

**GEOTECHNICAL DATA REPORT
HANLAN FEEDERMAIN SOUTH
CONTRACT 1
DIXIE ROAD / LAKESHORE ROAD, EAST
MISSISSAUGA, PEEL REGION**

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1 INTRODUCTION

Coffey Geotechnics Inc., (Coffey) was retained by CH2M HILL Canada Limited (CH2M) on behalf of the Regional Municipality of Peel to carry out a geotechnical investigation and prepare a Geotechnical Data Report (GDR) for the proposed Hanlan Feedermain South project in the City of Mississauga.

The Hanlan Feedermain Project consists of the design and construction of a 2400 mm diameter main to connect the Lakeview WTP in the South with the Hanlan Transfer Pumping Station in the North. The route of the main will be along Lakeshore Road, Dixie Road, Eastgate Avenue and Tomken Road with a total length of about 15 km. The project however is divided into two parts, designated as South and North within which there will be a further number of contracts. The South Project extends southerly from Eastgate Avenue to the Lakeview WTP. The approximate length of this route is 8600 m.

This report, however, deals only with Contract 1, an approximately 5680 m long section of the South Project along Lakeshore Road East, extending from Lakefront Promenade to Dixie Road, then continuing North along Dixie Road to Golden Orchard Drive. The feedermain in this section will be constructed as a tunnel within the bedrock at an approximate depth of 18 m to 33 m below ground surface.

Presented in this report are the results of the geotechnical investigation pertaining to this section of the feedermain. The report contains the factual data of the investigation, including a description of the Site, the regional geology, the method of investigation, the field and laboratory test results and a description of the overburden deposits and the bedrock.

2 DESCRIPTION OF THE SITE

The Site is located in the City of Mississauga and extends from Lakefront Promenade along Lakeshore Road East to Dixie Road, and then Northerly along Dixie Road from Lakeshore Road, East to Golden Orchard Drive. The total distance of this route is about 5680 m. The area adjoining this section of Lakeshore Road, East is residential to the North and commercial / industrial to the South. Proceeding North from Lakeshore Road, along Dixie Road, the adjoining area is residential to the CNR line, recreational (golf courses) to Larchview Trail from where it is commercial and residential to the QEW, then residential to Queensway, East and commercial and industrial to Golden Orchard Drive.

Along the above route Dixie Road crosses under the CNR Bridge about 300 m North of Lakeshore Road, then over the QEW and further to the North under the CPR-GO train tracks South of Dundas Street. Dixie Road crosses the Little Etobicoke Creek a short distance South of Golden Orchard Drive and Lakeshore Road crosses over the Applewood Creek, just west of Dixie Road.

The terrain gently slopes from West to East along Lakeshore Road, East from about Elevation 86 m to 84 m. Heading North along Dixie Road, the terrain rises gently from South to North, from about Elevation 84 m to 126 m, with local minor dips at the CNR and CPR underpasses.

3 REGIONAL PHYSIOGRAPHY, GEOLOGY AND HYDROGEOLOGY

Southern Ontario, including the Hanlan Feedermain project area, is known to have been subjected to extensive glaciations during the last 200,000 years. Four major periods of glaciation are known to have occurred in North America, which were interrupted by warmer climate inter-glacial periods. The last glacier (Wisconsin glacier) withdrew from the area approximately 8,000 years ago to 10,000 years ago. Remnants of the soil deposits laid down during the first three glaciations and the inter-glacial periods have been largely or completely obliterated by the last Wisconsin glacier as it advanced across and then withdrew from the project area. As the last glacier retreated eastward into the Lake Ontario basin, a shallow water body, Lake Peel, was dammed between the ice front and the Niagara escarpment and the Oak Ridges Moraine, which marks the northern terminus of the last major glacial advance out of the Lake Ontario basin. The resulting glacial lake sediments can be found in isolated, shallow depressions along the creek and river valleys. Sands and gravels left behind as near shore or delta deposits can also be found. As the glacier withdrew further and drainage through the forerunner of the present Hudson River into the Atlantic Ocean became possible, lake levels stabilized in the Ontario basin, forming glacial Lake Iroquois. This stable stage formed a prominent shoreline, the remnant of which can be found in the project area meandering within short distances to the North and South of Dundas Street.

The Hanlan Feedermain Project spans three of the numerous physiographic regions identified in Southern Ontario (Chapman and Putnam 1984). However, the project site that is the subject of this report lies fully within the Physiographic Region of the "Iroquois Plain" extending between the present shore line of Lake Ontario and the abandoned shore line of Lake Iroquois. North of the old shoreline lie the Physiographic Regions of the "South Slope" and "Peel Plain".

As delineated by Chapman and Putnam [15] the Peel Plain extends across the Halton, Peel and York Regions, including the northern part of the City of Toronto. To the South, the Peel Plain merges with the South Slope physiographic region, which forms a narrow strip between the Peel Plain and the old shoreline.[15] However, in a practical sense, the Peel Plain in Peel Region can be considered to extend to the location to the remnant shoreline of glacial Lake Iroquois at about Dundas Street (Sharpe, 1980)[16]. The land to the South of Dundas Street forms the Iroquois Plain physiographic region [15]. This area is largely underlain by sandy soils, although some glacial tills that are older than those underlying the Peel Plain are exposed at several locations along the present-day shoreline [16].

The bedrock underlying this Site is the grey Georgian Bay Formation, consisting of shale with interbedded siltstone and limestone layers. The rock surface generally slopes from North to South but several buried valleys are also known to exist within the rock.

Drainage in the vicinity of Dixie Road is provided by the Etobicoke Creek about 300 m to 700 m to the East and the Applewood Creek, about 200 to less than 100 m to the West. The hydrogeological study prepared as part of the Class EA study for the project indicates that for a long time the project area has been provided with municipal water services. Consequently the wells which used to be the source of water are not believed to be in use anymore. The hydrogeological study indicates that the sources of water for these former wells were either the top weathered and fractured zone of the bedrock or the sand layers that are found on the surface of the shale bedrock in the bedrock valleys. The bedrock is known to be a poor aquifer, with low yield, typically less than 2 gallons per minute (gpm) in wells, and poor water quality. The sand layers form a discontinuous and non-uniform aquifer.

4 METHOD OF INVESTIGATION

The field work for the investigation consisted of drilling thirty-seven (37) boreholes at the locations shown on Drawings No. 1 to 8 inclusive. The boreholes are designated as HF1-13 to HF1-46 and HF1-16A, HF1-17A and HF1-35A. In addition, nine (9) boreholes, HF1-13-1, HF1-25-1, HF1-26-1, HF1-27-1, HF1-29-1, HF1-34-1, HF1-38-1, HF1-42-1 and HF1-46-1 were augered within a distance of about 1 m to 2 m adjacent to Boreholes HF1-13, HF1-25, HF1-26, HF1-27, HF1-29, HF1-34, HF1-38, HF1-42 and HF1-46, respectively, for the purpose of installing shallow piezometers within the overburden or the upper fractured zone of the bedrock (HF1-42-1, HF1-46-1). The number, locations and depths of the boreholes were selected by CH2M who also provided the coordinates and ground surface elevations of the boreholes. The coordinates and elevations are shown on the logs of boreholes and are also tabulated in Table 4.1.

Table 4.1 - Borehole Locations and Elevations

Borehole Number	Location			Ground Surface Elevations (m)
	Station	Easting	Northing	
HF1-13		613834	4829804	125.6
HF1-13-1		613835	4829803	125.5
HF1-14		613992	4829698	124.4
HF1-15		614101	4829598	123.1
HF1-16		614206	4829497	119.9
HF1-16A		614237	4829468	119.3
HF1-17		614315	4829396	118.2
HF1-17A		614578	4829159	109.8
HF1-18		614716	4829023	112.9
HF1-19		614792	4828957	112.7
HF1-20		614897	4828859	112.3
HF1-21		615098	4828673	111.5
HF1-22		615240	4828538	110.6
HF1-23		615376	4828404	109.6
HF1-24		615468	4828325	108.2
HF1-25		615568	4828227	107.7

Borehole Number	Location			Ground Surface Elevations (m)
	Station	Easting	Northing	
HF1-25-1		615569	4828226	107.7
HF1-26		615576	4828108	106.9
HF1-26-1		615576	4828109	106.9
HF1-27		615676	4827961	105.1
HF1-27-1		615675	4827961	105.1
HF1-28		615849	4827794	103.5
HF1-29		616102	4827561	99.5
HF1-29-1		616103	4827560	99.5
HF1-30		616247	4827431	99.6
HF1-31		616313	4827361	99.6
HF1-32		616447	4827235	96.8
HF1-33		616538	4827159	92.8
HF1-34		616607	4827093	90.4
HF1-34-1		616609	4827092	90.4
HF1-35		616720	4826982	83.0
HF1-35A		616759	4826947	82.8
HF1-36		616824	4826885	86.5
HF1-37		616927	4826785	85.2
HF1-38		617012	4826729	84.2
HF1-38-1		617011	4826729	84.2
HF1-39		616877	4826579	83.9
HF1-40		616791	4826454	84.4
HF1-41		616690	4826354	84.7
HF1-42		616622	4826203	84.3

Borehole Number	Location			Ground Surface Elevations (m)
	Station	Easting	Northing	
HF1-42-1		616622	4826204	84.3
HF1-43		616511	4826084	84.7
HF1-44		616406	4825983	85.2
HF1-45		616358	4825849	86.0
HF1-46		616247	4825661	85.6
HF1-46-1		616248	4825660	85.6

The boreholes were drilled during the period between June 27 and November 10, 2011. Drilling dates are shown on the borehole logs. The depth of the boreholes ranged between 18.7 m and 26.2 m. The boreholes were advanced using hollow stem augers to the surface of the bedrock and through the upper, approximately 1 m to 2 m thick, highly weathered zone of the rock and by rock coring within the bedrock, using wire line equipment with an HQ3 (61mm) size core bit and triple-tube barrel. Coffey retained Aardvark Drilling Inc. to carry out the drilling, but provided full time technical monitoring of the drilling, sampling and field testing. Initially Aardvark supplied two (2) drilling rigs, a CME 55 and CME 75 drill rig, but after August 18, 2012 only one machine was operated.

In the field, the soil strata encountered were described by visually observing the materials returned on the auger flights and by sampling the soils at regular (0.75 m and 1.5 m) intervals of depth using a 50 mm O.D. Split Spoon sampler, in accordance with the Standard Penetration Test (ASTM D1586) method. This sampling method recovers samples from the soil strata, and the number of blows required to drive, after an initial penetration of 0.15 m, the sampler 0.3 m into the undisturbed soil (SPT 'N'-values) gives an indication of the compactness condition or consistency of the sampled material. The procedures to identify the soil samples in the field followed the methods suggested in the Canadian Foundation Engineering Manual (CFEM, 2006).

Upon encountering the inferred surface of the bedrock, identified by increased drilling resistance and the visual classification of the recovered samples, the boreholes were advanced through the upper, about 1 m to 2 m thick, highly weathered zone of the rock by augering and sampling by the SPT method before changing to diamond core drilling. The recovered rock core samples were visually examined and described in the field and the index properties, including total core recovery (TCR); solid core recovery (SCR); rock quality designation (RQD); fracture index (FI) and the thickness and percentage of hard layers (HL%), were measured and recorded. The geotechnical logging included also the description of the type, orientation and condition of the discontinuities and the degree of weathering. The explanation of these terms is given in Appendix A, on the "Explanation of Terms Used in the Bedrock Core Log" sheets. Photographs of the rock cores in the core-boxes were also taken. Field testing of the rock consisted of water pressure ("packer") tests to estimate the hydraulic conductivity of the rock mass. These tests were performed in selected boreholes and selected depths, generally within the anticipated zone of tunneling, by isolating 3 m long

sections using two (2) inflatable seals, “packers”, and introducing water into the test zone at three, increasingly greater, constant pressure. By measuring the pressure with a gauge and the “water take” (rate of water injection) by a flow meter, the hydraulic conductivity of the rock mass in the test zone can be estimated.

The hydraulic conductivity (i.e., secondary permeability) of the rock mass surrounding the test section was calculated using the relationship:

$$K = [Q/2\pi P_i L] [\ln(R/r_b)]$$

where

K = hydraulic conductivity of the rock mass surrounding the test section (m/s);

Q = rate of water injected into the test section (m³/s);

L = length of the test section (m);

r_b = radius of the borehole in the test section (m);

R = radius of influence (m), use R = L; and

P_i = net injection pressure (m) = P_g + h_g + h_s + h_f;

The net injection pressure is calculated as the combined pressure head (m) that is exerted on the test section. It is calculated as follows:

$$P_i = P_g + h_g + h_s + h_f$$

P_g = gauge pressure (m);

h_g = height of gauge above ground level (m);

h_s = depth to pre-test water level (m); and

h_f = friction losses (m)

Calibration checks of the flow gauge were performed at the ground surface prior to testing in Boreholes HF1-13 and HF1-23. The calibration consisted of injecting water into a container of known volume and ensuring that the recorded volume using the flow gauge was equal to the volume of the container. Another form of quality control involved checking the packers for leaks prior to testing. This was achieved by covering the packers with soap and water, then inflating the packers and observing the formation of air bubbles (or lack thereof). The presence of air bubbles would indicate a leak in the packer. The packer inflation pressures were also monitored closely during the test. A drop in pressure would indicate that the packer is deflating (and thus it or the supply line is leaking).

At the locations of some of the shafts the test zone was increased to 12 m. Results of the hydraulic conductivity tests are given on the individual borehole logs and are summarized on Table D4 in Appendix D of this GDR.

Groundwater levels were measured in every borehole after completion of drilling, and for the observation of the long-term groundwater conditions, 50 mm diameter standpipe type piezometers were installed in Boreholes HF1-13 / HF1-13-1, HF1-15, HF1-17, HF1-18, HF1-21, HF1-23, HF1-25 / HF1-25-1, HF1-26 / HF1-26-1, HF1-27-1, HF1-29 / HF1-29-1, HF1-32, HF1-34, HF1-34-1, HF1-35A, HF1-38 / HF1-38-1, HF1-40, HF1-42 / HF1-42-1, HF1-44, and HF1-46 / HF1-46-1. Details of the installations, such as the location and length of the well screen, the extent of the filter sand surrounding the screen and the thickness of the zone that was sealed with bentonite are shown on the borehole logs. Each installation was protected with a flush mount lockable steel cap. Water levels in the piezometers were monitored at least twice, but in the majority cases five (5) to six (6) times during the period of August 2011 and January 2012. The dates of the readings together with the observed water levels are given on the borehole logs and are also tabulated on Table 7.5.1 in Section 7.5 of this GDR.

The soil and rock core samples were first visually classified in the field by Coffey's supervising field personnel and were then taken to Coffey's laboratory where they were re-examined and classified by a geotechnical engineer or geologist. Selected representative soil and rock samples were subjected to laboratory testing. The testing program on the soil samples consisted of the measurement of the natural moisture contents of all soil samples, grain size analyses with hydrometer (22) and consistency (Atterberg) limits (7). Test results are shown on the individual borehole log sheets presented in **Appendix A**. The results of the grain size analyses and consistency (Atterberg) limits tests are attached in **Appendix B**.

Tests on the rock core samples included: Unconfined compression, UCS, tests (73) including density (ρ), Young's Modulus (E) and Poisson's Ratio (ν). These tests were performed in the rock mechanics laboratory of the Department of Mining of the Queen's University. Further selected rock core samples were sent to AMEC Earth and Environmental Laboratories to be tested for Abrasivity (19) and Slake Durability (15). Point-Load Strength Tests were also performed in Coffey's laboratory to obtain additional estimates of rock strengths. Tests were performed in both the diametral and axial directions of the core samples. The results of the above tests on the rock cores can be found in **Appendix D** and are discussed in Section 7.4 of this report.

A total of twenty-three (23) soil samples were tested to assess the on-Site soil management and off-Site disposal options for the excavated soil. The soil samples were analysed in accordance with the Ministry of Environment (MOE) current "Guidance on Sampling and Analytical Methods for Use at Contaminated Sites in Ontario" and in general accordance with O.Reg. 153/04 as amended. The test results and our interpretation are presented in **Section 8** and **Appendix E** of this report.

5 PREVIOUS INVESTIGATION

In the fall of 2009 Alston Associates Inc., carried out a preliminary investigation as part of the Environmental Assessment Study performed by AECOM. Twelve (12) of these boreholes are located within the Hanlan Feedermain South Project. These boreholes, which are numbered Boreholes 27, 28, 29, 30, 202, 203, 31, 32, 33, 34, 35 and 36 supplement the information provided by the present Coffey investigation and their records are enclosed in **Appendix C**.

6 SUMMARIZED SUBSURFACE CONDITIONS

The subsurface conditions encountered in the boreholes are briefly summarized in the following paragraphs with additional description of the observed strata in Section 7 below. For details, the individual borehole logs in **Appendix A** and **Appendix C** should be consulted.

Along Lakeshore Road and Dixie Road, South of the CNR underpass, the surficial fill material, including the topsoil or the pavement structure, ranges in thickness from about 0.8 m to 3 m. Underlying the fill material, the predominant native soil is cohesive silty clay and clayey silt or glacial till of the same texture exhibiting a generally very stiff to hard consistency. Underlying these, the surface of the bedrock was encountered at depths ranging between 2.6 m and 3.8 m (Elevations 83.4 m to 80.6 m) except at the CNR underpass where the bedrock lies 0.8 m below the ground surface (Elevation 82.0 m).

Further to the North along Dixie Road, from the CNR underpass to Golden Orchard Drive, the surface along the alignment is composed of topsoil and pavement, including the granular base and sub base. These are underlain by surficial fill material which extends to about 0.8 m to 5.3 m, but generally less than 3 m, below ground surface. The native soil below the fill is comprised predominantly of cohesionless sand, silty sand or sandy silt in a generally compact to dense, but occasionally loose or very dense, condition. Sand deposits were observed in the borings North of Dundas Street and South of the Queensway. Between these locations cohesive clayey deposits are present between the fill and the bedrock or the fill directly overlies the rock. Thin layers of cohesive soils were also observed directly overlying the bedrock in some of the boreholes North of Dundas Street and in most of the boreholes between the QEW and the CNR.

The overburden soil deposits in this section of Dixie Road are underlain by the shale bedrock. The bedrock surface was generally encountered in the borings at depths between 2.3 m and 4.9 m. Exceptions to this were observed at Golden Orchard Drive where overburden depths were 7 m to 9 m; at Queensway, East where the depth to rock surface was about 6.1 m, and along an approximately 950 m long section South of the QEW and North of the CNR bridge structure where the surface of the bedrock lies at depths ranging between about 6 m and 12 m below ground surface. The bedrock surface slopes from North to South from about Elevation 119 m at Golden Orchard Drive to 82 m at the CNR structure. In addition, the rock surface is undulating and based on Coffey's experience local variations of 2 m to 3 m within a short (5 m to 10 m) distance have been observed in the past.

The upper zone of the bedrock is highly, or occasionally completely, weathered. The distinction between completely weathered shale and the overlying cohesive glacial till, particularly if the latter contains abundant shale fragments, is not always clear and consequently it is possible that what is described as completely weathered shale may be a soil unit what is locally referred to a "glacial till and shale complex."

About one-third of the boreholes was open and dry prior to commencing rock coring. The water levels observed in the other boreholes prior to coring were recorded and are shown on the borehole logs. Piezometers were installed at twenty-four (24) locations in which the water levels were monitored over several weeks or months. The observed ground water levels in the piezometers on January 11, 2011 were found at depths of between 1.4 m and 6.4 m below the ground surface (bgs). Exceptions to this are Borehole HF1-32, in which the groundwater level was found at 11.3 m bgs, and in Borehole HF1-35A, located at the CNR underpass, where slight artesian conditions were noted.

7 DETAILED DESCRIPTION OF THE STRATA

The relevant properties of the main strata are summarized briefly in the following sections.

7.1 Fill

Fill was found in every borehole below the topsoil or the pavement structure extending to depths ranging between 0.8 m and 5.3 m. The composition of the fill often reflected the texture of the native soil, i.e., generally clayey silt to silty clay, or occasionally silty sand fill (Boreholes HF1-38 and HF1-40) was found along Lakeshore Road and Dixie Road, South of the CNR underpass. On Dixie Road, North of the CNR tracks, the fill material consisted of sand, silty sand or occasionally clayey silt (HF1-16, HF1-17 and HF1-18) or sandy clay (HF1-15). The compactness condition of the granular fill ranged from very loose to dense, but mostly loose to compact and the consistency of the cohesive clayey fill ranged from very soft to hard, but mostly stiff to very stiff along Lakeshore Road.

7.2 Silty Clay, Clayey Silt, Silty Clay / Clayey Silt Till, Silt

Fine grained cohesive soils of silty clay, clayey silt and silt (HF1-34), or glacial tills of the same texture, were encountered in twenty-three (23) boreholes generally underlying the cohesionless deposits of sand and silty sand or the fill. The consistency of these soils, when based on the SPT "N" values, was inferred to be very soft to hard, but mostly stiff to very stiff. Pocket penetrometer tests performed on suitable samples, however, indicated mostly very stiff to hard consistencies.

Results of particle size analyses performed on five selected silty clay / clayey silt (till) samples indicate 0-7% gravel, 2 - 29% sand, 41- 81% silt and 13- 33% clay size particles. (See Figures B4 and B5, Appendix B).

The results of consistency (Atterberg) limit tests performed on seven (7) silty clay / clayey silt samples gave liquid limits of 20-34%, plastic limits of 12-17% and plasticity indexes of 5-17%. Based on this, the clayey soils are classified as clays of low plasticity (CL) or clayey silts (CL-ML) in the Unified Soil Classification system. (**Figure B6, Appendix B**).

The results of one (1) Atterberg limit test performed on the silt sample obtained from BH HF1-34, (SS 5) gave a liquid limit of 19%, plastic limits of 16%, and a plasticity index of 3%. Based on this, the soil is classified as low plasticity silt (ML) in the Unified Soil Classification system. (**Figure B6, Appendix B**).

It should be noted, that where these cohesive soils are of glacial origin (glacial till) the presence of cobbles and boulders should be expected even though neither cobbles nor boulders were encountered in the boreholes. The cobbles and boulders are mostly of Precambrian origin and consist of granite or other intrusive rocks.

7.3 Sand, Silty Sand and Sandy Silt

Cohesionless granular deposits of sand, silty sand and sandy silt texture were encountered below the fill in sixteen (16) boreholes drilled during this investigation and in nine (9) boreholes drilled by Alston during the earlier investigation. The thickness of these cohesionless soils found generally below the fill in the boreholes drilled during the present investigation varies from 0.4 m to 6.9 m. Standard penetration tests performed in these deposits indicate very loose ('N'=4) to very dense ('N'=50/<150 mm), but mostly compact to dense state of compactness. The results of grain size analyses performed on sixteen (16) samples indicate 0% to 1% gravel, 50% to 84% sand, 9% to 37% silt and 4% to 11% clay size (<2 micron) particles (see **Figures B2** and **B3**, Appendix B). Alston Boreholes 35 and 202 report the presence of a sand and gravel layer at a depth of about 3.7 m and 2 m respectively. From the results of the grain size analyses, and using Hazen's formula, the hydraulic conductivity of these deposits is estimated to range between 5×10^{-3} and 4×10^{-6} cm/s, but mostly in the 10^{-3} to 10^{-4} cm/s range.

7.4 Shale Bedrock

The surface of the bedrock was contacted in every borehole at depths ranging between 2.3 m and 12.2 m, or between Elevation 119.3 m and 80.4 m. Locally, at the locations of the CNR (HF1-35, HF1-35A) and CPR (HF1-17A) underpasses, the surface of weathered bedrock was found near the ground surface at a depth of 0.8 m. There are minor local variations and undulations in the bedrock surface, but in general, the rock surface slopes down gently from West to East along Lakeshore Road, and from North to South along Dixie Road.

At its surface the rock is generally highly to occasionally completely weathered to a degree that it resembles soil with shale fragments. Some of this zone may actually be a basal glacial till mixed with shale that is locally referred to as a till / shale complex. In order to obtain an adequate seal for the borehole casing, the borehole within this weathered zone was advanced by augering and soil sampling for variable depths, but generally not more than 2 m, before converting to diamond core drilling using wire line tools of HQ3 (61 mm) size.

From the recovered rock cores the rock was identified as shale belonging to the Georgian Bay Formation. This formation consists of a dark grey coloured weak to medium strong laminated shale interbedded with light grey coloured strong to very strong limestone and siltstone layers. The Georgian Bay Formation is the dominant rock formation found in the GTA including significant parts of Peel and York Regions. Typically this formation consists of approximately 80% to 90% shale with various thicknesses of interbedded limestone and calcareous siltstone and very occasionally sandstone layers [7]. The shale is thinly laminated, gassy, generally medium strong, brittle, moderately fissile, thin to medium bedded with two (2) sets of near-vertical orthogonal joints [7]. The interbedded limestone and siltstone layers, which could be up to 600 mm to 800 mm in thickness, are typically strong to very strong.

