
14.20
Bx 4

1.40
6.0
7.15
7.50

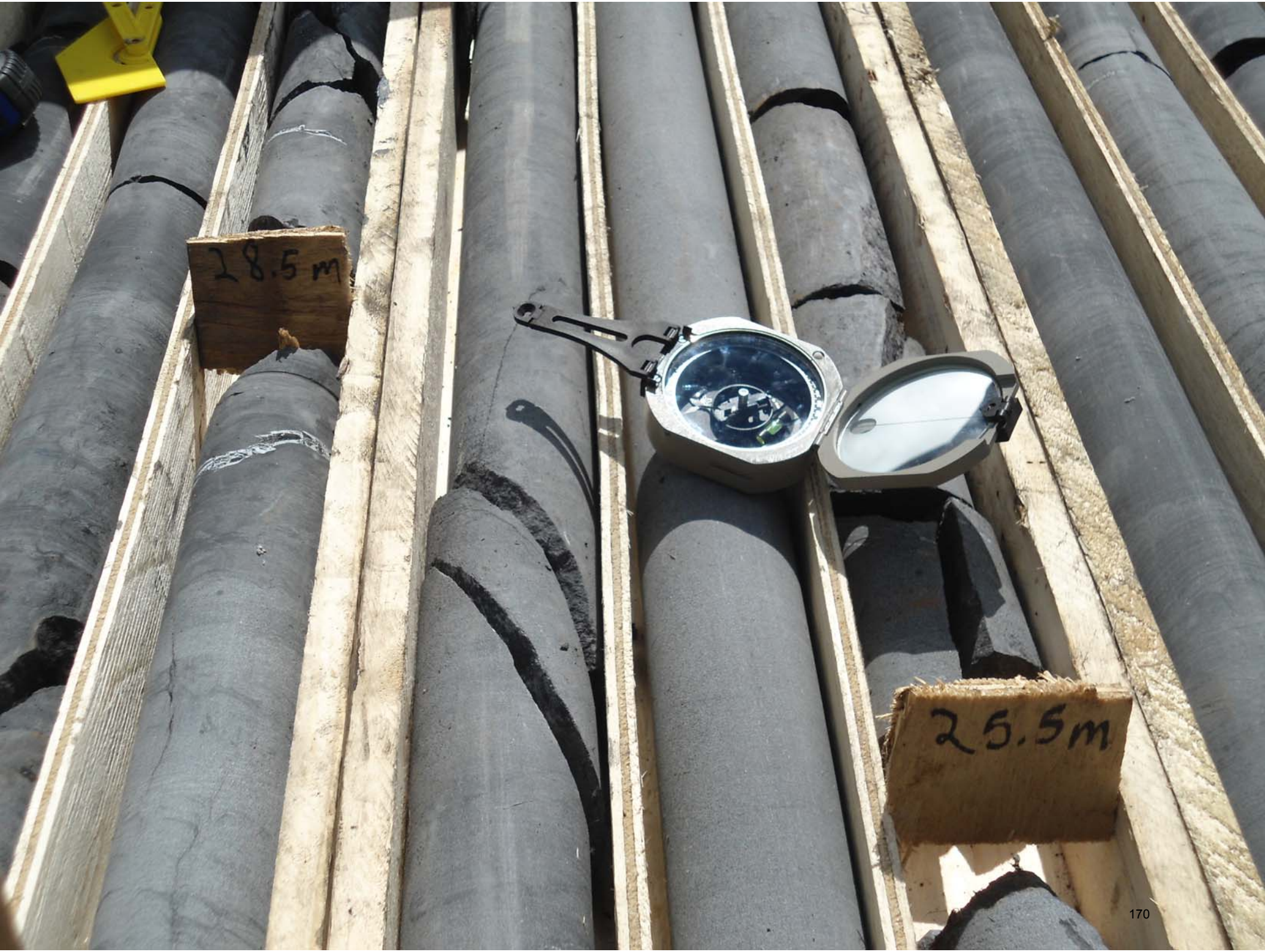
MW-21-Bx2
MW-21-Bx3
MW-21-Bx3
MW-21-Bx4
MW-21-Bx4
MW-21-Bx5

MW-21-Bx4
6m




22.5

25.5m


28.5 m
25.5m

25.5m
28.5m

MW-21-Bx 9
MW-21-Bx 10

MW-21-Bx6
MW-21-Bx7
25.5m
MW-21-Bx8

NW-21-B×17
NW-21-B×16

MW-21-BXP

NW-21-BX18

NW-24 Box 23

765

76.5

NW-21-4x

-5x10

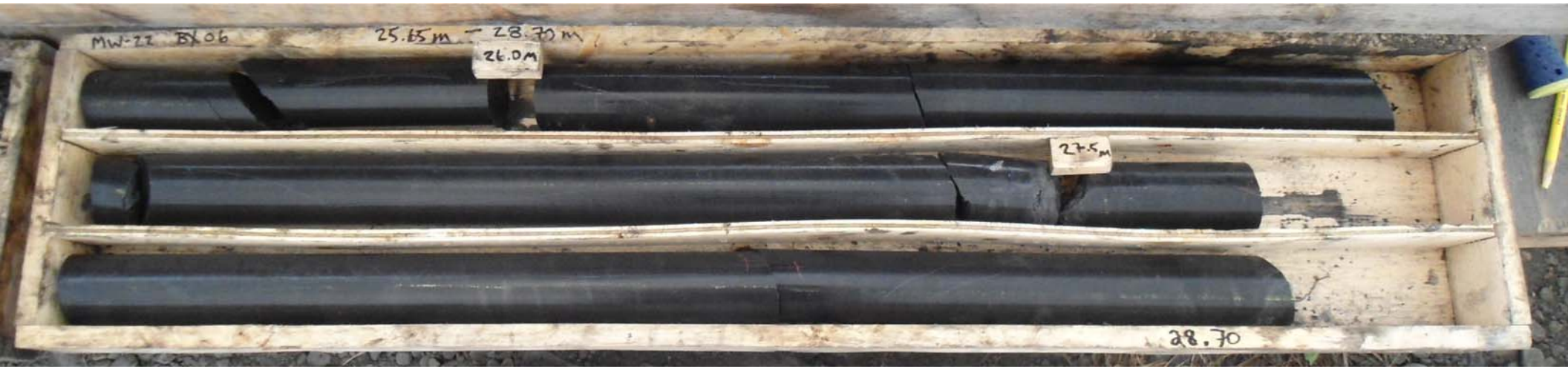
TERRACON

CORE LOG
GP-09

5.0m
9.5m
11.0m
12.5m
14.0m

15.42 M - 19.00 M
15.5M
17.0M
18.5

MW22 BX04 19.00M - 22.25M
20.0m
21.5m
MW22 BX05 22.25m - 25.65m
23.0m
24.5m
25.65


MW-22 BX06
25.65m – 28.70m
26.0M
27.5m
28.70

MW22 BX08 28.70M- 31.92M
29.0M
30.5
MW22 BX08 31.92M-
32.0m
33.5m
35m
35m
MW22 BX 10

MW22 BX04
36.5m
38m
38.25

39.9m
41.0m
41.35m
44.9m
44.63m

~~MW25 8x10~~ MW27 10x12 44.63m - 48.13m
45.5m
47.0m
48.13m

48.5m
50.0m
51.22m
51.5M
53.0M
54.5M
54.5m
MW22 BX 15 54.50M - 57.87M
56.0M
57.5M
57.87 m

59.0m
60.5m
MW22 BX17 61.13m - 64.30m
62.0m
63.5m
64.30m
MW22 BX18 64.30m - 67.65m
65.0m
66.5m
67.65m

68.0m
69.5m
70.86m
MW22 BX20 70.86m - 74.00m
71.0m
72.5m
74.00m
MW22 BX21 74.00m - 77.21m
75.5m
77.0m
77.21m

MW22 BX22 77.21m - 80.48M
78.5m
80.0m
80.48m
MW22 BX23 80.48M - 83.70M
81.5m
83.0m
83.70m
MW22

MW22 BX24 83.70M
84.5M
86.0M
87.01m

MW22 BX25 87.01m- 90.27m
87.5m
89.0m
90.27m
MW22 BX26 90.27m- 94.10m
90.5m
92.0m
93.5
94.10m

MW22 BX27 94.10m - 97.26m
95.0m
96.5m
97.26m
MW22 BX28 97.26m - 101.16m
98.0m
99.5m
100.15
MW22 BX29 100.16m - 101.00m (EOH)
101.0m
EOH
101m

MW-22, CP-09
33.78-33.95
Aus 28

CORE LOG
GP-10

GT-10-B×1
15m
6m
GT-10-B×2
10m

10.5
12m
18m
19.5m

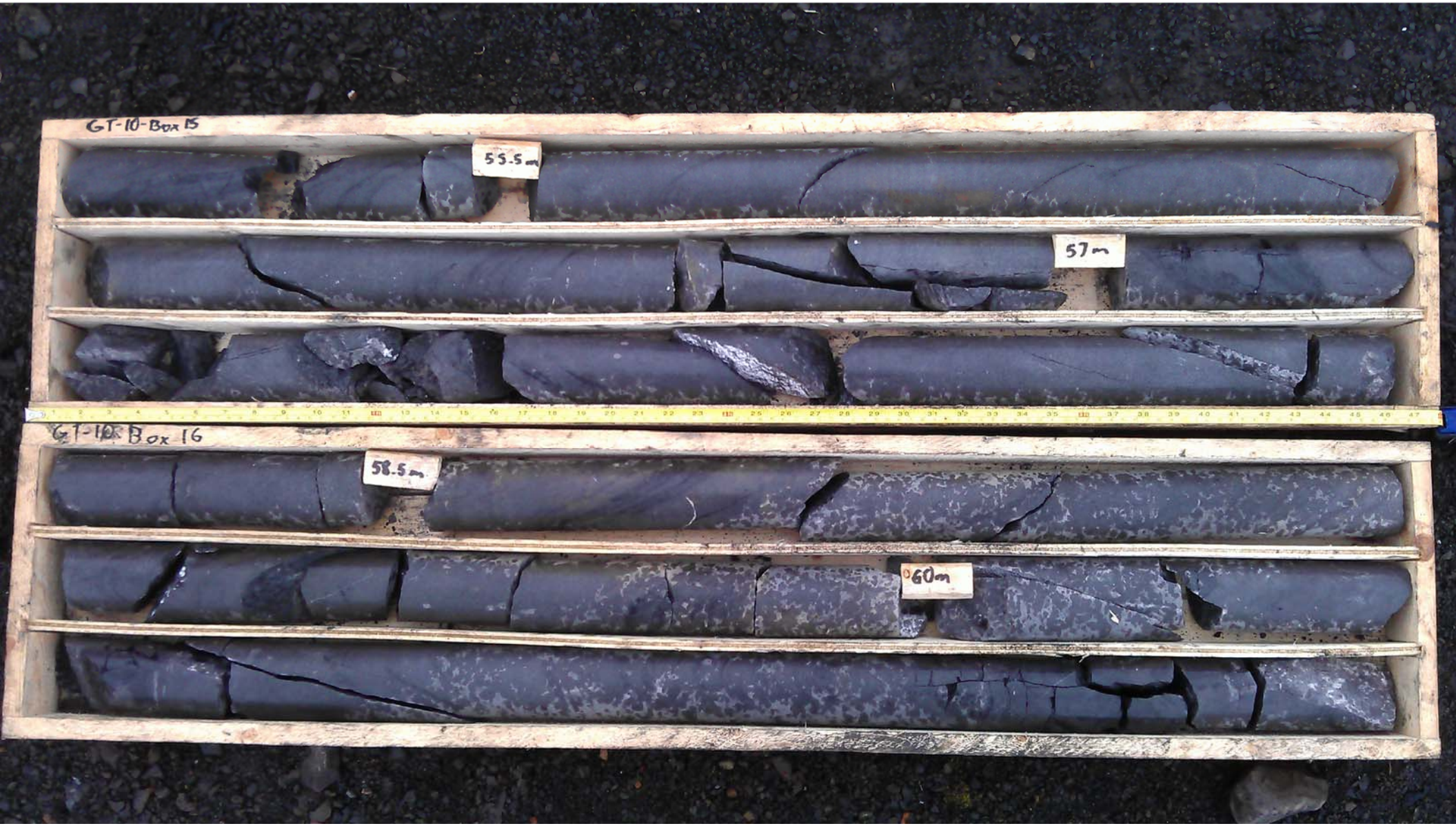
22.5m
24.85
24m
GT-10 = 1x6
27m
28.5m

GT-10-Bx8
34.5

36m
37.5m
37m
42m

43.5m
45m
GT-10 Box 12
46.5m
48m

GT-10-Box 13
47.5m
51m
GT-10-Box 14
52.5m
54m


GT-10-Box 15
55.5m
57m
GT-10 Box 16
58.5m
60m

GT-10-Box 17
61.5m
63m
GT-10-Box 18
66m
67.5m

GT-10 Box 19
69m
70.5m
GT-10 Box 20
73.5m

GP-10-BX21
78m
GP-10-BX22
78m
79.5m

GP-10 BX23
81m
82.5m
EOH

CORE LOG
GP-11

15.64m
18.5m
18m
19.5m
21m

22.00m
26.38m
29.34m

32.59m
35.55
59.22m
42.25m

45.51m
48.70m
51.79m

55.59m
58.12m

61.5
63
64.20m
65.5
66
67.35m
68
70.5
70.50m

73.60m
73.5
76.5
76.10m
78
79.5

82.62m
85.72m
90.00m

90 m
92.10m
93m
95.33m
96m
98.50m

CORE LOG
GP-16

1.5
3.0
4.5
6.0
MW-25-BR2 @ 9.0 m 12.75 m

22.5m
24.0m
25.35m
25.5m
27.0m

270m

34.68m - 37.95m
34.68m
37.75m

40.92m
44.12m
MW-25 BX/2 44.12m - 47.21m
46.5m
47.21m

53.60m - 56.70m
56.70m

56.76m - 59.72m
59.72m
59.72m - 62.82m
1 SAMPLE
60.0
62.82m

65.0m
66.0m

67.5m
69.1m
69.12m
70.5m
72 cm
EOH

CORE LOG
GP-17

MW20 Bx1 0.0M – 10.5M
1.5
3.0
4.5
6.0
7.5
9.0
10.5
10.50m
MW-20 Bx2 10.50M – 16.09M
12.0
13.5
15.0
16.09m

MW20 Bx 3. 16.09M – 19.50M
16.5
18.0
19.50m

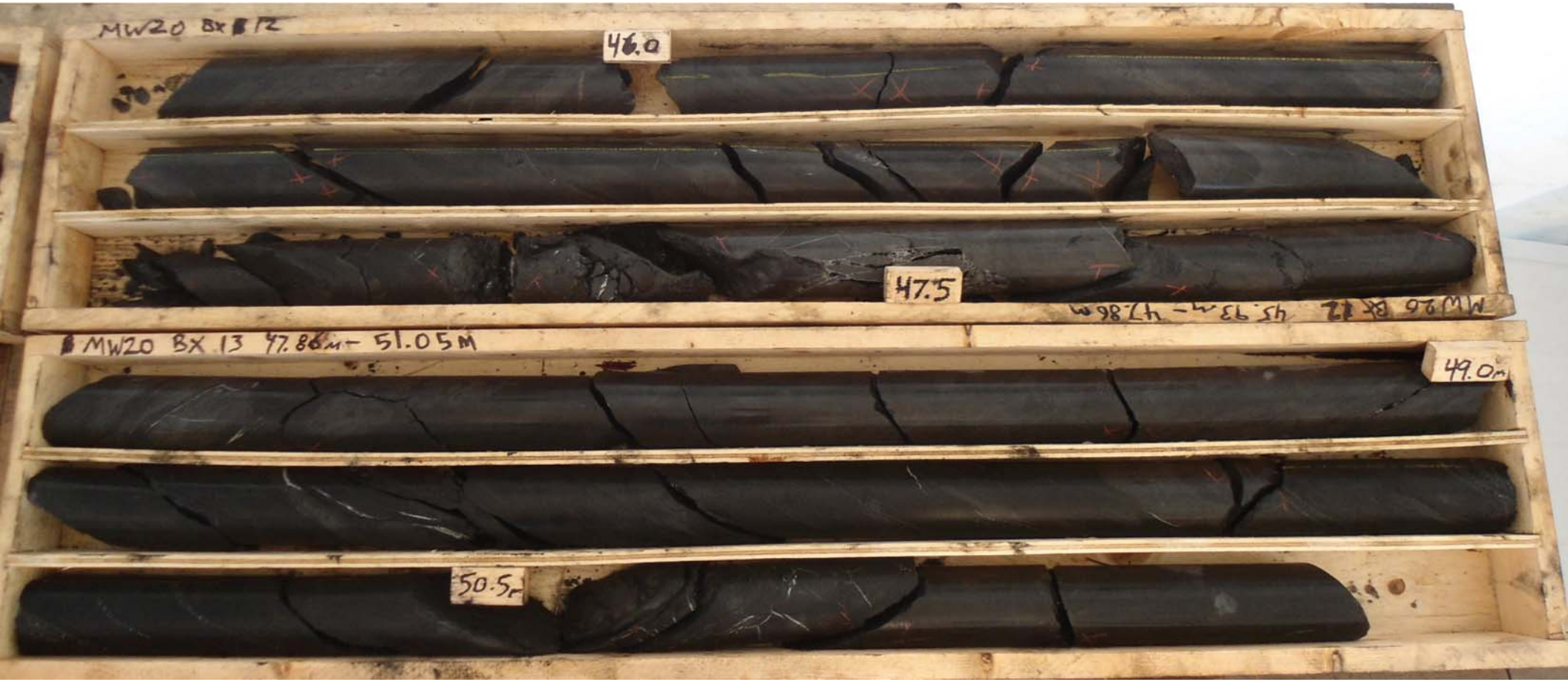
MW-20 BX4 19.80M – 22.5M
19.5
21.5M
22.50m
MW20 BX5 22.5M – 25.2M
23.0
24.5
25.20m

MW 20 BX6 25.70M — 30.13M
26.0
27.5
29.0
30.13M

32.5
32.0
33.5
35.0
36.5
36.50m

MW 20 Bx9 36.50m – 39.60m
38.0
39.5
MW 20 Bx10 39.60m – 43.10m
41.0
42.5

MW20 Bx11 43.10m-45.93m
44.0
45.5


MW20 BX 12
46.0
47.5
MW20 BX 13 47.86m - 51.05M
49.0m
50.5m

MW20 Bx 14 51.05m - 54.10m
52.0m
53.5m

55.0m
56.5m
MW20 Bx 16 57.14m - 58.88m
58.0m
59.5m
61.0m
62.5m
64.0m

MW20 - Bx 18 64.00m - 67.0 M
65.5m
67.0
MW20 Bx 19 67.0 M - 70.29 M
68.5
70.0
MW 20 BX 20 70.29 M - 73.52 M
71.5
73.0
GLAD
GLAD

MW 20 Bx 21 73.52 M – 76.56 M.
74.5
76.0
76.56m
MW 20 Bx 22 76.56M – 79.78 M
77.5
79.10
79.78m

MW 20 Bx 13 79.78M – 83.12M
80.5
82.0
EX
83.12m

MW 20 BX 24 83.12 M – 86.06 M
83.5
85.0
86.06m
MW 20 BX 25 86.06 M – 89.50 M
86.5
88.0
89.5
89.50m

MW 20 BX 26 89.50M – 92.80 M
91.0
92.5
92.80m

MW 20 Bx 27 92.80M — 96.1M
MW 20 Bx 20
94.0
95.5
96.1m
MW 20 Bx 28 96.1M — 99.11M
97.0
98.5
99.11m
MW 20 Bx 29 99.11M - 100.01M EOH
100.0
100.01m

CORE LOG
GP-18

5
3.5
4.55M – 4.85M
5.0m
6.5m

30m
95m

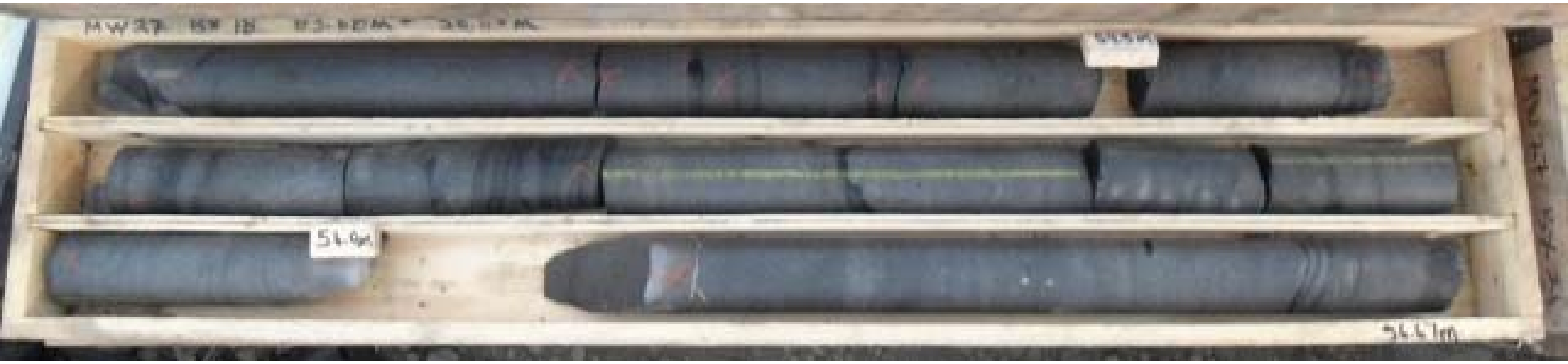
11.0m
12.5m
15.00
13.50m – 16.60m
14.0m
15.5m
16.60

16.60 M - 19.78 M
17.0M
18.5M
19.78 M

36.9m

41.0m
42.5m
44.0m
47.0m

MW27 BX16 49.73m - 50.74m
50.74m
MW27 BX17 50.74m - 53.68m
51.5m
63.0m
53.68m


54.9m
56.1m

MW 23 BX 19
53.6m
59.8m
MW 23 BX 20 59.91M – 63.03M
63.03m

MW27 BX21 63.08 m – 66.50 m
65.5m
66.50m

35.86m

92.40 m
95.62 m

98.0m
98.74m - 102.15m
99.5m
101.0m
102.15m

102.5m
104.0m
105.32m

MW-27 BX 26
113.50m
119.50m

119.0m
128.0m
EOH

CORE LOG
GP-19

7.5
9.0
10.5
13.5

165
184
195
SAMPLE

25.5
28.5
30

31.5M
33 M

36.75m
40.20m

425
426

435
45
465
SAMPLE.
48
495

51
525

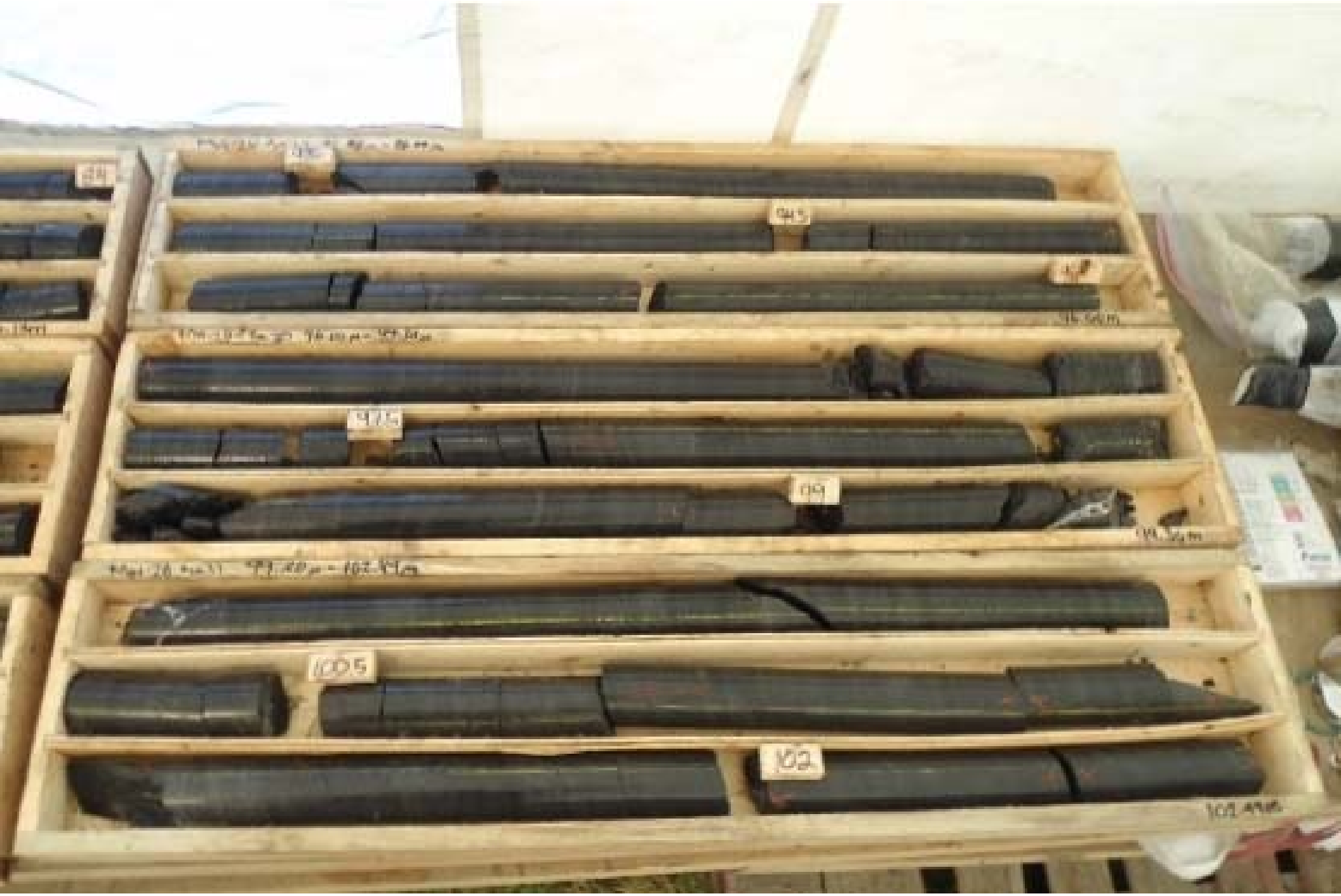
57
58.5
60
61.5
63

W5
68.5
16.00m
70.5
72

69
MW-28-BK22- 70.00m-73.3cm
70.5
72
73.30m

75
76.5N
76 M
79.5

76 M
79.50
31 M
88.5


1005
102

103.5
105
106.5
108
109.05m

109.5
117

185
114
115.6M
117 M
118.5M

120 M

135 mm.

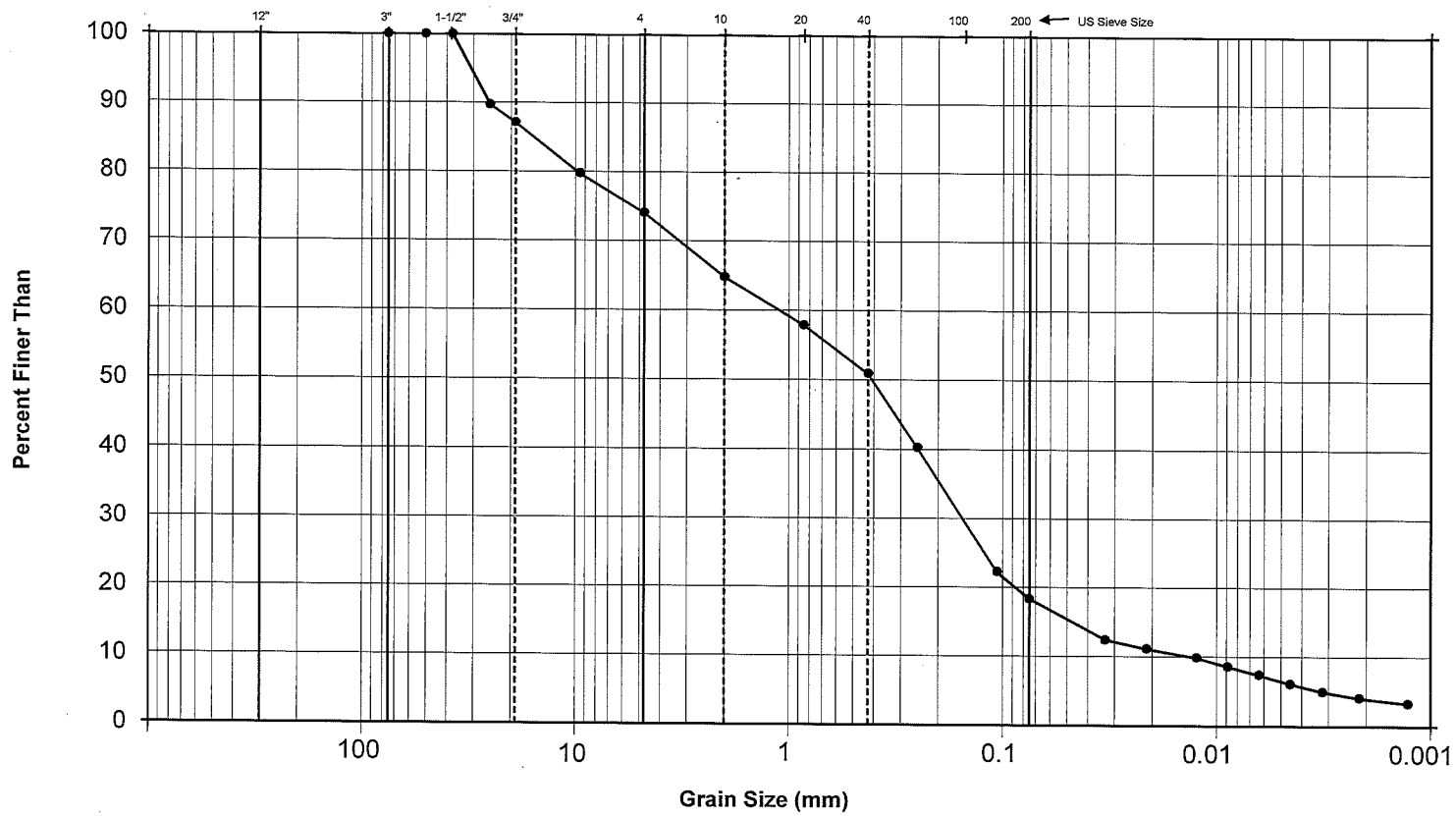
APPENDIX E

Laboratory Test Results

Golder Associates

Particle Size Analysis of Soil
(ASTM D422)

Project No.:	13-1359-0011	Lab No.:	A927-16
Project Title:	Fortune Minerals Lab Testing/Terracon Geotechnique		
Borehole:	GD01	Sample No.:	127751
Depth:	1.50-1.96 m		
Date Tested:	23-Oct-13	By:	DS



Diameter of Sieve (mm)	Percent Passing (%)
75.0	100.0
50.0	100.0
37.5	100.0
25.0	89.7
19.0	87.1
9.5	79.8
4.75	74.1
2.0	64.8
0.850	57.9
0.425	50.9
0.250	40.3
0.106	22.3
0.075	18.4
0.033	12.4
0.021	11.2
0.012	9.9
0.009	8.6
0.006	7.4
0.005	6.1
0.003	5.0
0.002	4.1
0.001	3.3

Boulder Size	Cobble Size	Coarse	Fine	Coarse	Medium	Fine	Silt and Clay Size
		Gravel Size		Sand Size			

Comments:

Reviewed:

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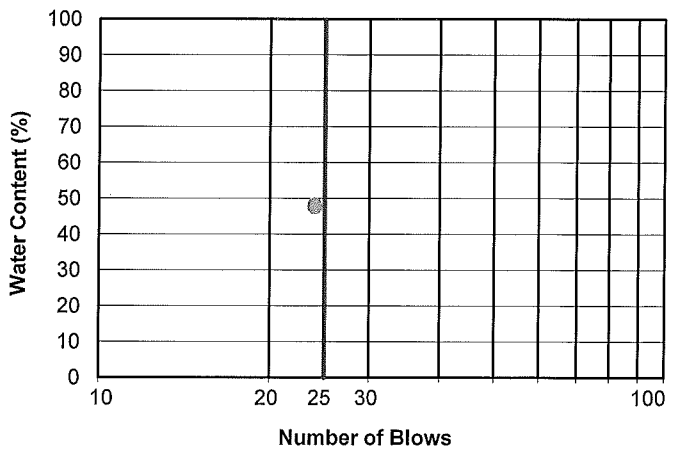
Atterberg Limits (ASTM D 4318)

Project No.:	13-1359-0011	Phase:	-
Short Title:	Fortune Minerals Lab Testing/Terracon Geotechnique-Arctos Anthracite	Sched:	A927-15
Tested By:	CG	Date:	23-Oct-13

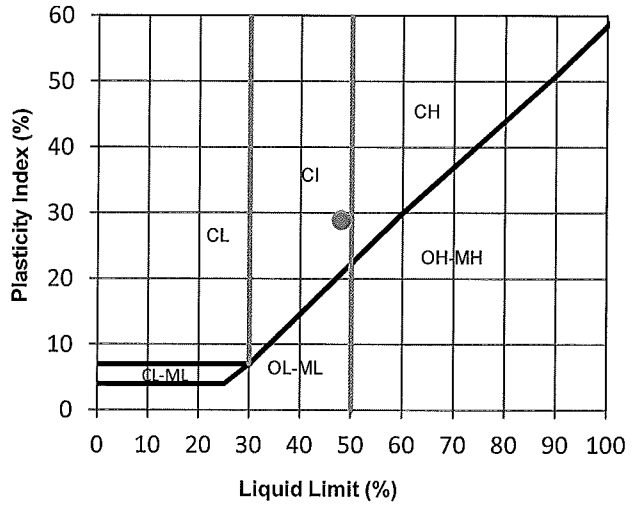
Borehole: GD01 Sample No.: 130449 Depth: 6.00-6.14 m

Liquid Limit Determination:			Natural Water Content:		
Number of Blows	24	24	As Received Water Content (%)		32.4%
Blow Correction Factor	1.00	1.00	**Plastic Limit Determination:**		
Mass of wet sample + tare (g)	42.43	41.62	Mass of wet sample + tare (g)	22.64	19.57
Mass of dry sample + tare (g)	37.12	36.33	Mass of dry sample + tare (g)	20.80	18.07
Mass of tare (g)	26.14	25.29	Mass of tare (g)	11.13	10.20
Weight of Water (g)	5.31	5.29	Weight of Water (g)	1.84	1.50
Weight of dry soil (g)	10.98	11.04	Weight of dry soil (g)	9.67	7.87
Water Content (%)	48.4	47.9	Water Content (%)	19.03	19.06
Liquid Limit	48.0	48.0	Average Water Content (%)		19.04

Liquid Limit Test



Plasticity chart for soil passing 425 µm sieve



Liquid Limit =	48	%
Plastic Limit =	19	%
Plasticity Index =	29	

Comments:

Reviewed:

Golder Associates

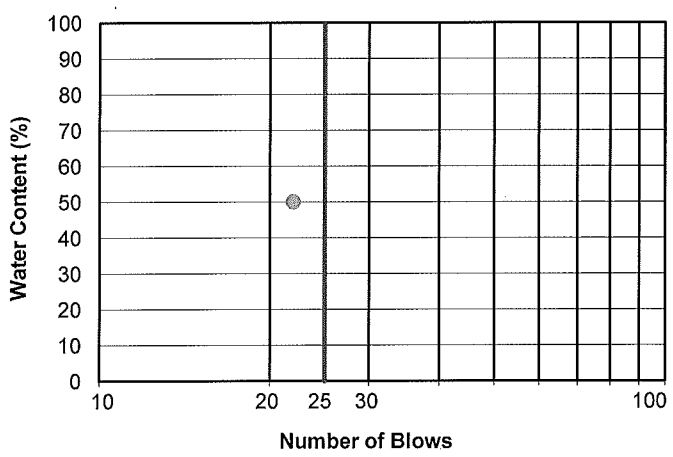
Atterberg Limits (ASTM D 4318)

Project No.: 13-1359-0011	Phase: 1000
Short Title: Fortune Minerals Lab Testing/Stantec&Terracon	Sched: A898-01
Tested By: CG	Date: 25-Sep-13

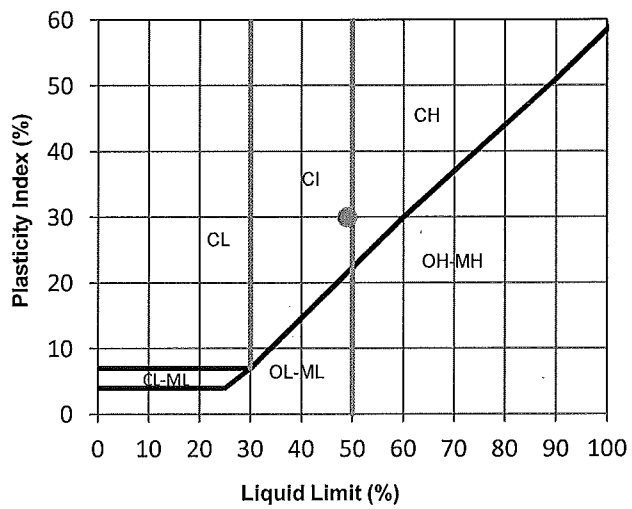
Borehole: GD-01 Sample No.: 130449-CORE Depth: 6.00-6.14 m

Liquid Limit Determination:			Natural Water Content:		
Number of Blows	22	22	As Received Water Content (%)		33.0%
Blow Correction Factor	0.99	0.99	**Plastic Limit Determination:**		
Mass of wet sample + tare (g)	38.42	37.07	Mass of wet sample + tare (g)	20.48	18.45
Mass of dry sample + tare (g)	32.52	31.36	Mass of dry sample + tare (g)	18.92	17.18
Mass of tare (g)	20.76	19.97	Mass of tare (g)	10.85	10.57
Weight of Water (g)	5.9	5.71	Weight of Water (g)	1.56	1.27
Weight of dry soil (g)	11.76	11.39	Weight of dry soil (g)	8.07	6.61
Water Content (%)	50.2	50.1	Water Content (%)	19.33	19.21
Liquid Limit	49.0	49.0	Average Water Content (%)		19.27

Liquid Limit Test



Plasticity chart for soil passing 425 µm sieve



Liquid Limit =	49	%
Plastic Limit =	19	%
Plasticity Index =	30	

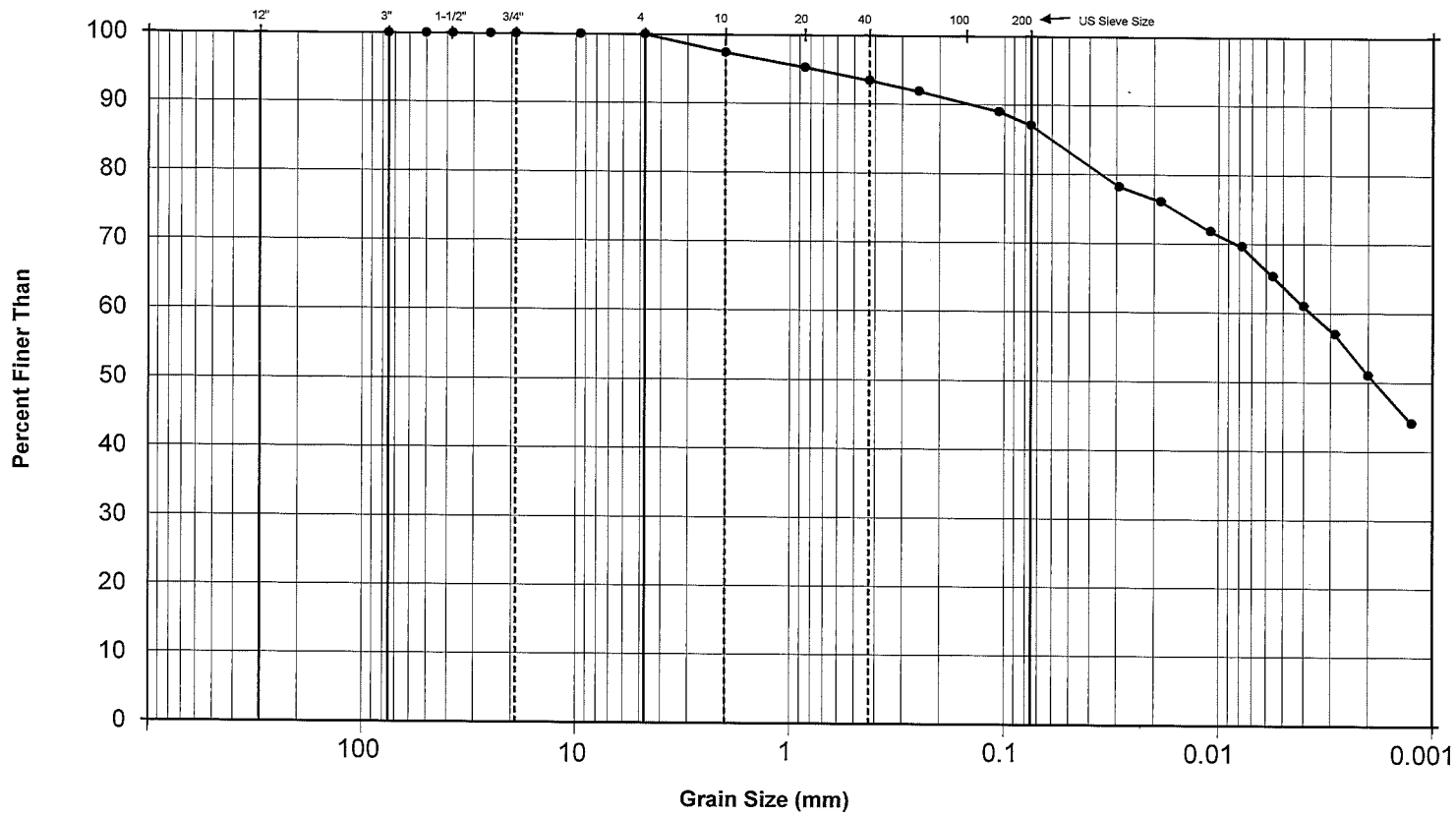
Comments:

Reviewed:

Golder Associates

Particle Size Analysis of Soil
(ASTM D422)

Project No.:	13-1359-0011	Lab No.:	A927-15
Project Title:	Fortune Minerals Lab Testing/Terracon Geotechnique		
Borehole:	GD01	Sample No.:	130449
Depth:	6.00-6.14 m		
Date Tested:	23-Oct-13	By:	DS



Boulder Size	Cobble Size	Gravel Size: Coarse	Gravel Size: Fine	Sand Size: Coarse	Sand Size: Medium	Sand Size: Fine	Silt and Clay Size

Diameter of Sieve (mm)	Percent Passing (%)
75.0	100.0
50.0	100.0
37.5	100.0
25.0	100.0
19.0	100.0
9.5	100.0
4.75	100.0
2.0	97.4
0.850	95.3
0.425	93.5
0.250	91.9
0.106	89.1
0.075	87.1
0.029	78.2
0.019	76.1
0.011	71.8
0.008	69.6
0.006	65.3
0.004	61.0
0.003	57.0
0.002	51.1
0.001	44.1

Comments:

Reviewed: LWB

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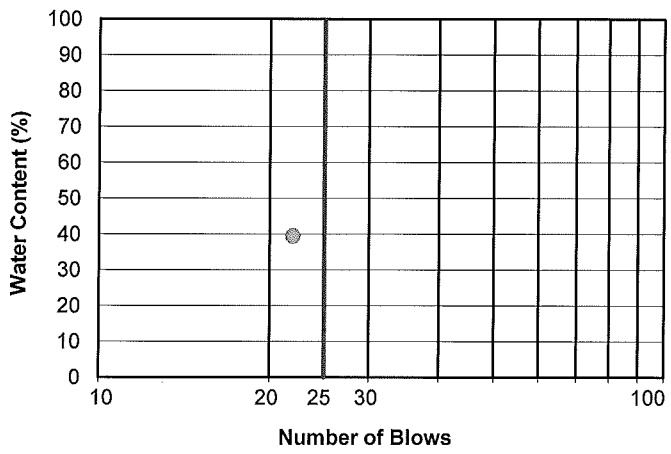
Atterberg Limits (ASTM D 4318)

Project No.: 13-1359-0011	Phase: 1000
Short Title: Fortune Minerals Lab Testing/Stantec&Terracon	Sched: A898-02
Tested By: CG	Date: 25-Sep-13

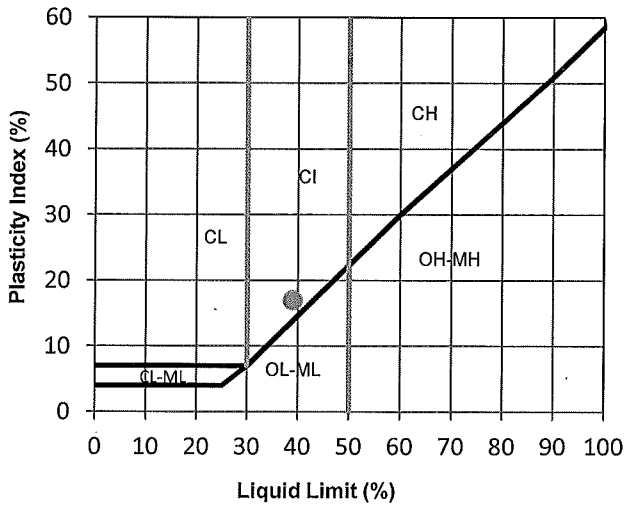
Borehole: GD-02 Sample No.: 130440-SPT Depth: 2.00-2.46 m

Liquid Limit Determination:			Natural Water Content:		
Number of Blows	22	22	As Received Water Content (%)		18.7%
Blow Correction Factor	0.99	0.99	**Plastic Limit Determination:**		
Mass of wet sample + tare (g)	35.21	38.17	Mass of wet sample + tare (g)	21.13	21.08
Mass of dry sample + tare (g)	30.56	32.82	Mass of dry sample + tare (g)	19.29	19.24
Mass of tare (g)	18.82	19.24	Mass of tare (g)	10.81	10.81
Weight of Water (g)	4.65	5.35	Weight of Water (g)	1.84	1.84
Weight of dry soil (g)	11.74	13.58	Weight of dry soil (g)	8.48	8.43
Water Content (%)	39.6	39.4	Water Content (%)	21.70	21.83
Liquid Limit	39.0	39.0	Average Water Content (%)		21.76

Liquid Limit Test



Plasticity chart for soil passing 425 µm sieve



Liquid Limit =	39	%
Plastic Limit =	22	%
Plasticity Index =	17	

Comments:

Reviewed:

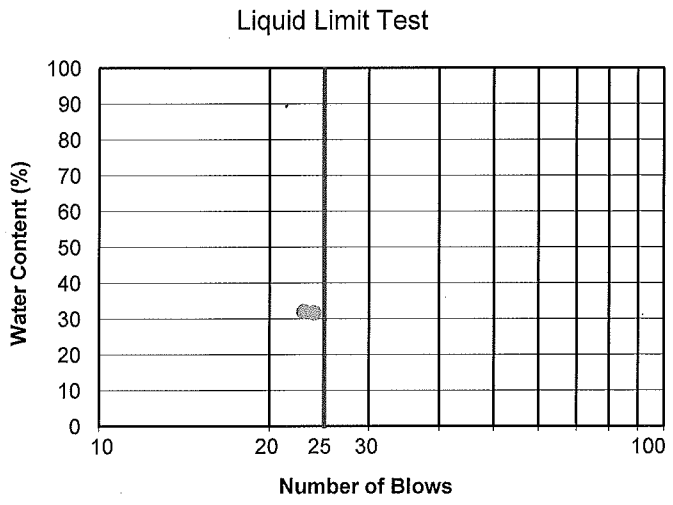
Golder Associates

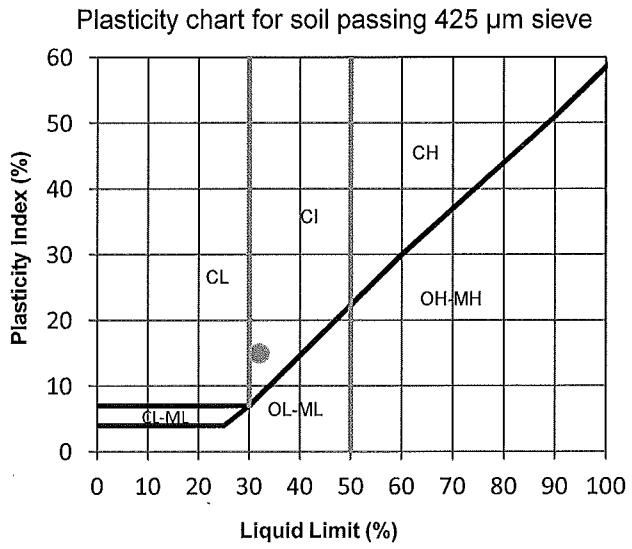
Atterberg Limits (ASTM D 4318)

Project No.: 13-1359-0011	Phase: 1000
Short Title: Fortune Minerals Lab Testing/Stantec&Terracon	Sched: A898-03
Tested By: CG	Date: 25-Sep-13

Borehole: GD-02 Sample No.: 130441-SPT Depth: 5.00-5.46 m

Liquid Limit Determination:			Natural Water Content:		
Number of Blows	23	24	As Received Water Content (%)		27.2%
Blow Correction Factor	0.99	1.00	**Plastic Limit Determination:**		
Mass of wet sample + tare (g)	47.30	44.89	Mass of wet sample + tare (g)	21.48	18.83
Mass of dry sample + tare (g)	42.28	39.66	Mass of dry sample + tare (g)	19.92	17.50
Mass of tare (g)	26.64	23.20	Mass of tare (g)	10.48	9.51
Weight of Water (g)	5.02	5.23	Weight of Water (g)	1.56	1.33
Weight of dry soil (g)	15.64	16.46	Weight of dry soil (g)	9.44	7.99
Water Content (%)	32.1	31.8	Water Content (%)	16.53	16.65
Liquid Limit	32.0	32.0	Average Water Content (%)		16.59





Liquid Limit =	32	%
Plastic Limit =	17	%
Plasticity Index =	15	

Comments:

Reviewed:

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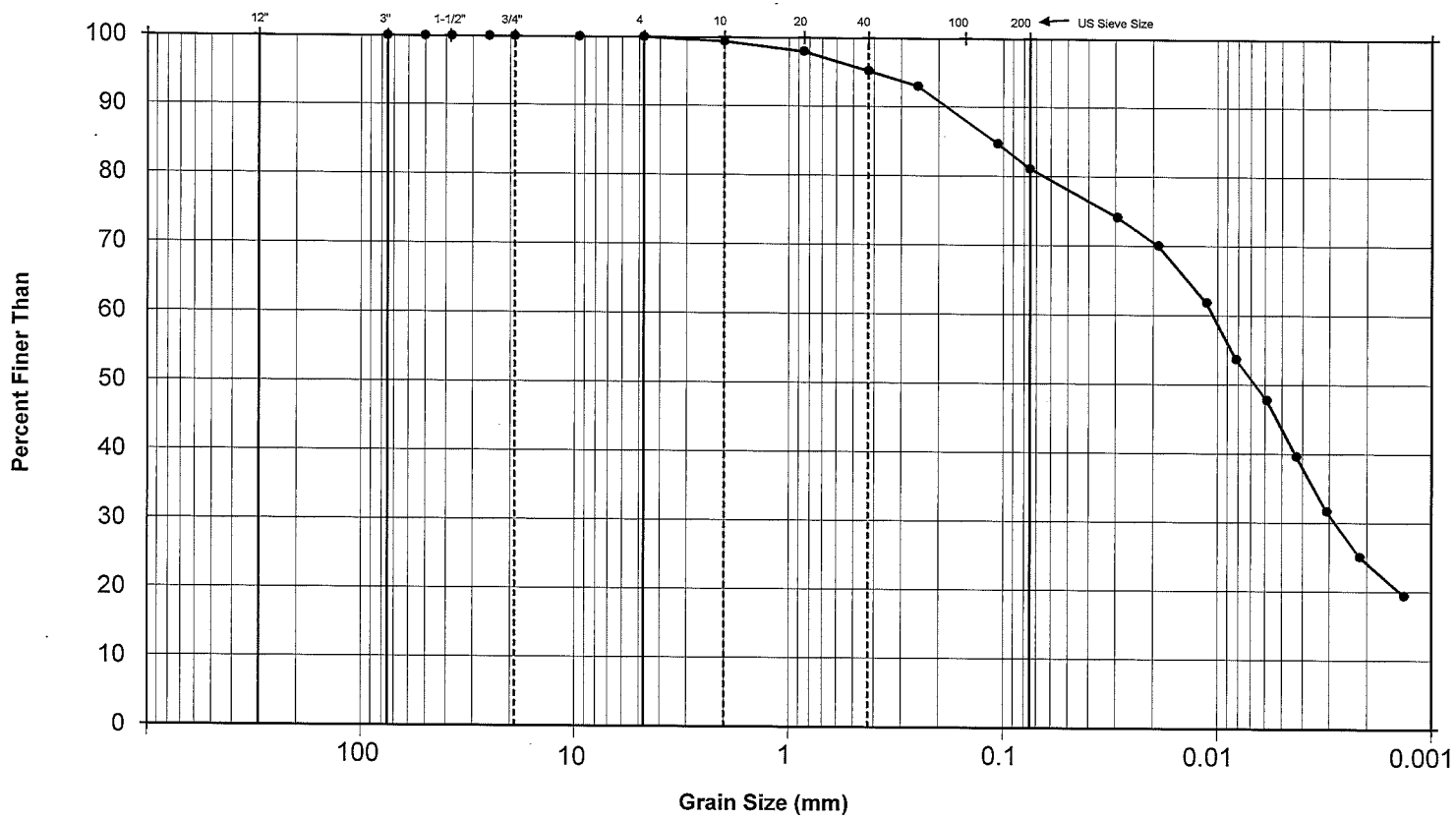
Particle Size Analysis of Soil
(ASTM D422)

Project No.:	13-1359-0011	Lab No.:	A927-12
Project Title:	Fortune Minerals Lab Testing/Terracon Geotechnique		
Borehole:	GD2	Sample No.:	130441
Depth:	5.00-5.46 m		
Date Tested:	23-Oct-13	By:	DS



Diameter of Sieve (mm)	Percent Passing (%)
75.0	100.0
50.0	100.0
37.5	100.0
25.0	100.0
19.0	100.0
9.5	100.0
4.75	100.0
2.0	99.4
0.850	98.0
0.425	95.2
0.250	93.1
0.106	84.7
0.075	81.1
0.029	74.1
0.019	70.0
0.011	61.9
0.008	53.7
0.006	47.8
0.004	39.6
0.003	31.7
0.002	25.1
0.001	19.5

Boulder Size	Cobble Size	Gravel Size		Sand Size			Silt and Clay Size
		Coarse	Fine	Coarse	Medium	Fine	

Comments:

Reviewed: [illegible]

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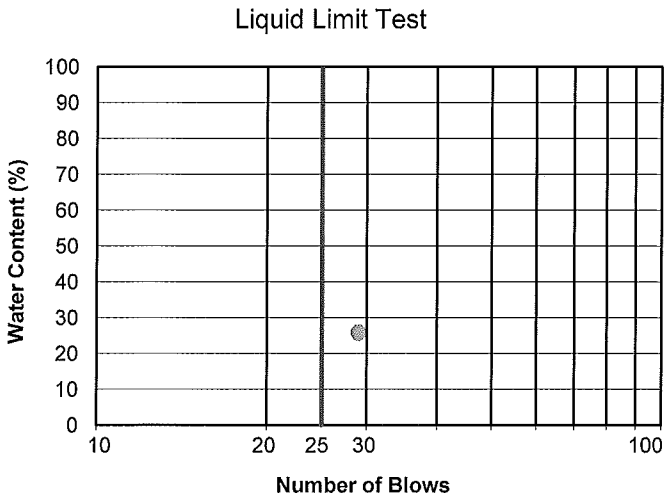
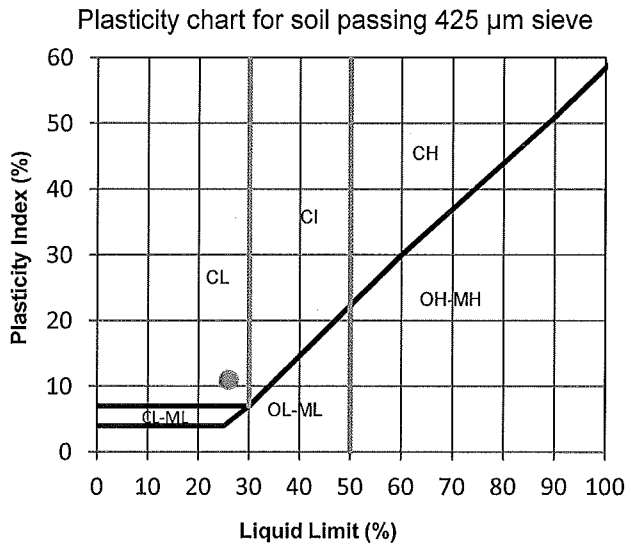
Atterberg Limits (ASTM D 4318)

Project No.: 13-1359-0011	Phase: 1000
Short Title: Fortune Minerals Lab Testing/Stantec&Terracon	Sched: A898-04
Tested By: CG	Date: 25-Sep-13

Borehole: GD-02 Sample No.: 130442-SPT Depth: 6.50-6.96 m

Liquid Limit Determination:			Natural Water Content:		
Number of Blows	29	29	As Received Water Content (%)		14.3%
Blow Correction Factor	1.02	1.02	**Plastic Limit Determination:**		
Mass of wet sample + tare (g)	37.47	45.29	Mass of wet sample + tare (g)	21.60	21.03
Mass of dry sample + tare (g)	33.66	41.22	Mass of dry sample + tare (g)	20.22	19.70
Mass of tare (g)	19.01	25.39	Mass of tare (g)	11.09	10.86
Weight of Water (g)	3.81	4.07	Weight of Water (g)	1.38	1.33
Weight of dry soil (g)	14.65	15.83	Weight of dry soil (g)	9.13	8.84
Water Content (%)	26.0	25.7	Water Content (%)	15.12	15.05
Liquid Limit	26.0	26.0	Average Water Content (%)		15.08





Liquid Limit =	26	%
Plastic Limit =	15	%
Plasticity Index =	11	

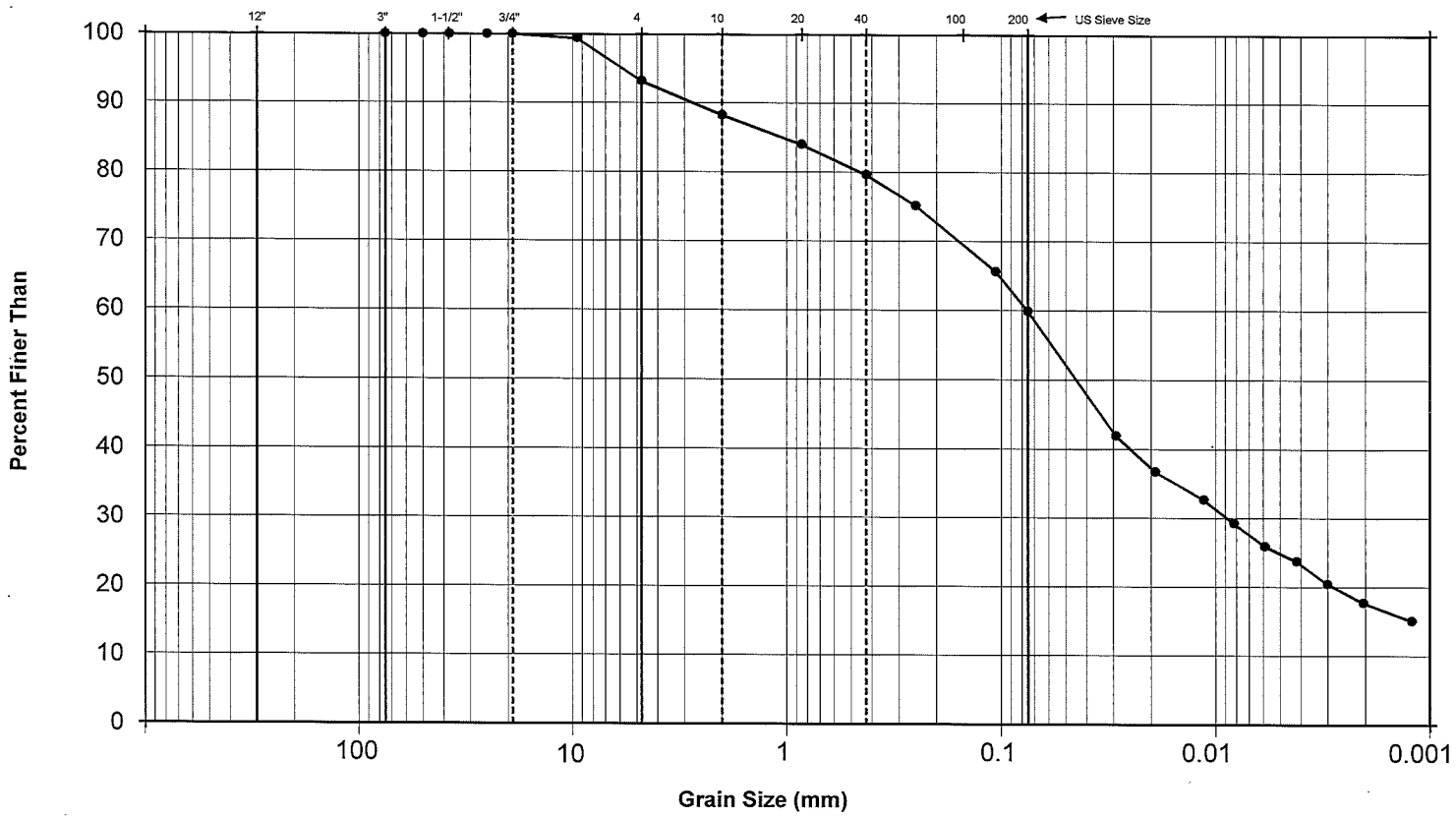
Comments:

Reviewed:

Golder Associates

Particle Size Analysis of Soil
(ASTM D422)

Project No.:	13-1359-0011	Lab No.:	A927-13
Project Title:	Fortune Minerals Lab Testing/Terracon Geotechnique		
Borehole:	GD2	Sample No.:	130442
Depth:	6.50-6.96 m		
Date Tested:	23-Oct-13	By:	DS



Boulder Size	Cobble Size	Gravel Size: Coarse	Gravel Size: Fine	Sand Size: Coarse	Sand Size: Medium	Sand Size: Fine	Silt and Clay Size

Diameter of Sieve (mm)	Percent Passing (%)
75.0	100.0
50.0	100.0
37.5	100.0
25.0	100.0
19.0	100.0
9.5	99.4
4.75	93.2
2.0	88.3
0.850	84.0
0.425	79.6
0.250	75.2
0.106	65.6
0.075	59.9
0.029	42.0
0.019	36.8
0.011	32.7
0.008	29.3
0.006	26.0
0.004	23.8
0.003	20.5
0.002	17.8
0.001	15.2

Comments:

Reviewed:

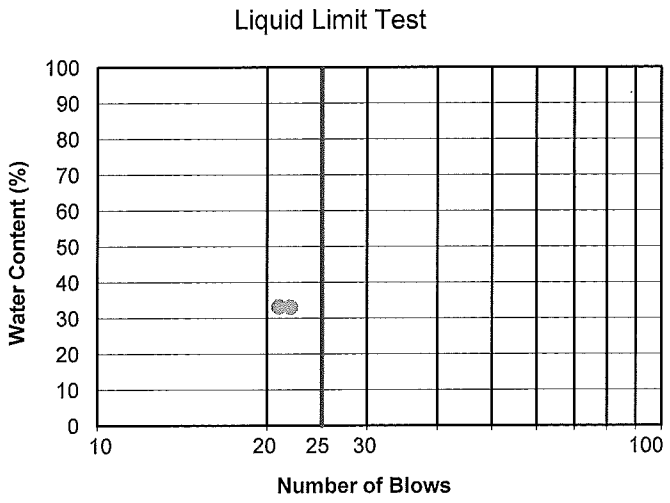
Golder Associates

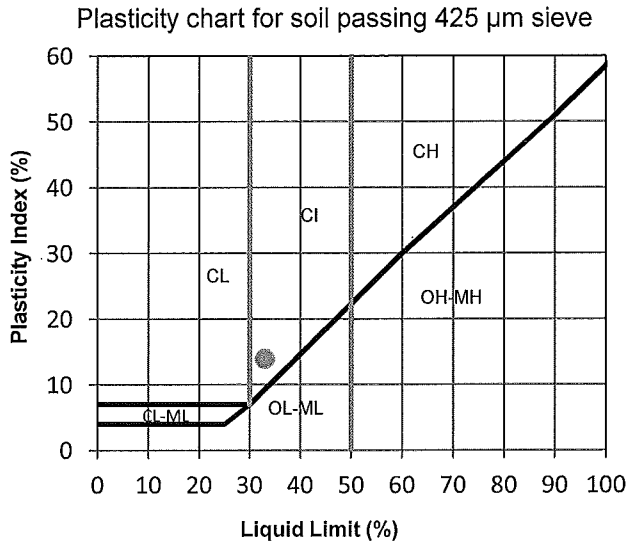
Atterberg Limits (ASTM D 4318)

Project No.: 13-1359-0011	Phase: 1000
Short Title: Fortune Minerals Lab Testing/Stantec&Terracon	Sched: A898-05
Tested By: CG	Date: 25-Sep-13

Borehole: GD-02 Sample No.: 130443-SPT Depth: 9.50-9.96 m

Liquid Limit Determination:			Natural Water Content:		
Number of Blows	21	22	As Received Water Content (%)		16.5%
Blow Correction Factor	0.98	0.99	**Plastic Limit Determination:**		
Mass of wet sample + tare (g)	46.04	36.19	Mass of wet sample + tare (g)	20.59	20.34
Mass of dry sample + tare (g)	42.40	32.02	Mass of dry sample + tare (g)	19.02	18.82
Mass of tare (g)	31.47	19.45	Mass of tare (g)	10.63	10.74
Weight of Water (g)	3.64	4.17	Weight of Water (g)	1.57	1.52
Weight of dry soil (g)	10.93	12.57	Weight of dry soil (g)	8.39	8.08
Water Content (%)	33.3	33.2	Water Content (%)	18.71	18.81
Liquid Limit	33.0	33.0	Average Water Content (%)		18.76





Liquid Limit =	33	%
Plastic Limit =	19	%
Plasticity Index =	14	

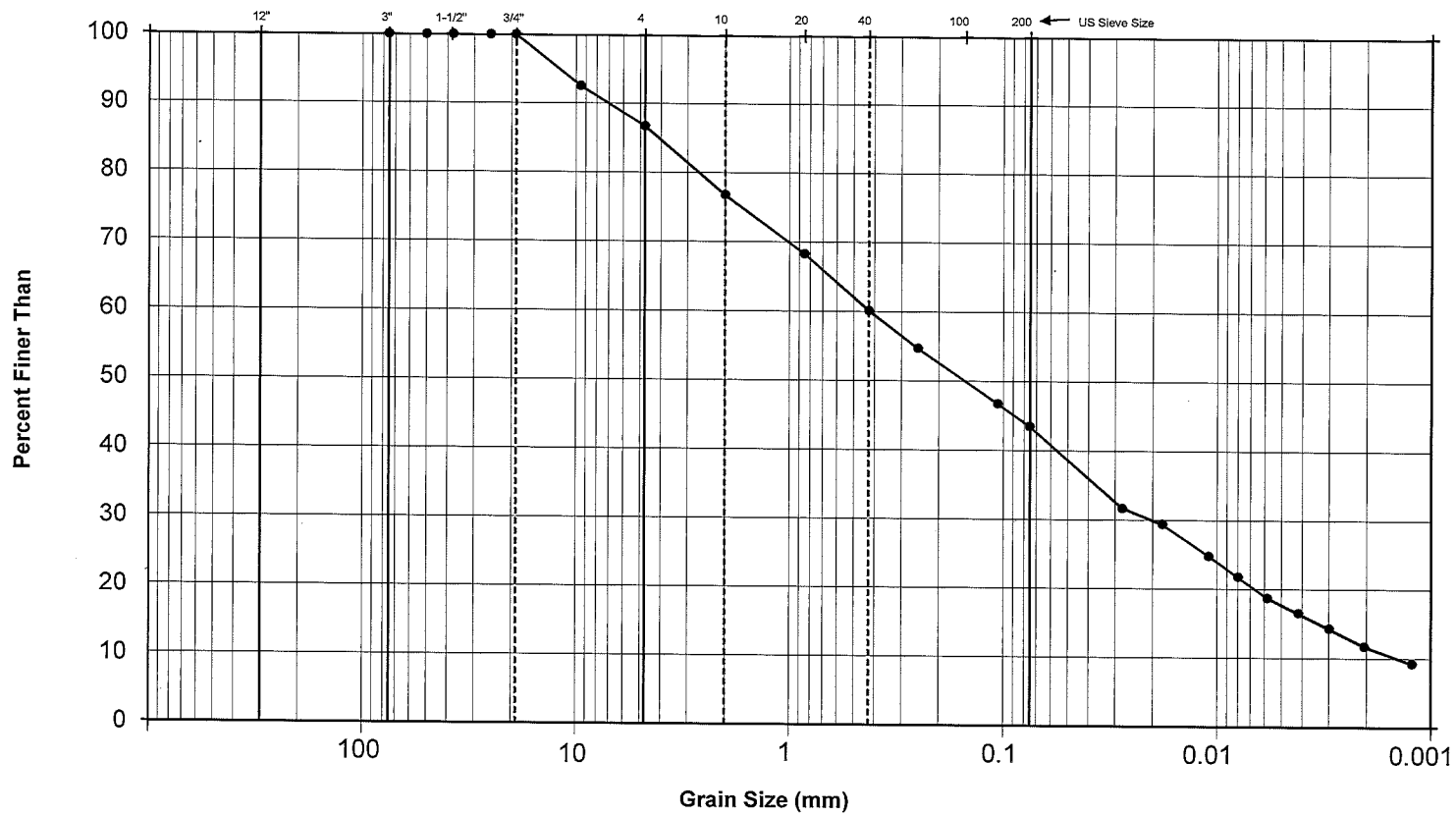
Comments:

Reviewed:

Golder Associates

Particle Size Analysis of Soil
(ASTM D422)

Project No.:	13-1359-0011	Lab No.:	A927-14
Project Title:	Fortune Minerals Lab Testing/Terracon Geotechnique		
Borehole:	GD2	Sample No.:	130443
Depth:	9.50-9.96 m		
Date Tested:	23-Oct-13	By:	DS



Diameter of Sieve (mm)	Percent Passing (%)
75.0	100.0
50.0	100.0
37.5	100.0
25.0	100.0
19.0	100.0
9.5	92.6
4.75	86.8
2.0	76.8
0.850	68.3
0.425	60.2
0.250	54.7
0.106	46.8
0.075	43.5
0.028	31.7
0.018	29.4
0.011	24.8
0.008	21.8
0.006	18.7
0.004	16.5
0.003	14.3
0.002	11.8
0.001	9.3

Boulder Size	Cobble Size	Gravel Size		Sand Size			Silt and Clay Size
		Coarse	Fine	Coarse	Medium	Fine	

Comments:

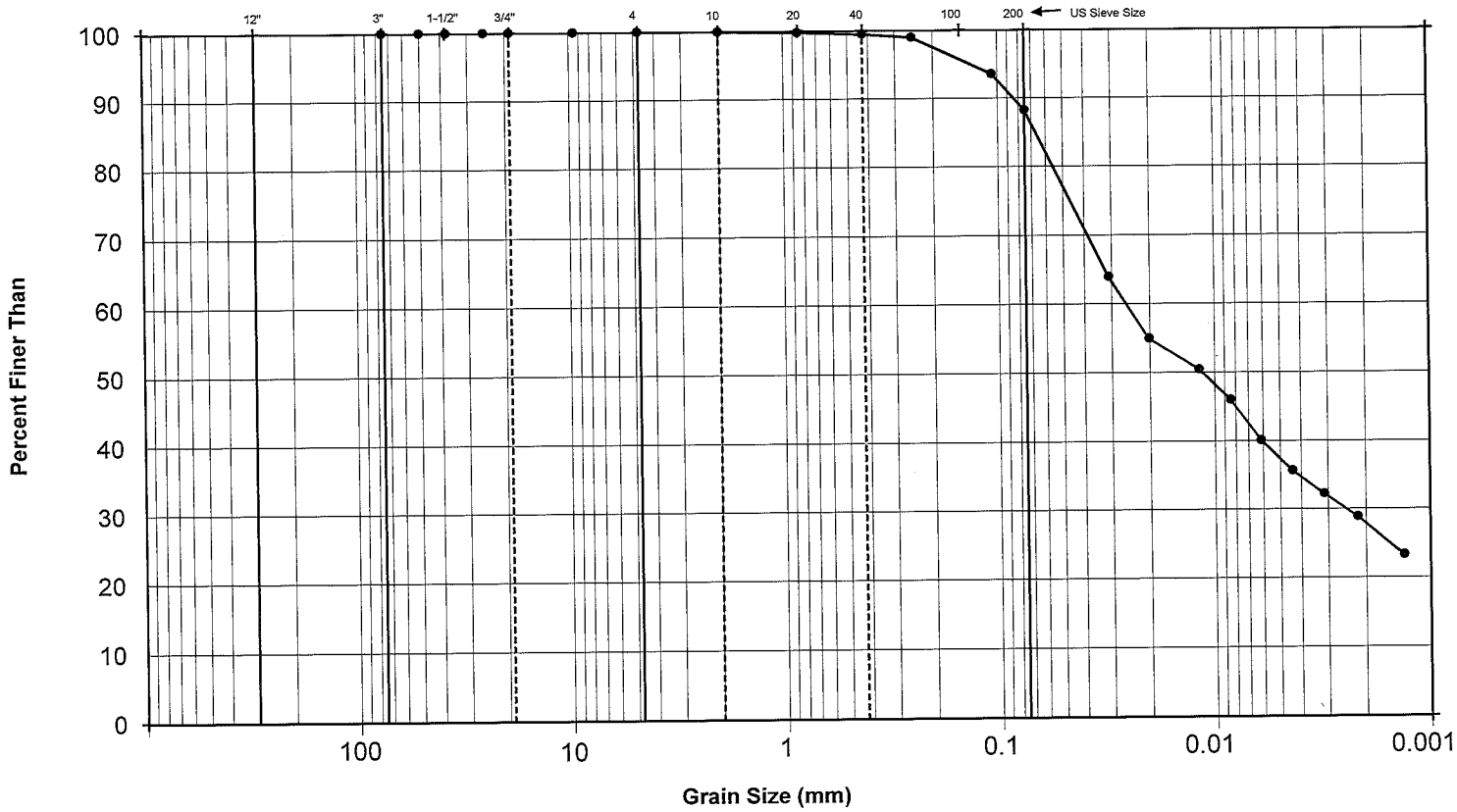
Reviewed: MB

GOLDER ASSOCIATES LTD.

Golder Associates

Particle Size Analysis of Soil
(ASTM D422)

Project No.:	13-1359-0011.1000	Lab No.:	A849-40
Project Title:	Terracon Geotechnique		
Borehole:	MW24-GD12	Sample No.:	130459
Depth:	0.15-0.35m		
Date Tested:	13-Aug-13	By:	DS



Boulder Size	Cobble Size	Gravel Size: Coarse	Gravel Size: Fine	Sand Size: Coarse	Sand Size: Medium	Sand Size: Fine	Silt and Clay Size

Diameter of Sieve (mm)	Percent Passing (%)
75.0	100.0
50.0	100.0
37.5	100.0
25.0	100.0
19.0	100.0
9.5	100.0
4.75	100.0
2.0	100.0
0.850	99.8
0.425	99.5
0.250	99.0
0.106	93.6
0.075	88.3
0.031	63.9
0.020	55.0
0.012	50.5
0.008	46.0
0.006	40.1
0.004	35.6
0.003	32.3
0.002	28.9
0.001	23.3

Comments:

Reviewed: AB

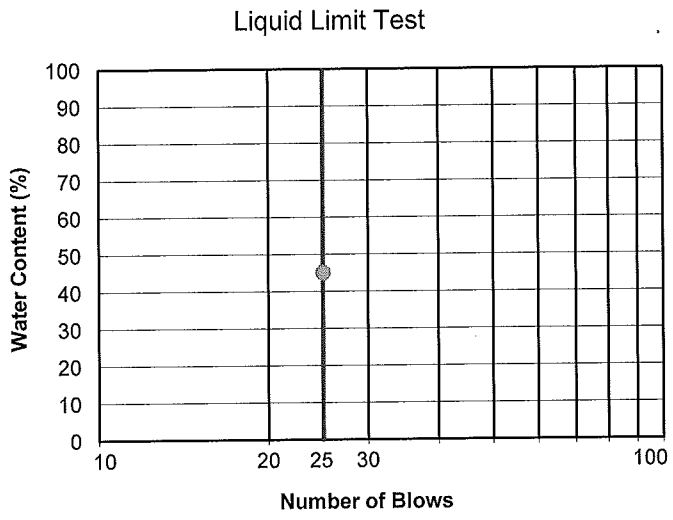
Golder Associates

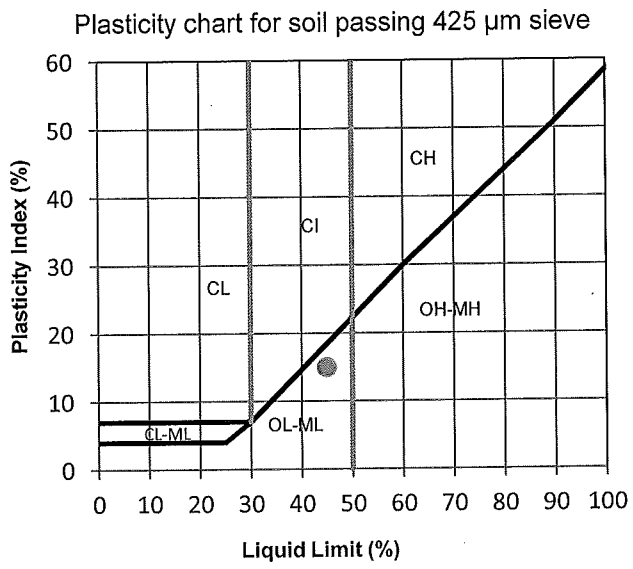
Atterberg Limits (ASTM D 4318)

Project No.: 13-1359-0011	Phase: 1000
Short Title: Terracon Geotechnique	Sched: A849-40
Tested By: CG	Date: 13-Aug-13

Borehole: MW24-GD12 Sample No.: 130459 Depth: 0.15-0.35m

Liquid Limit Determination:			Natural Water Content:		
Number of Blows	25	25	As Received Water Content (%)		45.3%
Blow Correction Factor	1.00	1.00	**Plastic Limit Determination:**		
Mass of wet sample + tare (g)	35.03	46.39	Mass of wet sample + tare (g)	19.78	20.55
Mass of dry sample + tare (g)	29.91	39.33	Mass of dry sample + tare (g)	17.82	18.26
Mass of tare (g)	18.60	23.64	Mass of tare (g)	11.29	10.72
Weight of Water (g)	5.12	7.06	Weight of Water (g)	1.96	2.29
Weight of dry soil (g)	11.31	15.69	Weight of dry soil (g)	6.53	7.54
Water Content (%)	45.3	45.0	Water Content (%)	30.02	30.37
Liquid Limit	45.0	45.0	Average Water Content (%)		30.19





Liquid Limit =	45	%
Plastic Limit =	30	%
Plasticity Index =	15	

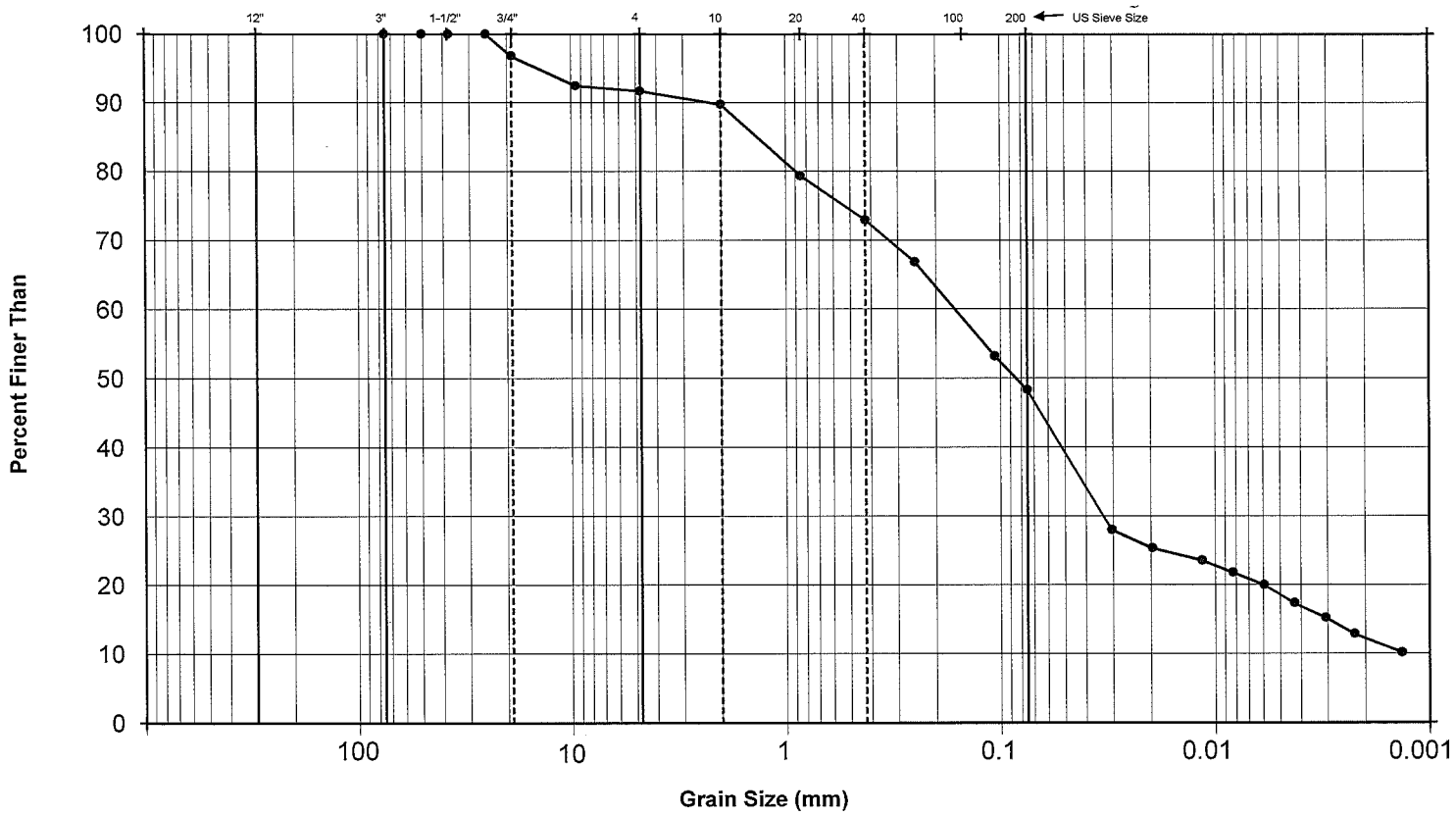
Comments:

Reviewed: MB

Golder Associates

Particle Size Analysis of Soil
(ASTM D422)

Project No.:	13-1359-0011.1000	Lab No.:	A849-41
Project Title:	Terracon Geotechnique		
Borehole:	MW24-GD12	Sample No.:	130460
Depth:	0.35-0.50m		
Date Tested:	13-Aug-13	By:	DS



Boulder Size	Cobble Size	Gravel Size: Coarse	Gravel Size: Fine	Sand Size: Coarse	Sand Size: Medium	Sand Size: Fine	Silt and Clay Size

Diameter of Sieve (mm)	Percent Passing (%)
75.0	100.0
50.0	100.0
37.5	100.0
25.0	100.0
19.0	96.8
9.5	92.5
4.75	91.7
2.0	89.8
0.850	79.4
0.425	72.9
0.250	66.9
0.106	53.2
0.075	48.3
0.030	28.0
0.020	25.3
0.012	23.6
0.008	21.8
0.006	20.0
0.004	17.3
0.003	15.2
0.002	12.9
0.001	10.2

Comments:

Reviewed: MB

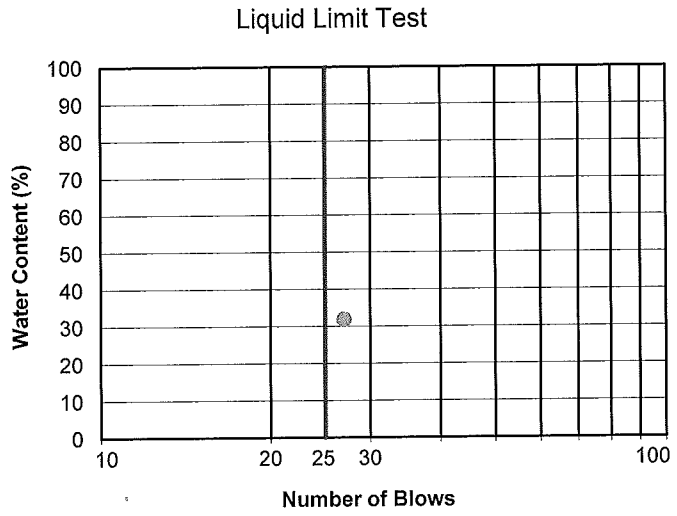
Golder Associates

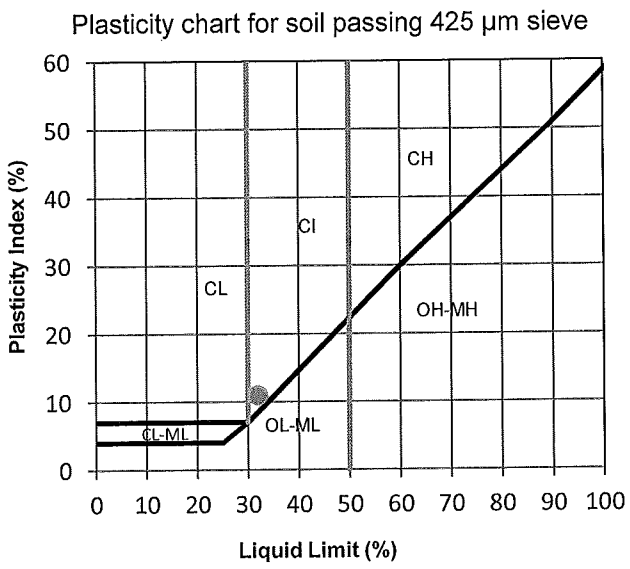
Atterberg Limits (ASTM D 4318)

Project No.: 13-1359-0011	Phase: 1000
Short Title: Terracon Geotechnique	Sched: A849-41
Tested By: CG	Date: 13-Aug-13

Borehole: MW24-GD12 Sample No.: 130460 Depth: 0.35-0.50m

Liquid Limit Determination:			Natural Water Content:		
Number of Blows	27	27	As Received Water Content (%)		15.0%
Blow Correction Factor	1.01	1.01	**Plastic Limit Determination:**		
Mass of wet sample + tare (g)	39.66	45.03	Mass of wet sample + tare (g)	22.26	23.96
Mass of dry sample + tare (g)	35.08	40.08	Mass of dry sample + tare (g)	20.30	21.76
Mass of tare (g)	20.74	24.56	Mass of tare (g)	10.87	11.09
Weight of Water (g)	4.58	4.95	Weight of Water (g)	1.96	2.20
Weight of dry soil (g)	14.34	15.52	Weight of dry soil (g)	9.43	10.67
Water Content (%)	31.9	31.9	Water Content (%)	20.78	20.62
Liquid Limit	32.0	32.0	Average Water Content (%)		20.70





Liquid Limit =	32	%
Plastic Limit =	21	%
Plasticity Index =	11	

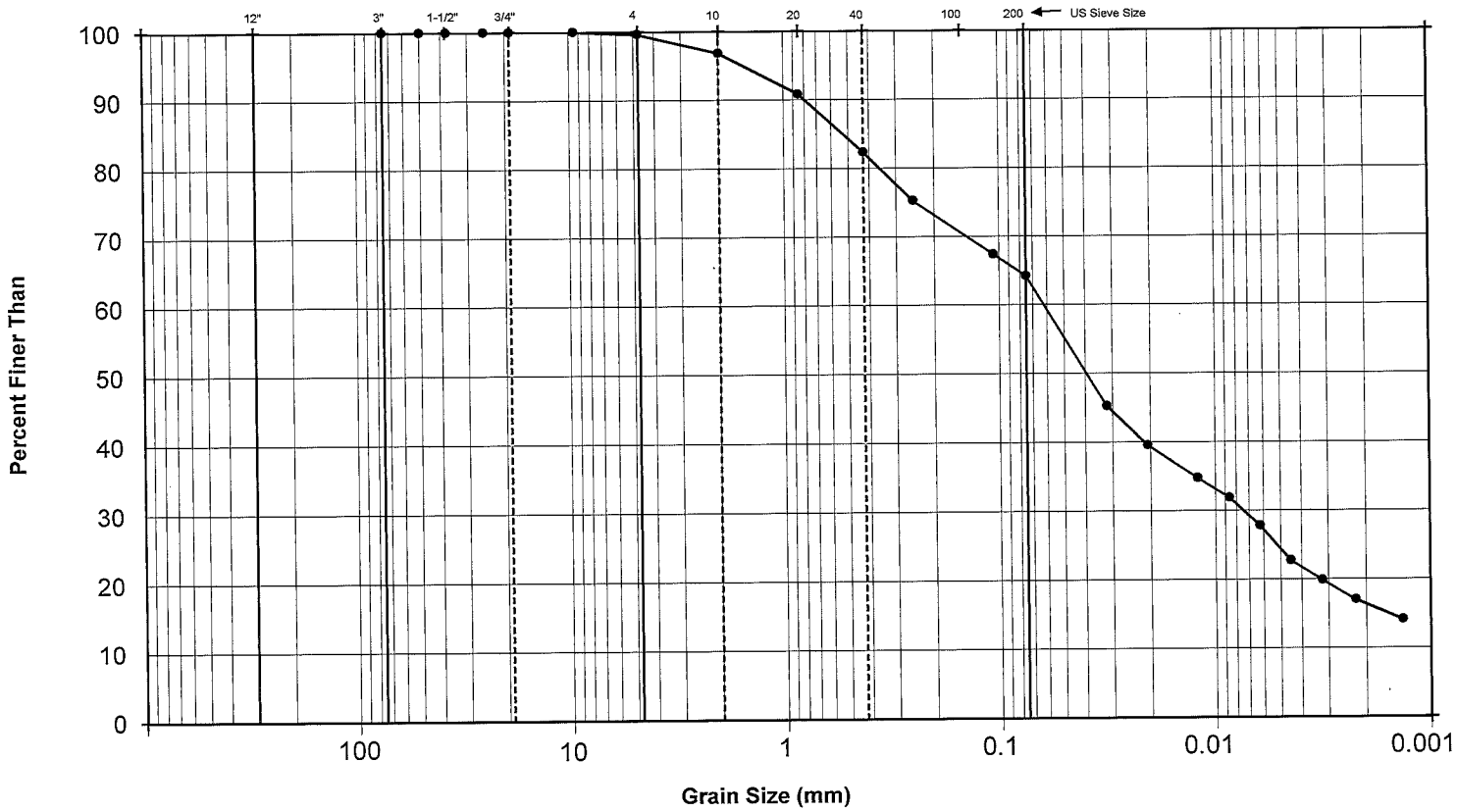
Comments:

Reviewed:

Golder Associates

Particle Size Analysis of Soil
(ASTM D422)

Project No.:	13-1359-0011.1000	Lab No.:	A849-42
Project Title:	Terracon Geotechnique		
Borehole:	MW24-GD12	Sample No.:	130461
Depth:	0.55-0.65m		
Date Tested:	13-Aug-13	By:	DS



Boulder Size	Cobble Size	Gravel Size: Coarse	Gravel Size: Fine	Sand Size: Coarse	Sand Size: Medium	Sand Size: Fine	Silt and Clay Size

Diameter of Sieve (mm)	Percent Passing (%)
75.0	100.0
50.0	100.0
37.5	100.0
25.0	100.0
19.0	100.0
9.5	100.0
4.75	99.6
2.0	96.8
0.850	90.9
0.425	82.4
0.250	75.3
0.106	67.4
0.075	64.2
0.032	45.3
0.021	39.6
0.012	34.8
0.009	31.9
0.006	27.8
0.004	22.8
0.003	19.9
0.002	17.0
0.001	14.2

Comments:

Reviewed: MB

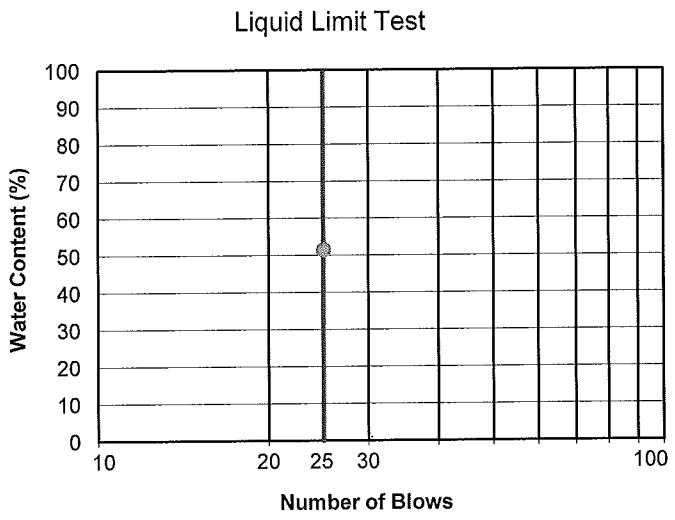
Golder Associates

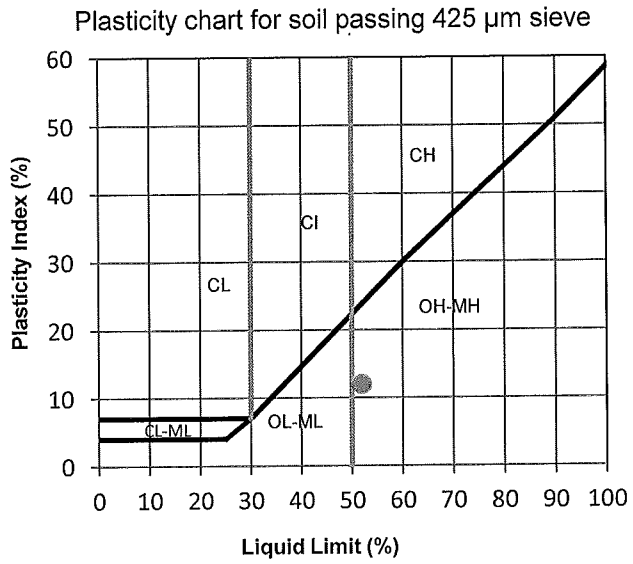
Atterberg Limits (ASTM D 4318)

Project No.: 13-1359-0011	Phase: 1000
Short Title: Terracon Geotechnique	Sched: A849-42
Tested By: CG	Date: 13-Aug-13

Borehole: MW24-GD12 Sample No.: 130461 Depth: 0.55-0.65m

Liquid Limit Determination:			Natural Water Content:		
Number of Blows	25	25	As Received Water Content (%)		25.4%
Blow Correction Factor	1.00	1.00	**Plastic Limit Determination:**		
Mass of wet sample + tare (g)	40.11	45.94	Mass of wet sample + tare (g)	19.35	17.64
Mass of dry sample + tare (g)	34.35	39.39	Mass of dry sample + tare (g)	17.03	15.63
Mass of tare (g)	23.18	26.69	Mass of tare (g)	11.21	10.56
Weight of Water (g)	5.76	6.55	Weight of Water (g)	2.32	2.01
Weight of dry soil (g)	11.17	12.7	Weight of dry soil (g)	5.82	5.07
Water Content (%)	51.6	51.6	Water Content (%)	39.86	39.64
Liquid Limit	52.0	52.0	Average Water Content (%)		39.75





Liquid Limit = 52 %
Plastic Limit = 40 %
Plasticity Index = 12

Comments:

Reviewed: MB

Golder Associates

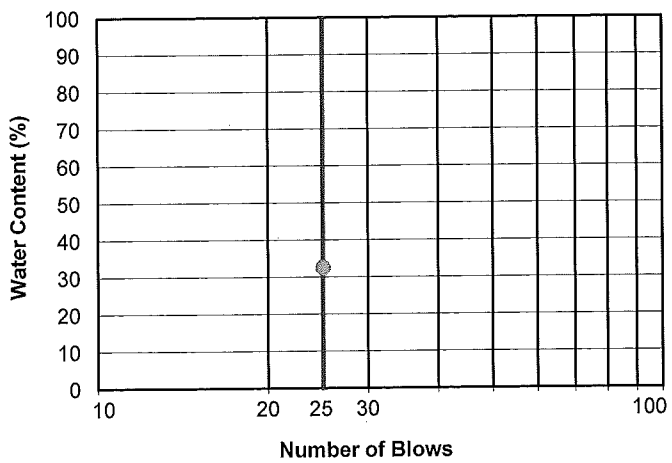
Atterberg Limits (ASTM D 4318)

Project No.: 13-1359-0011	Phase: 1000
Short Title: Terracon Geotechnique	Sched: A849-35
Tested By: CG	Date: 13-Aug-13

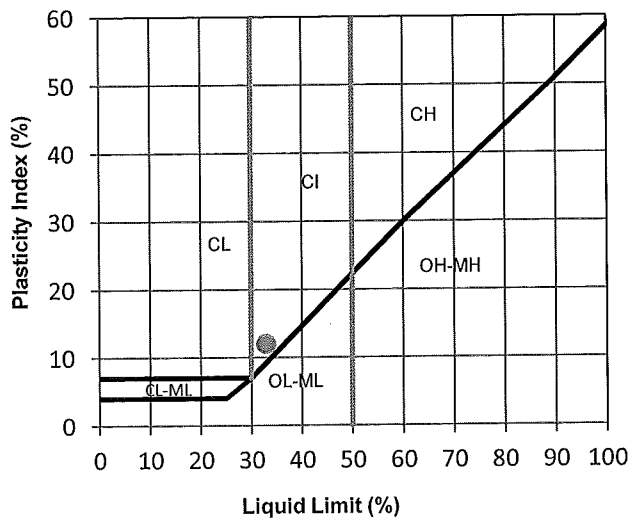
Borehole: MW24-GD12 Sample No.: 130454 Depth: 3.00-3.25m

Liquid Limit Determination:			Natural Water Content:		
Number of Blows	25	25	As Received Water Content (%)		19.8%
Blow Correction Factor	1.00	1.00	**Plastic Limit Determination:**		
Mass of wet sample + tare (g)	41.62	53.05	Mass of wet sample + tare (g)	21.78	24.79
Mass of dry sample + tare (g)	36.85	47.81	Mass of dry sample + tare (g)	19.80	22.39
Mass of tare (g)	22.28	31.71	Mass of tare (g)	10.32	10.80
Weight of Water (g)	4.77	5.24	Weight of Water (g)	1.98	2.40
Weight of dry soil (g)	14.57	16.1	Weight of dry soil (g)	9.48	11.59
Water Content (%)	32.7	32.5	Water Content (%)	20.89	20.71
Liquid Limit	33.0	33.0	Average Water Content (%)		20.80

Liquid Limit Test



Plasticity chart for soil passing 425 µm sieve



Liquid Limit = 33 %
Plastic Limit = 21 %
Plasticity Index = 12

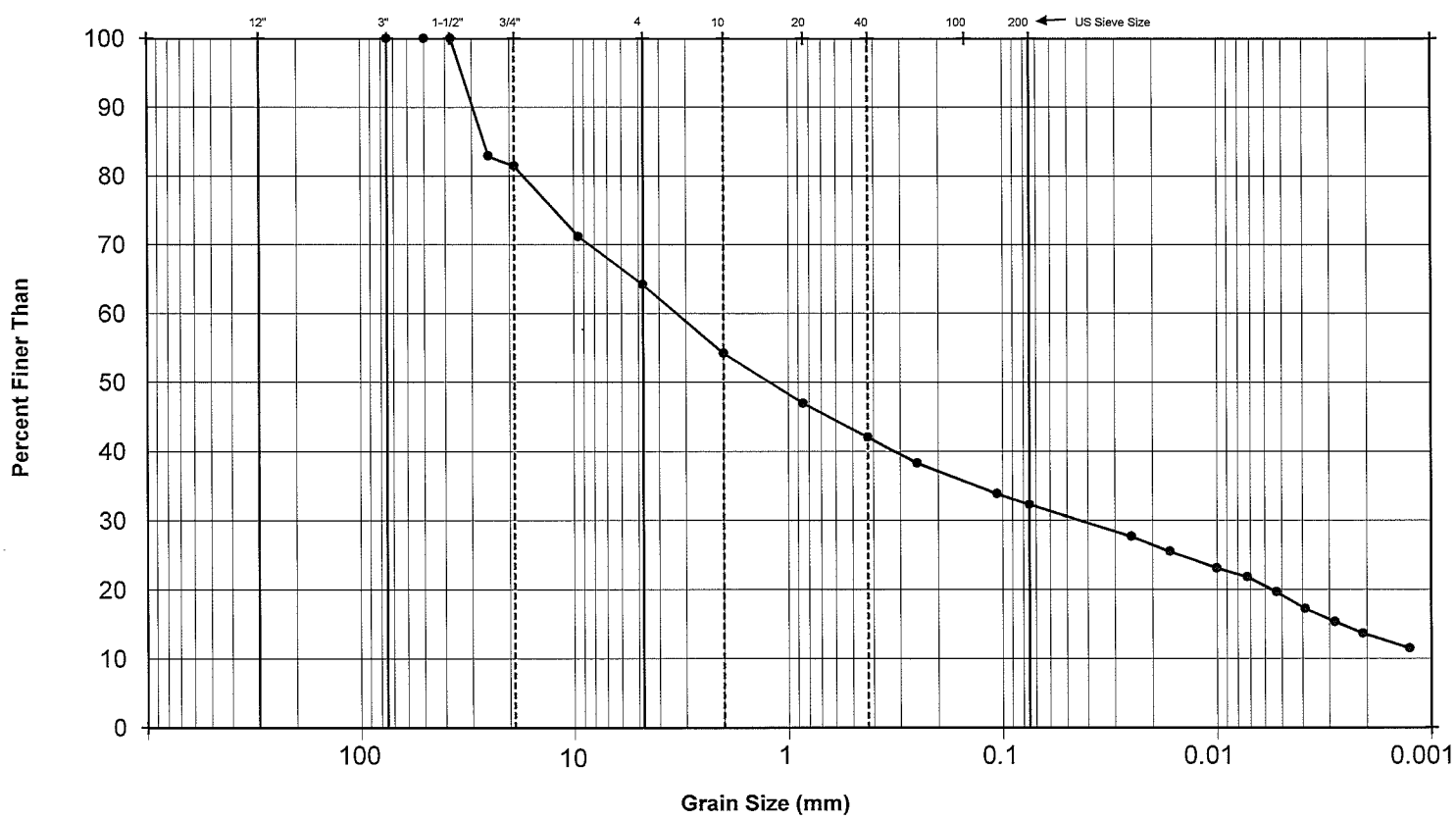
Comments:

Reviewed: MB

Golder Associates

Particle Size Analysis of Soil
(ASTM D422)

Project No.:	13-1359-0011.1000	Lab No.:	A849-43
Project Title:	Terracon Geotechnique		
Borehole:	MW24-GD12	Sample No.:	130462
Depth:	3.15-3.29m		
Date Tested:	13-Aug-13	By:	DS



Diameter of Sieve (mm)	Percent Passing (%)
75.0	100.0
50.0	100.0
37.5	100.0
25.0	82.9
19.0	81.5
9.5	71.2
4.75	64.2
2.0	54.2
0.850	47.0
0.425	42.0
0.250	38.3
0.106	33.9
0.075	32.3
0.025	27.7
0.017	25.5
0.010	23.1
0.007	21.8
0.005	19.7
0.004	17.2
0.003	15.4
0.002	13.7
0.001	11.5

Boulder Size	Cobble Size	Gravel Size		Sand Size			Silt and Clay Size
		Coarse	Fine	Coarse	Medium	Fine	

Comments:

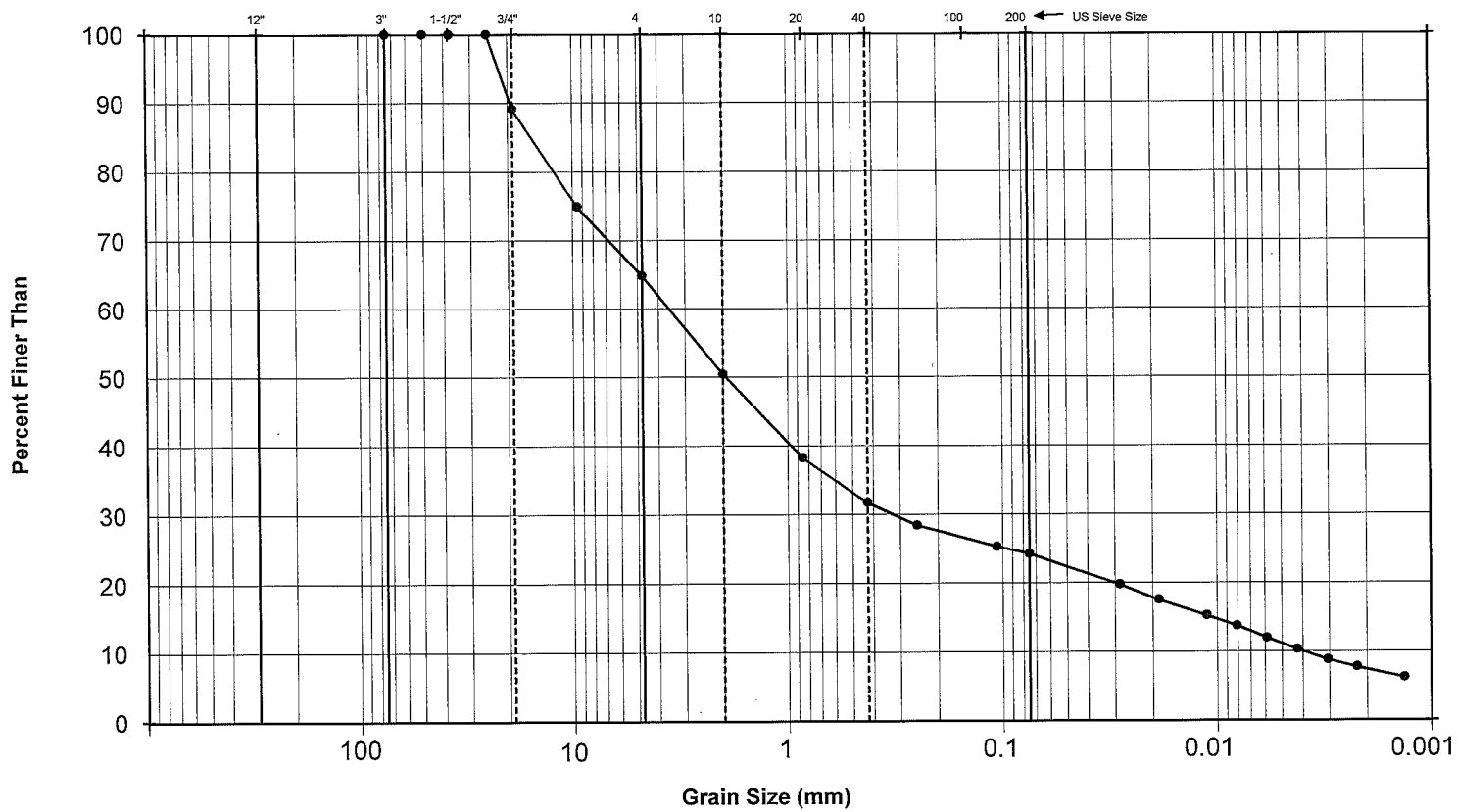
Reviewed: MB

GOLDER ASSOCIATES LTD.

Golder Associates

Particle Size Analysis of Soil
(ASTM D422)

Project No.:	13-1359-0011.1000	Lab No.:	A849-36
Project Title:	Terracon Geotechnique		
Borehole:	MW24-GD12	Sample No.:	130455
Depth:	4.50-4.70		
Date Tested:	13-Aug-13	By:	DS



Diameter of Sieve (mm)	Percent Passing (%)
75.0	100.0
50.0	100.0
37.5	100.0
25.0	100.0
19.0	89.2
9.5	74.9
4.75	64.8
2.0	50.4
0.850	38.2
0.425	31.7
0.250	28.4
0.106	25.3
0.075	24.3
0.028	19.8
0.019	17.5
0.011	15.3
0.008	13.8
0.006	12.0
0.004	10.3
0.003	8.8
0.002	7.7
0.001	6.2

Boulder Size	Cobble Size	Coarse	Fine	Coarse	Medium	Fine	Silt and Clay Size
		Gravel Size		Sand Size			

Comments:

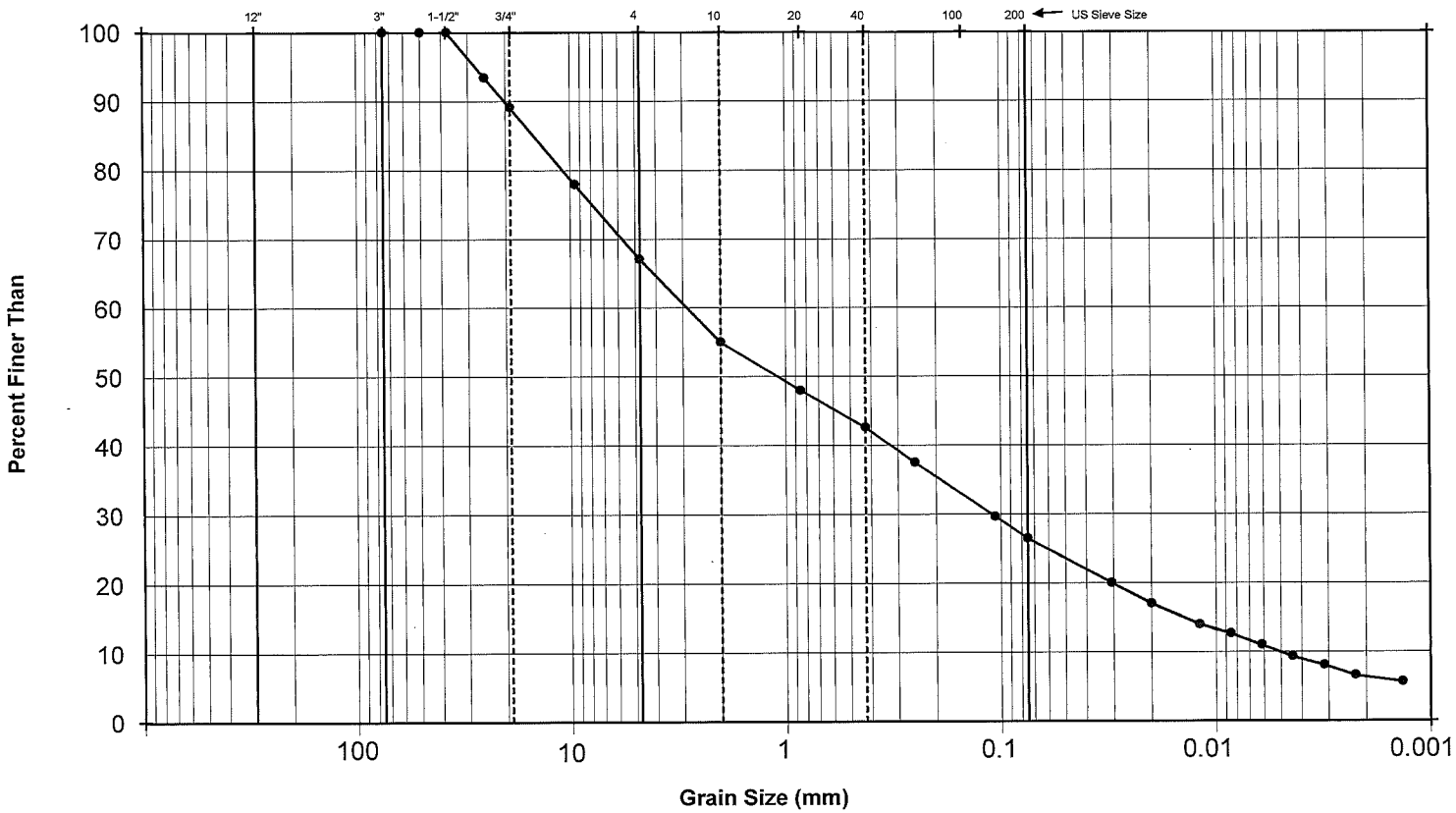
Reviewed: mB

GOLDER ASSOCIATES LTD.

Golder Associates

Particle Size Analysis of Soil
(ASTM D422)

Project No.:	13-1359-0011.1000	Lab No.:	A849-37
Project Title:	Terracon Geotechnique		
Borehole:	MW24-GD12	Sample No.:	130456
Depth:	7.50-7.83m		
Date Tested:	13-Aug-13	By:	DS



Boulder Size	Cobble Size	Gravel Size: Coarse	Gravel Size: Fine	Sand Size: Coarse	Sand Size: Medium	Sand Size: Fine	Silt and Clay Size

Diameter of Sieve (mm)	Percent Passing (%)
75.0	100.0
50.0	100.0
37.5	100.0
25.0	93.5
19.0	89.2
9.5	78.0
4.75	67.1
2.0	55.0
0.850	48.0
0.425	42.6
0.250	37.5
0.106	29.7
0.075	26.5
0.031	20.1
0.020	17.1
0.012	14.1
0.009	12.7
0.006	11.0
0.004	9.4
0.003	8.1
0.002	6.6
0.001	5.7

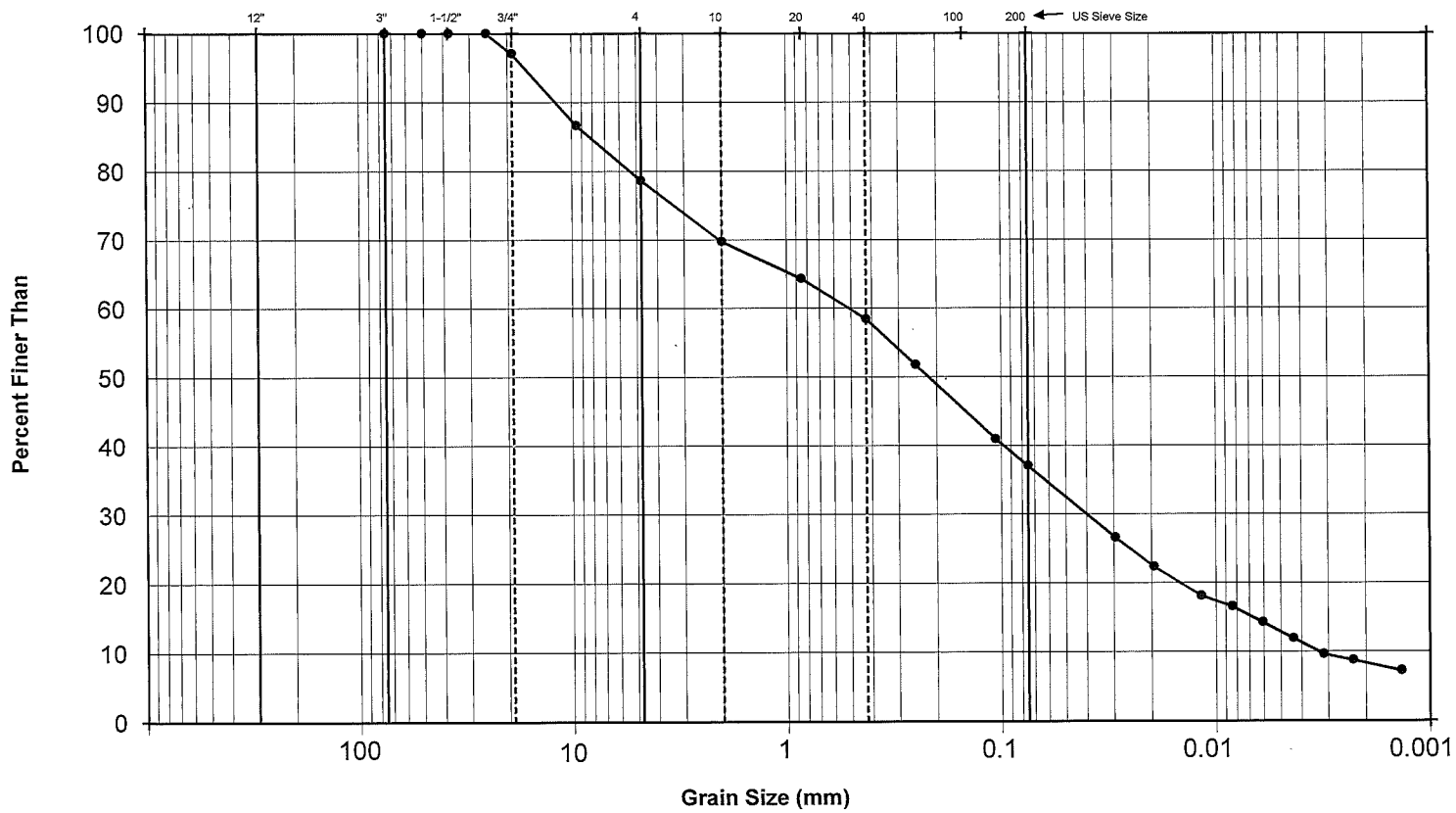
Comments:

Reviewed: MB

Golder Associates

Particle Size Analysis of Soil
(ASTM D422)

Project No.:	13-1359-0011.1000	Lab No.:	A849-38
Project Title:	Terracon Geotechnique		
Borehole:	MW24-GD12	Sample No.:	130457
Depth:	9.00-9.22m		
Date Tested:	13-Aug-13	By:	DS



Diameter of Sieve (mm)	Percent Passing (%)
75.0	100.0
50.0	100.0
37.5	100.0
25.0	100.0
19.0	97.1
9.5	86.7
4.75	78.7
2.0	69.8
0.850	64.3
0.425	58.5
0.250	51.8
0.106	41.0
0.075	37.1
0.029	26.6
0.019	22.4
0.012	18.1
0.008	16.6
0.006	14.3
0.004	12.0
0.003	9.7
0.002	8.8
0.001	7.2

Boulder Size	Cobble Size	Coarse	Fine	Coarse	Medium	Fine	Silt and Clay Size
		Gravel Size		Sand Size			

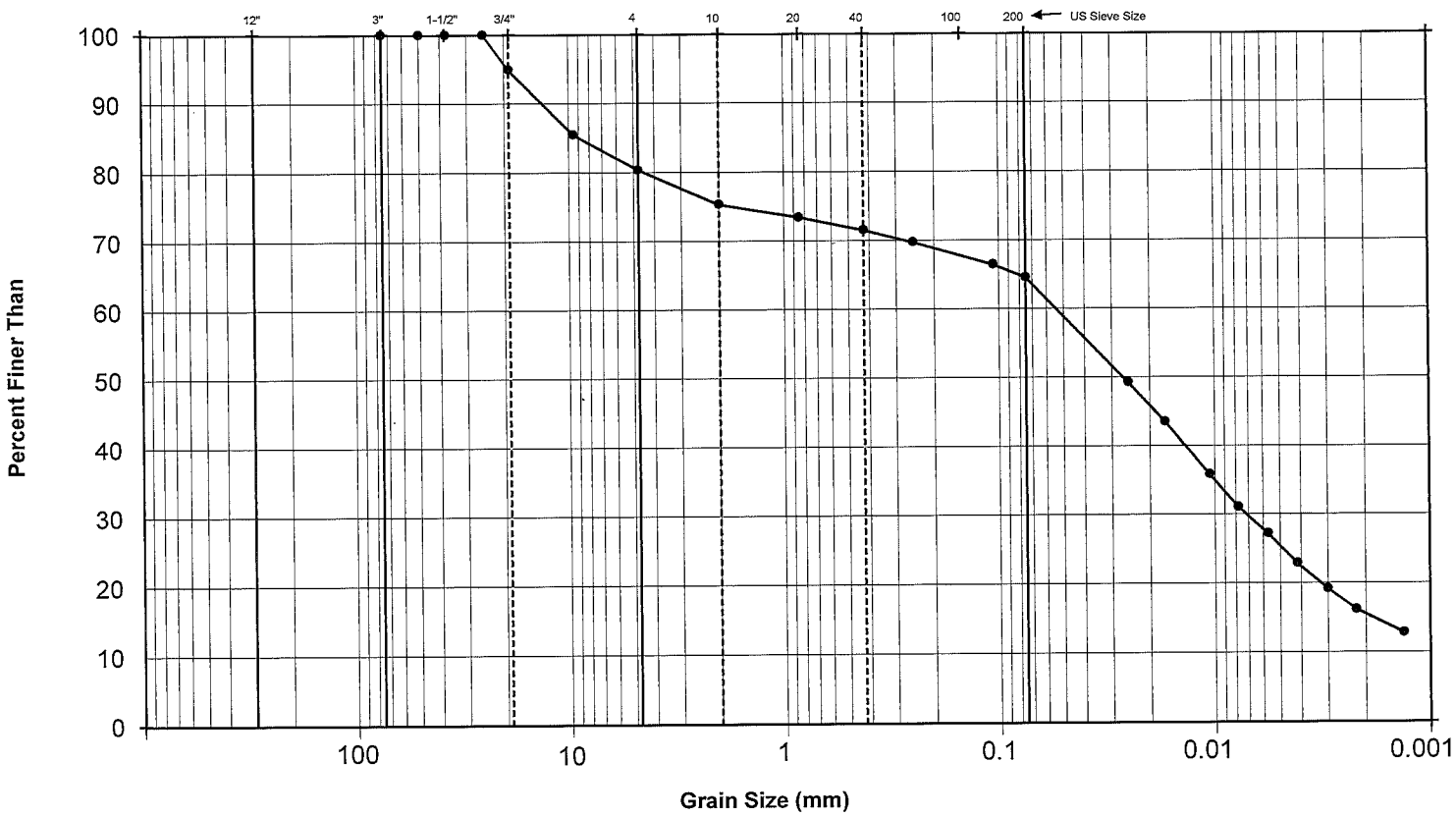
Comments:

Reviewed: MB

Golder Associates

Particle Size Analysis of Soil
(ASTM D422)

Project No.:	13-1359-0011.1000	Lab No.:	A849-39
Project Title:	Terracon Geotechnique		
Borehole:	MW24-GD12	Sample No.:	130458
Depth:	10.50-10.80m		
Date Tested:	13-Aug-13	By:	DS



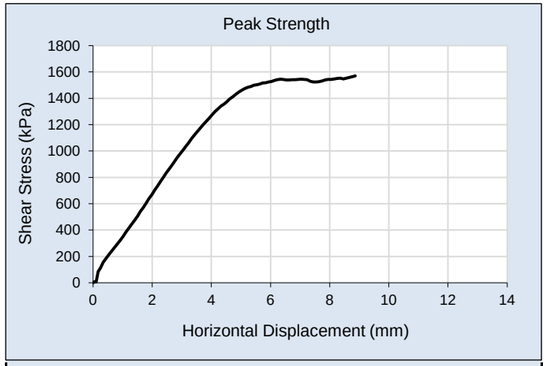
Diameter of Sieve (mm)	Percent Passing (%)
75.0	100.0
50.0	100.0
37.5	100.0
25.0	100.0
19.0	94.9
9.5	85.5
4.75	80.4
2.0	75.4
0.850	73.4
0.425	71.6
0.250	69.8
0.106	66.5
0.075	64.6
0.025	49.3
0.017	43.5
0.011	35.9
0.008	31.1
0.006	27.2
0.004	22.9
0.003	19.2
0.002	16.2
0.001	12.8

Boulder Size	Cobble Size	Gravel Size: Coarse	Gravel Size: Fine	Sand Size: Coarse	Sand Size: Medium	Sand Size: Fine	Silt and Clay Size

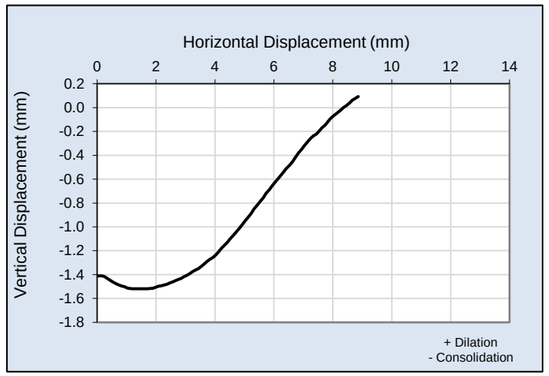
Comments:

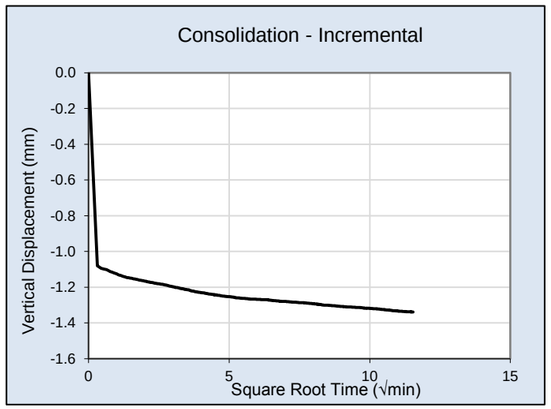
Reviewed: MB

GOLDER ASSOCIATES LTD.



Normal Load σ', kPa	**1000**	Shear Rate, mm/min	0.1273





Consolidation Test Results

T90	0.12	min
T50	0.03	min
Shear Rate	2.7951	mm/min
Delta H	-1.34	mm

Sample Identification

Project #	13-1359-0011	Borehole	GD-12/ MW24
Client	Arctos/Anthracite	Sample	130495
Project	Fortune Minerals	Depth	52.45-52.71
Location	-		

Initial - Sample Dimensions

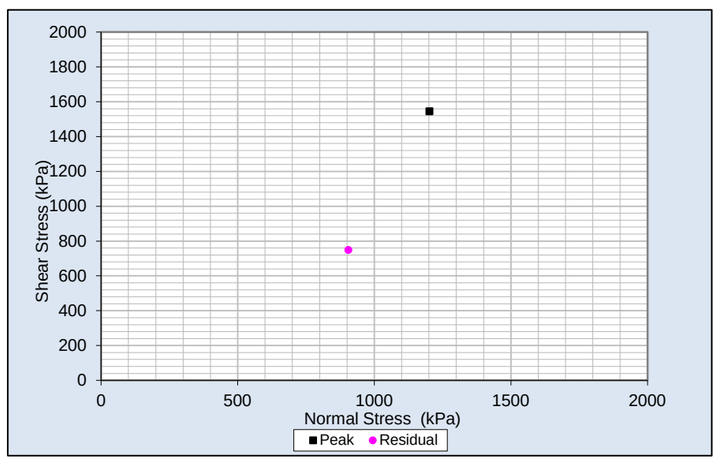
Trial Number	1
Shear box geometry	Circle
Diameter, mm	61.31
Depth, mm	27.18
Area, cm^2	29.52
Volume, cm^3	80.24

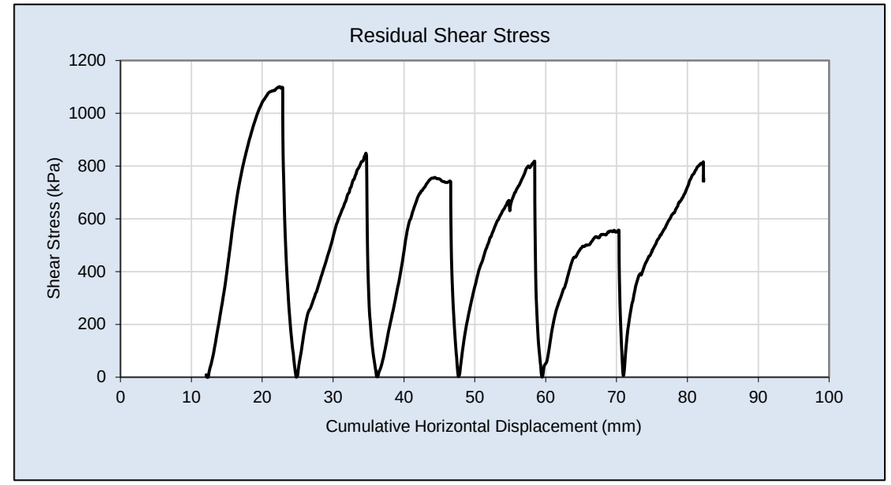
Weight Volume Relationships

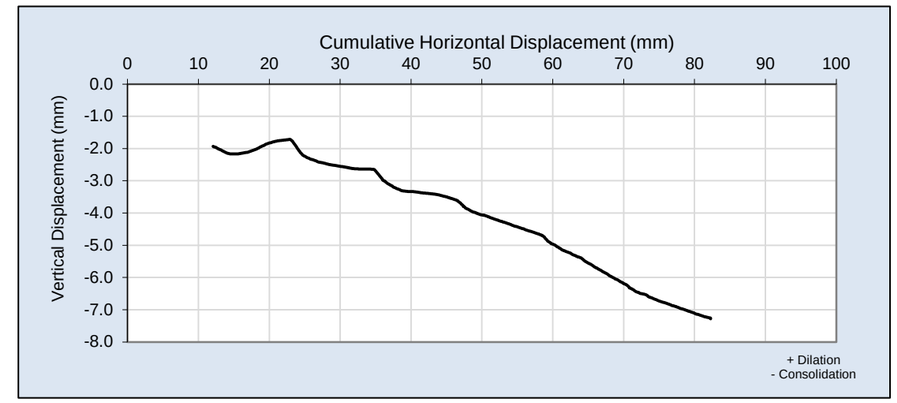
Test#		A863-04
Sample Type		Undisturbed
Initial Wet Wt, g		178.04
Initial Dry Wt, g		176.82
Initial Water Content, %		0.69
Final Water Content, %		10.73
Initial γ_{dry}, kg/m^3		2204
Final γ_{dry}, kg/m^3	(after consolidation)	2318
Specific Gravity	(assumed)	2.65
Initial Void Ratio, e		0.203

Test Results (Area Corrected)

Displacement at Failure, mm	6.333
Peak Normal Stress, kPa	1203
Peak Shear Stress, kPa	1545
Displacement at Residual, mm	45.152
Residual Normal Stress, kPa	906
Residual Shear Stress, kPa	749
Shear rate for Residual Stress, mm/min	0.0949







Index test results

Water Content (%)	0.20
Liquid Limit (%)	NP
Plastic Limit (%)	NP
Plasticity Index	NP

Equipment - DS-KWSOIL s/n: 913

Axial LPT Serial #	4146-ch3
Normal Load Cell Serial #	4146-ch4
Shear Load Cell Serial #	4146-ch1
Vertical LPT Serial #	4146-ch2

Client: Arctos Anthracite Joint Venture	Fortune Minerals Lab Testing/Terracon Geotechnique Arctos Anthracite Project
Golder Associates	DIRECT SHEAR TEST Borehole GD-12/ MW24 Sample 130495
PROJECT: 13-1359-0011	Check: MB Review: DJH

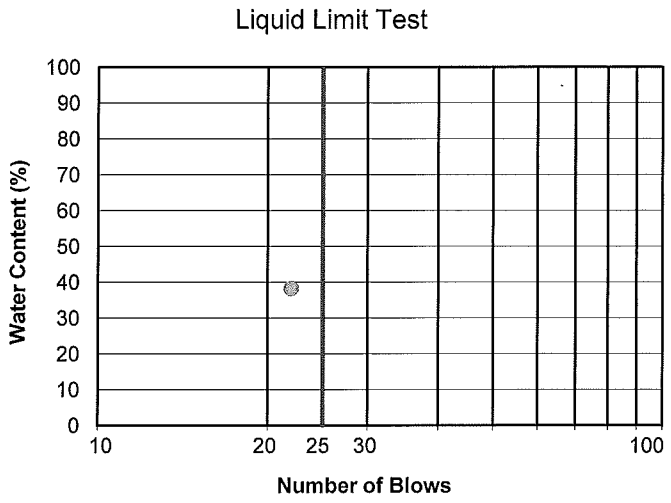
Golder Associates

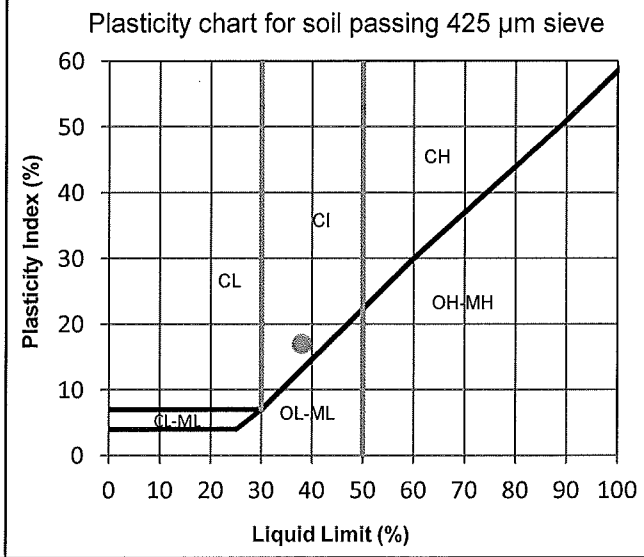
Atterberg Limits (ASTM D 4318)

Project No.: 13-1359-0011	Phase: 1000
Short Title: Fortune Minerals Lab Testing/Stantec&Terracon	Sched: A898-06
Tested By: CG	Date: 25-Sep-13

Borehole: GD-13 Sample No.: 127752-SPT Depth: 1.50-1.96 m

Liquid Limit Determination:			Natural Water Content:		
Number of Blows	22	22	As Received Water Content (%)		20.9%
Blow Correction Factor	0.99	0.99	**Plastic Limit Determination:**		
Mass of wet sample + tare (g)	35.33	35.62	Mass of wet sample + tare (g)	22.03	21.21
Mass of dry sample + tare (g)	32.02	32.76	Mass of dry sample + tare (g)	20.12	19.27
Mass of tare (g)	23.39	25.29	Mass of tare (g)	11.05	10.05
Weight of Water (g)	3.31	2.86	Weight of Water (g)	1.91	1.94
Weight of dry soil (g)	8.63	7.47	Weight of dry soil (g)	9.07	9.22
Water Content (%)	38.4	38.3	Water Content (%)	21.06	21.04
Liquid Limit	38.0	38.0	Average Water Content (%)		21.05





Liquid Limit =	38	%
Plastic Limit =	21	%
Plasticity Index =	17	

Comments:

Reviewed:

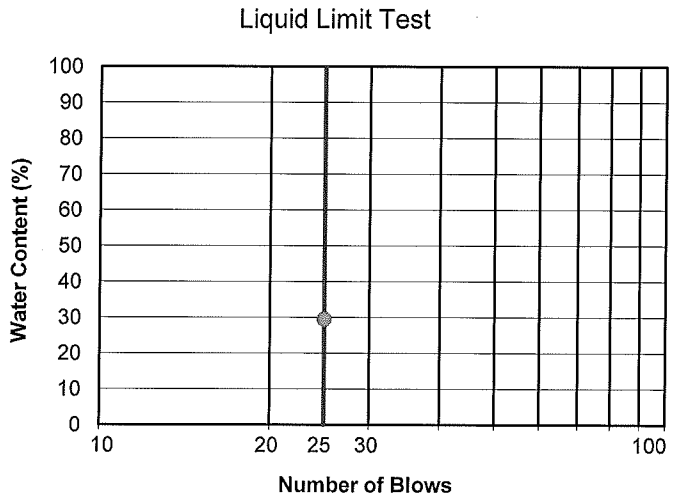
Golder Associates

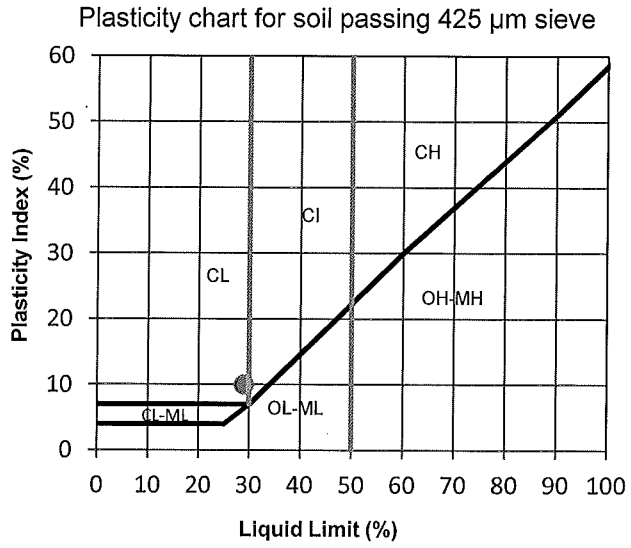
Atterberg Limits (ASTM D 4318)

Project No.:	13-1359-0011	Phase:	-
Short Title:	Fortune Minerals Lab Testing/Terracon Geotechnique-Arctos Anthracite	Sched:	A927-09
Tested By:	CG	Date:	23-Oct-13

Borehole: GD-14 Sample No.: 130433 Depth: 2.00-2.10 m

Liquid Limit Determination:			Natural Water Content:		
Number of Blows	25	25	As Received Water Content (%)		18.4%
Blow Correction Factor	1.00	1.00	**Plastic Limit Determination:**		
Mass of wet sample + tare (g)	36.06	40.60	Mass of wet sample + tare (g)	21.44	21.88
Mass of dry sample + tare (g)	32.37	37.27	Mass of dry sample + tare (g)	19.72	20.04
Mass of tare (g)	19.85	25.98	Mass of tare (g)	10.83	10.60
Weight of Water (g)	3.69	3.33	Weight of Water (g)	1.72	1.84
Weight of dry soil (g)	12.52	11.29	Weight of dry soil (g)	8.89	9.44
Water Content (%)	29.5	29.5	Water Content (%)	19.35	19.49
Liquid Limit	29.0	29.0	Average Water Content (%)		19.42





Liquid Limit =	29	%
Plastic Limit =	19	%
Plasticity Index =	10	

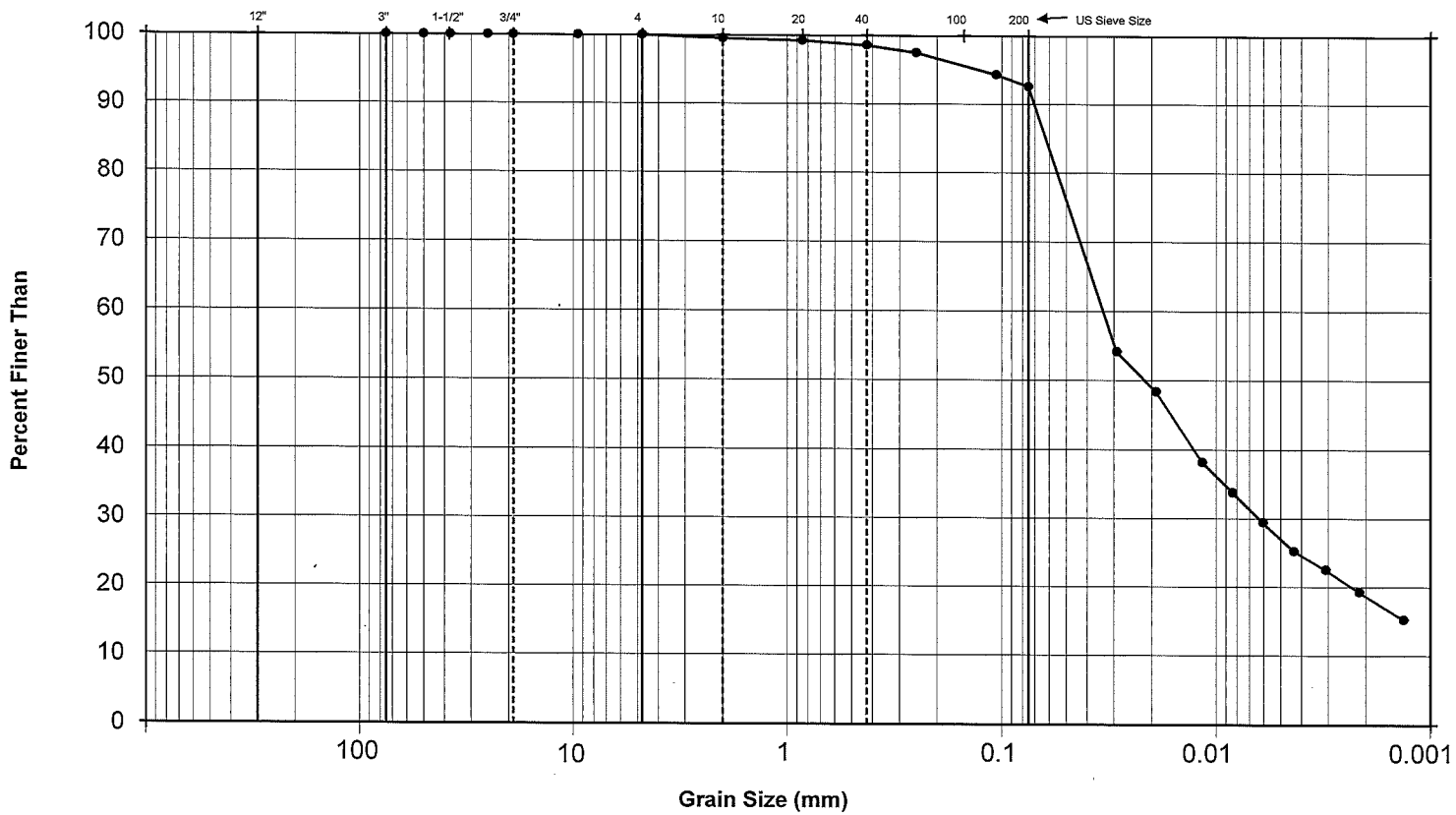
Comments:

Reviewed: MB

Golder Associates

Particle Size Analysis of Soil
(ASTM D422)

Project No.:	13-1359-0011	Lab No.:	A927-10
Project Title:	Fortune Minerals Lab Testing/Terracon Geotechnique		
Borehole:	GD-14	Sample No.:	130434
Depth:	3.50-3.73 m		
Date Tested:	23-Oct-13	By:	DS



Boulder Size	Cobble Size	Gravel Size: Coarse	Gravel Size: Fine	Sand Size: Coarse	Sand Size: Medium	Sand Size: Fine	Silt and Clay Size

Diameter of Sieve (mm)	Percent Passing (%)
75.0	100.0
50.0	100.0
37.5	100.0
25.0	100.0
19.0	100.0
9.5	100.0
4.75	100.0
2.0	99.5
0.850	99.2
0.425	98.6
0.250	97.5
0.106	94.3
0.075	92.6
0.029	54.2
0.019	48.4
0.012	38.2
0.008	33.8
0.006	29.5
0.004	25.3
0.003	22.6
0.002	19.3
0.001	15.3

Comments:

Reviewed: MB

Golder Associates

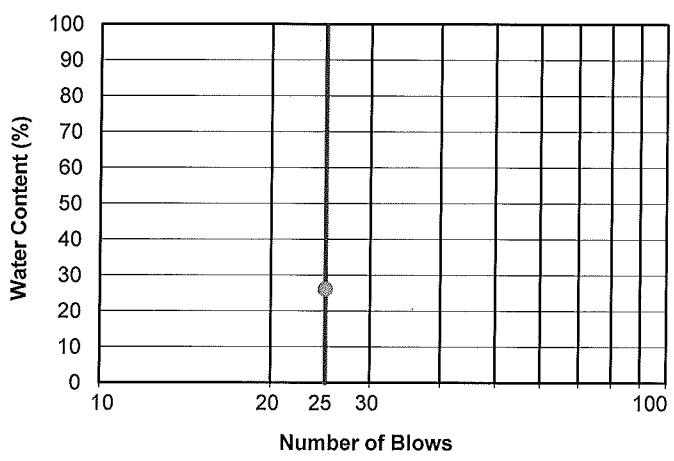
Atterberg Limits (ASTM D 4318)

Project No.: 13-1359-0011	Phase: -
Short Title: Fortune Minerals Lab Testing/Terracon Geotechnique-Arctos Anthracite	Sched: A927-10
Tested By: CG	Date: 23-Oct-13

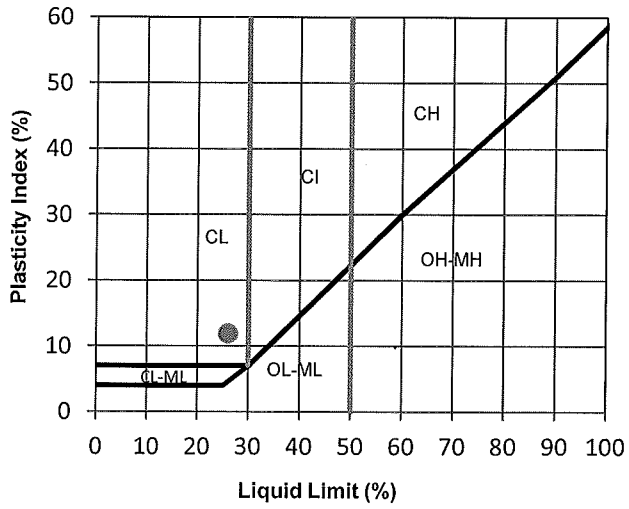
Borehole: GD-14 Sample No.: 130434 Depth: 3.50-3.73 m

Liquid Limit Determination:			Natural Water Content:		
Number of Blows	25	25	As Received Water Content (%)		9.8%
Blow Correction Factor	1.00	1.00	**Plastic Limit Determination:**		
Mass of wet sample + tare (g)	36.29	44.26	Mass of wet sample + tare (g)	21.21	20.15
Mass of dry sample + tare (g)	32.58	40.67	Mass of dry sample + tare (g)	19.90	18.96
Mass of tare (g)	18.47	26.98	Mass of tare (g)	10.91	10.67
Weight of Water (g)	3.71	3.59	Weight of Water (g)	1.31	1.19
Weight of dry soil (g)	14.11	13.69	Weight of dry soil (g)	8.99	8.29
Water Content (%)	26.3	26.2	Water Content (%)	14.57	14.35
Liquid Limit	26.0	26.0	Average Water Content (%)		14.46

Liquid Limit Test



Plasticity chart for soil passing 425 µm sieve



Liquid Limit =	26	%
Plastic Limit =	14	%
Plasticity Index =	12	

Comments:

Reviewed:

Slake Durability Index
ASTM D4644

Golder Associates

Project No.: 13-1359-0011
Short Title: Fortune Minerals Lab Testing/Terracon Geotechnique-Arctos-Anthracite
Borehole No.: GD-14
Sample No.: 130436-CORE
Technician: FC
Lab No.: A898-07
Date: 26-Sep-13

NATURAL WATER CONTENT	
Mass of Wet Sample+ Tare (g)	2367.31
Mass of Dry Sample+ Tare (g)	2353.55
Mass of Tare (g)	1730.53
Mass of Water (g)	13.76
Mass of Dry Sample (g)	623.02
Water Content (%)	2.2

1st CYCLE	
Mass of Dry Sample + Tare (g)	2277.57
Mass of Tare (g)	1730.53
Mass of Dry Sample (g)	547.04
Temperature before running (°C)	26.10
Temperature after running (°C)	25.40
Mass Lost (g)	75.98
Percentage of Mass Lost (%)	13.9

2nd CYCLE	
Mass of Dry Sample + Tare (g)	2224.76
Mass of Tare (g)	1730.53
Mass of Dry Sample (g)	494.23
Temperature before running (°C)	23.10
Temperature after running (°C)	22.60
Mass Lost (g)	52.81
Percentage of Mass Lost (%)	10.7

Slake Durability Index (%)	79.3

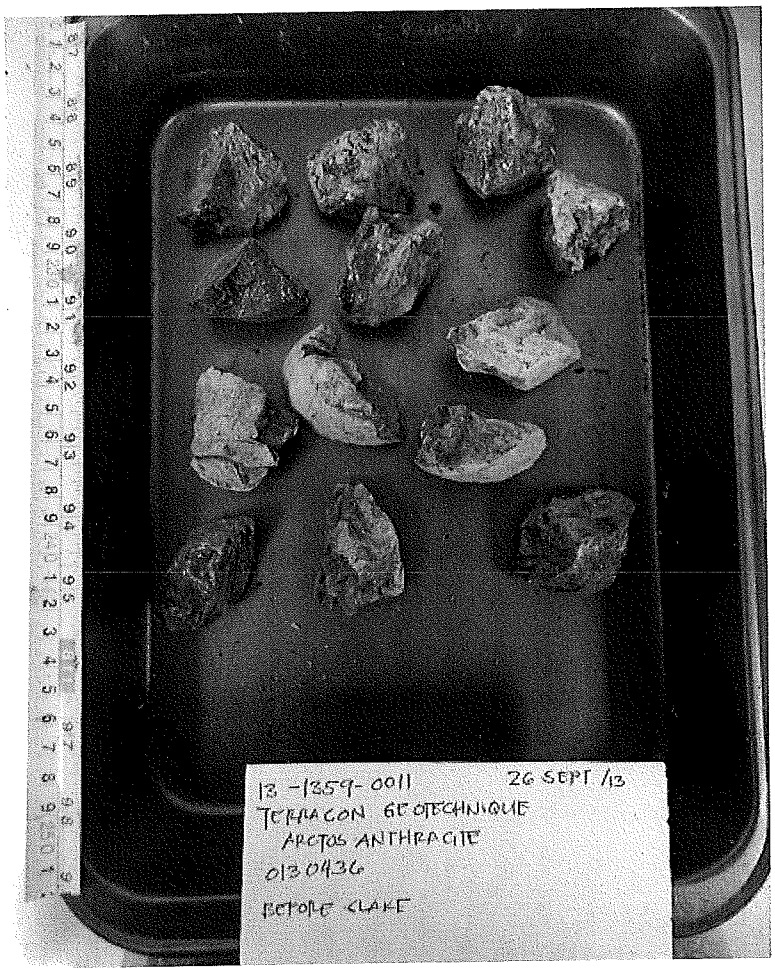
*Note: Please refer to Pre-test Photo for Sample Description and Post-test Photo for Slake Fragments

Reviewed _____

Slake Durability Index
ASTM D4644

Golder Associates

Project No.: 13-1359-0011
Short Title: Fortune Minerals Lab Testing/Terracon Geotechnique-Arctos-Anthracite
Borehole No.: GD-14
Sample No.: 130436-CORE
Technician: FC
Lab No.: A898-07
Date: 26-Sep-13



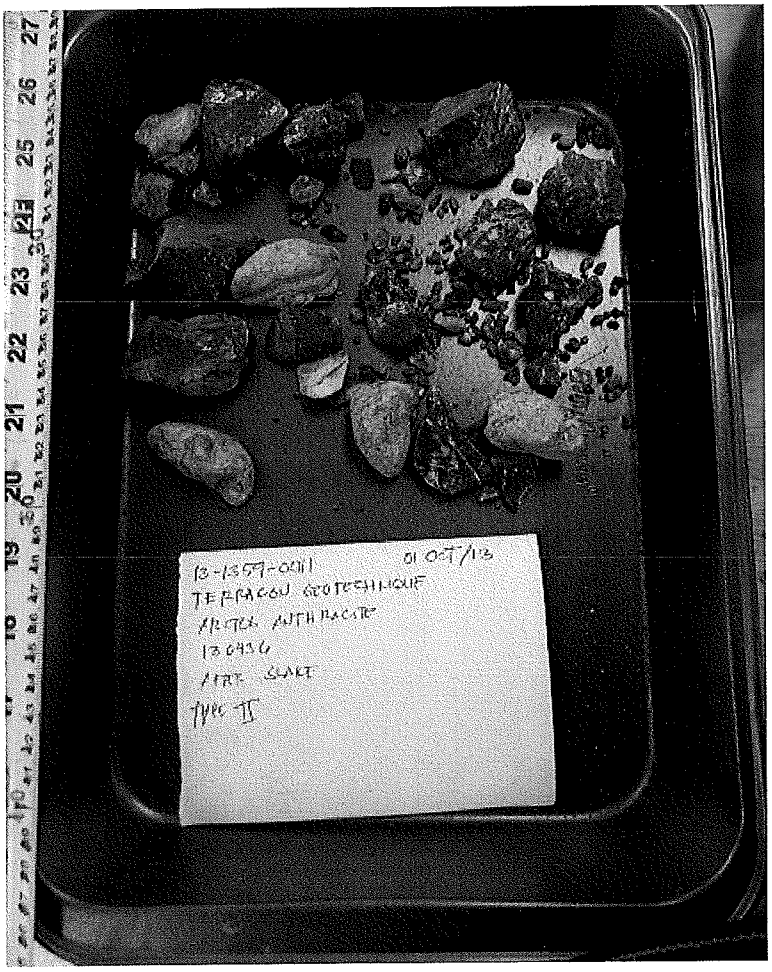
Sample Description: SILTSTONE ROCK CORE

Pre-test

Slake Durability Index
ASTM D4644

Golder Associates

Project No.: 13-1359-0011
Short Title: Fortune Minerals Lab Testing/Terracon Geotechnique-Arctos-Anthracite
Borehole No.: GD-14
Sample No.: 130436-CORE
Technician: FC
Lab No.: A898-07
Date: 26-Sep-13



Description of Slake Fragments: TYPE II, Retained specimen consist of large and small fragments

Post-test

Slake Durability Index
ASTM D4644

Golder Associates

Project No.: 13-1359-0011
Short Title: Fortune Minerals Lab Testing/Terracon Geotechnique-Arctos-Anthracite
Borehole No.: GD-14
Sample No.: 130437-CORE
Technician: FC
Lab No.: A898-08
Date: 26-Sep-13

NATURAL WATER CONTENT	
Mass of Wet Sample+ Tare (g)	2375.74
Mass of Dry Sample+ Tare (g)	2355.51
Mass of Tare (g)	1722.04
Mass of Water (g)	20.23
Mass of Dry Sample (g)	633.47
Water Content (%)	3.2

1st CYCLE	
Mass of Dry Sample + Tare (g)	2202.71
Mass of Tare (g)	1722.04
Mass of Dry Sample (g)	480.67
Temperature before running (°C)	26.80
Temperature after running (°C)	26.10
Mass Lost (g)	152.8
Percentage of Mass Lost (%)	31.8

2nd CYCLE	
Mass of Dry Sample + Tare (g)	2106.43
Mass of Tare (g)	1722.04
Mass of Dry Sample (g)	384.39
Temperature before running (°C)	23.00
Temperature after running (°C)	22.40
Mass Lost (g)	96.28
Percentage of Mass Lost (%)	25.0

Slake Durability Index (%)	60.7

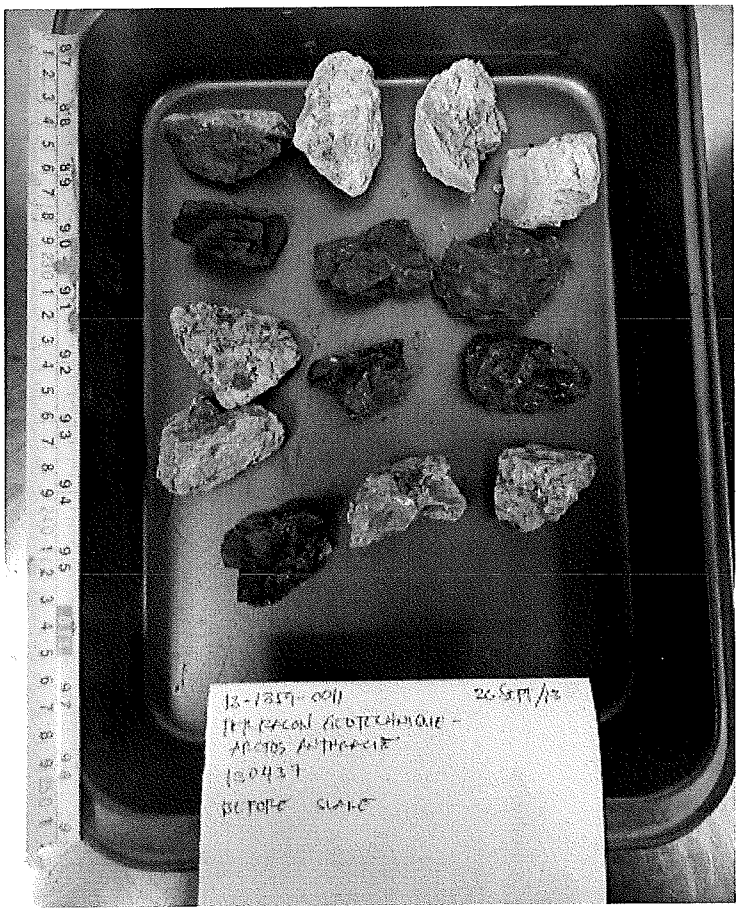
*Note: Please refer to Pre-test Photo for Sample Description and Post-test Photo for Slake Fragments