The descriptive terms used on the log of rock cores, and throughout this report are explained in the "List of Symbols and Abbreviations" enclosed in **Appendix A**. In general, the conventions of the International Society of Rock Mechanics (ISRM 1981) are adopted herein. The measured index properties of the formations are summarized in the sections that follow.

Total Core Recovery (TCR)

The TCR is the total lengths of the rock core recovered and expressed as a percentage of the actual lengths of the core run which was usually 1.5 m. The TCR was generally good with values ranging from 40% to 100%, average 98% and standard deviation 6%. Average TCR values in the individual boreholes ranged between 89% and 100%, with average 98% and standard deviation 2%.

Solid Core Recovery (SCR)

The SCR is the total lengths of solid cores that are full diameter rock cores and are expressed as a percentage of the lengths of the core run. SCR values ranged from 0% to 100%, with average 87% and standard deviation 22%. Average values in the individual boreholes range between 68% and 96%, with average 87% and standard deviation 6%. Lower SCR values were generally recorded near the rock surface due to weathering within the surface zone.

Rock Quality Designation (RQD)

The RQD values were obtained by measuring the total lengths of recovered rock core pieces which were longer than 100 mm and expressing the sum total of these, as a percentage of the lengths of the core run. On the basis of the RQD values which range between 0% and 100% (average 73% and standard deviation 27%) the rock quality is estimated to be very poor to excellent. The average RQD values in the individual boreholes ranged from 53% to 91%, with average 73% and standard deviation 8%, indicating mostly “fair to excellent” but predominantly “good” rock quality when using Deere’s Classification System. Generally the RQD values appear to increase with depths below the rock surface. The RQD values are given on the log of boreholes.

The RQD values are a general indicator of rock mass quality; however, in horizontally laminated fissile sedimentary rock formations, such as the Georgian Bay Formation, the reader is cautioned that RQD values are likely conservatively low. The relationship between rock quality and the RQD indices was suggested by Deere (1969) and is given below:

RQD (%)	DESIGNATION OF ROCK QUALITY
0 – 25	Very poor
25 – 50	Poor
50 - 75	Fair
75 - 90	Good
90 - 100	Excellent

A histogram of all the recorded RQD values (452), and their distribution into the above rock- mass classes, is given on **Figure D1** in Appendix D. As indicated 82% of the rock cores falls into the “fair” to “excellent” and 59% of the rock cores falls into the “good” to “excellent” category.

Fracture Index (FI)

Joint frequency or FI is a measure of the recorded frequency of fracturing and bedding plane separations in the rock cores. It is expressed as the number of fractures per 300 mm lengths of rock core run. Breaks which are obviously caused by drilling are excluded. A continuous vertical fracture, regardless of its lengths, is counted as one fracture. The recorded FI values range between zero and greater than 10. Average FI values in the individual boreholes range from 1.0 to 5.3 with an average of 2.9 and a standard deviation of 0.9. It should be noted, however, that since breaks that were caused by drilling, or handling when removing from the core barrel, cannot always be detected; consequently the recorded FI numbers could in some instances be on the high side.

Planes of weaknesses along which the core tended to break were the planes of bedding and the contact surface between the shale and the hard layers. This group of planes of weaknesses were generally very closely to moderately closely spaced, horizontal, planar to undulating, smooth to rough, tight and often with clay coating. The joints are open and rough and sometimes with clay infill. The conditions of the discontinuities are described in detail on the borehole logs

Hard Layers

When recovering the core samples, the thicknesses of the interbedded hard calcareous siltstone and limestone layers were measured and, where appropriate, their aggregate sum was expressed as a percentage of the core run. Recorded hard layer percentages range from 0% to 83 % (average 17% and standard deviation 15%) and average values in the individual boreholes range between 4% and 31% with average 17% and standard deviation 7%. Hard layers were often thin, in the range of 25 mm to 75 mm, and could be identified by their lighter grey colour as shown on the rock core photographs in Appendix D. Less frequently, thicker zones, in the order of 175 mm to 300 mm, were recorded and occasionally hard layers in the order of 400 mm to 825 mm were noted (Boreholes HF1-39; HF1-40; HF1-42 and HF1-46). This rock formation is known to contain such thick hard layers. The layers however are seldom continuous over a distance more than 5 m to 10 m.

Weathering

The degree of weathering of the rock in the core samples was visually observed as slight to moderate but the rock was generally fresh with some weathering on the discontinuity surfaces. Near the rock surface the degree of weathering is higher but at the depths where the tunnel is located, the rock should be considered as fresh to slightly weathered. Occasionally the shale contains clay layers of variable thicknesses, and where observed, these are indicated on the rock core logs.

Uniaxial Compressive Strength (USC)

Test results of the Unconfined Compressive Strength of seventy-two (72) rock core samples measured in the laboratory of Queens University Mining Department are presented in Table D3, Appendix D and are also shown on the rock core logs. Forty-three (43) tests performed on the shale samples gave values in the range of 5.2 MPa to 25.6 MPa with an average value of 13.1 MPa and standard deviation of 5.6MPa. Based on the measured values, the rock is classified as a weak rock in accordance with the ISRM (1981) convention. Tests on the limestone and siltstone layers gave UCS values ranging from 16.8 MPa to 133.5 MPa and averaging at 69.0 MPa (standard deviation 32.8 MPa) for the siltstone and 74.7 MPa (standard deviation 34.5 MPa) for the limestone. These values indicate that the interbedded siltstone and limestone

layers are weak to very strong. Based on previous projects carried out in the same rock formation, these limestone and siltstone layers are known to be typically strong to very strong (UCS = 50 MPa – 250 MPa). A histogram of the distribution of the UCS values into the ISRM strength categories is given on Figure D3 in Appendix D.

Point Load Index Strength

Additional indirect evaluation of the compressive strength of the rock was obtained by performing point load strength tests on 893 core samples (See **Table D2**, Appendix D). Tests were performed both in the axial and the diametral direction of the shale and limestone / siltstone core samples. As expected, testing of the shale samples in the diametral direction typically resulted in lower results.

Inferred unconfined compressive strength values were calculated as $UCS = \text{Point Load Index} \times 24^{[7]}$. This correlation factor between UCS and Point Load Index is commonly used for the Paleozoic rock formations found in Southern Ontario. It is known, however, that the factor could range between 20 and 25, and in extreme cases between 15 and 50. It should also be noted that for point load indices ($Is_{(50)}$) <1, (UCS < 25 MPa) the point load test may yield ambiguous results

The inferred UCS values range from <1 MPa to 62 MPa (average 23 MPa, standard deviation 12 MPa) for tests performed on the shale in the axial direction and between <1 MPa and 23 MPa (average 5 MPa, standard deviation 5 MPa) when tested in the diametral direction. Inferred UCS values on the hard limestone and siltstone samples ranged between 6 MPa and 269 MPa, with an average value of 114 MPa and a standard deviation of 60 MPa. Based on these tests, the shale rock is classified as extremely weak to weak in the diametral direction and extremely weak to strong, but typically weak to medium strong in the axial direction. The limestone / siltstone layers are weak to extremely strong, but typically strong to very strong. A histogram of the UCS values inferred from the point load index tests is presented on Figure D2.

Density

The density of seventy-one (71) intact rock samples used for the UCS tests ranged from 2,560 kg/m³ to 2,780 kg/m³, averaging at 2,630 kg/m³ and having a standard deviation of 40 kg/m³ (**Table D3**, Appendix D).

Young's Modulus (E)

The elastic or Young's Modulus of the intact rock material was measured when performing the uniaxial compression tests. Measured values for the shale ranged between 0.406 GPa and 5.345 GPa with an average of 1.891 GPa and a standard deviation of 1.470 GPa. Measured values for the limestone / siltstone layers ranged between 2.923 GPa and 26.804 GPa, with an average of 13.958 GPa and a standard deviation of 6.255 GPa . (**Table D3**, Appendix D).

Poisson's Ratio

The ratio of lateral to longitudinal strain in the elastic range of the intact rock was determined during the performance of the uniaxial compression tests. The fifty-three (53) Poisson's ratio values ranged from 0.10 to 0.35 for the shale (average = 0.19, standard deviation = 0.06) and between 0.1 and 0.22 for the limestone and siltstone layers (average 0.13, standard deviation 0.04). Results are shown in **Table D3**, Appendix D.

Hardness

Two (2) samples from Boreholes HF1-13 and HF1-21 were tested for their Moh's hardness from which test hardness values of 1.5 to 2.5 were obtained for the shale samples. These values are in good agreement with values obtained for the same rock formation from previous projects. During these previous investigations, the Moh's hardness rating for the calcareous siltstone and limestone layers was found to range from 4 to 7.5 with an average value of 6.5.

As a reference and way of comparison, the Moh's hardness scale is presented below:

Diamond	10
Corundum	9
Topaz	8
Quartz	7
Apatite	5
Fluorite	4
Calcite	3
Gypsum	2
Talc	1

It should be noted that the scale is not linear, as the difference in hardness between 9 and 10 is much greater than between 1 and 2.

Hydraulic Conductivity

In a number of boreholes at depths selected by CH2M, water pressure, "packer", tests were performed in order to estimate the hydraulic conductivity of the rock mass. These tests (46 in total) were conducted by isolating 3 m long zones in the rock using double inflatable packers and introducing water under three (3) constant pressure heads. The pressures used were in excess of the in-situ ground water pressure, but ensuring at the same time that the pressure used did not result in the hydro fracturing of the rock. A gasoline-operated pump was used to generate and maintain constant water pressure (measured by a gage) and the rate of delivery of water to the test section of rock was monitored using a flow meter. From the measured rate of water injection into the test section and the pressure used, the hydraulic conductivity of the rock mass within the test zone was calculated. A more detailed account of the tests is given in Section 4 of this report.

The test results are summarized in Table D4, Appendix D and are also presented on the individual borehole log sheets. As shown, the measured hydraulic conductivity values range from about 8×10^{-4} cm/s to 2×10^{-7} cm/s, with a weighted average of 2×10^{-7} cm/s. In many instances however there was no water intake by the rock thereby indicating very low hydraulic conductivity that was below the measuring capability of the testing equipment. In such cases the hydraulic conductivity was arbitrarily assumed to be $< 1 \times 10^{-8}$ cm/s.

In-situ Stresses

The Palaeozoic sedimentary rock formations in Southern Ontario, including the Georgian Bay Formation, are known to possess high horizontal stresses which exceed the vertical stress often by a factor greater than 4^{[2] [3] [5] [6] [9]}.

In-situ stress measurements were not performed as part of this investigation. Values obtained during a previous geotechnical investigation for the Burloak Water Intake Tunnel by Coffey, located about 28 km to the west, in the same Georgian Bay Formation by the deep-door stopper gauge system (DDGS) over coring method yielded a maximum horizontal stress of 6.5 MPa and a minimum horizontal stress of 4.6 MPa at a depth of 37 m below rock surface. The orientation of the maximum horizontal stress is about Azimuth 300°. The vertical stress at the test location was about 1MPa, thus giving a horizontal to vertical stress ratio of 6.5. Further information on the in-situ stresses is available from the literature.

In-situ stress measurements were carried out by a number of investigators in the Toronto area in the Georgian Bay Formation. These are presented as a general guide below.

Source	Depth (m)	Horizontal Stress (MPa)
Trow & Lo [11]	15 – 26	2.6 – 5.3
Morton, Lo & Belshaw [2]	9 – 15	up to 6.9
Lo & Morton [3]	9 – 10	2 - 4
Franklin & Hunger [5]	70	1.7*

* - measurements in a fracture zone

Time-Dependent Deformation Characteristics (TDD)

It has been observed, both in the laboratory and in the field^{[4], [3], [13]}, that upon relief of high residual horizontal stresses within the shale formations, time dependent, creep-like deformations take place. These time-dependent deformations (TDD) persist well beyond the initial elastic deformations and generally exceed the magnitude of the elastic movements. In the various publications, the TDD phenomenon is described as “swelling” or “rock squeeze” by the authors. While “rock squeeze” usually refers to the slow, creep-like deformation of the rock due to stress relief and “swelling” is primarily due to diffusion of salts of the pore water in the presence of freshwater, the two are inter-related and their total is the TDD.

A crude measure of the magnitude of TDD strain can be obtained in the laboratory by “free swell tests”. TDD measurements were not performed as part of this investigation and therefore, only values in the literature can be used as guidelines. Reported measured values in the laboratory range between 0.03 and 0.26% per log cycle of time^{[4] [6]}.

Further TDD values for the Georgian Bay Formation were obtained from actual field measurements carried out during previous tunnel constructions. Observed values, expressed as a percentage of the original excavated tunnel diameter per log cycle of time (e.g. 1, 10, 100, etc., days) are given below.

Lo and Morton (1976) [3]	$\varepsilon = 0.11\%/\text{Log cycle of time}$
Lieszkowszky, Ng et al. (1994) [13]	$\varepsilon = 0.0013 - 0.08\%/\text{Log cycle of time}$
Lieszkowszky, Ng et al. (1995) [14]	$\varepsilon = 0.02 - 0.08\%/\text{Log cycle of time}$
	$\varepsilon = 0.07 - 0.18\%/\text{Log cycle of time}$

Slake durability

All rocks, but shales in particular, are prone to disintegrate when exposed to repeated cycles of wetting and drying. The ability of the rock to resist the effect of wetting and drying can be tested by the “slake durability test” the results of which are reported as an index (I_{d2}). This index is the weight of the dry sample remaining in the test drum after two cycles of wetting and drying (“slaking”), which is then expressed as a percentage of the initial dry sample weight. I_{d2} values that approach zero (0%) indicate rock that is highly susceptible to slaking and those which are close to 100% are not susceptible, resistant rocks. Those materials that have an Index less than 80% may be regarded as soil like^{[1][7]}.

Fifteen (15) tests performed on the shale samples in the laboratories of AMEC gave Index (I_{d2}) values of 59.9 % to 82.1 % (average = 71.7%, standard deviation = 6.6%) indicating medium durability in Gamble’s Classification System. (See Table D3, Appendix D).

Cerchar Abrasiveness

Abrasiveness tests are used to evaluate the rate of wear of tools used to cut the rock. One of these tests is the “Cerchar Abrasivity” test. This test is performed by scratching a freshly broken rock surface with a sharp hardened pin over a distance of 10 mm. The Cerchar Abrasivity Index (CAI) is then calculated as the average abraded diameter of the pin in tenth of a millimetre. These tests were performed on nineteen (19) samples selected by CH2M in the laboratories of AMEC. Test results, with values indicating very low to low abrasiveness (5 samples) and low abrasiveness (14 samples), are presented on **Table D3** in Appendix D. There was no apparent difference in the degree of abrasiveness between shale, siltstone or limestone.

Gas

The Georgian Bay Formation is known to contain pockets of combustible gas^[7]. Gas was encountered in Boreholes HF1-20 (Run 11) and HF1-23 (Run 10), and dissipated in seventeen (17) minutes and ten (10) minutes, respectively. Gas may have been present at other locations, but was not detected either because of the configuration of the drill rig that prevented observation or that the low gas pressure may have been exceeded by the pressure of the drilling water.

7.5 Groundwater

To facilitate long-term water-level observations, 50 mm diameter standpipe type piezometers were installed in twenty-six (26) boreholes and depths selected by CH2M. Details of the installation, such as the location and length of the well screen, extent of the filter sand surround and bentonite clay seals are shown on the borehole logs. Each installation is protected by flush mount lockable metal caps.

The ground water levels in these piezometers were monitored by Coffey several weeks after they were installed. Groundwater measurements taken up to October 14, 2011 in the piezometers installed are

shown on the attached borehole logs. Further water level measurements were obtained by CH2M, and those taken from November 2011 to January 2012 are included in Table 7.5.1 following this page.

Note that some of the piezometer screens (9) were sealed within the overburden and these are designated as "Shallow". Others (17) were sealed into the bedrock. In general, the piezometric readings in both the overburden and the bedrock suggest a high ground water table throughout the project site. Of the seventeen (17) piezometers installed in the bedrock, fifteen (15) registered water levels between 2.1 m and 6.4 m, average 3.8 m below ground surface. In one installation (BH HF1-32) the water level was observed at a depth of 11.3 m, and in another (BH HF1-35A) a slight (<1 m) artesian head was observed. The nine (9) piezometers installed in the overburden indicated water levels between 1.4 m and 3.4 m (average 2.4 m) below ground surface.

Seasonal fluctuations in groundwater levels should be expected. Groundwater levels will also rise and fall in response to precipitation.

Table 7.5.1: Measured Water Levels in Piezometers

Borehole	Water Level: <u>Depth Below Ground Surface (m)</u> <u>Elevation (m)</u>							
	Before Coring, 2011 (DATE) W.L.	July, 2011 (DATE) W.L.	August 12, 2011	September 28, 2011	October 14, 2011	November 3, 2011	December 12, 2011	January 11, 2012
HF1-13 (Deep Well)	(06/27) <u>2.9</u> 122.7	-	<u>5.4</u> 120.2	<u>5.4</u> 120.2	<u>5.3</u> 120.3	<u>5.5</u> 120.1	<u>5.3</u> 120.3	<u>5.3</u> 120.3
HF1-13-1 (Shallow Well)	(07/04) <u>3.0</u> 122.5	-	<u>3.0</u> 122.5	<u>3.1</u> 122.4	<u>3.1</u> 122.4	<u>3.0</u> 122.5	<u>2.9</u> 122.6	<u>3.0</u> 122.5
HF1-15	(07/05) DRY	-	<u>5.2</u> 117.9	<u>5.4</u> 117.7	<u>5.3</u> 117.8	<u>5.3</u> 117.8	<u>6.2</u> 116.9	<u>6.1</u> 117.0
HF1-17	-	(07/21) <u>3.1</u> 115.1	<u>3.4</u> 114.8	<u>3.3</u> 114.9	<u>3.3</u> 114.9	<u>3.3</u> 114.9	<u>3.2</u> 115.0	<u>3.2</u> 115.0
HF1-18	(08/17) DRY	-	-	<u>2.3</u> 110.6	<u>2.2</u> 110.7	<u>2.3</u> 110.6	<u>2.2</u> 110.7	<u>2.2</u> 110.7
HF1-21	(07/12) <u>1.9</u> 109.6	(07/14) <u>2.1</u> 109.4	<u>2.3</u> 109.2	<u>2.3</u> 109.2	<u>2.2</u> 109.3	<u>2.2</u> 109.3	<u>2.1</u> 109.4	<u>2.1</u> 109.4

Borehole	Water Level: <u>Depth Below Ground Surface (m)</u> Elevation (m)							
	Before Coring , 2011 (DATE) W.L.	July, 2011 (DATE) W.L.	August 12, 2011	September 28, 2011	October 14, 2011	November 3, 2011	December 12, 2011	January 11, 2012
HF1-23	(07/18) 2.6 107.0	(07/21) 2.5 107.1	2.5 107.1	2.6 107.0	2.6 107.0	2.3 107.3	2.3 107.3	2.4 107.2
HF1-25 (Deep Well)	(07/20) 3.3 104.4	-	0.5 107.2	3.9 103.8	3.9 103.8	3.8 103.9	3.8 103.9	3.7 104.0
HF1-25-1 (Shallow Well)	-	-	2.7 105.0	2.8 104.9	2.8 104.9	2.6 105.1	2.5 105.2	2.5 105.2
HF1-26 (Deep Well)	(08/24) 2.3 104.6	-	-	3.3 103.6	3.6 103.3	3.8 103.1	3.8 103.1	6.0 100.9
HF1-26-1 (Shallow Well)	-	-	-	2.8 104.1	2.8 104.1	2.7 104.2	2.5 104.4	2.5 104.4
HF1-27-1 (Shallow Well)	-	-	-	2.4 102.7	2.4 102.7	2.2 102.9	2.0 103.1	2.0 103.1
HF1-29 (Deep Well)	-	-	1.9 101.6	4.9 98.6	5.2 98.3	5.0 98.5	5.0 98.5	6.4 97.1
HF1-29-1 (Shallow Well)	-	-	3.0 96.5	3.1 96.4	3.1 96.4	1.7 97.8	2.9 96.6	2.9 96.6
HF1-32	(08/03) 1.5 95.3	-	10.8 86.0	11.9 84.9	10.8 86.0	10.8 86.0	10.7 86.1	11.3 85.5
HF1-34 (Deep Well)	(08/10) 1.4 89.0	-	--	5.7 84.7	5.6 84.8	5.5 84.9	5.5 84.9	5.6 84.8
HF1-34-1 (Shallow Well)	-	-	--	1.9 88.5	1.8 88.6	1.7 88.7	1.5 88.9	1.5 88.9

Borehole	Water Level: <u>Depth Below Ground Surface (m)</u> Elevation (m)							
	Before Coring, 2011 (DATE) W.L.	July, 2011 (DATE) W.L.	August 12, 2011	September 28, 2011	October 14, 2011	November 3, 2011	December 12, 2011	January 11, 2012
HF1-35A	(09/02) <u>1.4</u> 81.4	-	-	Art.*	Art.*	Art.*	Art.*	Art.*
HF1-38 (Deep Well)	(09/08) <u>3.0</u> 81.2	-	-	<u>2.9</u> 81.3	<u>2.9</u> 81.3	<u>2.7</u> 81.5	<u>2.9</u> 81.3	<u>2.8</u> 81.4
HF1-38-1 (Shallow Well)	-	-	-	-	<u>2.7</u> 81.5	<u>1.6</u> 82.6	<u>1.3</u> 82.9	<u>1.4</u> 82.8
HF1-40	-	-	-	<u>3.6</u> 80.8	<u>3.6</u> 80.8	<u>3.5</u> 80.9	<u>3.3</u> 81.1	<u>3.5</u> 80.9
HF1-42 (Deep Well)	-	-	-	-	<u>2.9</u> 81.4	<u>2.5</u> 81.8	<u>2.4</u> 81.9	<u>2.4</u> 81.9
HF1-42-1 (Shallow Well)	-	-	-	-	<u>2.4</u> 81.9	<u>2.4</u> 81.9	<u>2.2</u> 82.1	<u>2.3</u> 82.2
HF1-44	(10/06) <u>3.0</u> 82.2	-	-	-	<u>2.4</u> 82.8	<u>2.3</u> 82.9	<u>2.4</u> 82.8	<u>2.5</u> 82.7
HF1-46 (Deep Well)	-	-	-	-	-	-	<u>3.3</u> 82.3	<u>3.4</u> 82.2
HF1-46-1 (Shallow Well)	-	-	-	-	-	-	<u>3.3</u> 82.3	<u>3.4</u> 82.2

* Art. = Weak artesian conditions observed; water level is slightly above the ground surface.

8 ENVIRONMENTAL SOIL QUALITY ASSESSMENT

A total of twenty-three (23) soil samples (i.e., thirteen (13) fill, nine (9) native and one (1) weathered shale) were selected from the boreholes drilled along the proposed feedermain alignment for environmental testing to assess on-site soil management and off-site disposal options for the excavated soil material. The locations of the boreholes are shown on **Drawings No. 1 to 8** attached in Appendix A.

Except where it is noted, no aesthetic impacts (i.e., staining, odours, etc.) were observed on the recovered samples. Topsoil was encountered in Boreholes HF1-16, HF1-25 and HF1-38. Trace of oxidation stains were encountered in Boreholes HF1-25, HF1-26, HF1-27, HF1-32 and HF1-37 to HF1-43. Traces of rootlets were encountered in Boreholes HF1-14 and HF1-25. Brick fragments were encountered in Borehole HF1-14. The samples were collected in general accordance with O.Reg. 153/04 as amended.

The samples were submitted to AGAT Laboratories in Mississauga, Ontario, which is a certified laboratory according to the Standards Council of Canada (SCC) and the Canadian Association for Laboratory Accreditation Inc. (CALA). The laboratory indicated to Coffey that all analyses were performed in accordance with the MOE QA/QC procedures.

Twenty-two (22) samples were tested for general chemistry and inorganic parameters including heavy metals, pH, sodium adsorption ratio (SAR) and electrical conductivity (EC) as set out in the MOE document *Soil, Ground Water and Sediment Standards for Use Under Part XV.1 of the Environmental Protection Act (O.Reg. 153/04 as amended)*, dated April 15, 2011 (known as 2011 MOE Standards) and twenty-two (22) samples for leachate analyses using the toxicity characteristic leaching procedure (TCLP) required by O.Reg. 347 (amended to O.Reg. 558/00, Leachate Quality Criteria) for metals and inorganic parameters for waste classification purposes.