Reviewed _____

Slake Durability Index
ASTM D4644

Golder Associates

Project No.: 13-1359-0011
Short Title: Fortune Minerals Lab Testing/Terracon Geotechnique-Arctos-Anthracite
Borehole No.: GD-14
Sample No.: 130437-CORE
Technician: FC
Lab No.: A898-08
Date: 26-Sep-13



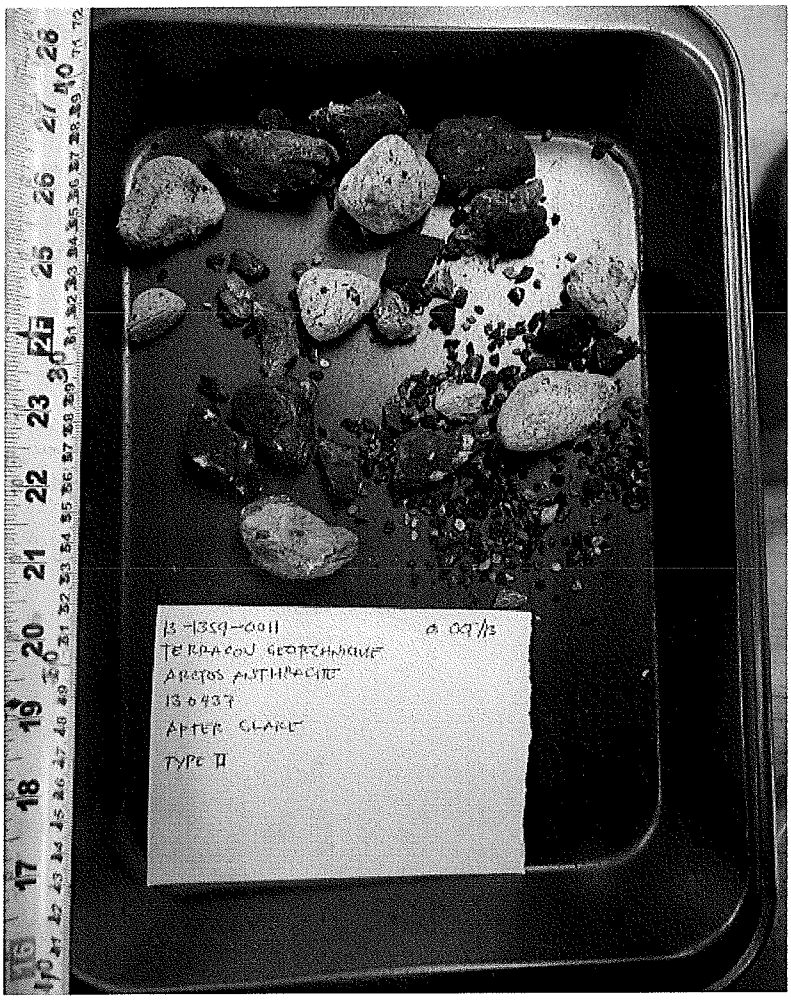
Sample Description: SILTSTONE ROCK CORE

Pre-test

Slake Durability Index
ASTM D4644

Golder Associates

Project No.: 13-1359-0011
Short Title: Fortune Minerals Lab Testing/Terracon Geotechnique-Arctos-Anthracite
Borehole No.: GD-14
Sample No.: 130437-CORE
Technician: FC
Lab No.: A898-08
Date: 26-Sep-13



Description of Slake Fragments: TYPE II, Retained specimen consist of large and small fragments

Post-test

Slake Durability Index
ASTM D4644

Golder Associates

Project No.: 13-1359-0011
Short Title: Fortune Minerals Lab Testing/Terracon Geotechnique-Arctos-Anthracite
Borehole No.: GD-14
Sample No.: 130438-CORE
Technician: FC
Lab No.: A898-09
Date: 30-Sep-13

NATURAL WATER CONTENT	
Mass of Wet Sample+ Tare (g)	2257.50
Mass of Dry Sample+ Tare (g)	2233.52
Mass of Tare (g)	1730.92
Mass of Water (g)	23.98
Mass of Dry Sample (g)	502.60
Water Content (%)	4.8

1st CYCLE	
Mass of Dry Sample + Tare (g)	2137.38
Mass of Tare (g)	1730.92
Mass of Dry Sample (g)	406.46
Temperature before running (°C)	20.50
Temperature after running (°C)	21.00
Mass Lost (g)	96.14
Percentage of Mass Lost (%)	23.7

2nd CYCLE	
Mass of Dry Sample + Tare (g)	2062.92
Mass of Tare (g)	1730.92
Mass of Dry Sample (g)	332.00
Temperature before running (°C)	18.90
Temperature after running (°C)	20.00
Mass Lost (g)	74.46
Percentage of Mass Lost (%)	22.4

Slake Durability Index (%)	66.1

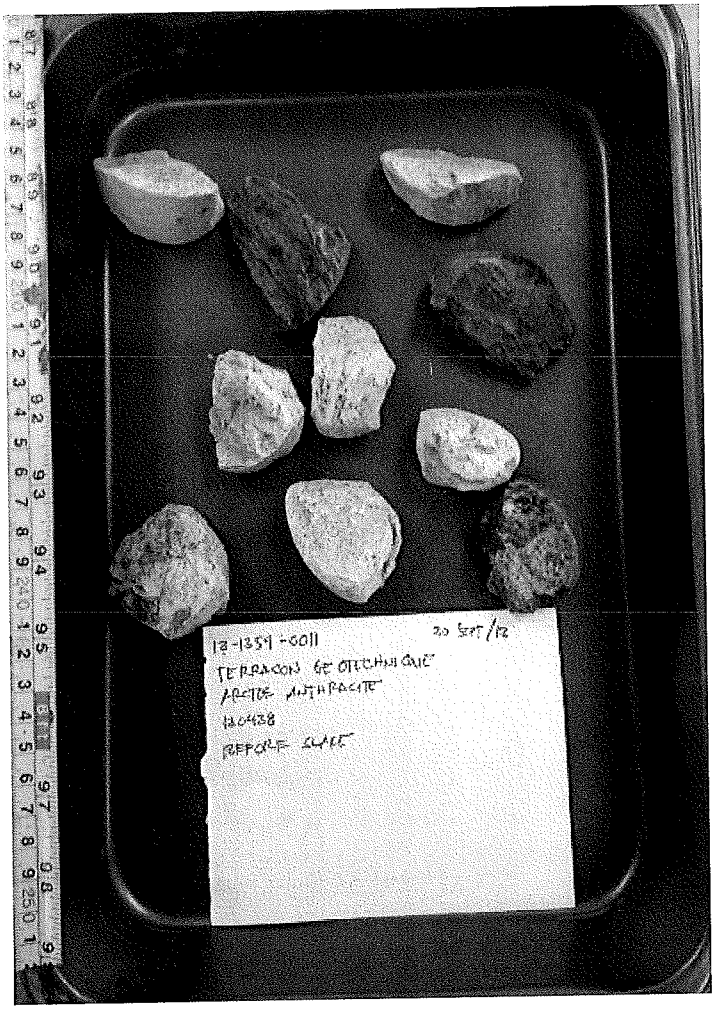
*Note: Please refer to Pre-test Photo for Sample Description and Post-test Photo for Slake Fragments

Reviewed _____

Slake Durability Index
ASTM D4644

Golder Associates

Project No.: 13-1359-0011
Short Title: Fortune Minerals Lab Testing/Terracon Geotechnique-Arctos-Anthracite
Borehole No.: GD-14
Sample No.: 130438-CORE
Technician: FC
Lab No.: A898-09
Date: 30-Sep-13



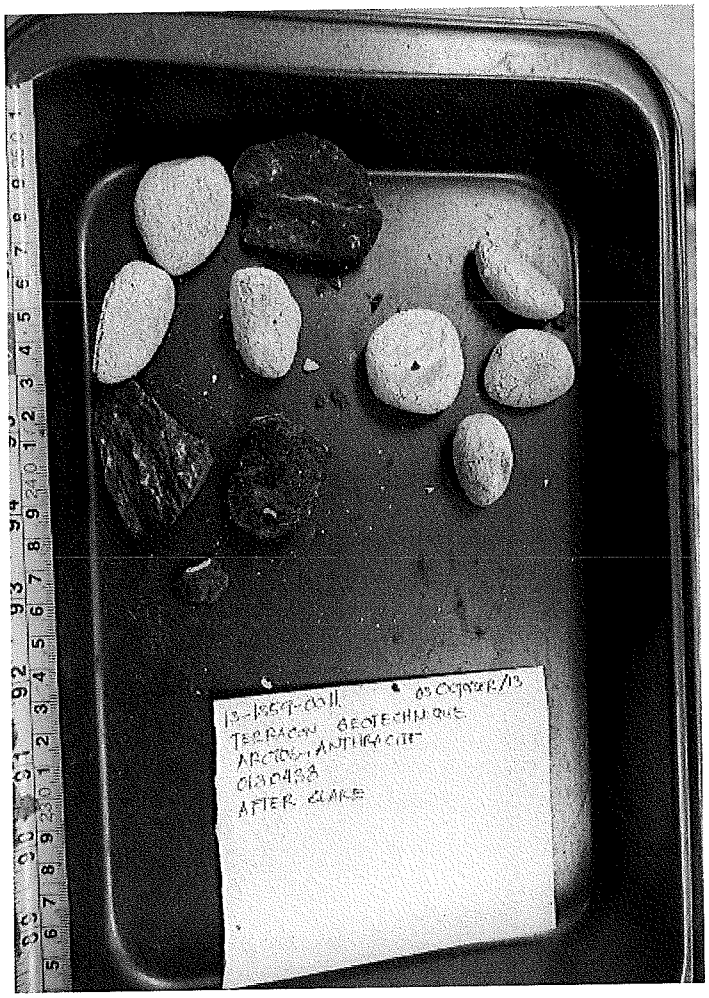
Sample Description: SILTSTONE ROCK CORE

Pre-test

Slake Durability Index
ASTM D4644

Golder Associates

Project No.: 13-1359-0011
Short Title: Fortune Minerals Lab Testing/Terracon Geotechnique-Arctos-Anthracite
Borehole No.: GD-14
Sample No.: 130438-CORE
Technician: FC
Lab No.: A898-09
Date: 30-Sep-13



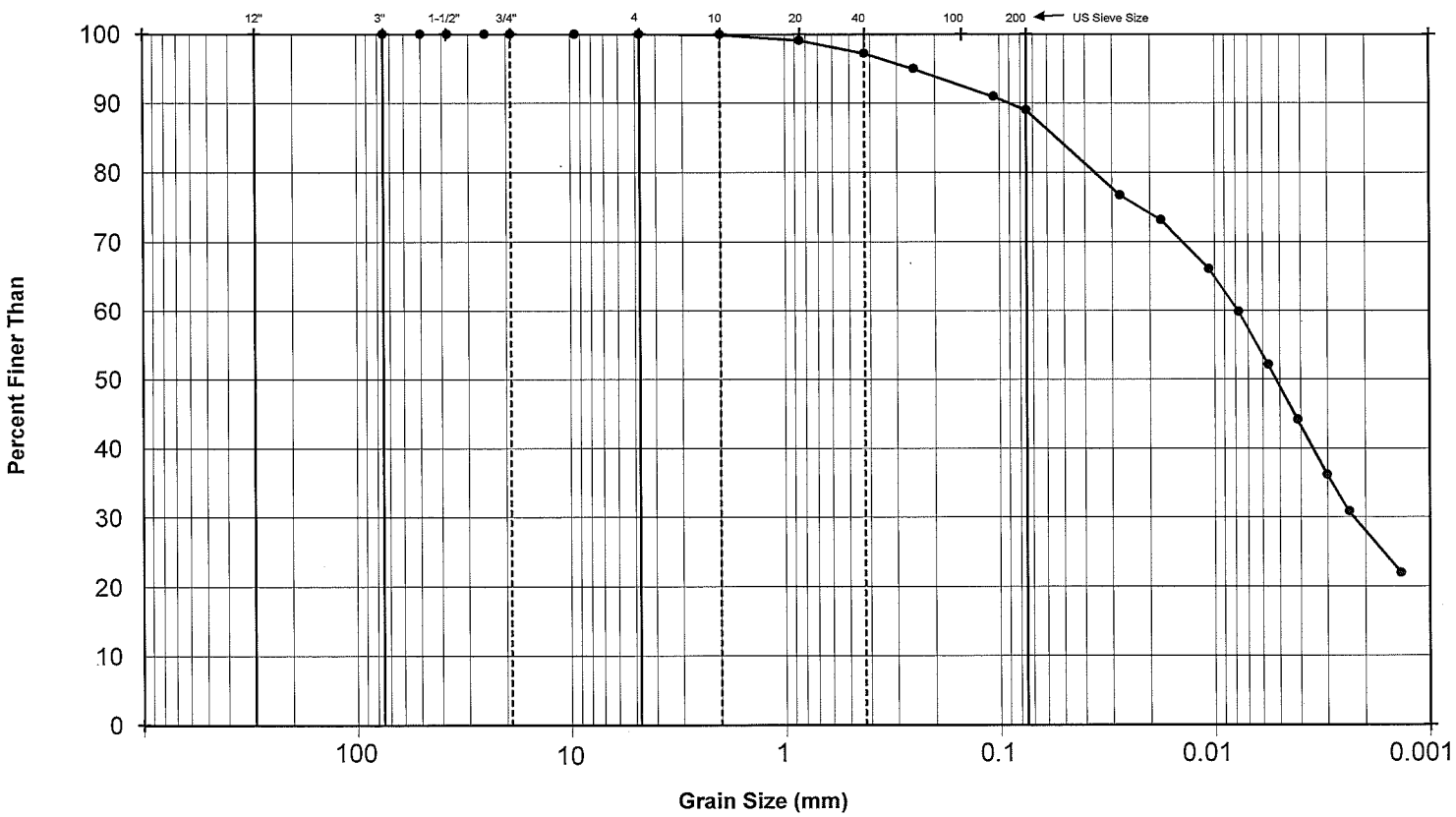
Description of Slake Fragments: TYPE III, Some sample mass dispersed in water during test

Post-test

Golder Associates

Particle Size Analysis of Soil
(ASTM D422)

Project No.:	13-1359-0011.1000	Lab No.:	A849-02
Project Title:	Terracon Geotechnique		
Borehole:	GD-15	Sample No.:	130124
Depth:	6.98-7.20m		
Date Tested:	7-Aug-13	By:	JL



Boulder Size	Cobble Size	Gravel Size: Coarse	Gravel Size: Fine	Sand Size: Coarse	Sand Size: Medium	Sand Size: Fine	Silt and Clay Size

Diameter of Sieve (mm)	Percent Passing (%)
75.0	100.0
50.0	100.0
37.5	100.0
25.0	100.0
19.0	100.0
9.5	100.0
4.75	100.0
2.0	99.9
0.850	99.1
0.425	97.2
0.250	95.0
0.106	91.0
0.075	89.0
0.027	76.7
0.018	73.2
0.011	66.1
0.008	59.9
0.006	52.1
0.004	44.1
0.003	36.2
0.002	30.8
0.001	22.0

Comments:

Reviewed: WS

Golder Associates

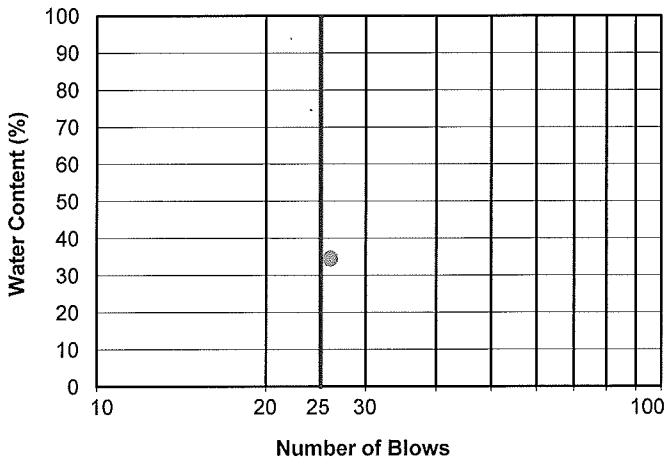
Atterberg Limits (ASTM D 4318)

Project No.: 13-1359-0011	Phase: 1000
Short Title: Terracon Geotechnique	Sched: A849-02
Tested By: JL	Date: 7-Aug-12

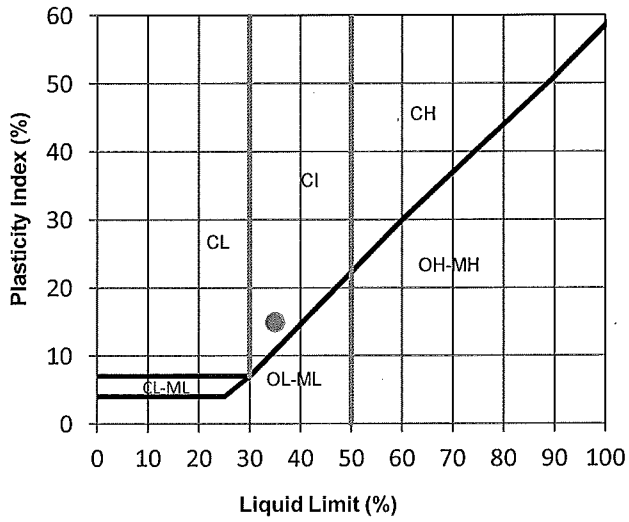
Borehole: GD-15 Sample No.: 130124 Depth: 6.98-7.20m

Liquid Limit Determination:			Natural Water Content:		
Number of Blows	26	26	As Received Water Content (%)		13.7%
Blow Correction Factor	1.01	1.01	**Plastic Limit Determination:**		
Mass of wet sample + tare (g)	30.18	29.34	Mass of wet sample + tare (g)	26.21	22.23
Mass of dry sample + tare (g)	27.27	26.55	Mass of dry sample + tare (g)	24.42	20.41
Mass of tare (g)	18.88	18.46	Mass of tare (g)	15.35	11.14
Weight of Water (g)	2.91	2.79	Weight of Water (g)	1.79	1.82
Weight of dry soil (g)	8.39	8.09	Weight of dry soil (g)	9.07	9.27
Water Content (%)	34.7	34.5	Water Content (%)	19.74	19.63
Liquid Limit	35.0	35.0	Average Water Content (%)		19.68

Liquid Limit Test



Plasticity chart for soil passing 425 µm sieve



Liquid Limit =	35	%
Plastic Limit =	20	%
Plasticity Index =	15	

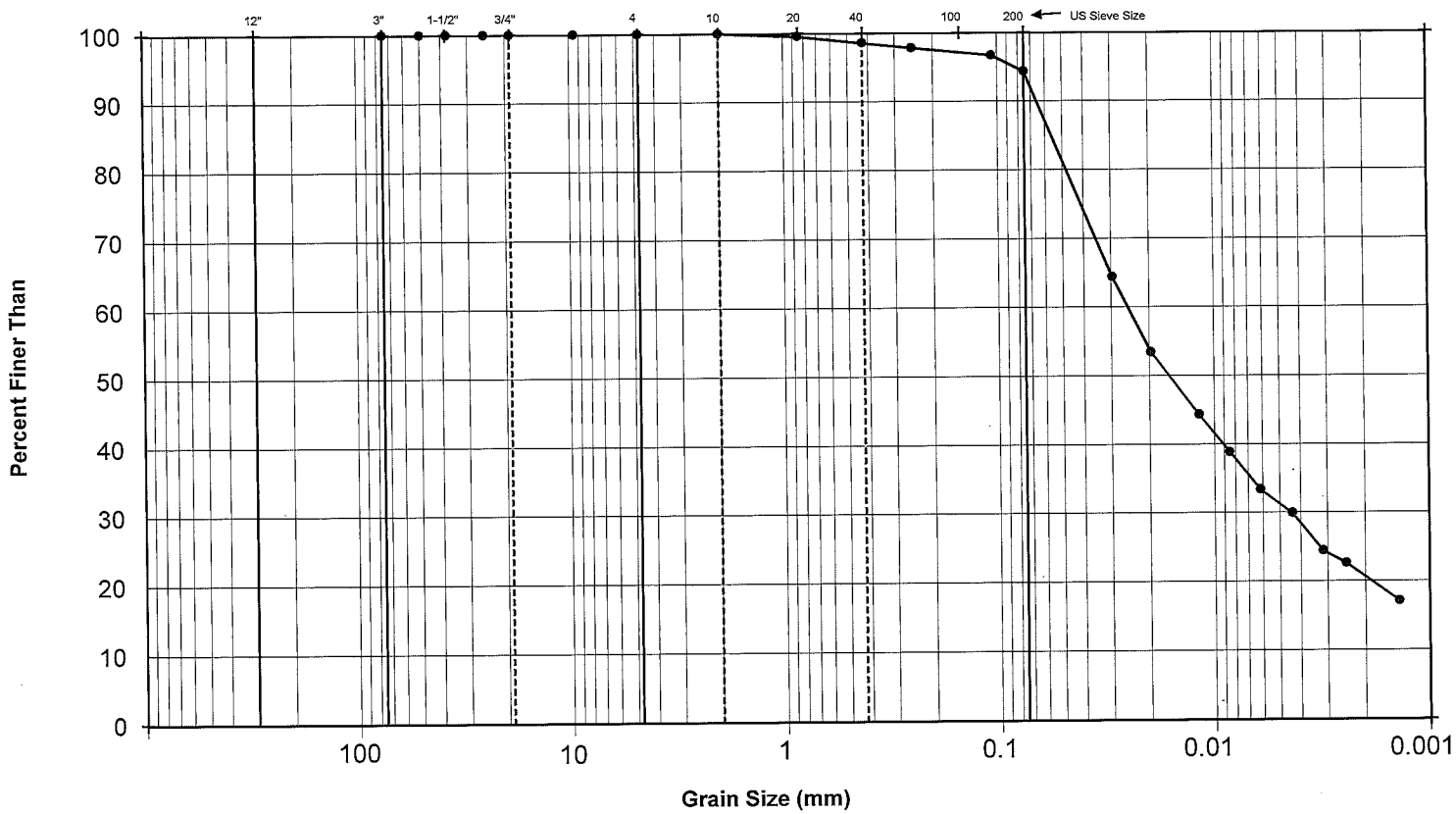
Comments:

Reviewed:

Golder Associates

Particle Size Analysis of Soil
(ASTM D422)

Project No.:	13-1359-0011.1000	Lab No.:	A849-03
Project Title:	Terracon Geotechnique		
Borehole:	GD-15	Sample No.:	130125
Depth:	7.20-7.40m		
Date Tested:	7-Aug-13	By:	JL



Boulder Size	Cobble Size	Coarse	Fine	Coarse	Medium	Fine	Silt and Clay Size
		Gravel Size		Sand Size			

Diameter of Sieve (mm)	Percent Passing (%)
75.0	100.0
50.0	100.0
37.5	100.0
25.0	100.0
19.0	100.0
9.5	100.0
4.75	100.0
2.0	100.0
0.850	99.6
0.425	98.6
0.250	97.8
0.106	96.7
0.075	94.4
0.030	64.4
0.020	53.5
0.012	44.3
0.008	38.8
0.006	33.4
0.004	29.9
0.003	24.5
0.002	22.6
0.001	17.2

Comments:

Reviewed: MB

Golder Associates

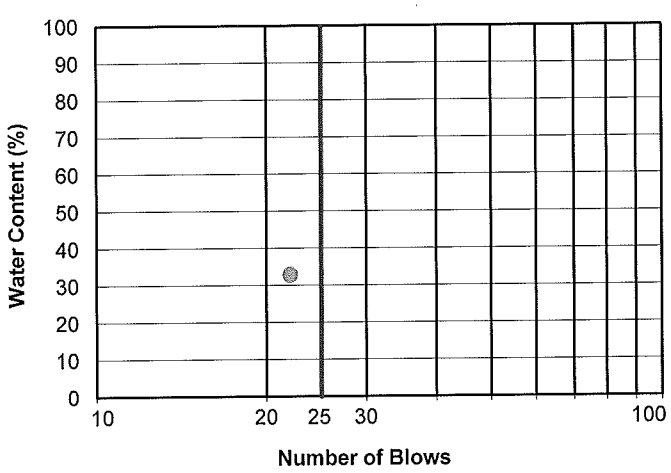
Atterberg Limits (ASTM D 4318)

Project No.: 13-1359-0011	Phase: 1000
Short Title: Terracon Geotechnique	Sched: A849-03
Tested By: JL	Date: 7-Aug-12

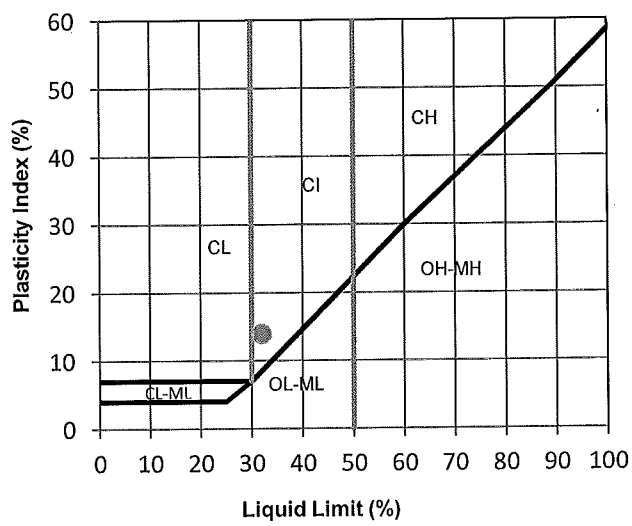
Borehole: GD-15 Sample No.: 130125 Depth: 7.20-7.40m

Liquid Limit Determination:			Natural Water Content:		
Number of Blows	22	22	As Received Water Content (%)		10.0%
Blow Correction Factor	0.99	0.99	**Plastic Limit Determination:**		
Mass of wet sample + tare (g)	31.16	31.06	Mass of wet sample + tare (g)	22.51	22.25
Mass of dry sample + tare (g)	27.98	27.94	Mass of dry sample + tare (g)	20.72	20.54
Mass of tare (g)	18.34	18.40	Mass of tare (g)	10.68	10.89
Weight of Water (g)	3.18	3.12	Weight of Water (g)	1.79	1.71
Weight of dry soil (g)	9.64	9.54	Weight of dry soil (g)	10.04	9.65
Water Content (%)	33.0	32.7	Water Content (%)	17.83	17.72
Liquid Limit	32.0	32.0	Average Water Content (%)		17.77

Liquid Limit Test



Plasticity chart for soil passing 425 µm sieve



Liquid Limit =	32	%
Plastic Limit =	18	%
Plasticity Index =	14	

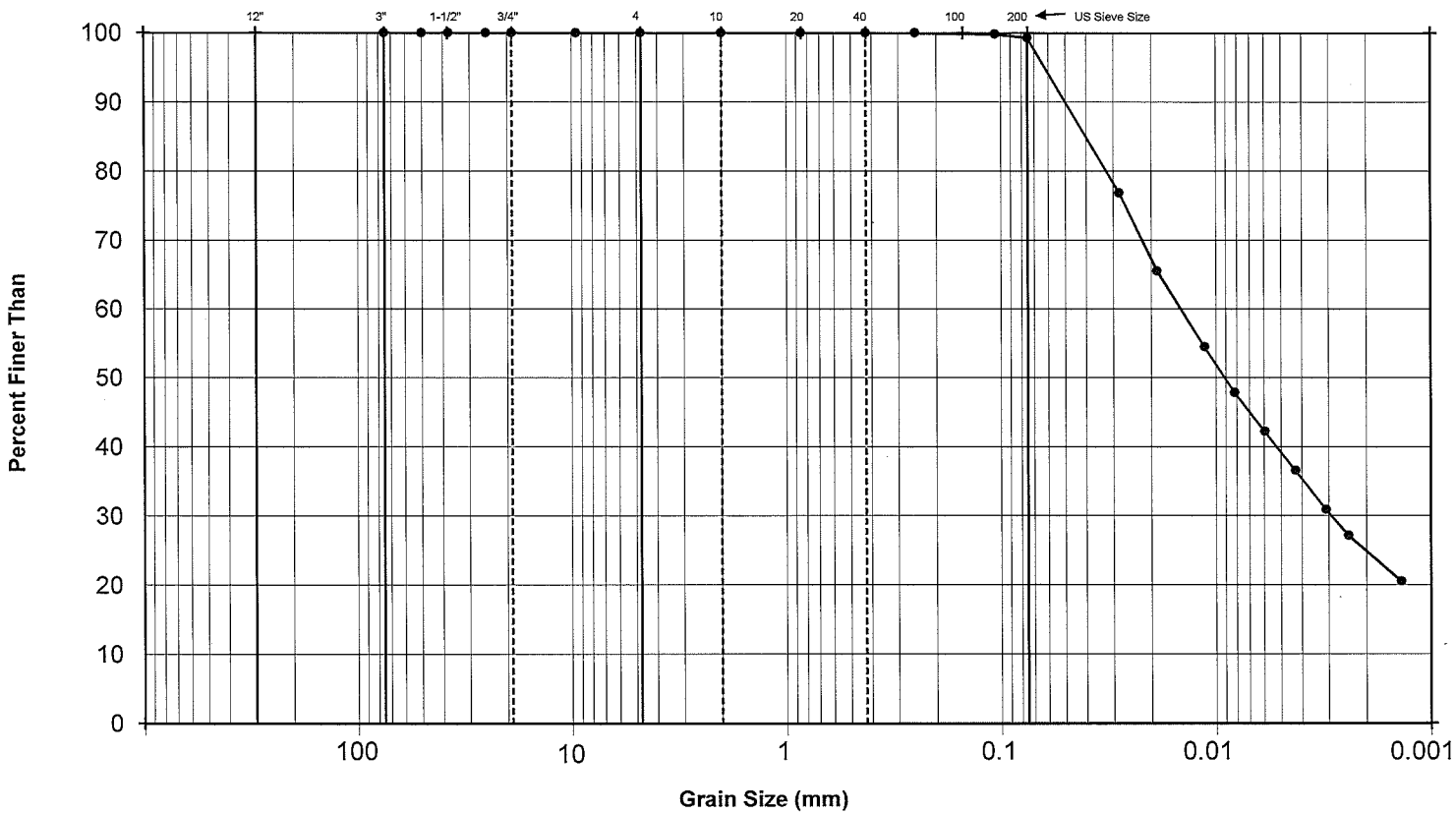
Comments: _____

Reviewed: _____

Golder Associates

Particle Size Analysis of Soil
(ASTM D422)

Project No.:	13-1359-0011.1000	Lab No.:	A849-01
Project Title:	Terracon Geotechnique		
Borehole:	GD-15	Sample No.:	130123
Depth:	7.50-7.72m		
Date Tested:	7-Aug-13	By:	JL



Boulder Size	Cobble Size	Gravel Size: Coarse	Gravel Size: Fine	Sand Size: Coarse	Sand Size: Medium	Sand Size: Fine	Silt and Clay Size

Diameter of Sieve (mm)	Percent Passing (%)
75.0	100.0
50.0	100.0
37.5	100.0
25.0	100.0
19.0	100.0
9.5	100.0
4.75	100.0
2.0	100.0
0.850	100.0
0.425	100.0
0.250	100.0
0.106	99.8
0.075	99.3
0.028	76.9
0.019	65.5
0.011	54.5
0.008	47.9
0.006	42.2
0.004	36.6
0.003	30.9
0.002	27.1
0.001	20.5

Comments:

Reviewed: MB

Golder Associates

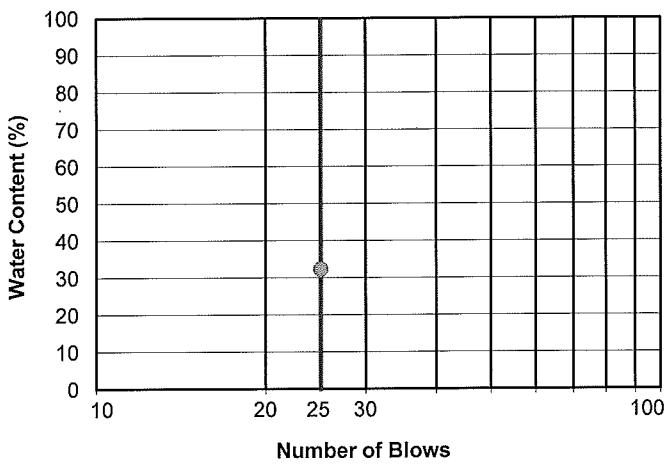
Atterberg Limits (ASTM D 4318)

Project No.: 13-1359-0011	Phase: 1000
Short Title: Terracon Geotechnique	Sched: A849-01
Tested By: JL	Date: 7-Aug-12

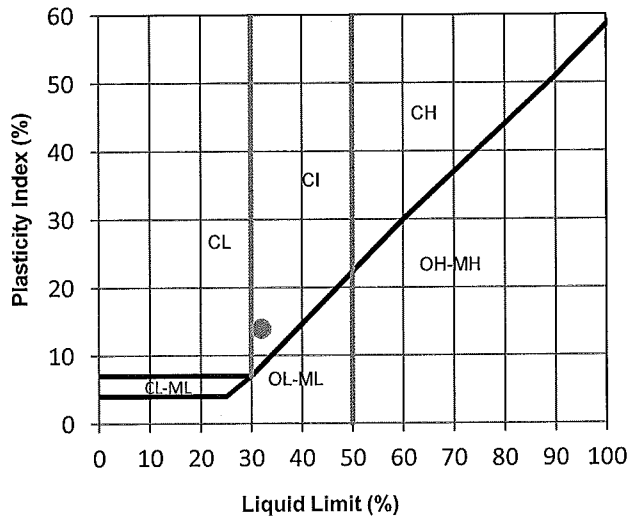
Borehole: GD-15 Sample No.: 130123 Depth: 7.50-7.72m

Liquid Limit Determination:			Natural Water Content:		
Number of Blows	25	25	As Received Water Content (%)		18.8%
Blow Correction Factor	1.00	1.00	**Plastic Limit Determination:**		
Mass of wet sample + tare (g)	38.24	36.19	Mass of wet sample + tare (g)	23.71	22.68
Mass of dry sample + tare (g)	35.11	33.38	Mass of dry sample + tare (g)	21.72	20.81
Mass of tare (g)	25.47	24.71	Mass of tare (g)	10.84	10.56
Weight of Water (g)	3.13	2.81	Weight of Water (g)	1.99	1.87
Weight of dry soil (g)	9.64	8.67	Weight of dry soil (g)	10.88	10.25
Water Content (%)	32.5	32.4	Water Content (%)	18.29	18.24
Liquid Limit	32.0	32.0	Average Water Content (%)		18.27

Liquid Limit Test



Plasticity chart for soil passing 425 µm sieve



Liquid Limit =	32	%
Plastic Limit =	18	%
Plasticity Index =	14	

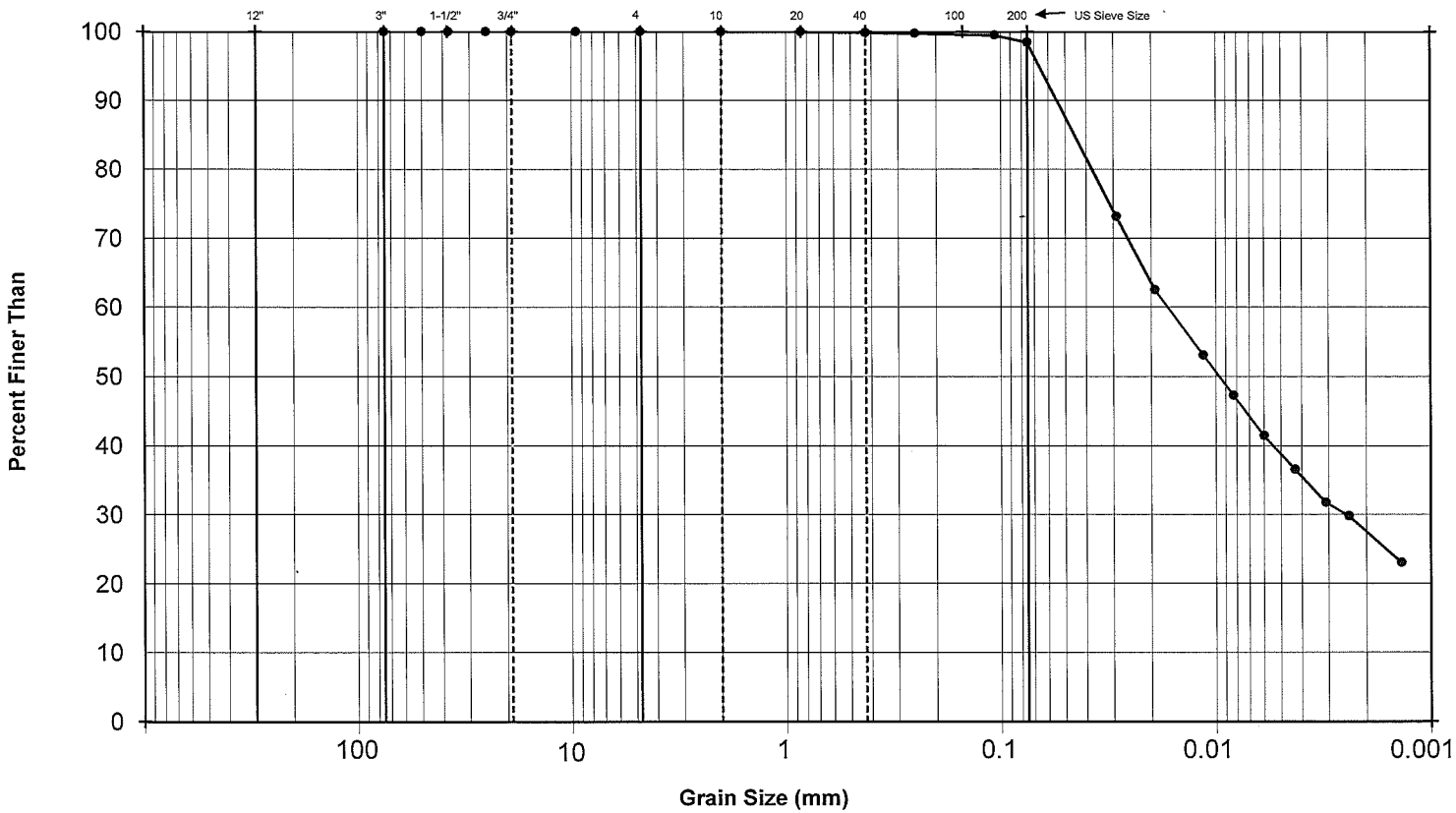
Comments:

Reviewed:

Golder Associates

Particle Size Analysis of Soil
(ASTM D422)

Project No.:	13-1359-0011.1000	Lab No.:	A849-04
Project Title:	Terracon Geotechnique		
Borehole:	GD-15	Sample No.:	130126
Depth:	8.30-8.70m		
Date Tested:	7-Aug-13	By:	JL



Boulder Size	Cobble Size	Gravel Size: Coarse	Gravel Size: Fine	Sand Size: Coarse	Sand Size: Medium	Sand Size: Fine	Silt and Clay Size

Diameter of Sieve (mm)	Percent Passing (%)
75.0	100.0
50.0	100.0
37.5	100.0
25.0	100.0
19.0	100.0
9.5	100.0
4.75	100.0
2.0	100.0
0.850	100.0
0.425	99.9
0.250	99.8
0.106	99.5
0.075	98.5
0.029	73.2
0.019	62.5
0.011	53.1
0.008	47.3
0.006	41.4
0.004	36.6
0.003	31.8
0.002	29.8
0.001	23.0

Comments:

Reviewed: MB

Golder Associates

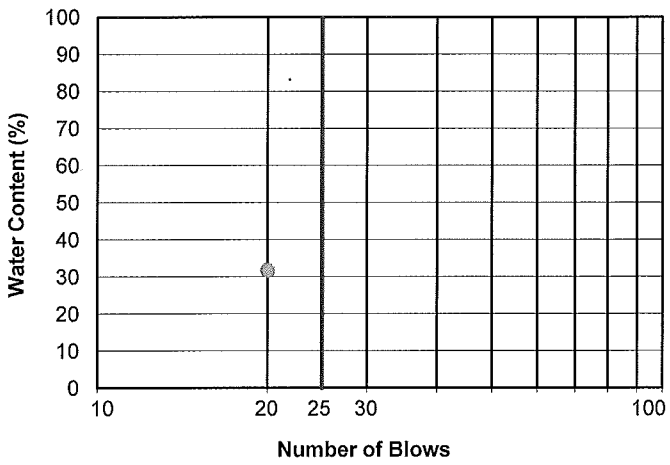
Atterberg Limits (ASTM D 4318)

Project No.: 13-1359-0011	Phase: 1000
Short Title: Terracon Geotechnique	Sched: A849-04
Tested By: JL	Date: 7-Aug-12

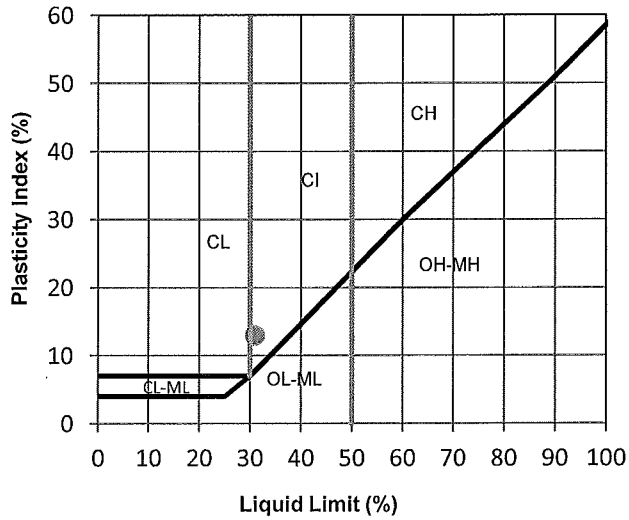
Borehole: GD-15 Sample No.: 130126 Depth: 8.30-8.70m

Liquid Limit Determination:			Natural Water Content:		
Number of Blows	20	20	As Received Water Content (%)		17.2%
Blow Correction Factor	0.97	0.97	**Plastic Limit Determination:**		
Mass of wet sample + tare (g)	37.20	31.70	Mass of wet sample + tare (g)	24.11	22.45
Mass of dry sample + tare (g)	34.33	28.62	Mass of dry sample + tare (g)	22.06	20.62
Mass of tare (g)	25.30	18.92	Mass of tare (g)	10.85	10.49
Weight of Water (g)	2.87	3.08	Weight of Water (g)	2.05	1.83
Weight of dry soil (g)	9.03	9.7	Weight of dry soil (g)	11.21	10.13
Water Content (%)	31.8	31.8	Water Content (%)	18.29	18.07
Liquid Limit	31.0	31.0	Average Water Content (%)		18.18

Liquid Limit Test



Plasticity chart for soil passing 425 µm sieve



Liquid Limit =	31	%
Plastic Limit =	18	%
Plasticity Index =	13	

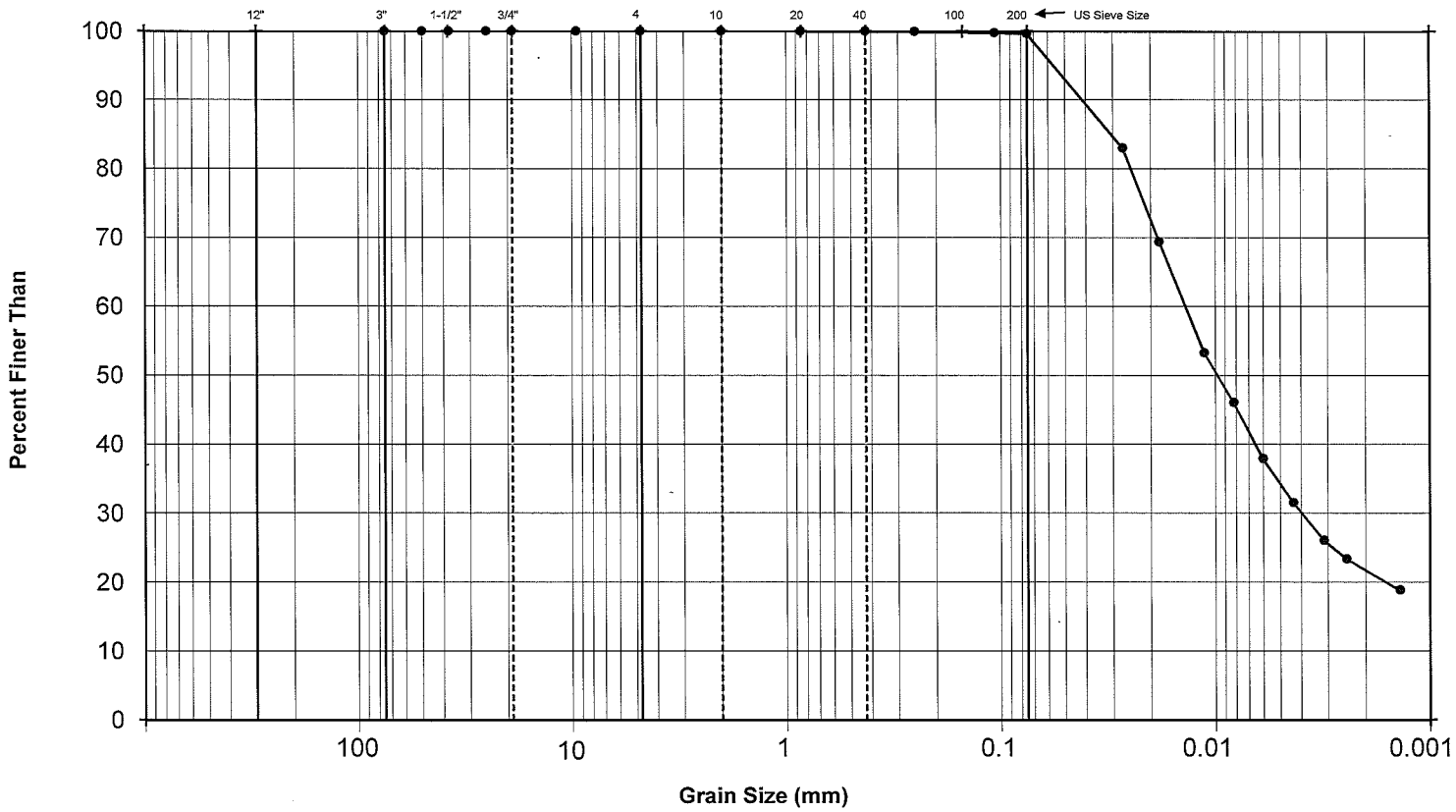
Comments:

Reviewed: MD

Golder Associates

Particle Size Analysis of Soil
(ASTM D422)

Project No.:	13-1359-0011.1000	Lab No.:	A849-05
Project Title:	Terracon Geotechnique		
Borehole:	GD-15	Sample No.:	130127
Depth:	8.70-8.85m		
Date Tested:	7-Aug-13	By:	JL



Boulder Size	Cobble Size	Coarse	Fine	Coarse	Medium	Fine	Silt and Clay Size
		Gravel Size		Sand Size			

Diameter of Sieve (mm)	Percent Passing (%)
75.0	100.0
50.0	100.0
37.5	100.0
25.0	100.0
19.0	100.0
9.5	100.0
4.75	100.0
2.0	100.0
0.850	100.0
0.425	100.0
0.250	99.9
0.106	99.8
0.075	99.7
0.027	83.0
0.018	69.4
0.011	53.3
0.008	46.0
0.006	37.9
0.004	31.5
0.003	26.1
0.002	23.4
0.001	18.8

Comments:

Reviewed:

Golder Associates

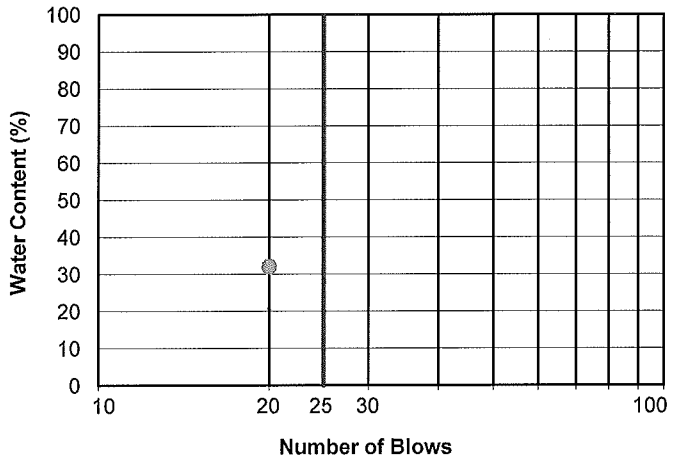
Atterberg Limits (ASTM D 4318)

Project No.: 13-1359-0011	Phase: 1000
Short Title: Terracon Geotechnique	Sched: A849-05
Tested By: JL	Date: 7-Aug-12

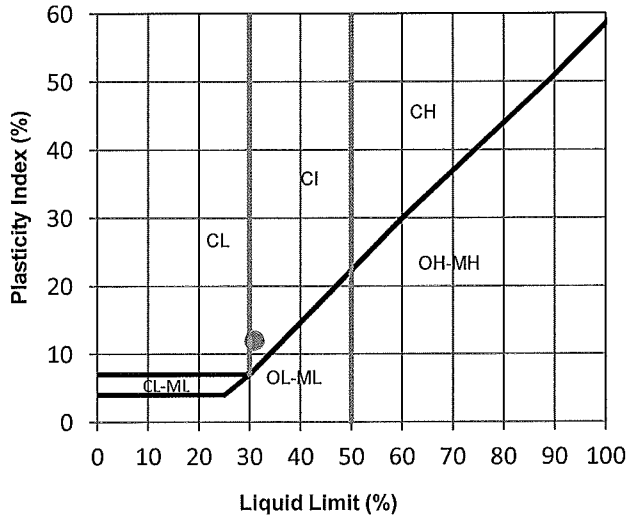
Borehole: GD-15 Sample No.: 130127 Depth: 8.70-8.85m

Liquid Limit Determination:			Natural Water Content:		
Number of Blows	20	20	As Received Water Content (%)		9.8%
Blow Correction Factor	0.97	0.97	**Plastic Limit Determination:**		
Mass of wet sample + tare (g)	36.14	37.41	Mass of wet sample + tare (g)	21.28	20.54
Mass of dry sample + tare (g)	33.53	34.59	Mass of dry sample + tare (g)	19.57	18.95
Mass of tare (g)	25.44	25.77	Mass of tare (g)	10.68	10.61
Weight of Water (g)	2.61	2.82	Weight of Water (g)	1.71	1.59
Weight of dry soil (g)	8.09	8.82	Weight of dry soil (g)	8.89	8.34
Water Content (%)	32.3	32.0	Water Content (%)	19.24	19.06
Liquid Limit	31.0	31.0	Average Water Content (%)		19.15

Liquid Limit Test



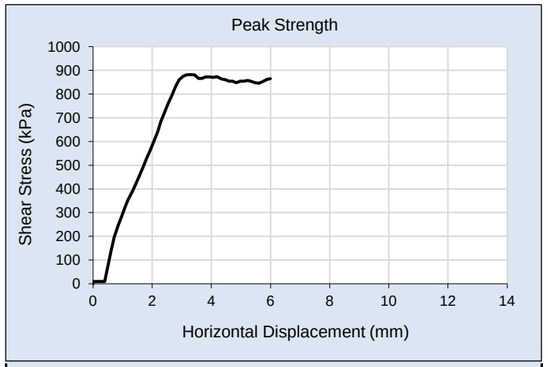
Plasticity chart for soil passing 425 µm sieve



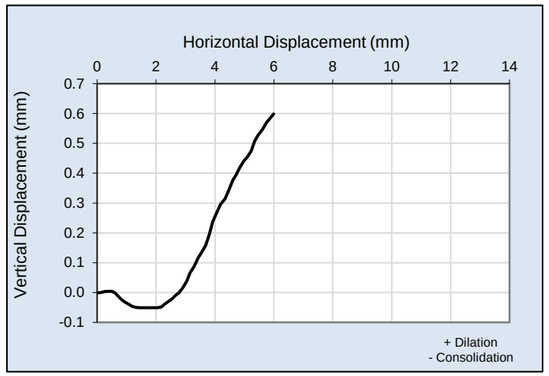
Liquid Limit =	31	%
Plastic Limit =	19	%
Plasticity Index =	12	

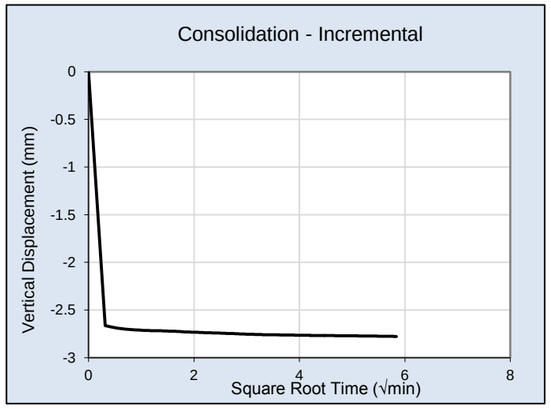
Comments:

Reviewed: MB



Normal Load σ', kPa	500	Shear Rate, mm/min	0.0248





Consolidation Test Results

T90	0.14	min
T50	0.03	min
Shear Rate	2.3712	mm/min
Delta H	-2.78	mm

Sample Identification

Project #	13-1359-0011	Borehole	GD-15
Client	Arctos/Anthracite	Sample	130135
Project	Fortune Minerals	Depth	64.75-65.25m
Location	-		

Initial - Sample Dimensions

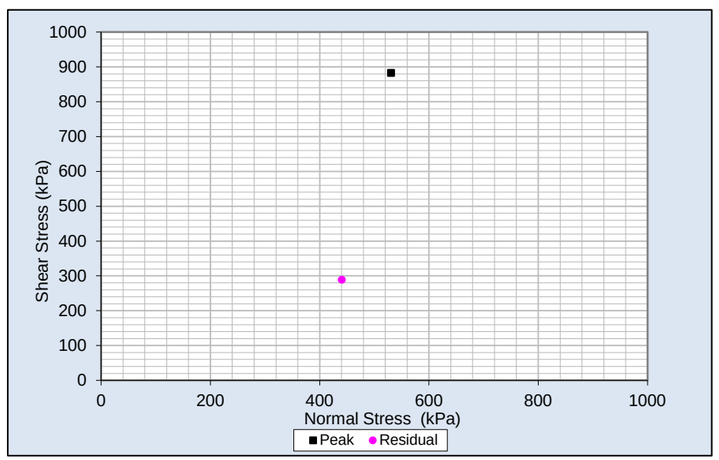
Trial Number	1
Shear box geometry	Circle
Diameter, mm	63.25
Depth, mm	25.16
Area, cm^2	31.42
Volume, cm^3	79.05

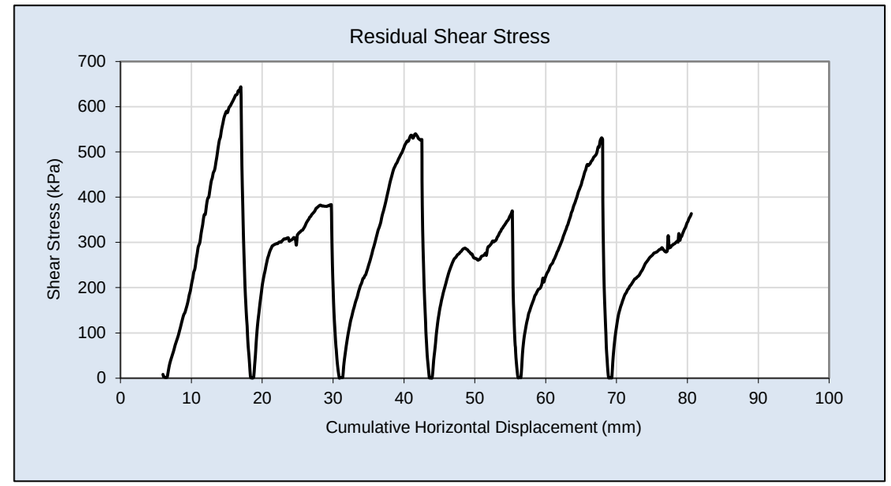
Weight Volume Relationships

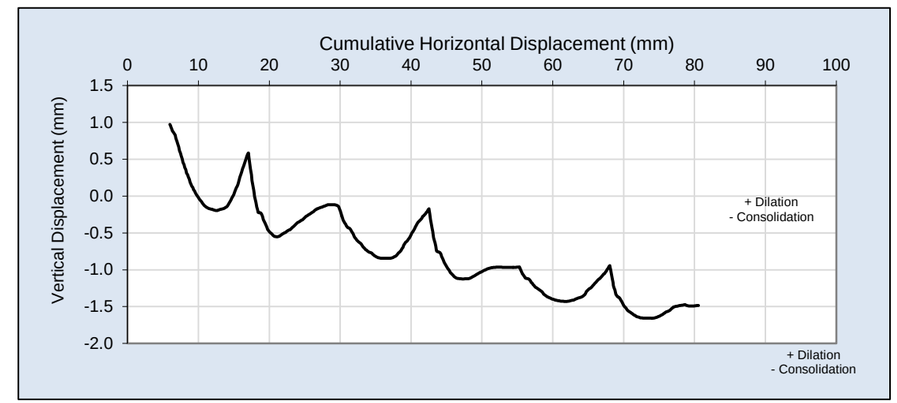
Test#		A863-01
Sample Type		Undisturbed
Initial Wet Wt, g		226.79
Initial Dry Wt, g		215.93
Initial Water Content, %		5.03
Final Water Content, %		6.48
Initial γ_{dry}, kg/m^3		2731
Final γ_{dry}, kg/m^3	(after consolidation)	3070
Specific Gravity	(assumed)	2.75
Initial Void Ratio, e		0.007

Test Results (Area Corrected)

Displacement at Failure, mm	3.292
Peak Normal Stress, kPa	531
Peak Shear Stress, kPa	882
Displacement at Residual, mm	76.396
Residual Normal Stress, kPa	441
Residual Shear Stress, kPa	288
Shear rate for Residual Stress, mm/min	0.0243







Index Test Results

Water Content (%)	5.00
Liquid Limit (%)	62
Plastic Limit (%)	17
Plasticity Index	45

Equipment - DS-KWSOIL s/n: 844

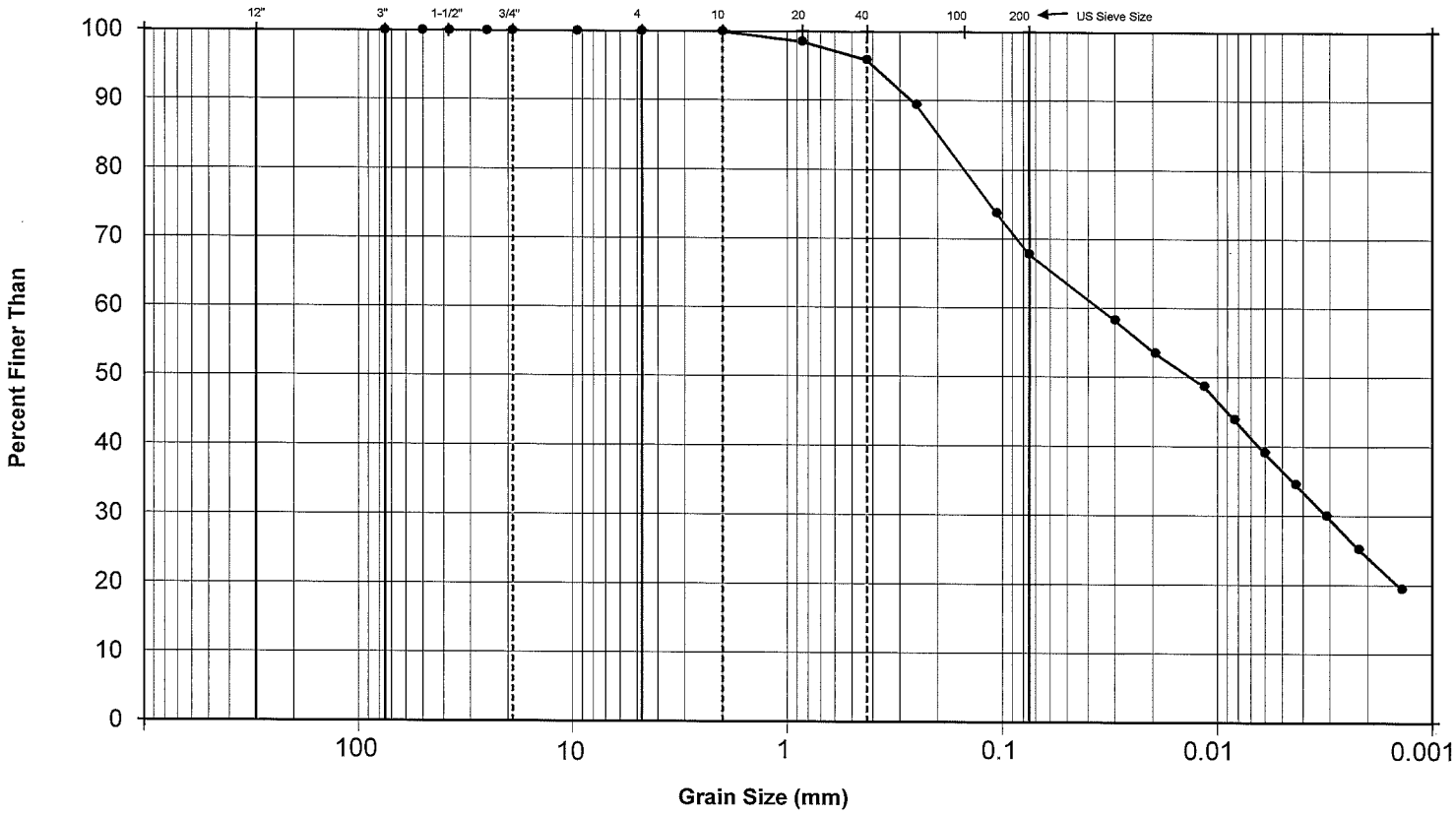
Axial LPT Serial #	4119-ch3
Normal Load Cell Serial #	4119-ch4
Shear Load Cell Serial #	4119-ch1
Vertical LPT Serial #	4119-ch2

Client: Arctos Anthracite Joint Venture	Fortune Minerals Lab Testing/Terracon Geotechnique Arctos Anthracite Project
Golder Associates	DIRECT SHEAR TEST Borehole GD-15 Sample 130135
PROJECT: 13-1359-0011	Check: MB Review: DJH

Golder Associates

Particle Size Analysis of Soil
(ASTM D422)

Project No.:	13-1359-0011	Lab No.:	A863-01
Project Title:	Fortune Minerals Lab Testing/Terracon Geotechnique		
Borehole:	GD-15	Sample No.:	130135
Depth:	64.75-65.25		
Date Tested:	25-Oct-13	By:	DS



Boulder Size	Cobble Size	Gravel Size: Coarse	Gravel Size: Fine	Sand Size: Coarse	Sand Size: Medium	Sand Size: Fine	Silt and Clay Size

Diameter of Sieve (mm)	Percent Passing (%)
75.0	100.0
50.0	100.0
37.5	100.0
25.0	100.0
19.0	100.0
9.5	100.0
4.75	100.0
2.0	100.0
0.850	98.6
0.425	95.9
0.250	89.5
0.106	73.8
0.075	67.8
0.030	58.3
0.019	53.5
0.011	48.7
0.008	44.0
0.006	39.2
0.004	34.6
0.003	30.1
0.002	25.3
0.001	19.5

Comments:

Reviewed:

Golder Associates

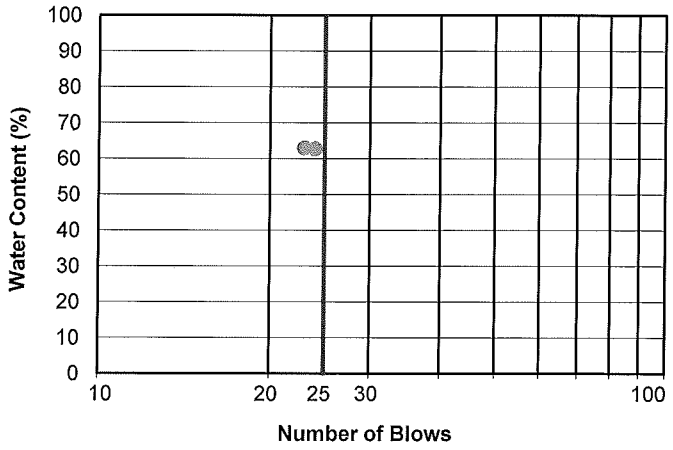
Atterberg Limits (ASTM D 4318)

Project No.: 13-1359-0011	Phase: 1000
Short Title: Fortune Minerals Lab Testing/Terracon Geotechnique	Sched: A863-01
Tested By: CG	Date: 25-Oct-13

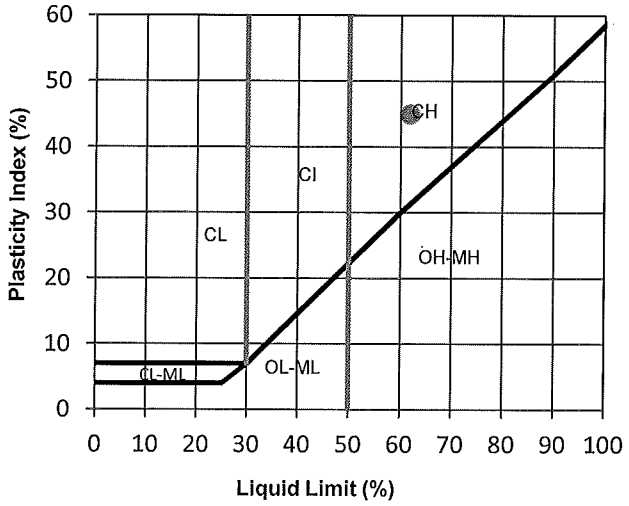
Borehole: GD-15 Sample No.: 130135 Depth: 64.75-65.25 m

Liquid Limit Determination:			Natural Water Content:		
Number of Blows	23	24	As Received Water Content (%)		5.0%
Blow Correction Factor	0.99	1.00	**Plastic Limit Determination:**		
Mass of wet sample + tare (g)	35.16	38.82	Mass of wet sample + tare (g)	20.39	20.79
Mass of dry sample + tare (g)	28.49	31.71	Mass of dry sample + tare (g)	18.99	19.29
Mass of tare (g)	17.90	20.38	Mass of tare (g)	10.91	10.67
Weight of Water (g)	6.67	7.11	Weight of Water (g)	1.40	1.50
Weight of dry soil (g)	10.59	11.33	Weight of dry soil (g)	8.08	8.62
Water Content (%)	63.0	62.8	Water Content (%)	17.33	17.40
Liquid Limit	62.0	62.0	Average Water Content (%)		17.36

Liquid Limit Test



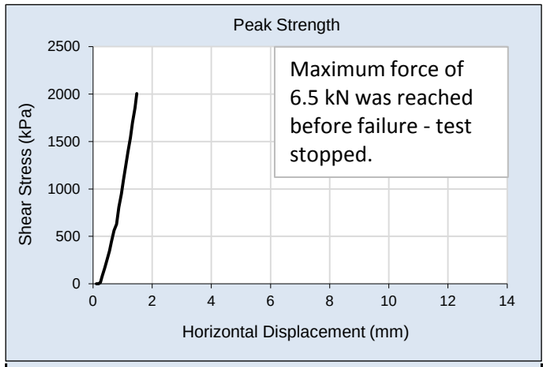
Plasticity chart for soil passing 425 µm sieve



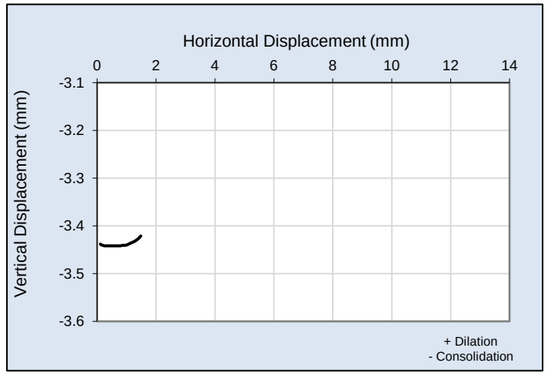
Liquid Limit =	62	%
Plastic Limit =	17	%
Plasticity Index =	45	

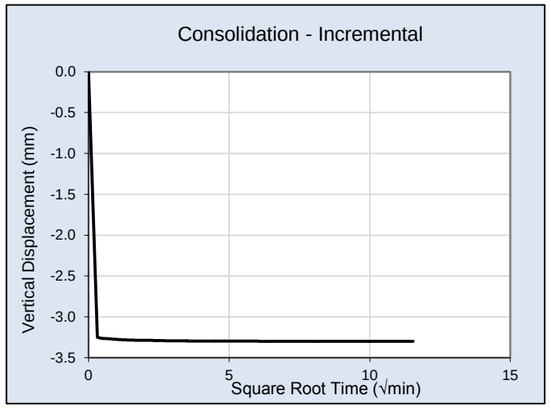
Comments:

Reviewed:



Normal Load σ', kPa	2000	Shear Rate, mm/min	0.1009





Consolidation Test Results

T90	0.12	min
T50	0.03	min
Shear Rate	2.7951	mm/min
Delta H	-3.30	mm

Sample Identification

Project #	13-1359-0011	Borehole	GP-15
Client	Arctos/Anthracite	Sample	130130
Project	Fortune Minerals	Depth	28.65-28.90m
Location	-		

Initial - Sample Dimensions

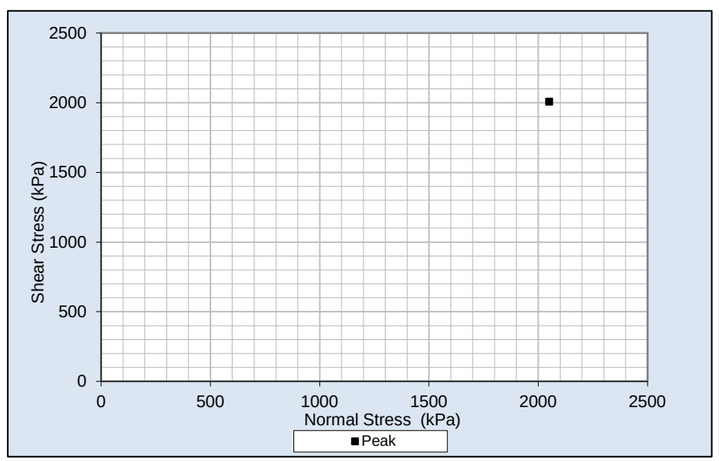
Trial Number	1
Shear box geometry	Circle
Diameter, mm	63.40
Depth, mm	25.40
Area, cm^2	31.57
Volume, cm^3	80.19

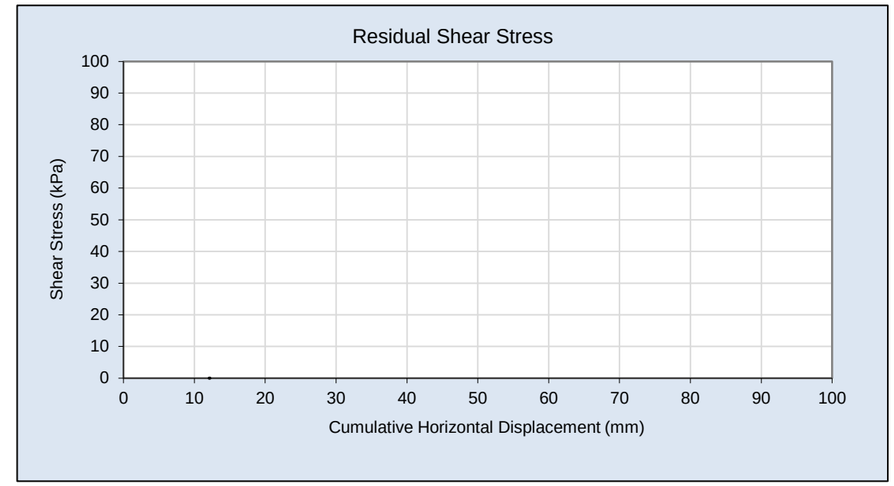
Weight Volume Relationships

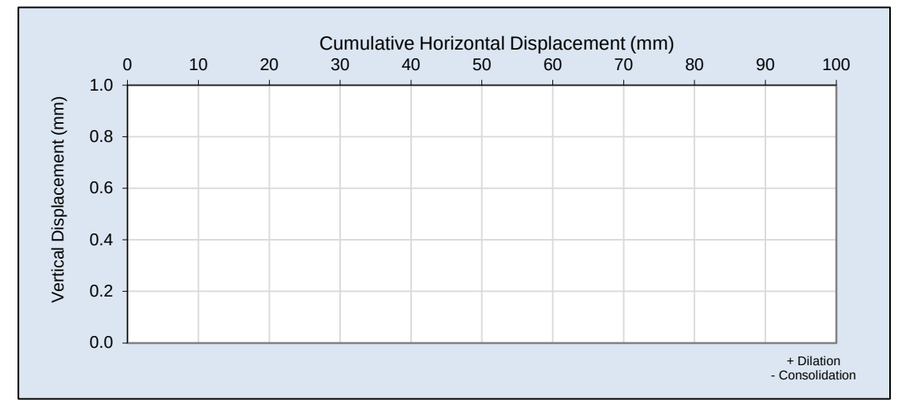
Test#		A928-11
Sample Type		Undisturbed
Initial Wet Wt, g		209.16
Initial Dry Wt, g		208.0
Initial Water Content, %		0.55
Final Water Content, %		3.00
Initial γ_{dry}, kg/m^3		2594
Final γ_{dry}, kg/m^3	(after consolidation)	2981
Specific Gravity	(assumed)	2.65
Initial Void Ratio, e		0.022

Test Results (Area Corrected)

Displacement at Failure, mm	1.481	Note: Maximum force of 6.5 kN was reached during shear test stopped to avoid damaging equipment
Peak Normal Stress, kPa	2052	
Peak Shear Stress, kPa	2005	
Displacement at Residual, mm	-	
Residual Normal Stress, kPa	-	
Residual Shear Stress, kPa	-	
Shear rate for Residual Stress, mm/min	-	







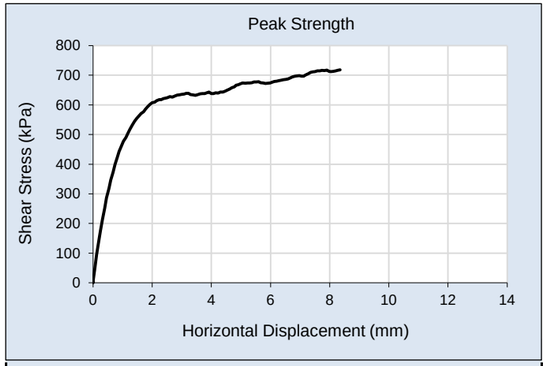
Index Test Results

Water Content (%)	1.00
Liquid Limit (%)	16
Plastic Limit (%)	13
Plasticity Index	3

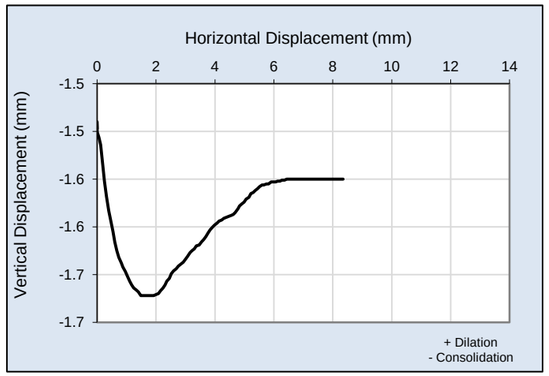
Equipment - DS-KWSOIL s/n: 906

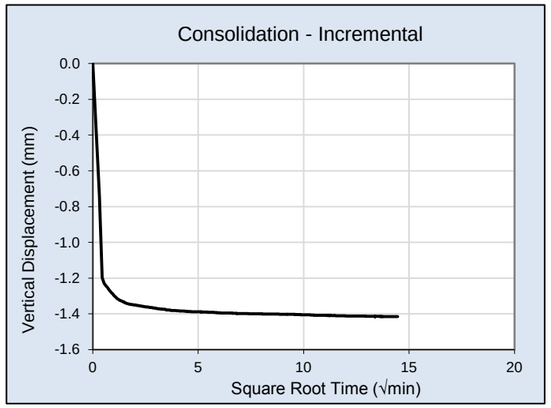
Axial LPT Serial #	4143-ch3
Normal Load Cell Serial #	4143-ch4
Shear Load Cell Serial #	4143-ch1
Vertical LPT Serial #	4143-ch2

Client: Arctos Anthracite Joint Venture	Fortune Minerals Lab Testing/Terracon Geotechnique Arctos Anthracite Project
Golder Associates	DIRECT SHEAR TEST Borehole GP-15 Sample 130130
PROJECT: 13-1359-0011	Check: MB Review: DJH



Normal Load σ', kPa	1000	Shear Rate, mm/min	0.0251





Consolidation Test Results

T90	0.25	min
T50	0.06	min
Shear Rate	1.3696	mm/min
Delta H	-1.42	mm

Sample Identification

Project #	13-1359-0011	Borehole	GD-15
Client	Arctos/ Anthracite	Sample	130135
Project	Fortune Minerals	Depth	64.75-65.25m
Location	-		

Initial - Sample Dimensions

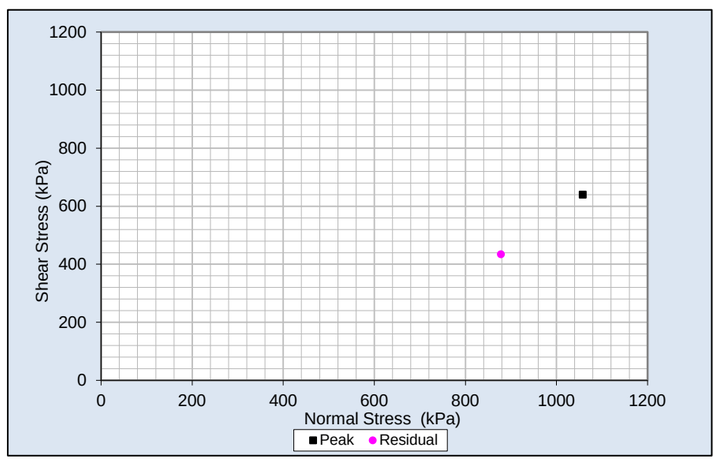
Trial Number	1
Shear box geometry	Circle
Diameter, mm	63.30
Depth, mm	25.16
Area, cm^2	31.47
Volume, cm^3	79.18