The laboratory test results were compared with Table 2 Full Depth Generic Site Condition Standards in a Potable Ground Water Condition and Table 3 Full Depth Generic Site Condition Standards in a Non-Potable Ground Water Condition for Residential / Parkland / Institutional (RPI) and Industrial / Commercial / Community (ICC) property use.

A summary of the samples analysed and the types of tests performed are listed in **Table 8.1**.

Table 8.1: Summary of Environmental and Chemical Tests

BH No.	Sample No.	Depth (m)	Soil Type	O. Reg. 153 (511) Table 2 Metals & Inorganics	O. Reg. 347 (558) Metals & Inorganics
HF1-13	1	0.76-1.22	Silty sand fill	✓	✓
HF1-13	6	4.57-5.03	Sand	✓	✓
HF1-14	2	1.52-1.98	Silty sand fill	✓	✓
HF1-14	5	3.81-4.27	Sand	✓	✓

BH No.	Sample No.	Depth (m)	Soil Type	O. Reg. 153 (511) Table 2 Metals & Inorganics	O. Reg. 347 (558) Metals & Inorganics
HF1-16	1A	0.76-1.02	Clayey silt fill	✓	✓
HF1-19	1	0.76-1.22	Silty sand fill	✓	✓
HF1-19	3	2.29-2.74	Silty Clay	✓	✓
HF1-22	1	0.76-1.22	Silty sand fill	✓	✓
HF1-22	3	2.29-2.74	Silty sand	✓	✓
HF1-24	1	0.76-1.22	Silty sand fill	✓	✓
HF1-24	3	2.29-2.74	Silty sand	✓	✓
HF1-25	1	0.76-1.22	Silty sand, fill	✓	
HF1-25	3	2.29-2.74	Sand		✓
HF1-28	2	0.76-1.22	Silty sand, fill	✓	✓
HF1-28	4	2.29-2.74	Silty sand, fill	✓	✓
HF1-30	2	1.52-1.98	Sand, fill	✓	✓
HF1-33	1	0.76-1.22	Sand, fill	✓	✓
HF1-33	3	2.29-2.74	Sand	✓	✓
HF1-36	4	3.05-3.51	Silty clay	✓	✓
HF1-38	1	0.76-1.22	Fill, sand	✓	✓
HF1-38	3	2.29-2.74	Cilty clay	✓	✓
HF1-38	5/6	3.81-4.62	Shale	✓	✓
HF1-43	1	0.76-1.22	Fill, Clayey silt	✓	✓

The analytical laboratory results showed that the concentration of general chemistry and inorganic parameters in the twenty-two (22) samples analysed, except EC in the sample HF1-38 SS5/6, SAR in the soil samples HF1-22 SS1 and HF1-24 SS3, and EC and SAR in the samples HF1-13 SS1, HF1-16 SS1A, HF1-22 SS3, HF1-28 SS2, HF1-30 SS2, HF1-33 SS1 and HF1-43 SS1, met the *2011 MOE Table 2 and Table 3 Standards* for RPI property use.

EC and SAR in the soil samples HF1-13 SS1, HF1-28 SS2, HF1-30 SS2, HF1-33 SS1 and EC in the sample HF1-43 SS1 exceeded the *2011 MOE Table 2 and Table 3 Standards* for ICC property use.

The Leachate concentrations of metals and inorganic parameters in the twenty-two (22) samples analysed met the O.Reg. 558 Schedule 4 limits for leachate quality listed in *O.Reg. 347* (amended *O.Reg.558/00*). Therefore, the tested soils can be classified as non-hazardous solid waste for metals and inorganic parameters for the purpose of off-site disposal at a landfill site licensed by the MOE to accept such waste.

Based on the laboratory results, the soils obtained from Boreholes HF1-13 at the depth of sample SS6, HF1-14, HF1-19 at the sampled depth, HF1-24 at the depth of sample SS1, HF1-25 at the sampled depth, HF1-28 at the depth of sample SS4, HF1-33 at the depth of sample SS3, HF1-36 and HF1-38 at the sampled depths are considered to be chemically suitable for re-use on site or at off-site redevelopment sites accepting soil that meets the *2011 MOE Table 2 and Table 3 Standards* for RPI property use, provided that the soil is free of stains, odours, debris, cinders, mixed materials, etc. when excavated. The environmental quality of soil below the depths analysed is unknown since no chemical analyses were conducted on the soils.

The soils obtained from Boreholes HF1-16, HF1-22 at the sampled depths, HF1-24 at the depth of sample SS3 and the weathered shale from Borehole HF1-38 at the sampled depth are considered to be chemically suitable for re-use at redevelopment sites accepting soils that meet the *2011 MOE Table 2 and Table 3 Standards* for ICC property use.

Should the soils obtained from Boreholes HF1-13 at the depth of sample SS1, HF1-28 and HF1-30 at the depth of sample SS2, HF1-33 at the depth of sample SS1, and HF1-43 at the sampled depth require off-site management, they are not considered to be chemically suitable for re-use on-site or at a redevelopment site accepting soil that meets the *2011 MOE Table 2 and Table 3 Standards* for ICC property use due to the exceedance of EC and SAR values. The elevated EC and SAR values in the soil samples are likely attributable to the use of de-icing salts on the road where the boreholes are located. This material may be suitable for re-use as fill within the right-of-way of other municipal or provincial roadways ("highway" as defined in the Highway Traffic Act); however, the owners or operators of these potential receiving sites must be notified of the environmental quality of the soil and must agree in writing to accept the soil. Consideration should be given to stockpiling the soil and conducting additional analyses. Without additional test results that confirm that concentration is actually lower than the found to date and if the soil cannot be re-used within the right-of-way as defined in the Highway Traffic Act, it will require disposal as a waste at a landfill licensed by the MOE to accept such waste.

It should be noted that acceptance of this material will be at the discretion of the receiving site(s). Depending on the total quantity of soil to be removed additional testing may be required by the receiving site to meet the requirements of O.Reg. 153/04 as amended. Organic staining and the presence of topsoil in soil may limit the re-use of this material at sites requiring inorganic fill, regardless of the results of the chemical analyses.

The analytical data are attached to this report in **Appendix E**.

Coffey makes no warranty, express or implied, as to whether or not excavated soils will be accepted by receivers. Off-site receivers may require additional testing prior to acceptance of any soils. The receiver may also reject soils based on other criteria, such as presence of organic material, peat, topsoil, rubble, or elevated moisture content.

The testing has been conducted in order to assess the possible options for soil disposal only and is not intended to constitute a Phase 2 Environmental Site Assessment and as such does not comment on the environmental condition of the site. Soil quality may vary at locations other than those tested.

During excavation, soils that exhibit stained, hydrocarbon, solvents or other odours, or contain rubble, debris, cinders or other visual evidence of impacts, must not be taken to a clean fill site. These materials should be segregated on-site and this office should be contacted immediately.

9 LIMITATIONS

The reader's attention is drawn to the attached document entitled 'Important Information about your Coffey Report', which presents information on the uses and limitations of this report.

For and on behalf of Coffey Geotechnics Inc.

Alex Campbell, B.A.Sc.

Engineer in Training

Janos Garami, P.Eng.

Principal

For: Ivan Lieszkowszky, P.Eng. FEIC

Senior Principal

Important information about your **Coffey Report**

As a client of Coffey you should know that site subsurface conditions cause more construction problems than any other factor. These notes have been prepared by Coffey to help you interpret and understand the limitations of your report.

Your report is based on project specific criteria

Your report has been developed on the basis of your unique project specific requirements as understood by Coffey and applies only to the site investigated. Project criteria typically include the general nature of the project; its size and configuration; the location of any structures on the site; other site improvements; the presence of underground utilities; and the additional risk imposed by scope-of-service limitations imposed by the client. Your report should not be used if there are any changes to the project without first asking Coffey to assess how factors that changed subsequent to the date of the report affect the report's recommendations. Coffey cannot accept responsibility for problems that may occur due to changed factors if they are not consulted.

Subsurface conditions can change

Subsurface conditions are created by natural processes and the activity of man. For example, water levels can vary with time, fill may be placed on a site and pollutants may migrate with time. Because a report is based on conditions which existed at the time of subsurface exploration, decisions should not be based on a report whose adequacy may have been affected by time. Consult Coffey to be advised how time may have impacted on the project.

Interpretation of factual data

Site assessment identifies actual subsurface conditions only at those points where samples are taken and when they are taken. Data derived from literature and external data source review, sampling and subsequent laboratory testing are interpreted by geologists, engineers or scientists to provide an opinion about overall site conditions, their likely impact on the proposed development and recommended actions. Actual conditions may differ from those inferred to exist, because no professional, no matter how qualified, can reveal what is hidden by

earth, rock and time. The actual interface between materials may be far more gradual or abrupt than assumed based on the facts obtained. Nothing can be done to change the actual site conditions which exist, but steps can be taken to reduce the impact of unexpected conditions. For this reason, owners should retain the services of Coffey through the development stage, to identify variances, conduct additional tests if required, and recommend solutions to problems encountered on site.

Your report will only give preliminary recommendations

Your report is based on the assumption that the site conditions as revealed through selective point sampling are indicative of actual conditions throughout an area. This assumption cannot be substantiated until project implementation has commenced and therefore your report recommendations can only be regarded as preliminary. Only Coffey, who prepared the report, is fully familiar with the background information needed to assess whether or not the report's recommendations are valid and whether or not changes should be considered as the project develops. If another party undertakes the implementation of the recommendations of this report there is a risk that the report will be misinterpreted and Coffey cannot be held responsible for such misinterpretation.

Your report is prepared for specific purposes and persons

To avoid misuse of the information contained in your report it is recommended that you confer with Coffey before passing your report on to another party who may not be familiar with the background and the purpose of the report. Your report should not be applied to any project other than that originally specified at the time the report was issued.

Important information about your **Coffey** Report

Interpretation by other design professionals

Costly problems can occur when other design professionals develop their plans based on misinterpretations of a report. To help avoid misinterpretations, retain Coffey to work with other project design professionals who are affected by the report. Have Coffey explain the report implications to design professionals affected by them and then review plans and specifications produced to see how they incorporate the report findings.

Data should not be separated from the report

The report as a whole presents the findings of the site assessment and the report should not be copied in part or altered in any way.

Logs, figures, drawings, etc. are customarily included in our reports and are developed by scientists, engineers or geologists based on their interpretation of field logs (assembled by field personnel) and laboratory evaluation of field samples. These logs etc. should not under any circumstances be redrawn for inclusion in other documents or separated from the report in any way.

Geoenvironmental concerns are not at issue

Your report is not likely to relate any findings, conclusions, or recommendations about the potential for hazardous materials existing at the site unless specifically required to do so by the client. Specialist equipment, techniques, and personnel are used to perform a geoenvironmental assessment.

Contamination can create major health, safety and environmental risks. If you have no information about the potential for your site to be contaminated or create an environmental hazard, you are advised to contact Coffey for information relating to geoenvironmental issues.

Rely on Coffey for additional assistance

Coffey is familiar with a variety of techniques and approaches that can be used to help reduce risks for all parties to a project, from design to construction. It is common that not all approaches will be necessarily dealt with in your site assessment report due to concepts proposed at that time. As the project progresses through design towards construction, speak with Coffey to develop alternative approaches to problems that may be of genuine benefit both in time and cost.

Responsibility

Reporting relies on interpretation of factual information based on judgement and opinion and has a level of uncertainty attached to it, which is far less exact than the design disciplines. This has often resulted in claims being lodged against consultants, which are unfounded. To help prevent this problem, a number of clauses have been developed for use in contracts, reports and other documents. Responsibility clauses do not transfer appropriate liabilities from Coffey to other parties but are included to identify where Coffey's responsibilities begin and end. Their use is intended to help all parties involved to recognise their individual responsibilities. Read all documents from Coffey closely and do not hesitate to ask any questions you may have.

Appendix A

List of References

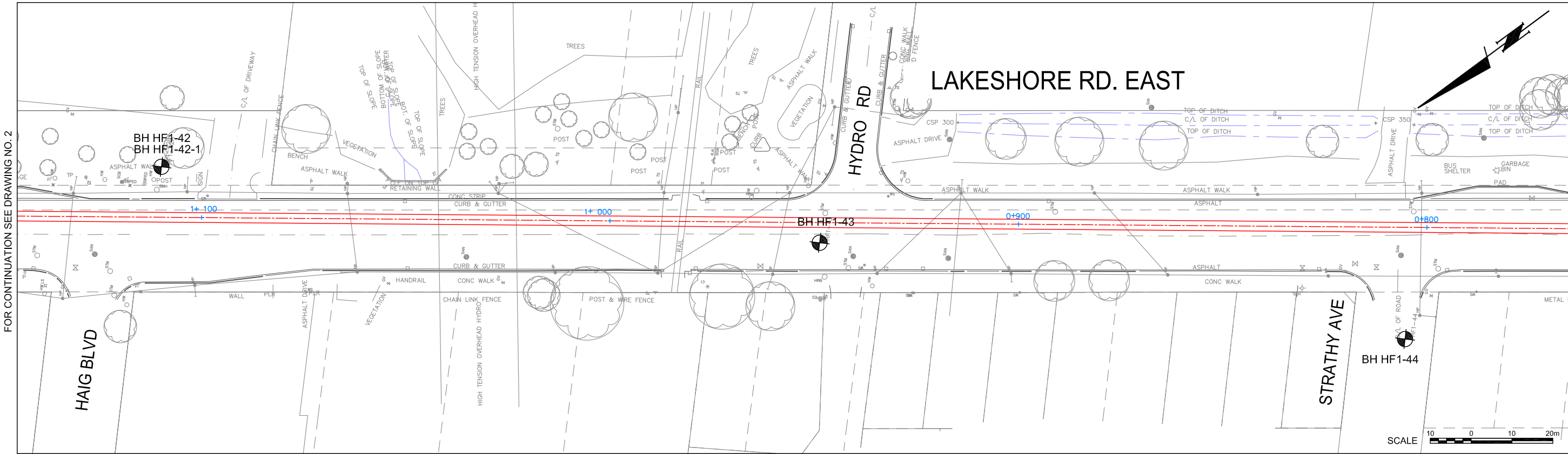
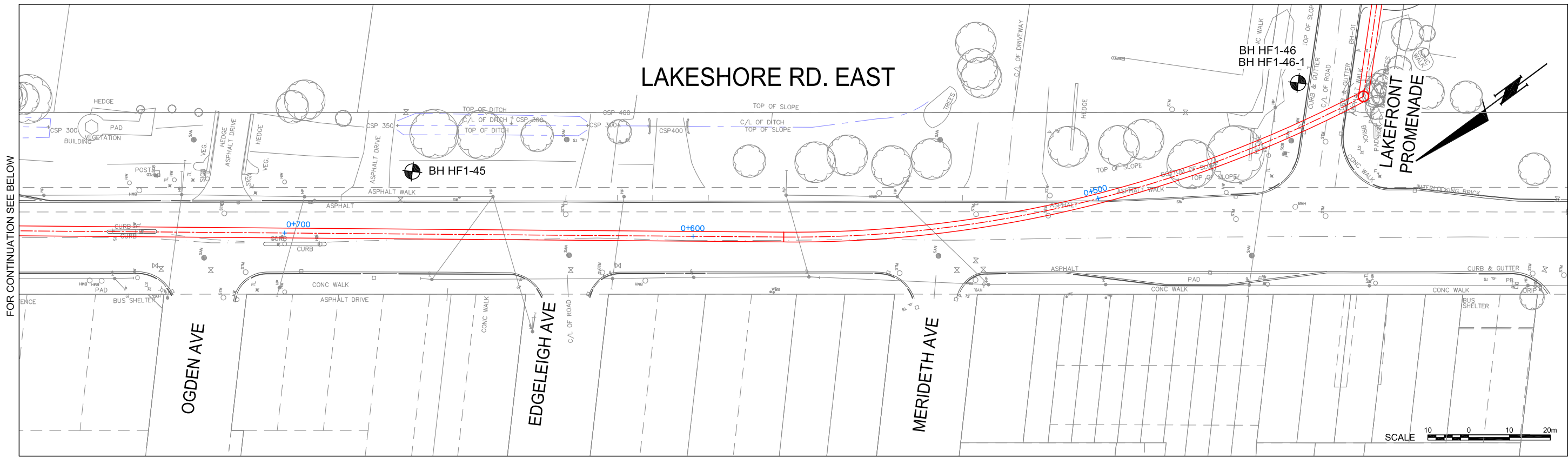
Borehole Location Plans

List of Symbols and Abbreviations



Logs of Boreholes

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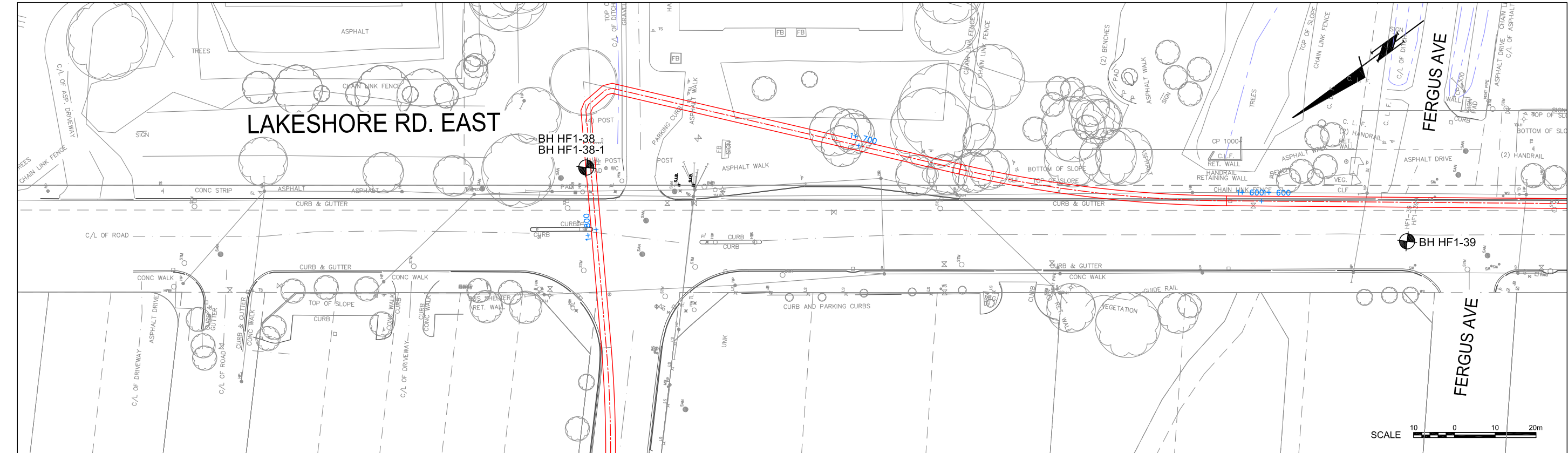
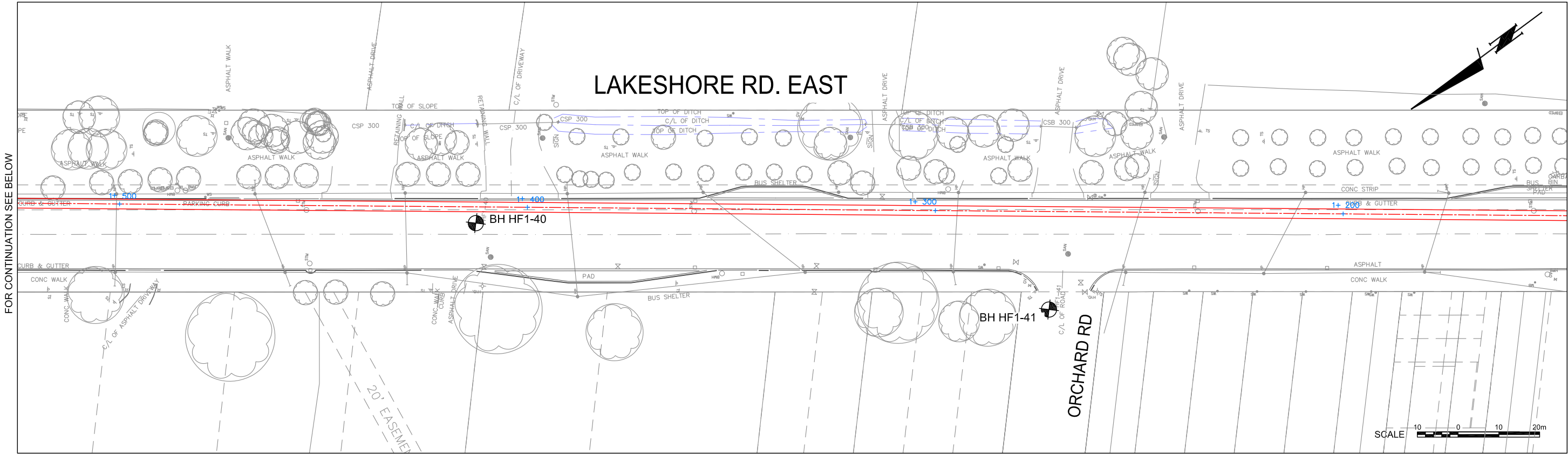
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-  BH PREVIOUS BOREHOLE BY OTHERS

drawn	SH
approved	IL
date	NOVEMBER, 2012
scale	AS SHOWN
original size	Tabloid





client:	CH2M Hill Canada Ltd.	
project:	GEOTECHNICAL INVESTIGATION HANLAN FEEDERMAIN SOUTH	
title:	BOREHOLE LOCATION PLAN	
project no:	GEOTMARK00233AA	drawing no: 1



FOR CONTINUATION SEE DRAWING NO. 3

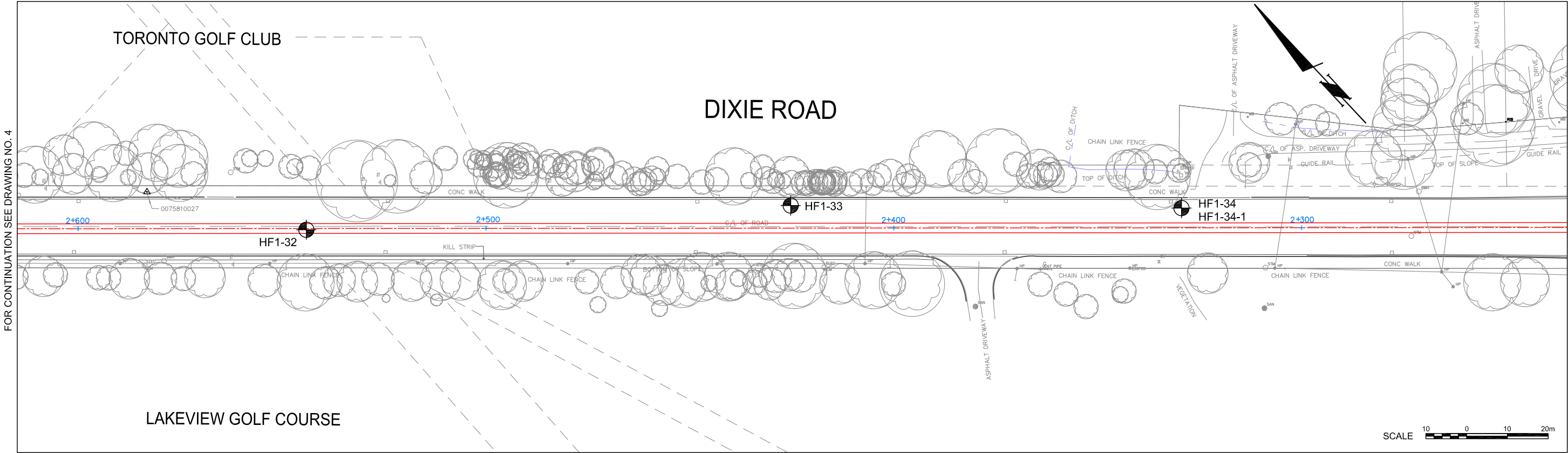
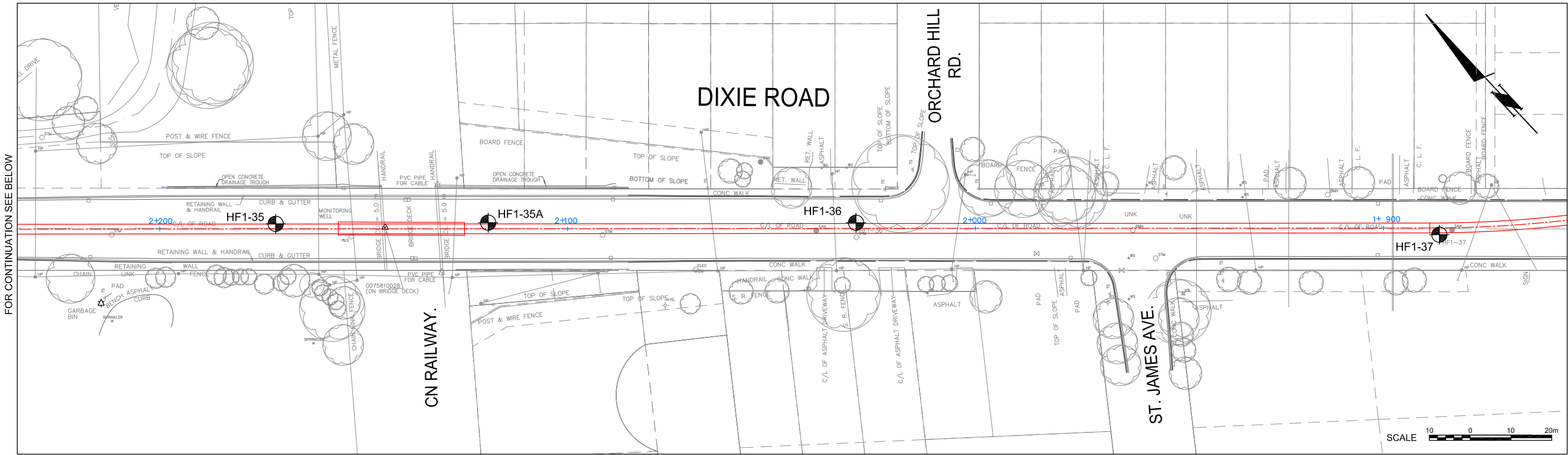
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-  BH PREVIOUS BOREHOLE BY OTHERS

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original size	Tabloid



client:	CH2M Hill Canada Ltd.	
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title:	BOREHOLE LOCATION PLAN	
project no:	GEOTMARK00233AA	drawing no: 2



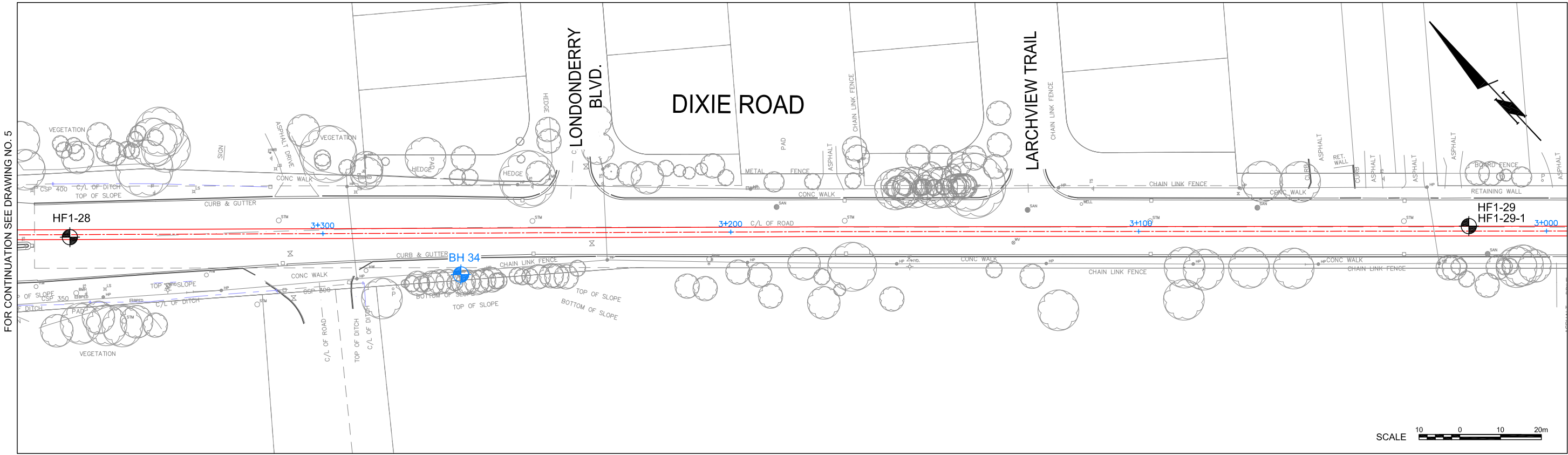
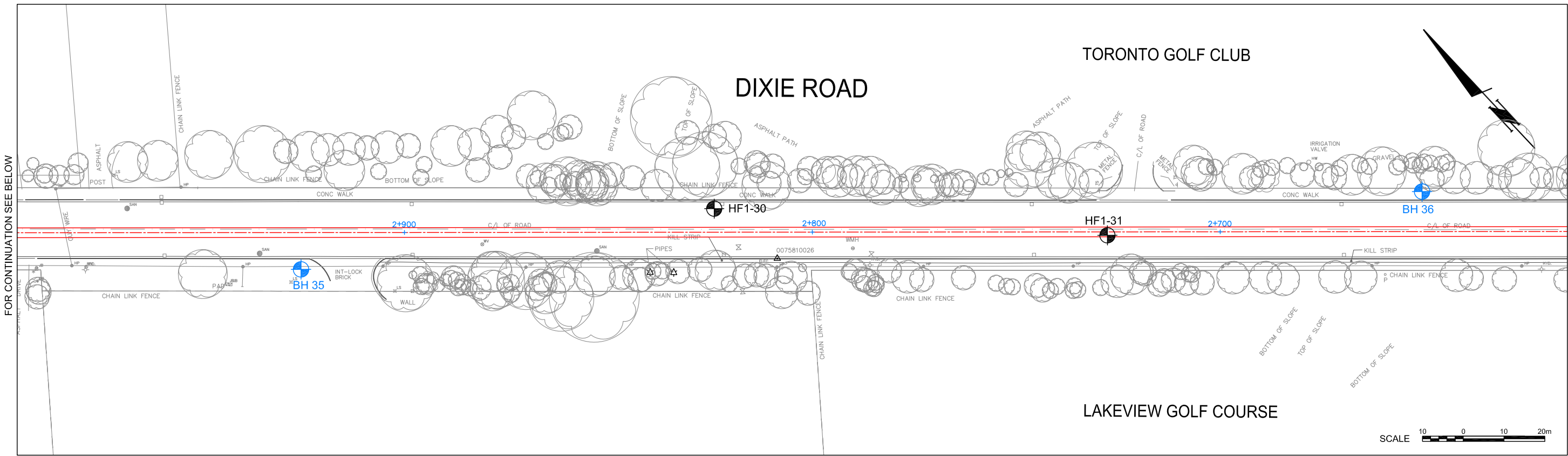
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- BH PREVIOUS BOREHOLE BY OTHERS

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original size	Tabloid



client:	CH2M Hill Canada Ltd.	
project:	GEOTECHNICAL INVESTIGATION HANLAN FEEDERMAIN SOUTH	
title:	BOREHOLE LOCATION PLAN	
project no:	GEOTMARK00233AA	drawing no: 3



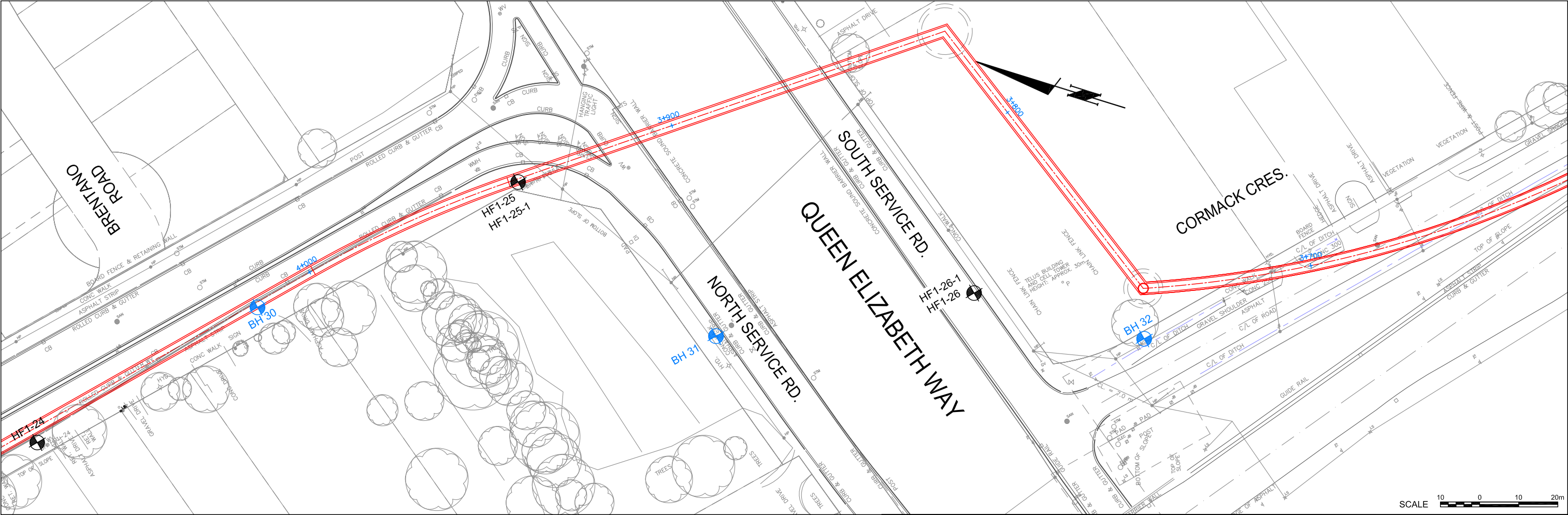
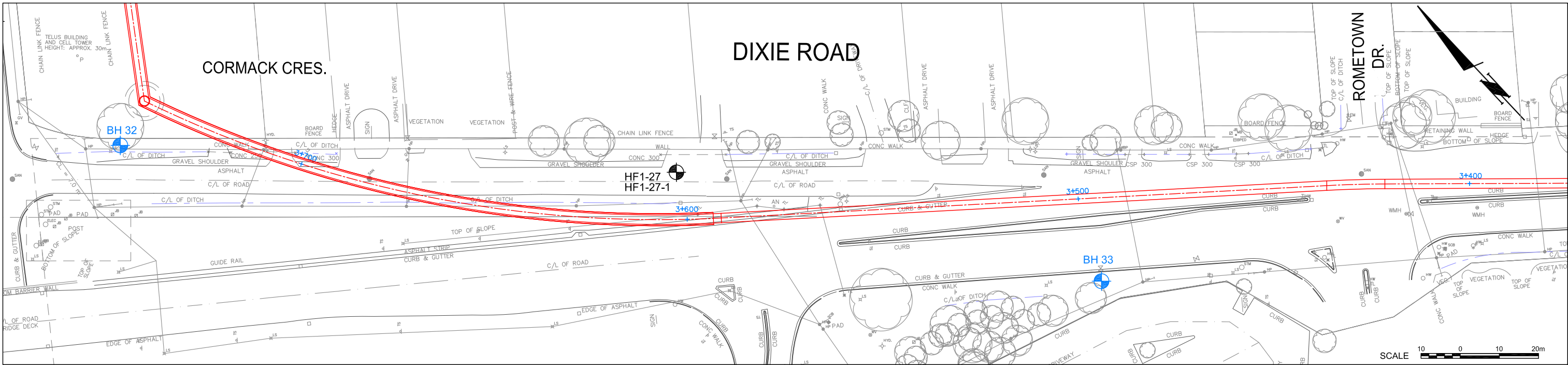
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client:	CH2M Hill Canada Ltd.	
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title:	BOREHOLE LOCATION PLAN	
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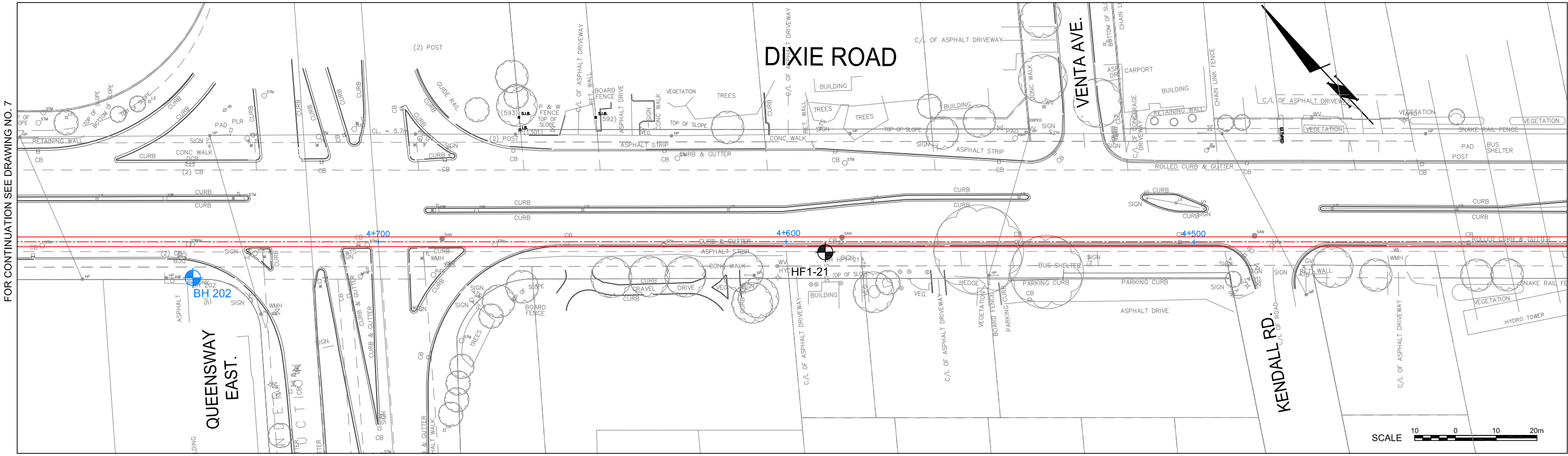
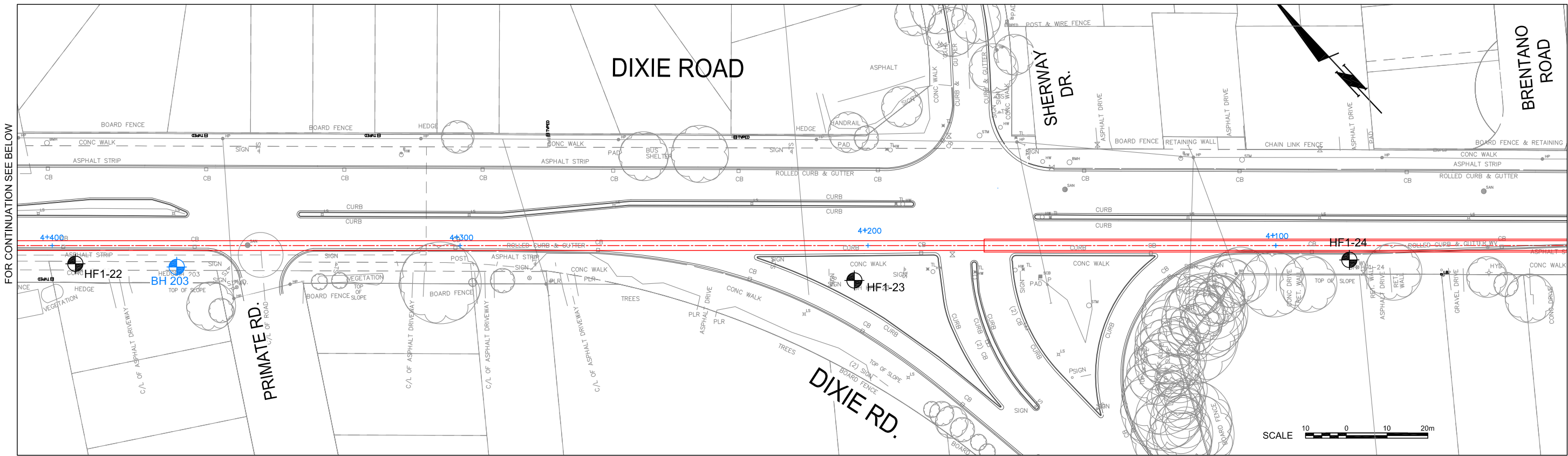
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project:	GEOTECHNICAL INVESTIGATION HANLAN FEEDERMAIN SOUTH	
title:	BOREHOLE LOCATION PLAN	
project no:	GEOTMARK00233AA	drawing no: 5



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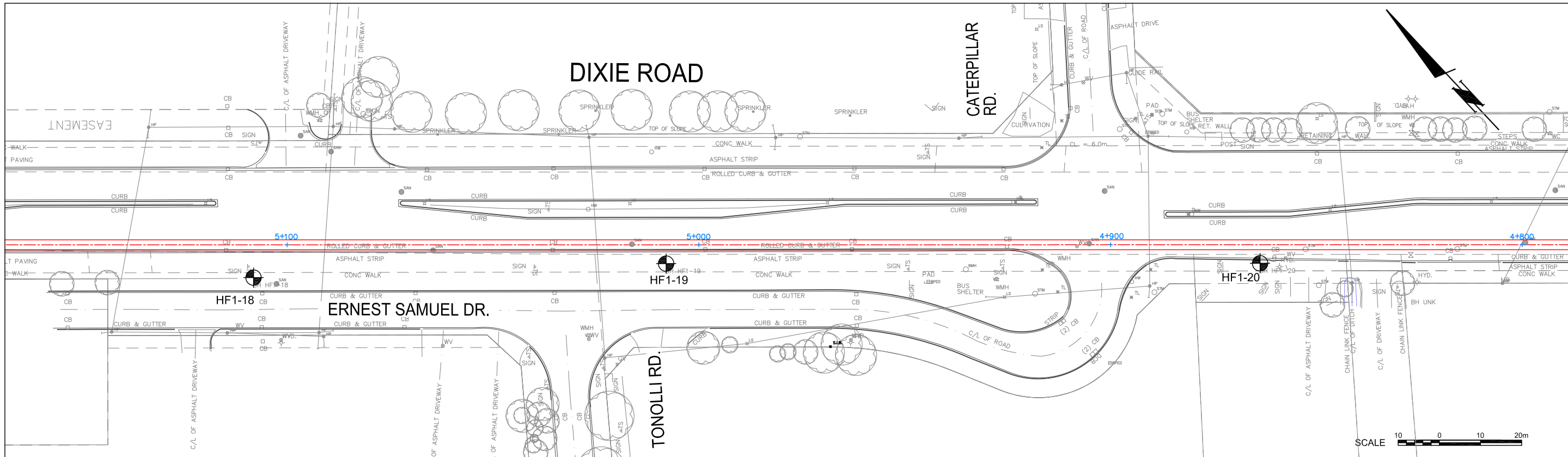
coffey

geotechnics

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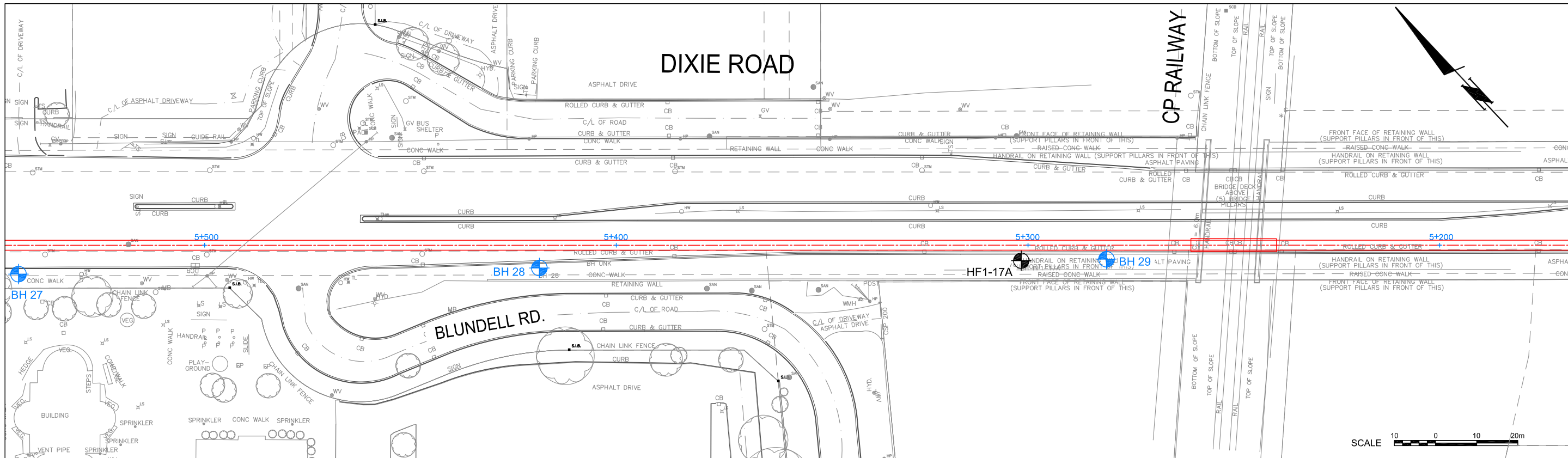
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FOR CONTINUATION SEE BELOW



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FOR CONTINUATION SEE DRAWING NO. 8



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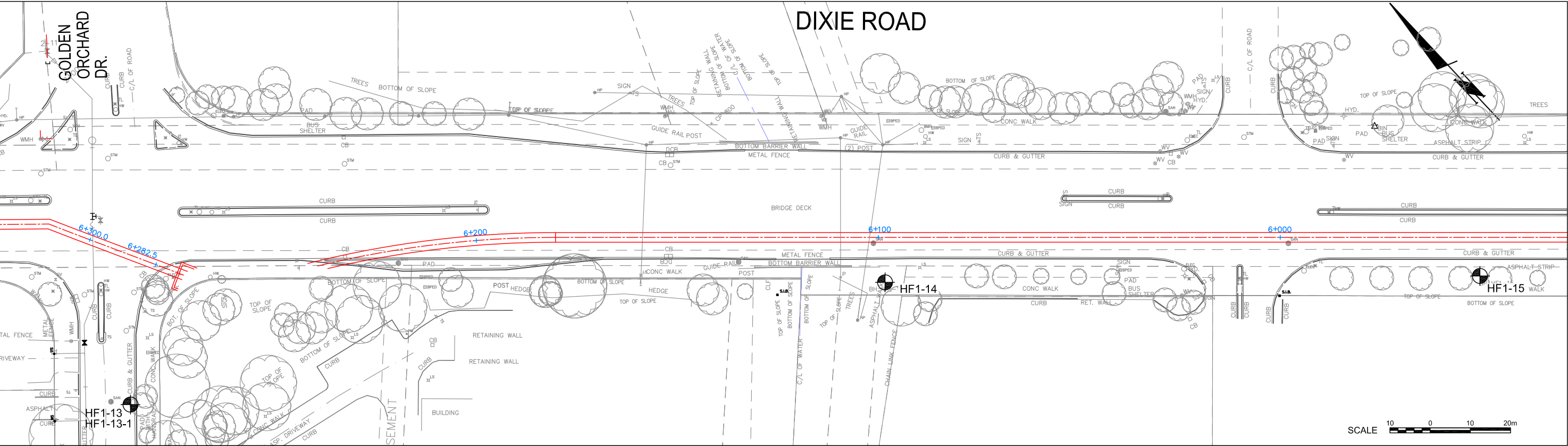
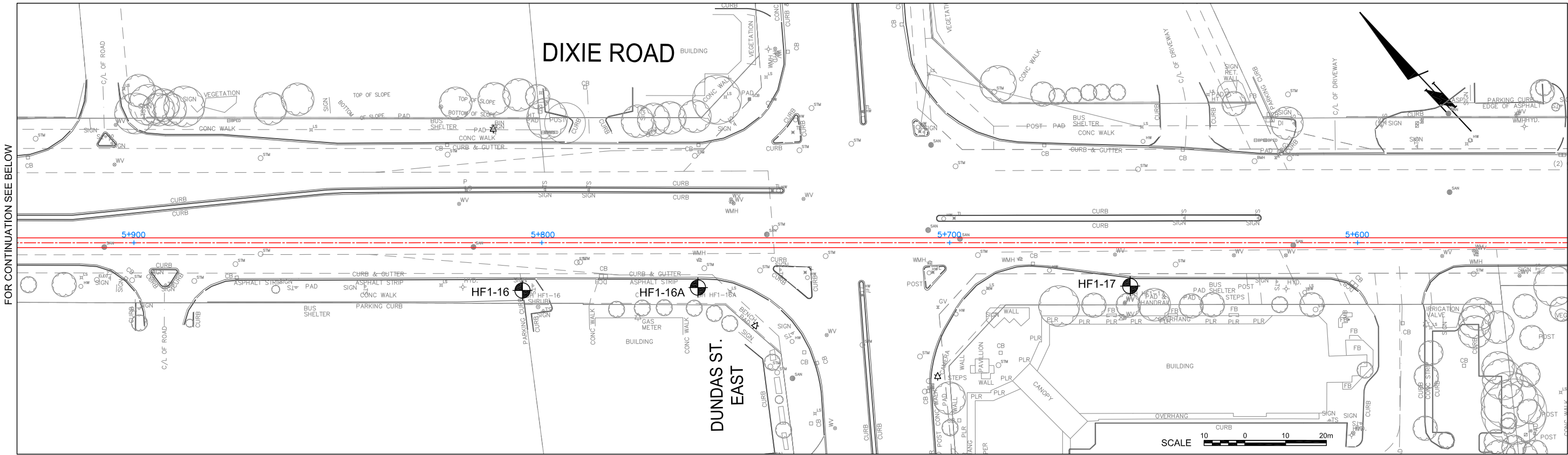
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client:	CH2M Hill Canada Ltd.	
project:	GEOTECHNICAL INVESTIGATION HANLAN FEEDERMAIN SOUTH	
title:	BOREHOLE LOCATION PLAN	
project no:	GEOTMARK00233AA	drawing no: 7



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project:	GEOTECHNICAL INVESTIGATION HANLAN FEEDERMAIN SOUTH	
title:	BOREHOLE LOCATION PLAN	
project no:	GEOTMARK00233AA	drawing no: 8

LIST OF SYMBOLS & ABBREVIATIONS

The following are common symbols and abbreviations used in Coffey borehole logs and geotechnical report:

I. SAMPLE TYPE/FIELD TEST

AS	Auger Sample
GS	Grab Sample
NR	No Recovery
RC	Rock Core
NQ,RC	NQ-Size Rock Core (47.5mm)
HQ,RC	HQ-Size Rock Core (63.4mm)
SC	Soil Core
SH	Shelby Tube
SS	Split Spoon (Split Barrel)
TW	Thin Walled Tube, e.g. Pitcher Sampler
VANE, V	Vane Test

Consistency	C_u (kPa)	N (blows/30cm)*
Very soft	0 – 12	0 – 2
Soft	12 – 25	2 – 4
Firm	25 – 50	4 – 8
Stiff	50 – 100	8 – 15
Very Stiff	100 – 200	15 – 30
Hard	over 200	over 30

*Based on the Canadian Foundation Engineering Manual, and would be used if direct field/lab measurement of shear strength is not conducted.