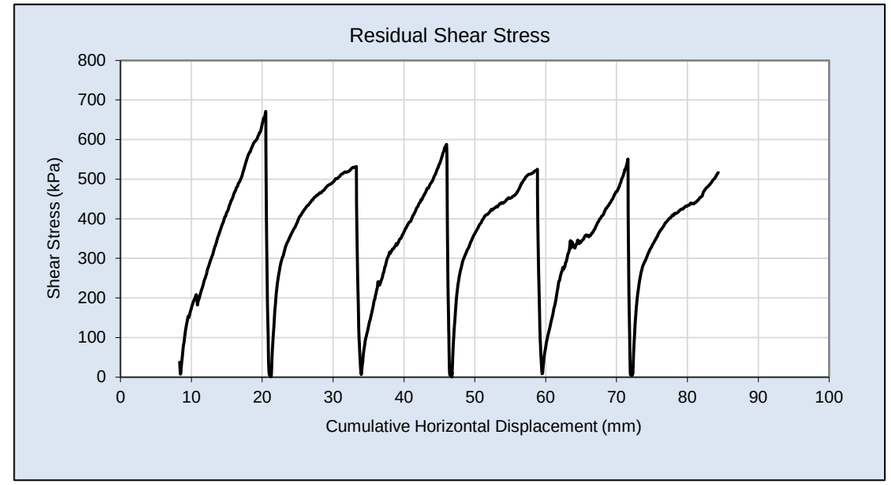
Weight Volume Relationships

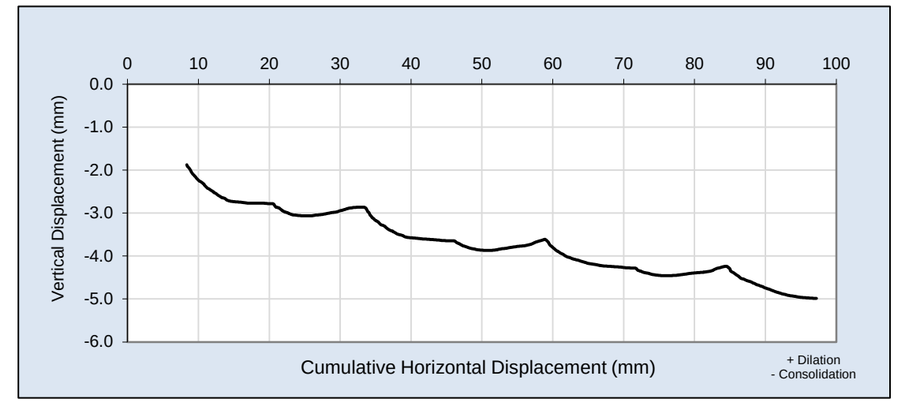
Test#		A863-01
Sample Type		Undisturbed
Initial Wet Wt, g		189.88
Initial Dry Wt, g		183.11
Initial Water Content, %		3.70
Final Water Content, %		9.93
Initial γ_{dry}, kg/m^3		2313
Final γ_{dry}, kg/m^3	(after consolidation)	2450
Specific Gravity	(assumed)	2.75
Initial Void Ratio, e		0.189

Test Results (Area Corrected)

Displacement at Failure, mm	3.151
Peak Normal Stress, kPa	1059
Peak Shear Stress, kPa	639
Displacement at Residual, mm	80.028
Residual Normal Stress, kPa	879
Residual Shear Stress, kPa	434
Shear rate for Residual Stress, mm/min	0.0240







Index Test Results

Water Content (%)	5.00
Liquid Limit (%)	62
Plastic Limit (%)	17
Plasticity Index	45

Equipment - DS-KWSOIL s/n: 844

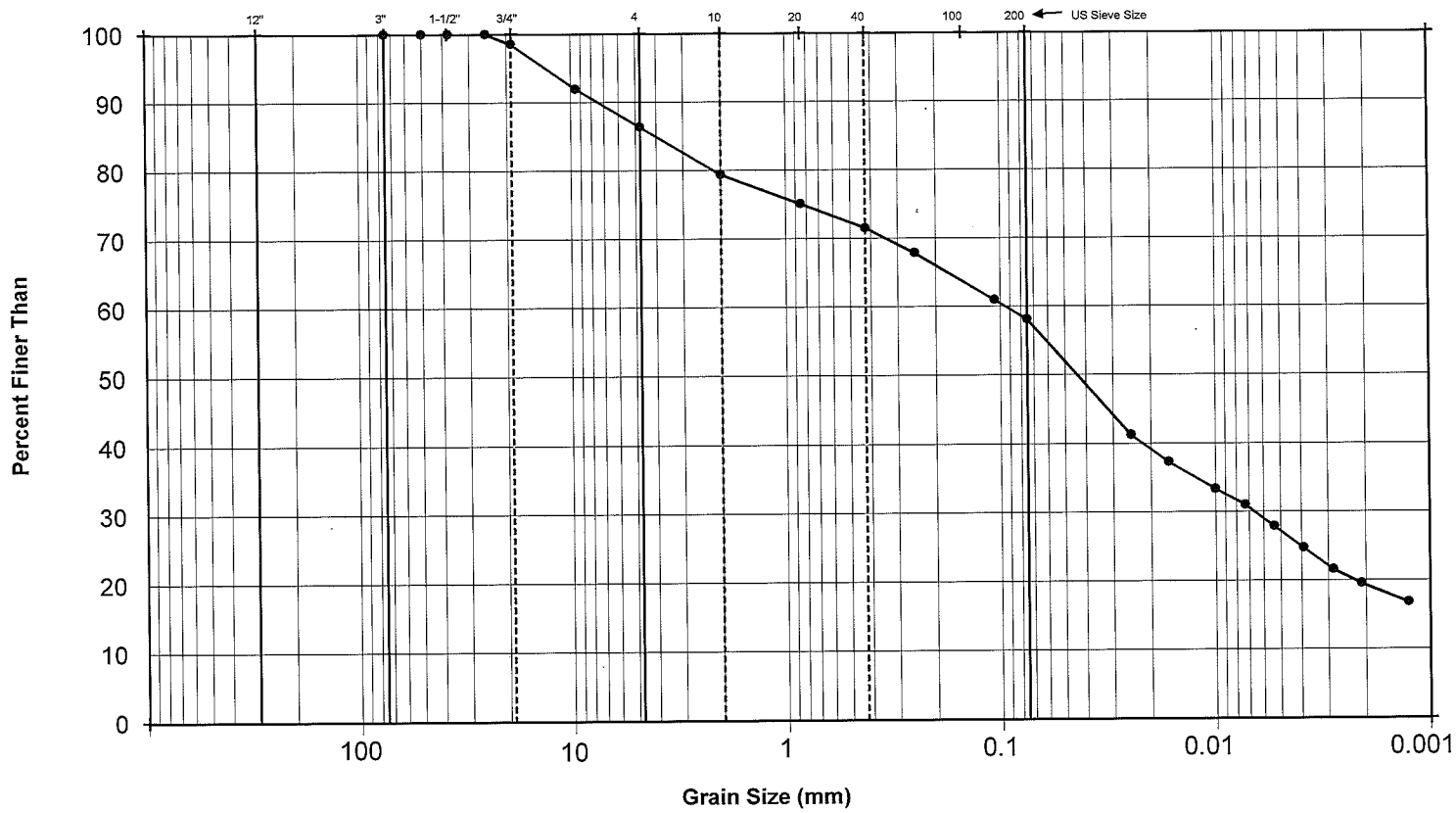
Axial LPT Serial #	4119-ch3
Normal Load Cell Serial #	4119-ch4
Shear Load Cell Serial #	4119-ch1
Vertical LPT Serial #	4119-ch2

Client: Arctos Anthracite Joint Venture	Fortune Minerals Lab Testing/Terracon Geotechnique Arctos Anthracite Project
Golder Associates	DIRECT SHEAR TEST Borehole GD-15 Sample 130135
PROJECT: 13-1359-0011	Check: MB Review: DJH

Golder Associates

Particle Size Analysis of Soil
(ASTM D422)

Project No.:	13-1359-0011.1000	Lab No.:	A849-67
Project Title:	Terracon Geotechnique		
Borehole:	MW26/GD20	Sample No.:	130486
Depth:	1.25-1.50m		
Date Tested:	13-Aug-13	By:	DS



Boulder Size	Cobble Size	Gravel Size: Coarse	Gravel Size: Fine	Sand Size: Coarse	Sand Size: Medium	Sand Size: Fine	Silt and Clay Size

Diameter of Sieve (mm)	Percent Passing (%)
75.0	100.0
50.0	100.0
37.5	100.0
25.0	100.0
19.0	98.5
9.5	92.0
4.75	86.4
2.0	79.4
0.850	75.1
0.425	71.6
0.250	67.9
0.106	61.0
0.075	58.2
0.025	41.3
0.016	37.3
0.010	33.4
0.007	31.0
0.005	27.9
0.004	24.8
0.003	21.6
0.002	19.6
0.001	16.8

Comments:

Reviewed: MB

Golder Associates

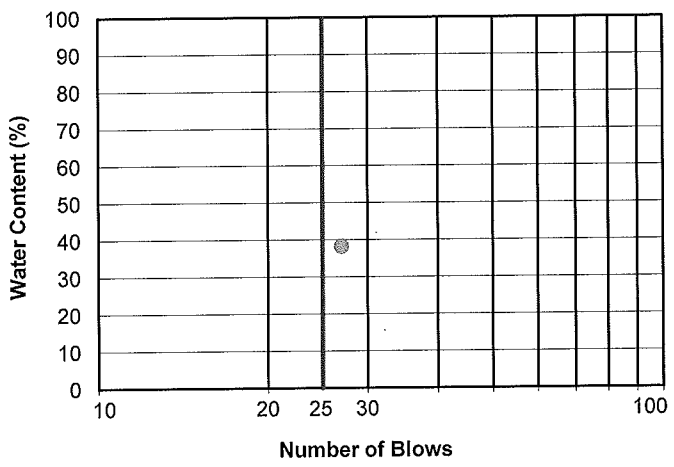
Atterberg Limits (ASTM D 4318)

Project No.: 13-1359-0011	Phase: 1000
Short Title: Terracon Geotechnique	Sched: A849-67
Tested By: CG	Date: 13-Aug-13

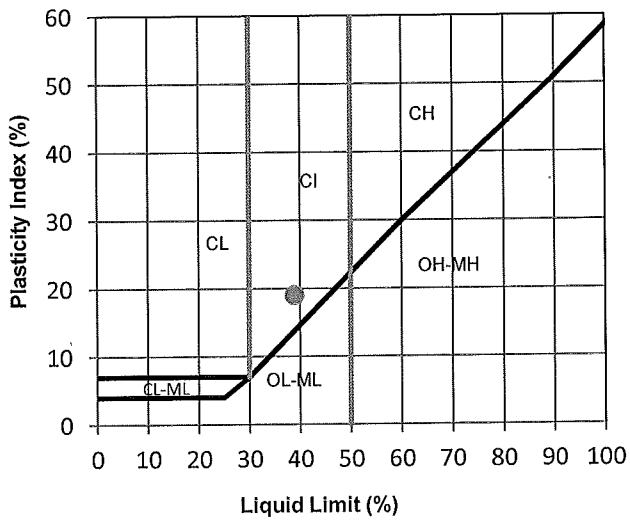
Borehole: MW2/GD20 Sample No.: 130486 Depth: 1.25-1.50m

Liquid Limit Determination:			Natural Water Content:		
Number of Blows	27	27	As Received Water Content (%)		9.4%
Blow Correction Factor	1.01	1.01	**Plastic Limit Determination:**		
Mass of wet sample + tare (g)	47.04	47.33	Mass of wet sample + tare (g)	22.44	19.68
Mass of dry sample + tare (g)	40.93	40.93	Mass of dry sample + tare (g)	20.52	17.99
Mass of tare (g)	24.99	24.19	Mass of tare (g)	11.01	9.55
Weight of Water (g)	6.11	6.4	Weight of Water (g)	1.92	1.69
Weight of dry soil (g)	15.94	16.74	Weight of dry soil (g)	9.51	8.44
Water Content (%)	38.3	38.2	Water Content (%)	20.19	20.02
Liquid Limit	39.0	39.0	Average Water Content (%)		20.11

Liquid Limit Test



Plasticity chart for soil passing 425 µm sieve



Liquid Limit =	39	%
Plastic Limit =	20	%
Plasticity Index =	19	

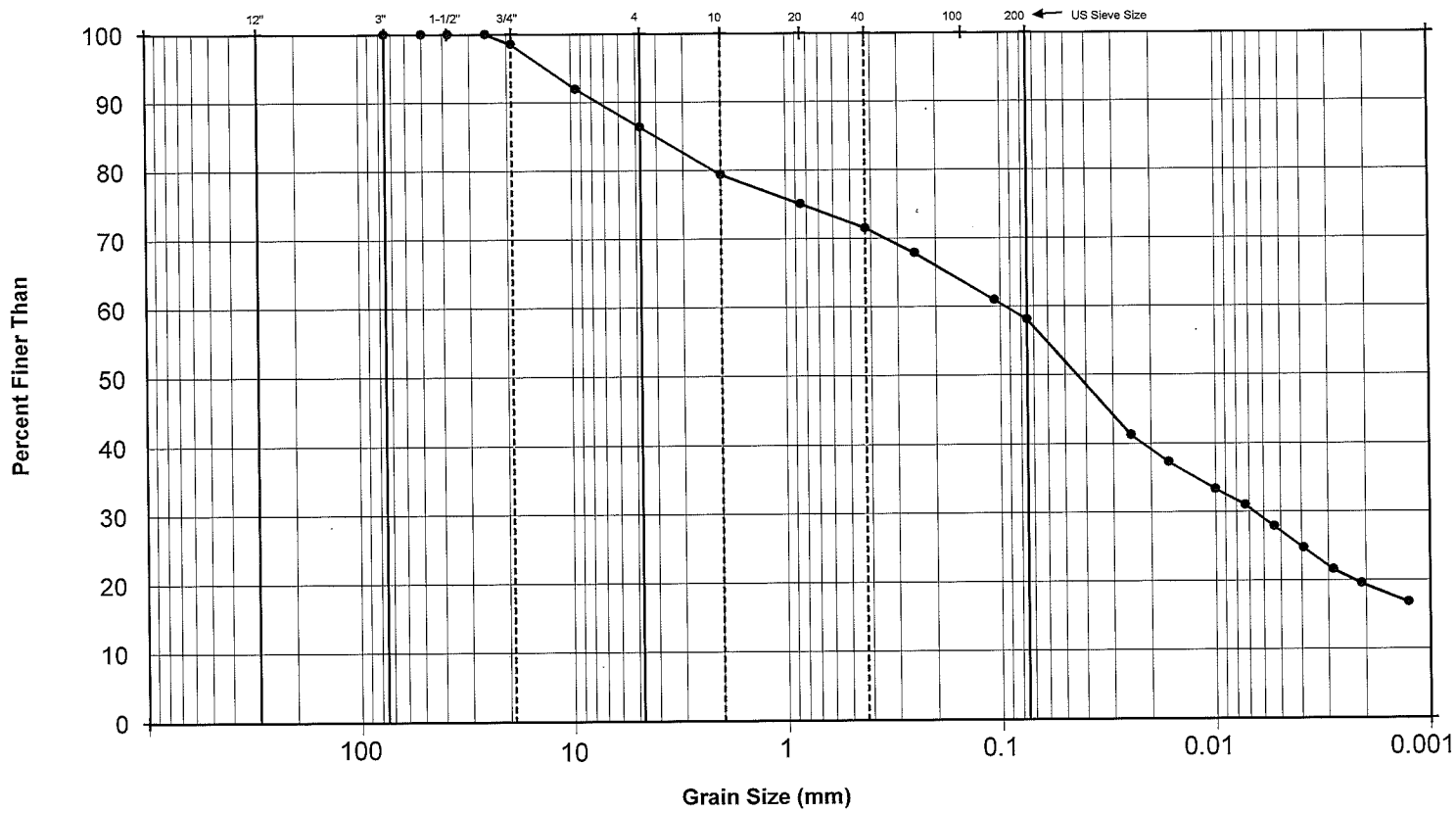
Comments: _____

Reviewed: MB

Golder Associates

Particle Size Analysis of Soil
(ASTM D422)

Project No.:	13-1359-0011.1000	Lab No.:	A849-67
Project Title:	Terracon Geotechnique		
Borehole:	MW26/GD20	Sample No.:	130486
Depth:	1.25-1.50m		
Date Tested:	13-Aug-13	By:	DS



Boulder Size	Cobble Size	Gravel Size: Coarse	Gravel Size: Fine	Sand Size: Coarse	Sand Size: Medium	Sand Size: Fine	Silt and Clay Size

Diameter of Sieve (mm)	Percent Passing (%)
75.0	100.0
50.0	100.0
37.5	100.0
25.0	100.0
19.0	98.5
9.5	92.0
4.75	86.4
2.0	79.4
0.850	75.1
0.425	71.6
0.250	67.9
0.106	61.0
0.075	58.2
0.025	41.3
0.016	37.3
0.010	33.4
0.007	31.0
0.005	27.9
0.004	24.8
0.003	21.6
0.002	19.6
0.001	16.8

Comments:

Reviewed: MB

Golder Associates

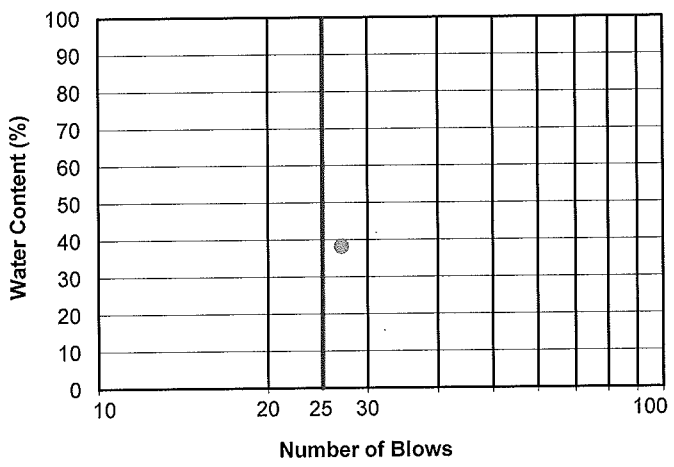
Atterberg Limits (ASTM D 4318)

Project No.: 13-1359-0011	Phase: 1000
Short Title: Terracon Geotechnique	Sched: A849-67
Tested By: CG	Date: 13-Aug-13

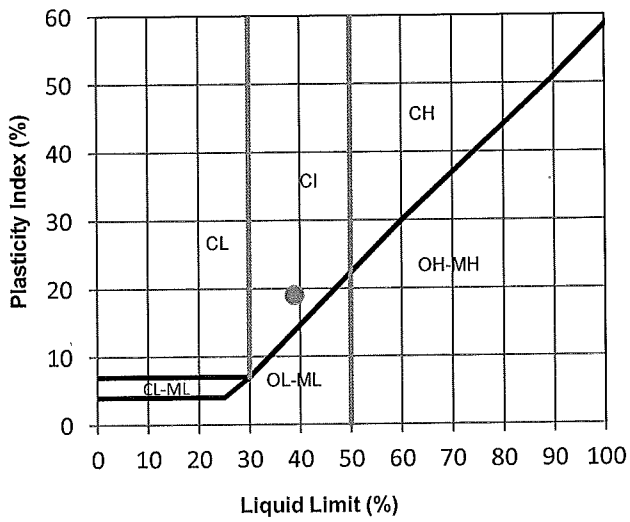
Borehole: MW2/GD20 Sample No.: 130486 Depth: 1.25-1.50m

Liquid Limit Determination:			Natural Water Content:		
Number of Blows	27	27	As Received Water Content (%)		9.4%
Blow Correction Factor	1.01	1.01	**Plastic Limit Determination:**		
Mass of wet sample + tare (g)	47.04	47.33	Mass of wet sample + tare (g)	22.44	19.68
Mass of dry sample + tare (g)	40.93	40.93	Mass of dry sample + tare (g)	20.52	17.99
Mass of tare (g)	24.99	24.19	Mass of tare (g)	11.01	9.55
Weight of Water (g)	6.11	6.4	Weight of Water (g)	1.92	1.69
Weight of dry soil (g)	15.94	16.74	Weight of dry soil (g)	9.51	8.44
Water Content (%)	38.3	38.2	Water Content (%)	20.19	20.02
Liquid Limit	39.0	39.0	Average Water Content (%)		20.11

Liquid Limit Test



Plasticity chart for soil passing 425 µm sieve



Liquid Limit =	39	%
Plastic Limit =	20	%
Plasticity Index =	19	

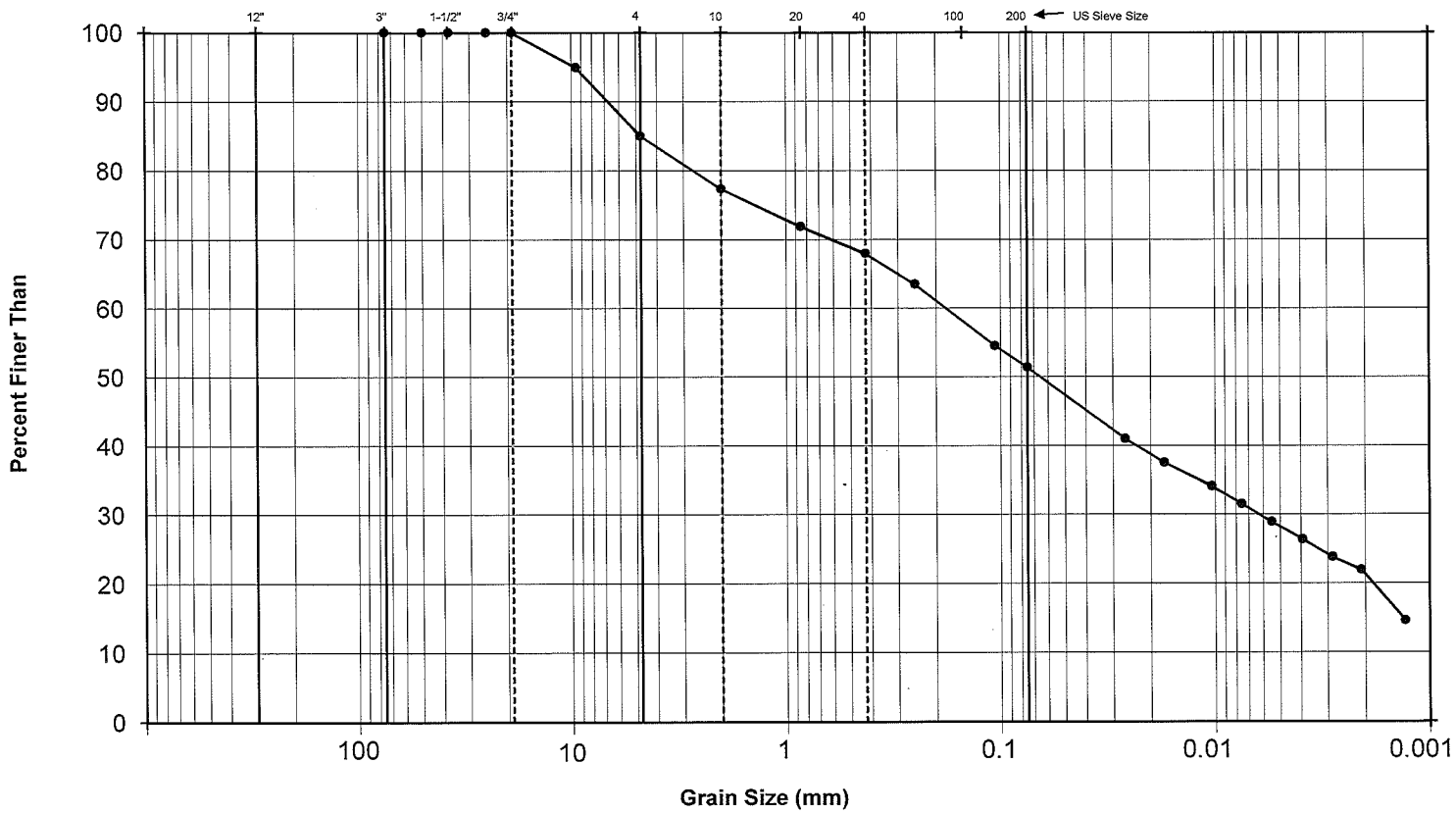
Comments: _____

Reviewed: MB

Golder Associates

Particle Size Analysis of Soil
(ASTM D422)

Project No.:	13-1359-0011.1000	Lab No.:	A849-54
Project Title:	Terracon Geotechnique		
Borehole:	MW26/GD20	Sample No.:	130473
Depth:	1.50-1.64m		
Date Tested:	13-Aug-13	By:	DS



Diameter of Sieve (mm)	Percent Passing (%)
75.0	100.0
50.0	100.0
37.5	100.0
25.0	100.0
19.0	100.0
9.5	94.9
4.75	85.0
2.0	77.4
0.850	71.9
0.425	68.0
0.250	63.5
0.106	54.5
0.075	51.4
0.026	41.0
0.017	37.5
0.010	34.1
0.008	31.5
0.005	28.9
0.004	26.4
0.003	23.8
0.002	22.0
0.001	14.6

Boulder Size	Cobble Size	Gravel Size: Coarse	Gravel Size: Fine	Sand Size: Coarse	Sand Size: Medium	Sand Size: Fine	Silt and Clay Size

Comments:

Reviewed: MB

GOLDER ASSOCIATES LTD.

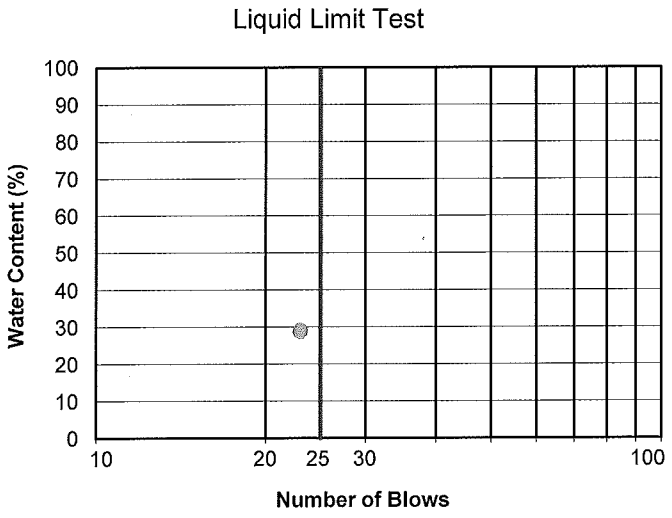
Golder Associates

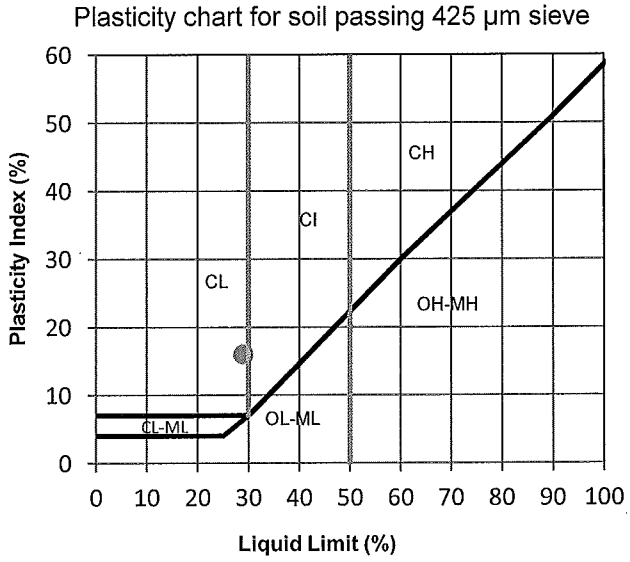
Atterberg Limits (ASTM D 4318)

Project No.: 13-1359-0011	Phase: 1000
Short Title: Terracon Geotechnique	Sched: A849-55
Tested By: CG	Date: 13-Aug-13

Borehole: MW2/GD20 Sample No.: 130474 Depth: 3.00-3.14m

Liquid Limit Determination:			Natural Water Content:		
Number of Blows	23	23	As Received Water Content (%)		13.2%
Blow Correction Factor	0.99	0.99	**Plastic Limit Determination:**		
Mass of wet sample + tare (g)	36.85	40.23	Mass of wet sample + tare (g)	23.42	22.10
Mass of dry sample + tare (g)	32.70	35.66	Mass of dry sample + tare (g)	21.95	20.81
Mass of tare (g)	18.44	19.81	Mass of tare (g)	10.74	10.85
Weight of Water (g)	4.15	4.57	Weight of Water (g)	1.47	1.29
Weight of dry soil (g)	14.26	15.85	Weight of dry soil (g)	11.21	9.96
Water Content (%)	29.1	28.8	Water Content (%)	13.11	12.95
Liquid Limit	29.0	29.0	Average Water Content (%)		13.03





Liquid Limit = 29 %
Plastic Limit = 13 %
Plasticity Index = 16

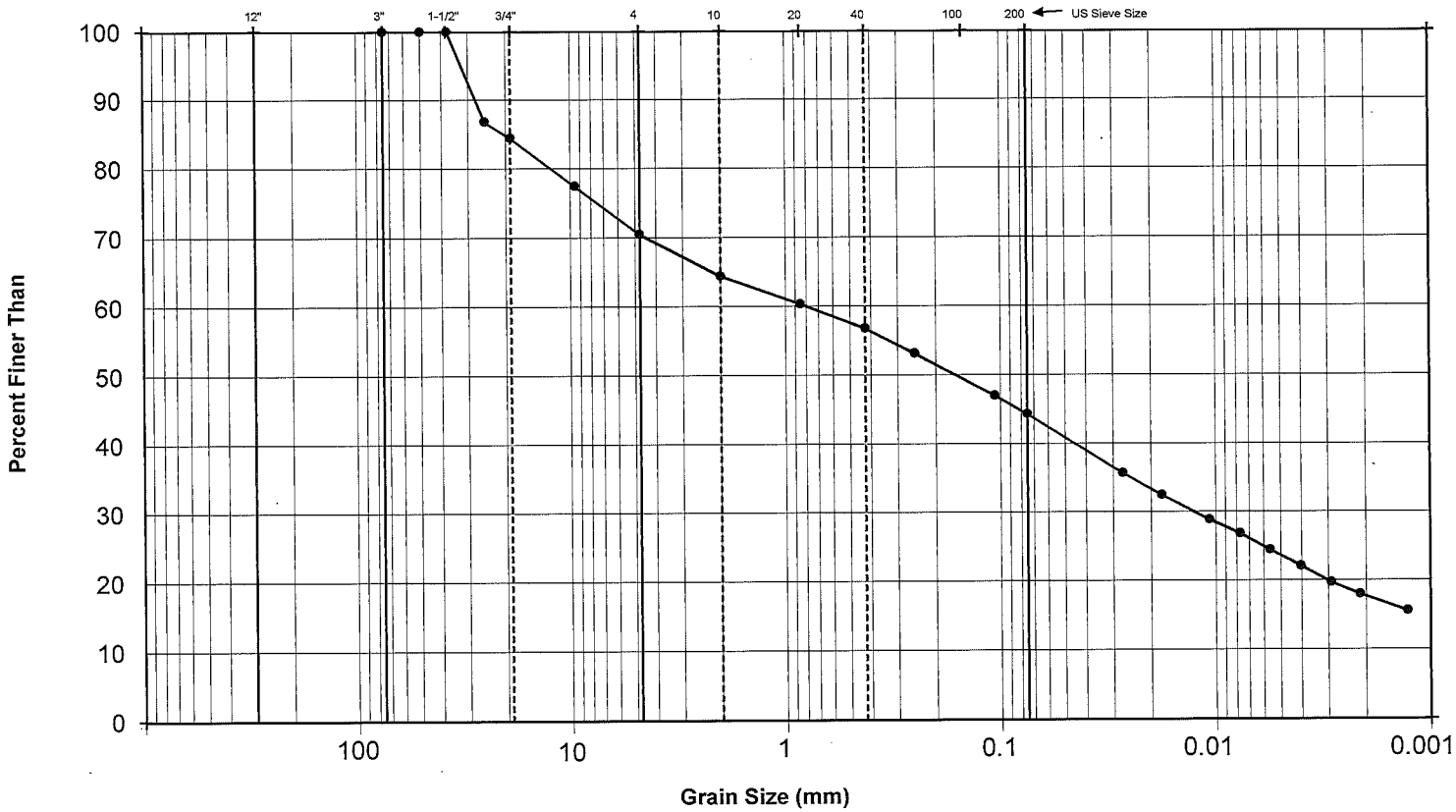
Comments:

Reviewed:

Golder Associates

Particle Size Analysis of Soil
(ASTM D422)

Project No.:	13-1359-0011.1000	Lab No.:	A849-25
Project Title:	Terracon Geotechnique		
Borehole:	GD-21	Sample No.:	130119
Depth:	2.00-2.15m		
Date Tested:	13-Aug-13	By:	DS



Boulder Size	Cobble Size	Gravel Size: Coarse	Gravel Size: Fine	Sand Size: Coarse	Sand Size: Medium	Sand Size: Fine	Silt and Clay Size

Diameter of Sieve (mm)	Percent Passing (%)
75.0	100.0
50.0	100.0
37.5	100.0
25.0	86.8
19.0	84.4
9.5	77.4
4.75	70.5
2.0	64.4
0.850	60.4
0.425	56.8
0.250	53.2
0.106	47.0
0.075	44.3
0.027	35.7
0.018	32.5
0.011	28.8
0.008	26.8
0.006	24.4
0.004	22.1
0.003	19.7
0.002	18.0
0.001	15.6

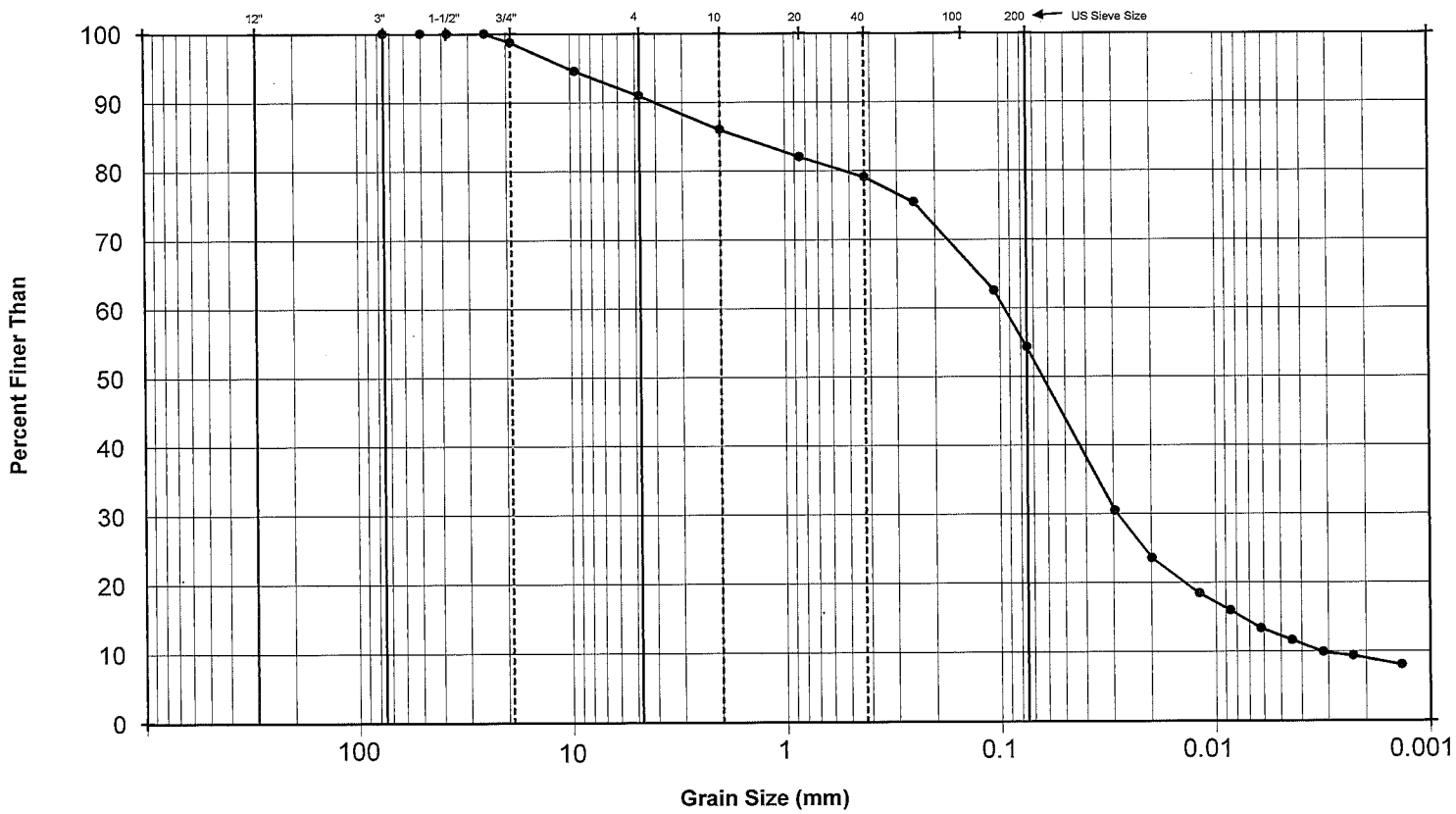
Comments:

Reviewed: MB

Golder Associates

Particle Size Analysis of Soil
(ASTM D422)

Project No.:	13-1359-0011.1000	Lab No.:	A849-23
Project Title:	Terracon Geotechnique		
Borehole:	GD-21	Sample No.:	130117
Depth:	2.00-2.38m		
Date Tested:	13-Aug-13	By:	DS



Boulder Size	Cobble Size	Gravel Size: Coarse	Gravel Size: Fine	Sand Size: Coarse	Sand Size: Medium	Sand Size: Fine	Silt and Clay Size

Diameter of Sieve (mm)	Percent Passing (%)
75.0	100.0
50.0	100.0
37.5	100.0
25.0	100.0
19.0	98.8
9.5	94.5
4.75	91.0
2.0	86.1
0.850	82.0
0.425	79.1
0.250	75.4
0.106	62.6
0.075	54.4
0.029	30.5
0.020	23.6
0.012	18.4
0.009	16.0
0.006	13.4
0.004	11.6
0.003	9.9
0.002	9.4
0.001	8.1

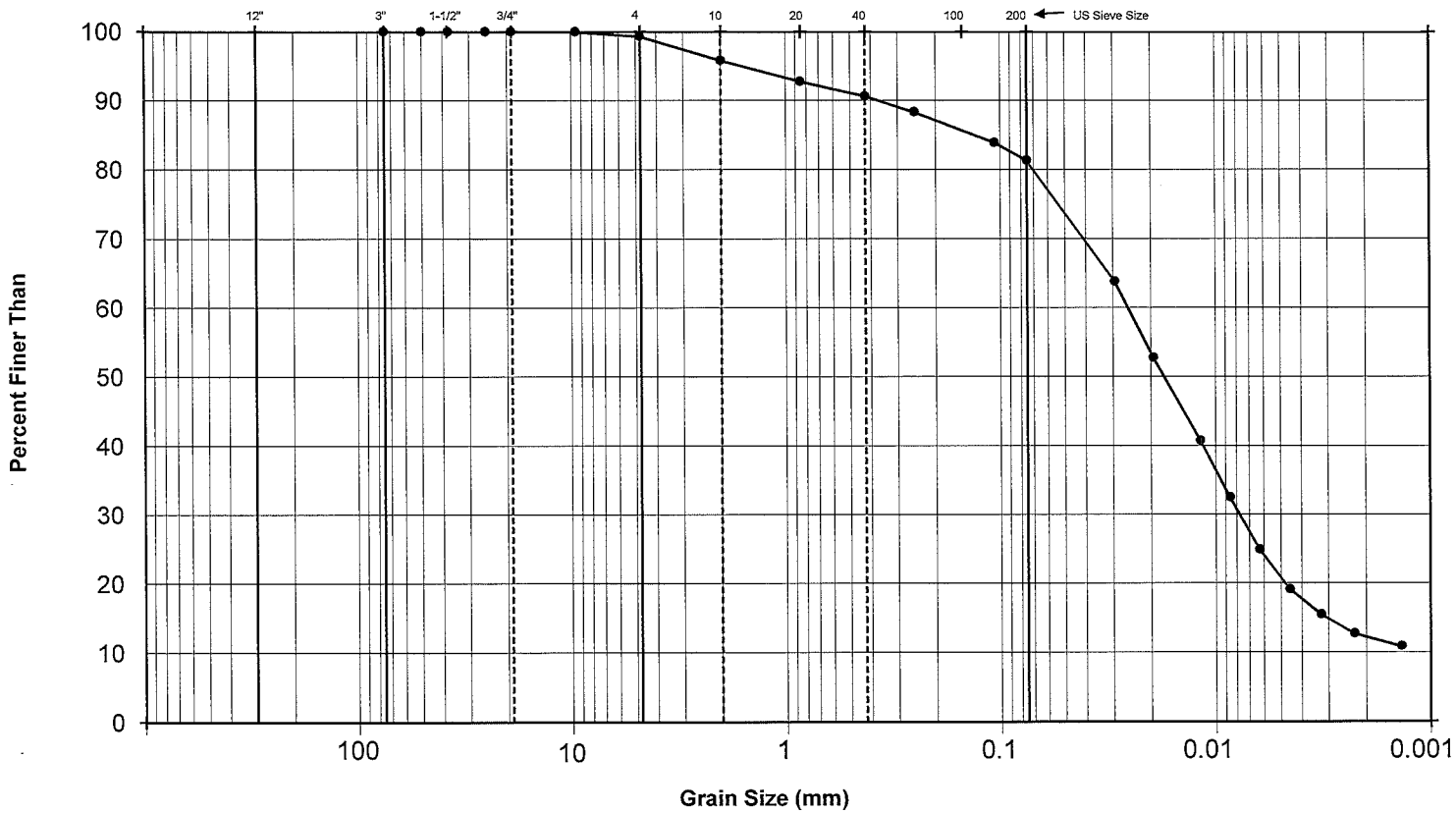
Comments:

Reviewed:

Golder Associates

Particle Size Analysis of Soil
(ASTM D422)

Project No.:	13-1359-0011.1000	Lab No.:	A849-24
Project Title:	Terracon Geotechnique		
Borehole:	GD-21	Sample No.:	130118
Depth:	3.50-3.60m		
Date Tested:	13-Aug-13	By:	DS



Boulder Size	Cobble Size	Gravel Size: Coarse	Gravel Size: Fine	Sand Size: Coarse	Sand Size: Medium	Sand Size: Fine	Silt and Clay Size

Diameter of Sieve (mm)	Percent Passing (%)
75.0	100.0
50.0	100.0
37.5	100.0
25.0	100.0
19.0	100.0
9.5	100.0
4.75	99.4
2.0	95.9
0.850	92.8
0.425	90.7
0.250	88.3
0.106	83.9
0.075	81.3
0.029	63.8
0.019	52.8
0.012	40.8
0.009	32.5
0.006	24.9
0.005	19.1
0.003	15.5
0.002	12.7
0.001	10.9

Comments:

Reviewed: MB

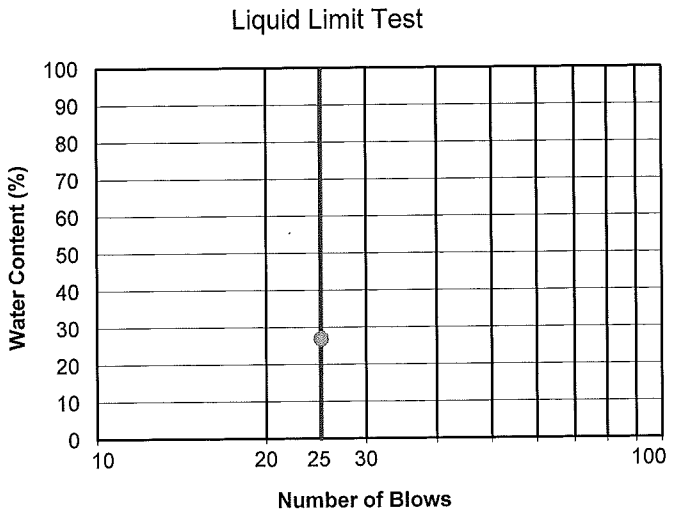
Golder Associates

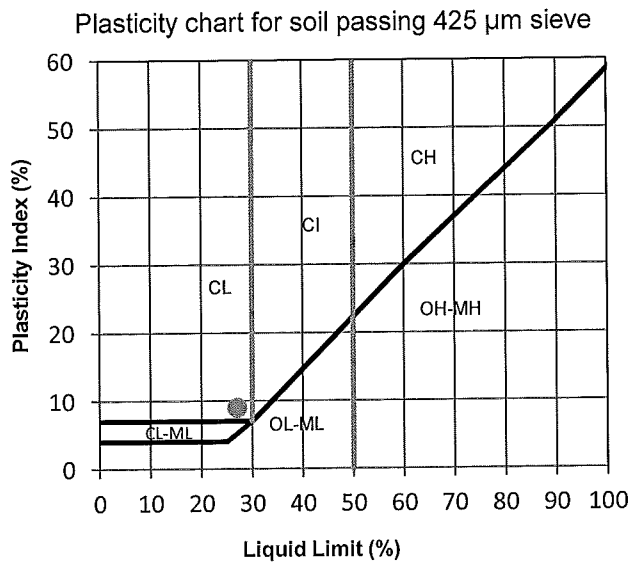
Atterberg Limits (ASTM D 4318)

Project No.: 13-1359-0011	Phase: 1000
Short Title: Terracon Geotechnique	Sched: A849-24
Tested By: CG	Date: 13-Aug-13

Borehole: GD-21 Sample No.: 130118 Depth: 3.50-3.60m

Liquid Limit Determination:			Natural Water Content:		
Number of Blows	25	25	As Received Water Content (%)		22.1%
Blow Correction Factor	1.00	1.00	**Plastic Limit Determination:**		
Mass of wet sample + tare (g)	46.62	43.32	Mass of wet sample + tare (g)	19.83	20.30
Mass of dry sample + tare (g)	41.94	38.27	Mass of dry sample + tare (g)	18.34	18.77
Mass of tare (g)	24.61	19.47	Mass of tare (g)	10.05	10.56
Weight of Water (g)	4.68	5.05	Weight of Water (g)	1.49	1.53
Weight of dry soil (g)	17.33	18.8	Weight of dry soil (g)	8.29	8.21
Water Content (%)	27.0	26.9	Water Content (%)	17.97	18.64
Liquid Limit	27.0	27.0	Average Water Content (%)		18.30





Liquid Limit =	27	%
Plastic Limit =	18	%
Plasticity Index =	9	

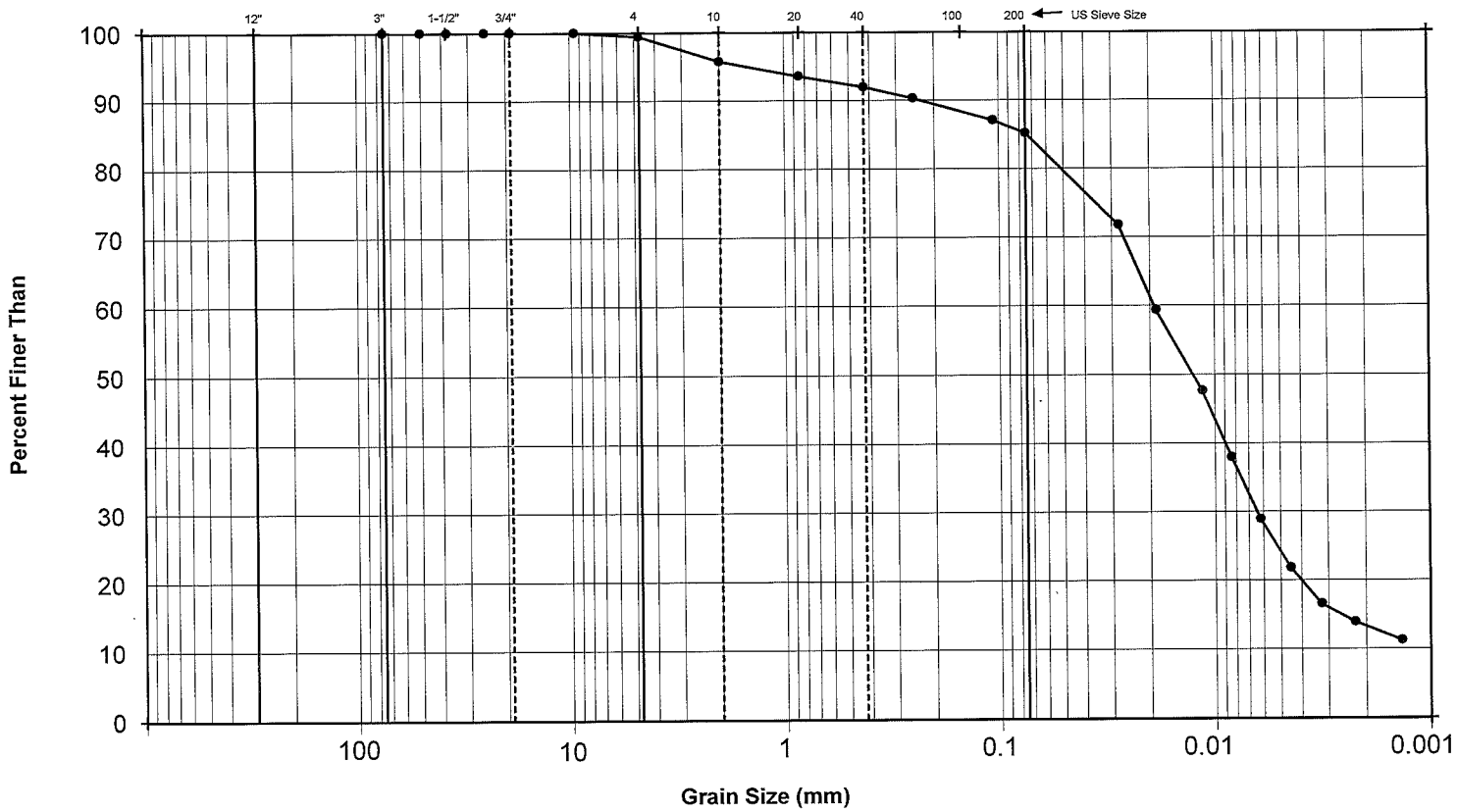
Comments:

Reviewed: MB

Golder Associates

Particle Size Analysis of Soil
(ASTM D422)

Project No.:	13-1359-0011.1000	Lab No.:	A849-26
Project Title:	Terracon Geotechnique		
Borehole:	GD-21	Sample No.:	130120
Depth:	3.60-3.70m		
Date Tested:	13-Aug-13	By:	DS



Boulder Size	Cobble Size	Gravel Size: Coarse	Gravel Size: Fine	Sand Size: Coarse	Sand Size: Medium	Sand Size: Fine	Silt and Clay Size

Diameter of Sieve (mm)	Percent Passing (%)
75.0	100.0
50.0	100.0
37.5	100.0
25.0	100.0
19.0	100.0
9.5	100.0
4.75	99.4
2.0	95.8
0.850	93.6
0.425	92.0
0.250	90.3
0.106	87.1
0.075	85.2
0.028	71.7
0.019	59.4
0.011	47.7
0.008	38.0
0.006	28.9
0.004	21.9
0.003	16.6
0.002	13.9
0.001	11.3

Comments:

Reviewed: MB

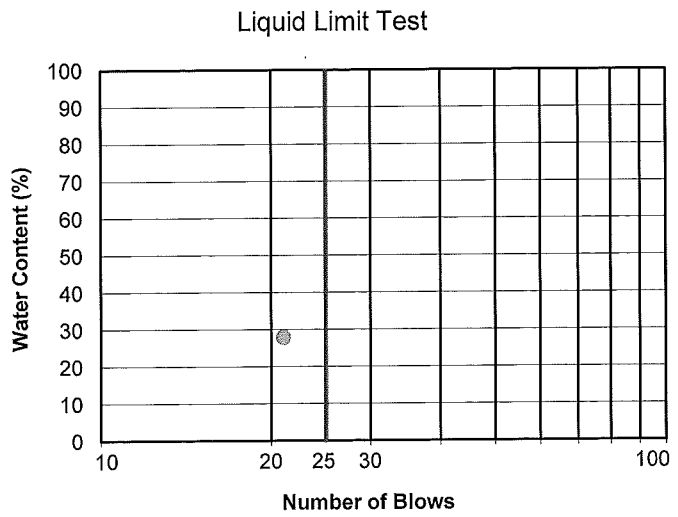
Golder Associates

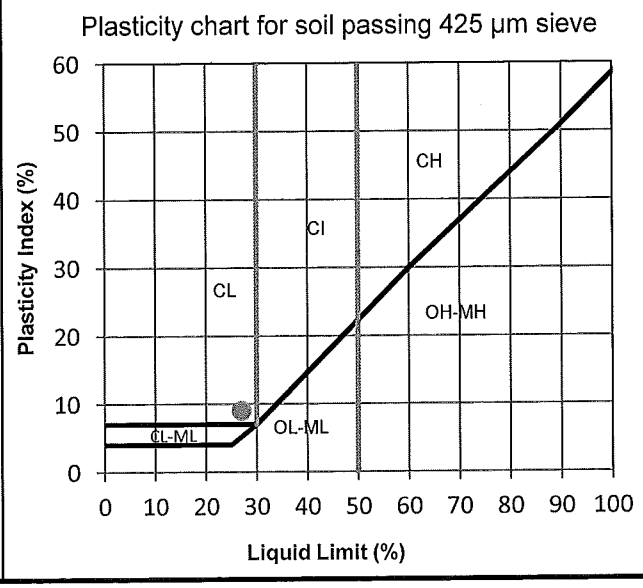
Atterberg Limits (ASTM D 4318)

Project No.: 13-1359-0011	Phase: 1000
Short Title: Terracon Geotechnique	Sched: A849-26
Tested By: CG	Date: 13-Aug-13

Borehole: GD-21 Sample No.: 130120 Depth: 3.60-3.70m

Liquid Limit Determination:			Natural Water Content:		
Number of Blows	21	21	As Received Water Content (%)		17.8%
Blow Correction Factor	0.98	0.98	**Plastic Limit Determination:**		
Mass of wet sample + tare (g)	39.67	40.71	Mass of wet sample + tare (g)	20.92	20.36
Mass of dry sample + tare (g)	35.16	36.15	Mass of dry sample + tare (g)	19.13	18.65
Mass of tare (g)	19.06	19.83	Mass of tare (g)	9.20	9.34
Weight of Water (g)	4.51	4.56	Weight of Water (g)	1.79	1.71
Weight of dry soil (g)	16.1	16.32	Weight of dry soil (g)	9.93	9.31
Water Content (%)	28.0	27.9	Water Content (%)	18.03	18.37
Liquid Limit	27.0	27.0	Average Water Content (%)		18.20





Liquid Limit =	27	%
Plastic Limit =	18	%
Plasticity Index =	9	

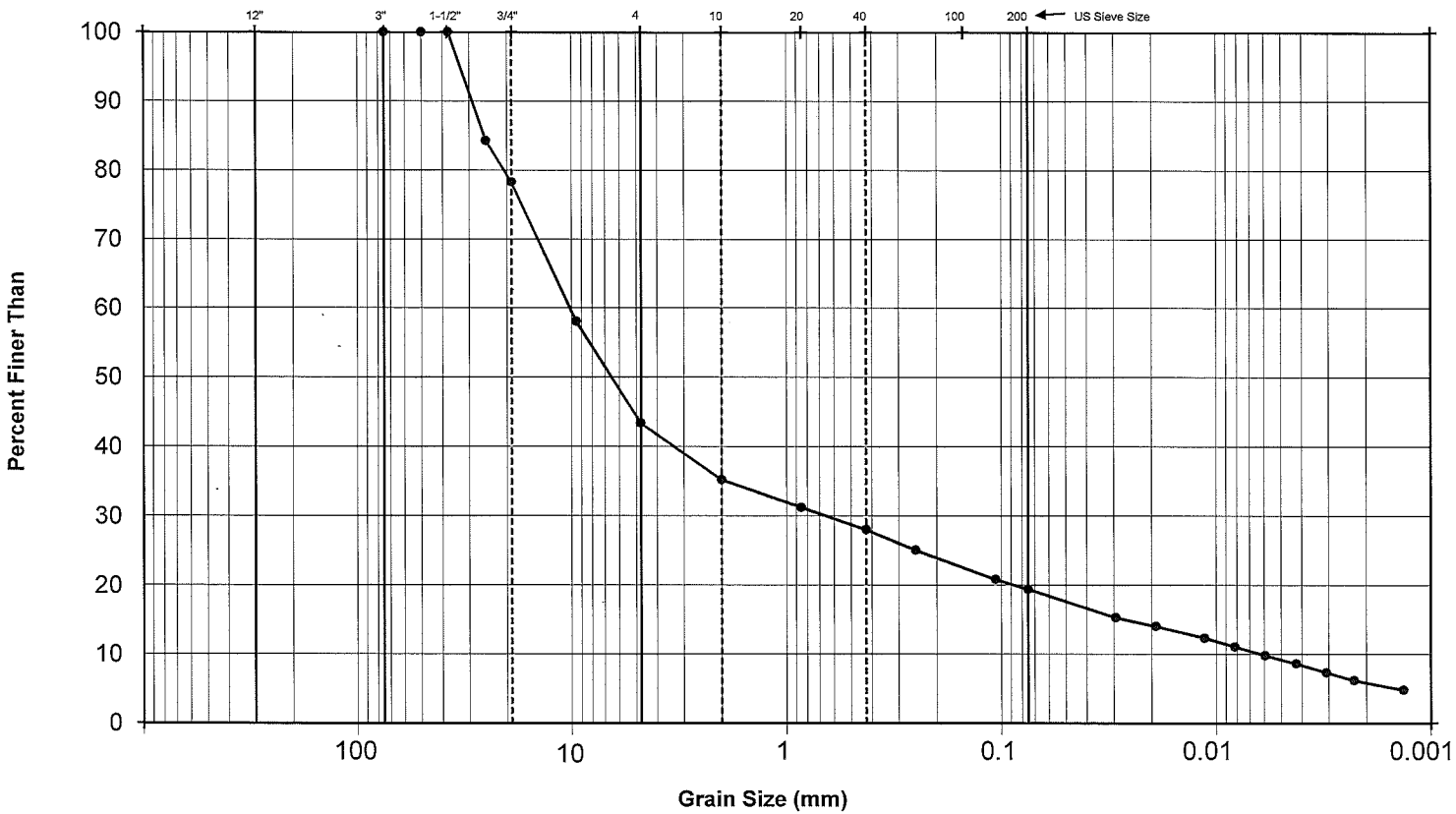
Comments:

Reviewed: MB

Golder Associates

Particle Size Analysis of Soil
(ASTM D422)

Project No.:	13-1359-0011.1000	Lab No.:	A824-01
Project Title:	Terracon Geotechnique Lab Testing		
Borehole:	GP 08/MW21	Sample No.:	1
Depth:	0.00-1.40m		
Date Tested:	15-Jul-13	By:	DS



Boulder Size	Cobble Size	Coarse	Fine	Coarse	Medium	Fine	Silt and Clay Size
		Gravel Size		Sand Size			

Diameter of Sieve (mm)	Percent Passing (%)
75.0	100.0
50.0	100.0
37.5	100.0
25.0	84.3
19.0	78.3
9.5	58.0
4.75	43.4
2.0	35.2
0.850	31.2
0.425	28.0
0.250	25.1
0.106	20.8
0.075	19.4
0.029	15.3
0.019	14.0
0.011	12.3
0.008	11.1
0.006	9.8
0.004	8.6
0.003	7.3
0.002	6.2
0.001	4.8

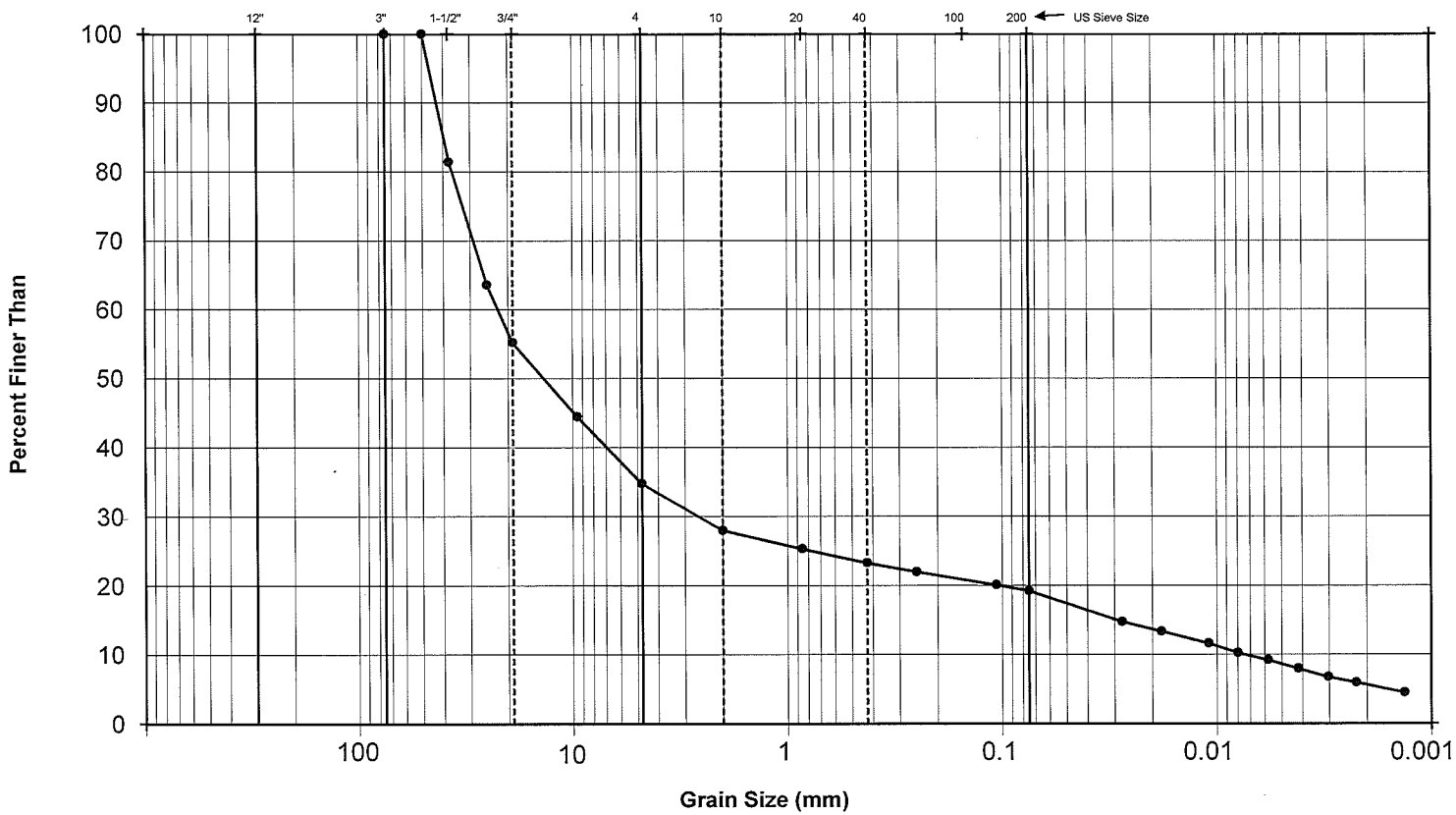
Comments:

Reviewed:

Golder Associates

Particle Size Analysis of Soil
(ASTM D422)

Project No.:	13-1359-0011.1000	Lab No.:	A824-02
Project Title:	Terracon Geotechnique Lab Testing		
Borehole:	GP 08/MW21	Sample No.:	2
Depth:	3.00-3.90m		
Date Tested:	15-Jul-13	By:	DS



Boulder Size	Cobble Size	Gravel Size: Coarse	Gravel Size: Fine	Sand Size: Coarse	Sand Size: Medium	Sand Size: Fine	Silt and Clay Size

Diameter of Sieve (mm)	Percent Passing (%)
75.0	100.0
50.0	100.0
37.5	81.4
25.0	63.6
19.0	55.2
9.5	44.5
4.75	34.8
2.0	28.0
0.850	25.3
0.425	23.3
0.250	22.0
0.106	20.1
0.075	19.3
0.028	14.8
0.018	13.4
0.011	11.6
0.008	10.2
0.006	9.2
0.004	8.0
0.003	6.8
0.002	6.0
0.001	4.5

Comments:

Reviewed: MB

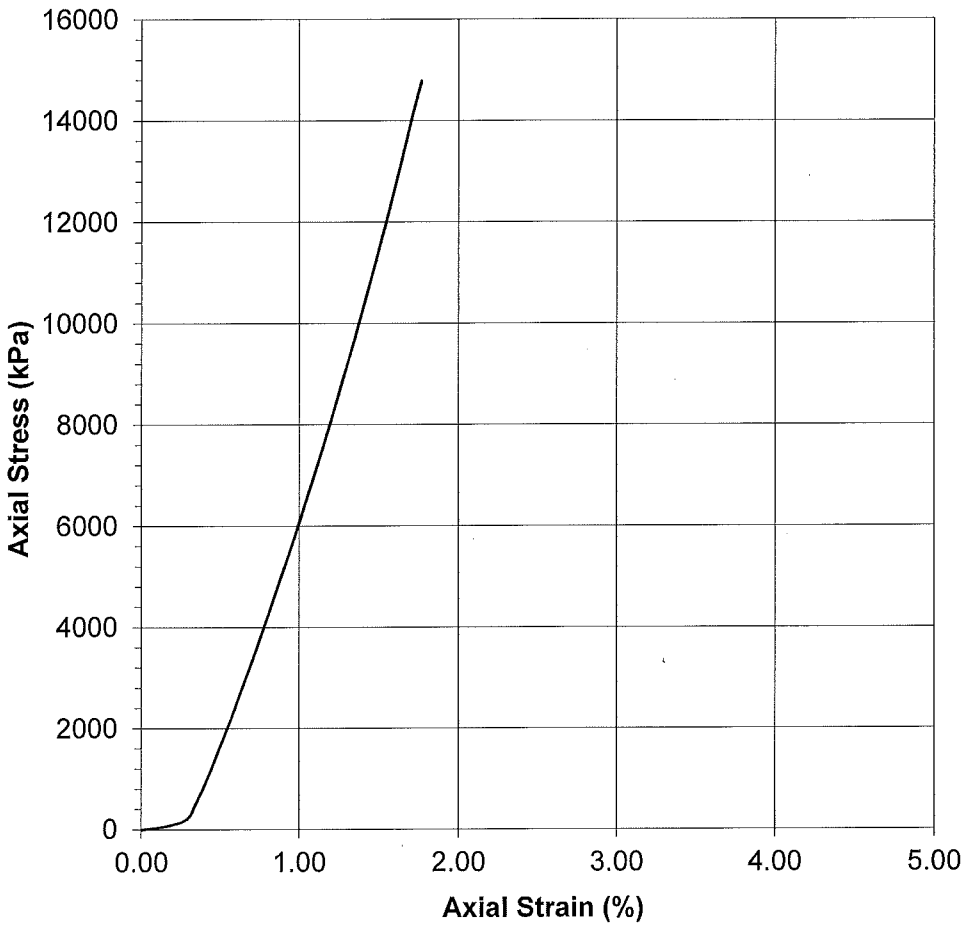
Golder Associates

UNCONFINED COMPRESSIVE STRENGTH

Project No.:	13-1359-0011
Lab No.:	A824-11
BH No.:	GP 08
Sample No.:	6
Depth:	81.45 m to 81.60 m

Height:	12.58 cm	Initial e	0.050	**Peak Stress =**	**32000.0 kPa**
Diameter:	6.31 cm			**at**	**1.77 Strain**
Wet Mass:	1065.36 g	L/D Ratio:	1.99		
% Water:	1.8				
Wet Density:	2708 kg/m³				
Dry Density:	2660 kg/m³				

Unconfined Compressive Strength



Notes/Comments: Sample Exceeded 47 kN, moved to concrete compression machine - Peak = 101.87 kN

Reviewed: OH

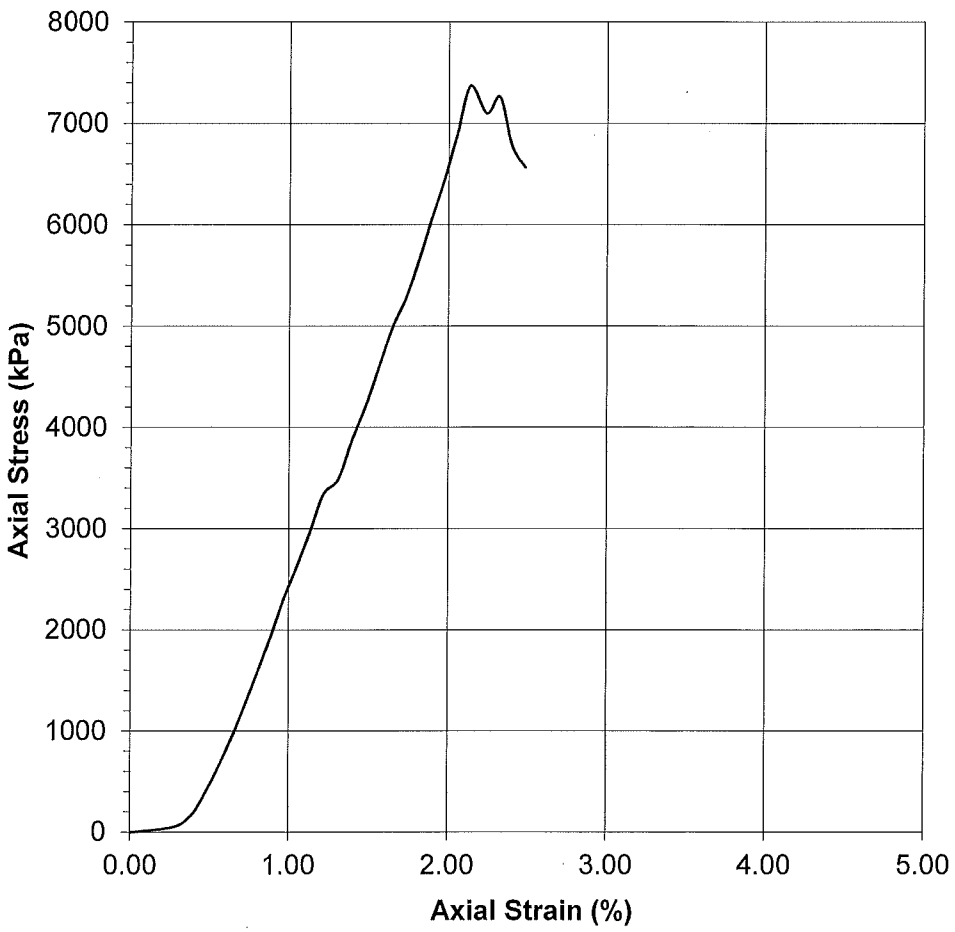
Golder Associates

UNCONFINED COMPRESSIVE STRENGTH

Project No.:	13-1359-0011
Lab No.:	A824-12
BH No.:	GP 08
Sample No.:	0
Depth:	83.40 m to 83.55 m

Height:	12.09 cm	Initial e	0.073	**Peak Stress =**	**7369.3 kPa**
Diameter:	6.33 cm			**at**	**2.13 Strain**
Wet Mass:	980.35 g	L/D Ratio:	1.91		
% Water:	2.5				
Wet Density:	2577 kg/m^3				
Dry Density:	2514 kg/m^3				

Unconfined Compressive Strength



Notes/Comments:

Reviewed:

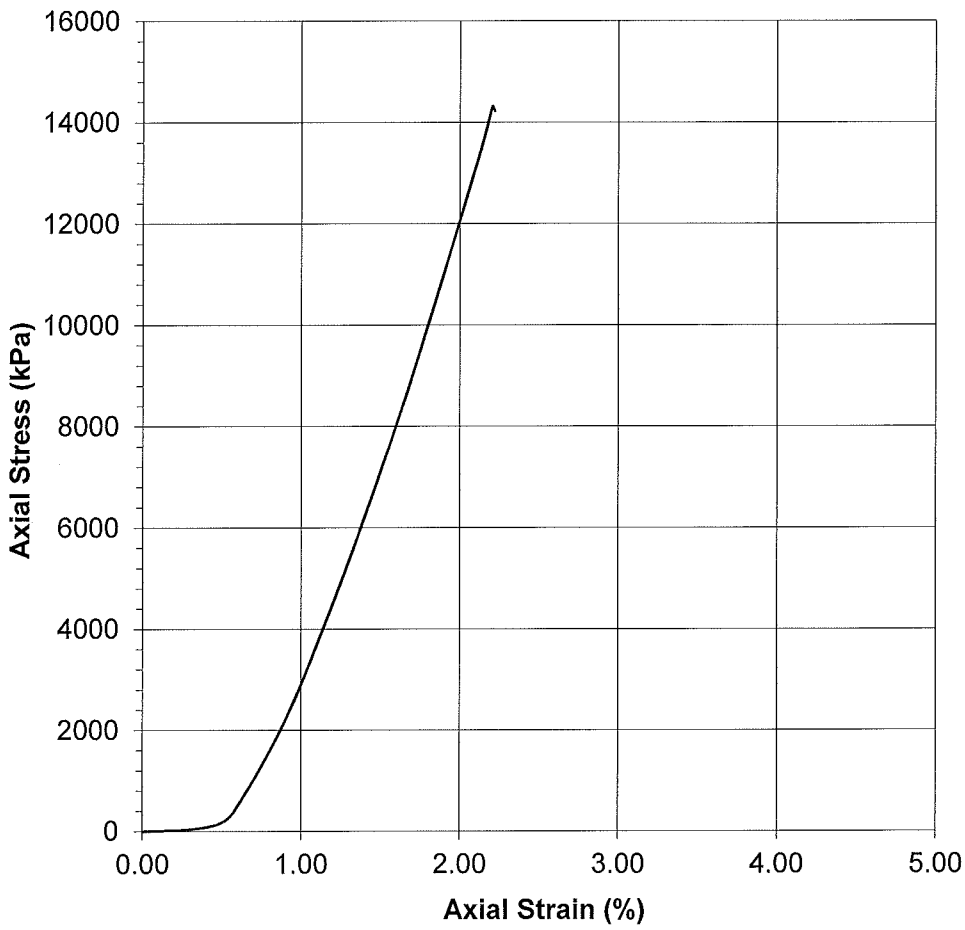
Golder Associates

UNCONFINED COMPRESSIVE STRENGTH

Project No.:	13-1359-0011
Lab No.:	A824-13
BH No.:	GP 08
Sample No.:	0
Depth:	88.17 m to 88.40 m

Height:	11.56 cm	Initial e	0.056	**Peak Stress =**	**17510.0 kPa**
Diameter:	6.31 cm			**at**	**2.20 Strain**
Wet Mass:	946.26 g	L/D Ratio:	1.83		
% Water:	2.1				
Wet Density:	2618 kg/m^3				
Dry Density:	2564 kg/m^3				

Unconfined Compressive Strength



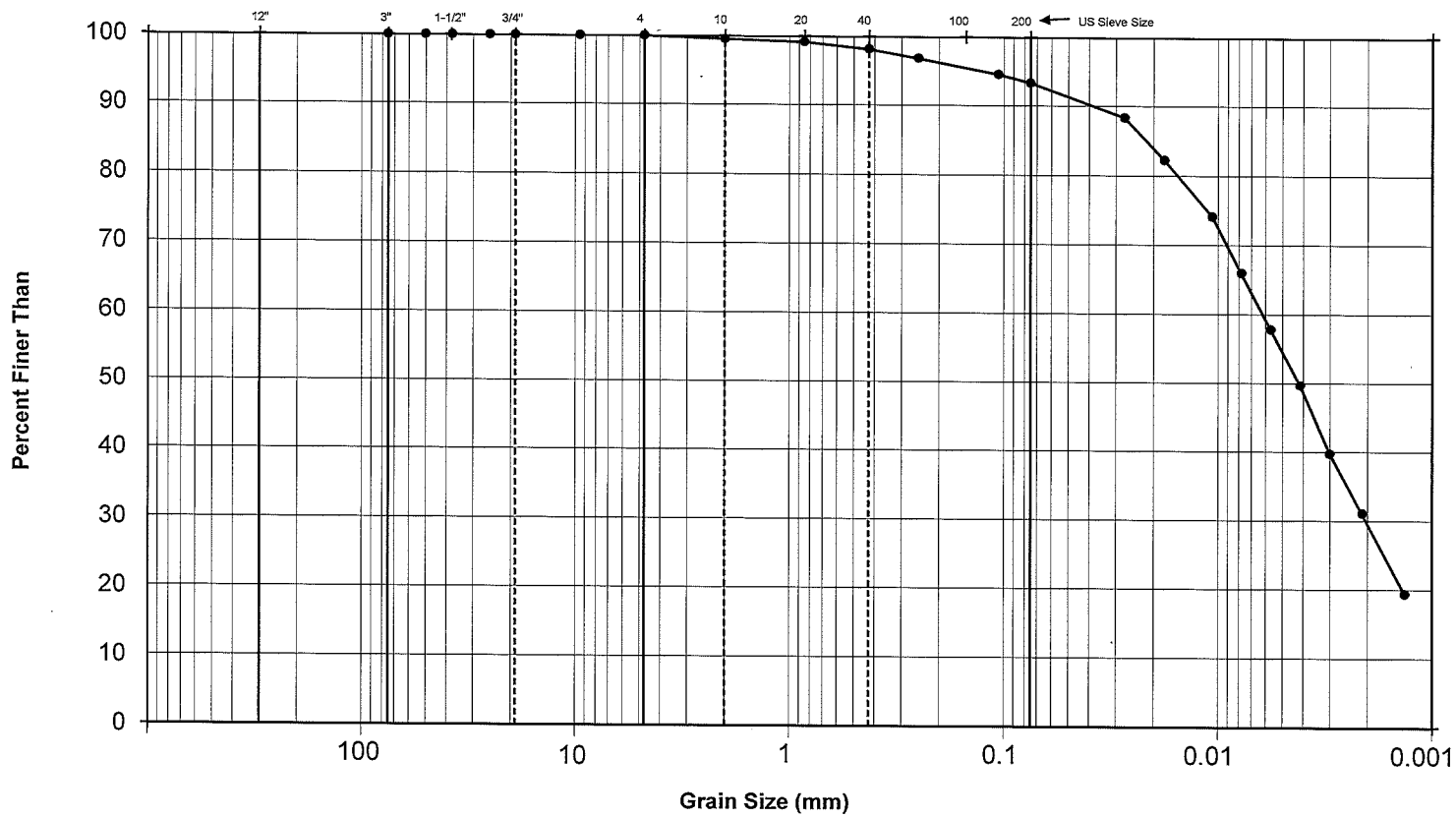
Notes/Comments: Sample Exceeded 45 kN . Moved to concrete compression machine - peak = 56 kN

Reviewed:

Golder Associates

Particle Size Analysis of Soil
(ASTM D422)

Project No.:	13-1359-0011	Lab No.:	A927-06
Project Title:	Fortune Minerals Lab Testing/Terracon Geotechnique		
Borehole:	GP-09	Sample No.:	130428
Depth:	0.15-0.30 m		
Date Tested:	23-Oct-13	By:	DS



Diameter of Sieve (mm)	Percent Passing (%)
75.0	100.0
50.0	100.0
37.5	100.0
25.0	100.0
19.0	100.0
9.5	100.0
4.75	100.0
2.0	99.6
0.850	99.2
0.425	98.2
0.250	96.9
0.106	94.6
0.075	93.4
0.027	88.4
0.018	82.3
0.011	74.1
0.008	66.0
0.006	57.8
0.004	49.7
0.003	39.8
0.002	31.1
0.001	19.4

Boulder Size	Cobble Size	Coarse	Fine	Coarse	Medium	Fine	Silt and Clay Size
		Gravel Size		Sand Size			

Comments:

Reviewed: MB

GOLDER ASSOCIATES LTD.