II. PENETRATION RESISTANCE

Standard Penetration Test (SPT):

The SPT "N" value is defined as the number of blows required to drive a standard 51mm (2in) O.D. Split Spoon Sampler 30cm (12in) into undisturbed ground in a borehole by means of a hammer weighing 63.5kg (140lb) and falling freely a distance of 76cm (30in). For penetrations less than 30cm (12in), "N" values are indicated as the number of blows for the penetration achieved.

HB:	Hammer Bouncing
HW:	Hammer Weight; sampler is penetrated under hammer weight only, i.e. without impact load.

Dynamic Cone Penetration Test:

It is the continuous penetration of a 50mm (2in) O.D., 60° conical steel point 30cm (12in) into undisturbed ground in a borehole by means of a hammer weighing 63.5kg (140lb) and falling freely a distance of 76cm (30in). The resistance to the Dynamic Cone Penetration Test is measured as the number of blows required to drive the conical steel point as specified.

Peizo-Cone Penetration Test (CPT):

An electronic cone penetrometer with a 60° conical tip and a projected end area of 10cm² pushed through ground at a penetration rate of 2cm/s. Measurements of tip resistance q_t , porewater pressure u_t , and sleeve friction f_s , are recorded electronically at 25mm (1in) penetration intervals.

III. SOIL CONSISTENCY/COMPACTNESS

(a) Cohesionless Soils

Cohesionless soils are described on the basis of their compactness as indicated by SPT N values as follows:

Compactness	N (blows/30cm)
Very loose	0 - 4
Loose	4 - 10
Compact	10 - 30
Dense	30 - 50
Very Dense	over 50

(b) Cohesive Soils

Cohesive soils are described on the basis of their consistency as indicated by undrained shear strength C_u values as follows:

IV SOIL CLASSIFICATION

All sample descriptions included in this report follow the Canadian Foundations Engineering Manual soil classification system which follows the standard proposed by the International Society for Soil Mechanics and Foundation Engineering, with the exception that soil fractions are classified on the basis of the following grain size diameters:

Boulder	>200mm
Cobbles	76.2 -200mm
Gravel	4.75-76.2mm
Sand	0.075-4.75mm
Silt	0.002-0.075mm
Clay	<0.002mm

The classification is based on the amounts by weight within the respective grain-size fractions, as follows:

Noun	gravel, sand, silt, clay	>35% and main fraction
"and"	and gravel, and silt etc	>35%
adjective	gravelly, sandy etc	20-35%
"some"	some sand, some silt etc	10-20%
"trace"	trace sand, trace silt etc	1-10%

Clay soils are classified based on their measured or estimated plasticity and their plot on the plasticity chart of the Unified Soil Classification System (USCS) as follows:

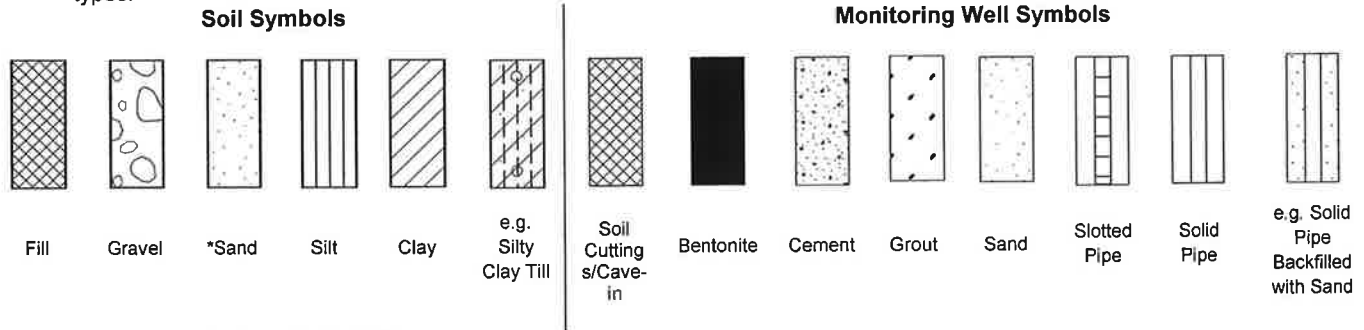
CL-ML	clayey silt
CL	silty clay
CI	clay of medium plasticity
CH	clay of high plasticity

With the exception of those samples for which a grain size analyses and / or Atterberg Limits test has been conducted, all samples are primary classified based on visual inspection. Visual inspection, however, is not sufficiently accurate to provide an exact estimate of grain sizes or precise differentiation between soil groups based on grain sizes. Similarly estimates of the plasticity of the soils are subject to error.

LIST OF SYMBOLS & ABBREVIATIONS

V. SOIL / MONITORING WELL SYMBOLS

The following are common graphic symbols used in the borehole logs to represent basic soil types and monitoring well installations. Combinations of the shown symbols are used in the borehole logs to represent soils composed of different soil types:



VI. ADDITIONAL NOTES

Stratification lines shown in the borehole logs represent approximate boundary lines between material types; vertical and lateral transitions may be gradual. In addition, water level readings were made at time(s) noted on the borehole logs. Fluctuations of groundwater levels may occur and should be expected.

VII. STRESS AND STRAIN

γ	shear strain
Δ	change in, e.g. in stress: $\Delta\sigma$
ϵ	linear strain
ϵ_v	volumetric strain
η	coefficient of viscosity
ν	Poisson's ratio
u	porewater pressure
σ	total stress
σ'	effective stress ($\sigma - u$)
σ'_{vo}	initial effective overburden stress
σ_1	major principal stress
σ_2	intermediate principal stress
σ_3	minor principal stress
σ_{oct}	mean/octahedral stress $(\sigma_1 + \sigma_2 + \sigma_3)/3$
τ	shear stress
E	Young's modulus of deformation
G	Shear modulus of deformation
K	Bulk modulus of compressibility

VIII. SOIL PROPERTIES

(a) Index Properties

ρ, γ	bulk density, unit weight
ρ_d, γ_d	dry density, unit weight
ρ_w, γ_w	density, unit weight of water
ρ_{sat}, γ_{sat}	saturated density, unit weight
ρ', γ'	submerged density, unit weight ($\gamma - \gamma_w$)
G_s	specific gravity of solid particles
e	void ratio
n	porosity
S	degree of saturation
MC, w	moisture/water content
LL, w_L	liquid limit
PL, w_P	plastic limit
w_s	shrinkage limit
PI, I_P	plasticity index ($w_L - w_P$)
I_L	liquidity index $(w - w_P)/I_P$
e_{max}	void ratio in loosest state
e_{min}	void ratio in densest state

D_R relative density $(e_{max} - e)/(e_{max} - e_{min})$

(b) Hydraulic Properties

h	hydraulic head or potential
q	rate of flow
v	velocity of flow
i	hydraulic gradient
k	hydraulic conductivity
j	seepage force per unit volume

(c) Consolidation (one-dimensional)

C_c	compression index
C_r	recompression index
C_s	swelling index
C_a	coefficient of secondary compression
m_v	coefficient of volume change
c_v	coefficient of consolidation
T_v	time factor (vertical direction)
U	degree of consolidation
σ'_p	pre-consolidation pressure
OCR	overconsolidation ratio

(d) Shear Strength

T_p	peak shear strength
T_r	residual shear strength
ϕ', ϕ	effective angle of internal friction
δ	angle of interface friction
μ	coefficient of friction ($\tan \delta$)
c'	effective cohesion
c_u, s_u	undrained shear strength
p	mean total stress $(\sigma_1 + \sigma_3)/2$
p'	mean effective stress $(\sigma'_1 + \sigma'_3)/2$
q	$(\sigma_1 - \sigma_3)/2$ or $(\sigma'_1 - \sigma'_3)/2$
q_u	compressive strength $(\sigma_1 - \sigma_3)$
S_t	Sensitivity
UCS	Unconfined Compressive Strength (associated strains reported are rounded)

LIST OF SYMBOLS & ABBREVIATIONS

IX. ROCK CLASSIFICATION

The terms and definitions used for rock descriptions are consistent with international standards as set out in the journal of the International Society of Rock Mechanics (ISRM), the Quarterly Journal of Engineering Geology (QJEG), and the bulletin of the International Association of Engineering Geology (IAEG).

Total Core Recovery (TCR):

The TCR value is defined as the sum of rock core lengths recovered from a core run, divided by the length of the core run and expressed as a percentage.

Solid Core Recovery (SCR):

The SCR value is defined as the sum of solid, full diameter rock core lengths recovered from a core run, expressed as a percentage of the total length of the core run.

Rock Quality Designation (RQD):

The RQD value is defined as the sum of lengths of rock core pieces measured along centerline of core equal to or greater than 100mm (4in) recovered from a core run, expressed as a percentage of the total length of the core run. Core fractured by drilling is considered intact.

Rock Quality	RQD (%)
Excellent	90 - 100
Good	75 - 90
Fair	50 - 75
Poor	25 - 50
Very Poor	0 - 25

Fracture Index:

The fracture index is expressed as the number of discontinuities per 300mm (1ft). It excludes drill-induced (mechanical) fractures and fragmented zones, and is reported as ">25" if frequency exceeds 25 fractures per 300mm.

Broken Zone:

It is the zone of full diameter core of very low RQD which may include some drill-induced (mechanical) fractures.

Fragmented Zone:

It is the zone where core is less than full diameter and RQD = 0.

Bedding:

Term	Bed Thickness	
	(mm)	(in)
Very Thickly Bedded	>2000	>78
Thickly Bedded	600-2000	24-78
Medium Bedded	200-600	7.8-24
Thinly Bedded	60-200	2.4-7.8
Very Thinly Bedded	20-60	0.72-2.4
Laminated	6-20	0.24-0.72
Thinly Laminated	<6	<0.24

Strength:

Term	Grade	Description	Unconfined Compressive Strength	
			(MPa)	(psi)
Extremely Weak	R0	Indented by thumbnail	0.25-1	36-145
Very Weak	R1	Crumbles under firm blows with point of a geological hammer, can be peeled by a pocket knife.	1-5	145-725
Weak	R2	Can be peeled by a pocket knife with difficulty, shallow indentations made by firm blow with point of geological hammer	5-25	725-3625
Medium Strong	R3	Cannot be scraped or peeled with pocket knife, can be fractured with single firm blow of geological hammer	25-50	3625-7250
Strong	R4	Requires more than one blow of geological hammer to fracture it	50-100	7250-14500
Very Strong	R5	Requires many blows of geological hammer to fracture it	100-250	14500-36250
Extremely Strong	R6	Can only be chipped with geological hammer	>250	>36250

LIST OF SYMBOLS & ABBREVIATIONS

Weathering:

<u>Term</u>	<u>Grade</u>	<u>Description</u>
Fresh	W1	No visible sign of rock material weathering.
Slightly Weathered	W2	Discoloration indicates weathering of rock material and discontinuity surfaces. All the rock material may be discolored by weathering and may be somewhat weaker than in its fresh condition.
Moderately Weathered	W3	Less than half of the rock material is decomposed and/or disintegrated to soil. Fresh or discolored rock may be present as a discontinuous framework or corestone.
Highly Weathered	W4	More than half of the rock material is decomposed and/or disintegrated to soil. Fresh or discolored rock may be present as a discontinuous framework or corestone.
Completely Weathered	W5	All of rock material is decomposed and/or disintegrated to a soil. The original mass structure is still largely intact. A soil description is required.
Residual Soil	W6	All of rock material is converted to soil. The mass structure and material fabric are destroyed.

X. DEFECT LOGGING

Type of Discontinuity:

<u>Term</u>	<u>Code</u>	<u>Description</u>
Bedding Parting	BP	Natural parting parallel to the surface of deposition, between layers
Contact	CN	Surface between two different lithologies (rock units)
Drilling Induced	DI	Fracture caused by drilling. Commonly smooth (core spun) or irregular (broken in tension)
Joint	JT	Fracture across which rock has little or no tensile strength
Shear	SR	Fracture along which movement has occurred
Vein	VN	Fracture infilled with minerals

Shape of Discontinuity:

<u>Term</u>	<u>Code</u>	<u>Description</u>
Planar	PL	Forms a continuous plane
Curved	CU	Has a gradual change in orientation
Undulating	UN	Has a wavy surface
Stepped	ST	Has equal to or greater than one defined steps
Irregular	IR	Many changes in orientation
Serrated	SE	Saw-tooth pattern

Aperture of Discontinuity:

<u>Term</u>	<u>Defect Width (mm)</u>	<u>Description</u>
Tight	Nil	
Very Narrow	>0-2mm	Closed
Narrow	2-6mm	
Moderately Narrow	6-20mm	Gapped
Moderately Wide	20-60mm	
Wide	60-200mm	Open
Very Wide	>200mm	

Spacing:

<u>Term</u>	<u>Spacing (mm)</u>
Very widely spaced	>2000
Widely spaced	600-2000
Moderately widely spaced	200-600
Closely spaced	60-200
Very closely spaced	20-60
Extremely closely spaced	<20

Roughness of Discontinuity:

<u>Term</u>	<u>Code</u>	<u>Description</u>
Slickensided	SL	Very smooth, polished surface
Smooth	S	Roughness not detected with finger
Defined ridges	DR	Fine-medium sandpaper feel
Rough	R	Medium-coarse sandpaper feel
Very rough	VR	Very well defined ridges and/or steps

Infill Type:

<u>Term</u>	<u>Code</u>	<u>Description</u>
Calcite	CA	Clear-white, calcareous, crystalline
Clay	CL	Clay-coating or infilled seam
Gravel	G	---
Iron Oxide	Fe	Yellow/orange/brown discoloration
Quartz	QZ	Clear-white, crystalline
Sand	S	---
Silt	Z	---

LOG OF BOREHOLE HF1-13

SHEET 1 OF 1

Project Name: HANLAN FEEDERMAIN SOUTH CONTRACT 1 Client: CH2M HILL CANADA LTD. Northing: 4829804 m
 Project No.: GEOTMARK00233AA Drilling Method Used: Solid Stem Augering 150mm Easting: 613834 m
 Project Location: DIXIE RD, MISSISSAUGA Date: 27 - 29 June 2011 Ground Surface Elevation: 125.6 m

Depth Scale (m)	Stratigraphic Symbol	Subsurface Conditions		Samples		Penetration / Strength Results		Moisture / Plasticity		Instrumentation Details	Groundwater Conditions	Headspace Vapor (ppm) LEL (%)	Elevation Scale (m)	Comments
		Depth / Elevation (m)	Description	Number	Type	Blow Counts / 150mm	N Value	Recovery %	Relative Drilling Resistance					
									Penetration Test Values (Blows / 0.3m) X N Values ♦ Dynamic Cone + Becker Hammer Test (BPT) 20 40 60 80					
									Undrained Shear Strength Values (kPa) □ Field Vane ○ Unconfined ■ Lab Vane ● Quick Triaxial ▲ Pocket Penetrometer	PL MC LL				
0.5			150mm Asphalt 150mm Granular Base										125.5	
1.0			FILL silty sand trace clay, trace gravel brown, moist, loose	1	SS	4 4 5	(9)	100	X				125.0	
1.5		124.1	SILTY CLAY trace gravel (possible fill) grey, stiff	2	SS	3 5 5	(10)	89	X				124.0	
2.0		123.3	SAND fine grained, some silt to silty, trace clay, brown, compact, stratified	3	SS	9 10 13	(23)	89	X				123.5	
2.5			grey, wet	4	SS	7 8 11	(19)	83	X				123.0	0 76 17 7
3.0													122.5	spoon wet
3.5													122.0	
4.0		121.8	SILTY SAND fine grained sand, trace clay, brown, compact, stratified, dilatant	5	SS	2 6 11	(17)	83	X				121.5	0 65 28 7
4.5													121.0	
5.0				6	SS	2 8 14	(22)	100	X				120.5	
5.5			very loose	7	SS	1 1 3	(4)	100	X				120.0	0 63 31 6
6.0													119.5	
6.5			compact	8	SS	3 6 12	(18)	100	X				119.0	
7.0		118.6	SHALE hard										118.5	inferred shale
7.4				9	SS	100	100	98						

Rock Coring Started

BEFORE CORING

Date / Time	Water Depth (m)	Elevation (m)
27 June 2011	2.9	122.7
12 August 2011	5.4	120.2
28 September 2011	5.4	120.2
14 October 2011	5.3	120.3

Rock Core Log Next Page



Additional Notes:

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 Sample Types: A=Auger; DP=Direct Push; G=Grab; RC=Rock Core; SC=Soil Core; SS=Split Barrel (Split Spoon); ST=Shelby Tube.

Coffey Representatives

AA	Originated By
AC	Prepared By
IL	Checked By

LOG OF BOREHOLE HF1-13

SHEET 1 OF 2

Project Name: HANLAN FEEDERMAIN SOUTH CONTRACT 1

Client: CH2M HILL CANADA LTD.

Date: 27 - 29 June 2011

Project No.: GEOTMARK00233AA

Drilling Method Used: ROCK CORING HQ3

Northing: 4829804 m

Project Location: DIXIE RD, MISSISSAUGA

Ground Surface Elevation: 125.6 m

Easting: 613834 m

Borehole Location: SEE DRAWING

Datum Elevation: Geodetic

Diameter: 61mm

(m) STRATA ELEV DEPTH	ROCK DESCRIPTION See Soil Logs for soil descriptions.	GROUND WATER CONDITIONS	(m) CORE ELEV DEPTH	CORE SAMPLE			TOTAL CORE RECOVERY (%)	SOLID CORE RECOVERY (%)	HARD LAYER (%)	ROD (%)	FRACTURE INDEX (per 0.3m)	DISCONTINUITIES AND WEATHERING	HYDRAULIC CONDUCTIVITY k (cm/sec) [P (kPa)]	POINT LOAD TEST UCS AXIAL (MPa)	POINT LOAD TEST UCS DIAMETRAL (MPa)	UNIAxIAL COMPRESSION (MPa)	DENSITY (g/cc) [E (GPa)]
				NUMBER	SIZE	CORE RATE (m/min)											
118.2			118.2														
7.4	GEORGIAN BAY FORMATION Dark grey, SHALE laminated, interbedded with light grey LIMESTONE and SILTSTONE layers, strong to very strong		7.4 118.0 7.6	1	HQ3	0.03	51	0	0	0		horizontal bedding partings, very closely to closely spaced, planar to stepped, smooth, occasionally rough, tight, occasional clay infill, slightly weathered		43	2		
				2	HQ3	0.06	92	72	0	25							
			116.5 9.1	3	HQ3	0.07	95	90	0	49		bedding partings, very closely to closely spaced, generally horizontal, planar to undulating, smooth, occasionally rough, tight (40%) to open (60%), some with clay infill, fresh to slightly weathered		41	6		
	25mm hard layer at 10.6 and 11.3m		115.0 10.6	4	HQ3		100	100	5	93		widely spaced bedding partings, slightly weathered		54	23		
	25mm hard layer at 12.2 and 13.2m		113.5 12.1	5	HQ3		93	79	3	67		horizontal joints and contacts, very closely to closely spaced, joints rough and open, some with clay infill, slightly weathered		15	0		
	medium strong 75mm hard layer at 14.2 and 14.5m 25mm hard layer at 14.8m		112.0 13.6	6	HQ3	0.11	97	95	12	90		horizontal joints and contacts, very closely to closely spaced, joints open and rough, slightly weathered		267	85		
	weak 50mm hard layer at 15.2m 100mm hard layer at 15.3m 25mm hard layer at 15.7, 15.9, and 16.1m		110.4 15.2	7	HQ3	0.14	100	92	15	72		joints, contacts, and bedding partings, moderately closely to very closely spaced, generally horizontal, planar, smooth (50%) to rough (50%), tight (50%) to open (50%), some with clay infill, fresh to slightly weathered	No flow[167] ('k' < 1.00E-08) 2.08E-7 [304] No flow[441] ('k' < 1.00E-08)	48	5	46.3 [7]	2.71 [7]
	25mm hard layer at 17.1 and 17.5m		108.9 16.7									horizontal contacts, moderately closely spaced, planar, smooth to rough, open, some clay infill, fresh to slightly weathered		32	6	133.5 [19]	13.62 [19]

Continued Next Page

E = Modulus of Elasticity

Additional Notes:

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LOG OF BOREHOLE HF1-13

SHEET 2 OF 2

Project Name: HANLAN FEEDERMAIN SOUTH CONTRACT 1

Client: CH2M HILL CANADA LTD.

Date: 27 - 29 June 2011

Project No.: GEOTMARK00233AA

Drilling Method Used: ROCK CORING HQ3

Northing: 4829804 m

Project Location: DIXIE RD, MISSISSAUGA

Ground Surface Elevation: 125.6 m

Easting: 613834 m

Borehole Location: SEE DRAWING

Datum Elevation: Geodetic

Diameter: 61mm

(m) STRATA ELEV DEPTH	ROCK DESCRIPTION See Soil Logs for soil descriptions.	GROUND WATER CONDITIONS	(m) CORE ELEV DEPTH	CORE SAMPLE			TOTAL CORE RECOVERY (%)	SOLID CORE RECOVERY (%)	HARD LAYER (%)	ROD (%)	FRACTURE INDEX (per 0.3m)	DISCONTINUITIES AND WEATHERING	HYDRAULIC CONDUCTIVITY k (cm/sec) [P (kPa)]	POINT LOAD TEST UCS AXIAL (MPa)	POINT LOAD TEST UCS DIAMETRAL (MPa)	UNIAxIAL COMPRESSION (MPa)	DENSITY (g/cc) [E (GPa)]
				NUMBER	SIZE	CORE RATE (m/min)											
	GEORGIAN BAY FORMATION Dark grey, SHALE laminated, interbedded with light grey LIMESTONE and SILTSTONE layers, strong to very strong (<i>continued</i>) weak to medium strong 25mm hard layer at 19.5 and 19.7m			8	HQ3	0.15	98	98	3	91		horizontal contacts, moderately closely spaced, planar, smooth to rough, open, some clay infill, fresh to slightly weathered (<i>continued</i>)					
			107.4														
			18.2									horizontal joints, conacts, and bedding partings, moderately closely spaced, planar, smooth (50%) to rough (50%), generally open, fresh to slightly weathered	7.57E-7 [167]	35	5		
				9	HQ3		100	100	3	92			1.25E-6 [304]				
			105.9										2.86E-6 [441]				
			19.7									horizontal joints and bedding partings, closely spaced, planar to undulating, rough, occasionally smooth, open, slightly weathered		163	53		
	unfractured, weak medium strong		104.6														
			21.0	11	HQ3		100	100	0	100		horizontal joints, widely to closely spaced, undulating to planar, rough, open, clay coating, slightly weathered		41	5	13.7	2.6 [2]
			104.4														
			21.2														
				12	HQ3	0.13	100	100	0	95				31	10		
	50mm hard layer at 23.1 , 23.9, and 24.2m		102.8									horizontal joints, and bedding partings, closely spaced, planar to undulating, rough and open, occasionally smooth, slightly weathered		163	89		
			22.8											40	5		
				13	HQ3	0.12	100	100	10	92							
			101.3														
	25mm hard layer at 24.3 and 24.9m		24.3									horizontal joints and bedding partings, moderately closely spaced to very closely spaced, planar, smooth, open, slightly weathered		39	8		
				14	HQ3	0.10	100	98	3	97							
99.8			99.8														
25.8			25.8														

Date / Time	Water Depth (m)	Elevation (m)
BEFORE CORING 27 June 2011	2.9	122.7
12 August 2011	5.4	120.2
28 September 2011	5.4	120.2
14 October 2011	5.3	120.3

E = Modulus of Elasticity



Additional Notes:

This log is to be read in conjunction with accompanying general notes and borehole log symbols sheet. Stratification lines represent approximate boundary lines between material types, vertical and lateral transitions may be gradual. Water level readings were made at time(s) noted, fluctuations of groundwater levels may occur and should be expected.
Sample Types: A=Auger; DP=Direct Push; G=Grab; RC=Rock Core; SC=Soil Core; SS=Split Barrel (Split Spoon); ST=Shelby Tube.

Coffey Representatives

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LOG OF BOREHOLE HF1-13-1

SHEET 1 OF 1

Project Name: HANLAN FEEDERMAIN SOUTH CONTRACT 1

Client: CH2M HILL CANADA LTD.

Northing: 4829804 m

Project No.: GEOTMARK00233AA

Drilling Method Used: Hollow Stem Augering 200mm

Easting: 613835 m

Project Location: DIXIE RD, MISSISSAUGA

Date: 4 July 2011

Ground Surface Elevation: 125.5 m

Depth Scale (m)	Subsurface Conditions		Samples		Penetration / Strength Results		Moisture / Plasticity		Instrumentation Details	Groundwater Conditions	Headspace Vapor (ppm) LEL (%)	Elevation Scale (m)	Comments
	Stratigraphic Symbol	Depth / Elevation (m)	Description	Number Type	Blow Counts / 150mm N Value	Recovery %	Relative Drilling Resistance	Penetration Test Values (Blows / 0.3m) X N Values ♦ Dynamic Cone + Becker Hammer Test (BPT) Undrained Shear Strength Values (kPa) □ Field Vane ○ Unconfined ■ Lab Vane ● Quick Triaxial ▲ Pocket Penetrometer	Plastic Limit Natural Water Content Liquid Limit PL MC LL				
0.5			See log of Borehole HF1-13 for stratigraphy.									125.0	
1.0												124.5	
1.5												124.0	
2.0												123.5	
2.5												123.0	
3.0												122.5	
3.5												122.0	
4.0												121.5	
4.5												121.0	
5.0												120.5	
5.5												120.0	
6.0												119.5	
6.5												119.0	
7.0												118.5	

BOREHOLE HF1-13-1
TERMINATED AT 7.1m BGL

	Date / Time	Water Depth (m)	Elevation (m)
UPON COMPLETION	4 July 2011	3.0	122.5
	12 August 2011	3.0	122.5
	28 September 2011	3.1	122.4
	14 October 2011	3.1	122.4

SOIL LOG FOR CH2M GEOTMARK00233AA_BH13 TO BH24.GPJ COFFEY STANDARD GDT_29/5/12



Additional Notes:

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Sample Types: A=Auger; DP=Direct Push; G=Grab; RC=Rock Core; SC=Soil Core; SS=Split Barrel (Split Spoon); ST=Shelby Tube.

Coffey Representatives

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IL	Checked By

LOG OF BOREHOLE HF1-14

SHEET 1 OF 1

Project Name: HANLAN FEEDERMAIN SOUTH CONTRACT 1	Client: CH2M HILL CANADA LTD.	Northings: 4829698 m
Project No.: GEOTMARK00233AA	Drilling Method Used: Solid Stem Sugering 150mm	Easting: 613992 m
Project Location: DIXIE RD, MISSISSAUGA	Date: 27 - 28 June 2011	Ground Surface Elevation: 124.4 m

Depth Scale (m)	Subsurface Conditions		Samples		Penetration / Strength Results				Moisture / Plasticity			Instrumentation Details	Groundwater Conditions	Headspace Vapor (ppm) LEL (%)	Elevation Scale (m)	Comments
	Stratigraphic Symbol	Depth / Elevation (m)	Description	Number Type	Blow Counts / 150mm N Value	Recovery %	Relative Drilling Resistance	Penetration Test Values (Blows / 0.3m) X N Values ♦ Dynamic Cone + Becker Hammer Test (BPT) 20 40 60 80	Undrained Shear Strength Values (kPa) □ Field Vane ○ Unconfined ■ Lab Vane ● Quick Triaxial ▲ Pocket Penetrometer	Plastic Limit	Natural Water Content	Liquid Limit				
0.5			140mm Asphalt												124.0	
1.0			FILL silty sand, some clay, some fine grained gravel trace rootlets, trace brick fragments brown, very loose to loose	1 SS	5 7 3	(10)	83	X							123.5	
1.5															123.0	
2.0				2 SS	1 2 1	(3)	67	X							122.5	
2.5															122.0	
3.0				3 SS	1 2 3	(5)	89	X							121.5	
3.5															121.0	
4.0		120.6		4 SS	1 2 3	(5)	89	X							120.5	
4.5		3.8	SAND trace to some silt, trace gravel, trace clay, brown/grey, compact to dense	5 SS	4 7 9	(16)	72	X							120.0	
5.0															119.5	0 81 13 6
5.5				6 SS	6 8 12	(20)	94	X							119.0	
6.0															118.5	
6.5				7 SS	2 8 13	(21)	94	X							118.0	
7.0															117.5	
7.5															117.0	
8.0				8 SS	2 6 13	(19)	89	X							116.5	
8.5															116.0	
9.0		115.4		9 SS	2 9 35	(44)	94	X							115.5	
9.0		9.0	silt pocket	10 SS	50 50 50	(50)	93									

Rock Coring Started

BEFORE CORING
Date / Time
27 June 2011Water Depth (m)
3.8Elevation (m)
120.6

Rock Core Log Next Page



Additional Notes:

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Sample Types: A=Auger; DP=Direct Push; G=Grab; RC=Rock Core; SC=Soil Core; SS=Split Barrel (Split Spoon); ST=Shelby Tube.

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SOIL LOG FOR CH2M GEOTMARK00233AA BH13 TO BH24.GPJ COFFEY STANDARD GDT 29/5/12

LOG OF BOREHOLE HF1-14

SHEET 1 OF 2

Project Name: HANLAN FEEDERMAIN SOUTH CONTRACT 1

Client: CH2M HILL CANADA LTD.

Date: 27 - 28 June 2011

Project No.: GEOTMARK00233AA

Drilling Method Used: ROCK CORING HQ3

Northing: 4829698 m

Project Location: DIXIE RD, MISSISSAUGA

Ground Surface Elevation: 124.4 m

Easting: 613992 m

Borehole Location: SEE DRAWING

Datum Elevation: Geodetic

Diameter: 61mm

(m) STRATA ELEV DEPTH	ROCK DESCRIPTION See Soil Logs for soil descriptions.	GROUND WATER CONDITIONS	(m) CORE ELEV DEPTH	CORE SAMPLE			TOTAL CORE RECOVERY (%)	SOLID CORE RECOVERY (%)	HARD LAYER (%)	ROD (%)	FRACTURE INDEX (per 0.3m)	DISCONTINUITIES AND WEATHERING	HYDRAULIC CONDUCTIVITY k (cm/sec) [P (kPa)]	POINT LOAD TEST UCS AXIAL (MPa)	POINT LOAD TEST UCS DIAMETRAL (MPa)	UNIAxIAL COMPRESSION (MPa)	DENSITY (g/cc) [E (GPa)]
				NUMBER	SIZE	CORE RATE (m/min)											
115.4			115.4														
9.0	GEORGIAN BAY FORMATION grey, SHALE thinly laminated, interbedded with light grey LIMESTONE and SILTSTONE layers, strong to very strong Run1: extremely weak to very weak, 175mm clay seam at 9.1 m Run2: weak		9.0	1	HQ3	0.04	100	0	0	0							
			115.0														
			9.4	2	HQ3	0.07	100	68	0	40		joints and bedding partings, horizontal, occasionally vertical, moderately closely to very closely spaced, planar to undulating, smooth (60%) to rough (40%), tight, occasionally open, some with gravel infill, slightly to moderately weathered		34	1		
	hard layer at 11.0m		113.5														
			10.9	3	HQ3	0.10	100	87	2	28		joints and bedding partings, generally horizontal, some 10 to 90 degrees, moderately closely spaced to very closely spaced, planar to stepped, generally smooth, open (50%) to tight (50%), clay coating, slightly to moderately weathered		42	6		
	25mm hard layer at 12.6m, 100mm hard layer at 13.7m		112.0														
			12.4	4	HQ3	0.10	100	90	13	55		joints and bedding partings, generally horizontal, occasionally 0 to 90 degrees, moderately closely to very closely spaced, planar to undulating, generally smooth, open, occasionally tight, clay coating, slightly to moderately weathered		256	75		
	25mm hard layers at 13.9, 14.1, and 15.4m, 150mm hard layer at 14.2m		110.5														
			13.9	5	HQ3	0.13	100	98	15	72		joints and bedding partings, generally horizontal, moderately closely to very closely spaced, planar to stepped, smooth (50%) to rough (50%), open, some tight, clay coating, slightly weathered		37	4		
	25 mm hard layer at 15.8m, 50 mm hard layer at 16.2m, 35 mm had layer at 16.8m, 12 mm clay seam at 15.5m		108.9														
			15.5	6	HQ3	0.09	100	97	9	90		joints and bedding partings, generally horizontal, moderately closely spaced, planar to stepped, smooth (60%) to rough (40%), open, clay coating, slightly weathered		34	1		
	weak to medium strong, 50mm hard layer at 18.3m		107.4														
			17.0	7	HQ3	0.08	100	98	10	75		joints and bedding partings, horizontal, occasionally 0 to 90 degrees, moderately closely to very closely spaced, planar to stepped, smooth, generally open, clay coating, some clay infill, slightly weathered to fresh		182	82		
	clay seam at 18.6m, 50mm hard layer at 18.6m, 35mm hard layer at 19.3m		105.9														
			18.5													11	2.62 [2]

Continued Next Page

E = Modulus of Elasticity



Additional Notes:

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Coffey Representatives

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LOG OF BOREHOLE HF1-14

SHEET 2 OF 2

Project Name: HANLAN FEEDERMAIN SOUTH CONTRACT 1

Client: CH2M HILL CANADA LTD.

Date: 27 - 28 June 2011

Project No.: GEOTMARK00233AA

Drilling Method Used: ROCK CORING HQ3

Northing: 4829698 m

Project Location: DIXIE RD, MISSISSAUGA

Ground Surface Elevation: 124.4 m

Easting: 613992 m

Borehole Location: SEE DRAWING

Datum Elevation: Geodetic

Diameter: 61mm

(m) STRATA ELEV DEPTH	ROCK DESCRIPTION See Soil Logs for soil descriptions.	GROUND WATER CONDITIONS	(m) CORE ELEV DEPTH	CORE SAMPLE			TOTAL CORE RECOVERY (%)	SOLID CORE RECOVERY (%)	HARD LAYER (%)	RQD (%)	FRACTURE INDEX (per 0.3m)				DISCONTINUITIES AND WEATHERING	HYDRAULIC CONDUCTIVITY k (cm/sec) [P (kPa)]	POINT LOAD TEST UCS AXIAL (MPa)	POINT LOAD TEST UCS DIAMETRAL (MPa)	UNIAXIAL COMPRESSION (MPa)	DENSITY (g/cc) [E (GPa)]			
				NUMBER	SIZE	CORE RATE (m/min)					2	4	6	8									
98.3 26.1	GEORGIAN BAY FORMATION grey, SHALE thinly laminated, interbedded with light grey LIMESTONE and SILTSTONE layers, strong to very strong (<i>continued</i>) 38mm clay seam at 20.3m, 75mm hard layer at 21.4m 100mm hard layer at 21.4m, 75mm hard layer at 22.5m, 25mm hard layer at 21.7, and 23.1m, 50mm hard layer at 21.9, 22.0, 22.4, 22.7, and 22.8m, 75mm hard layer at 23.0m 25mm hard layer at 23.4m 25mm hard layer at 22.7m, 12mm hard layer at 22.8m		104.4	8	HQ3	0.08	100	98	6	77					joints, contacts, and bedding partings, generally horizontal, moderately closely to extremely closely spaced, planar to stepped, smooth (70%) to rough (30%), open (50%) to tight (50%), clay coating, slightly weathered to fresh (<i>continued</i>)	4	3						
			20.0												joints, contacts, and bedding partings, generally horizontal, widely to very closely spaced, planar to stepped, generally smooth, open, some clay infill, slightly weathered to fresh								
				9	HQ3	0.04	100	97	5	68													
			102.8												joints and bedding partings, generally horizontal, moderately widely to very closely spaced, planar to undulating, smooth (40%) to rough (60%), open , clay coating, slightly weathered to fresh								
			21.6	10	HQ3	0.06	100	97	35	92										11	18		
			101.3												joint, 5 degrees, undulating, smooth, open, clay coating, slightly weathered to fresh								
			23.1	11	HQ3	0.03	100	100	3	100													
			99.8																				
			24.6	12	HQ3	0.06	100	100	3	100					horizontal joint, undulating, smooth, open, clay coating, slightly weathered to fresh					18	7		
			98.3																				
26.1																							

Date / Time Water Depth (m) Elevation (m)
 BEFORE CORING 27 June 2011 3.8 120.6

54 10

E = Modulus of Elasticity



Additional Notes:

This log is to be read in conjunction with accompanying general notes and borehole log symbols sheet. Stratification lines represent approximate boundary lines between material types, vertical and lateral transitions may be gradual. Water level readings were made at time(s) noted, fluctuations of groundwater levels may occur and should be expected.
 Sample Types: A=Auger; DP=Direct Push; G=Grab; RC=Rock Core; SC=Soil Core; SS=Split Barrel (Split Spoon); ST=Shelby Tube.

Coffey Representatives

BB	Originated By
AC	Prepared By
IL	Checked By

LOG OF BOREHOLE HF1-15

SHEET 1 OF 1

Project Name: HANLAN FEEDERMAIN SOUTH CONTRACT 1

Client: CH2M HILL CANADA LTD.

Northing: 4829598 m

Project No.: GEOTMARK00233AA

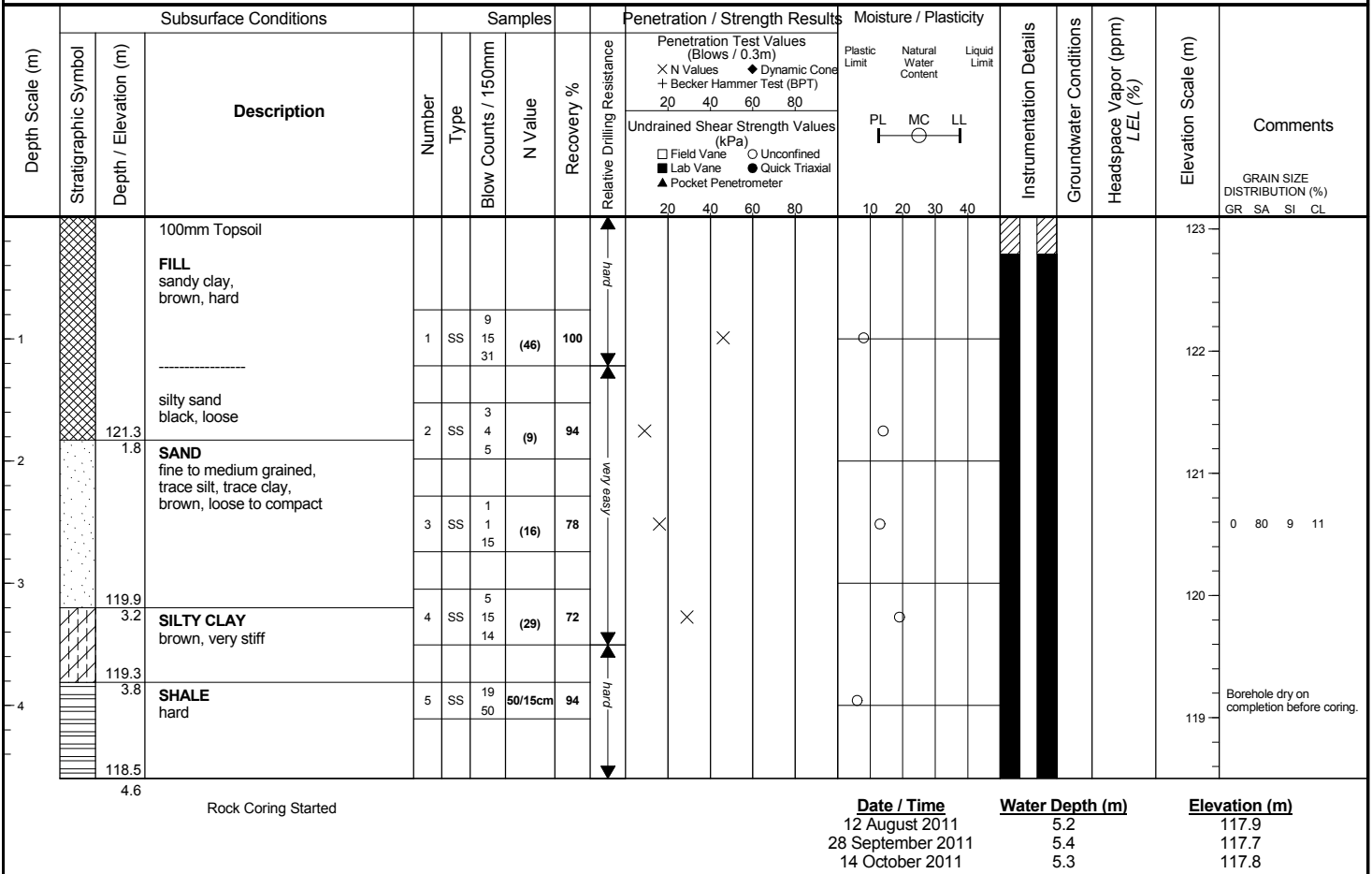
Drilling Method Used: Hollow Stem Augering 200mm

Easting: 614101 m

Project Location: DIXIE RD, MISSISSAUGA

Date: 5 - 7 July 2011

Ground Surface Elevation: 123.1 m



Rock Core Log Next Page



Additional Notes:

This log is to be read in conjunction with accompanying general notes and borehole log symbols sheet. Stratification lines represent approximate boundary lines between material types; vertical and lateral transitions may be gradual. Water level readings were made at time(s) noted; fluctuations of groundwater levels may occur and should be expected.
Sample Types: A=Auger; DP=Direct Push; G=Grab; RC=Rock Core; SC=Soil Core; SS=Split Barrel (Split Spoon); ST=Shelby Tube.

Coffey Representatives

AA	Originated By
AC	Prepared By
IL	Checked By

LOG OF BOREHOLE HF1-15

SHEET 1 OF 2

Project Name: HANLAN FEEDERMAIN SOUTH CONTRACT 1

Client: CH2M HILL CANADA LTD.

Date: 5 - 7 July 2011

Project No.: GEOTMARK00233AA

Drilling Method Used: ROCK CORING HQ3

Northing: 4829598 m

Project Location: DIXIE RD, MISSISSAUGA

Ground Surface Elevation: 123.1 m

Easting: 614101 m

Borehole Location: SEE DRAWING

Datum Elevation: Geodetic

Diameter: 61mm

(m) STRATA ELEV DEPTH	ROCK DESCRIPTION See Soil Logs for soil descriptions.	GROUND WATER CONDITIONS	(m) CORE ELEV DEPTH	CORE SAMPLE			TOTAL CORE RECOVERY (%)	SOLID CORE RECOVERY (%)	HARD LAYER (%)	RQD (%)	FRACTURE INDEX (per 0.3m)	DISCONTINUITIES AND WEATHERING	HYDRAULIC CONDUCTIVITY k (cm/sec) [P (kPa)]	POINT LOAD TEST UCS AXIAL (MPa)	POINT LOAD TEST UCS DIAMETRAL (MPa)	UNIAxIAL COMPRESSION (MPa)	DENSITY (g/cc) [E (GPa)]
				NUMBER	SIZE	CORE RATE (m/min)											
118.5 4.6	GEORGIAN BAY FORMATION grey, SHALE thinly laminated, interbedded with light grey LIMESTONE , SILTSTONE layers, strong to very strong 25mm hard layer at 6.9m medium strong, 25mm hard layer at 7.7m, 75mm hard layers at 7.8 and 8.3m 50mm hard layer at 9.3m, 100mm hard layer at 9.5m, 25mm hard layer at 10.5m 100mm hard layers at 10.8, 11.6, and 11.7m very weak, 25mm hard layer at 12.2m, 100mm hard layer at 12.6m, 125mm hard layer at 13.2m, 75mm hard layer at 13.4m weak		118.5 4.6	1	HQ3	0.06	90	22	0	0		horizontal bedding partings, very closely spaced, planar, rough, open, highly weathered to fresh	No flow[128] ('k' < 1.00E-8) 7.92E-4 [235] 7.47E-5 [343] 5.94E-6 [128] 5.90E-6 [235] 4.78E-6 [343]	38	2		
			117.0 6.1	2	HQ3	0.08	100	92	1	64		horizontal bedding partings, moderately widely spaced to very closely spaced, planar, smooth (30%) to rough (70%), generally open, some clay infill, slightly weathered to fresh					
			115.5 7.6	3	HQ3	0.12	100	88	11	55		horizontal contacts and bedding partings, moderately widely spaced to very closely spaced, planar, occasionally undulating, smooth (40%) to rough (60%), open, some with clay infill, slightly weathered to fresh					
			113.9 9.2	4	HQ3	0.12	100	87	11	64		horizontal contacts and bedding partings, moderately widely spaced to very closely spaced, generally planar, smooth (25%) to rough (75%), generally open, some with clay infill, slightly weathered to fresh					
			112.4 10.7	5	HQ3	0.14	100	97	19	80		horizontal contacts and bedding partings, moderately widely spaced to very closely spaced, generally planar, rough, occasionally smooth, open, slightly weathered to fresh					
			110.9 12.2	6	HQ3	0.14	100	84	21	75		horizontal contacts and bedding partings, closely spaced to very closely spaced, planar, smooth (50%) to rough (50%), open, occasionally tight, highly weathered				53.8	2.62 [11]
			109.3 13.8	7	HQ3	0.15	100	100	0	93		horizontal bedding partings, moderately widely spaced to very closely spaced, planar, smooth, occasionally rough, generally open, slightly weathered to fresh					
			107.8 15.3														

Continued Next Page

E = Modulus of Elasticity

Additional Notes:

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Sample Types: A=Auger; DP=Direct Push; G=Grab; RC=Rock Core; SC=Soil Core; SS=Split Barrel (Split Spoon); ST=Shelby Tube.

Coffey Representatives

AA	Originated By
AC	Prepared By
IL	Checked By

LOG OF BOREHOLE HF1-15

SHEET 2 OF 2

Project Name: HANLAN FEEDERMAIN SOUTH CONTRACT 1

Client: CH2M HILL CANADA LTD.