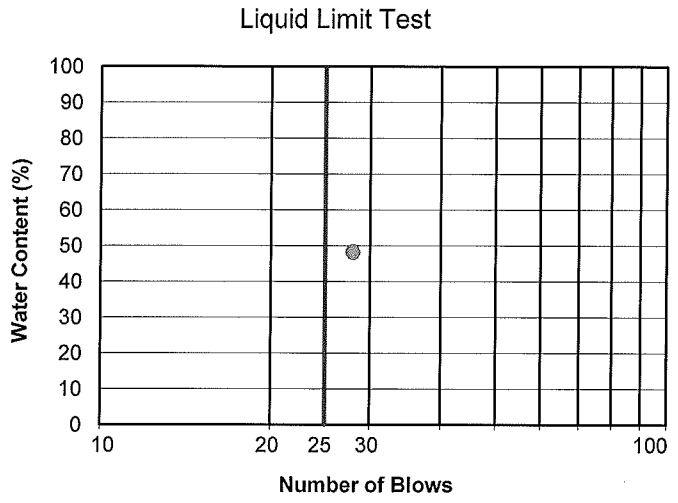
Golder Associates

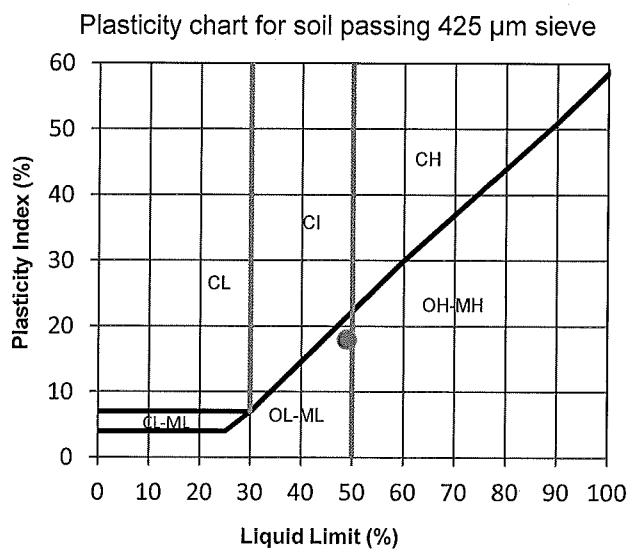
Atterberg Limits (ASTM D 4318)

Project No.: 13-1359-0011	Phase: -
Short Title: Fortune Minerals Lab Testing/Terracon Geotechnique-Arctos Anthracite	Sched: A927-08
Tested By: CG	Date: 23-Oct-13

Borehole: GP-09B Sample No.: 130432 Depth: 0.00-1.50 m

Liquid Limit Determination:			Natural Water Content:		
Number of Blows	28	28	As Received Water Content (%)		41.3%
Blow Correction Factor	1.01	1.01	**Plastic Limit Determination:**		
Mass of wet sample + tare (g)	43.15	39.33	Mass of wet sample + tare (g)	17.97	19.70
Mass of dry sample + tare (g)	37.40	34.06	Mass of dry sample + tare (g)	15.94	17.53
Mass of tare (g)	25.52	23.12	Mass of tare (g)	9.51	10.61
Weight of Water (g)	5.75	5.27	Weight of Water (g)	2.03	2.17
Weight of dry soil (g)	11.88	10.94	Weight of dry soil (g)	6.43	6.92
Water Content (%)	48.4	48.2	Water Content (%)	31.57	31.36
Liquid Limit	49.0	49.0	Average Water Content (%)		31.46





Liquid Limit =	49	%
Plastic Limit =	31	%
Plasticity Index =	18	

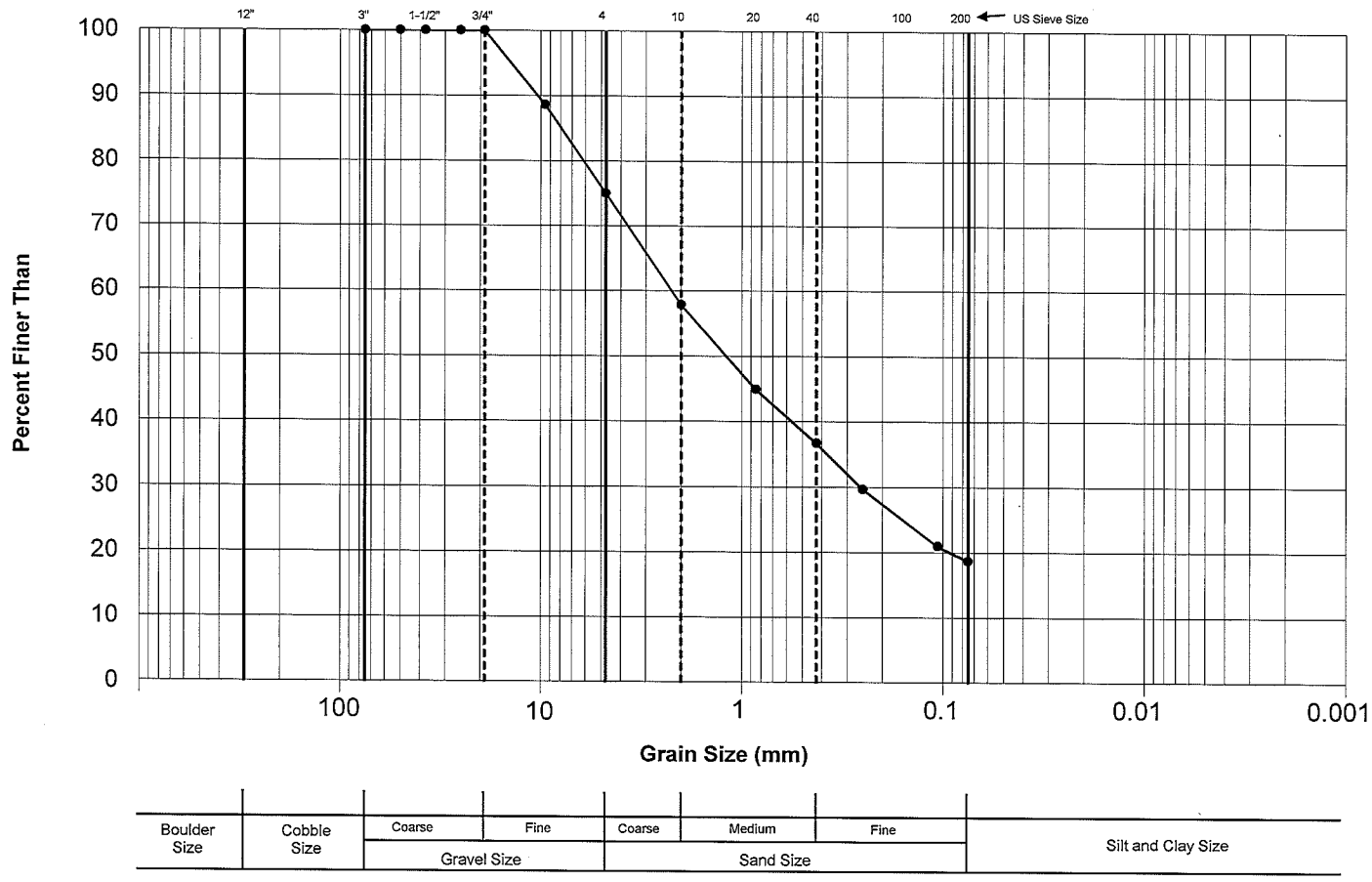
Comments:

Reviewed:

Golder Associates

PARTICLE SIZE ANALYSIS OF SOIL
(ASTM D422)

Project No.:	13-1359-0011	Lab No.:	A927-04
Project Title:	Fortune Minerals Lab Testing/Terracon Geotechnique		
Borehole:	GP-09	Sample:	130425+130426
Depth:	1.50-1.55 & 4.50-4.83 m		
Date Tested:	23-Oct-13	By:	DS



Diameter of Sieve (mm)	Percent Passing (%)
75.000	100.0
50.000	100.0
37.500	100.0
25.000	100.0
19.000	100.0
9.500	88.6
4.750	75.1
2.000	57.9
0.850	44.9
0.425	36.7
0.250	29.7
0.106	20.9
0.075	18.7

Comments:

Reviewed:

Golder Associates

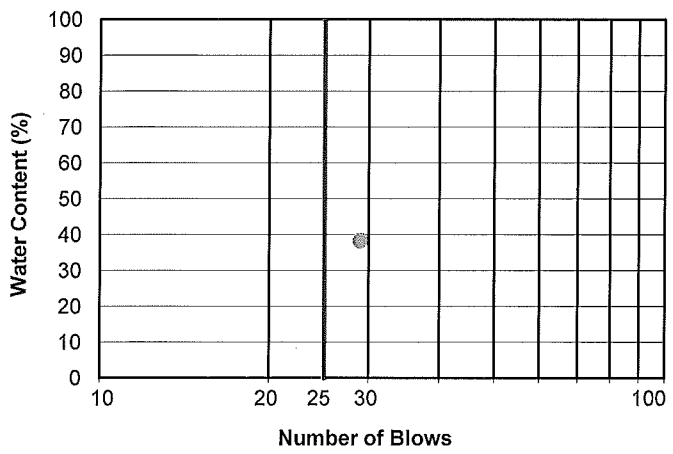
Atterberg Limits (ASTM D 4318)

Project No.:	13-1359-0011	Phase:	-
Short Title:	Fortune Minerals Lab Testing/Terracon Geotechnique-Arctos Anthracite	Sched:	A927-06
Tested By:	CG	Date:	23-Oct-13

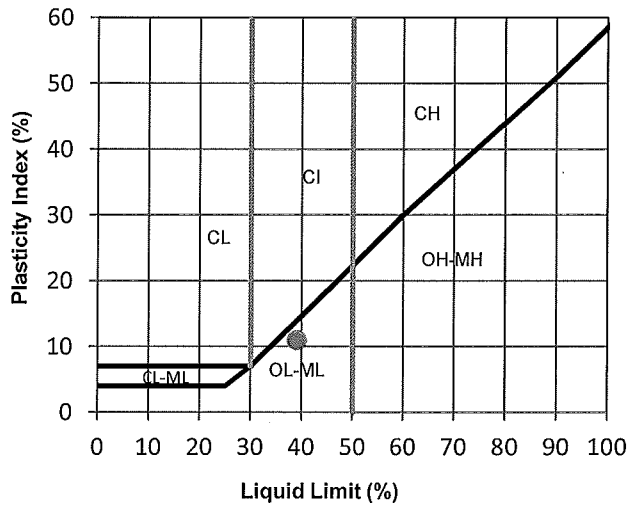
Borehole: GP-09 Sample No.: 130428 Depth: 0.15-0.30 m

Liquid Limit Determination:			Natural Water Content:		
Number of Blows	29	29	As Received Water Content (%)		32.1%
Blow Correction Factor	1.02	1.02	**Plastic Limit Determination:**		
Mass of wet sample + tare (g)	32.62	36.06	Mass of wet sample + tare (g)	18.79	20.56
Mass of dry sample + tare (g)	29.14	32.60	Mass of dry sample + tare (g)	16.92	18.40
Mass of tare (g)	20.12	23.61	Mass of tare (g)	10.25	10.72
Weight of Water (g)	3.48	3.46	Weight of Water (g)	1.87	2.16
Weight of dry soil (g)	9.02	8.99	Weight of dry soil (g)	6.67	7.68
Water Content (%)	38.6	38.5	Water Content (%)	28.04	28.13
Liquid Limit	39.0	39.0	Average Water Content (%)		28.08

Liquid Limit Test



Plasticity chart for soil passing 425 µm sieve



Liquid Limit =	39	%
Plastic Limit =	28	%
Plasticity Index =	11	

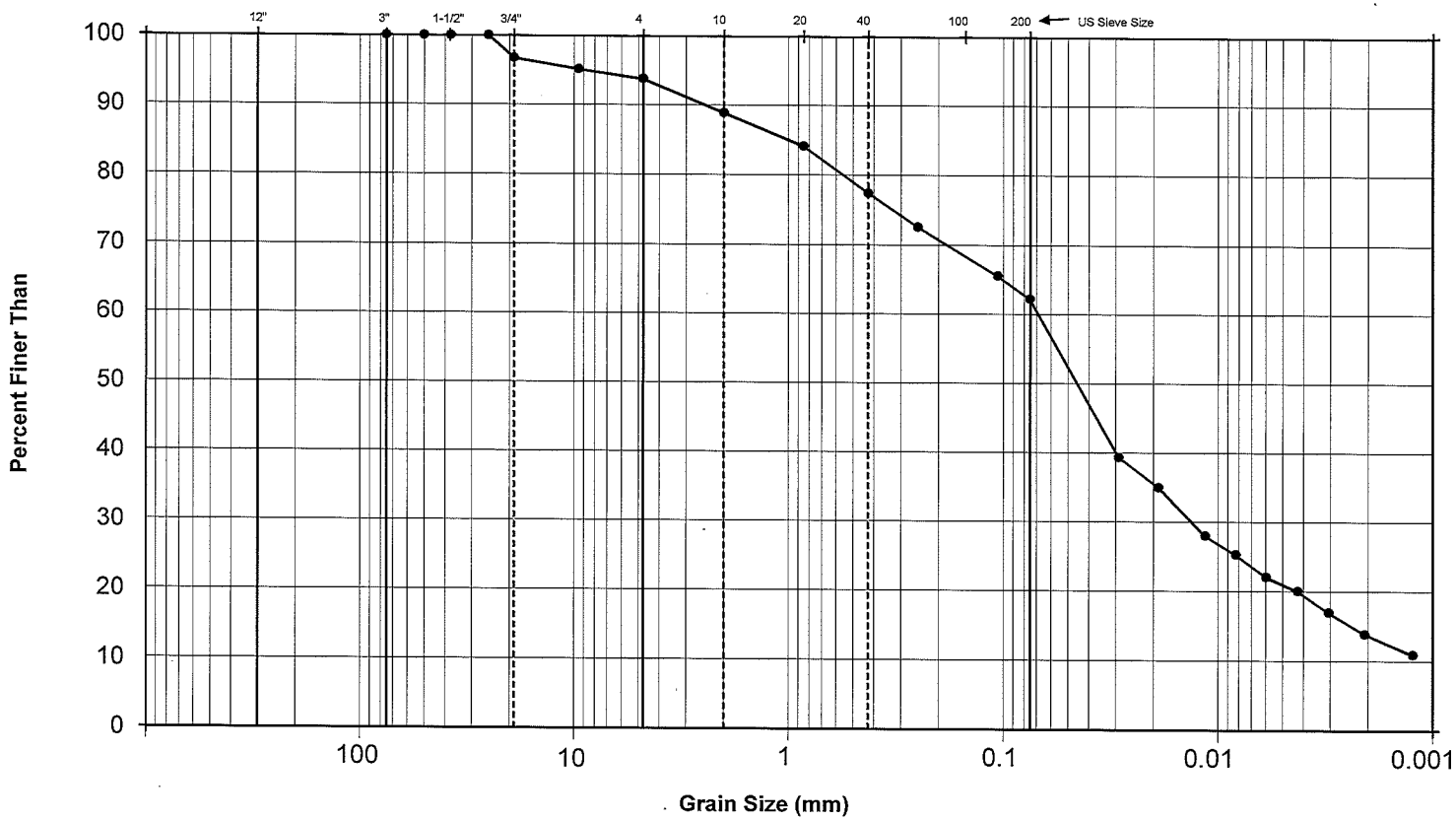
Comments:

Reviewed:

Golder Associates

Particle Size Analysis of Soil
(ASTM D422)

Project No.:	13-1359-0011	Lab No.:	A927-05
Project Title:	Fortune Minerals Lab Testing/Terracon Geotechnique		
Borehole:	GP-09	Sample No.:	130427
Depth:	6.00-6.26 m		
Date Tested:	23-Oct-13	By:	DS



Diameter of Sieve (mm)	Percent Passing (%)
75.0	100.0
50.0	100.0
37.5	100.0
25.0	100.0
19.0	96.7
9.5	95.2
4.75	93.8
2.0	88.9
0.850	84.1
0.425	77.4
0.250	72.6
0.106	65.6
0.075	62.2
0.029	39.3
0.019	35.0
0.011	28.0
0.008	25.3
0.006	22.1
0.004	20.1
0.003	17.0
0.002	13.9
0.001	10.9

Boulder Size	Cobble Size	Coarse	Fine	Coarse	Medium	Fine	Silt and Clay Size
		Gravel Size		Sand Size			

Comments:

Reviewed: MB

GOLDER ASSOCIATES LTD.

Golder Associates

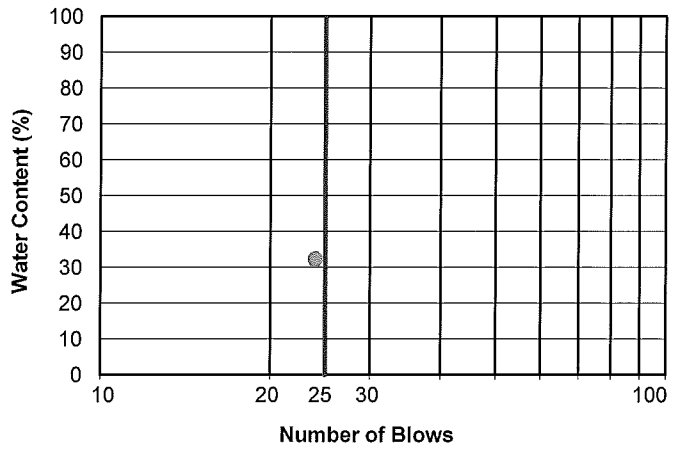
Atterberg Limits (ASTM D 4318)

Project No.:	13-1359-0011	Phase:	-
Short Title:	Fortune Minerals Lab Testing/Terracon Geotechnique-Arctos Anthracite	Sched:	A927-05
Tested By:	CG	Date:	23-Oct-13

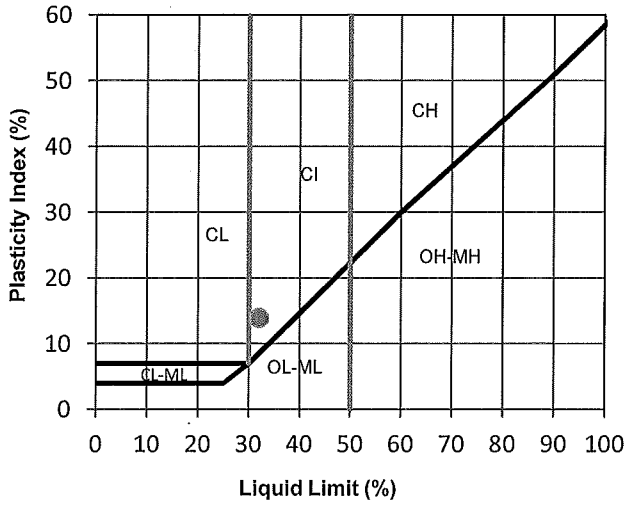
Borehole: GP-09 Sample No.: 130427 Depth: 6.00-6.26 m

Liquid Limit Determination:			Natural Water Content:		
Number of Blows	24	24	As Received Water Content (%)		13.7%
Blow Correction Factor	1.00	1.00	**Plastic Limit Determination:**		
Mass of wet sample + tare (g)	40.49	41.51	Mass of wet sample + tare (g)	19.86	19.31
Mass of dry sample + tare (g)	36.99	37.93	Mass of dry sample + tare (g)	18.45	17.90
Mass of tare (g)	26.21	26.85	Mass of tare (g)	10.79	10.16
Weight of Water (g)	3.5	3.58	Weight of Water (g)	1.41	1.41
Weight of dry soil (g)	10.78	11.08	Weight of dry soil (g)	7.66	7.74
Water Content (%)	32.5	32.3	Water Content (%)	18.41	18.22
Liquid Limit	32.0	32.0	Average Water Content (%)		18.31

Liquid Limit Test



Plasticity chart for soil passing 425 µm sieve



Liquid Limit =	32	%
Plastic Limit =	18	%
Plasticity Index =	14	

Comments:

Reviewed:

Golder Associates

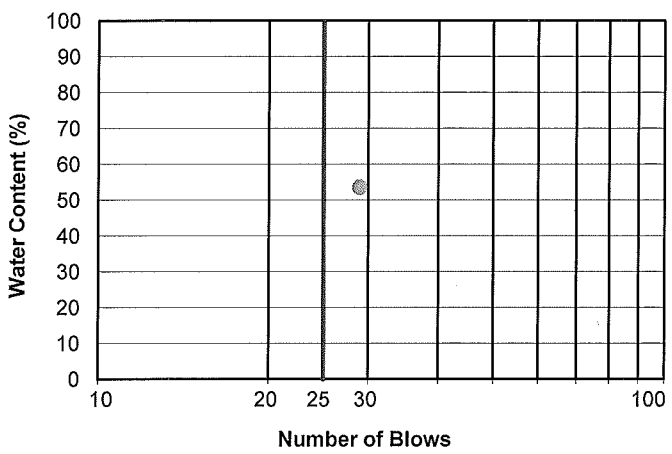
Atterberg Limits (ASTM D 4318)

Project No.:	13-1359-0011	Phase:	-
Short Title:	Fortune Minerals Lab Testing/Terracon Geotechnique-Arctos Anthracite	Sched:	A927-07
Tested By:	CG	Date:	23-Oct-13

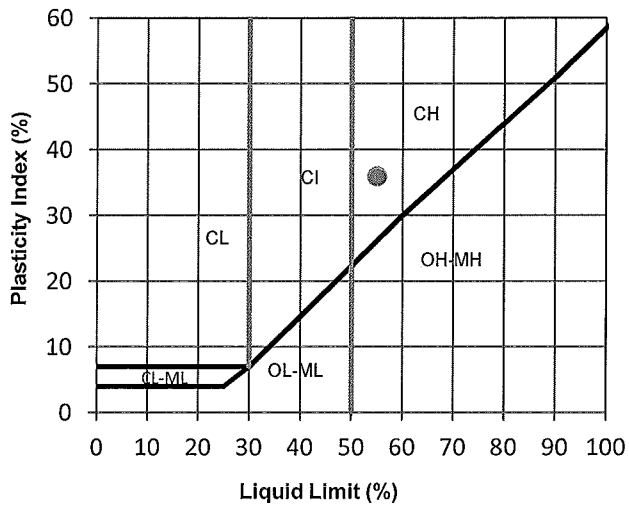
Borehole: GP-09 Sample No.: 130429 Depth: 33.78-33.95 m

Liquid Limit Determination:			Natural Water Content:		
Number of Blows	29	29	As Received Water Content (%)		6.1%
Blow Correction Factor	1.02	1.02	**Plastic Limit Determination:**		
Mass of wet sample + tare (g)	37.33	38.09	Mass of wet sample + tare (g)	21.49	18.76
Mass of dry sample + tare (g)	31.42	32.36	Mass of dry sample + tare (g)	19.83	17.23
Mass of tare (g)	20.43	21.70	Mass of tare (g)	11.21	9.20
Weight of Water (g)	5.91	5.73	Weight of Water (g)	1.66	1.53
Weight of dry soil (g)	10.99	10.66	Weight of dry soil (g)	8.62	8.03
Water Content (%)	53.8	53.8	Water Content (%)	19.26	19.05
Liquid Limit	55.0	55.0	Average Water Content (%)		19.16

Liquid Limit Test



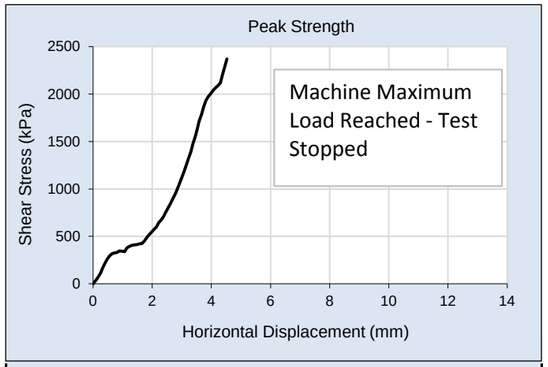
Plasticity chart for soil passing 425 µm sieve



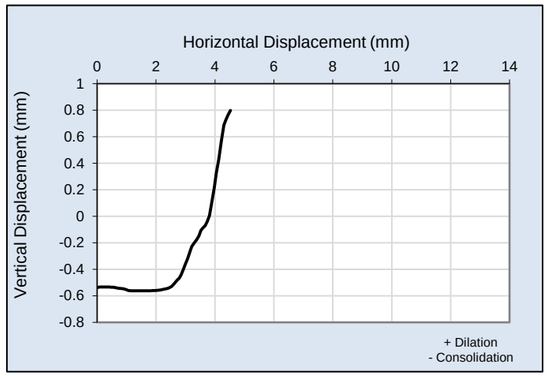
Liquid Limit =	55	%
Plastic Limit =	19	%
Plasticity Index =	36	

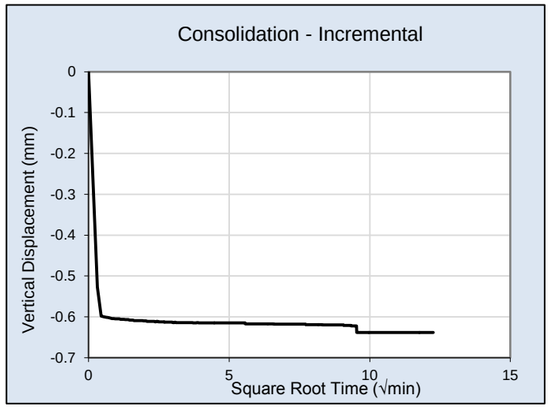
Comments:

Reviewed:



Normal Load σ', kPa	750	Shear Rate, mm/min	0.1578





Consolidation Test Results

T90	0.16	min
T50	0.04	min
Shear Rate	2.1400	mm/min
Delta H	-0.64	mm

Sample Identification

Project #	13-1359-0011	Borehole	GP-09
Client	Arctos/Anthracite	Sample	130430
Project	Fortune Minerals	Depth	51.63-51.91m
Location	-		

Initial - Sample Dimensions

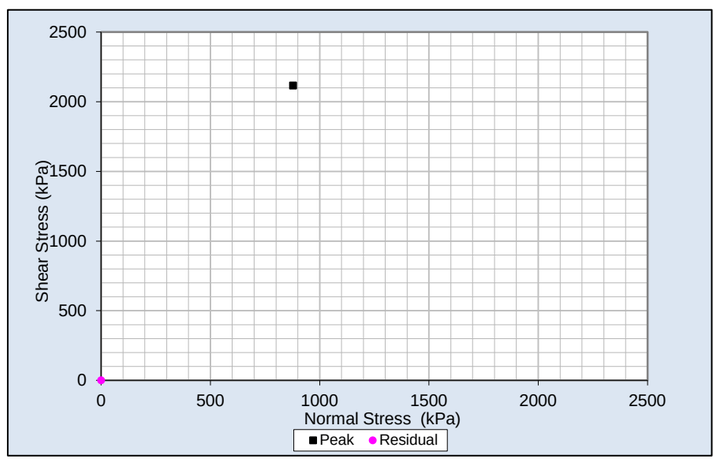
Trial Number	1
Shear box geometry	Circle
Diameter, mm	60.95
Depth, mm	24.77
Area, cm^2	29.18
Volume, cm^3	72.27

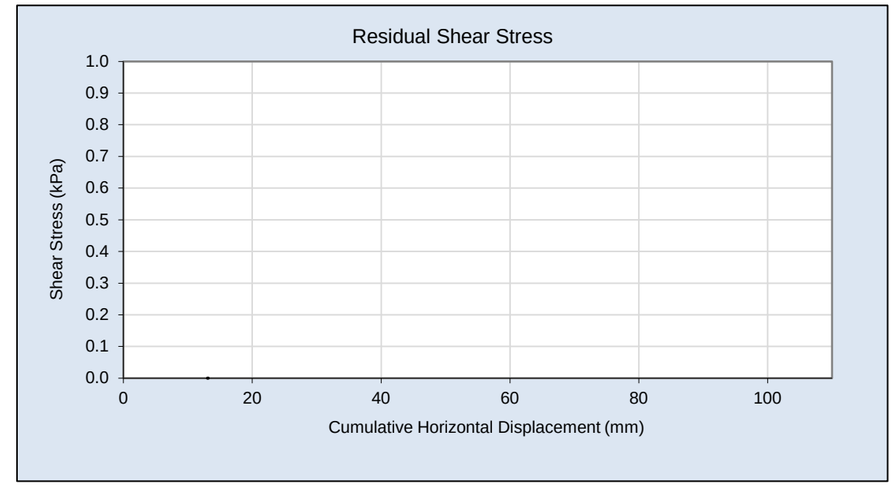
Weight Volume Relationships

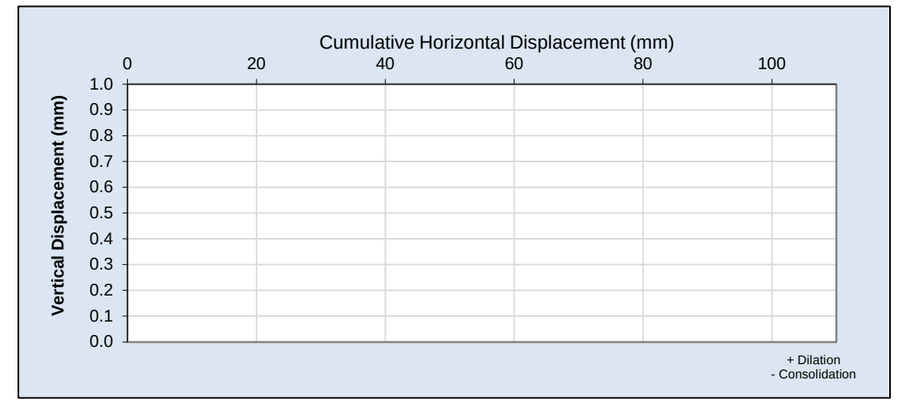
Test#		A927-17
Sample Type		Undisturbed
Initial Wet Wt, g		228.25
Initial Dry Wt, g		227.34
Initial Water Content, %		0.40
Final Water Content, %		0.55
Initial γ_{dry}, kg/m^3		3146
Final γ_{dry}, kg/m^3	(after consolidation)	3229
Specific Gravity	(assumed)	3.15
Initial Void Ratio, e		0.001

Test Results (Area Corrected)

Displacement at Failure, mm	4.307	Note: Maximum load of 6.5 kN
Peak Normal Stress, kPa	879	was already reached
Peak Shear Stress, kPa	2115	during shear.
Displacement at Residual, mm	-	
Residual Normal Stress, kPa	-	
Residual Shear Stress, kPa	-	
Shear rate for Residual Stress, mm/min	-	







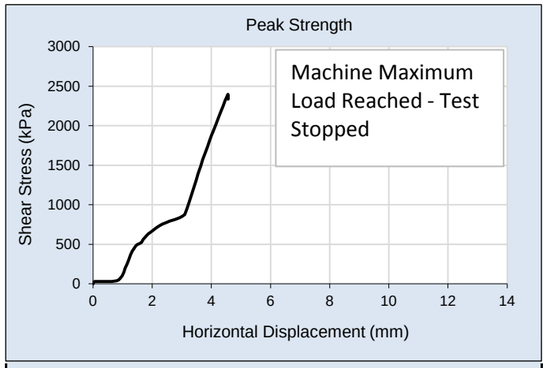
Index Test Results

Water Content (%)	-
Liquid Limit (%)	-
Plastic Limit (%)	-
Plasticity Index	-

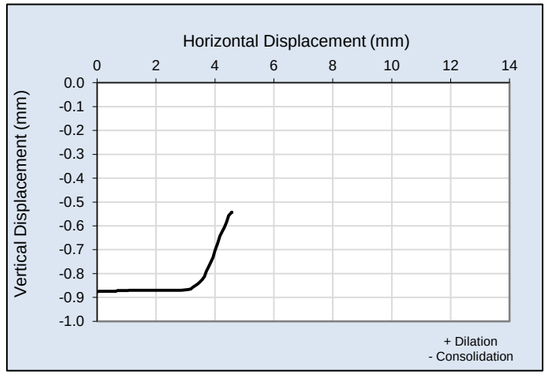
Equipment - DS-KWSOIL s/n: 906

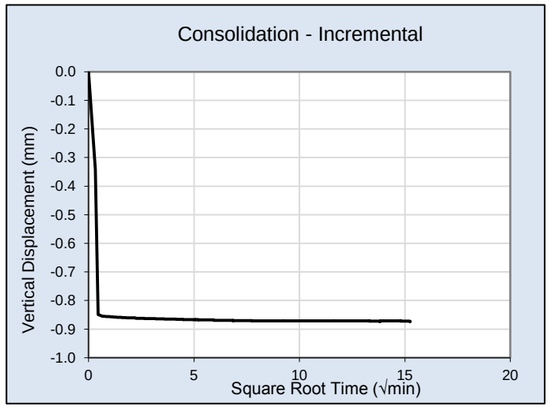
Axial LPT Serial #	4143-ch3
Normal Load Cell Serial #	4143-ch4
Shear Load Cell Serial #	4143-ch1
Vertical LPT Serial #	4143-ch2

Client: Arctos Anthracite Joint Venture	Fortune Minerals Lab Testing/Terracon Geotechnique Arctos Anthracite Project
Golder Associates	DIRECT SHEAR TEST Borehole GP-09 Sample 130430
PROJECT: 13-1359-0011	Check: MB Review: DJH



Normal Load σ', kPa	1500	Shear Rate, mm/min	0.1298





Consolidation Test Results

T90	0.16	min
T50	0.04	min
Shear Rate	2.1400	mm/min
Delta H	-0.87	mm

Sample Identification

Project #	13-1359-0011	Borehole	GP-09
Client	Arctos/Anthracite	Sample	130431
Project	Forrtune Minerals	Depth	73.25-73.58m
Location	-		

Initial - Sample Dimensions

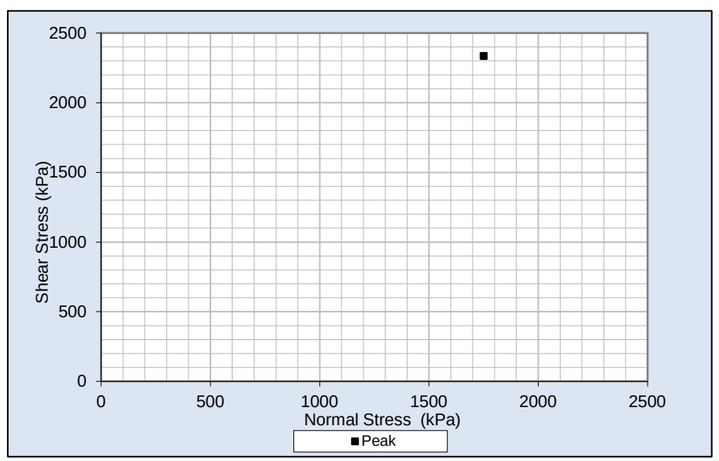
Trial Number	1
Shear box geometry	Circle
Diameter, mm	61.20
Depth, mm	25.34
Area, cm^2	29.42
Volume, cm^3	74.54

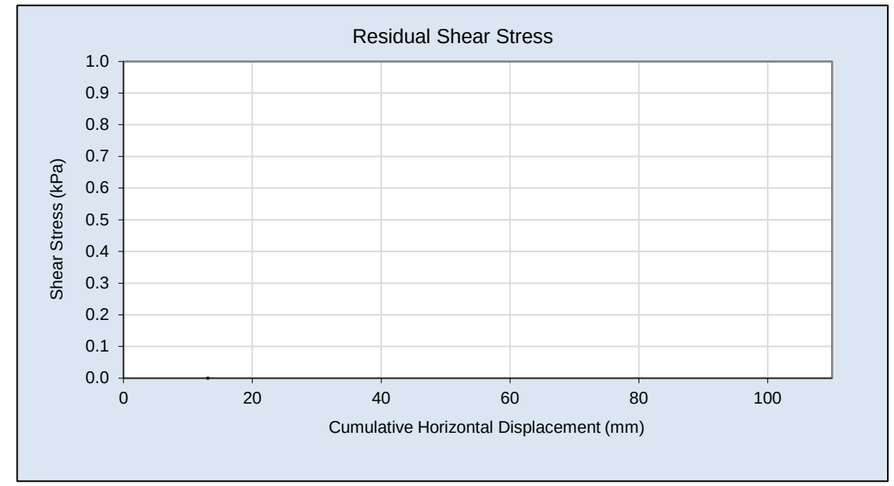
Weight Volume Relationships

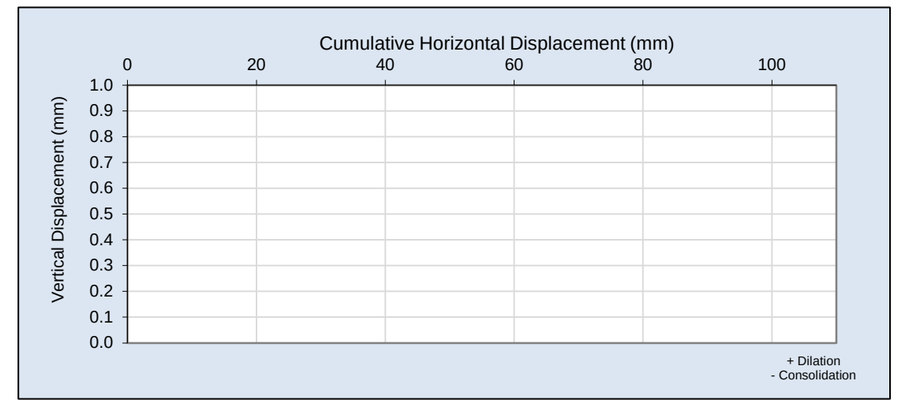
Test#		A927-18
Sample Type		Undisturbed
Initial Wet Wt, g		198.54
Initial Dry Wt, g		197.81
Initial Water content		0.37
Final Water content		0.67
Initial γ_{dry}, kg/m^3		2654
Final γ_{dry}, kg/m^3	(after consolidation)	2748
Specific Gravity	(assumed)	2.7
Initial Void Ratio, e		0.017

Test Results (Area Corrected)

Displacement at Failure, mm	4.571	Note: Maximum load of 6.5KN
Peak Normal Stress, kPa	1752	was already reached during
Peak Shear Stress, kPa	2335	shearing.
Displacement at Residual, mm	-	
Residual Normal Stress, kPa	-	
Residual Shear Stress, kPa	-	
Shear rate for Residual Stress, mm/min	-	







Index Test Results

Water Content (%)	-
Liquid Limit (%)	-
Plastic Limit (%)	-
Plasticity Index	-

Equipment - DS-KWSOIL s/n: 913

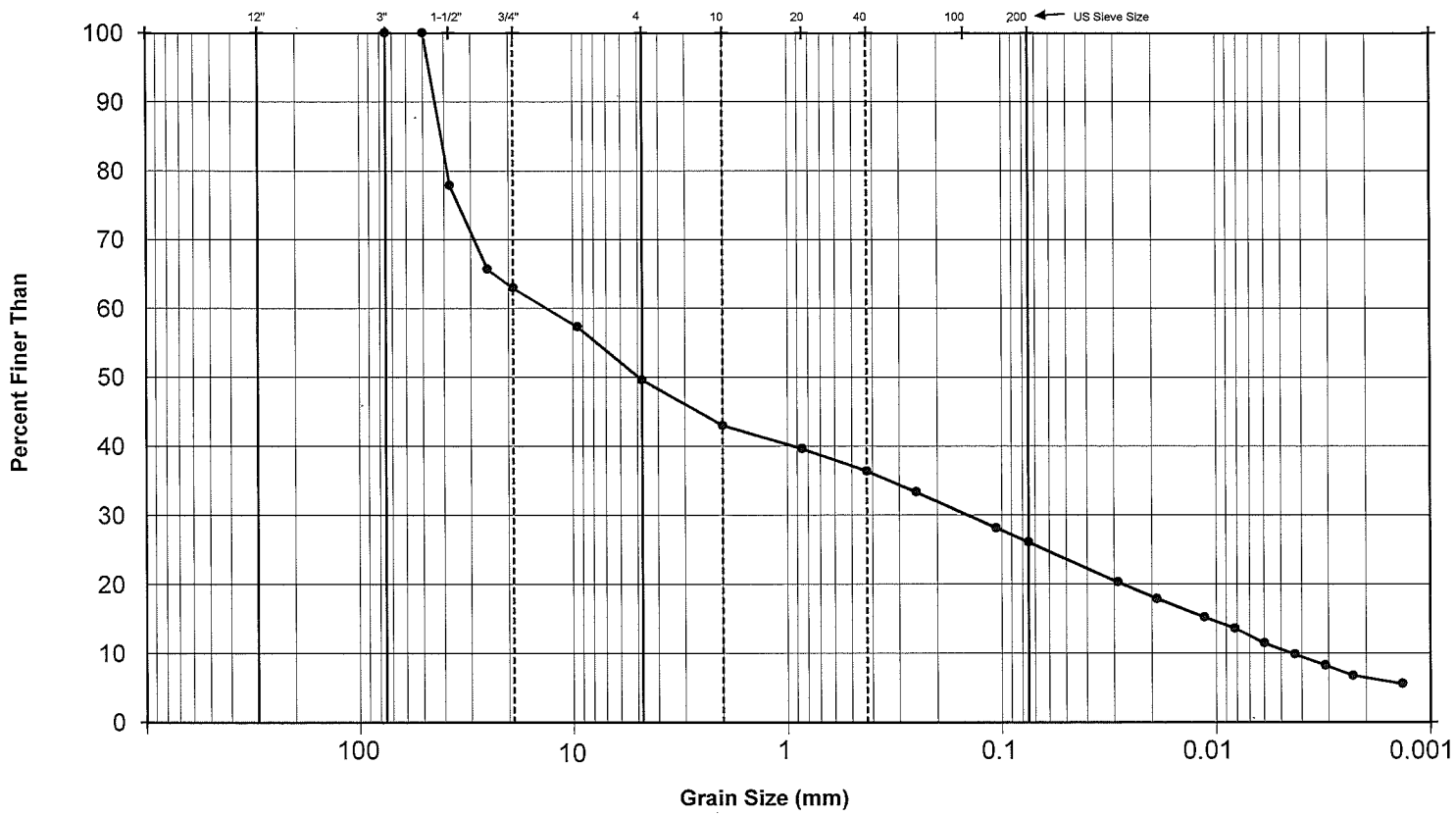
Axial LPT Serial #	4146-ch3
Normal Load Cell Serial #	4146-ch4
Shear Load Cell Serial #	4146-ch1
Vertical LPT Serial #	4146-ch2

Client: Arctos Anthracite Joint Venture	Fortune Minerals Lab Testing/Terracon Geotechnique Arctos Anthracite Project
Golder Associates	DIRECT SHEAR TEST Borehole GP-09 Sample 130431
PROJECT: 13-1359-0011	Check: MB Review: DJH

Golder Associates

Particle Size Analysis of Soil
(ASTM D422)

Project No.:	13-1359-0011.1000	Lab No.:	A824-03
Project Title:	Terracon Geotechnique Lab Testing		
Borehole:	GP 10	Sample No.:	1
Depth:	1.50-3.00m		
Date Tested:	15-Jul-13	By:	DS



Diameter of Sieve (mm)	Percent Passing (%)
75.0	100.0
50.0	100.0
37.5	77.9
25.0	65.7
19.0	63.0
9.5	57.3
4.75	49.6
2.0	43.0
0.850	39.6
0.425	36.4
0.250	33.4
0.106	28.2
0.075	26.1
0.029	20.3
0.019	17.9
0.011	15.2
0.008	13.6
0.006	11.5
0.004	9.9
0.003	8.3
0.002	6.8
0.001	5.6

Boulder Size	Cobble Size	Coarse	Fine	Coarse	Medium	Fine	Silt and Clay Size
		Gravel Size		Sand Size			

Comments:

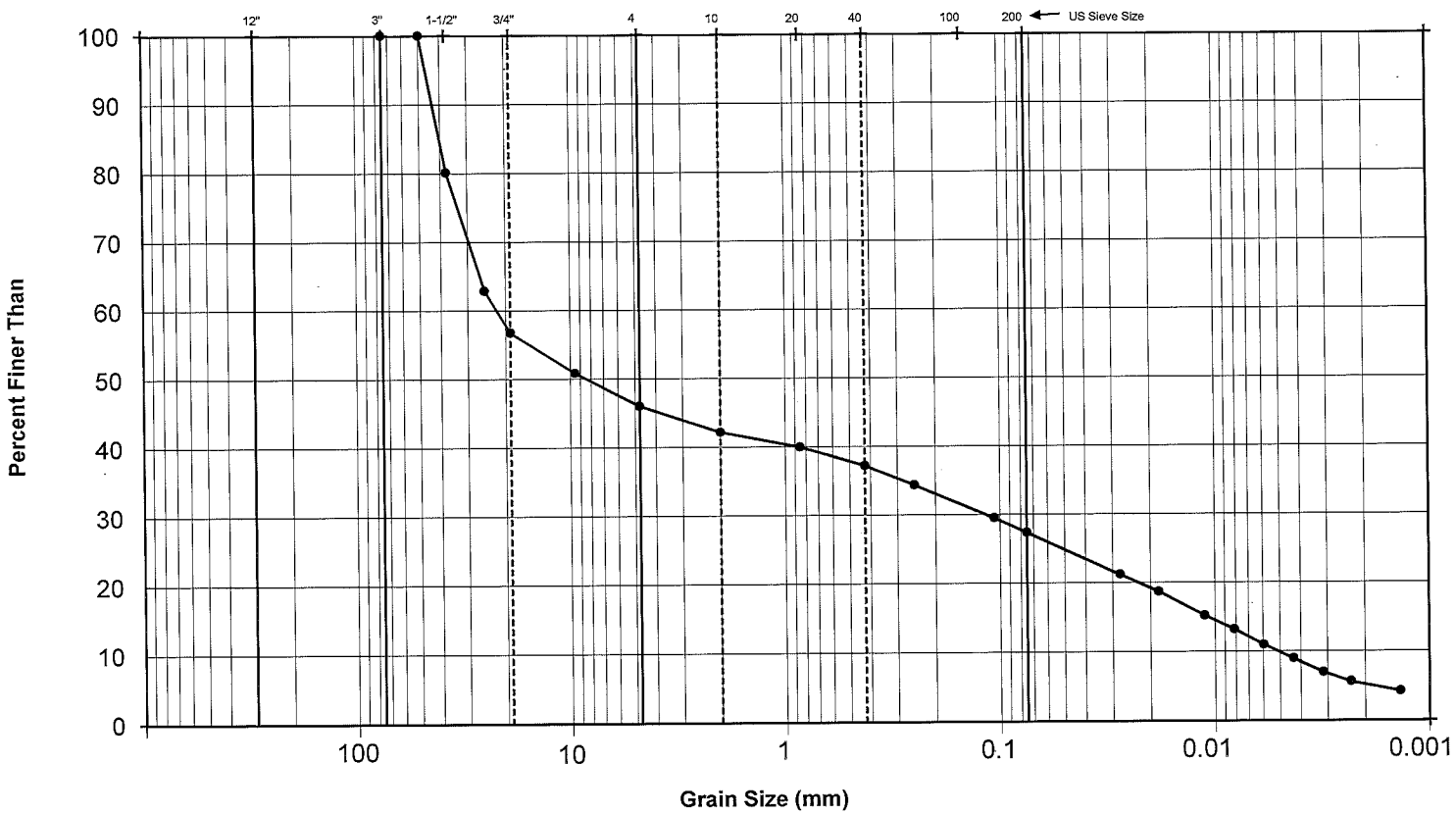
Reviewed: MB

GOLDER ASSOCIATES LTD.

Golder Associates

Particle Size Analysis of Soil
(ASTM D422)

Project No.:	13-1359-0011.1000	Lab No.:	A824-04
Project Title:	Terracon Geotechnique Lab Testing		
Borehole:	GP 10	Sample No.:	2
Depth:	3.00-4.50m		
Date Tested:	15-Jul-13	By:	DS



Boulder Size	Cobble Size	Gravel Size: Coarse	Gravel Size: Fine	Sand Size: Coarse	Sand Size: Medium	Sand Size: Fine	Silt and Clay Size

Diameter of Sieve (mm)	Percent Passing (%)
75.0	100.0
50.0	100.0
37.5	80.1
25.0	62.9
19.0	56.8
9.5	50.9
4.75	46.0
2.0	42.2
0.850	40.0
0.425	37.2
0.250	34.4
0.106	29.5
0.075	27.4
0.028	21.2
0.018	18.7
0.011	15.2
0.008	13.2
0.006	11.0
0.004	9.0
0.003	7.0
0.002	5.6
0.001	4.2

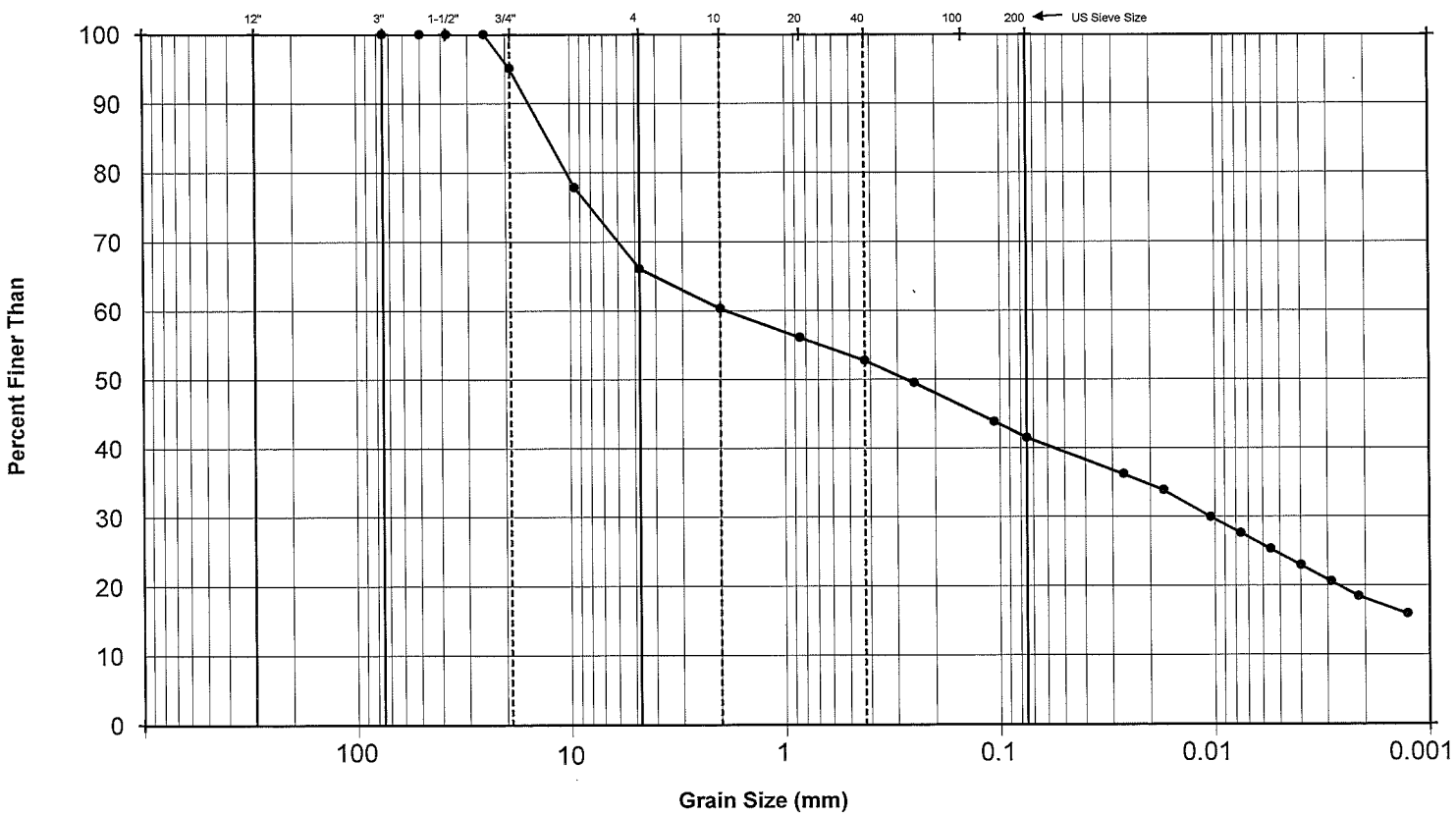
Comments:

Reviewed: MB

Golder Associates

Particle Size Analysis of Soil
(ASTM D422)

Project No.:	13-1359-0011.1000	Lab No.:	A824-05
Project Title:	Terracon Geotechnique Lab Testing		
Borehole:	GP 10	Sample No.:	3
Depth:	4.50-6.00m		
Date Tested:	15-Jul-13	By:	DS



Boulder Size	Cobble Size	Gravel Size: Coarse	Gravel Size: Fine	Sand Size: Coarse	Sand Size: Medium	Sand Size: Fine	Silt and Clay Size

Diameter of Sieve (mm)	Percent Passing (%)
75.0	100.0
50.0	100.0
37.5	100.0
25.0	100.0
19.0	95.1
9.5	77.9
4.75	66.1
2.0	60.3
0.850	56.1
0.425	52.8
0.250	49.5
0.106	43.9
0.075	41.5
0.027	36.2
0.017	33.9
0.010	30.0
0.008	27.6
0.005	25.3
0.004	22.9
0.003	20.6
0.002	18.5
0.001	15.9

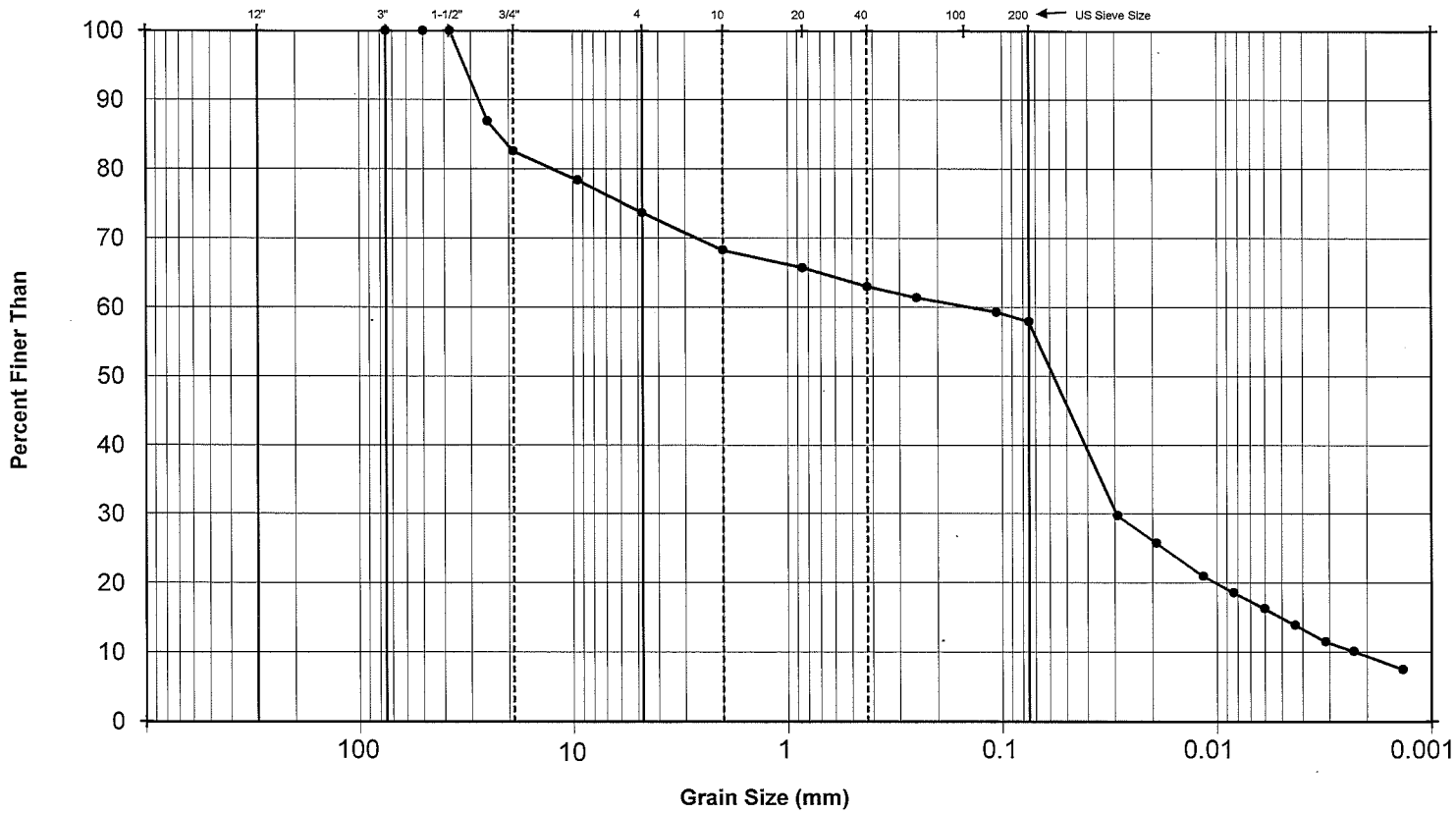
Comments:

Reviewed: mB

Golder Associates

Particle Size Analysis of Soil
(ASTM D422)

Project No.:	13-1359-0011.1000	Lab No.:	A824-06
Project Title:	Terracon Geotechnique Lab Testing		
Borehole:	GP 10	Sample No.:	4
Depth:	9.00-10.50m		
Date Tested:	15-Jul-13	By:	DS



Boulder Size	Cobble Size	Gravel Size: Coarse	Gravel Size: Fine	Sand Size: Coarse	Sand Size: Medium	Sand Size: Fine	Silt and Clay Size

Diameter of Sieve (mm)	Percent Passing (%)
75.0	100.0
50.0	100.0
37.5	100.0
25.0	86.9
19.0	82.6
9.5	78.4
4.75	73.7
2.0	68.3
0.850	65.7
0.425	63.0
0.250	61.4
0.106	59.3
0.075	57.9
0.029	29.7
0.019	25.7
0.012	21.0
0.008	18.6
0.006	16.3
0.004	13.9
0.003	11.5
0.002	10.1
0.001	7.5

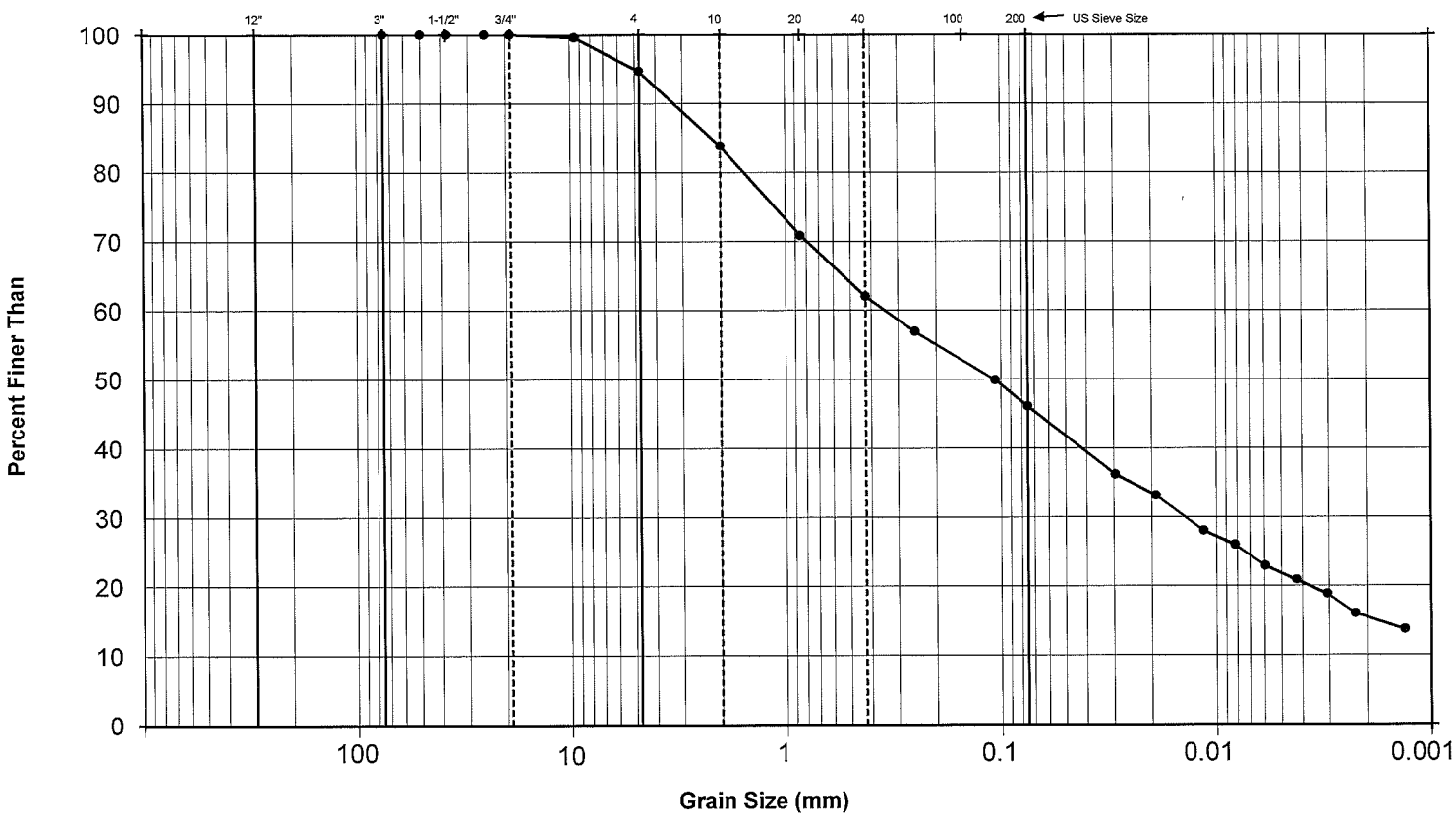
Comments:
Weathered bedrock. When washed sample was observed to contain clumps.

Reviewed: MB

Golder Associates

Particle Size Analysis of Soil
(ASTM D422)

Project No.:	13-1359-0011.1000	Lab No.:	A824-07
Project Title:	Terracon Geotechnique Lab Testing		
Borehole:	GP 10	Sample No.:	7
Depth:	22.50-24.00m		
Date Tested:	15-Jul-13	By:	DS



Boulder Size	Cobble Size	Gravel Size: Coarse	Gravel Size: Fine	Sand Size: Coarse	Sand Size: Medium	Sand Size: Fine	Silt and Clay Size

Diameter of Sieve (mm)	Percent Passing (%)
75.0	100.0
50.0	100.0
37.5	100.0
25.0	100.0
19.0	100.0
9.5	99.6
4.75	94.7
2.0	83.8
0.850	70.9
0.425	62.0
0.250	56.9
0.106	49.9
0.075	46.1
0.029	36.2
0.019	33.2
0.011	28.0
0.008	26.0
0.006	22.9
0.004	20.9
0.003	18.8
0.002	16.0
0.001	13.7

Comments:

Reviewed: MB

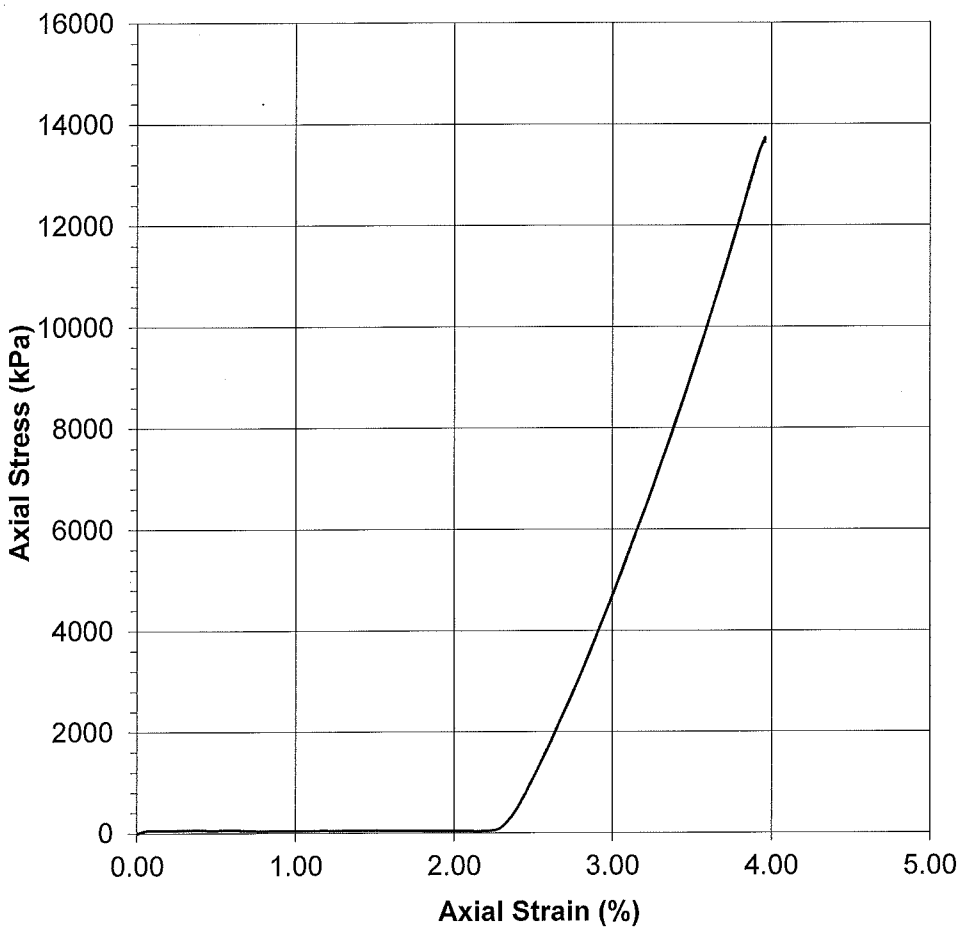
Golder Associates

UNCONFINED COMPRESSIVE STRENGTH

Project No.:	13-1359-0011
Lab No.:	A824-09
BH No.:	GP 10
Sample No.:	5
Depth:	63 m to 63.3 m

Height:	12.22 cm	Initial e	0.032	**Peak Stress =**	**24048.0 kPa**
Diameter:	6.34 cm			**at**	**3.96 Strain**
Wet Mass:	1042.14 g	L/D Ratio:	1.93		
% Water:	1.2				
Wet Density:	2704 kg/m^3				
Dry Density:	2672 kg/m^3				

Unconfined Compressive Strength



Notes/Comments: Exceeded 45 kN, switched to concrete compression machine - Peak load = 79 kN

Reviewed: OM

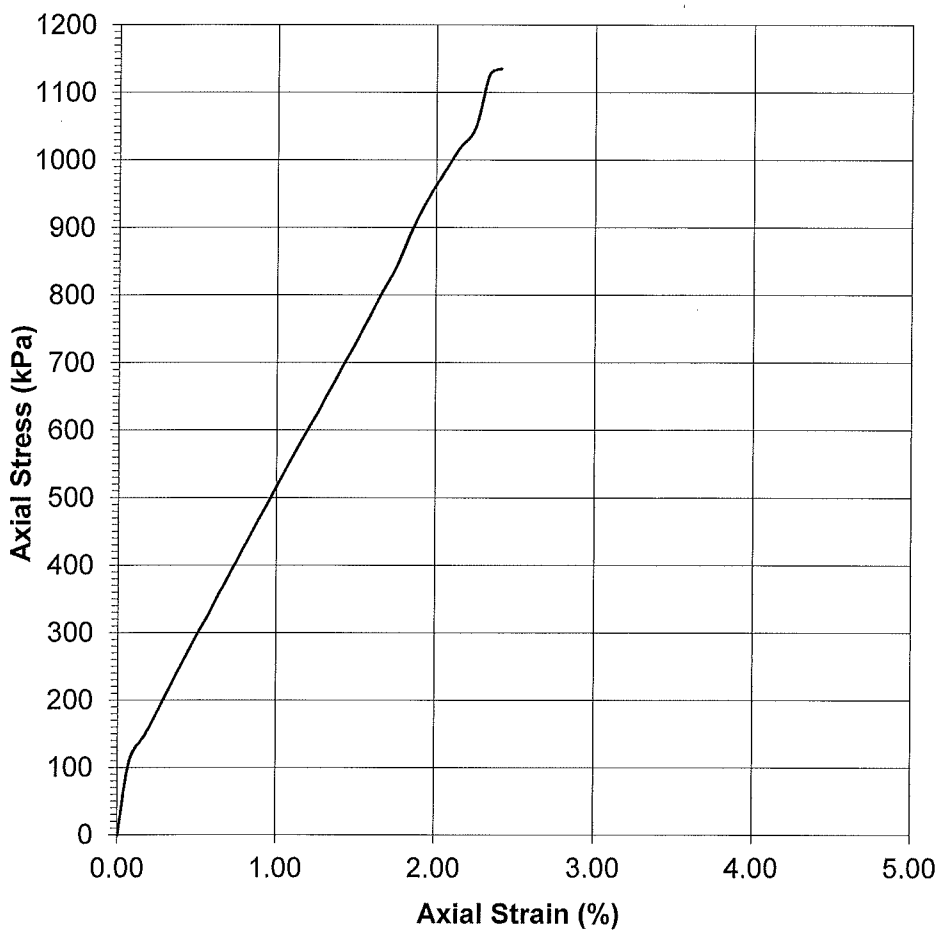
Golder Associates

UNCONFINED COMPRESSIVE STRENGTH

Project No.:	13-1359-0011
Lab No.:	A824-10
BH No.:	GP 10
Sample No.:	6
Depth:	67.20 m to 67.45 m

Height:	12.45 cm	Initial e	0.047	**Peak Stress =**	**1135.6 kPa**
Diameter:	6.33 cm			**at**	**2.40 Strain**
Wet Mass:	1018.55 g	L/D Ratio:	1.97		
% Water:	2.9				
Wet Density:	2604 kg/m^3				
Dry Density:	2530 kg/m^3				

Unconfined Compressive Strength



Notes/Comments:

Reviewed: OM

Slake Durability Index - ASTM D4644

Golder Associates

Project No. 13-1359-0011.1000
Short Title: Fortune Minerals Lab Testing
Sample: GP10; Sa 6; 67.2-67.45m
Technician: FC
Date: 16-Jul-13

Mass of wet sample+ Tare (g)	2286.64
Mass of dry sample+ Tare (g)	2270.73
Mass of tare (g)	1722.39
Mass of water (g)	15.91
Mass of dry sample (g)	548.34
Moisture Content (%)	2.90

First Cycle	
Mass of dry sample + Tare (g)	2262.2
Mass of Tare (g)	1722.39
Mass of dry Sample (g)	539.81
Temperature before running (°C)	27.6
Temperature after running (°C)	26.7
Mass lost (g)	8.53
Percentage of mass lost (%)	1.58

Second Cycle	
Mass of dry sample + Tare (g)	2253.57
Mass of Tare (g)	1722.39
Mass of dry Sample (g)	531.18
Temperature before running (°C)	22.9
Temperature after running (°C)	23.1
Mass lost (g)	8.63
Percentage of mass lost (%)	1.62

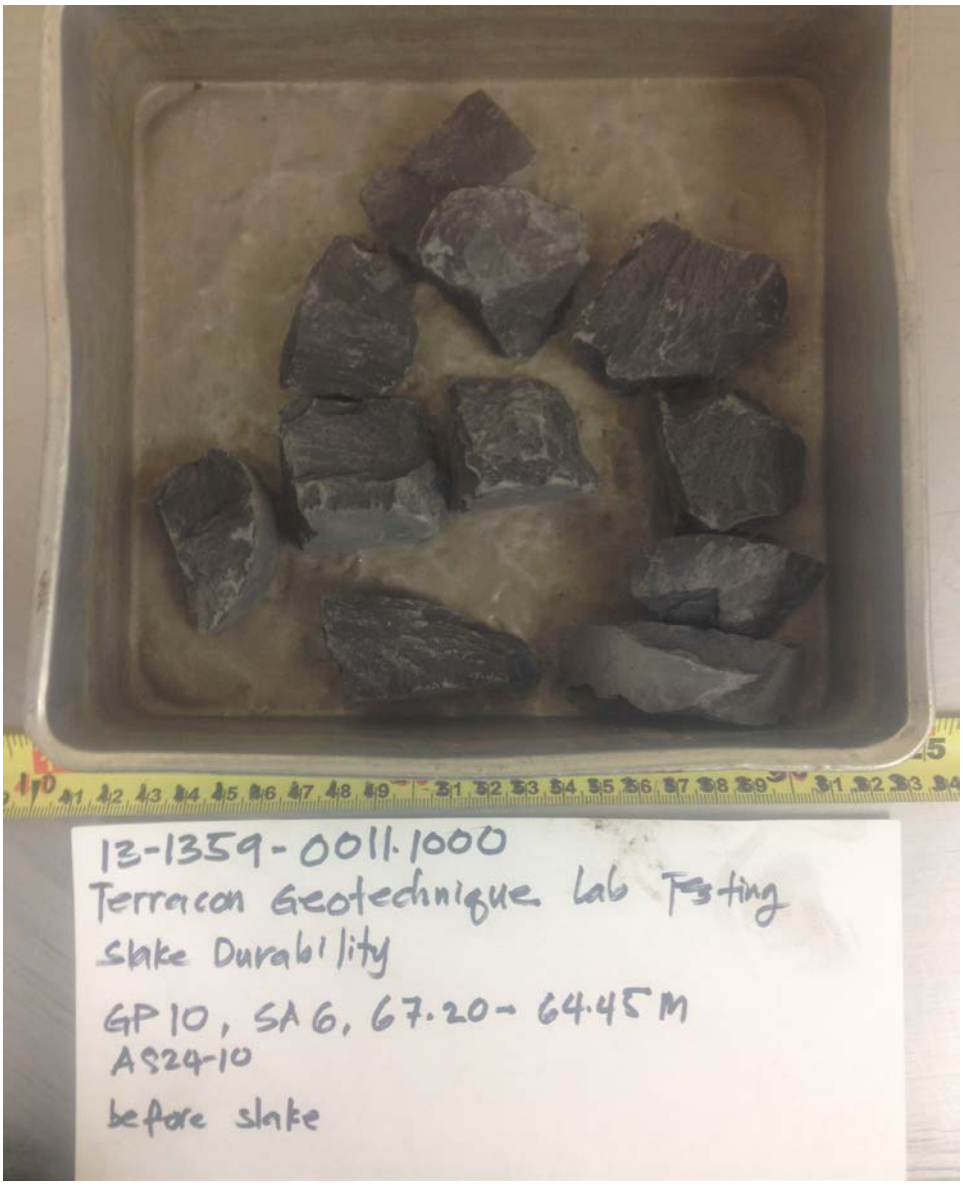
Slake durability index (%)	**96.9**

Description after Testing
Type II - Retained specimen consist of large and small fragments

Checked: _____

Slake Durability Index - ASTM D4644

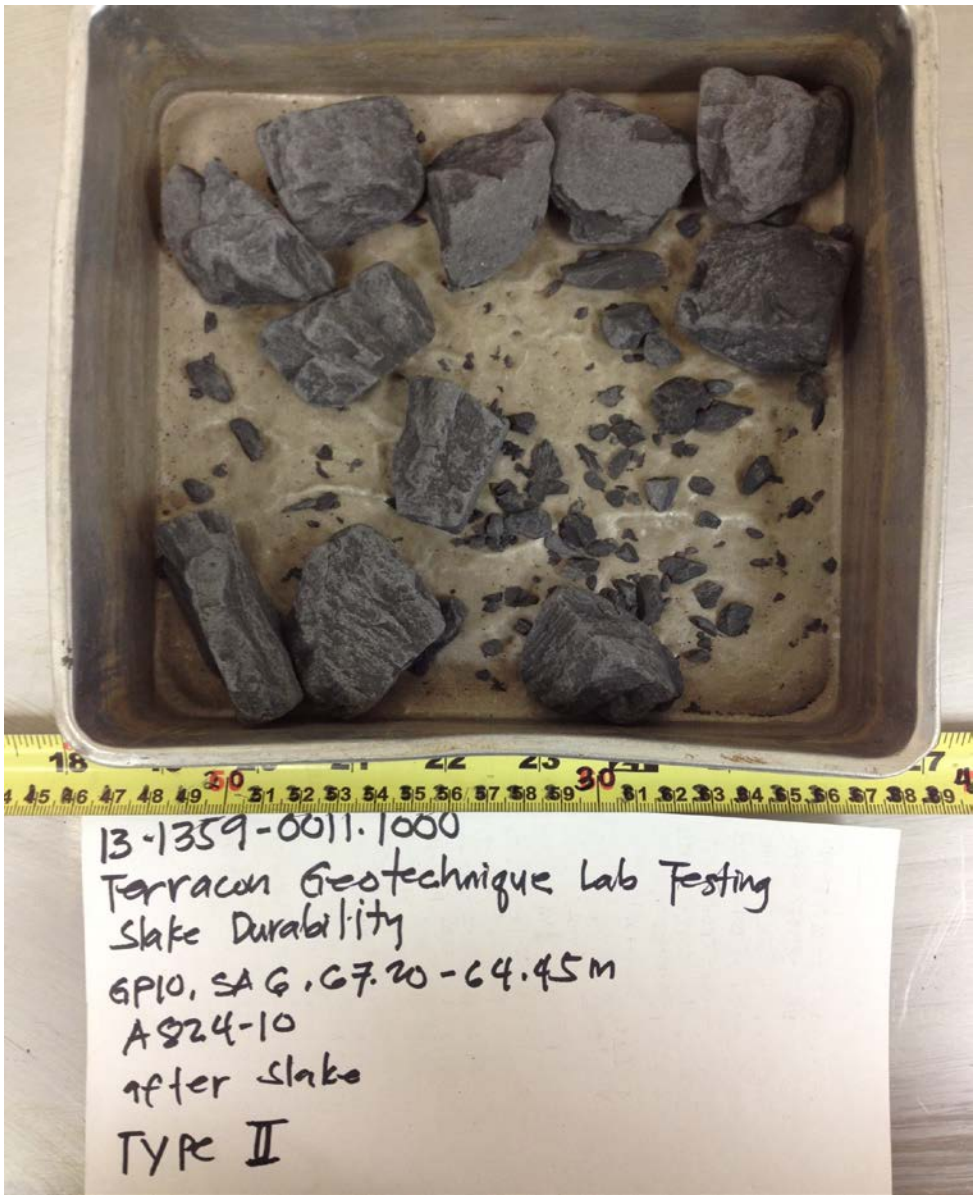
Project No.	13-1359-0011.1000
Short Title:	Fortune Minerals Lab Testing
Sample:	GP10; Sa 6; 67.2-67.45m
Technician:	FC
Date:	16-Jul-13