Date: 5 - 7 July 2011

Project No.: GEOTMARK00233AA

Drilling Method Used: ROCK CORING HQ3

Northing: 4829598 m

Project Location: DIXIE RD, MISSISSAUGA


Ground Surface Elevation: 123.1 m

Easting: 614101 m

Borehole Location: SEE DRAWING

Datum Elevation: Geodetic

Diameter: 61mm

(m) STRATA ELEV DEPTH	ROCK DESCRIPTION See Soil Logs for soil descriptions.	GROUND WATER CONDITIONS	(m) CORE ELEV DEPTH	CORE SAMPLE			TOTAL CORE RECOVERY (%)	SOLID CORE RECOVERY (%)	HARD LAYER (%)	ROD (%)	FRACTURE INDEX (per 0.3m)				DISCONTINUITIES AND WEATHERING	HYDRAULIC CONDUCTIVITY k (cm/sec) [P (kPa)]	POINT LOAD TEST UCS AXIAL (MPa)	POINT LOAD TEST UCS DIAMETRAL (MPa)	UNIAxIAL COMPRESSION (MPa)	DENSITY (g/cc) [E (GPa)]
				NUMBER	SIZE	CORE RATE (m/min)					2	4	6	8						
98.4 24.7	GEORGIAN BAY FORMATION grey, SHALE thinly laminated, interbedded with light grey LIMESTONE , SILTSTONE layers, strong to very strong (<i>continued</i>) 50mm hard layer at 16.9m, 100mm hard layers at 17.0 and 17.7m, 25mm hard layer at 17.9m 75mm hard layer at 18.7m 50mm hard layer at 19.9m Run12: medium strong, 75mm hard layer at 20.9m, 50mm hard layer at 21.1m, 25mm hard layer at 21.2m, 75mm hard layer at 21.5m 50mm hard layer at 24.2m, 25mm hard layer at 23.2m		106.3	8	HQ3	0.14	100	100	0	100					horizontal bedding parting, planar, smooth, open, slightly weathered to fresh (<i>continued</i>)		27	7		
			16.8	9	HQ3	0.13	100	98	18	88					horizontal contacts and bedding partings, moderately widely spaced to very closely spaced, planar, smooth, occasionally rough, open, some with clay infill, slightly weathered to fresh		1	247		
			104.8												slightly weathered to fresh					
			18.3	10	HQ3		100	98	5	78							8	8		
			103.3																	
			19.8	11	HQ3	0.10	92	92	17	67					horizontal contacts, very closely spaced, undulating to stepped, smooth, open, clay coating, slightly weathered to fresh					
			103.0																	
			20.1	12	HQ3	0.14	98	88	20	72					joints, contacts, and bedding partings, some 10 to 90 degrees, moderately widely spaced to very closely spaced, planar to stepped, smooth (50%) to rough (50%), open (50%) to tight (50%), clay coating, slightly weathered to fresh		14	8		
			101.5																	
			21.6	13	HQ3	0.07	100	100	0	100					slightly weathered to fresh		15	10		
			99.9																	
			23.2	14	HQ3	0.08	100	100	5	100					horizontal bedding parting, planar, clay coating, healed, fresh		111	25		
			98.4																	
			24.7																	

Date / Time	Water Depth (m)	Elevation (m)
12 August 2011	5.2	117.9
28 September 2011	5.4	117.7
14 October 2011	5.3	117.8

E = Modulus of Elasticity



Additional Notes:

This log is to be read in conjunction with accompanying general notes and borehole log symbols sheet. Stratification lines represent approximate boundary lines between material types; vertical and lateral transitions may be gradual. Water level readings were made at time(s) noted; fluctuations of groundwater levels may occur and should be expected.
Sample Types: A=Auger; DP=Direct Push; G=Grab; RC=Rock Core; SC=Soil Core; SS=Split Barrel (Split Spoon); ST=Shelby Tube.

Coffey Representatives

AA	Originated By
AC	Prepared By
IL	Checked By

LOG OF BOREHOLE HF1-16

SHEET 1 OF 2

Project Name: HANLAN FEEDERMAIN SOUTH CONTRACT 1

Client: CH2M HILL CANADA LTD.

Date: 29 June 2011

Project No.: GEOTMARK00233AA

Drilling Method Used: ROCK CORING HQ3

Northing: 4829497 m

Project Location: DIXIE RD, MISSISSAUGA

Ground Surface Elevation: 119.9 m

Easting: 614206 m

Borehole Location: SEE DRAWING

Datum Elevation: Geodetic

Diameter: 61mm

(m) STRATA ELEV DEPTH	ROCK DESCRIPTION See Soil Logs for soil descriptions.	GROUND WATER CONDITIONS	(m) CORE ELEV DEPTH	CORE SAMPLE			TOTAL CORE RECOVERY (%)	SOLID CORE RECOVERY (%)	HARD LAYER (%)	RQD (%)	FRACTURE INDEX (per 0.3m)	DISCONTINUITIES AND WEATHERING	HYDRAULIC CONDUCTIVITY k (cm/sec) [P (kPa)]	POINT LOAD TEST UCS AXIAL (MPa)	POINT LOAD TEST UCS DIAMETRAL (MPa)	UNIAxIAL COMPRESSION (MPa)	DENSITY (g/cc) [E (GPa)]
				NUMBER	SIZE	CORE RATE (m/min)											
115.9 4.0	GEORGIAN BAY FORMATION grey, SHALE thinly laminated, interbedded with light grey LIMESTONE and SILTSTONE layers, strong to very strong Run1: very weak to weak Run 2: 100mm clay seam at 5.1m, 25mm hard layer at 5.5m, 50m hard layer at 5.9m, 100mm hard layer at 6.2m Run3: medium strong, 84mm hard layer at 6.6m, 140mm hard layer at 7.5m, 40mm clay seam at 6.8m 75mm hard layer at 7.8m, 100mm hard layer at 9.1m, 25mm hard layer at 8.3, 8.9, and 9.0m, 50mm hard layer at 8.7m 100mm hard layer at 9.5m, 40mm hard layer at 9.8m, 25mm hard layer at 10.6m 50mm hard layer at 11.4m, 25mm hard layer at 12.2m 25mm hard layer at 12.9m, 12mm hard layer at 13.0m, 50mm hard layer at 13.7m weak, 25mm hard layers at 14.0 and 15.0m, 75mm hard layer at 14.7m, 40mm clay seam at 13.9m		115.9 4.0	1	HQ3	0.14	81	9	0	0	<div><div></div><div></div><div></div><div></div><div></div><div></div><div></div><div></div><div></div><div></div><div></div><div></div><div></div><div></div><div></div><div></div><div></div><div></div><div></div><div></div><div></div><div></div><div></div><div></div><div></div><div></div><div></div><div></div><div></div><div></div><div></div><div></div><div></div><div></div><div></div><div></div><div></div><div></div><div></div><div></div><div></div><div></div><div></div><div></div><div></div><div></div><div></div><div></div><div></div><div></div><div></div><div></div><div></div><div></div><div></div><div></div><div></div><div></div><div></div><div></div><div></div><div></div><div></div><div></div><div></div><div></div><div></div><div></div><div></div><div></div><div></div><div></div><div></div><div></div><div></div><div></div><div></div><div></div><div></div><div></div><div></div><div></div><div></div><div></div><div></div><div></div><div></div><div></div><div></div><div></div><div></div><div></div><div></div><div></div><div></div><div></div><div></div><div></div><div></div><div></div><div></div><div></div><div></div><div></div><div></div><div></div><div></div><div></div><div></div><div></div><div></div><div></div><div></div><div></div><div></div><div></div><div></div><div></div><div></div><div></div><div></div><div></div><div></div><div></div><div></div><div></div><div></div><div></div><div></div><div></div><div></div><div></div><div></div><div></div><div></div><div></div><div></div><div></div><div></div><div></div><div></div><div></div><div></div><div></div><div></div><div></div><div></div><div></div><div></div><div></div><div></div><div></div><div></div><div></div><div></div><div></div><div></div><div></div><div></div><div></div><div></div><div></div><div></div><div></div><div></div><div></div><div></div><div></div><div></div><div></div><div></div><div></div><div></div><div></div><div></div><div></div><div></div><div></div><div></div><div></div><div></div><div></div><div></div><div></div><div></div><div></div><div></div><div></div><div></div><div></div><div></div><div></div><div></div><div></div><div></div><div></div><div></div><div></div><div></div><div></div><div></div><div></div><div></div><div></div><div></div><div></div><div></div><div></div><div></div><div></div><div></div><div></div><div></div><div></div><div></div><div></div><div></div><div></div><div></div><div></div><div></div><div></div><div></div><div></div><div></div><div></div><div></div><div></div><div></div><div></div><div></div><div></div><div></div><div></div><div></div><div></div><div></div><div></div><div></div><div></div><div></div><div></div><div></div><div></div><div></div><div></div><div></div><div></div><div></div><div></div><div></div><div></div><div></div><div></div><div></div><div></div><div></div><div></div><div></div><div></div><div></div><div></div><div></div><div></div><div></div><div></div><div></div><div></div><div></div><div></div><div></div><div></div><div></div><div></div><div></div><div></div><div></div><div></div><div></div><div></div><div></div><div></div><div></div><div></div><div></div><div></div><div></div><div></div><div></div><div></div><div></div><div></div><div></div><div></div><div></div><div></div><div></div><div></div><div></div><div></div><div></div><div></div><div></div><div></div><div></div><div></div><div></div><div></div><div></div><div></div><div></div><div></div><div></div><div></div><div></div><div></div><div></div><div></div><div></div><div></div><div></div><div></div><div></div><div></div><div></div><div></div><div></div><div></div><div></div><div></div><div></div><div></div><div></div><div></div><div></div><div></div><div></div><div></div><div></div><div></div><div></div><div></div><div></div><div></div><div></div><div></div><div></div><div></div><div></div><div></div><div></div><div></div><div></div><div></div><div></div><div></div><div></div><div></div><div></div><div></div><div></div><div></div><div></div><div></div><div></div><div></div><div></div><div></div><div></div><div></div><div></div><div></div><div></div><div></div><div></div><div></div><div></div><div></div><div></div><div></div><div></div><div></div><div></div><div></div><div></div><div></div><div></div><div></div><div></div><div></div><div></div><div></div><div></div><div></div><div></div><div></div><div></div><div></div><div></div><div></div><div></div><div></div><div></div><div></div><div></div><div></div><div></div><div></div><div></div><div></div><div></div><div></div><div></div><div></div><div></div><div></div><div></div><div></div><div></div><div></div><div></div><div></div><div></div><div></div><div></div><div></div><div></div><div></div><div></div><div></div><div></div><div></div><div></div><div></div><div></div><div></div><div></div><div></div><div></div><div></div><div></div><div></div><div></div><div></div><div></div><div></div><div></div><div></div><div></div><div></div><div></div><div></div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Additional Notes:

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Sample Types: A=Auger; DP=Direct Push; G=Grab; RC=Rock Core; SC=Soil Core; SS=Split Barrel (Split Spoon); ST=Shelby Tube.

LOG OF BOREHOLE HF1-16

SHEET 2 OF 2

Project Name: HANLAN FEEDERMAIN SOUTH CONTRACT 1

Client: CH2M HILL CANADA LTD.

Date: 29 June 2011

Project No.: GEOTMARK00233AA

Drilling Method Used: ROCK CORING HQ3

Northing: 4829497 m

Project Location: DIXIE RD, MISSISSAUGA

Ground Surface Elevation: 119.9 m

Easting: 614206 m

Borehole Location: SEE DRAWING

Datum Elevation: Geodetic

Diameter: 61mm

(m) STRATA ELEV DEPTH	ROCK DESCRIPTION See Soil Logs for soil descriptions.	GROUND WATER CONDITIONS	(m) CORE ELEV DEPTH	CORE SAMPLE			TOTAL CORE RECOVERY (%)	SOLID CORE RECOVERY (%)	HARD LAYER (%)	RQD (%)	FRACTURE INDEX (per 0.3m)				DISCONTINUITIES AND WEATHERING	HYDRAULIC CONDUCTIVITY k (cm/sec) [P (kPa)]	POINT LOAD TEST UCS AXIAL (MPa)	POINT LOAD TEST UCS DIAMETRAL (MPa)	UNIAxIAL COMPRESSION (MPa)	DENSITY (g/cc) [E (GPa)]		
				NUMBER	SIZE	CORE RATE (m/min)					2	4	6	8								
95.5 24.4	GEORGIAN BAY FORMATION grey, SHALE thinly laminated, interbedded with light grey LIMESTONE and SILTSTONE layers, strong to very strong (<i>continued</i>) 25mm hard layer at 15.5 and 15.8m, 50mm hard layer at 15.6 and 16.0m, 65mm hard layer at 15.7 and 16.6m, 75mm hard layer at 15.9m 50mm hard layer at 17.1m, 75mm hard layer at 17.6 and 18.1m 35mm hard layer at 18.4m, 25mm hard layer at 18.8m weak to medium strong, 25mm clay seam at 21.4m clay seam at 22.9m, 50 mm hard layer at 23.6m, 25mm hard layer at 23.8m, 25mm hard layer at 23.9m, 150mm hard layer at 24.1m		104.6											contacts and bedding partings, generally horizontal, widely spaced to closely spaced, planar to stepped, smooth (60%) to rough (40%), generally open, clay coating slightly to moderately weathered (<i>continued</i>) joints and bedding partings, generally horizontal, widely spaced to very closely spaced, planar to undulating, smooth, occasionally rough, generally open, slightly weathered joints, contacts, and bedding partings, moderately widely spaced to closely spaced, planar to stepped, generally smooth, open, slightly weathered joints and bedding partings, generally horizontal, moderately widely spaced, planar to undulating, generally smooth, open, slightly weathered to fresh horizontal bedding parting, undulating, smooth, open, fresh horizontal bedding parting, undulating, smooth, open, fresh vertical joints and horizontal bedding partings, moderately widely spaced to closely spaced, undulating to stepped, smooth, occasionally rough, open, slightly weathered to fresh		80	144					
			15.3																			
				9	HQ3	0.12	100	100	16	85												
			103.1																			
			16.8																			
				10	HQ3	0.10	100	100	21	92											20.4	2.63 [3]
			101.6																			
			18.3																			
				11	HQ3	0.09	100	100	4	90											15	4
			100.1																			
			19.8																		17	4
				12	HQ3	0.05	100	100	0	100												

Date / Time Water Depth (m) Elevation (m)
BEFORE CORING 29 June 2011 3.5 116.4

E = Modulus of Elasticity



Additional Notes:

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Sample Types: A=Auger; DP=Direct Push; G=Grab; RC=Rock Core; SC=Soil Core; SS=Split Barrel (Split Spoon); ST=Shelby Tube.

Coffey Representatives

BB	Originated By
AC	Prepared By
IL	Checked By

LOG OF BOREHOLE HF1-16A

SHEET 1 OF 1

Project Name: HANLAN FEEDERMAIN SOUTH CONTRACT 1

Client: CH2M HILL CANADA LTD.

Northing: 4829468 m

Project No.: GEOTMARK00233AA

Drilling Method Used: Hollow Stem Augering 200mm

Easting: 614237 m

Project Location: DIXIE RD, MISSISSAUGA

Date: 16 August 2011

Ground Surface Elevation: 119.3 m

Depth Scale (m)	Subsurface Conditions		Samples		Penetration / Strength Results		Moisture / Plasticity		Instrumentation Details	Groundwater Conditions	Headspace Vapor (ppm) LEL (%)	Elevation Scale (m)	Comments
	Stratigraphic Symbol	Depth / Elevation (m)	Description	Number Type	Blow Counts / 150mm N Value	Recovery %	Relative Drilling Resistance	Penetration Test Values (Blows / 0.3m) X N Values ♦ Dynamic Cone + Becker Hammer Test (BPT) 20 40 60 80 Undrained Shear Strength Values (kPa) □ Field Vane ○ Unconfined ■ Lab Vane ● Quick Triaxial ▲ Pocket Penetrometer	Plastic Limit Natural Water Content Liquid Limit PL MC LL				
0.5			Topsoil									119.0	
1.0		118.2	FILL silty sand, trace gravel, topsoil, black, loose to compact	1 SS	3 3 10	(13)	78	X				118.5	
1.5		117.8	SAND fine, brown, compact									118.0	
2.0		117.0	SILTY CLAY laminated, brown to grey, hard	2 SS	17 25 38	(63)	89	X				117.5	
2.5		117.0	SHALE extremely weathered, hard	3 SS	19 28 45	(73)	94	X				117.0	
3.0												116.5	
3.5												116.0	
4.0												115.5	
4.3		115.0		5 SS	50	50/8cm	100					115.0	
				6 SS	50	50/0cm						115.0	Borehole dry on completion before coring.

Rock Coring Started

Rock Core Log Next Page



Additional Notes:

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Sample Types: A=Auger; DP=Direct Push; G=Grab; RC=Rock Core; SC=Soil Core; SS=Split Barrel (Split Spoon); ST=Shelby Tube.

Coffey Representatives

AA	Originated By
AC	Prepared By
IL	Checked By

LOG OF BOREHOLE HF1-16A

SHEET 1 OF 2

Project Name: HANLAN FEEDERMAIN SOUTH CONTRACT 1

Client: CH2M HILL CANADA LTD.

Date: 16 August 2011

Project No.: GEOTMARK00233AA

Drilling Method Used: ROCK CORING HQ3

Northing: 4829468 m

Project Location: DIXIE RD, MISSISSAUGA

Ground Surface Elevation: 119.3 m

Easting: 614237 m

Borehole Location: SEE DRAWING

Datum Elevation: Geodetic

Diameter: 61mm

(m) STRATA ELEV DEPTH	ROCK DESCRIPTION See Soil Logs for soil descriptions.	GROUND WATER CONDITIONS	(m) CORE ELEV DEPTH	CORE SAMPLE			TOTAL CORE RECOVERY (%)	SOLID CORE RECOVERY (%)	HARD LAYER (%)	RQD (%)	FRACTURE INDEX (per 0.3m)	DISCONTINUITIES AND WEATHERING	HYDRAULIC CONDUCTIVITY k (cm/sec) [P (kPa)]	POINT LOAD TEST UCS AXIAL (MPa)	POINT LOAD TEST UCS DIAMETRAL (MPa)	UNIAXIAL COMPRESSION (MPa)	DENSITY (g/cc) [E (GPa)]
				NUMBER	SIZE	CORE RATE (m/min)											
115.0			115.0								2 4 6 8						
4.3	GEORGIAN BAY FORMATION grey, SHALE thinly laminated, interbedded with light grey LIMESTONE and SILTSTONE layers, strong to very strong Run1: extremely weak, 300mm fragmented zone at 4.5m Run2: extremely to very weak, 175mm fragmented zone at 4.8m, 25mm hard layer at 5.2m, 100mm hard layer at 5.6m Run3: very weak to weak, 50mm hard layer at 6.6m and 6.9m, 225mm hard layer at 7.5m 25mm hard layer at 8.0m, 8.8m, 8.9m and 9.1m, 125mm hard layer at 8.1m, 75mm hard layer at 8.4m and 8.7m, 50mm hard layer at 8.5m weak 200mm fragmented zone at 11.4m, 25mm hard layer at 12.0m 50mm hard layer at 12.7m, 25mm hard layer at 13.0m and 13.8m, 225mm hard layer at 13.1m 50mm hard layer at 14.6m		4.3	1	HQ3	0.23	44	6	0	0	<div><div></div><div></div><div></div><div></div><div></div><div></div><div></div><div></div><div></div><div></div><div></div><div></div><div></div><div></div><div></div><div></div><div></div><div></div><div></div><div></div><div></div><div></div><div></div><div></div><div></div><div></div><div></div><div></div><div></div><div></div><div></div><div></div><div></div><div></div><div></div><div></div><div></div><div></div><div></div><div></div><div></div><div></div><div></div><div></div><div></div><div></div><div></div><div></div><div></div><div></div><div></div><div></div><div></div><div></div><div></div><div></div><div></div><div></div><div></div><div></div><div></div><div></div><div></div><div></div><div></div><div></div><div></div><div></div><div></div><div></div><div></div><div></div><div></div><div></div><div></div><div></div><div></div><div></div><div></div><div></div><div></div><div></div><div></div><div></div><div></div><div></div><div></div><div></div><div></div><div></div><div></div><div></div><div></div><div></div><div></div><div></div><div></div><div></div><div></div><div></div><div></div><div></div><div></div><div></div><div></div><div></div><div></div><div></div><div></div><div></div><div></div><div></div><div></div><div></div><div></div><div></div><div></div><div></div><div></div><div></div><div></div><div></div><div></div><div></div><div></div><div></div><div></div><div></div><div></div><div></div><div></div><div></div><div></div><div></div><div></div><div></div><div></div><div></div><div></div><div></div><div></div><div></div><div></div><div></div><div></div><div></div><div></div><div></div><div></div><div></div><div></div><div></div><div></div><div></div><div></div><div></div><div></div><div></div><div></div><div></div><div></div><div></div><div></div><div></div><div></div><div></div><div></div><div></div><div></div><div></div><div></div><div></div><div></div><div></div><div></div><div></div><div></div><div></div><div></div><div></div><div></div><div></div><div></div><div></div><div></div><div></div><div></div><div></div><div></div><div></div><div></div><div></div><div></div><div></div><div></div><div></div><div></div><div></div><div></div><div></div><div></div><div></div><div></div><div></div><div></div><div></div><div></div><div></div><div></div><div></div><div></div><div></div><div></div><div></div><div></div><div></div><div></div><div></div><div></div><div></div><div></div><div></div><div></div><div></div><div></div><div></div><div></div><div></div><div></div><div></div><div></div><div></div><div></div><div></div><div></div><div></div><div></div><div></div><div></div><div></div><div></div><div></div><div></div><div></div><div></div><div></div><div></div><div></div><div></div><div></div><div></div><div></div><div></div><div></div><div></div><div></div><div></div><div></div><div></div><div></div><div></div><div></div><div></div><div></div><div></div><div></div><div></div><div></div><div></div><div></div><div></div><div></div><div></div><div></div><div></div><div></div><div></div><div></div><div></div><div></div><div></div><div></div><div></div><div></div><div></div><div></div><div></div><div></div><div></div><div></div><div></div><div></div><div></div><div></div><div></div><div></div><div></div><div></div><div></div><div></div><div></div><div></div><div></div><div></div><div></div><div></div><div></div><div></div><div></div><div></div><div></div><div></div><div></div><div></div><div></div><div></div><div></div><div></div><div></div><div></div><div></div><div></div><div></div><div></div><div></div><div></div><div></div><div></div><div></div><div></div><div></div><div></div><div></div><div></div><div></div><div></div><div></div><div></div><div></div><div></div><div></div><div></div><div></div><div></div><div></div><div></div><div></div><div></div><div></div><div></div><div></div><div></div><div></div><div></div><div></div><div></div><div></div><div></div><div></div><div></div><div></div><div></div><div></div><div></div><div></div><div></div><div></div><div></div><div></div><div></div><div></div><div></div><div></div><div></div><div></div><div></div><div></div><div></div><div></div><div></div><div></div><div></div><div></div><div></div><div></div><div></div><div></div><div></div><div></div><div></div><div></div><div></div><div></div><div></div><div></div><div></div><div></div><div></div><div></div><div></div><div></div><div></div><div></div><div></div><div></div><div></div><div></div><div></div><div></div><div></div><div></div><div></div><div></div><div></div><div></div><div></div><div></div><div></div><div></div><div></div><div></div><div></div><div></div><div></div><div></div><div></div><div></div><div></div><div></div><div></div><div></div><div></div><div></div><div></div><div></div><div></div><div></div><div></div><div></div><div></div><div></div><div></div><div></div><div></div><div></div><div></div><div></div><div></div><div></div><div></div><div></div><di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Continued Next Page

E = Modulus of Elasticity

Additional Notes:

This log is to be read in conjunction with accompanying general notes and borehole log symbols sheet. Stratification lines represent approximate boundary lines between material types, vertical and lateral transitions may be gradual. Water level readings were made at time(s) noted, fluctuations of groundwater levels may occur and should be expected.
Sample Types: A=Auger; DP=Direct Push; G=Grab; RC=Rock Core; SC=Soil Core; SS=Split Barrel (Split Spoon); ST=Shelby Tube.

Coffey Representatives

AA	Originated By
AC	Prepared By
IL	Checked By

LOG OF BOREHOLE HF1-16A

SHEET 2 OF 2

Project Name: HANLAN FEEDERMAIN SOUTH CONTRACT 1

Client: CH2M HILL CANADA LTD.