Before testing

Slake Durability Index - ASTM D4644

Project No.	13-1359-0011.1000
Short Title:	Fortune Minerals Lab Testing
Sample:	GP10; Sa 6; 67.2-67.45m
Technician:	FC
Date:	16-Jul-13

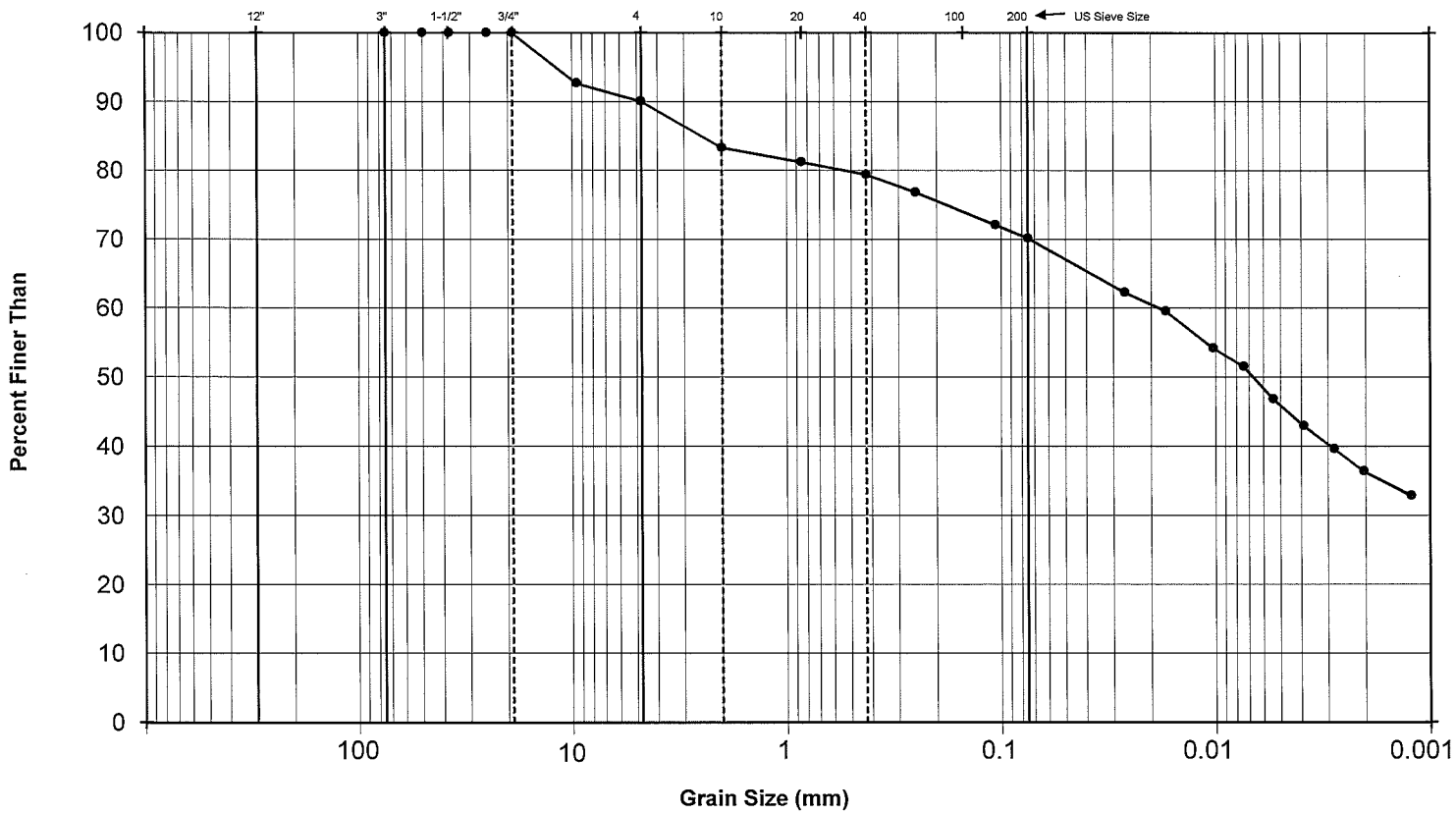


After Testing

Golder Associates

Particle Size Analysis of Soil
(ASTM D422)

Project No.:	13-1359-0011.1000	Lab No.:	A827-01
Project Title:	Terracon Geotechnique		
Borehole:	GP-11	Sample No.:	SA1
Depth:	1.40 - 1.50m		
Date Tested:	17-Jul-13	By:	DS



Boulder Size	Cobble Size	Gravel Size: Coarse	Gravel Size: Fine	Sand Size: Coarse	Sand Size: Medium	Sand Size: Fine	Silt and Clay Size

Diameter of Sieve (mm)	Percent Passing (%)
75.0	100.0
50.0	100.0
37.5	100.0
25.0	100.0
19.0	100.0
9.5	92.7
4.75	90.1
2.0	83.4
0.850	81.3
0.425	79.4
0.250	76.9
0.106	72.1
0.075	70.2
0.027	62.3
0.017	59.6
0.010	54.2
0.007	51.5
0.005	46.8
0.004	43.0
0.003	39.6
0.002	36.4
0.001	32.9

Comments:

Reviewed: GH

Golder Associates

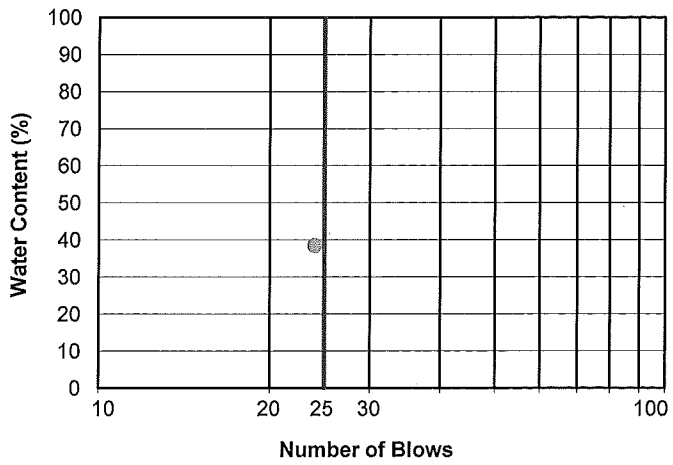
Atterberg Limits (ASTM D 4318)

Project No.: 13-1359-0011	Phase: 1000
Short Title: Terracon Geotechnique	Sched: A827-01
Tested By: DS	Date: 22-Jul-13

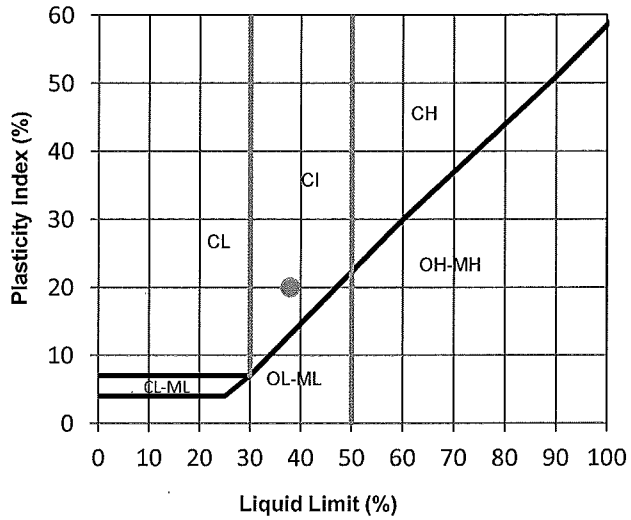
Borehole: GP-11 Sample No.: SA1 Depth: 1.40 - 1.50m

Liquid Limit Determination:			Natural Water Content:		
Number of Blows	24	24	As Received Water Content (%)		22.1%
Blow Correction Factor	1.00	1.00	**Plastic Limit Determination:**		
Mass of wet sample + tare (g)	34.40	38.61	Mass of wet sample + tare (g)	21.57	18.82
Mass of dry sample + tare (g)	30.62	34.41	Mass of dry sample + tare (g)	19.97	17.52
Mass of tare (g)	20.80	23.50	Mass of tare (g)	11.19	10.31
Weight of Water (g)	3.78	4.2	Weight of Water (g)	1.60	1.30
Weight of dry soil (g)	9.82	10.91	Weight of dry soil (g)	8.78	7.21
Water Content (%)	38.5	38.5	Water Content (%)	18.22	18.03
Liquid Limit	38.0	38.0	Average Water Content (%)		18.13

Liquid Limit Test



Plasticity chart for soil passing 425 µm sieve



Liquid Limit =	38	%
Plastic Limit =	18	%
Plasticity Index =	20	

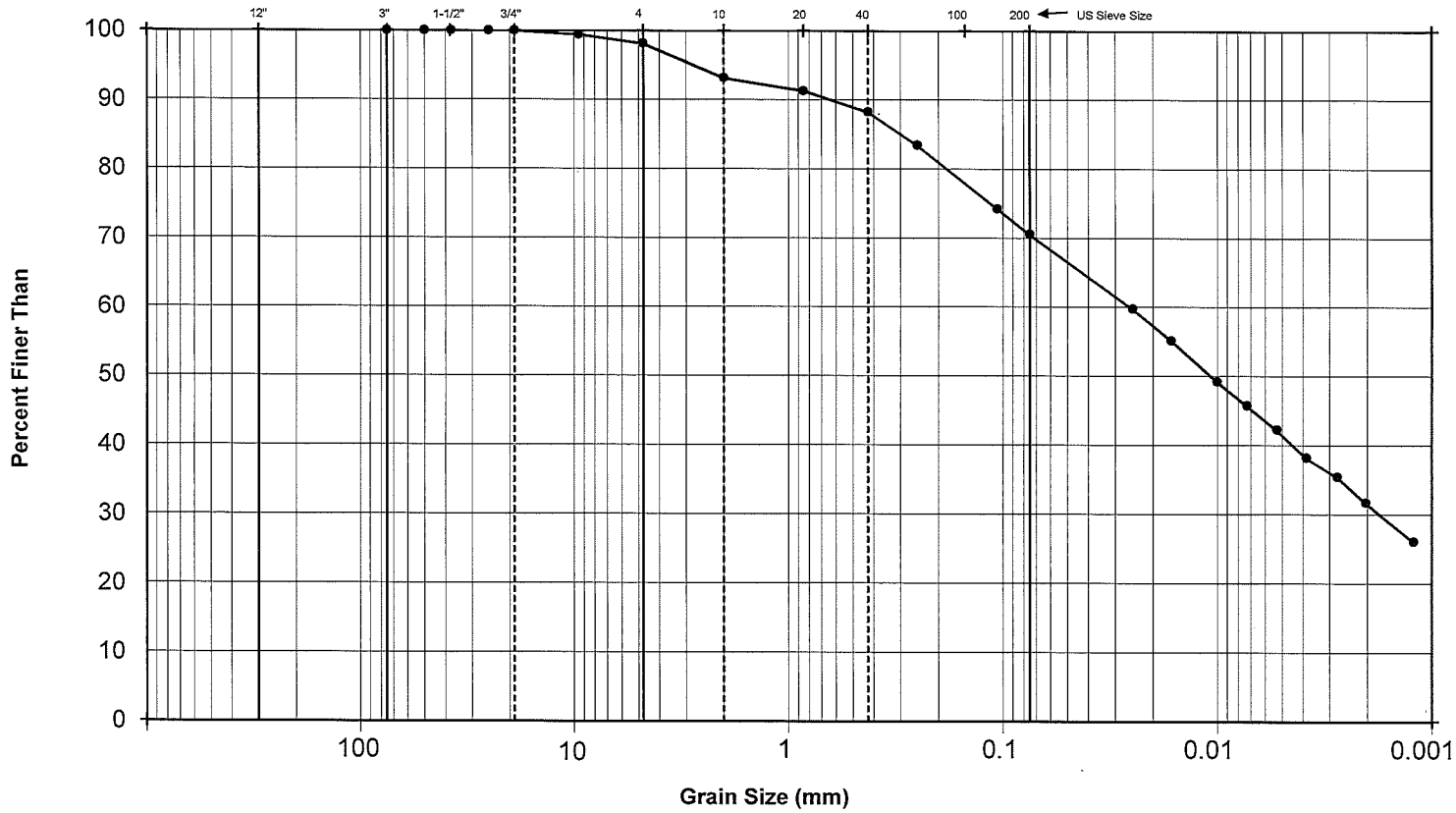
Comments:

Reviewed: OH

Golder Associates

Particle Size Analysis of Soil
(ASTM D422)

Project No.:	13-1359-0011.1000	Lab No.:	A827-02
Project Title:	Terracon Geotechnique		
Borehole:	GP-11	Sample No.:	SA2
Depth:	1.50 - 1.95m		
Date Tested:	17-Jul-13	By:	DS



Diameter of Sieve (mm)	Percent Passing (%)
75.0	100.0
50.0	100.0
37.5	100.0
25.0	100.0
19.0	100.0
9.5	99.4
4.75	98.1
2.0	93.2
0.850	91.3
0.425	88.3
0.250	83.4
0.106	74.2
0.075	70.6
0.025	59.7
0.016	55.1
0.010	49.2
0.007	45.7
0.005	42.2
0.004	38.2
0.003	35.5
0.002	31.7
0.001	26.1

Boulder Size	Cobble Size	Coarse	Fine	Coarse	Medium	Fine	Silt and Clay Size
		Gravel Size		Sand Size			

Comments:

Reviewed:

GOLDER ASSOCIATES LTD.

Golder Associates

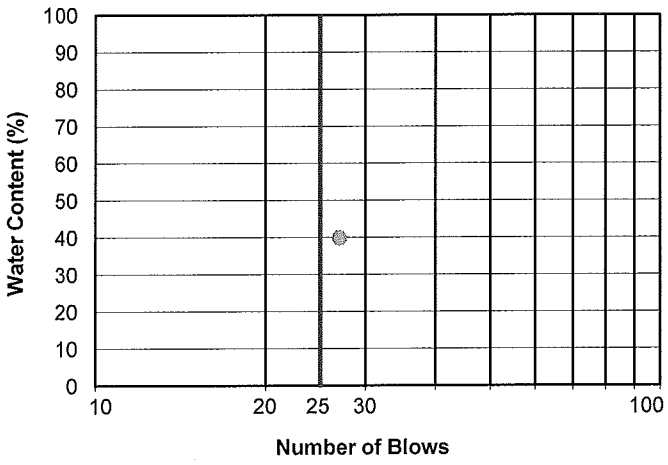
Atterberg Limits (ASTM D 4318)

Project No.: 13-1359-0011	Phase: 1000
Short Title: Terracon Geotechnique	Sched: A827-02
Tested By: DS	Date: 22-Jul-13

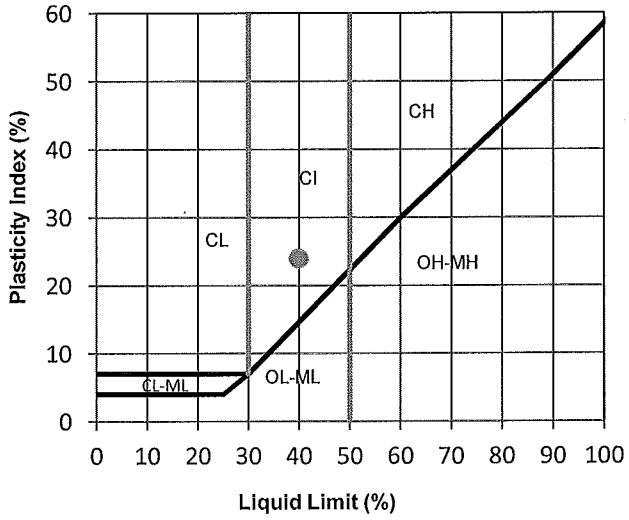
Borehole: GP-11 Sample No.: SA2 Depth: 1.50 - 1.95m

Liquid Limit Determination:			Natural Water Content:		
Number of Blows	27	27	As Received Water Content (%)		22.2%
Blow Correction Factor	1.01	1.01	**Plastic Limit Determination:**		
Mass of wet sample + tare (g)	31.24	30.14	Mass of wet sample + tare (g)	21.28	17.93
Mass of dry sample + tare (g)	27.45	26.46	Mass of dry sample + tare (g)	19.78	16.70
Mass of tare (g)	17.97	17.24	Mass of tare (g)	10.61	9.13
Weight of Water (g)	3.79	3.68	Weight of Water (g)	1.50	1.23
Weight of dry soil (g)	9.48	9.22	Weight of dry soil (g)	9.17	7.57
Water Content (%)	40.0	39.9	Water Content (%)	16.36	16.25
Liquid Limit	40.0	40.0	Average Water Content (%)		16.30

Liquid Limit Test



Plasticity chart for soil passing 425 µm sieve



Liquid Limit =	40	%
Plastic Limit =	16	%
Plasticity Index =	24	

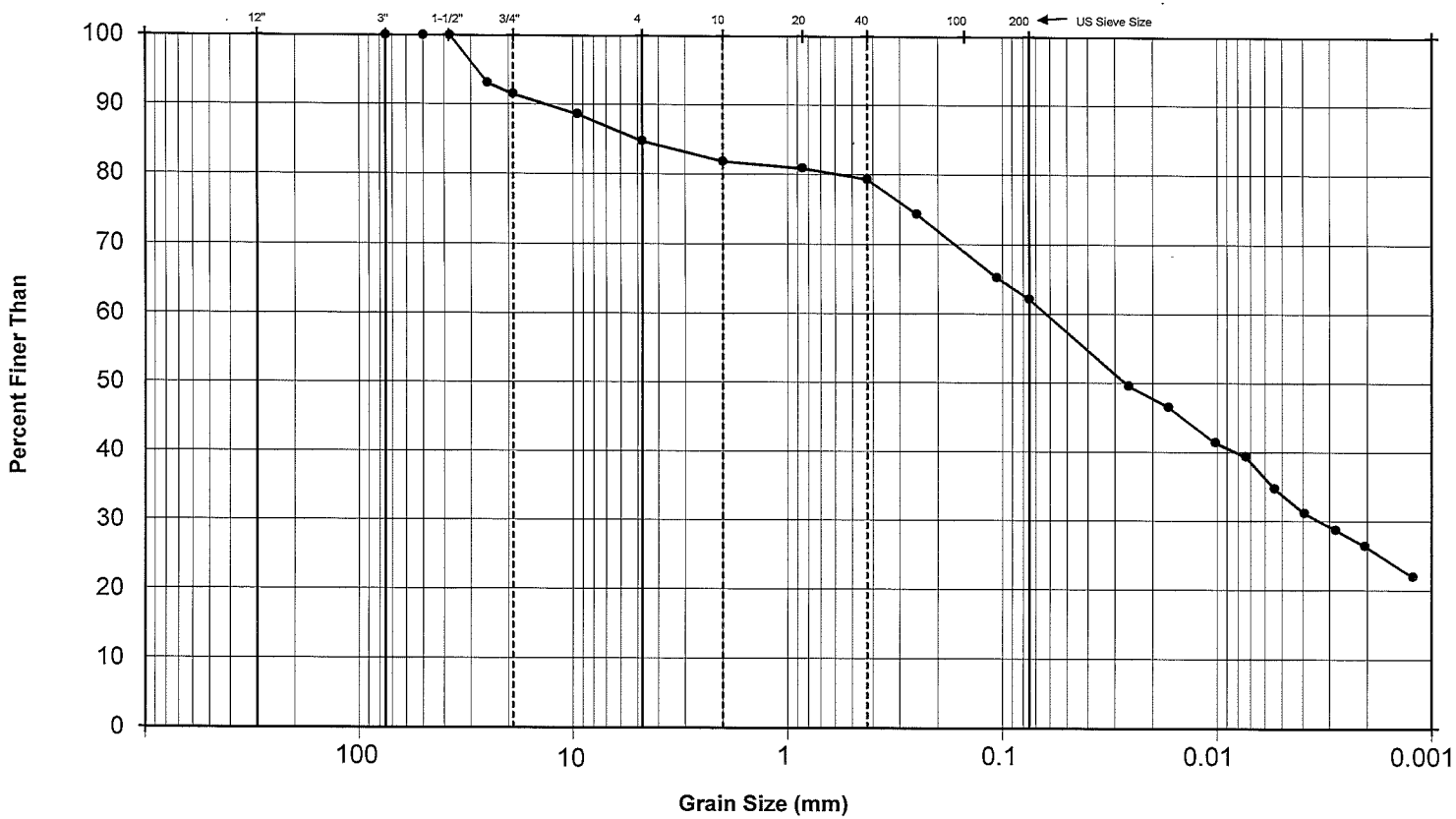
Comments:

Reviewed:

Golder Associates

Particle Size Analysis of Soil
(ASTM D422)

Project No.:	13-1359-0011.1000	Lab No.:	A827-03
Project Title:	Terracon Geotechnique		
Borehole:	GP-11	Sample No.:	SA3
Depth:	1.80 - 1.95m		
Date Tested:	17-Jul-13	By:	DS



Diameter of Sieve (mm)	Percent Passing (%)
75.0	100.0
50.0	100.0
37.5	100.0
25.0	93.1
19.0	91.5
9.5	88.6
4.75	84.8
2.0	81.9
0.850	80.9
0.425	79.4
0.250	74.4
0.106	65.3
0.075	62.2
0.026	49.6
0.017	46.6
0.010	41.4
0.007	39.4
0.005	34.8
0.004	31.2
0.003	28.8
0.002	26.5
0.001	22.0

Boulder Size	Cobble Size	Gravel Size		Sand Size			Silt and Clay Size
		Coarse	Fine	Coarse	Medium	Fine	

Comments:

Reviewed: OH

GOLDER ASSOCIATES LTD.

Golder Associates

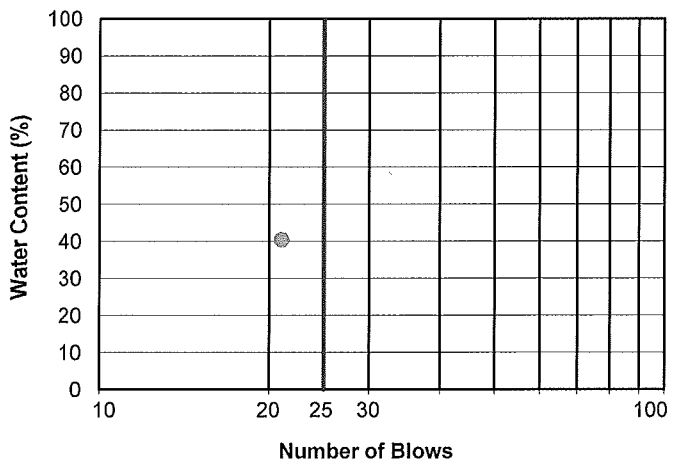
Atterberg Limits (ASTM D 4318)

Project No.: 13-1359-0011	Phase: 1000
Short Title: Terracon Geotechnique	Sched: A827-03
Tested By: DS	Date: 22-Jul-13

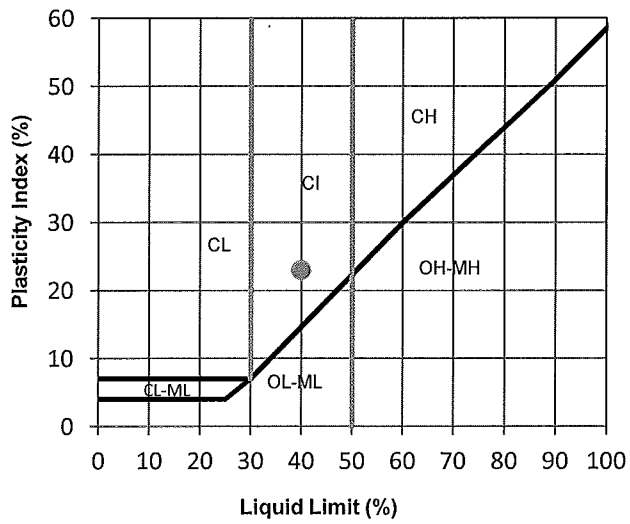
Borehole: GP-11 Sample No.: SA3 Depth: 1.80 - 1.95m

Liquid Limit Determination:			Natural Water Content:		
Number of Blows	21	21	As Received Water Content (%)		14.1%
Blow Correction Factor	0.98	0.98	**Plastic Limit Determination:**		
Mass of wet sample + tare (g)	39.00	37.91	Mass of wet sample + tare (g)	19.57	18.72
Mass of dry sample + tare (g)	34.92	34.01	Mass of dry sample + tare (g)	18.29	17.55
Mass of tare (g)	24.85	24.35	Mass of tare (g)	10.55	10.48
Weight of Water (g)	4.08	3.9	Weight of Water (g)	1.28	1.17
Weight of dry soil (g)	10.07	9.66	Weight of dry soil (g)	7.74	7.07
Water Content (%)	40.5	40.4	Water Content (%)	16.54	16.55
Liquid Limit	40.0	40.0	Average Water Content (%)		16.54

Liquid Limit Test



Plasticity chart for soil passing 425 µm sieve



Liquid Limit =	40	%
Plastic Limit =	17	%
Plasticity Index =	23	

Comments:

Reviewed:

Golder Associates

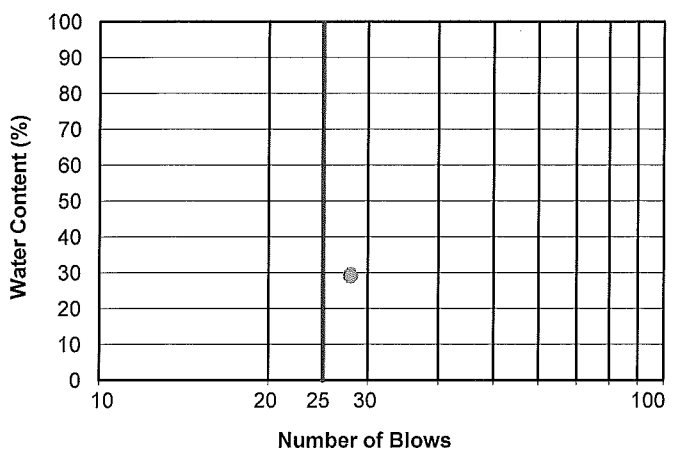
Atterberg Limits (ASTM D 4318)

Project No.:	13-1359-0011	Phase:	-
Short Title:	Fortune Minerals Lab Testing/Terracon Geotechnique-Arctos Anthracite	Sched:	A928-08
Tested By:	CG	Date:	23-Oct-13

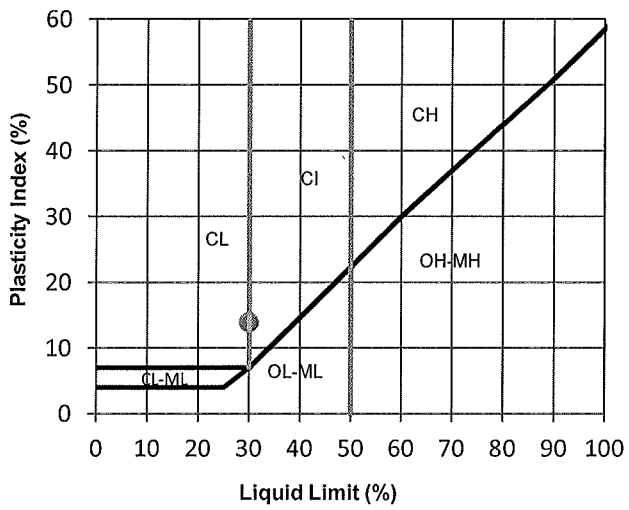
Borehole: GP16 Sample No.: 130411 Depth: 4.55-4.76 m

Liquid Limit Determination:			Natural Water Content:		
Number of Blows	28	28	As Received Water Content (%)		18.1%
Blow Correction Factor	1.01	1.01	**Plastic Limit Determination:**		
Mass of wet sample + tare (g)	47.32	49.48	Mass of wet sample + tare (g)	18.64	19.46
Mass of dry sample + tare (g)	42.18	43.82	Mass of dry sample + tare (g)	17.50	18.25
Mass of tare (g)	24.81	24.55	Mass of tare (g)	10.45	10.79
Weight of Water (g)	5.14	5.66	Weight of Water (g)	1.14	1.21
Weight of dry soil (g)	17.37	19.27	Weight of dry soil (g)	7.05	7.46
Water Content (%)	29.6	29.4	Water Content (%)	16.17	16.22
Liquid Limit	30.0	30.0	Average Water Content (%)		16.20

Liquid Limit Test



Plasticity chart for soil passing 425 µm sieve



Liquid Limit =	30	%
Plastic Limit =	16	%
Plasticity Index =	14	

Comments:

Reviewed:

Golder Associates

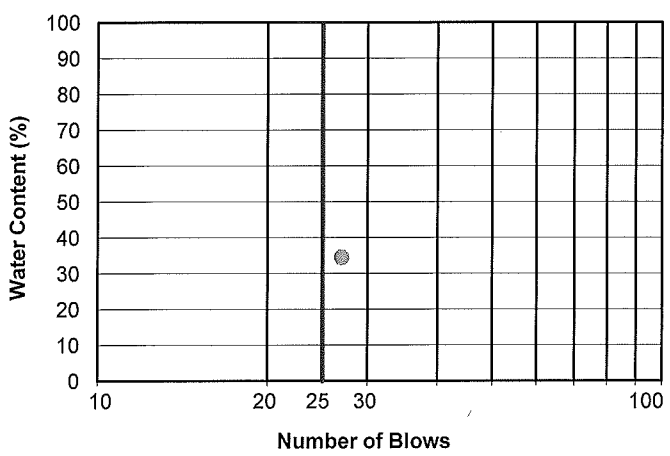
Atterberg Limits (ASTM D 4318)

Project No.:	13-1359-0011	Phase:	-
Short Title:	Fortune Minerals Lab Testing/Terracon Geotechnique-Arctos Anthracite	Sched:	A928-01
Tested By:	CG	Date:	22-Oct-13

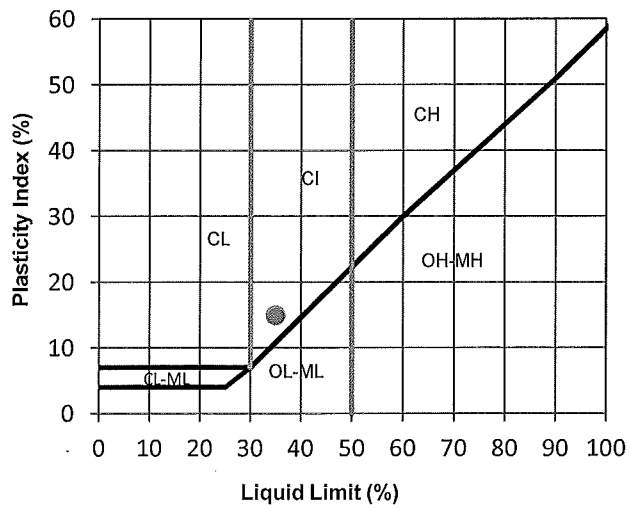
Borehole: GP16 Sample No.: 130412 Depth: 6.05-6.19 m

Liquid Limit Determination:			Natural Water Content:		
Number of Blows	27	27	As Received Water Content (%)		18.1%
Blow Correction Factor	1.01	1.01	**Plastic Limit Determination:**		
Mass of wet sample + tare (g)	50.35	50.80	Mass of wet sample + tare (g)	18.42	20.80
Mass of dry sample + tare (g)	43.87	44.52	Mass of dry sample + tare (g)	17.18	19.24
Mass of tare (g)	25.24	26.37	Mass of tare (g)	10.82	11.28
Weight of Water (g)	6.48	6.28	Weight of Water (g)	1.24	1.56
Weight of dry soil (g)	18.63	18.15	Weight of dry soil (g)	6.36	7.96
Water Content (%)	34.8	34.6	Water Content (%)	19.50	19.60
Liquid Limit	35.0	35.0	Average Water Content (%)		19.55

Liquid Limit Test



Plasticity chart for soil passing 425 µm sieve



Liquid Limit =	35	%
Plastic Limit =	20	%
Plasticity Index =	15	

Comments:

Reviewed:

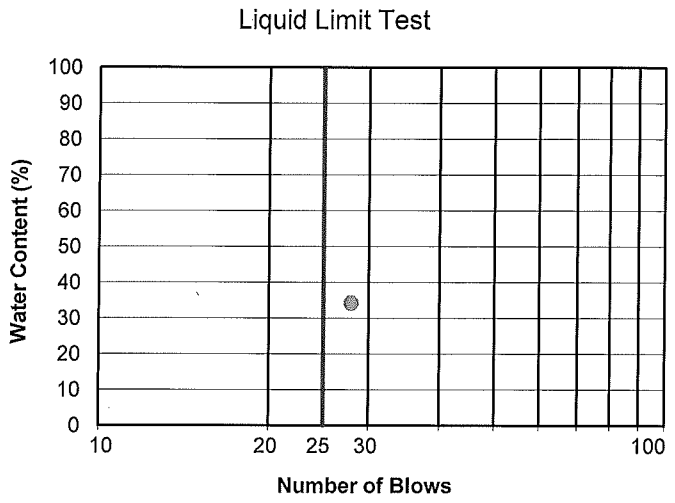
Golder Associates

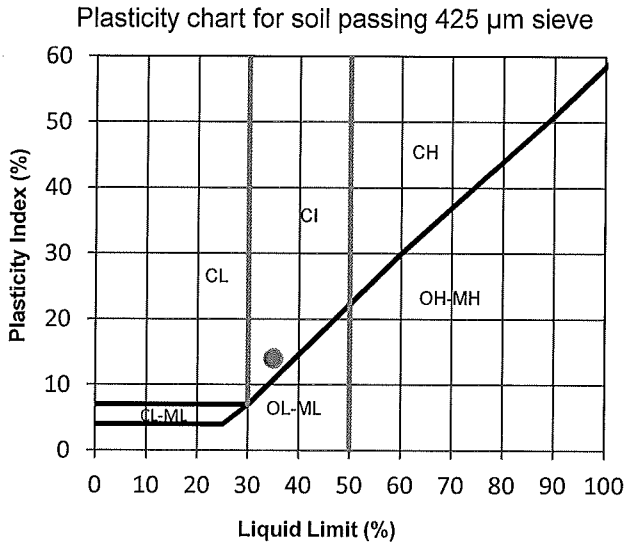
Atterberg Limits (ASTM D 4318)

Project No.:	13-1359-0011	Phase:	-
Short Title:	Fortune Minerals Lab Testing/Terracon Geotechnique-Arctos Anthracite	Sched:	A927-02
Tested By:	CG	Date:	23-Oct-13

Borehole: GP-16 Sample No.: 130415 Depth: 6.52-6.70 m

Liquid Limit Determination:			Natural Water Content:		
Number of Blows	28	28	As Received Water Content (%)		17.3%
Blow Correction Factor	1.01	1.01	**Plastic Limit Determination:**		
Mass of wet sample + tare (g)	44.17	47.48	Mass of wet sample + tare (g)	20.79	19.75
Mass of dry sample + tare (g)	37.84	41.35	Mass of dry sample + tare (g)	19.11	18.22
Mass of tare (g)	19.33	23.45	Mass of tare (g)	10.91	10.77
Weight of Water (g)	6.33	6.13	Weight of Water (g)	1.68	1.53
Weight of dry soil (g)	18.51	17.9	Weight of dry soil (g)	8.20	7.45
Water Content (%)	34.2	34.2	Water Content (%)	20.49	20.54
Liquid Limit	35.0	35.0	Average Water Content (%)		20.51





Liquid Limit =	35	%
Plastic Limit =	21	%
Plasticity Index =	14	

Comments: _____

Reviewed: _____

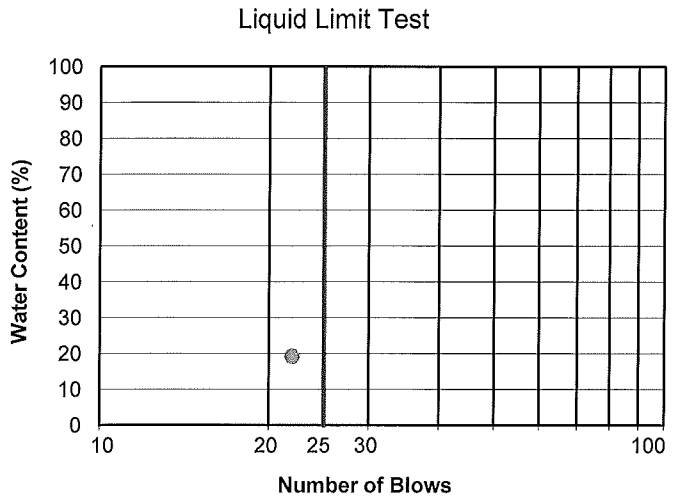
Golder Associates

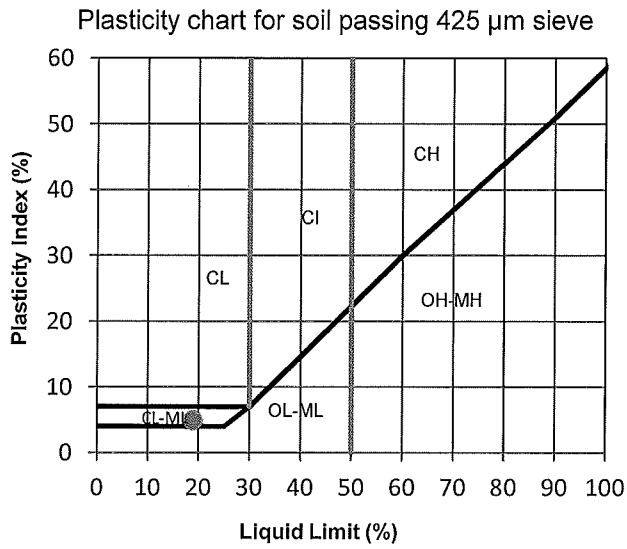
Atterberg Limits (ASTM D 4318)

Project No.:	13-1359-0011	Phase:	-
Short Title:	Fortune Minerals Lab Testing/Terracon Geotechnique-Arctos Anthracite	Sched:	A928-09
Tested By:	CG	Date:	28-Oct-13

Borehole: GP16 Sample No.: 130416 Depth: 66.50-66.71 m

Liquid Limit Determination:			Natural Water Content:		
Number of Blows	22	22	As Received Water Content (%)		1.3%
Blow Correction Factor	0.99	0.99	**Plastic Limit Determination:**		
Mass of wet sample + tare (g)	47.62	46.48	Mass of wet sample + tare (g)	18.61	19.08
Mass of dry sample + tare (g)	43.98	42.69	Mass of dry sample + tare (g)	17.48	17.91
Mass of tare (g)	25.17	23.04	Mass of tare (g)	9.54	9.73
Weight of Water (g)	3.64	3.79	Weight of Water (g)	1.13	1.17
Weight of dry soil (g)	18.81	19.65	Weight of dry soil (g)	7.94	8.18
Water Content (%)	19.4	19.3	Water Content (%)	14.23	14.30
Liquid Limit	19.0	19.0	Average Water Content (%)		14.27

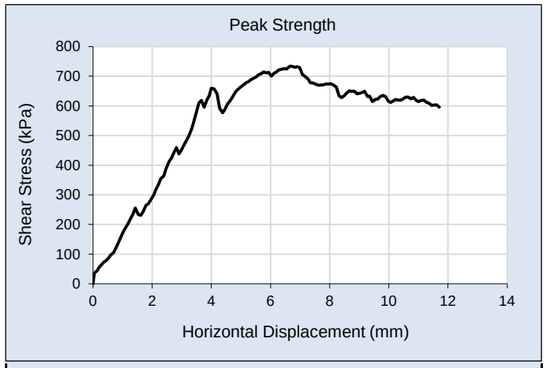




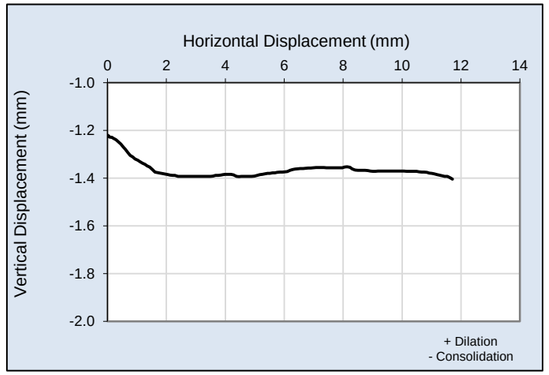
Liquid Limit =	19	%
Plastic Limit =	14	%
Plasticity Index =	5	

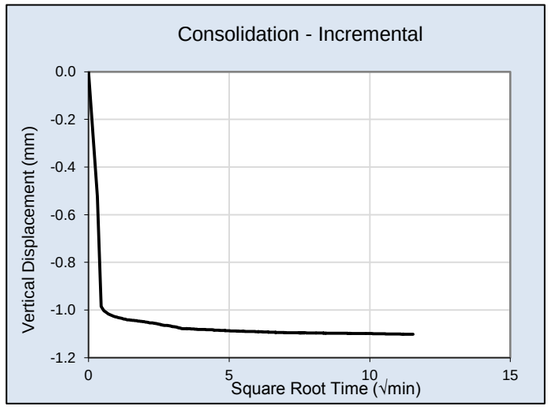
Comments:

Reviewed:



Normal Load σ', kPa	500	Shear Rate, mm/min	0.1737





Consolidation Test Results

T90	0.30	min
T50	0.07	min
Shear Rate	1.1319	mm/min
Delta H	-1.10	mm

Sample Identification

Project #	13-1359-0011	Borehole	GP-16
Client	Arctos/Anthracite	Sample	130416
Project	Fortune Minerals	Depth	66.50-66.71m
Location	-		

Initial - Sample Dimensions

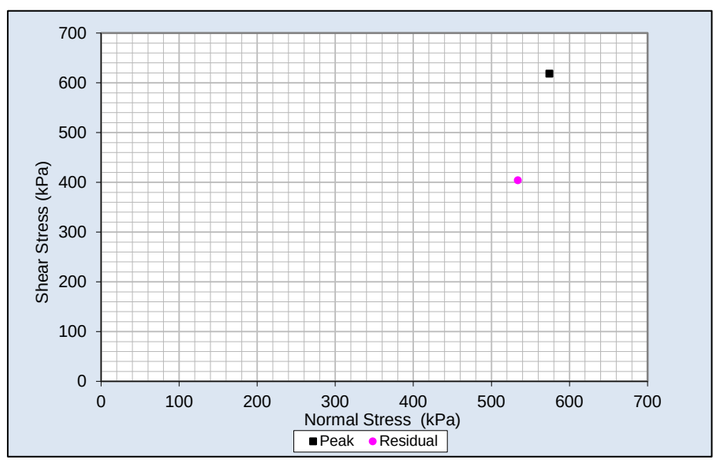
Trial Number	1
Shear box geometry	Circle
Diameter, mm	61.18
Depth, mm	24.96
Area, cm^2	29.40
Volume, cm^3	73.38

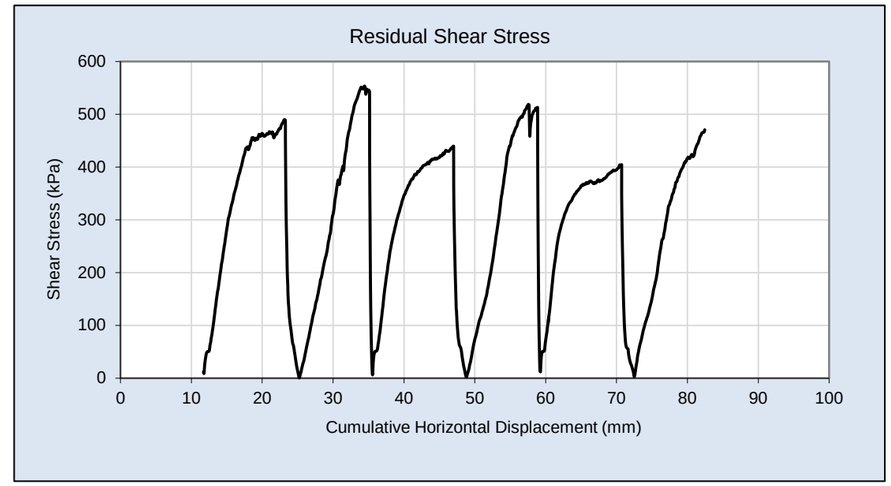
Weight Volume Relationships

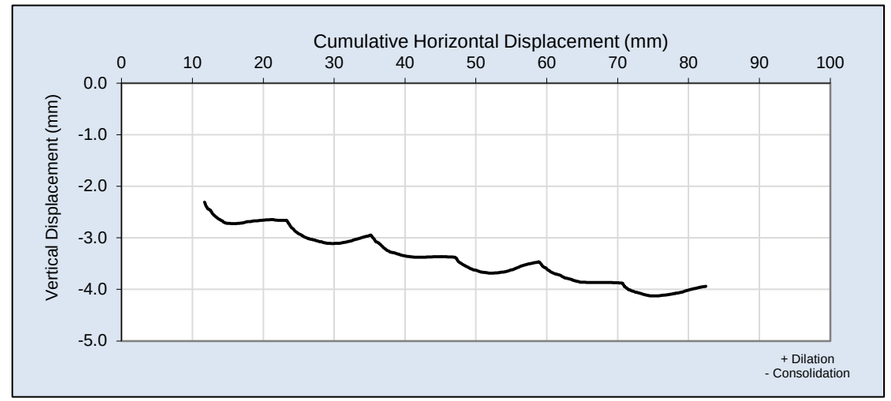
Test#		A928-09
Sample Type		Undisturbed
Initial Wet Wt, g		222.15
Initial Dry Wt, g		219.21
Initial Water Content, %		1.34
Final Water Content, %		6.89
Initial γ_{dry}, kg/m^3		2988
Final γ_{dry}, kg/m^3	(after consolidation)	3126
Specific Gravity	(assumed)	3.00
Initial Void Ratio, e		0.004

Test Results (Area Corrected)

Displacement at Failure, mm	3.665
Peak Normal Stress, kPa	575
Peak Shear Stress, kPa	618
Displacement at Residual, mm	70
Residual Normal Stress, kPa	534
Residual Shear Stress, kPa	404
Shear rate for Residual Stress, mm/min	0.1659







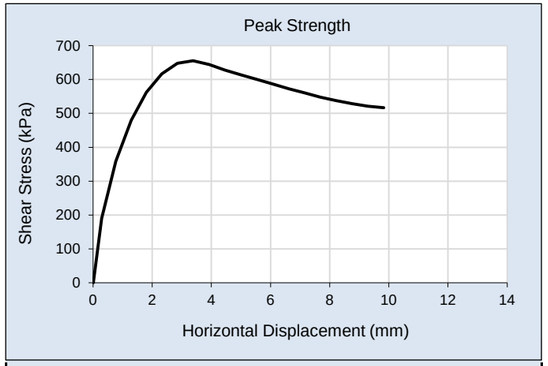
Index Test Results

Water Content (%)	1.30
Liquid Limit (%)	19
Plastic Limit (%)	14
Plasticity Index	5

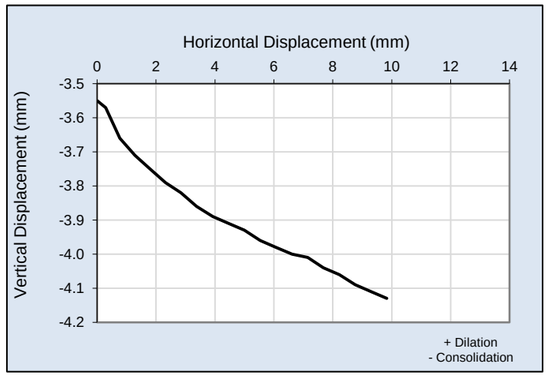
Equipment - DS-KWSOIL s/n: 906

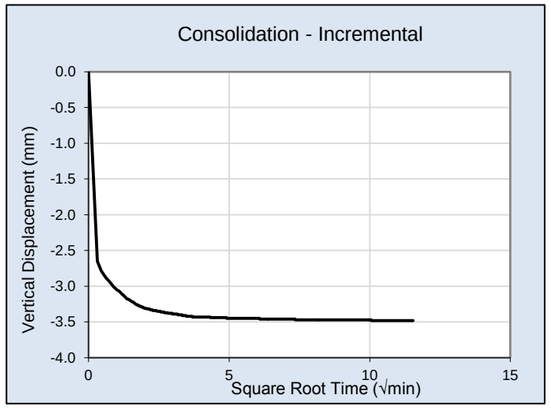
Axial LPT Serial #	4143-ch3
Normal Load Cell Serial #	4143-ch4
Shear Load Cell Serial #	4143-ch1
Vertical LPT Serial #	4143-ch2

Client: Arctos Anthracite Joint Venture	Fortune Minerals Lab Testing/Terracon Geotechnique Arctos Anthracite Project
Golder Associates	DIRECT SHEAR TEST Borehole GP-16 Sample 130416
PROJECT: 13-1359-0011	Check: MB Review: DJH



Normal Load σ', kPa	1000	Shear Rate, mm/min	0.1777





Consolidation Test Results

T90	0.56	min
T50	0.13	min
Shear Rate	0.6087	mm/min
Delta H	-3.48	mm

Sample Identification

Project #	13-1359-0011	Borehole	GD-16
Client	Arctos/Anthracite	Sample	130415
Project	Fortune Minerals	Depth	6.52-6.70m
Location	-		

Initial - Sample Dimensions

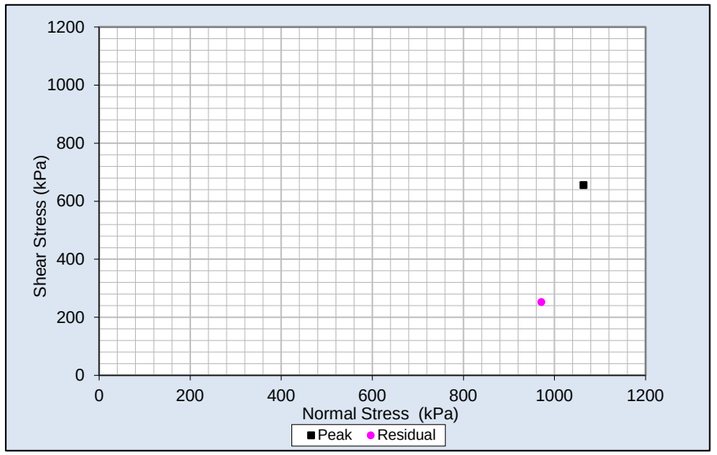
Trial Number	1
Shear box geometry	Circle
Diameter, mm	63.30
Depth, mm	25.16
Area, cm^2	31.47
Volume, cm^3	79.18

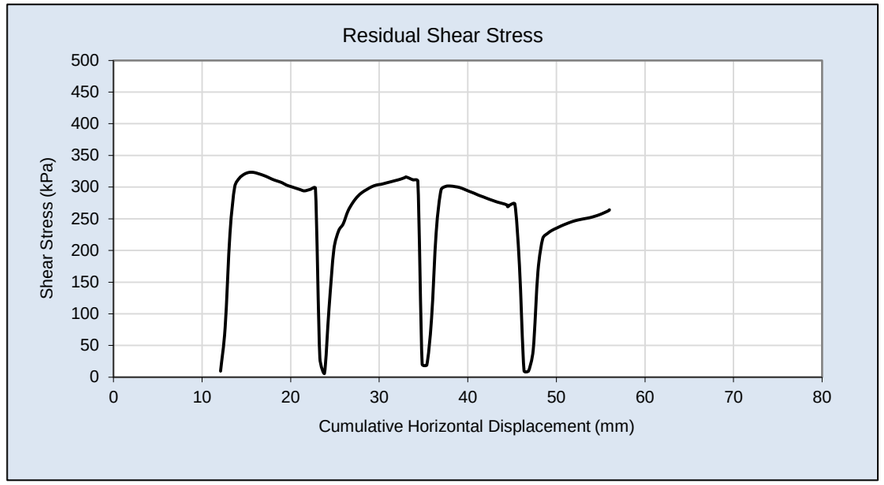
Weight Volume Relationships

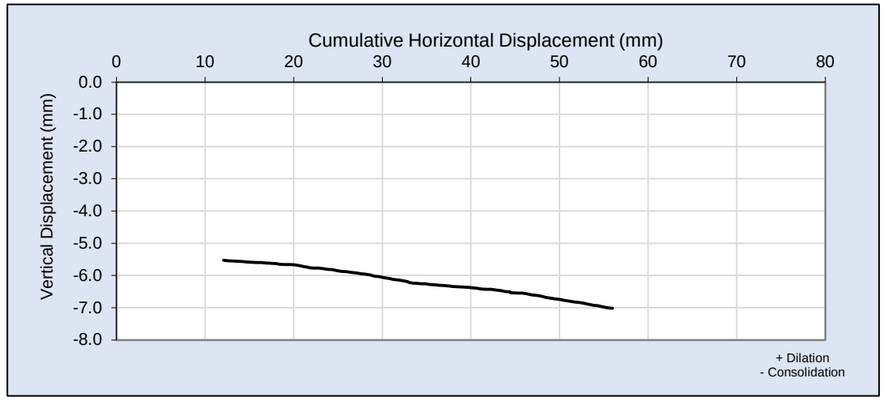
Test#		A927-02
Sample Type		Undisturbed
Initial Wet Wt, g		162.88
Initial Dry Wt, g		139.43
Initial Water Content, %		16.82
Final Water Content, %		16.55
Initial γ_{dry}, kg/m^3		1761
Final γ_{dry}, kg/m^3	(after consolidation)	2044
Specific Gravity	(assumed)	2.65
Initial Void Ratio, e		0.505

Test Results (Area Corrected)

Displacement at Failure, mm	3.380
Peak Normal Stress, kPa	1065
Peak Shear Stress, kPa	655
Displacement at Residual, mm	53.786
Residual Normal Stress, kPa	972
Residual Shear Stress, kPa	252
Shear rate for Residual Stress, mm/min	0.1678







Index Test Results

Water Content (%)	17.30
Liquid Limit (%)	35
Plastic Limit (%)	21
Plasticity Index	14

Equipment - DS-KWSOIL s/n: 763

Axial LPT Serial #	4092-ch3
Normal Load Cell Serial #	4092-ch4
Shear Load Cell Serial #	4092-ch1
Vertical LPT Serial #	4092-ch2

Client: Arctos Anthracite Joint Venture	Fortune Minerals Lab Testing/Terracon Geotechnique Arctos Anthracite Project
Golder Associates	DIRECT SHEAR TEST Borehole GD-16 Sample 130415
PROJECT: 13-1359-0011	Check: MB Review: DJH

Golder Associates

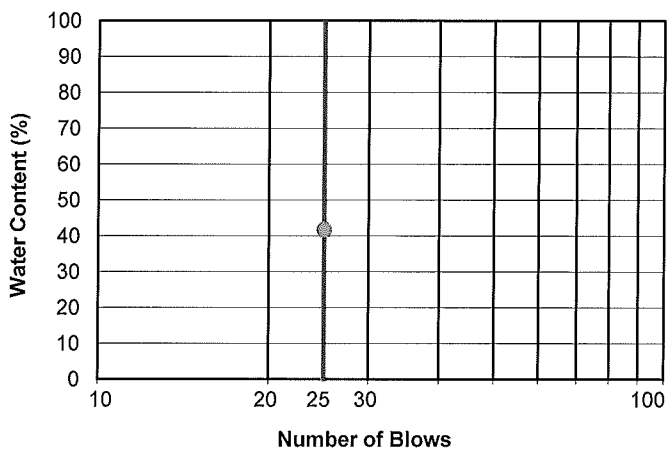
Atterberg Limits (ASTM D 4318)

Project No.: 13-1359-0011	Phase: 1000
Short Title: Fortune Minerals Lab Testing/Terracon Geotechnique	Sched: A863-15
Tested By: CG	Date: 22-Oct-13

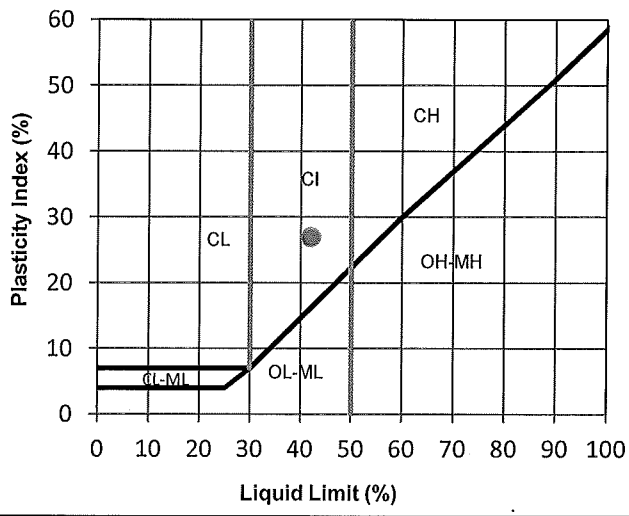
Borehole: GP-17/MW20 Sample No.: 130487 Depth: 3.00-3.12 m

Liquid Limit Determination:			Natural Water Content:		
Number of Blows	25	25	As Received Water Content (%)		13.4%
Blow Correction Factor	1.00	1.00	**Plastic Limit Determination:**		
Mass of wet sample + tare (g)	38.65	41.92	Mass of wet sample + tare (g)	20.61	20.56
Mass of dry sample + tare (g)	34.39	37.58	Mass of dry sample + tare (g)	19.33	19.29
Mass of tare (g)	24.23	27.17	Mass of tare (g)	10.48	10.58
Weight of Water (g)	4.26	4.34	Weight of Water (g)	1.28	1.27
Weight of dry soil (g)	10.16	10.41	Weight of dry soil (g)	8.85	8.71
Water Content (%)	41.9	41.7	Water Content (%)	14.46	14.58
Liquid Limit	42.0	42.0	Average Water Content (%)		14.52

Liquid Limit Test



Plasticity chart for soil passing 425 µm sieve



Liquid Limit =	42	%
Plastic Limit =	15	%
Plasticity Index =	27	

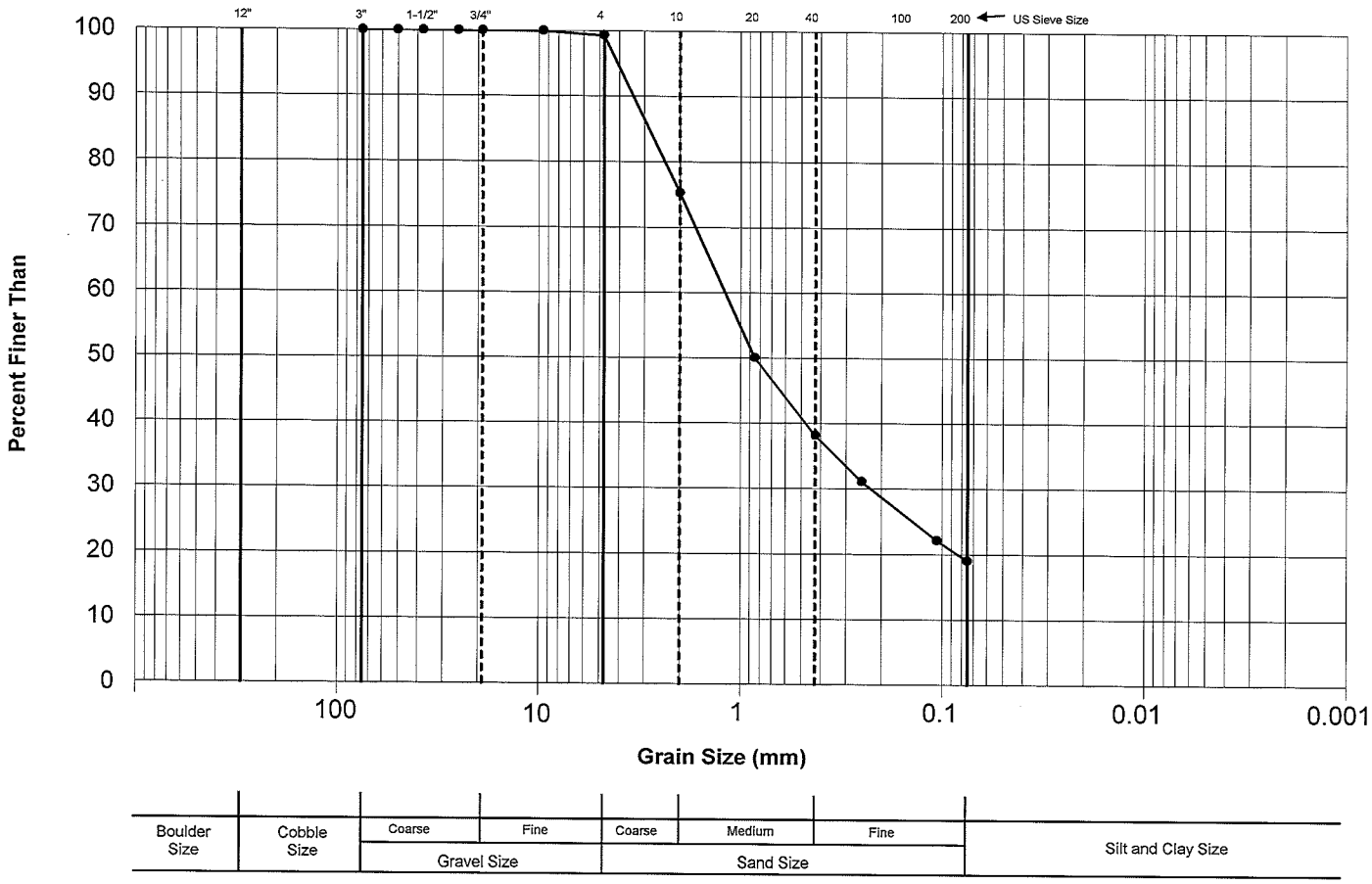
Comments:

Reviewed:

Golder Associates

PARTICLE SIZE ANALYSIS OF SOIL
(ASTM D422)

Project No.:	13-1359-0011.1000	Lab No.:	A863-17
Project Title:	Fortune Minerals Lab Testing/Terracon Geotechnique		
Borehole:	GP-17/MW20	Sample:	130491
Depth:	32.20-32.37 m		
Date Tested:	25-Oct-13	By:	DS



Diameter of Sieve (mm)	Percent Passing (%)
75.000	100.0
50.000	100.0
37.500	100.0
25.000	100.0
19.000	100.0
9.500	100.0
4.750	99.3
2.000	75.3
0.850	50.1
0.425	38.2
0.250	31.1
0.106	22.2
0.075	19.1

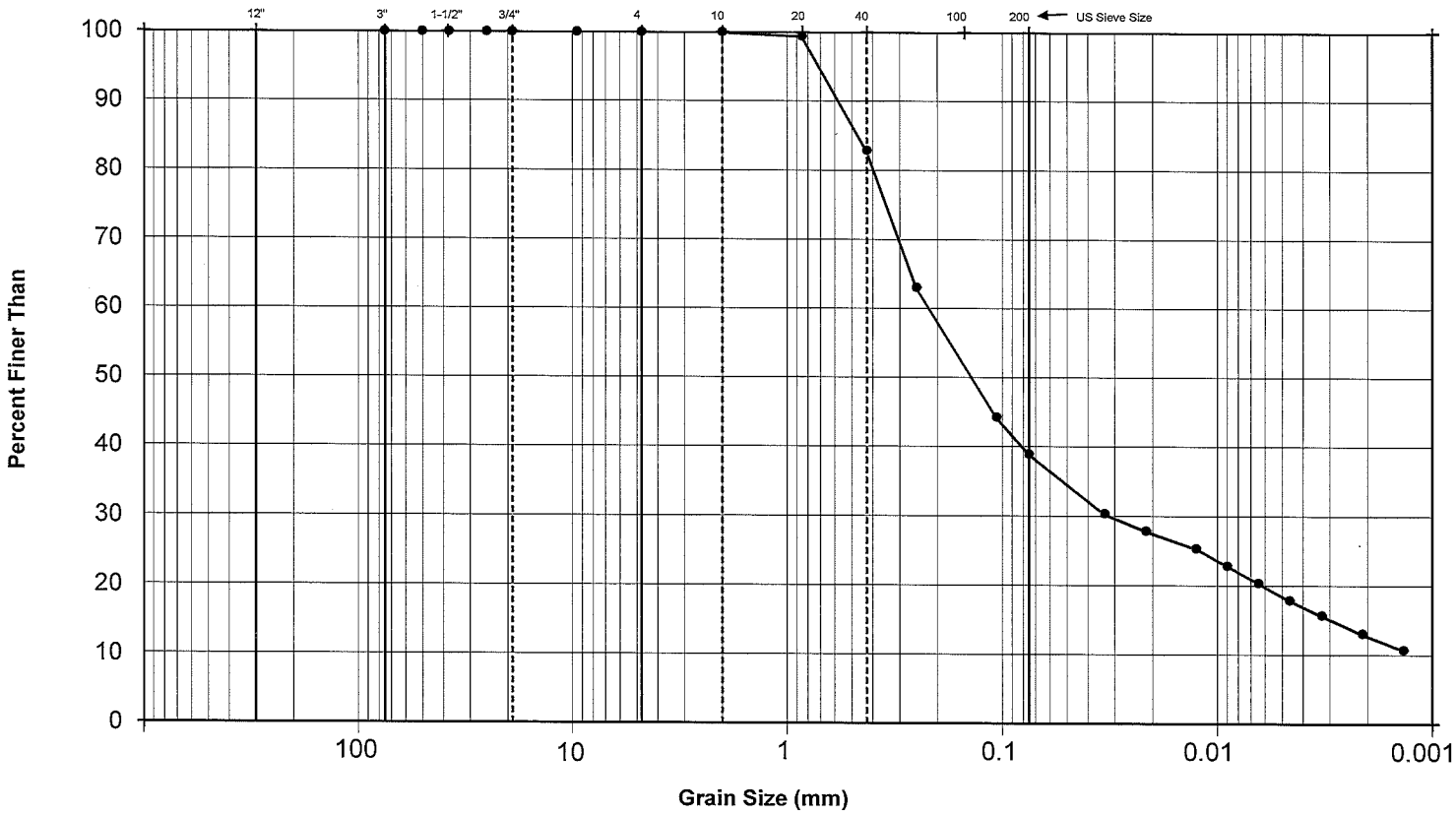
Comments:

Reviewed:

Golder Associates

Particle Size Analysis of Soil
(ASTM D422)

Project No.:	13-1359-0011	Lab No.:	A863-04
Project Title:	Fortune Minerals Lab Testing/Terracon Geotechnique		
Borehole:	GP-17/MW20	Sample No.:	130495
Depth:	52.45-52.71		
Date Tested:	23-Oct-13	By:	DS



Diameter of Sieve (mm)	Percent Passing (%)
75.0	100.0
50.0	100.0
37.5	100.0
25.0	100.0
19.0	100.0
9.5	100.0
4.75	100.0
2.0	100.0
0.850	99.4
0.425	82.9
0.250	63.1
0.106	44.3
0.075	38.9
0.033	30.4
0.021	27.9
0.013	25.4
0.009	22.9
0.006	20.4
0.005	17.9
0.003	15.7
0.002	13.1
0.001	10.8

Boulder Size	Cobble Size	Coarse	Fine	Coarse	Medium	Fine	Silt and Clay Size
		Gravel Size		Sand Size			

Comments:

Reviewed: [signature]

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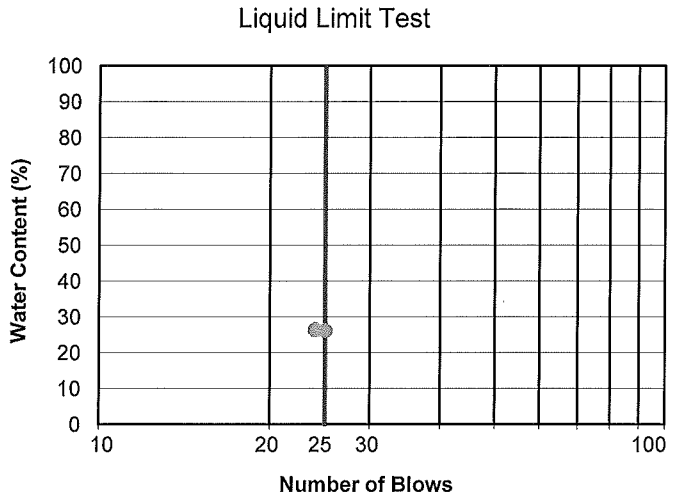
Golder Associates

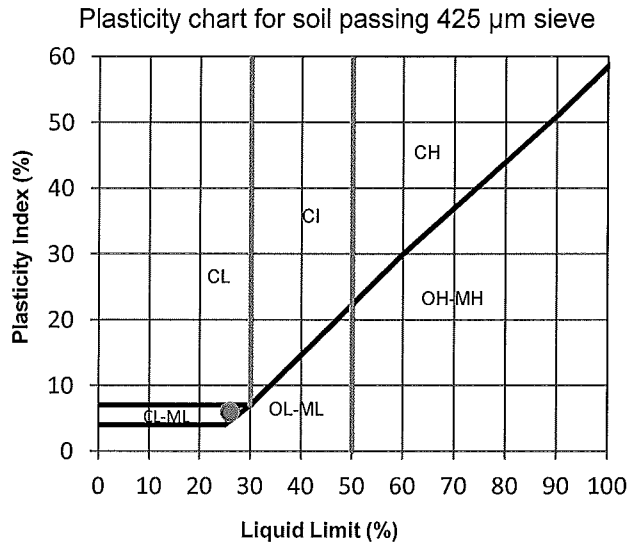
Atterberg Limits (ASTM D 4318)

Project No.:	13-1359-0011	Phase:	1000
Short Title:	Fortune Minerals Lab Testing/Terracon Geotechnique	Sched:	A863-05
Tested By:	CG	Date:	22-Oct-13

Borehole: GP-17/MW20 Sample No.: 130500 Depth: 82.86-82.93 m

Liquid Limit Determination:			Natural Water Content:		
Number of Blows	24	25	As Received Water Content (%)		3.3%
Blow Correction Factor	1.00	1.00	**Plastic Limit Determination:**		
Mass of wet sample + tare (g)	47.81	47.91	Mass of wet sample + tare (g)	18.68	18.23
Mass of dry sample + tare (g)	43.24	42.77	Mass of dry sample + tare (g)	17.33	16.93
Mass of tare (g)	25.99	23.19	Mass of tare (g)	10.62	10.61
Weight of Water (g)	4.57	5.14	Weight of Water (g)	1.35	1.30
Weight of dry soil (g)	17.25	19.58	Weight of dry soil (g)	6.71	6.32
Water Content (%)	26.5	26.3	Water Content (%)	20.12	20.57
Liquid Limit	26.0	26.0	Average Water Content (%)		20.34





Liquid Limit =	26	%
Plastic Limit =	20	%
Plasticity Index =	6	

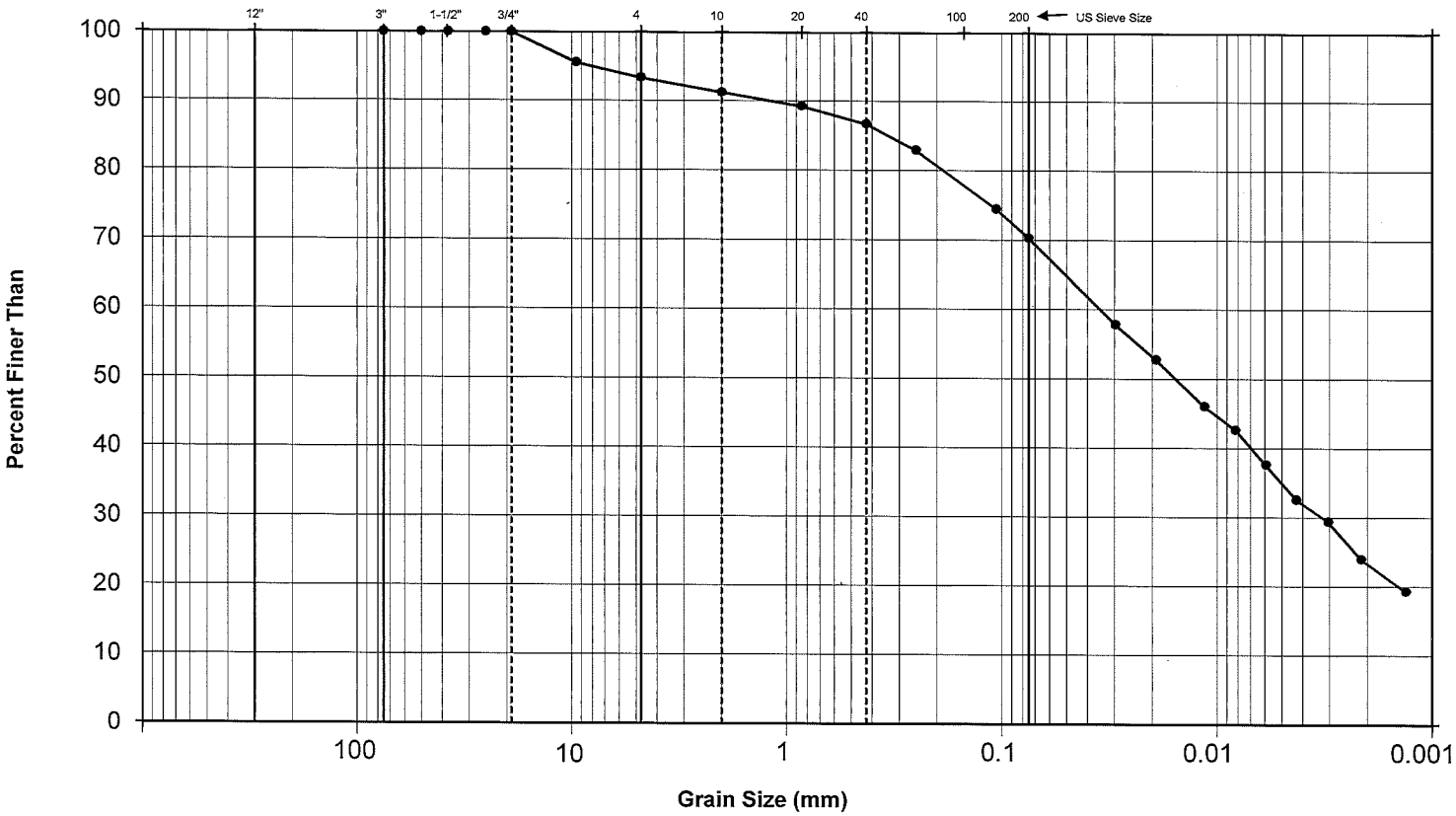
Comments:

Reviewed:

Golder Associates

Particle Size Analysis of Soil
(ASTM D422)

Project No.:	13-1359-0011	Lab No.:	A928-02
Project Title:	Fortune Minerals Lab Testing/Terracon Geotechnique		
Borehole:	GP18	Sample No.:	130418
Depth:	0.00-0.15 m		
Date Tested:	22-Oct-13	By:	DS



Boulder Size	Cobble Size	Gravel Size: Coarse	Gravel Size: Fine	Sand Size: Coarse	Sand Size: Medium	Sand Size: Fine	Silt and Clay Size

Diameter of Sieve (mm)	Percent Passing (%)
75.0	100.0
50.0	100.0
37.5	100.0
25.0	100.0
19.0	100.0
9.5	95.5
4.75	93.4
2.0	91.3
0.850	89.3
0.425	86.7
0.250	82.9
0.106	74.5
0.075	70.4
0.030	57.8
0.019	52.8
0.011	46.1
0.008	42.7
0.006	37.7
0.004	32.6
0.003	29.5
0.002	24.0
0.001	19.4

Comments:

Reviewed:

Golder Associates

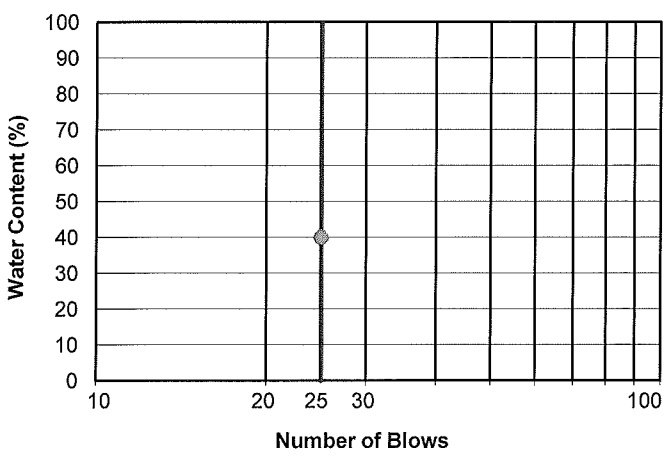
Atterberg Limits (ASTM D 4318)

Project No.:	13-1359-0011	Phase:	-
Short Title:	Fortune Minerals Lab Testing/Terracon Geotechnique-Arctos Anthracite	Sched:	A928-02
Tested By:	CG	Date:	22-Oct-13

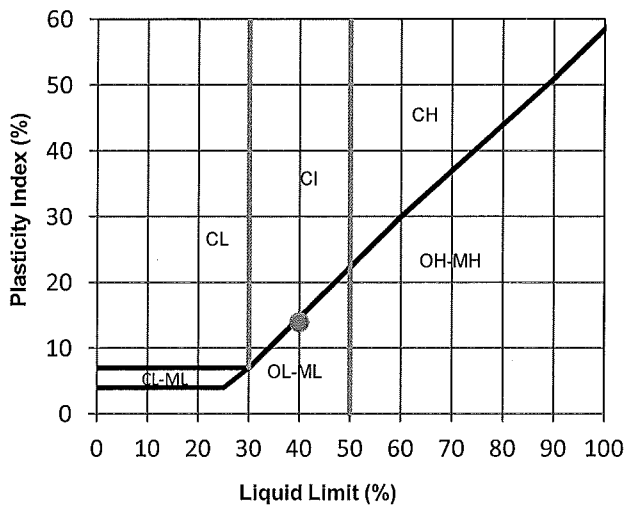
Borehole: GP18 Sample No.: 130418 Depth: 0.00-0.15 m

Liquid Limit Determination:			Natural Water Content:		
Number of Blows	25	25	As Received Water Content (%)		33.4%
Blow Correction Factor	1.00	1.00	**Plastic Limit Determination:**		
Mass of wet sample + tare (g)	43.99	32.66	Mass of wet sample + tare (g)	19.64	21.01
Mass of dry sample + tare (g)	39.30	28.68	Mass of dry sample + tare (g)	17.80	18.95
Mass of tare (g)	27.63	18.77	Mass of tare (g)	10.72	11.05
Weight of Water (g)	4.69	3.98	Weight of Water (g)	1.84	2.06
Weight of dry soil (g)	11.67	9.91	Weight of dry soil (g)	7.08	7.90
Water Content (%)	40.2	40.2	Water Content (%)	25.99	26.08
Liquid Limit	40.0	40.0	Average Water Content (%)		26.03

Liquid Limit Test



Plasticity chart for soil passing 425 µm sieve



Liquid Limit =	40	%
Plastic Limit =	26	%
Plasticity Index =	14	

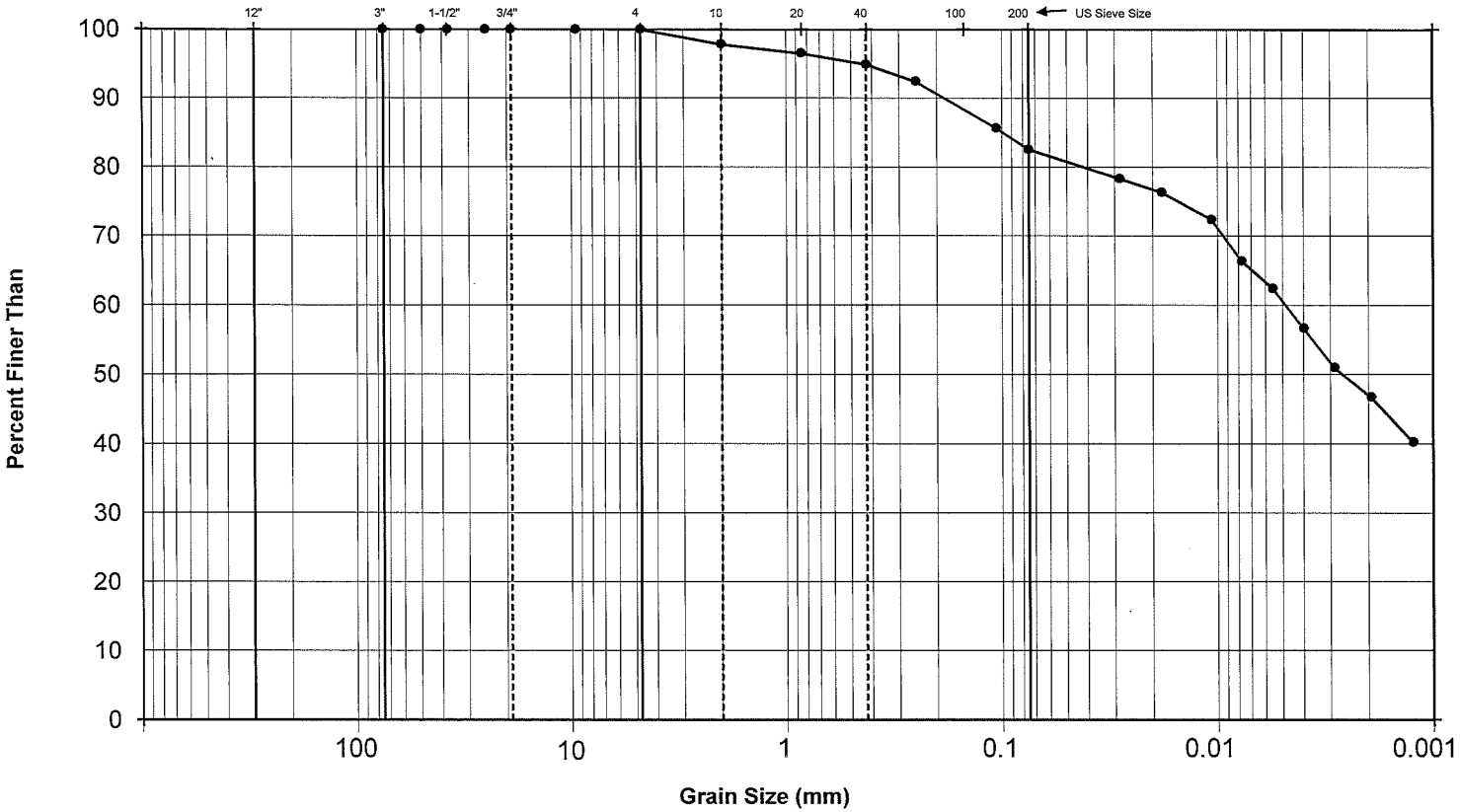
Comments:

Reviewed:

Golder Associates

Particle Size Analysis of Soil
(ASTM D422)

Project No.:	13-1359-0011	Lab No.:	A928-03
Project Title:	Fortune Minerals Lab Testing/Terracon Geotechnique		
Borehole:	GP18	Sample No.:	130419
Depth:	0.15-0.30 m		
Date Tested:	22-Oct-13	By:	DS



Boulder Size	Cobble Size	Gravel Size: Coarse	Gravel Size: Fine	Sand Size: Coarse	Sand Size: Medium	Sand Size: Fine	Silt and Clay Size

Diameter of Sieve (mm)	Percent Passing (%)
75.0	100.0
50.0	100.0
37.5	100.0
25.0	100.0
19.0	100.0
9.5	100.0
4.75	100.0
2.0	97.9
0.850	96.5
0.425	94.9
0.250	92.5
0.106	85.7
0.075	82.6
0.028	78.3
0.018	76.3
0.011	72.4
0.008	66.4
0.006	62.4
0.004	56.7
0.003	51.0
0.002	46.8
0.001	40.3

Comments:

Reviewed:

Golder Associates

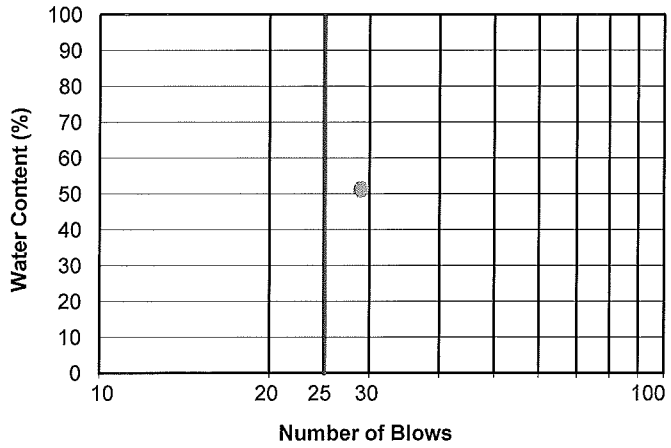
Atterberg Limits (ASTM D 4318)

Project No.:	13-1359-0011	Phase:	-
Short Title:	Fortune Minerals Lab Testing/Terracon Geotechnique-Arctos Anthracite	Sched:	A928-03
Tested By:	CG	Date:	22-Oct-13

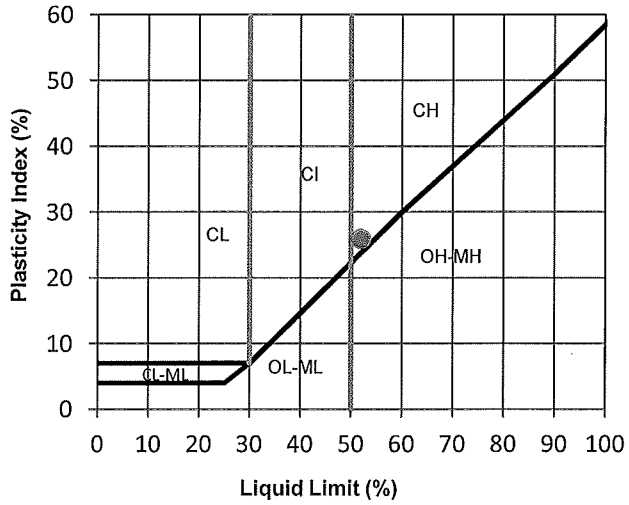
Borehole: GP18 Sample No.: 130419 Depth: 0.15-0.30 m

Liquid Limit Determination:			Natural Water Content:		
Number of Blows	29	29	As Received Water Content (%)		29.8%
Blow Correction Factor	1.02	1.02	**Plastic Limit Determination:**		
Mass of wet sample + tare (g)	35.41	47.11	Mass of wet sample + tare (g)	18.79	19.57
Mass of dry sample + tare (g)	29.63	39.35	Mass of dry sample + tare (g)	17.03	17.77
Mass of tare (g)	18.42	24.23	Mass of tare (g)	10.21	10.85
Weight of Water (g)	5.78	7.76	Weight of Water (g)	1.76	1.80
Weight of dry soil (g)	11.21	15.12	Weight of dry soil (g)	6.82	6.92
Water Content (%)	51.6	51.3	Water Content (%)	25.81	26.01
Liquid Limit	52.0	52.0	Average Water Content (%)		25.91

Liquid Limit Test



Plasticity chart for soil passing 425 µm sieve



Liquid Limit =	52	%
Plastic Limit =	26	%
Plasticity Index =	26	

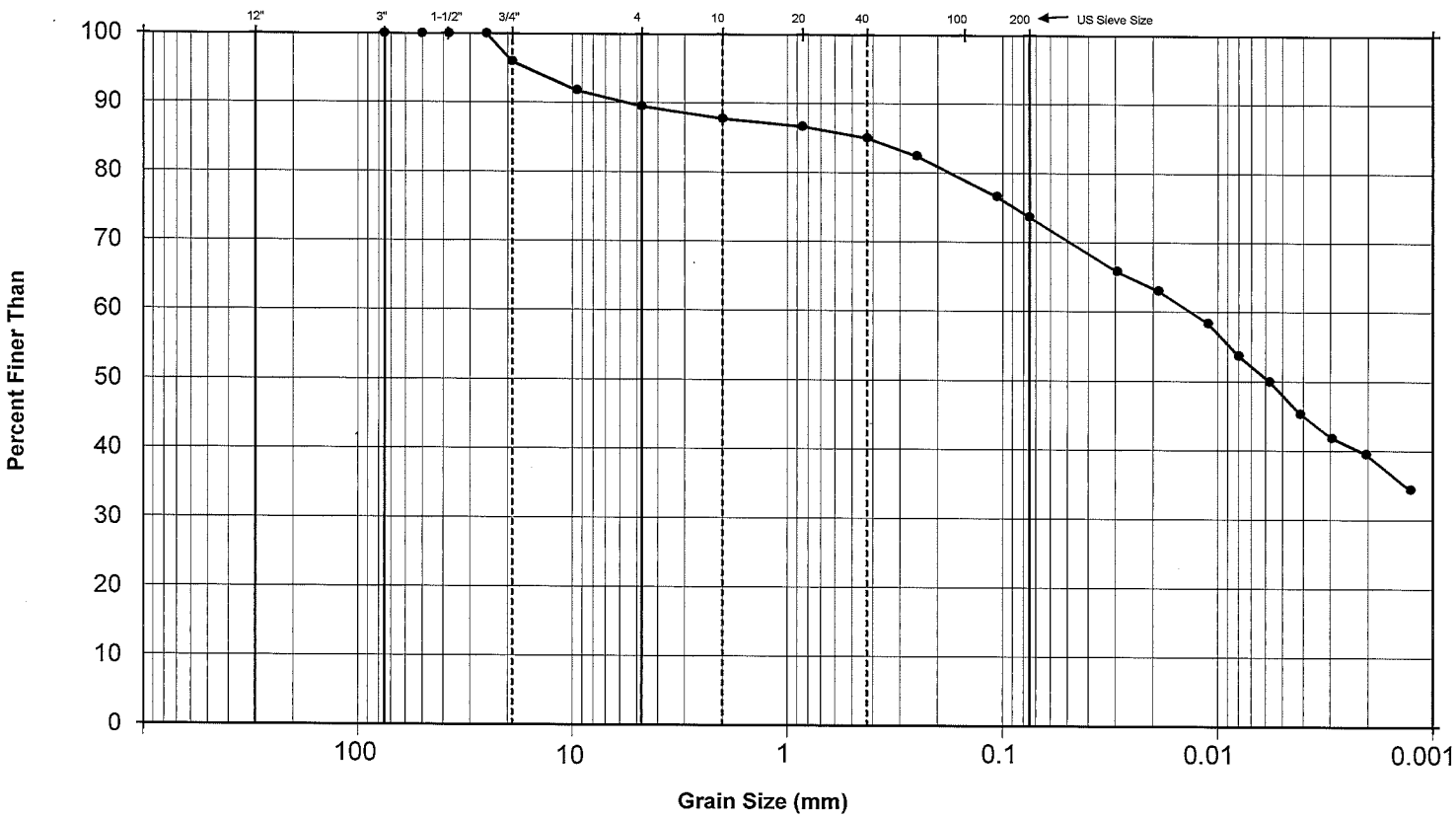
Comments:

Reviewed:

Golder Associates

Particle Size Analysis of Soil
(ASTM D422)

Project No.:	13-1359-0011	Lab No.:	A928-04
Project Title:	Fortune Minerals Lab Testing/Terracon Geotechnique		
Borehole:	GP18	Sample No.:	130420
Depth:	0.30-0.50 m		
Date Tested:	22-Oct-13	By:	DS



Diameter of Sieve (mm)	Percent Passing (%)
75.0	100.0
50.0	100.0
37.5	100.0
25.0	100.0
19.0	96.0
9.5	91.8
4.75	89.6
2.0	87.8
0.850	86.7
0.425	85.1
0.250	82.5
0.106	76.6
0.075	73.7
0.029	65.8
0.019	63.0
0.011	58.4
0.008	53.7
0.006	50.0
0.004	45.4
0.003	41.9
0.002	39.6
0.001	34.4

Boulder Size	Cobble Size	Coarse	Fine	Coarse	Medium	Fine	Silt and Clay Size
		Gravel Size		Sand Size			

Comments:

Reviewed: [illegible]

GOLDER ASSOCIATES LTD.

Golder Associates

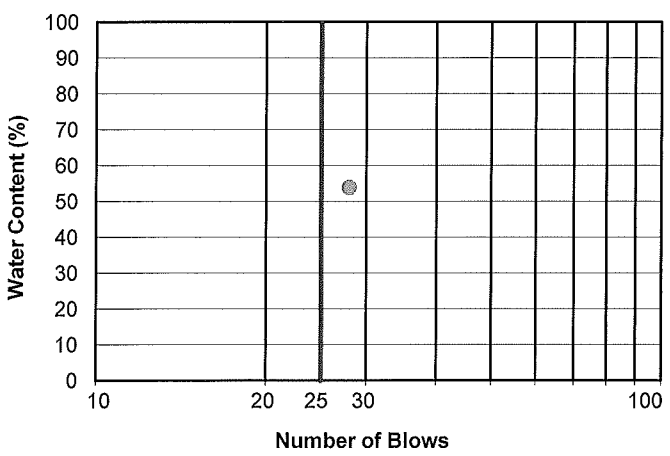
Atterberg Limits (ASTM D 4318)

Project No.:	13-1359-0011	Phase:	-
Short Title:	Fortune Minerals Lab Testing/Terracon Geotechnique-Arctos Anthracite	Sched:	A928-04
Tested By:	CG	Date:	22-Oct-13

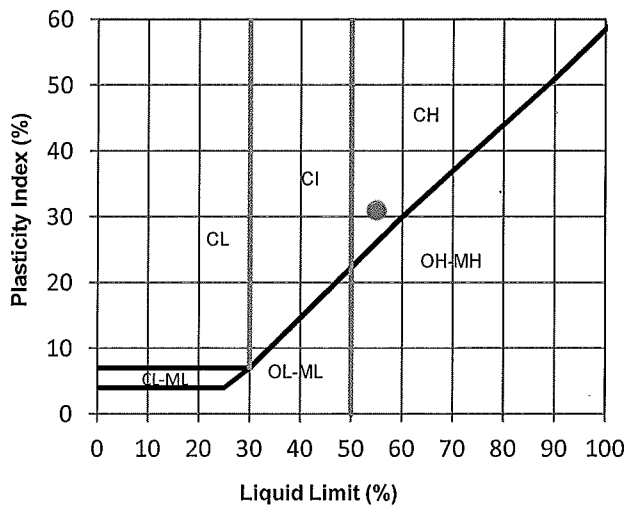
Borehole: GP18 Sample No.: 130420 Depth: 0.30-0.50 m

Liquid Limit Determination:			Natural Water Content:		
Number of Blows	28	28	As Received Water Content (%)		27.5%
Blow Correction Factor	1.01	1.01	**Plastic Limit Determination:**		
Mass of wet sample + tare (g)	42.39	32.93	Mass of wet sample + tare (g)	19.60	21.34
Mass of dry sample + tare (g)	36.72	28.38	Mass of dry sample + tare (g)	17.92	19.38
Mass of tare (g)	26.23	19.97	Mass of tare (g)	10.88	11.24
Weight of Water (g)	5.67	4.55	Weight of Water (g)	1.68	1.96
Weight of dry soil (g)	10.49	8.41	Weight of dry soil (g)	7.04	8.14
Water Content (%)	54.1	54.1	Water Content (%)	23.86	24.08
Liquid Limit	55.0	55.0	Average Water Content (%)		23.97

Liquid Limit Test



Plasticity chart for soil passing 425 µm sieve



Liquid Limit =	55	%
Plastic Limit =	24	%
Plasticity Index =	31	

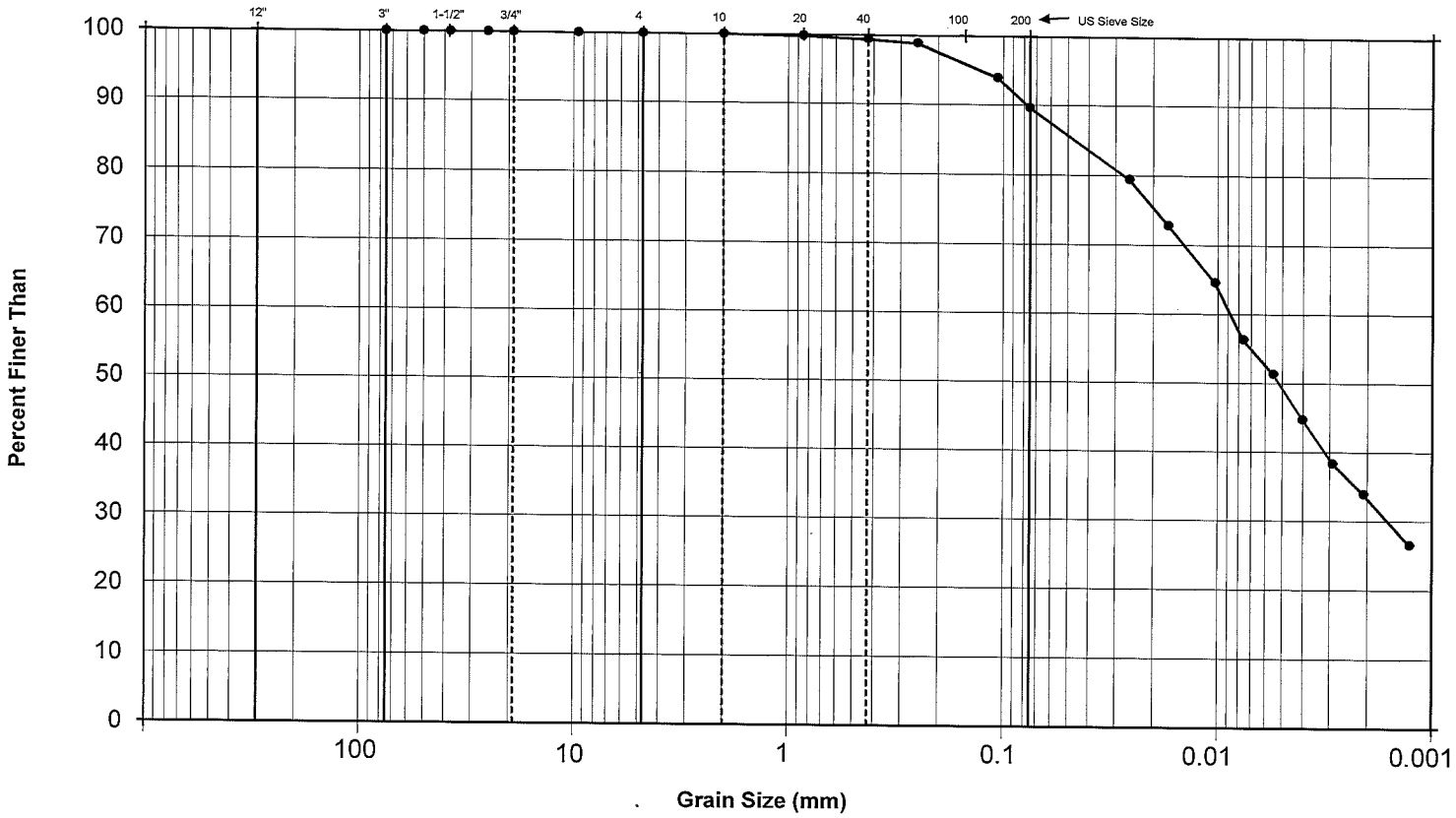
Comments:

Reviewed:

Golder Associates

Particle Size Analysis of Soil
(ASTM D422)

Project No.:	13-1359-0011	Lab No.:	A928-05
Project Title:	Fortune Minerals Lab Testing/Terracon Geotechnique		
Borehole:	GP18	Sample No.:	130421
Depth:	39.92-40.12 m		
Date Tested:	23-Oct-13	By:	DS

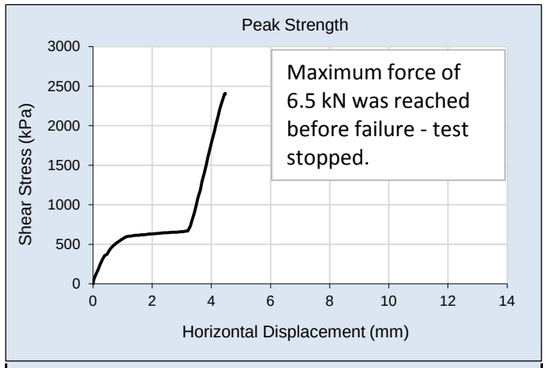


Boulder Size	Cobble Size	Gravel Size: Coarse	Gravel Size: Fine	Sand Size: Coarse	Sand Size: Medium	Sand Size: Fine	Silt and Clay Size

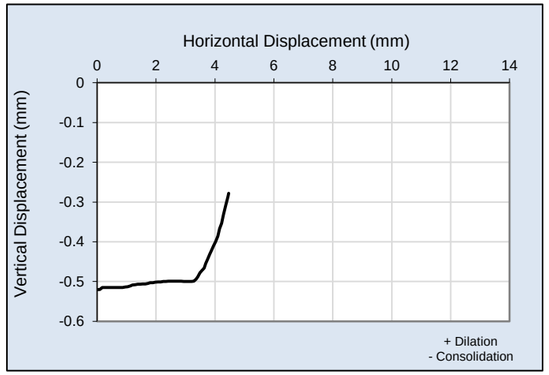
Diameter of Sieve (mm)	Percent Passing (%)
75.0	100.0
50.0	100.0
37.5	100.0
25.0	100.0
19.0	100.0
9.5	100.0
4.75	100.0
2.0	100.0
0.850	99.9
0.425	99.4
0.250	98.9
0.106	94.0
0.075	89.7
0.026	79.5
0.017	72.9
0.010	64.6
0.008	56.3
0.006	51.4
0.004	44.8
0.003	38.4
0.002	33.9
0.001	26.6

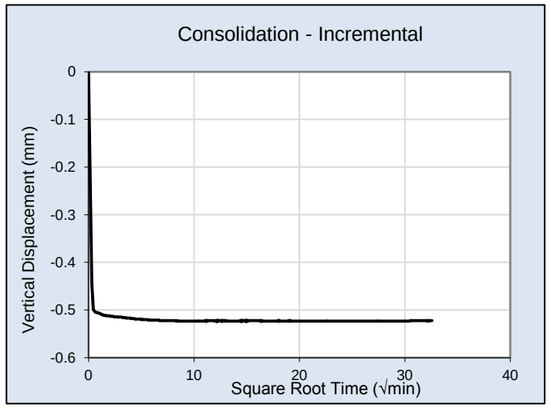
Comments:

Reviewed:



Normal Load σ', kPa	1000	Shear Rate, mm/min	0.1600





Consolidation Test Results

T90	0.25	min
T50	0.06	min
Shear Rate	1.3696	mm/min
Delta H	-0.52	mm

Sample Identification

Project #	13-1359-0011	Borehole	GP-18
Client	Arctos/Anthracite	Sample	130421
Project	Fortune Minerals	Depth	39.92-40.12m
Location	-		

Initial - Sample Dimensions

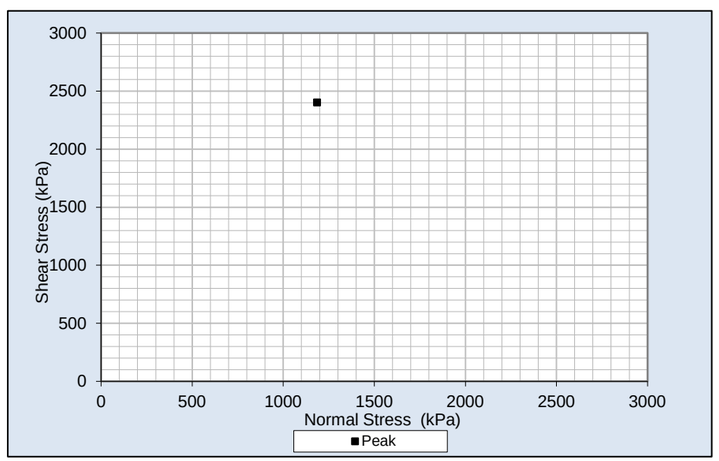
Trial Number	1
Shear box geometry	Circle
Diameter, mm	60.60
Depth, mm	25.91
Area, cm^2	28.84
Volume, cm^3	74.73

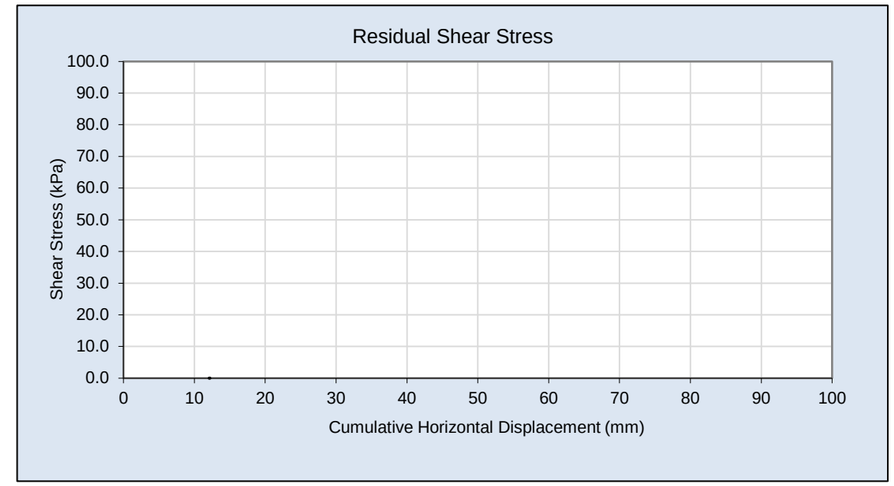
Weight Volume Relationships

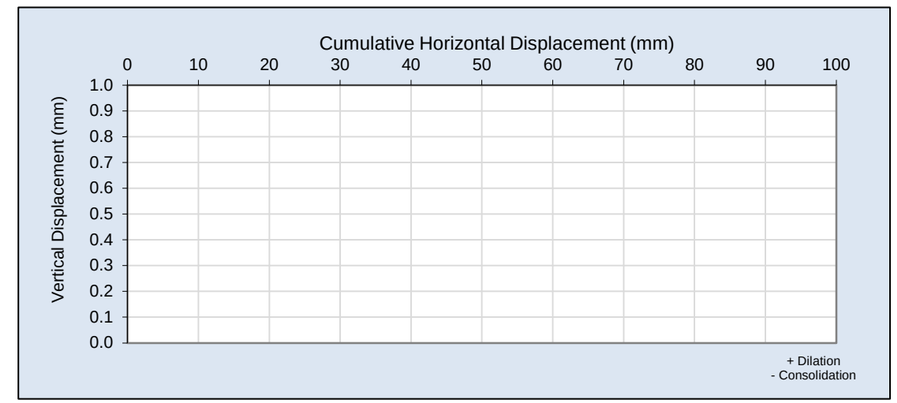
Test#		A928-05
Sample Type		Undisturbed
Initial Wet Wt, g		200.04
Initial Dry Wt, g		197.63
Initial Water Content, %		1.22
Final Water Content, %		1.69
Initial γ_{dry}, kg/m^3		2645
Final γ_{dry}, kg/m^3	(after consolidation)	2699
Specific Gravity	(assumed)	2.65
Initial Void Ratio, e		0.002

Test Results (Area Corrected)

Displacement at Failure, mm	4.463	Note: Maximum force of 6.5 kN was reached during shear test stopped to avoid damaging equipment
Peak Normal Stress, kPa	1188	
Peak Shear Stress, kPa	2400	
Displacement at Residual, mm	-	
Residual Normal Stress, kPa	-	
Residual Shear Stress, kPa	-	
Shear rate for Residual Stress, mm/min	-	







Index Test Results

Water Content (%)	1.20
Liquid Limit (%)	-
Plastic Limit (%)	-
Plasticity Index	-

Equipment - DS-KWSOIL s/n: 905

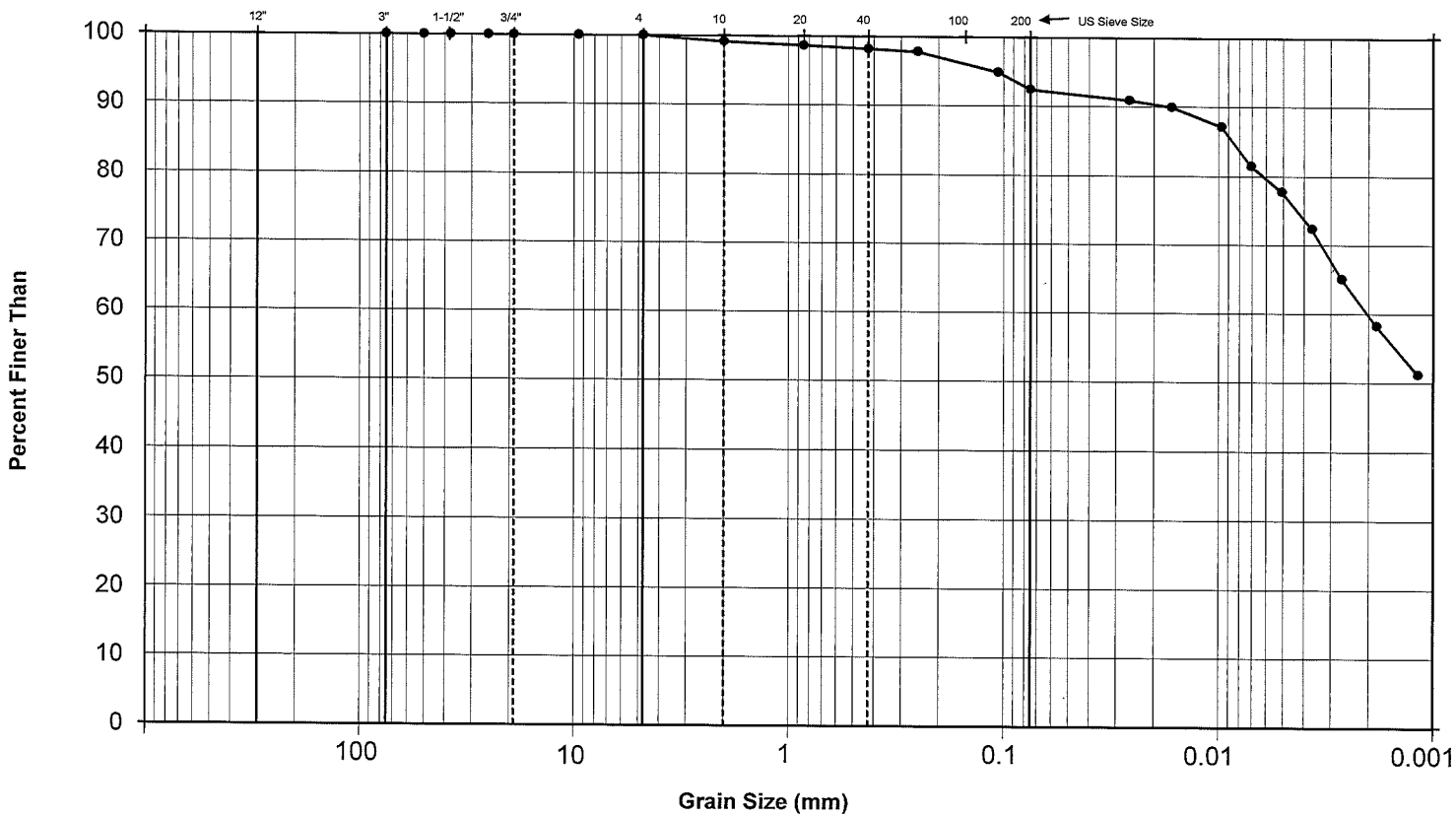
Axial LPT Serial #	4142-ch3
Normal Load Cell Serial #	4142-ch4
Shear Load Cell Serial #	4142-ch1
Vertical LPT Serial #	4142-ch2

Client: Arctos Anthracite Joint Venture	Fortune Minerals Lab Testing/Terracon Geotechnique Arctos Anthracite Project
Golder Associates	DIRECT SHEAR TEST Borehole GP-18 Sample 130421
PROJECT: 13-1359-0011	Check: MB Review: DJH

Golder Associates

Particle Size Analysis of Soil
(ASTM D422)

Project No.:	13-1359-0011	Lab No.:	A928-06
Project Title:	Fortune Minerals Lab Testing/Terracon Geotechnique		
Borehole:	GP18	Sample No.:	130422
Depth:	43.65-43.90 m		
Date Tested:	22-Oct-13	By:	DS



Diameter of Sieve (mm)	Percent Passing (%)
75.0	100.0
50.0	100.0
37.5	100.0
25.0	100.0
19.0	100.0
9.5	100.0
4.75	100.0
2.0	99.2
0.850	98.6
0.425	98.2
0.250	97.8
0.106	94.9
0.075	92.5
0.026	91.0
0.017	90.0
0.010	87.2
0.007	81.6
0.005	77.8
0.004	72.4
0.003	65.1
0.002	58.3
0.001	51.2

Boulder Size	Cobble Size	Gravel Size		Sand Size			Silt and Clay Size
		Coarse	Fine	Coarse	Medium	Fine	

Comments:

Reviewed:

GOLDER ASSOCIATES LTD.

Golder Associates

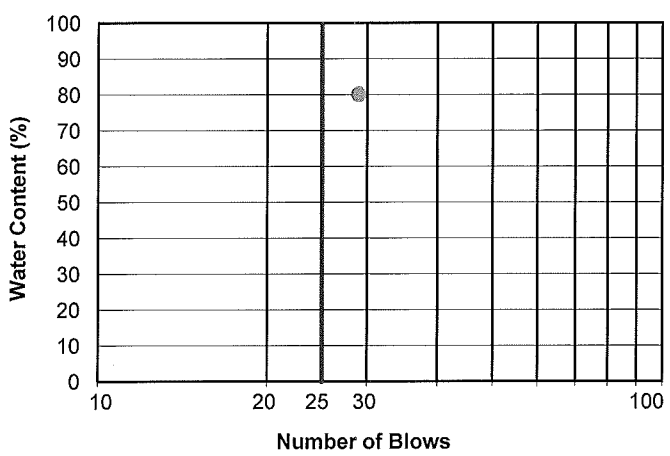
Atterberg Limits (ASTM D 4318)

Project No.: 13-1359-0011	Phase: -
Short Title: Fortune Minerals Lab Testing/Terracon Geotechnique-Arctos Anthracite	Sched: A928-06
Tested By: CG	Date: 22-Oct-13

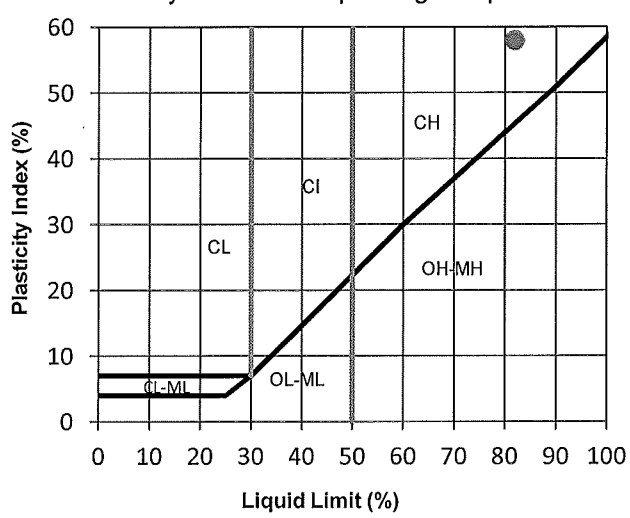
Borehole: GP18 Sample No.: 130422 Depth: 43.65-43.90 m

Liquid Limit Determination:			Natural Water Content:		
Number of Blows	29	29	As Received Water Content (%)		14.5%
Blow Correction Factor	1.02	1.02	**Plastic Limit Determination:**		
Mass of wet sample + tare (g)	42.55	53.48	Mass of wet sample + tare (g)	19.38	18.52
Mass of dry sample + tare (g)	33.83	42.56	Mass of dry sample + tare (g)	17.76	17.02
Mass of tare (g)	22.98	28.96	Mass of tare (g)	11.05	10.64
Weight of Water (g)	8.72	10.92	Weight of Water (g)	1.62	1.50
Weight of dry soil (g)	10.85	13.6	Weight of dry soil (g)	6.71	6.38
Water Content (%)	80.4	80.3	Water Content (%)	24.14	23.51
Liquid Limit	82.0	82.0	Average Water Content (%)		23.83

Liquid Limit Test



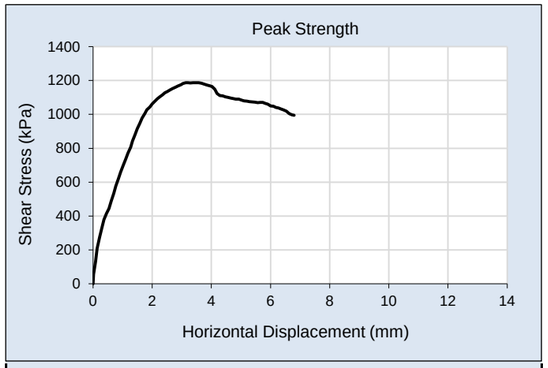
Plasticity chart for soil passing 425 µm sieve



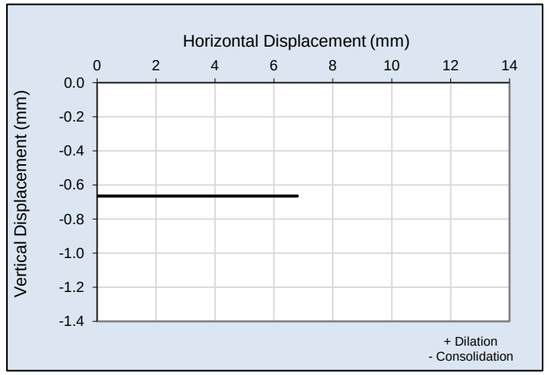
Liquid Limit =	82	%
Plastic Limit =	24	%
Plasticity Index =	58	

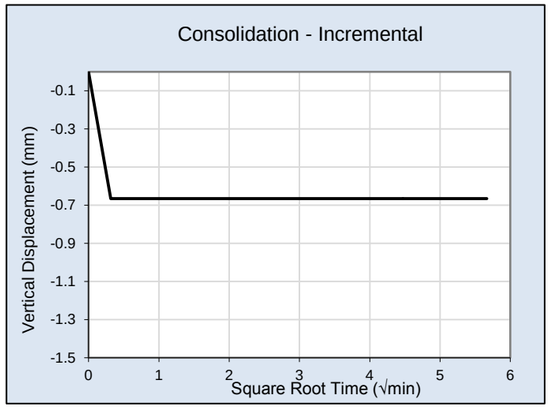
Comments:

Reviewed:



Normal Load σ', kPa	2000	Shear Rate, mm/min	0.1735





Consolidation Test Results

T90	0.12	min
T50	0.03	min
Shear Rate	2.7951	mm/min
Delta H	-0.67	mm

Sample Identification

Project #	13-1359-0011	Borehole	GP-18
Client	Arctos/Anthracite	Sample	130422
Project	Fortune Minerals	Depth	43.65-43.90m
Location	-		

Initial - Sample Dimensions

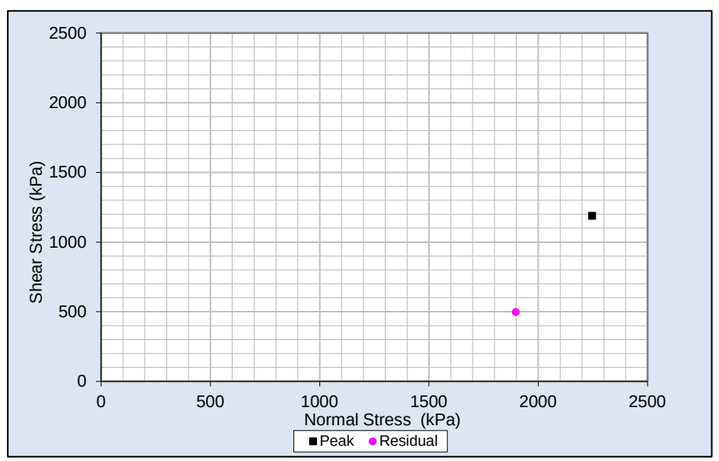
Trial Number	1
Shear box geometry	Circle
Diameter, mm	61.47
Depth, mm	25.40
Area, cm^2	29.68
Volume, cm^3	75.38

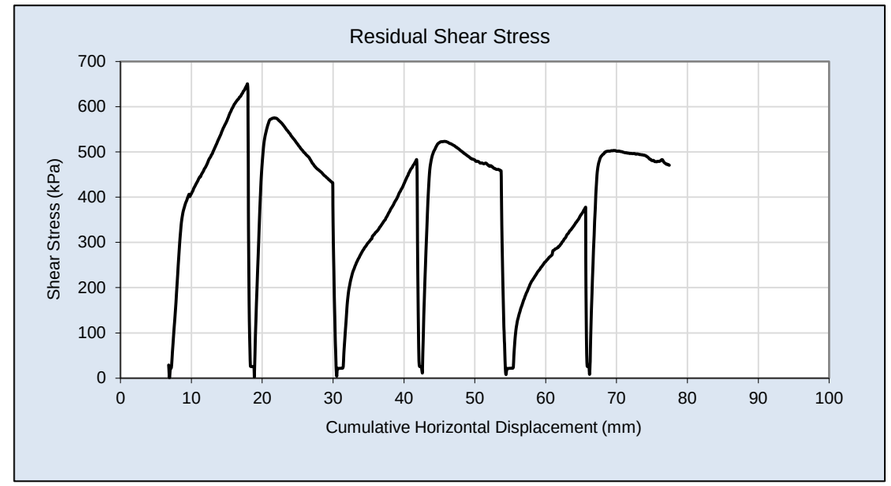
Weight Volume Relationships

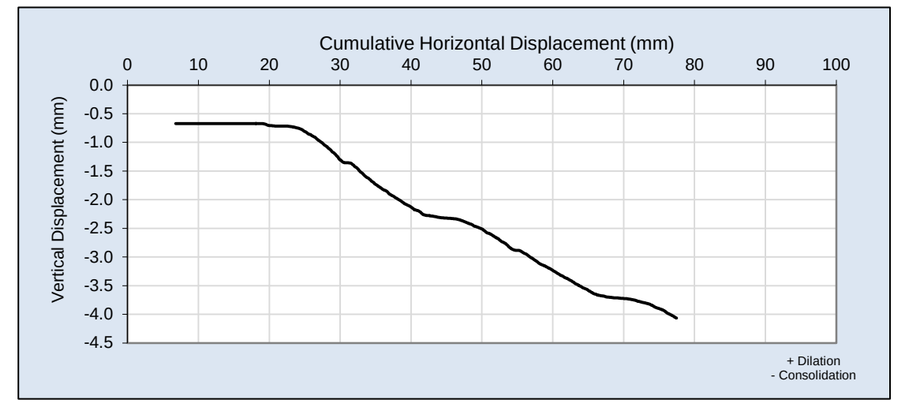
Test#		A928-06
Sample Type		Undisturbed
Initial Wet Wt, g		183.96
Initial Dry Wt, g		176.58
Initial Water Content, %		4.18
Final Water Content, %		12.75
Initial γ_{dry}, kg/m^3		2343
Final γ_{dry}, kg/m^3	(after consolidation)	2406
Specific Gravity	(assumed)	2.65
Initial Void Ratio, e		0.131

Test Results (Area Corrected)

Displacement at Failure, mm	3.131
Peak Normal Stress, kPa	2248
Peak Shear Stress, kPa	1187
Displacement at Residual, mm	72.032
Residual Normal Stress, kPa	1898
Residual Shear Stress, kPa	497
Shear rate for Residual Stress, mm/min	0.1660







Index Test Results

Water Content (%)	14.50
Liquid Limit (%)	82
Plastic Limit (%)	24
Plasticity Index	58

Equipment - DS-KWSOIL s/n: 906

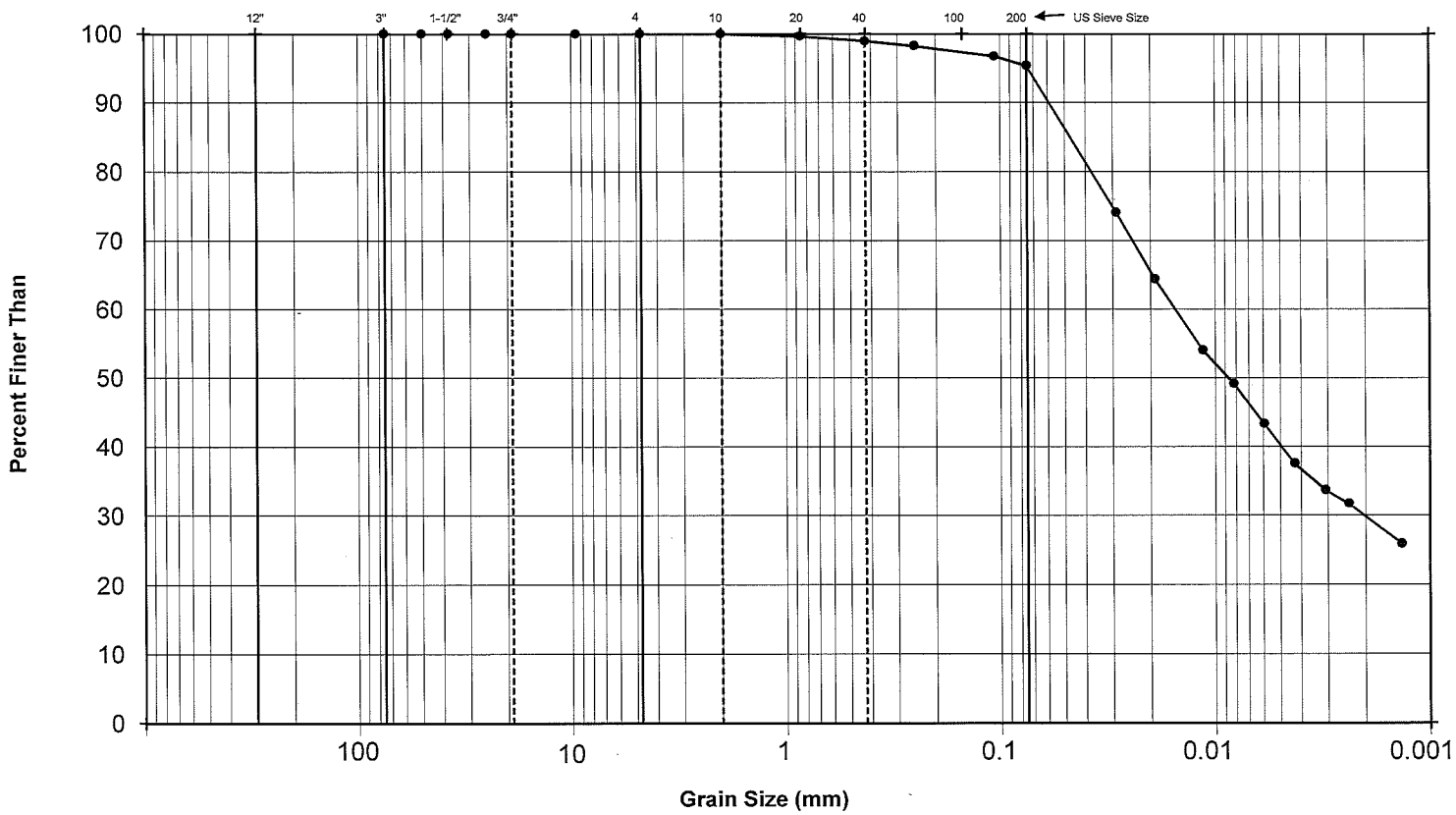
Axial LPT Serial #	4143-ch3
Normal Load Cell Serial #	4143-ch4
Shear Load Cell Serial #	4143-ch1
Vertical LPT Serial #	4143-ch2

Client: Arctos Anthracite Joint Venture	Fortune Minerals Lab Testing/Terracon Geotechnique Arctos Anthracite Project
Golder Associates	DIRECT SHEAR TEST Borehole GP-18 Sample 130422
PROJECT: 13-1359-0011	Check: MB Review: DJH

Golder Associates

Particle Size Analysis of Soil
(ASTM D422)

Project No.:	13-1359-0011.1000	Lab No.:	A849-17
Project Title:	Terracon Geotechnique		
Borehole:	GD-19/MW-28	Sample No.:	130144
Depth:	1.05-1.25m		
Date Tested:	7-Aug-13	By:	JL



Boulder Size	Cobble Size	Coarse	Fine	Coarse	Medium	Fine	Silt and Clay Size
		Gravel Size		Sand Size			

Diameter of Sieve (mm)	Percent Passing (%)
75.0	100.0
50.0	100.0
37.5	100.0
25.0	100.0
19.0	100.0
9.5	100.0
4.75	100.0
2.0	100.0
0.850	99.7
0.425	99.0
0.250	98.3
0.106	96.8
0.075	95.4
0.029	74.1
0.019	64.4
0.011	54.0
0.008	49.2
0.006	43.4
0.004	37.6
0.003	33.7
0.002	31.7
0.001	25.9

Comments:

Reviewed:

Golder Associates

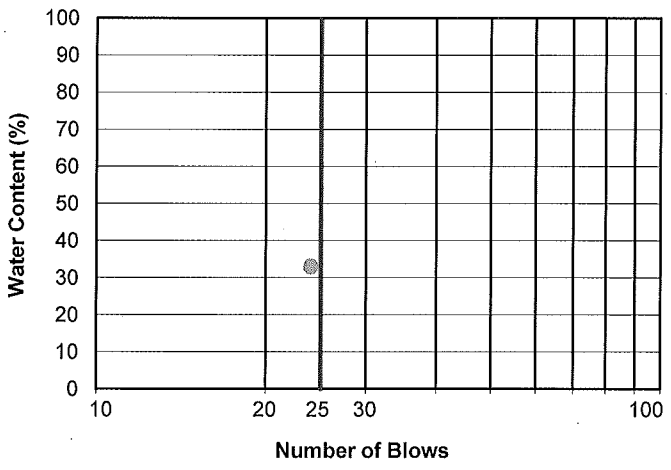
Atterberg Limits (ASTM D 4318)

Project No.: 13-1359-0011	Phase: 1000
Short Title: Terracon Geotechnique	Sched: A849-17
Tested By: JL	Date: 7-Aug-12

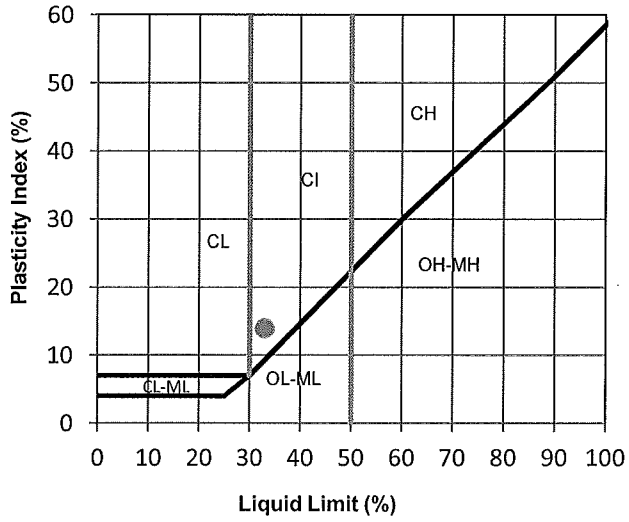
Borehole: GD-19/MW-28 Sample No.: 130144 Depth: 1.05-1.25m

Liquid Limit Determination:			Natural Water Content:		
Number of Blows	24	24	As Received Water Content (%)		16.7%
Blow Correction Factor	1.00	1.00	**Plastic Limit Determination:**		
Mass of wet sample + tare (g)	37.95	36.36	Mass of wet sample + tare (g)	22.36	21.16
Mass of dry sample + tare (g)	34.67	32.68	Mass of dry sample + tare (g)	20.48	19.21
Mass of tare (g)	24.79	21.52	Mass of tare (g)	10.82	9.19
Weight of Water (g)	3.28	3.68	Weight of Water (g)	1.88	1.95
Weight of dry soil (g)	9.88	11.16	Weight of dry soil (g)	9.66	10.02
Water Content (%)	33.2	33.0	Water Content (%)	19.46	19.46
Liquid Limit	33.0	33.0	Average Water Content (%)		19.46

Liquid Limit Test



Plasticity chart for soil passing 425 µm sieve



Liquid Limit =	33	%
Plastic Limit =	19	%
Plasticity Index =	14	

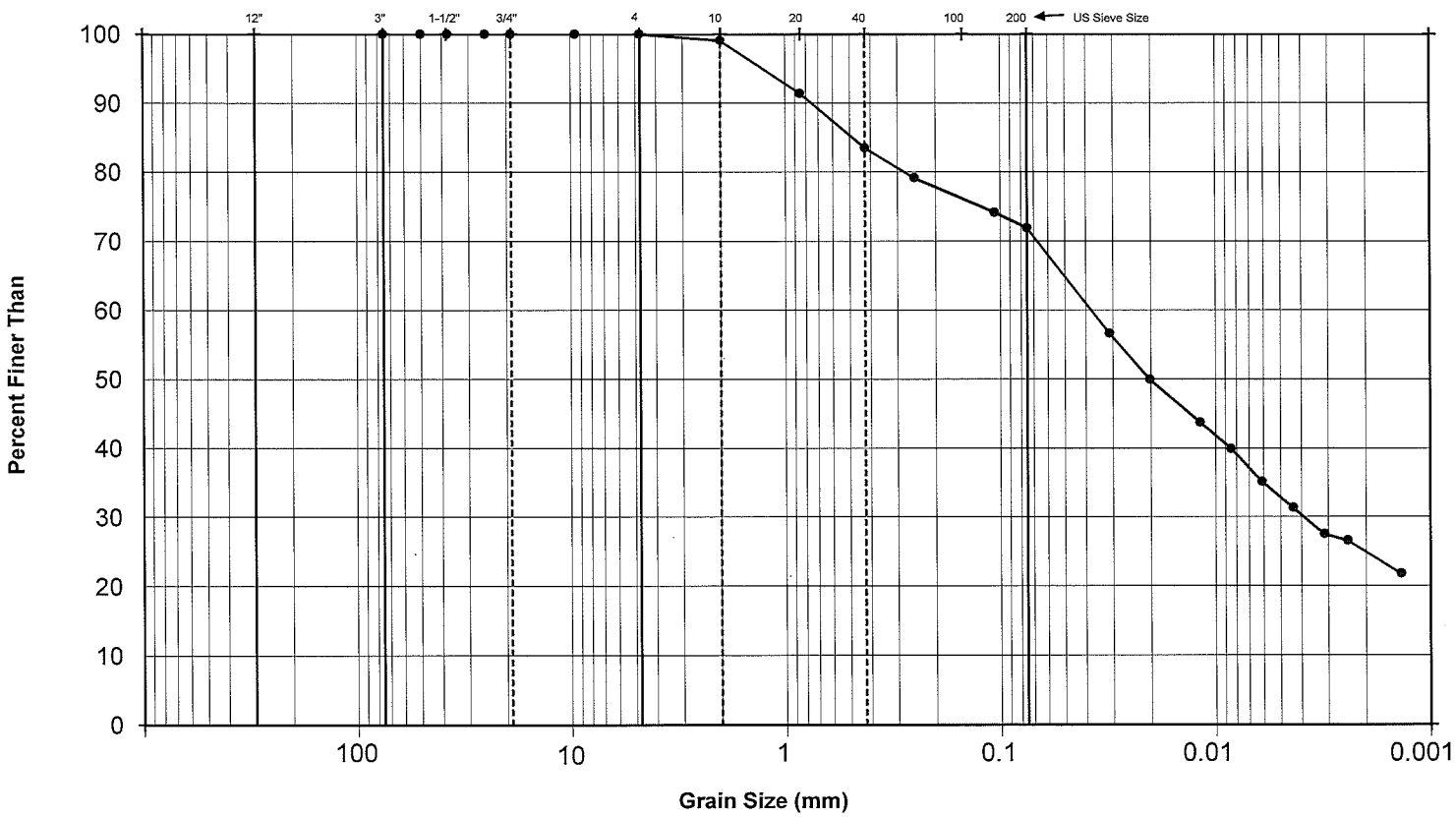
Comments:

Reviewed:

Golder Associates

Particle Size Analysis of Soil
(ASTM D422)

Project No.:	13-1359-0011.1000	Lab No.:	A849-18
Project Title:	Terracon Geotechnique		
Borehole:	GD-19/MW-28	Sample No.:	130145
Depth:	1.25-1.50m		
Date Tested:	7-Aug-13	By:	JL



Boulder Size	Cobble Size	Gravel Size: Coarse	Gravel Size: Fine	Sand Size: Coarse	Sand Size: Medium	Sand Size: Fine	Silt and Clay Size

Diameter of Sieve (mm)	Percent Passing (%)
75.0	100.0
50.0	100.0
37.5	100.0
25.0	100.0
19.0	100.0
9.5	100.0
4.75	100.0
2.0	99.1
0.850	91.4
0.425	83.5
0.250	79.1
0.106	74.2
0.075	71.9
0.031	56.7
0.020	50.0
0.012	43.8
0.008	39.9
0.006	35.2
0.004	31.3
0.003	27.5
0.002	26.6
0.001	21.8

Comments:

Reviewed: MB

Golder Associates

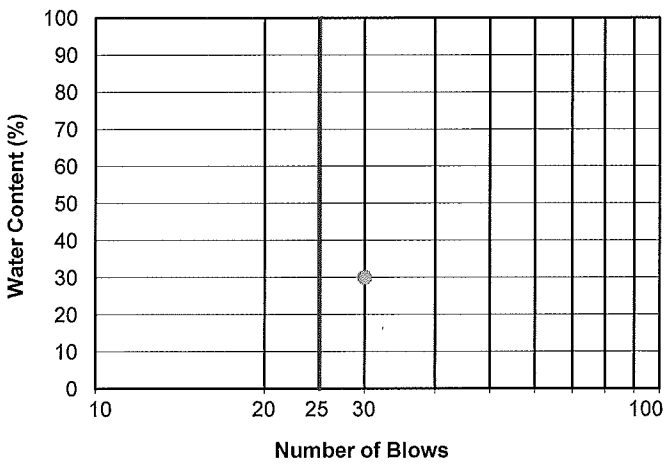
Atterberg Limits (ASTM D 4318)

Project No.: 13-1359-0011	Phase: 1000
Short Title: Terracon Geotechnique	Sched: A849-18
Tested By: JL	Date: 7-Aug-12

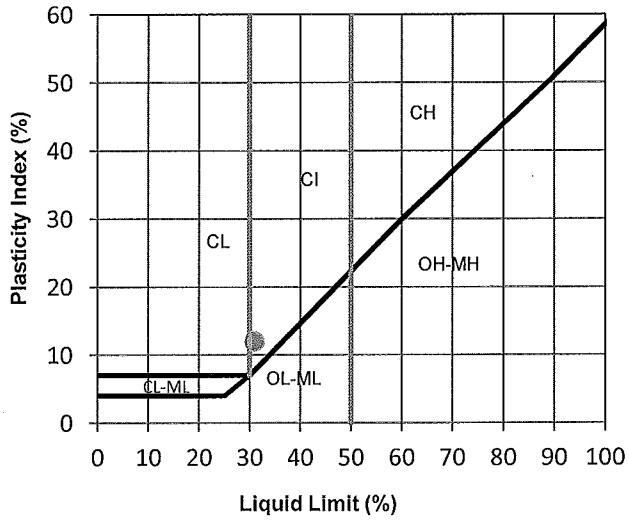
Borehole: GD-19/MW-28 Sample No.: 130145 Depth: 1.25-1.50m

Liquid Limit Determination:			Natural Water Content:		
Number of Blows	30	30	As Received Water Content (%)		15.0%
Blow Correction Factor	1.02	1.02	**Plastic Limit Determination:**		
Mass of wet sample + tare (g)	39.43	34.38	Mass of wet sample + tare (g)	22.93	23.74
Mass of dry sample + tare (g)	36.21	31.23	Mass of dry sample + tare (g)	21.12	21.71
Mass of tare (g)	25.50	20.75	Mass of tare (g)	11.41	10.86
Weight of Water (g)	3.22	3.15	Weight of Water (g)	1.81	2.03
Weight of dry soil (g)	10.71	10.48	Weight of dry soil (g)	9.71	10.85
Water Content (%)	30.1	30.1	Water Content (%)	18.64	18.71
Liquid Limit	31.0	31.0	Average Water Content (%)		18.68

Liquid Limit Test



Plasticity chart for soil passing 425 µm sieve



Liquid Limit =	31	%
Plastic Limit =	19	%
Plasticity Index =	12	

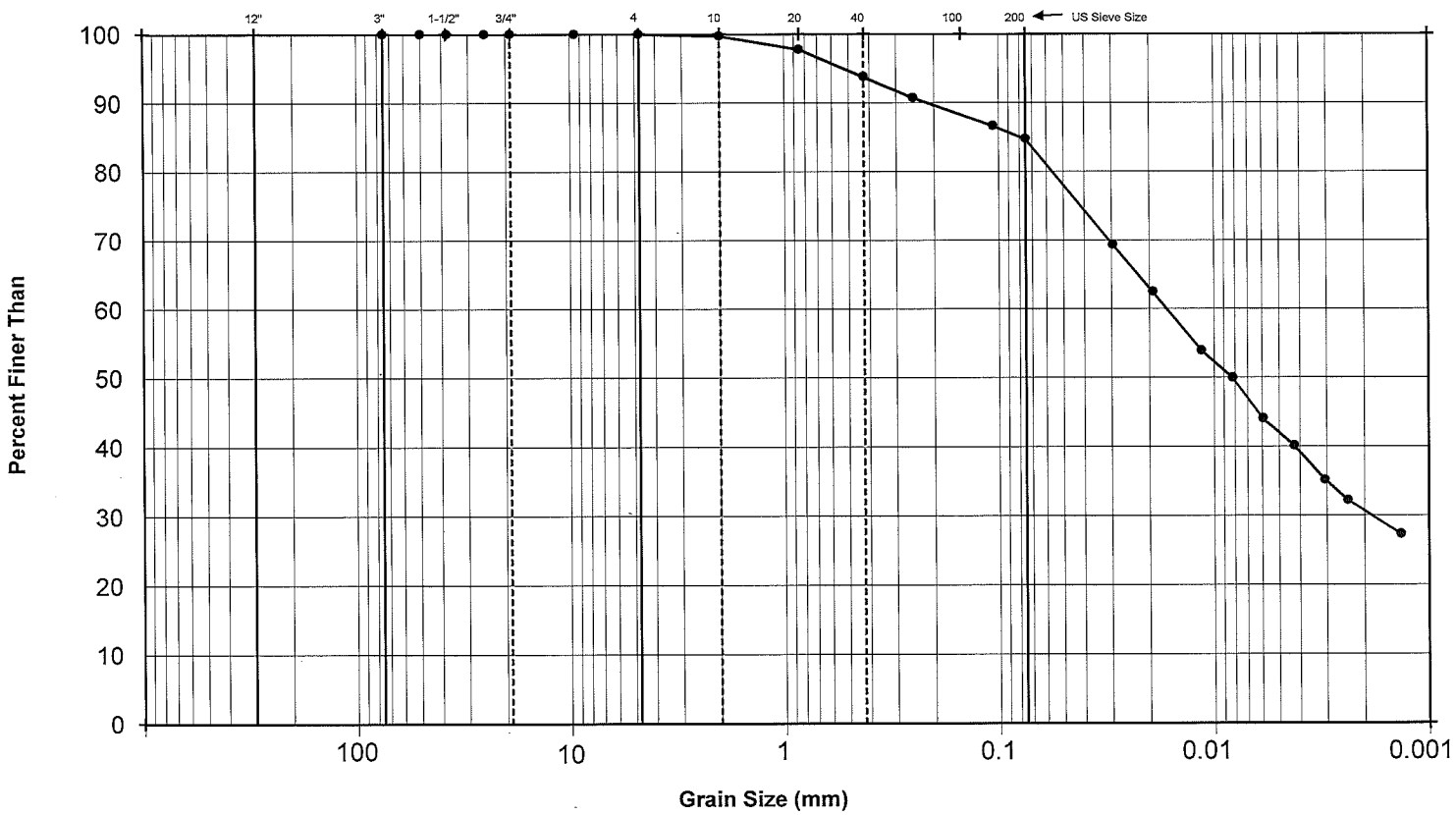
Comments:

Reviewed:

Golder Associates

Particle Size Analysis of Soil
(ASTM D422)

Project No.:	13-1359-0011.1000	Lab No.:	A849-16
Project Title:	Terracon Geotechnique		
Borehole:	GD-19/MW-28	Sample No.:	130143
Depth:	1.50-1.81m		
Date Tested:	7-Aug-13	By:	JL



Boulder Size	Cobble Size	Gravel Size: Coarse	Gravel Size: Fine	Sand Size: Coarse	Sand Size: Medium	Sand Size: Fine	Silt and Clay Size

Diameter of Sieve (mm)	Percent Passing (%)
75.0	100.0
50.0	100.0
37.5	100.0
25.0	100.0
19.0	100.0
9.5	100.0
4.75	100.0
2.0	99.7
0.850	97.8
0.425	93.8
0.250	90.8
0.106	86.7
0.075	84.8
0.030	69.4
0.019	62.5
0.011	53.9
0.008	50.0
0.006	44.1
0.004	40.1
0.003	35.2
0.002	32.3
0.001	27.3

Comments:

Reviewed: mb

Golder Associates

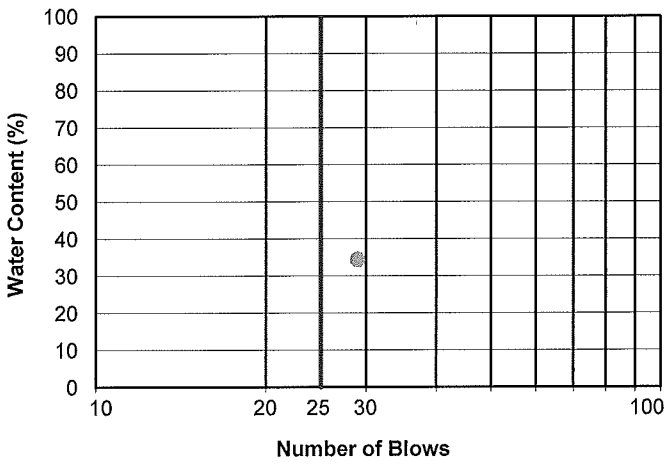
Atterberg Limits (ASTM D 4318)

Project No.: 13-1359-0011	Phase: 1000
Short Title: Terracon Geotechnique	Sched: A849-16
Tested By: JL	Date: 7-Aug-12

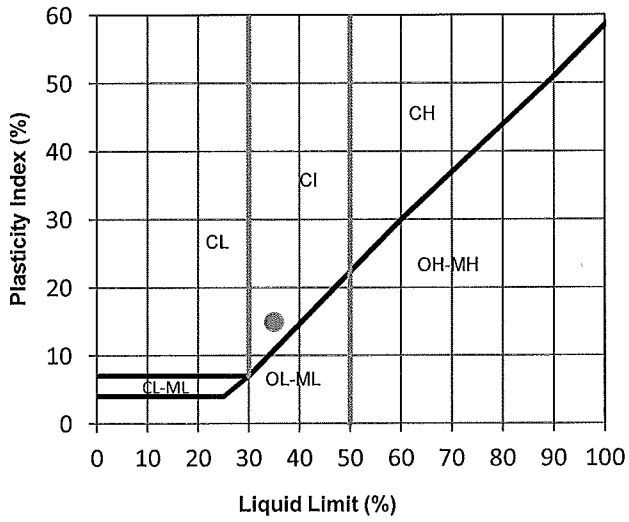
Borehole: GD-19/MW-28 Sample No.: 130143 Depth: 1.50-1.81m

Liquid Limit Determination:			Natural Water Content:		
Number of Blows	29	29	As Received Water Content (%)		20.6%
Blow Correction Factor	1.02	1.02	**Plastic Limit Determination:**		
Mass of wet sample + tare (g)	36.41	37.42	Mass of wet sample + tare (g)	22.40	21.45
Mass of dry sample + tare (g)	33.55	34.14	Mass of dry sample + tare (g)	20.49	19.60
Mass of tare (g)	25.28	24.63	Mass of tare (g)	10.84	10.34
Weight of Water (g)	2.86	3.28	Weight of Water (g)	1.91	1.85
Weight of dry soil (g)	8.27	9.51	Weight of dry soil (g)	9.65	9.26
Water Content (%)	34.6	34.5	Water Content (%)	19.79	19.98
Liquid Limit	35.0	35.0	Average Water Content (%)		19.89

Liquid Limit Test



Plasticity chart for soil passing 425 µm sieve



Liquid Limit =	35	%
Plastic Limit =	20	%
Plasticity Index =	15	

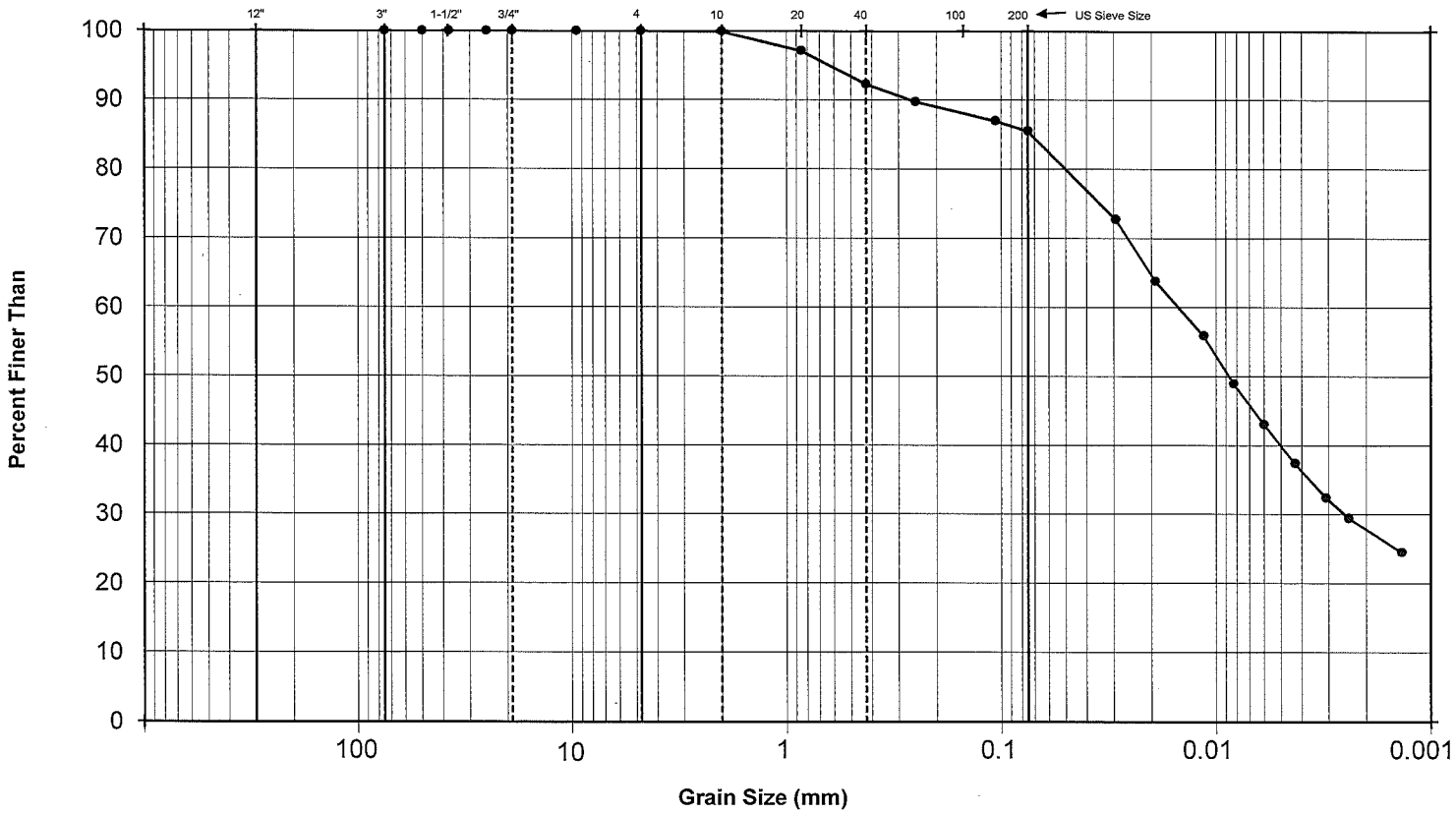
Comments:

Reviewed:

Golder Associates

Particle Size Analysis of Soil
(ASTM D422)

Project No.:	13-1359-0011.1000	Lab No.:	A849-19
Project Title:	Terracon Geotechnique		
Borehole:	GD-19/MW-28	Sample No.:	130146
Depth:	1.55-1.85m		
Date Tested:	7-Aug-13	By:	JL



Boulder Size	Cobble Size	Gravel Size: Coarse	Gravel Size: Fine	Sand Size: Coarse	Sand Size: Medium	Sand Size: Fine	Silt and Clay Size

Diameter of Sieve (mm)	Percent Passing (%)
75.0	100.0
50.0	100.0
37.5	100.0
25.0	100.0
19.0	100.0
9.5	100.0
4.75	100.0
2.0	99.9
0.850	97.1
0.425	92.3
0.250	89.8
0.106	87.0
0.075	85.6
0.029	72.7
0.019	63.8
0.011	55.9
0.008	49.0
0.006	43.1
0.004	37.4
0.003	32.4
0.002	29.5
0.001	24.5

Comments:

Reviewed: MB

GOLDER ASSOCIATES LTD.

Golder Associates

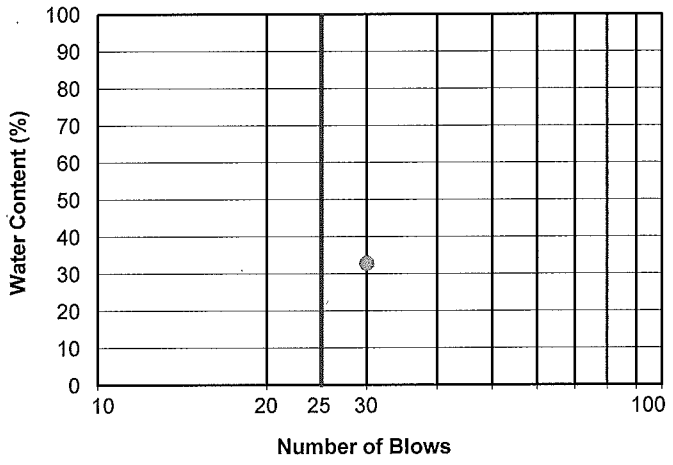
Atterberg Limits (ASTM D 4318)

Project No.: 13-1359-0011	Phase: 1000
Short Title: Terracon Geotechnique	Sched: A849-19
Tested By: JL	Date: 7-Aug-12

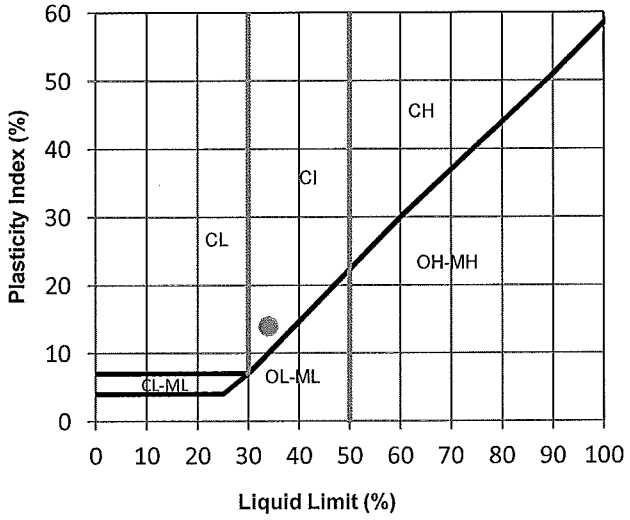
Borehole: GD-19/MW-28 Sample No.: 130146 Depth: 1.55-1.85m

Liquid Limit Determination:			Natural Water Content:		
Number of Blows	30	30	As Received Water Content (%)		20.0%
Blow Correction Factor	1.02	1.02	**Plastic Limit Determination:**		
Mass of wet sample + tare (g)	39.57	42.13	Mass of wet sample + tare (g)	19.53	20.00
Mass of dry sample + tare (g)	36.38	38.72	Mass of dry sample + tare (g)	17.85	18.23
Mass of tare (g)	26.68	28.32	Mass of tare (g)	9.37	9.13
Weight of Water (g)	3.19	3.41	Weight of Water (g)	1.68	1.77
Weight of dry soil (g)	9.7	10.4	Weight of dry soil (g)	8.48	9.10
Water Content (%)	32.9	32.8	Water Content (%)	19.81	19.45
Liquid Limit	34.0	34.0	Average Water Content (%)		19.63

Liquid Limit Test



Plasticity chart for soil passing 425 µm sieve



Liquid Limit =	34	%
Plastic Limit =	20	%
Plasticity Index =	14	

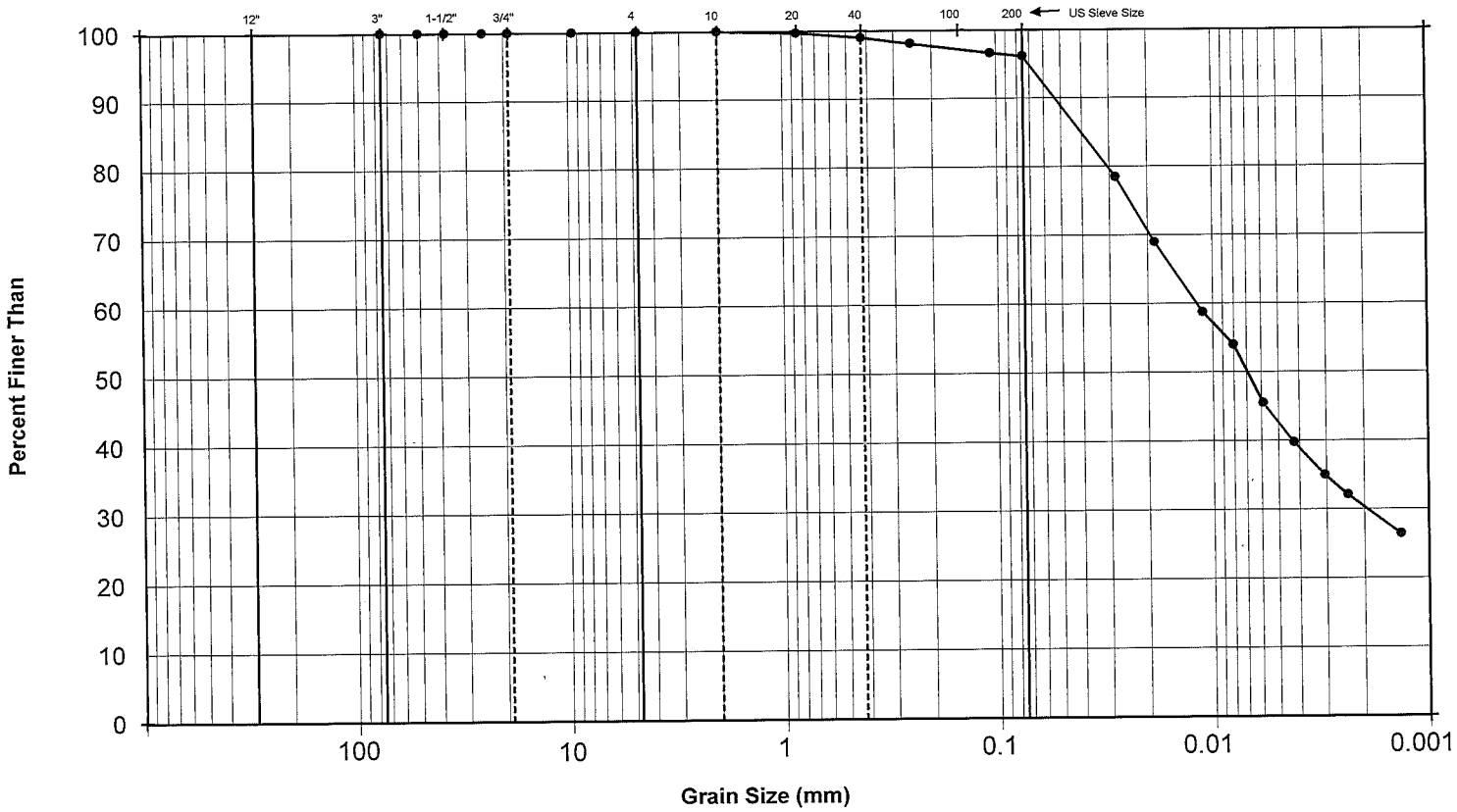
Comments:

Reviewed:

Golder Associates

Particle Size Analysis of Soil
(ASTM D422)

Project No.:	13-1359-0011.1000	Lab No.:	A849-23
Project Title:	Terracon Geotechnique		
Borehole:	GD-19/MW-28	Sample No.:	130147
Depth:	2.00-2.50m		
Date Tested:	7-Aug-13	By:	JL



Boulder Size	Cobble Size	Gravel Size: Coarse	Gravel Size: Fine	Sand Size: Coarse	Sand Size: Medium	Sand Size: Fine	Silt and Clay Size

Diameter of Sieve (mm)	Percent Passing (%)
75.0	100.0
50.0	100.0
37.5	100.0
25.0	100.0
19.0	100.0
9.5	100.0
4.75	100.0
2.0	100.0
0.850	99.7
0.425	99.0
0.250	98.1
0.106	96.6
0.075	96.1
0.028	78.5
0.019	69.0
0.011	58.8
0.008	54.0
0.006	45.4
0.004	39.7
0.003	35.0
0.002	32.1
0.001	26.4

Comments:

Reviewed:

Golder Associates

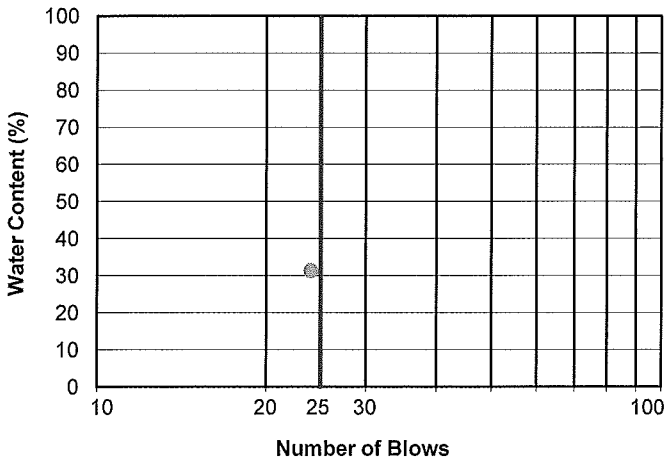
Atterberg Limits (ASTM D 4318)

Project No.: 13-1359-0011	Phase: 1000
Short Title: Terracon Geotechnique	Sched: A849-23
Tested By: JL	Date: 7-Aug-12

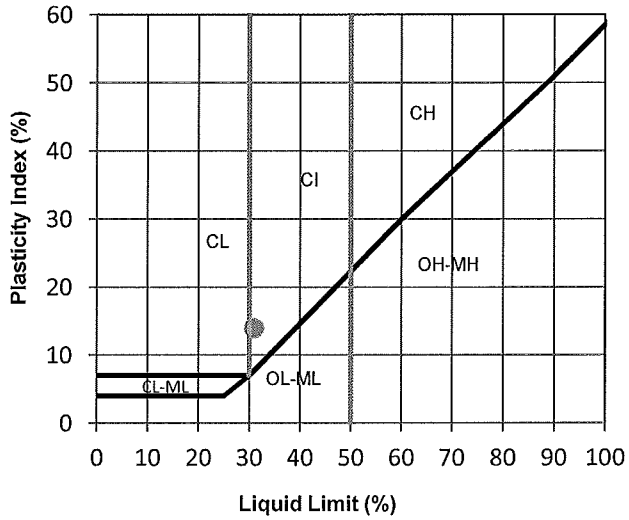
Borehole: GD-19/MW-28 Sample No.: 130147 Depth: 2.00-2.50m

Liquid Limit Determination:			Natural Water Content:		
Number of Blows	24	24	As Received Water Content (%)		14.9%
Blow Correction Factor	1.00	1.00	**Plastic Limit Determination:**		
Mass of wet sample + tare (g)	31.78	42.54	Mass of wet sample + tare (g)	19.85	22.09
Mass of dry sample + tare (g)	28.84	39.31	Mass of dry sample + tare (g)	18.45	20.41
Mass of tare (g)	19.46	29.02	Mass of tare (g)	10.31	10.65
Weight of Water (g)	2.94	3.23	Weight of Water (g)	1.40	1.68
Weight of dry soil (g)	9.38	10.29	Weight of dry soil (g)	8.14	9.76
Water Content (%)	31.3	31.4	Water Content (%)	17.20	17.21
Liquid Limit	31.0	31.0	Average Water Content (%)		17.21

Liquid Limit Test



Plasticity chart for soil passing 425 µm sieve



Liquid Limit =	31	%
Plastic Limit =	17	%
Plasticity Index =	14	

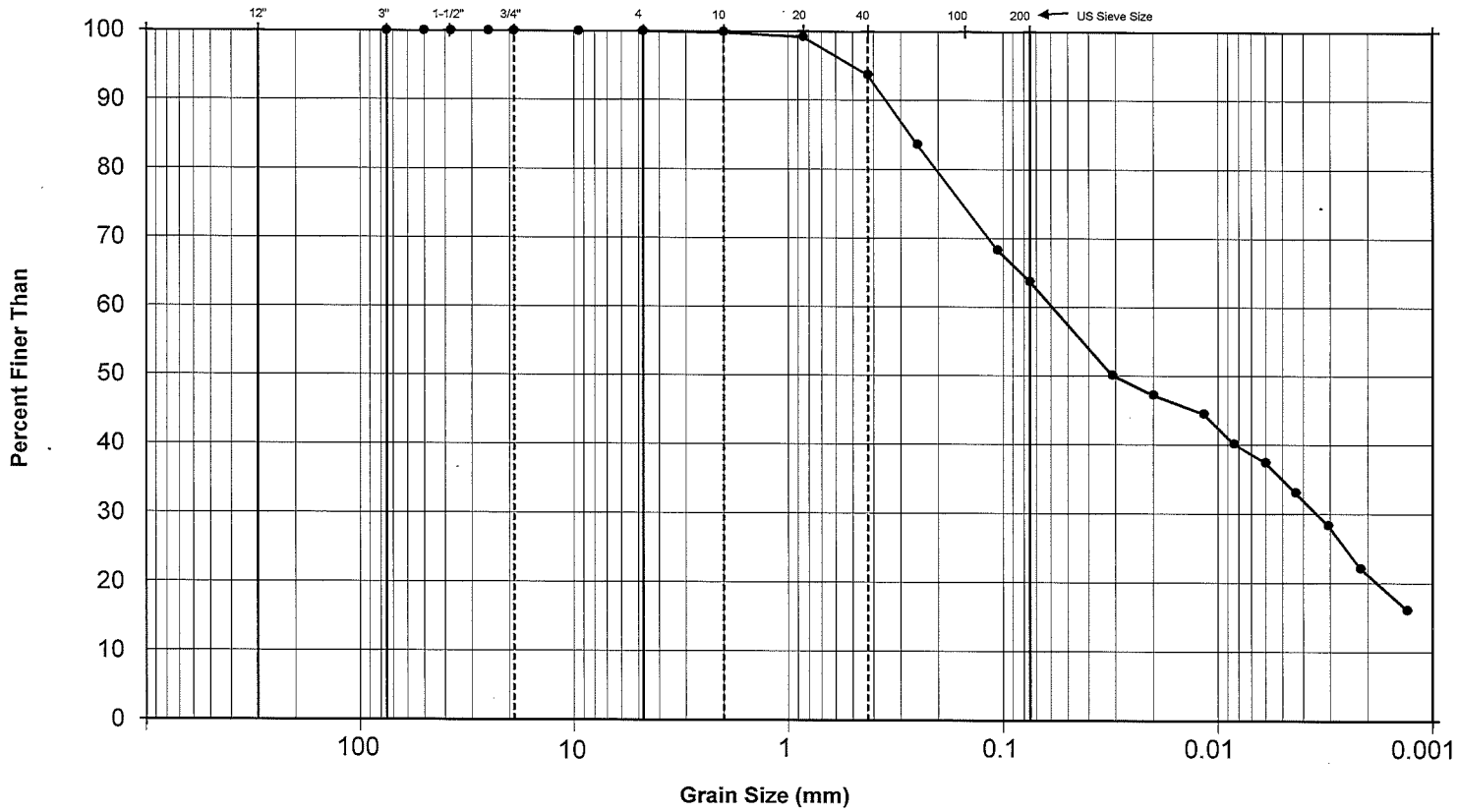
Comments:

Reviewed:

Golder Associates

Particle Size Analysis of Soil
(ASTM D422)

Project No.:	13-1359-0011	Lab No.:	A928-07
Project Title:	Fortune Minerals Lab Testing/Terracon Geotechnique		
Borehole:	GP19	Sample No.:	130452
Depth:	47.15-47.56 m		
Date Tested:	4-Nov-13	By:	DS



Boulder Size	Cobble Size	Coarse	Fine	Coarse	Medium	Fine	Silt and Clay Size
		Gravel Size		Sand Size			

Diameter of Sieve (mm)	Percent Passing (%)
75.0	100.0
50.0	100.0
37.5	100.0
25.0	100.0
19.0	100.0
9.5	100.0
4.75	100.0
2.0	99.9
0.850	99.2
0.425	93.8
0.250	83.7
0.106	68.3
0.075	63.8
0.031	50.2
0.020	47.2
0.012	44.6
0.008	40.2
0.006	37.5
0.004	33.1
0.003	28.4
0.002	22.2
0.001	16.1

Comments:

Reviewed:

GOLDER ASSOCIATES LTD.

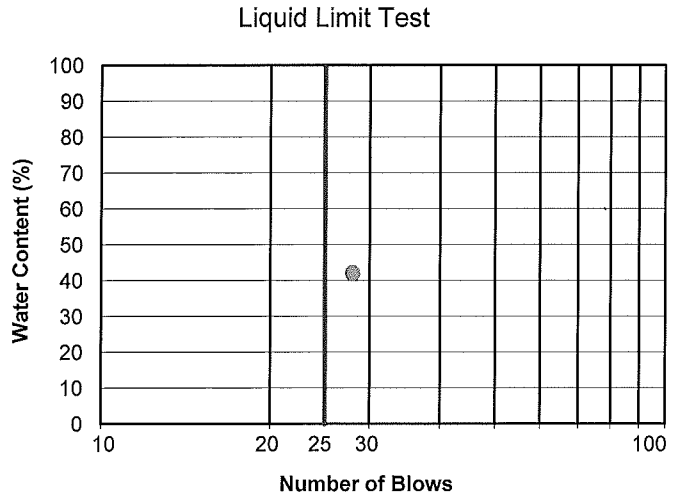
Golder Associates

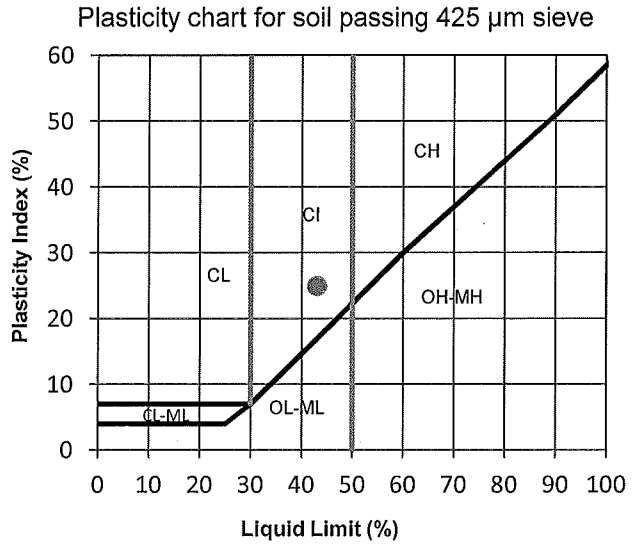
Atterberg Limits (ASTM D 4318)

Project No.:	13-1359-0011	Phase:	-
Short Title:	Fortune Minerals Lab Testing/Terracon Geotechnique-Arctos Anthracite	Sched:	A928-07
Tested By:	CG	Date:	4-Nov-13

Borehole: GP19 Sample No.: 130452 Depth: 47.15-47.56 m

Liquid Limit Determination:			Natural Water Content:		
Number of Blows	28	28	As Received Water Content (%)		14.2%
Blow Correction Factor	1.01	1.01	**Plastic Limit Determination:**		
Mass of wet sample + tare (g)	43.34	48.69	Mass of wet sample + tare (g)	19.73	22.68
Mass of dry sample + tare (g)	36.91	41.61	Mass of dry sample + tare (g)	18.27	20.93
Mass of tare (g)	21.69	24.77	Mass of tare (g)	9.73	11.24
Weight of Water (g)	6.43	7.08	Weight of Water (g)	1.46	1.75
Weight of dry soil (g)	15.22	16.84	Weight of dry soil (g)	8.54	9.69
Water Content (%)	42.2	42.0	Water Content (%)	17.10	18.06
Liquid Limit	43.0	43.0	Average Water Content (%)		17.58

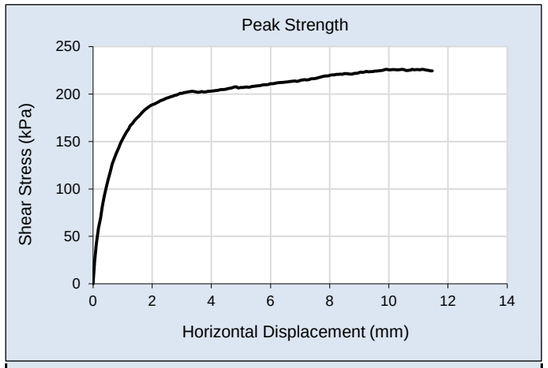




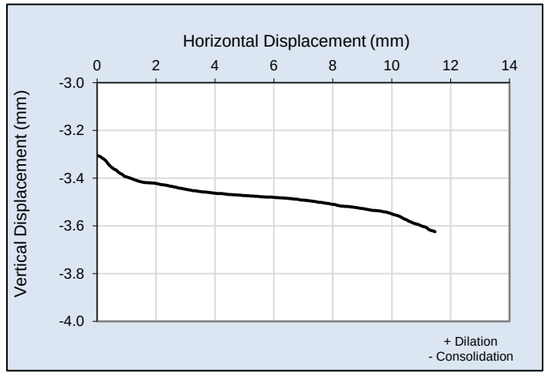
Liquid Limit =	43	%
Plastic Limit =	18	%
Plasticity Index =	25	

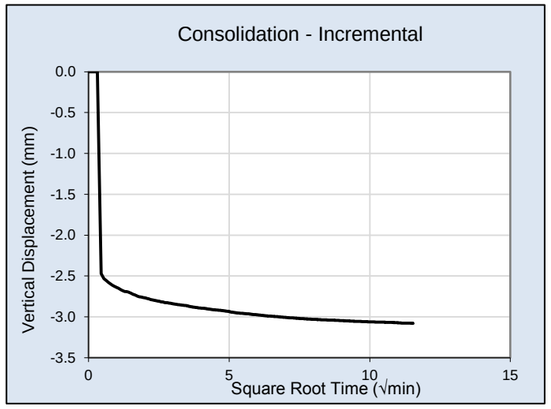
Comments:

Reviewed:



Normal Load σ', kPa	500	Shear Rate, mm/min	0.0337





Consolidation Test Results

T90	10.24	min
T50	2.39	min
Shear Rate	0.0334	mm/min
Delta H	-3.08	mm

Sample Identification

Project #	13-1359-0011	Borehole	GP-19
Client	Arctos/Anthracite	Sample	130452
Project	Fortune Minerals	Depth	47.15-47.56m
Location	-		

Initial - Sample Dimensions

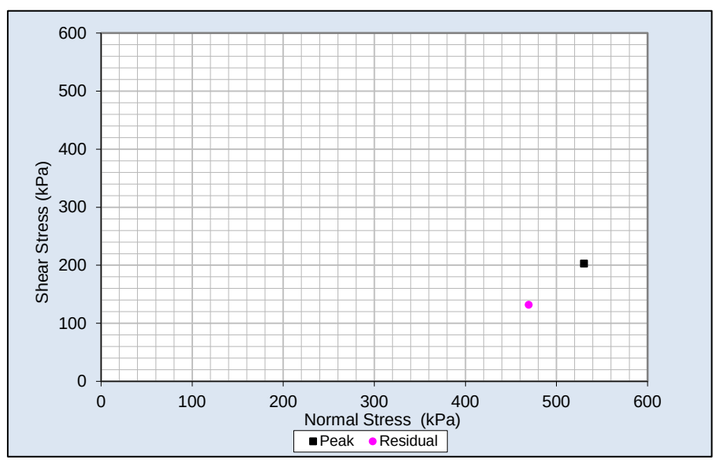
Trial Number	1
Shear box geometry	Circle
Diameter, mm	63.30
Depth, mm	25.16
Area, cm^2	31.47
Volume, cm^3	79.18

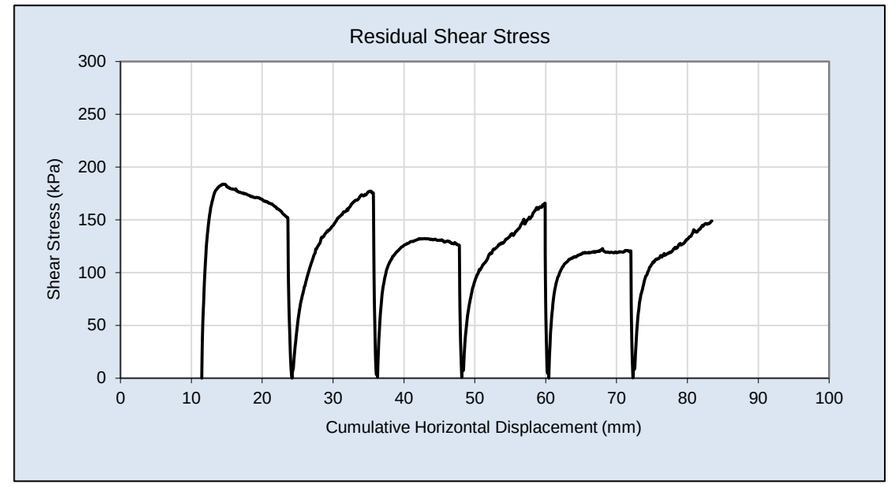
Weight Volume Relationships

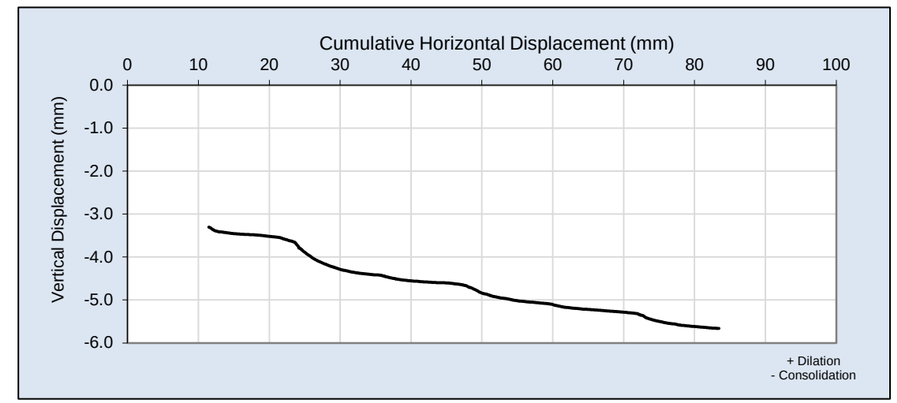
Test#		A928-07
Sample Type		Undisturbed
Initial Wet Wt, g		175.19
Initial Dry Wt, g		153.41
Initial Water Content, %		14.20
Final Water Content, %		15.98
Initial γ_{dry}, kg/m^3		1937
Final γ_{dry}, kg/m^3	(after consolidation)	2208
Specific Gravity	(assumed)	2.65
Initial Void Ratio, e		0.368

Test Results (Area Corrected)

Displacement at Failure, mm	3.424
Peak Normal Stress, kPa	531
Peak Shear Stress, kPa	203
Displacement at Residual, mm	80.039
Residual Normal Stress, kPa	470
Residual Shear Stress, kPa	132
Shear rate for Residual Stress, mm/min	0.0328







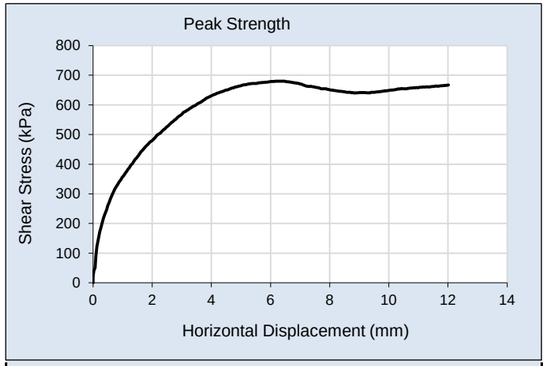
Index Test Results

Water Content (%)	14.20
Liquid Limit (%)	43
Plastic Limit (%)	18
Plasticity Index	25

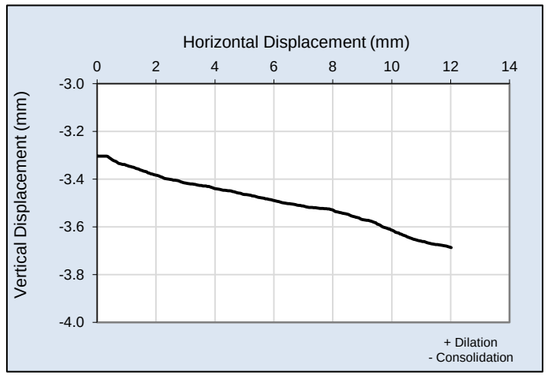
Equipment - DS-KWSOIL s/n: 905

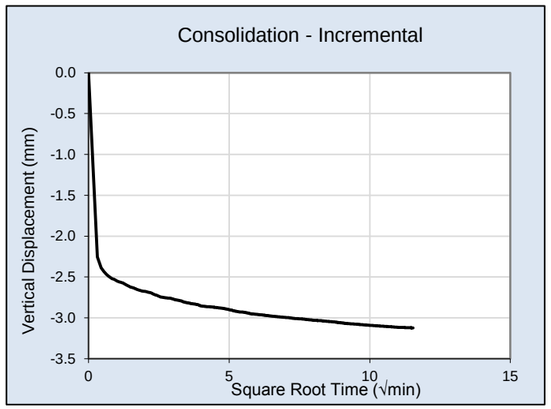
Axial LPT Serial #	4142-ch3
Normal Load Cell Serial #	4142-ch4
Shear Load Cell Serial #	4142-ch1
Vertical LPT Serial #	4142-ch2

Client: Arctos/Anthracite	Fortune Minerals Lab Testing/Terracon Geotechnique Arctos Anthracite Project
Golder Associates	DIRECT SHEAR TEST Borehole GP-19 Sample 130452
PROJECT: 13-1359-0011	Check: MB Review: DJH



Normal Load σ', kPa	**1000**	Shear Rate, mm/min	0.0511





Consolidation Test Results

T90	6.76	min
T50	1.58	min
Shear Rate	0.0507	mm/min
Delta H	-3.12	mm

Sample Identification

Project #	13-1359-0011	Borehole	GP-19
Client	Arctos/Anthracite	Sample	130452
Project	Fortune Minerals	Depth	47.15-47.56m
Location	-		

Initial - Sample Dimensions

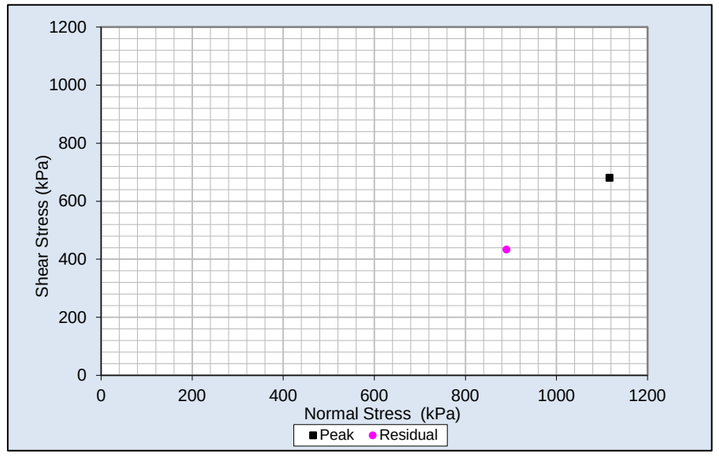
Trial Number	1
Shear box geometry	Circle
Diameter, mm	63.30
Depth, mm	25.16
Area, cm^2	31.47
Volume, cm^3	79.18

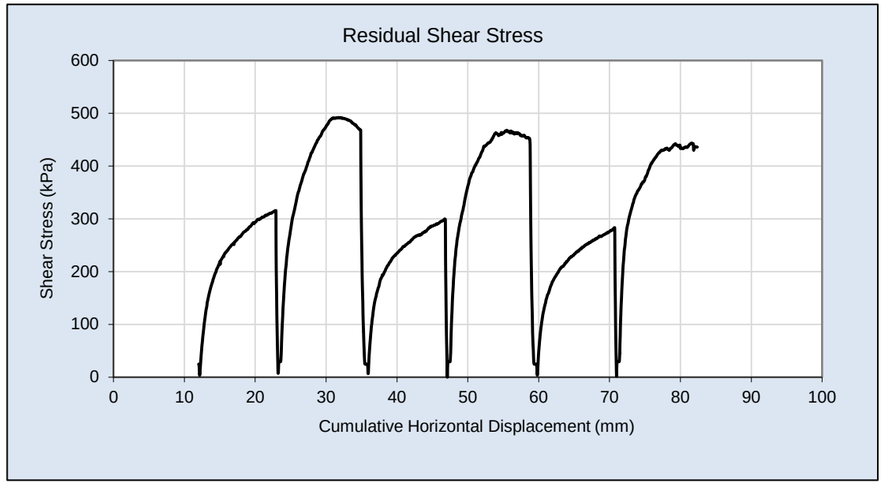
Weight Volume Relationships

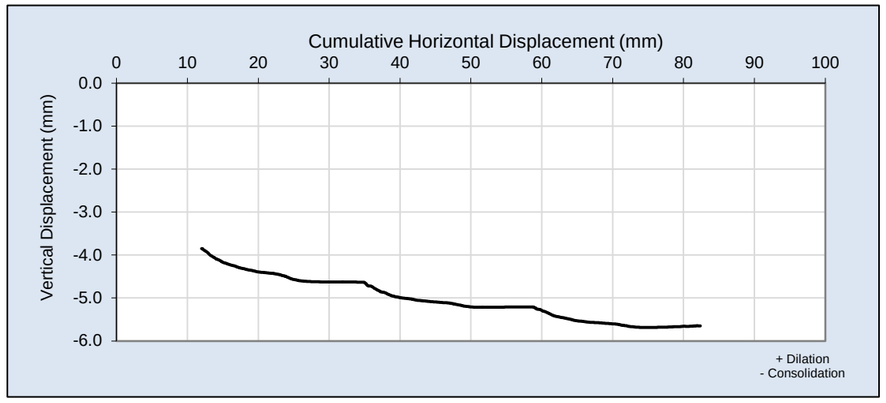
Test#		A928-07
Sample Type		Undisturbed
Initial Wet Wt, g		180.13
Initial Dry Wt, g		161.32
Initial Water Content, %		11.66
Final Water Content, %		12.17
Initial γ_{dry}, kg/m^3		2037
Final γ_{dry}, kg/m^3	(after consolidation)	2326
Specific Gravity	(assumed)	2.65
Initial Void Ratio, e		0.301

Test Results (Area Corrected)

Displacement at Failure, mm	6.225
Peak Normal Stress, kPa	1118
Peak Shear Stress, kPa	680
Displacement at Residual, mm	78.619
Residual Normal Stress, kPa	891
Residual Shear Stress, kPa	433
Shear rate for Residual Stress, mm/min	0.0493







Index Test Results

Water Content (%)	14.20
Liquid Limit (%)	43
Plastic Limit (%)	18
Plasticity Index	25

Equipment - DS-KWSOIL s/n: 906

Axial LPT Serial #	4143-ch3
Normal Load Cell Serial #	4143-ch4
Shear Load Cell Serial #	4143-ch1
Vertical LPT Serial #	4143-ch2

Client: Arctos Anthracite Joint Venture	Fortune Minerals Lab Testing/Terracon Geotechnique Arctos Anthracite Project
Golder Associates	DIRECT SHEAR TEST Borehole GP-19 Sample 130452
PROJECT: 13-1359-0011	Check: MB Review: DJH

APPENDIX F

Seismic Data

Government of Canada Gouvernement du Canada Canada

Natural Resources Canada

Determine 2010 National Building Code of Canada seismic hazard values

Latitude and longitude values should be entered in decimal degree (DD.DDDD) or degree:minute:second (DD:MM:SS.S) format. UTM coordinates can be converted to latitude and longitude using the Canadian Spatial Reference System Service's online **GSRUG** application.

For more information see **seismic hazard in Canada**

Supporting documentation and calculators for other editions of the code

2010 National Building Code of Canada seismic hazard calculator

Jump to search results

Latitude

57.2092

Longitude (in Canada should be entered as negative values)

-128.8344

Number of closest points for interpolation

7 points

Parameter to display on map (values for all 5 parameters will be determined)

Sa (0.2)

Enter location place name (optional)

Type of structure (optional)

Company/Organization (optional)

Name (optional)

Email (optional)

Personal Information Collection Statement

The personal information you provide using the seismic hazard calculator form for the seismic hazard calculator is collected under the authority of the Resources and Technical Surveys Act and will be used by Natural Resources Canada to conduct research into earthquakes in Canada. The information may

also be used to contact you for follow-up research or to confirm the data provided.

Please note that the information you provide using the seismic hazard calculator may be routed through an American or other internationally-based server. However, in the event that this occurs, the information will be deleted from the American or internationally-based server after one week.

There are no legal or administrative consequences for refusing to provide the personal information requested. Under the Privacy Act, you have rights of access to, correction of, and protection of personal information.

The information you provide using this form is described in the following standard Personal Information Bank (PIB): Public Communications - PSU 914. For more information about this PIB and your privacy rights, please consult Info Source: Sources of Federal Government and Employee Information, which is published on the Internet by the Treasury Board of Canada Secretariat at: http://infosource.gc.ca/index-eng.asp.

Calculate

Page will reload with results inserted at the end of the page under the heading "Search Results"

Search Results

2010 National Building Code of Canada interpolated seismic hazard values

Determined for a 2% in 50 year (0.000404 per annum) probability of exceedence. Values are for "firm ground" (NBCC 2010 soil class C - average shear wave velocity 360-750 m/s). Median (50th percentile) values are given in units of g for spectral acceleration (Sa(T), where T is the period in seconds) and peak ground acceleration (PGA). Only 2 significant figures are to be used.

These values have been interpolated Using Shepards method from a 10 km spaced grid of points. Depending on the gradient of the nearby points, values at this location calculated directly from the hazard program may vary. More than 95 percent of interpolated values are within 2 percent of the calculated values.

Site Coordinates:**57.2092** °N **128.8343**°W

User File Reference:

Requested by:**,**

National Building Code interpolated seismic hazard values

2%/50 years (0.000404 per annum) probability

Sa(0.2)	Sa(0.5)	Sa(1.0)	Sa(2.0)	PGA
0.095 g	**0.063 g**	**0.046 g**	**0.030 g**	**0.046 g**

Interpolated seismic hazard values at other probabilities

40%/50 years (0.01 per annum)

Sa(0.2)	Sa(0.5)	Sa(1.0)	Sa(2.0)	PGA
0.018 g	0.018 g	0.014 g	0.009 g	0.009 g

10%/50 years (0.0021 per annum)

Sa(0.2)	Sa(0.5)	Sa(1.0)	Sa(2.0)	PGA

0.041 g	0.034 g	0.026 g	0.018 g	0.022 g

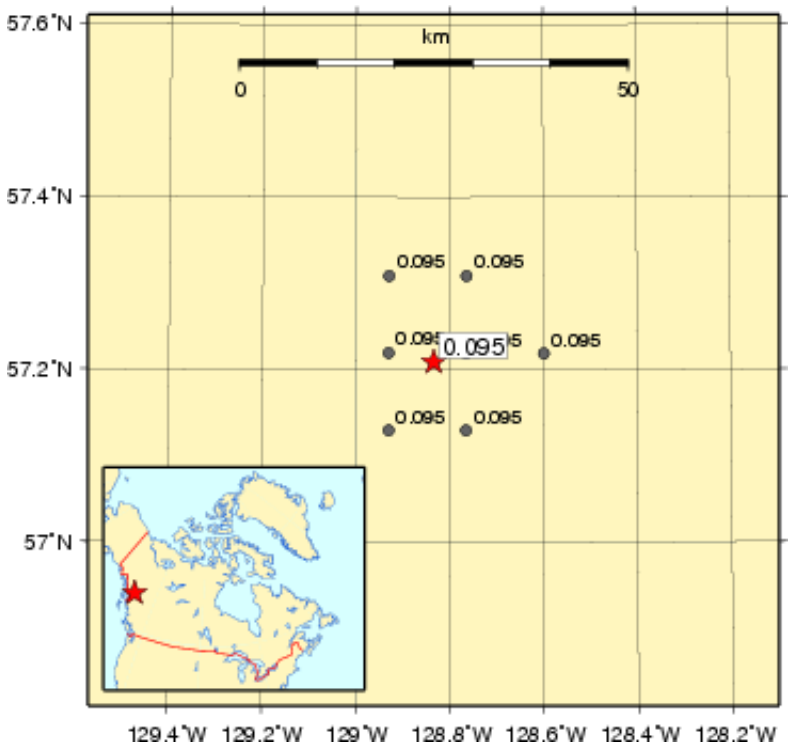
5%/50 years (0.001 per annum)

Sa(0.2)	Sa(0.5)	Sa(1.0)	Sa(2.0)	PGA
0.057 g	0.045 g	0.034 g	0.023 g	0.031 g

Generate a pdf version of the interpolated NBCC 2010 values

Nearby points values for National Building Code probabilities

Distance		Latitude	Longitude	Sa(0.2)	Sa(0.5)	Sa(1.0)	Sa(2.0)	PGA
14.210	km	57.219	-128.599	0.095	0.059	0.044	0.029	0.045
12.501	km	57.309	-128.930	0.095	0.063	0.046	0.031	0.046
11.876	km	57.309	-128.764	0.095	0.060	0.044	0.030	0.045
10.529	km	57.130	-128.930	0.095	0.066	0.048	0.032	0.048
9.748	km	57.130	-128.765	0.095	0.063	0.046	0.030	0.047
5.886	km	57.220	-128.930	0.095	0.064	0.047	0.031	0.047
4.313	km	57.219	-128.765	0.095	0.062	0.045	0.030	0.046
Interpolated		57.2092	-128.8343	0.095	0.063	0.046	0.030	0.046



Date modified: 2013-07-23

Government of Canada Gouvernement du Canada

Canada

Natural Resources Canada

Natural Resources Canada > Hazards > Natural Hazards > Earthquakes

Search the Earthquake Database

This form makes available seismic bulletin data from the **National Earthquake Database (NEDB)** since 1985. As some parameters like focal depth are poorly known for most earthquakes, they are often specified only as nominal or default values. Before using the data, please **reach us by email** for additional information on the limitations of the dataset. Information for recent earthquakes (within the last year) should be considered preliminary, possibly incomplete, and subject to change. Lastly, the information for mining-related-event and blasts may not be complete.

Use of this data is subject to the **END-USER AGREEMENT FOR DIGITAL DATA** of the GSC. In addition, all users of this data are asked to include a **citation to Earthquakes Canada** in their work.

Note that all queries and data use **Coordinated Universal Time** (UTC).
The current time is 2013-12-19 23:28:21 UTC.

Longitudes in Canada should be entered as negative values.

Search Parameters

Jump to search results

Date.Time

From (YYYY/MM/DD HH:MM:SS):
1985/01/01 23:26:

To (YYYY/MM/DD HH:MM:SS):
2013/12/19 23:26:

Depth

From (km):
0

To (km):
100

Magnitude

From ($M_{[n|s|l|?]}$):
-3

To ($M_{[n|s|l|?]}$):
9.9

Region

Choose one of the following and fill out its corresponding section below
Radius Region

If you chose Radius above fill in the options below
Radius options

Latitude
57.2092

Radius (km)
250

Longitude

-128.8344

If you chose Region above fill in the options below
Region options

North Region
90

East Region
-40

South Region
41

West Region
-150

Type

Types of events to include

- [x] Quakes
- [x] Mining events
- [x] Blasts
- [x] Induced

Felt

- [ ] Only show earthquakes that were felt

Sorting

Sorting Options

Date Latitude Longitude depth mag

Order

Ordering Options

Ascending Descending

Output

Output Options

HTML Text XLS CSV

Note: only html will allow map below to be visible

Submit Request

Searches return earthquakes from 1985 to the present. The database contains nearly 56900 earthquakes in or near Canada and nearly 14500 mining-related events, mining and construction blasts, and other induced events between 1985-2009. The search tool will time out and fail if very large sets of data are requested. If your request fails to complete, try selecting a smaller time period and/or a smaller area to search.

See also the following Open file, which contains all earthquakes from the database in or near Canada with a magnitude of 2.5 and greater for the time period of 1627 to 2008. It can be downloaded from the GeoPub website:

Seismic Hazard Earthquake Epicentre File (SHEEF) used in the fourth generation seismic hazard maps of Canada. Halchuk, S. Geological Survey of Canada, Open File 6208, 2009

Search Results

Date	Time(UT)	Lat	Long	Depth	Mag	Region and Comment
2012/06/07	23:19:23	57.797	-124.844	0.0g	4.4ML	168 km WSW of Fort Nelson
2013/04/29	20:19:50	56.324	-131.232	5.0g	4.2Mw	88 km WNW of Stewart
2008/02/11	10:12:04	57.400	-125.547	1.0g	4.1ML	229 km WSW of Fort Nelson
2004/09/07	02:21:03	56.797	-131.378	5.0g	3.9ML	129 km WNW of Stewart
2006/09/07	12:41:19	57.392	-132.615	1.0g	3.6ML	147 km ESE of Juneau
2009/11/09	04:07:06	57.699	-132.497	1.0g	3.5ML	131 km ESE of Juneau
2012/01/06	14:23:21	57.185	-131.938	1.0g	3.5ML	179 km WSW of Dease Lk.
1993/11/09	00:11:16	57.566	-132.748	5.0g	3.5ML	Northern Coast Mountains
2005/08/11	15:44:05	56.991	-131.906	1.0g	3.4ML	Northern Coast Mountains
2000/11/11	16:21:10	56.383	-131.072	1.0g	3.4ML	84 km WNW of Stewart
2008/11/11	06:25:26	55.805	-130.308	1.0g	3.4ML	24 km WSW of Stewart
1986/02/01	05:00:29	57.780	-132.500	18.0g	3.4ML	UNLOCATED AFTERSHOCKS AT 05:13
1992/08/13	19:09:03	57.108	-130.954	10.0g	3.4ML	NORTHERN COAST MOUNTAINS
1985/11/30	17:55:13	56.769	-131.135	18.0g	3.3ML	126 km S from Telegraph Creek
1986/10/04	04:11:40	57.845	-132.685	18.0g	3.2ML	90 km W from Telegraph Creek
1992/01/13	20:56:13	57.791	-126.058	10.0g	3.2ML	SOUTH of MUNCHO LAKE
2008/01/18	00:36:09	55.829	-128.650	1.0g	3.2ML	84 km E of Stewart
2011/12/25	05:27:52	57.737	-132.182	1.0g	3.1ML	146 km ESE of Juneau
1998/10/05	10:04:08	58.180	-127.086	10.0g	3.1ML	Cassiar Mountains
1985/09/04	11:03:15	57.674	-125.534	18.0g	3.1ML	183 km NE from Bear Lake
2008/01/18	14:40:31	55.944	-129.756	5.0g	3.1ML	14 km E of Stewart
2009/01/19	20:11:07	56.088	-128.126	1.0g	3.0ML	116 km E of Stewart
1998/10/05	09:59:47	58.131	-127.069	10.0g	3.0ML	Cassiar Mountains
2009/03/20	08:17:09	56.151	-127.779	10.0g	3.0ML	139 km E of Stewart
2011/02/16	05:22:35	57.182	-132.900	1.0g	2.9ML	147 km E of Sitka
1992/08/13	19:29:17	57.107	-130.925	10.0g	2.9ML	NORTHERN COAST MOUNTAINS
2006/11/17	01:07:25	57.533	-132.699	1.0g	2.9ML	132 km SE of Juneau
2005/12/12	08:08:37	56.952	-131.898	10.0g	2.9ML	Northern Coast Mountains
2002/12/11	17:13:01	55.344	-130.819	10.0g	2.9ML	84 km SW of Stewart
2011/01/03	23:45:33	57.549	-132.871	10.0g	2.9ML	124 km ESE of Juneau
1994/07/15	22:20:50	57.968	-126.378	18.0g	2.9ML	Northwest of Williston Lake
2011/10/26	23:06:45	57.895	-132.625	5.0g	2.9ML	114 km ESE of Juneau

2011/12/24	01:56:55	57.602	-132.806	10.0g	2.9ML	123 km ESE of Juneau
2004/09/06	08:46:13	56.771	-131.470	1.0g	2.8ML	130 km WNW of Stewart
1996/06/24	10:37:52	59.391	-128.686	15.0g	2.8ML	Cassiar Mountains
1986/10/02	08:54:53	57.822	-132.705	18.0g	2.8ML	92 km W from Telegraph Creek
1995/06/04	19:44:24	57.126	-132.093	0.0g	2.8ML	Northern Coast Mountains
1997/10/05	12:24:23	58.091	-126.137	5.0g	2.8ML	Northwest of Williston Lake
2007/12/31	14:27:27	57.383	-132.969	1.0g	2.8ML	133 km ESE of Juneau
1993/10/19	13:54:35	57.787	-125.433	0.0g	2.8ML	Northwest of Williston Lake
2005/12/12	02:20:15	56.961	-131.897	1.0g	2.8ML	Northern Coast Mountains
2005/11/29	00:03:17	56.740	-131.614	1.0g	2.8ML	134 km NW of Stewart
1985/11/30	17:38:00	56.689	-131.271	18.0g	2.8ML	FORESHOCK
2007/11/17	13:06:34	57.615	-132.606	1.0g	2.8ML	131 km ESE of Juneau
2009/01/27	02:10:24	56.093	-128.162	1.0g	2.8ML	114 km E of Stewart
2010/06/16	15:13:50	56.700	-132.262	5.0g	2.8ML	164 km WNW of Stewart
1987/05/05	14:53:37	57.641	-126.145	18.0g	2.8ML	166 km N from Bear Lake
2012/03/08	04:10:48	57.357	-132.760	1.0g	2.8ML	143 km ESE of Juneau
2011/09/09	17:42:07	55.792	-130.327	1.0g	2.8ML	26 km WSW of Stewart
2010/05/21	12:07:18	57.228	-132.311	1.0	2.8ML	172 km ESE of Juneau
2003/11/04	10:15:45	57.311	-131.841	10.0g	2.7ML	165 km WSW of Dease Lk.
2012/01/12	12:39:47	57.490	-132.891	10.6	2.7ML	127 km ESE of Juneau
2013/11/27	06:47:38	58.084	-126.277	1.0g	2.7ML	222 km WSW of Fort Nelson
2012/03/30	09:16:53	57.771	-132.838	25.0g	2.7ML	110 km ESE of Juneau
2004/10/31	03:16:10	58.852	-127.683	15.0g	2.7ML	East of Cassiar Mountains
2009/02/02	12:03:59	58.331	-126.845	1.0g	2.7ML	186 km E of Dease Lk.
2013/04/14	10:38:11	57.333	-132.862	5.0g	2.7ML	141 km ESE of Juneau
2003/06/23	12:54:38	57.467	-132.603	5.0g	2.7ML	Northern Coast Mountains
1993/10/09	12:54:55	55.046	-128.236	5.0g	2.7ML	Central Coast Mountains
2009/01/15	05:04:33	56.096	-128.146	1.0g	2.7ML	115 km E of Stewart
2009/01/15	12:55:35	56.087	-128.135	1.0g	2.7ML	116 km E of Stewart
2000/04/10	14:55:55	56.361	-125.666	10.0g	2.6ML	Ominica Mountains
2011/09/08	02:18:44	57.223	-132.649	1.0g	2.6ML	159 km ESE of Juneau
2010/04/09	00:11:30	57.528	-132.891	1.0g	2.6ML	124 km ESE of Juneau
2010/11/05	09:16:06	57.692	-131.938	30.0g	2.6ML	139 km WSW of Dease Lk.
1993/12/28	17:28:00	58.048	-127.647	5.0g	2.6ML	Northwest of Williston Lake

2005/08/11	04:41:59	57.554	-132.556	1.0g	2.6ML	138 km ESE of Juneau
1992/11/04	16:19:44	57.774	-132.522	5.0g	2.5ML	NORTHERN COAST MOUNTAINS
2003/05/15	09:28:30	57.633	-132.529	1.0g	2.5ML	Northern Coast Mountains
2000/10/19	19:12:48	57.584	-126.538	1.0g	2.5ML	Omineca Mountains
1992/07/21	15:44:10	58.639	-126.682	10.0g	2.5ML	NORTHERN B.C.
1989/03/25	18:38:07	57.464	-126.070	18.0g	2.5ML	NORTHWEST of WILLISTON LAKE
2013/01/05	18:44:21	57.587	-132.767	1.0g	2.5ML	125 km ESE of Juneau
1986/02/15	07:17:13	57.070	-132.840	18.0g	2.5ML	137 km SW from Telegraph Creek
2008/11/02	07:09:49	57.502	-132.931	15.0g	2.5ML	125 km ESE of Juneau
2010/11/27	21:31:22	57.762	-132.515	1.0g	2.5ML	127 km ESE of Juneau
2012/08/02	11:46:35	57.143	-132.484	10.0g	2.5ML	172 km ESE of Juneau
2013/04/13	10:45:09	57.591	-132.723	1.0g	2.5ML	127 km ESE of Juneau
2013/10/06	00:59:37	57.418	-125.067	1.0g	2.5ML	208 km WSW of Fort Nelson
2008/06/07	05:04:00	57.858	-126.050	5.0g	2.5ML	222 km WSW of Fort Nelson
1994/05/15	19:41:12	57.011	-131.317	0.0g	2.5ML	145 km NW of Stewart
2012/05/15	02:44:41	57.734	-132.555	1.0g	2.5ML	126 km ESE of Juneau
1989/12/19	21:47:02	58.034	-132.326	18.0g	2.5ML	NORTHERN COAST MOUNTAINS
2013/04/13	23:49:36	57.626	-132.750	5.0g	2.4ML	123 km ESE of Juneau
2012/03/04	12:49:10	57.671	-132.810	20.0g	2.4ML	118 km ESE of Juneau
2006/01/01	02:14:45	57.288	-132.881	30.0g	2.4ML	Southeastern Alaska.
2011/10/19	13:58:17	57.503	-132.828	1.0g	2.4ML	129 km ESE of Juneau
2010/07/28	07:15:06	56.276	-128.607	5.0g	2.4ML	93 km ENE of Stewart
2004/08/30	22:21:18	57.618	-132.064	1.0g	2.4ML	150 km WSW of Dease Lk.
2008/06/30	09:55:26	55.994	-130.046	1.0g	2.4ML	7 km NW of Stewart
2013/05/25	13:14:37	57.392	-132.719	20.0g	2.4ML	142 km ESE of Juneau
2007/01/22	16:24:30	56.958	-124.740	10.0g	2.4ML	239 km SW of Fort Nelson
1990/01/29	08:40:51	56.353	-130.675	5.0g	2.4ML	COAST MOUNTAINS
2010/07/25	12:06:07	57.012	-132.498	5.0g	2.4ML	171 km E of Sitka
2010/05/02	23:20:11	57.577	-125.853	10.0g	2.4ML	230 km WSW of Fort Nelson
2000/01/19	03:00:59	57.473	-132.299	1.0g	2.3ML	Northern Coast Mountains
2013/06/08	17:15:30	57.586	-132.898	15.0g	2.3ML	120 km ESE of Juneau
2013/03/08	11:03:30	57.509	-132.832	10.0g	2.3ML	128 km ESE of Juneau
1995/06/29	23:47:17	58.029	-127.663	5.0g	2.3ML	Cassiar Mountains
2011/03/03	16:01:04	57.488	-132.947	5.0g	2.3ML	125 km ESE of Juneau

2009/02/14	09:53:21	57.570	-132.737	1.0g	2.3ML	128 km ESE of Juneau
2002/05/09	00:56:59	57.187	-126.691	0.0g	2.3MN	Blast
2000/06/16	23:02:39	57.160	-126.672	0.4	2.3ML	244 km SE of Dease Lk.
1990/09/20	23:04:06	56.350	-130.860	5.0g	2.3ML	NORTHERN COAST MOUNTAINS
1992/05/26	23:21:50	56.062	-129.888	10.0g	2.3ML	NORTHERN COAST MOUNTAINS
2002/02/25	22:00:12	57.085	-126.533	0.0g	2.3MN	Blast
2011/09/09	18:53:08	57.533	-132.916	1.0g	2.3ML	123 km ESE of Juneau
2011/05/13	09:41:01	57.505	-132.887	15.0g	2.3ML	126 km ESE of Juneau
1987/03/09	11:23:46	57.912	-125.537	18.0g	2.3ML	194 km SW from Fort Nelson
1992/04/27	23:11:05	56.041	-130.205	5.0g	2.2ML	COAST MOUNTAINS NEAR STEWART
1994/04/11	16:35:59	57.587	-125.944	15.0g	2.2ML	Northwest of Williston Lake
1990/09/20	23:10:35	56.369	-130.717	5.0g	2.2ML	NORTHERN COAST MOUNTAINS
2002/07/23	21:12:26	57.276	-126.710	0.0g	2.2MN	Blast
2013/05/25	13:12:44	57.548	-132.883	15.0g	2.2ML	123 km ESE of Juneau
2003/06/06	15:46:01	57.748	-132.505	10.0g	2.2ML	Northern Coast Mountains
2013/01/10	12:06:46	57.845	-132.453	30.0g	2.2ML	126 km ESE of Juneau
2001/03/13	02:41:27	56.490	-125.600	10.0g	2.2ML	West of Williston Lake
2000/07/10	21:23:17	57.181	-126.637	1.0g	2.2ML	Omenica Mountains
2008/10/09	18:34:30	57.669	-132.759	1.0g	2.2ML	120 km ESE of Juneau
2013/10/02	10:48:48	57.433	-125.039	5.0g	2.2ML	205 km WSW of Fort Nelson
1995/06/21	17:28:09	57.745	-131.925	0.0g	2.2ML	Northern Coast Mountains
2002/04/27	23:04:22	57.357	-126.928	0.0g	2.2MN	Probable blast
2008/08/01	11:38:44	57.562	-132.906	15.0g	2.1ML	121 km ESE of Juneau
2013/04/15	11:40:19	57.435	-132.787	10.0g	2.1ML	136 km ESE of Juneau
1994/01/24	22:53:43	57.871	-126.180	10.0g	2.1ML	Northwest of Williston Lake
1995/10/25	13:39:59	59.179	-127.224	10.0g	2.1ML	West of Liard River
1986/01/12	19:09:03	58.140	-132.440	18.0g	2.1ML	80 km W from Telegraph Creek
2003/04/25	09:40:32	55.428	-130.008	1.0g	2.0ML	56 km S of Stewart
2001/07/04	21:06:17	57.224	-126.398	0.0g	2.0ML	Probable blast
1992/04/15	01:04:08	56.060	-129.931	10.0g	2.0ML	COAST MOUNTAINS
1990/05/07	03:37:35	58.885	-128.103	10.0g	2.0ML	NORTHERN B.C.
2013/06/09	15:01:45	57.679	-132.863	20.0g	2.0ML	115 km ESE of Juneau
2013/06/22	14:20:43	57.749	-132.762	30.0g	2.0ML	115 km ESE of Juneau

2010/07/09	12:21:18	57.581	-132.788	1.0g	2.0ML	125 km ESE of Juneau
2000/04/07	20:54:46	57.236	-126.681	0.0g	2.0ML	Cassiar Mountains
2010/08/13	11:02:35	57.851	-132.815	1.0g	1.9ML	106 km ESE of Juneau
2004/02/27	17:18:28	56.384	-125.726	1.0g	1.9ML	Omineca Mountains
1990/11/02	00:48:18	57.472	-132.923	10.0g	1.9ML	SOUTHEASTERN ALASKA.
1990/09/11	20:06:24	56.677	-131.360	5.0g	1.9ML	NORTHERN COAST MOUNTAINS
1991/01/17	18:46:30	57.439	-132.654	10.0g	1.9ML	B.C.-ALASKA BORDER
1991/12/24	20:48:59	56.065	-130.180	5.0g	1.9ML	NORTHERN COAST MOUNTAINS
2001/05/16	21:05:13	57.435	-126.371	0.0g	1.8ML	Probable blast
1992/08/13	20:24:30	57.110	-130.838	10.0g	1.8ML	NORTHERN COAST MOUNTAINS
1993/10/13	11:17:33	56.649	-130.097	10.0g	1.8ML	Northern Coast Mountains
1994/04/26	00:30:10	56.948	-132.465	0.0g	1.8ML	Coast of southeastern Alaska.
2006/10/02	20:50:24	55.706	-129.803	15.0g	1.8ML	27 km SE of Stewart
1994/06/12	15:50:33	56.471	-131.457	0.0g	1.8ML	109 km NW of Stewart
1992/09/06	22:50:57	57.488	-130.676	10.0g	1.7ML	NORTHERN COAST MOUNTAINS
1990/08/09	06:59:39	58.040	-129.649	5.0g	1.7ML	NORTHERN B.C.
1991/01/05	02:01:04	57.415	-132.759	10.0g	1.6ML	B.C. - ALASKA BORDER
1990/04/22	13:17:43	56.717	-131.341	5.0g	1.6ML	NORTHERN COAST MOUNTAINS
1991/11/26	00:57:22	57.835	-132.520	10.0g	1.6ML	NORTHERN COAST MOUNTAINS
2001/05/29	21:11:36	57.400	-126.439	0.0g	1.6ML	Probable blast
1992/08/14	07:02:50	57.097	-130.736	10.0g	1.6ML	137 km NNW of Stewart
2001/04/20	07:55:37	58.003	-125.373	5.0g	1.5ML	Muskwa Mountains
1993/10/10	00:00:56	57.111	-130.784	18.0g	1.5ML	Northern Coast Mountains
1992/08/14	07:02:50	57.097	-130.736	10.0g	1.5ML	NORTHERN COAST MOUNTAINS
1990/09/11	20:10:07	56.703	-131.329	5.0g	1.5ML	NORTHERN COAST MOUNTAINS
1991/01/04	20:34:52	57.408	-132.755	10.0g	1.5ML	B.C. - ALASKA BORDER
1990/04/22	12:48:57	56.719	-131.350	5.0g	1.5ML	NORTHERN COAST MOUNTAINS
1985/01/21	04:03:05	58.209	-126.951	18.0g	1.4ML	157 km S from Skooks Landing
1992/08/14	16:12:53	57.931	-129.987	10.0g	1.4ML	56 km S of Dease Lk.
1993/10/05	22:38:09	57.117	-130.807	10.0g	1.3ML	Northern Coast Mountains
1990/01/23	13:43:58	56.481	-130.817	5.0g	1.3ML	COAST MOUNTAINS
1991/04/14	18:08:40	56.594	-131.371	10.0g	1.2ML	NORTHERN COAST MOUNTAINS
1991/03/03	10:11:15	57.755	-132.437	10.0g	1.2ML	NORTHERN COAST MOUNTAINS
1991/06/16	15:09:54	57.781	-129.928	18.0g	1.2ML	SKEENA MOUNTAINS

1990/06/27	01:36:52	57.841	-131.989	5.0g	1.1ML	261 km S of TESLIN
1992/09/07	03:57:56	57.515	-130.606	10.0g	1.1ML	NORTHERN COAST MOUNTAINS
1990/10/05	11:42:47	56.689	-131.308	5.0g	1.0ML	NORTHERN COAST MOUNTAINS
1985/01/21	03:29:14	58.142	-126.878	18.0g	0.9ML	165 km S from Skooks Landing

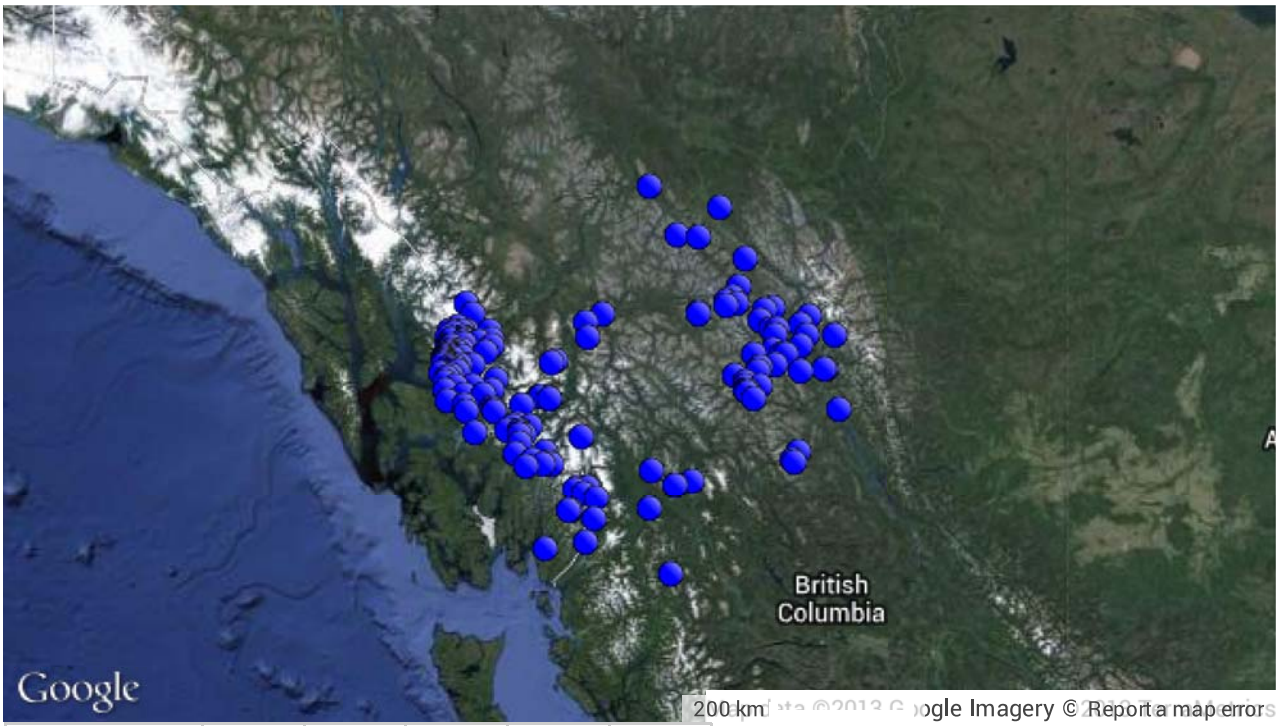
"g" - depth fixed by seismologist

Search totals

A total of 171 events found.

Magnitude	< 1	1	2	3	4	5	6	7	8	9
Total	1	35	111	21	3	0	0	0	0	0

Map



Magnitude	8+	7	6	5	1-4

[Download the Google Earth File]

Date modified: 2013-07-23

APPENDIX G

Local Meteorological Data

Local Meteorological Data

The historical data for the climate at Mount Klappan is unavailable. The nearest available climate data is for the town of Dease Lake, BC. Dease Lake is located approximately 160 km northwest of Mount Klappan. The climate information database provided by the Government of Canada stopped recording data in Dease Lake in 2006. A summary of the most recent 5 years is included in Appendix G. The data suggests there are distinct seasons of snow and rain with total annual precipitation values in the 450-600 mm/yr range; snowfall accounting for approximately 40% total amounts. Highest rainfall values for a single month usually occurred in July and ranged from 80 mm to 130 mm per month. The data suggests a low-moderate amount of annual precipitation and not a significant factor for slope stability.

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Climate

Home > Data

Monthly Data

Monthly Data Report for 2002

Metadata including Station Name, Province, Latitude, Longitude, Elevation, Climate ID, WMO ID, TC ID

DEASE LAKE BRITISH COLUMBIA					
Latitude:	58°25'42.006" N	**Longitude**:	130°00'38.004" W	**Elevation**:	806.60 m
Climate ID:	1192340	**WMO ID**:	71958	**TC ID**:	WDL

Monthly Data Report for 2002

	Mean Max Temp °C	Mean Min Temp °C	Mean Temp °C	Extr Max Temp °C	Extr Min Temp °C	Total Rain mm	Total Snow cm	Total Precip mm	Snow Grnd Last Day cm	Dir of Max Gust 10's deg	Spd of Max Gust km/h
Month											
Jan	-9.7	-17.4	-13.6	3.1	-37.4	0.0	44.4	36.2	66		
Feb	-4.0	-16.3	-10.2	4.0	-30.8	0.0	15.4	10.0	61		
Mar	-3.9	-19.1	-11.5	4.3	-33.5	0.0	20.0	20.0	61		
Apr	4.7E	-12.3*	-4.2*	20.1E	-24.8*	1.8	8.1	7.4	20		
May	11.9	-1.5E	5.3E	21.6	-14.2E	20.4	1.8	22.2	0		
Jun	18.7	3.4	11.0	28.0	-1.5	60.4	T	60.4	0		
Jul	16.0E	6.1*	11.0*	24.1E	2.0*	128.2	0.0	128.2	0		
Aug	15.9E	6.2*	11.2*	21.9E	-0.7*	70.8	0.0	70.8	0		
Sept	12.0E	1.3*	6.7*	18.0E	-4.2*	31.2	T	31.2	0		
Oct	6.8*	-1.7*	2.4*	13.5*	-10.1*	27.8	12.6	40.4	0		
Nov	0.1E	-7.6*	-3.6*	7.0E	-15.1*	1.6	18.5	20.1	M		
Dec	-7.2E	-13.5E	-10.6*	2.4E	-25.6E	T	8.0	5.8	14		
Sum						342.2	128.8	452.7			
Avg	5.1	-6.0	-0.5								
Xtrm				28.0	-37.4						

Summary, average and extreme values are based on the data above.

Notes on Data Quality.

Legend

- [empty] = No data available
- M = Missing
- E = Estimated
- B = More than one occurrence and estimated
- * = The value displayed is based on incomplete data
- S = More than one occurrence
- T = Trace

Date modified: 2013-11-12

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Climate

Home > Data

Monthly Data

Monthly Data Report for 2003

Metadata including Station Name, Province, Latitude, Longitude, Elevation, Climate ID, WMO ID, TC ID

DEASE LAKE BRITISH COLUMBIA					
Latitude:	58°25'42.006" N	**Longitude**:	130°00'38.004" W	**Elevation**:	806.60 m
Climate ID:	1192340	**WMO ID**:	71958	**TC ID**:	WDL

Monthly Data Report for 2003

	Mean Max Temp °C	Mean Min Temp °C	Mean Temp °C	Extr Max Temp °C	Extr Min Temp °C	Total Rain mm	Total Snow cm	Total Precip mm	Snow Grnd Last Day cm	Dir of Max Gust 10's deg	Spd of Max Gust km/h
Month											
Jan	-10.8E	-19.1*	-14.9*	5.5E	-36.7*	1.6	74.4	66.4	62		
Feb	-6.4E	-15.1E	-10.4*	2.2E	-29.7E	0.0	41.8	41.8	69		
Mar	-1.9E	-16.3*	-8.8*	6.3E	-38.0*	4.0	39.8	41.6	61		
Apr	7.9E	-7.4E	0.3*	18.7B	-24.7E	1.0	6.0	7.0	0		
May	13.0E	-1.7*	5.4*	20.3E	-9.8*	16.0	3.2	19.2	0		
Jun	16.3E	3.8E	10.1*	23.7E	-2.0E	61.4	0.0	61.4	0		
Jul	19.8E	6.9*	13.3*	26.7E	2.7*	77.2	0.0	77.2	0		
Aug	18.5E	3.5*	11.2*	24.2E	-3.0*	48.4	0.0	48.4	0		
Sept	11.7E	2.2*	7.0*	18.8E	-3.8*	81.6	3.6	85.2	0		
Oct	7.4E	-2.2*	2.5*	19.4E	-16.0*	12.2E	11.6E	23.8E	0		
Nov	-4.6E	-13.7*	-9.7*	6.9E	-27.8*	2.4	47.6	43.6	M		
Dec	-5.9E	-13.9*	-9.5*	5.9E	-30.2*	0.0	11.8	11.0	28		
Sum						305.8	239.8	526.6			
Avg	5.4	-6.1	-0.3								
Xtrm				26.7	-38.0						

Summary, average and extreme values are based on the data above.

Notes on Data Quality.

Legend

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Monthly Data Report for 2004

Metadata including Station Name, Province, Latitude, Longitude, Elevation, Climate ID, WMO ID, TC ID

DEASE LAKE BRITISH COLUMBIA					
Latitude:	58°25'42.006" N	**Longitude**:	130°00'38.004" W	**Elevation**:	806.60 m
Climate ID:	1192340	**WMO ID**:	71958	**TC ID**:	WDL

Monthly Data Report for 2004

	Mean Max Temp °C	Mean Min Temp °C	Mean Temp °C	Extr Max Temp °C	Extr Min Temp °C	Total Rain mm	Total Snow cm	Total Precip mm	Snow Grnd Last Day cm	Dir of Max Gust 10's deg	Spd of Max Gust km/h
Month											
Jan	-14.2*	-23.6*	-19.4*	-0.4*	-42.7*	0.0	37.9	41.2	M		
Feb	-0.9E	-13.0E	-7.4*	6.6E	-29.0E	0.0	7.2E	5.8E	46		
Mar	1.6E	-11.0E	-4.9*	10.6E	-22.3E	1.2	41.4	37.8	39		
Apr	8.7E	-4.2E	2.1E	21.8E	-14.0E	6.2	10.8	16.2	0		
May	15.7E	0.2E	8.0*	21.5E	-7.8E	24.6	2.0	26.6	0		
Jun	22.7E	5.8E	14.1E	31.9E	-2.2E	82.8	0.0	82.8	0		
Jul	20.5E	8.3*	14.6*	27.9E	5.6*	83.6	0.0	83.6	0		
Aug	21.0E	6.2E	13.7*	29.9E	-2.3E	26.6	0.0	26.6	0		
Sept	11.1E	0.8E	6.0E	17.7E	-4.5E	56.8	0.0	56.8	0		
Oct	5.3E	-3.7E	1.1*	16.0E	-16.6E	16.4	12.8	27.4	M		
Nov	-1.5E	-9.1E	-5.3E	5.8E	-15.8E	T	42.2	34.2	28		
Dec	-7.4E	-14.3E	-10.8*	4.7E	-33.3E	6.2	18.6E	21.6E	35		
Sum						304.4	172.9	460.6			
Avg	6.9	-4.8	1.0								
Xtrm				31.9	-42.7						

Summary, average and extreme values are based on the data above.

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Monthly Data Report for 2005

Metadata including Station Name, Province, Latitude, Longitude, Elevation, Climate ID, WMO ID, TC ID

DEASE LAKE BRITISH COLUMBIA					
Latitude:	58°25'42.006" N	**Longitude**:	130°00'38.004" W	**Elevation**:	806.60 m
Climate ID:	1192340	**WMO ID**:	71958	**TC ID**:	WDL

Monthly Data Report for 2005

	Mean Max Temp °C	Mean Min Temp °C	Mean Temp °C	Extr Max Temp °C	Extr Min Temp °C	Total Rain mm	Total Snow cm	Total Precip mm	Snow Grnd Last Day cm	Dir of Max Gust 10's deg	Spd of Max Gust km/h
Month											
Jan	-13.8*	-23.2E	-18.4*	1.5*	-43.4E	0.0	66.3	66.3	88		
Feb	-3.0E	-14.3E	-8.6*	7.1E	-35.9E	0.0	36.8	31.2	81		
Mar	3.4E	-9.0E	-2.7*	9.7E	-23.5E	0.8	10.4	9.8	50		
Apr	9.2E	-3.5E	2.7*	21.8E	-10.0E	2.6	7.2E	9.2E	0		
May	17.3E	0.8E	9.2*	23.4E	-4.5E	38.2	0.0	38.2	0		
Jun	18.3E	4.8E	11.7E	25.6E	-2.1E	79.8	0.0	79.8	0		
Jul	17.1E	7.0E	12.2*	22.1E	2.8E	85.8	0.0	85.8	0		
Aug	18.9E	6.0E	12.3E	28.9B	-2.2E	52.6	0.0	52.6	0		
Sept	12.2E	2.5E	7.3*	17.7E	-3.3E	45.0	0.0	45.0	0		
Oct	6.2E	-2.8E	1.7*	12.1E	-9.8E	3.6	19.1	21.2	5		
Nov	-0.7E	-7.7E	-3.8*	12.4E	-24.1E	3.6	21.4	20.4	0		
Dec	-7.4E	-14.2*	-10.9*	2.2E	-26.3*	1.8	24.0	23.4	13		
Sum						313.8	185.2	482.9			
Avg	6.5	-4.5	1.1								
Xtrm				28.9	-43.4						

Summary, average and extreme values are based on the data above.

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Monthly Data Report for 2006

Metadata including Station Name, Province, Latitude, Longitude, Elevation, Climate ID, WMO ID, TC ID

DEASE LAKE BRITISH COLUMBIA					
Latitude:	58°25'42.006" N	**Longitude**:	130°00'38.004" W	**Elevation**:	806.60 m
Climate ID:	1192340	**WMO ID**:	71958	**TC ID**:	WDL

Monthly Data Report for 2006

	Mean Max Temp °C	Mean Min Temp °C	Mean Temp °C	Extr Max Temp °C	Extr Min Temp °C	Total Rain mm	Total Snow cm	Total Precip mm	Snow Grnd Last Day cm	Dir of Max Gust 10's deg	Spd of Max Gust km/h
Month											
Jan	-12.1E	-18.1E	-15.2*	-1.3E	-28.2E	0.0	85.4	70.8	75		
Feb	-6.4E	-19.5E	-13.5*	6.7E	-34.1E	0.0	17.2	13.8	51		
Mar	-2.9E	-15.5E	-8.8*	7.8E	-37.7E	0.0	27.2	23.0	47		
Apr	6.6E	-4.3E	1.2*	13.6E	-13.6E	0.0	54.0	51.8	M		
May	12.2E	-0.5E	5.7E	20.3E	-4.9E	43.0	9.2	50.0	0		
Jun	18.3E	4.4E	11.3*	30.7E	-1.2E	63.3	0.0	63.3	0		
Jul	19.0E	6.2E	12.8E	26.4E	0.8E	84.2	0.0	84.2	0		
Aug	15.8E	4.7E	10.4E	21.1E	-0.4E	87.8	0.0	87.8	0		
Sept	13.4E	2.5E	8.3*	25.5E	-6.3E	70.7	0.0	70.7	0		
Oct	5.9E	-3.6E	0.9E	15.4E	-17.0E	36.4	18.6	53.0	3		
Nov	-12.7E	-21.8E	-17.2*	-4.4E	-37.2E	0.0	57.2	39.8	44		
Dec	-4.6E	-13.8E	-9.5E	4.6E	-24.6E	0.0	20.6*	16.4*	M		
Sum						385.4	289.4	624.6			
Avg	4.4	-6.6	-1.1								
Xtrm				30.7	-37.7						

Summary, average and extreme values are based on the data above.

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APPENDIX H

Aberfan and Rocky Mountain Coal Mine Operations:
Out of Pit Waste Rock Structures Research into Tip Slope Failures

Aberfan and Rocky Mountain Coal Mine Operations:
Out-of-Pit Waste Rock Structures Research into Tip Slope Failures

A. Literature's Key Technical Findings

A1. Rocky Mountain Area of Western Canada

Detailed Geotechnical research to determine the circumstances and causes of slope failures of waste piles constructed at coal mine sites extending from the Sparwood-Fernie area north to the Qintette area of British Columbia are summarized herein. These studies date from 1985. This extensive research was in part due to the numerous coal spoil failure occurrences (exceeding 50) and accompanied by at least 8 fatalities caused directly by these failures that have occurred.

The key technical findings from the Rocky Mountain Coal Mine research studies are:

1) Drainage/Pore Pressure control in Dumps and Dump's Foundations are critical;

2) Density (compaction) control of material in the waste dumps are critical;

3) Dump sites are recommended to be placed on natural typographic slopes that are minimal;

4) Dump Foundation materials and their saturation can contribute to instability.

5) The common failure mechanism is flow failure.

A2. Aberfan, Wales

One of the earliest and most disastrous coal tip failures occurred on October 21, 1966 at Aberfan, Wales. Because of the high loss of life in this slip event, a high level tribunal was struck with support by a strong technical team lead by Dr. Alan Bishop of Imperial College. This technical team prepared an exhaustive examination of the October 21, 1966 slip event and two identical historical slip events that preceded the 1966 event in 1939 and 1954. The findings included slip causes and recommendations and were presented in a Tribunal report dated November, 1968.

The Aberfan Tribunal report clearly stated, "The principal lesson to be learned from this disaster is that large tips of colliery rubbish (or indeed any type of spoil) have to be treated as engineering structures," and further, "For complete safety, therefore, attention has to be given both to compaction and to drainage," (Bishop et al 1969, P. 44).

These findings are fully congruent with the findings by Morgenstern at al (2004) in which his summary paper studied several decades of coal spoil dump performances in the Canadian Rocky Mountains. In Morgenstern's research, he identified the failures as flow failures. These flow failures are stated to be a function of (a) spoil density (collapsive and dilative shear behaviour); (b) Local spoil saturation (poor drainage); and (c) site foundation slopes generally of 15 degrees and steeper.

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APPENDIX I

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