Date: 16 August 2011

Project No.: GEOTMARK00233AA

Drilling Method Used: ROCK CORING HQ3

Northing: 4829468 m

Project Location: DIXIE RD, MISSISSAUGA

Ground Surface Elevation: 119.3 m

Easting: 614237 m

Borehole Location: SEE DRAWING

Datum Elevation: Geodetic

Diameter: 61mm

(m) STRATA ELEV DEPTH	ROCK DESCRIPTION See Soil Logs for soil descriptions.	GROUND WATER CONDITIONS	(m) CORE ELEV DEPTH	CORE SAMPLE			TOTAL CORE RECOVERY (%)	SOLID CORE RECOVERY (%)	HARD LAYER (%)	ROD (%)	FRACTURE INDEX (per 0.3m)	DISCONTINUITIES AND WEATHERING	HYDRAULIC CONDUCTIVITY k (cm/sec) [P (kPa)]	POINT LOAD TEST UCS AXIAL (MPa)	POINT LOAD TEST UCS DIAMETRAL (MPa)	UNIAxIAL COMPRESSION (MPa)	DENSITY (g/cc) [E (GPa)]
				NUMBER	SIZE	CORE RATE (m/min)											
	GEORGIAN BAY FORMATION grey, SHALE thinly laminated, interbedded with light grey LIMESTONE and SILTSTONE layers, strong to very strong (<i>continued</i>) 100mm hard layer at 15.8m, 175mm hard layer at 16.4m, 50mm hard layer at 16.7m, 25mm hard layer at 16.6m		103.8 15.5											43	1		
	300mm hard layer at 17.0m, 25mm hard layer at 17.3m		102.4 16.9	9	HQ3	0.29	98	98	25	78		contacts and bedding partings, 0-10 degrees, closely to very closely spaced, planar, generally open, rough (50%) to smooth (50%), slightly weathered to fresh		239	206		
	25mm hard layer at 18.8m		100.8 18.5	10	HQ3	0.26	98	97	22	80		contacts and bedding partings, 0-10 degrees, closely to very closely spaced, planar, generally open, rough (50%) to smooth (50%), slightly weathered to fresh		40	2	12.8	2.57 [2]
	50mm hard layer at 20.2m		99.3 20.0	11	HQ3	0.30	100	100	2	97		horizontal bedding parting and contact, widely spaced, planar, smooth to rough, open, fresh		21	4		
	50mm hard layer at 22.0m and 23.0m, 100mm hard layer at 22.8m		97.8 21.5	12	HQ3	0.30	100	98	3	68		horizontal bedding partings and contact, moderately widely to very closely spaced, generally planar, rough (75%) to smooth (25%), open, fresh		44	7		
	25mm hard layer at 20.7m, 23.3m and 23.4m, 125mm hard layer at 23.1m, 75mm hard layer at 23.9m, 50mm hard layer at 24.0m		96.2 23.1	13	HQ3	0.39	100	97	13	90		horizontal bedding partings and contact, moderately widely spaced to closely spaced, planar, rough, open, fresh		42	1	22.3	2.64 [3]
			94.9 24.4	14	HQ3	0.22	100	98	25	59		bedding partings and contact, moderately widely to very closely spaced, planar, rough, open, some with clay infill, fresh		218	130		

Date / Time Water Depth (m) Elevation (m)

E = Modulus of Elasticity



Additional Notes:

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Sample Types: A=Auger; DP=Direct Push; G=Grab; RC=Rock Core; SC=Soil Core; SS=Split Barrel (Split Spoon); ST=Shelby Tube.

Coffey Representatives

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LOG OF BOREHOLE HF1-17

SHEET 1 OF 1

Project Name: HANLAN FEEDERMAIN SOUTH CONTRACT 1	Client: CH2M HILL CANADA LTD.	Northing: 4829396 m
Project No.: GEOTMARK00233AA	Drilling Method Used: Hollow Stem Augering 200mm	Easting: 614315 m
Project Location: DIXIE RD, MISSISSAUGA	Date: 5 July 2011	Ground Surface Elevation: 118.2 m

Depth Scale (m)	Subsurface Conditions		Samples		Penetration / Strength Results		Moisture / Plasticity		Instrumentation Details	Groundwater Conditions	Headspace Vapor (ppm) LEL (%)	Elevation Scale (m)	Comments
	Stratigraphic Symbol	Depth / Elevation (m)	Description	Number Type	Blow Counts / 150mm N Value	Recovery %	Relative Drilling Resistance	Penetration Test Values (Blows / 0.3m) X N Values ♦ Dynamic Cone + Becker Hammer Test (BPT) 20 40 60 80 Undrained Shear Strength Values (kPa) □ Field Vane ○ Unconfined ■ Lab Vane ● Quick Triaxial ▲ Pocket Penetrometer	Plastic Limit Natural Water Content Liquid Limit PL MC LL				
0.5			150mm Topsoil									118.0	
1.0			FILL silty sand, some gravel trace wood and rootlets brown, loose	1 SS	4 1 3 3	(4)	89	X				117.5	
1.5		116.7	clayey silt trace wood brown, soft									117.0	
2.0		115.8	SHALE completely weathered, grey, hard	2 SS	46 50 50 50	50/13cm	45					116.5	
2.4				3 SS	50	50/8cm	100					116.0	Borehole dry on completion before coring.

Rock Coring Started

Date / Time	Water Depth (m)	Elevation (m)
21 July 2011	3.1	115.1
12 August 2011	3.4	114.8
28 September 2011	3.3	114.9
14 October 2011	3.3	114.9

Rock Core Log Next Page

Additional Notes:

This log is to be read in conjunction with accompanying general notes and borehole log symbols sheet. Stratification lines represent approximate boundary lines between material types, vertical and lateral transitions may be gradual. Water level readings were made at time(s) noted, fluctuations of groundwater levels may occur and should be expected.

Sample Types: A=Auger; DP=Direct Push; G=Grab; RC=Rock Core; SC=Soil Core; SS=Split Barrel (Split Spoon); ST=Shelby Tube.

Coffey Representatives

BB	Originated By
AC	Prepared By
IL	Checked By

LOG OF BOREHOLE HF1-17

SHEET 1 OF 3

Project Name: HANLAN FEEDERMAIN SOUTH CONTRACT 1

Client: CH2M HILL CANADA LTD.

Date: 5 July 2011

Project No.: GEOTMARK00233AA

Drilling Method Used: ROCK CORING HQ3

Northing: 4829396 m

Project Location: DIXIE RD, MISSISSAUGA

Ground Surface Elevation: 118.2 m

Easting: 614315 m

Borehole Location: SEE DRAWING

Datum Elevation: Geodetic

Diameter: 61mm

(m) STRATA ELEV DEPTH	ROCK DESCRIPTION See Soil Logs for soil descriptions.	GROUND WATER CONDITIONS	(m) CORE ELEV DEPTH	CORE SAMPLE			TOTAL CORE RECOVERY (%)	SOLID CORE RECOVERY (%)	HARD LAYER (%)	ROD (%)	FRACTURE INDEX (per 0.3m)	DISCONTINUITIES AND WEATHERING	HYDRAULIC CONDUCTIVITY k (cm/sec) [P (kPa)]	POINT LOAD TEST UCS AXIAL (MPa)	POINT LOAD TEST UCS DIAMETRAL (MPa)	UNIAxIAL COMPRESSION (MPa)	DENSITY (g/cc) [E (GPa)]
				NUMBER	SIZE	CORE RATE (m/min)											
115.8 2.4	GEORGIAN BAY FORMATION grey, SHALE thinly laminated, interbedded with light grey LIMESTONE and SILTSTONE layers, strong to very strong Run1: very weak to weak, 12mm hard layer at 4.5m, 75mm hard layer at 4.6m 25mm hard layer at 4.7m, 50mm hard layer at 5.1m fractured zone from 6.7 to 6.8m, 35mm hard layer at 6.1 and 6.5m, 50mm hard layer at 7.0, 7.3, and 7.5m fractured zone from 8.3 to 8.4m, 12mm hard layer at 7.8, 8.7, and 9.1m, 25mm hard layer at 8.2m, 100mm hard layer at 8.3m 50mm hard layer at 9.6m weak to medium strong, 50mm hard layer at 11.5m weak,		115.8 2.4	1	HQ3	0.14	78	0	0	0		highly weathered					
			115.1 3.1									joints, contacts, and bedding partings, horizontal, occasionally vertical, moderately widely spaced to very closely spaced, planar to stepped, smooth (70%) to rough (30%), open (70%) to tight (30%), some with clay coating, occasionally with iron oxide infill, highly to moderately weathered					
			113.6 4.6	2	HQ3	0.10	100	67	6	37		horizontal joints, contacts, and bedding partings, moderately widely spaced to very closely spaced, undulating to stepped, generally smooth, open, generally with clay coating, highly weathered					
			112.1 6.1	3	HQ3	0.14	90	13	5	0		joints, contacts, and bedding partings, generally horizontal, some vertical joints, moderately widely spaced to extremely closely spaced, planar to stepped, smooth (50%) to rough (50%), open, occasionally tight, some with clay coating, moderately weathered					
			110.5 7.7	4	HQ3	0.07	95	78	11	42		horizontal joints, contacts and bedding partings, moderately widely spaced to very closely spaced, planar to stepped, smooth (60%) to rough (40%), open, some with clay coating, moderately weathered					
			109.0 9.2	5	HQ3	0.14	100	92	13	63		joints, contacts, and bedding partings, generally horizontal, moderately widely spaced to very closely spaced, planar to stepped, generally smooth, generally open, some with clay coating, moderately weathered					
			107.5 10.7	6	HQ3	0.08	100	98	3	72		joints and bedding partings, generally horizontal, moderately widely spaced to closely spaced, undulating to stepped, generally smooth, open, clay coating, slightly weathered					
			106.0 12.2	7	HQ3	0.10	100	95	3	90							

Continued Next Page

E = Modulus of Elasticity

Additional Notes:

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Sample Types: A=Auger; DP=Direct Push; G=Grab; RC=Rock Core; SC=Soil Core; SS=Split Barrel (Split Spoon); ST=Shelby Tube.

Coffey Representatives

BB	Originated By
AC	Prepared By
IL	Checked By

LOG OF BOREHOLE HF1-17

SHEET 2 OF 3

Project Name: HANLAN FEEDERMAIN SOUTH CONTRACT 1

Client: CH2M HILL CANADA LTD.

Date: 5 July 2011

Project No.: GEOTMARK00233AA

Drilling Method Used: ROCK CORING HQ3

Northing: 4829396 m

Project Location: DIXIE RD, MISSISSAUGA

Ground Surface Elevation: 118.2 m

Easting: 614315 m

Borehole Location: SEE DRAWING

Datum Elevation: Geodetic

Diameter: 61mm

(m) STRATA ELEV DEPTH	ROCK DESCRIPTION See Soil Logs for soil descriptions.	GROUND WATER CONDITIONS	(m) CORE ELEV DEPTH	CORE SAMPLE			TOTAL CORE RECOVERY (%)	SOLID CORE RECOVERY (%)	HARD LAYER (%)	ROD (%)	FRACTURE INDEX (per 0.3m)	DISCONTINUITIES AND WEATHERING	HYDRAULIC CONDUCTIVITY k (cm/sec) [P (kPa)]	POINT LOAD TEST UCS AXIAL (MPa)	POINT LOAD TEST UCS DIAMETRAL (MPa)	UNIAxIAL COMPRESSION (MPa)	DENSITY (g/cc) [E (GPa)]
				NUMBER	SIZE	CORE RATE (m/min)											
	crushed zone from 13.3 to 13.4m, 50mm hard layer at 12.5 and 13.3m, 12mm hard layer at 13.2m GEORGIAN BAY FORMATION grey, SHALE thinly laminated, interbedded with light grey LIMESTONE and SILTSTONE layers, strong to very strong (<i>continued</i>) weak to medium strong, 25mm hard layer at 13.8 and 14.2m		104.4	8	HQ3	0.15	100	95	7	63		joints, contacts, and bedding partings, generally horizontal, moderately widely spaced to very closely spaced, undulating to stepped, smooth, occasionally rough, generally open, clay coating, moderately to slightly weathered (<i>continued</i>)		12	6		
			13.8	9	HQ3	0.12	100	98	30	85		joints and bedding partings, horizontal (70%) to vertical (30%), widely spaced to very closely spaced, planar to stepped, smooth, occasionally rough, open, occasionally tight, some with clay coating, slightly weathered	No flow[206] ($k' < 1.00E-8$) No flow[373] ($k' < 1.00E-8$)	13	3	27	2.63 [5]
	50mm hard layer at 15.5, 16.2, and 16.3m, 25mm hard layer at 15.8m, 200mm hard layer at 16.5m		102.9	10	HQ3	0.14	100	98	25	82		joints, contacts, and bedding partings, generally horizontal, occasionally 5 - 10 degrees, moderately widely spaced to very closely spaced, planar to stepped, smooth (60%) to rough (40%), generally open, clay coating, slightly weathered	No flow[549] ($k' < 1.00E-8$)	165	162		
			15.3											26	6	115.1	2.78 [27]
			101.4	11	HQ3	0.15	100	100	0	87		horizontal joints, contacts, and bedding partings, widely spaced to closely spaced, planar to undulating, generally smooth, open (60%) to tight (40%), some with clay coating, slightly weathered	No flow[206] ($k' < 1.00E-8$) No flow[373] ($k' < 1.00E-8$)	15	3		
	25mm hard layer at 18.5m, 50mm hard layer at 19.7m		99.9	12	HQ3	0.13	100	100	5	95		joints and bedding partings, generally horizontal, widely spaced to very closely spaced, planar to stepped, generally smooth, open (50%) to tight (50%), clay coating, slightly weathered to fresh	No flow[549] ($k' < 1.00E-8$)			19	2.62 [4]
			18.3											56	3		
	strong to medium strong		98.3	13	HQ3	0.12	100	100	0	100		horizontal bedding partings, widely spaced, undulating, smooth, open, clay coating, fresh		21	12		
			19.9														
	strong to medium strong, 100mm hard layer at 22.3m		96.8	14	HQ3	0.13	100	98	6	85		horizontal bedding partings, closely spaced, undulating to stepped, generally smooth, open, clay coating/infill, slightly weathered to fresh					
			21.4														

Continued Next Page

E = Modulus of Elasticity

Additional Notes:

This log is to be read in conjunction with accompanying general notes and borehole log symbols sheet. Stratification lines represent approximate boundary lines between material types, vertical and lateral transitions may be gradual. Water level readings were made at time(s) noted, fluctuations of groundwater levels may occur and should be expected.

Sample Types: A=Auger; DP=Direct Push; G=Grab; RC=Rock Core; SC=Soil Core; SS=Split Barrel (Split Spoon); ST=Shelby Tube.

Coffey Representatives

BB	Originated By
AC	Prepared By
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LOG OF BOREHOLE HF1-17

SHEET 3 OF 3

Project Name: HANLAN FEEDERMAIN SOUTH CONTRACT 1

Client: CH2M HILL CANADA LTD.

Date: 5 July 2011

Project No.: GEOTMARK00233AA

Drilling Method Used: ROCK CORING HQ3

Northing: 4829396 m

Project Location: DIXIE RD, MISSISSAUGA

Ground Surface Elevation: 118.2 m

Easting: 614315 m

Borehole Location: SEE DRAWING

Datum Elevation: Geodetic

Diameter: 61mm

(m) STRATA ELEV DEPTH	ROCK DESCRIPTION See Soil Logs for soil descriptions.	GROUND WATER CONDITIONS	(m) CORE ELEV DEPTH	CORE SAMPLE			TOTAL CORE RECOVERY (%)	SOLID CORE RECOVERY (%)	HARD LAYER (%)	ROD (%)	FRACTURE INDEX (per 0.3m)	DISCONTINUITIES AND WEATHERING	HYDRAULIC CONDUCTIVITY k (cm/sec) [P (kPa)]	POINT LOAD TEST UCS AXIAL (MPa)	POINT LOAD TEST UCS DIAMETRAL (MPa)	UNIAxIAL COMPRESSION (MPa)	DENSITY (g/cc) [E (GPa)]
				NUMBER	SIZE	CORE RATE (m/min)											
93.8 24.4	GEORGIAN BAY FORMATION grey, SHALE thinly laminated, interbedded with light grey LIMESTONE and SILTSTONE layers, strong to very strong (<i>continued</i>) Run15: strong to medium strong, 75mm hard layer at 23.1m, 100mm hard layer at 23.3m, 25mm hard layer at 23.5m, 50mm hard layer at 24.2		95.3 22.9 93.8 24.4	15	HQ3	0.11	100	100	17	98		horizontal joints and bedding partings, widely spaced to extremely closely spaced, planar to stepped, smooth (40%) to rough (60%), open (60%) to tight (40%), clay coating, fresh		179 122 15	167		

Date / Time	Water Depth (m)	Elevation (m)
21 July 2011	3.1	115.1
12 August 2011	3.4	114.8
28 September 2011	3.3	114.9
14 October 2011	3.3	114.9

E = Modulus of Elasticity



Additional Notes:

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Sample Types: A=Auger; DP=Direct Push; G=Grab; RC=Rock Core; SC=Soil Core; SS=Split Barrel (Split Spoon); ST=Shelby Tube.

Coffey Representatives

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LOG OF BOREHOLE HF1-17A

SHEET 1 OF 1

Project Name: HANLAN FEEDERMAIN SOUTH CONTRACT 1

Client: CH2M HILL CANADA LTD.

Northing: 4829159 m

Project No.: GEOTMARK00233AA

Drilling Method Used: Hollow Stem Augering 200mm

Easting: 614578 m

Project Location: DIXIE RD, MISSISSAUGA

Date: 11 July 2011

Ground Surface Elevation: 109.8 m

Depth Scale (m)	Subsurface Conditions		Samples		Penetration / Strength Results				Moisture / Plasticity			Instrumentation Details	Groundwater Conditions	Headspace Vapor (ppm) LEL (%)	Elevation Scale (m)	Comments
	Stratigraphic Symbol	Depth / Elevation (m)	Description	Number	Type	Blow Counts / 150mm	N Value	Recovery %	Relative Drilling Resistance	Penetration Test Values (Blows / 0.3m)	Undrained Shear Strength Values (kPa)	Plastic Limit	Natural Water Content	Liquid Limit		
0.5		109.0	76mm Asphalt 280mm Granular Base							X N Values ♦ Dynamic Cone + Becker Hammer Test (BPT) 20 40 60 80	□ Field Vane ○ Unconfined ■ Lab Vane ● Quick Triaxial ▲ Pocket Penetrometer	PL	MC	LL		
1.0		0.8	SHALE completely weathered, grey, hard, trace oxidation	1	SS	26	50/13cm	100								
1.5				2	SS	50	50/5cm	100								
2.0				3	SS	50	50/8cm	100								
2.5																
2.9		106.9														

Rock Coring Started

Rock Core Log Next Page



Additional Notes:

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Sample Types: A=Auger; DP=Direct Push; G=Grab; RC=Rock Core; SC=Soil Core; SS=Split Barrel (Split Spoon); ST=Shelby Tube.

Coffey Representatives

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LOG OF BOREHOLE HF1-17A

SHEET 1 OF 3

Project Name: HANLAN FEEDERMAIN SOUTH CONTRACT 1

Client: CH2M HILL CANADA LTD.

Date: 11 July 2011

Project No.: GEOTMARK00233AA

Drilling Method Used: ROCK CORING HQ3

Northing: 4829159 m

Project Location: DIXIE RD, MISSISSAUGA

Ground Surface Elevation: 109.8 m

Easting: 614578 m

Borehole Location: SEE DRAWING

Datum Elevation: Geodetic

Diameter: 61mm

(m) STRATA ELEV DEPTH	ROCK DESCRIPTION See Soil Logs for soil descriptions.	GROUND WATER CONDITIONS	(m) CORE ELEV DEPTH	CORE SAMPLE			TOTAL CORE RECOVERY (%)	SOLID CORE RECOVERY (%)	HARD LAYER (%)	ROD (%)	FRACTURE INDEX (per 0.3m)	DISCONTINUITIES AND WEATHERING	HYDRAULIC CONDUCTIVITY k (cm/sec) [P (kPa)]	POINT LOAD TEST UCS AXIAL (MPa)	POINT LOAD TEST UCS DIAMETRAL (MPa)	UNIAxIAL COMPRESSION (MPa)	DENSITY (g/cc) [E (GPa)]
				NUMBER	SIZE	CORE RATE (m/min)											
106.9			106.9														
2.9	GEORGIAN BAY FORMATION grey, SHALE thinly laminated, interbedded with light grey LIMESTONE and SILTSTONE layers, strong to very strong Run1: extremely weak to weak Run2: very weak, 12mm clay seam at 3.8m, 25mm hard layer at 3.1 and 3.7m, 50mm hard layer at 4.4m Run3: weak, 12mm hard layer at 4.9m, 25mm hard layer at 5.0m, 75mm hard layer at 5.8m 25mm hard layer at 7.1m, 50mm hard layer at 7.5m 150mm hard layer at 7.7m, 175mm hard layer at 8.1m, 12mm hard layer at 8.3m, 25mm hard layer at 8.6m 25mm hard layer at 9.7m, 12mm hard layer at 9.8m 100mm hard layer at 11.0m 75mm clay seam at 12.3m, 100mm hard layer at 13.7m		2.9	1	HQ3	0.08	100	0	0	0		highly weathered					
			106.7														
			3.1									horizontal joints and bedding partings, widely spaced to closely spaced, undulating to stepped, generally smooth, generally open, clay coating, highly weathered to moderately weathered		12	2		
				2	HQ3	0.08	80	67	7	13							
			105.1														
			4.7									horizontal joints and contacts, moderately widely spaced to very closely spaced, undulating to stepped, generally smooth, open, clay coating, slightly to moderately weathered			80		
				3	HQ3	0.14	100	100	10	92							
			103.6														
			6.2									joints, contacts, and bedding partings, generally horizontal, moderately widely spaced to extremely closely spaced, planar to undulating, smooth (40%) to rough (60%), open (60%) to tight (40%), clay coating, slightly to moderately weathered		216	6		
				4	HQ3	0.14	100	95	5	50							
			102.1														
			7.7									horizontal joints, contacts, and bedding partings, closely spaced, undulating to stepped, rough, occasionally smooth, generally open, clay coating, slightly weathered	1.17E-6 [108]				
				5	HQ3	0.13	100	100	24	100			1.76E-6 [216]	14	2		
			100.6														
			9.2									joints and bedding partings, generally horizontal, moderately widely spaced to very closely spaced, planar to undulating, smooth (50%) to rough (50%), open (70%) to tight (30%), clay coating, slightly weathered to fresh	1.17E-6 [324]				
				6	HQ3	0.10	97	95	4	92				19	1		
			99.0														
			10.8									vertical joints and horizontal bedding partings, widely spaced to very closely spaced, planar to undulating, smooth (30%) to rough (70%), open (30%) to tight (70%), fresh		10	4		
				7	HQ3	0.07	100	93	7	88			9.66E-6 [147]				
			97.5										4.56E-6 [255]				
			12.3										2.56E-6 [353]				

Continued Next Page

E = Modulus of Elasticity

Additional Notes:

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Sample Types: A=Auger; DP=Direct Push; G=Grab; RC=Rock Core; SC=Soil Core; SS=Split Barrel (Split Spoon); ST=Shelby Tube.

Coffey Representatives

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LOG OF BOREHOLE HF1-17A

SHEET 2 OF 3

Project Name: HANLAN FEEDERMAIN SOUTH CONTRACT 1

Client: CH2M HILL CANADA LTD.

Date: 11 July 2011

Project No.: GEOTMARK00233AA

Drilling Method Used: ROCK CORING HQ3

Northing: 4829159 m

Project Location: DIXIE RD, MISSISSAUGA

Ground Surface Elevation: 109.8 m

Easting: 614578 m

Borehole Location: SEE DRAWING

Datum Elevation: Geodetic

Diameter: 61mm

(m) STRATA ELEV DEPTH	ROCK DESCRIPTION See Soil Logs for soil descriptions.	GROUND WATER CONDITIONS	(m) CORE ELEV DEPTH	CORE SAMPLE			TOTAL CORE RECOVERY (%)	SOLID CORE RECOVERY (%)	HARD LAYER (%)	ROD (%)	FRACTURE INDEX (per 0.3m)	DISCONTINUITIES AND WEATHERING	HYDRAULIC CONDUCTIVITY k (cm/sec) [P (kPa)]	POINT LOAD TEST UCS AXIAL (MPa)	POINT LOAD TEST UCS DIAMETRAL (MPa)	UNIAxIAL COMPRESSION (MPa)	DENSITY (g/cc) [E (GPa)]
				NUMBER	SIZE	CORE RATE (m/min)											
	GEORGIAN BAY FORMATION grey, SHALE thinly laminated, interbedded with light grey LIMESTONE and SILTSTONE layers, strong to very strong (<i>continued</i>) Run9: 75mm hard layer at 13.8m, 38mm hard layer at 14.6m and 14.9m, 50mm hard layer at 14.7m and 14.8m, 225mm hard layer at 15.1m		96.0	8	HQ3	0.14	100	95	7	90		horizontal joints, contacts, and bedding partings, moderately widely spaced to closely spaced, planar to stepped, smooth, generally open, clay coating, fresh (<i>continued</i>)		16	5		
	75mm hard layer at 15.4m		13.8									horizontal joints, contacts, and bedding partings, some vertical joints, moderately widely spaced to very closely spaced, planar to stepped, smooth (30%) to rough (70%), open (50%) to tight (50%), clay coating, slightly to moderately weathered		40	2		
	50mm hard layer at 17.2m, 75mm hard layer at 17.6m		94.5	9	HQ3	0.09	100	80	32	52		horizontal joints, widely spaced to closely spaced, undulating, rough, open, clay coating, fresh		17	6		
			15.3														
			92.9	10	HQ3	0.11	100	100	5	100		joints, contacts, and bedding partings, horizontal, occasionally vertical, moderatel widely spaced to very closely spaced, planar to undulating, generally rough, generally tight, clay coating, fresh		15	4		
			16.9											13	9	25.6	2.63 [5]
			91.4	11	HQ3	0.08	100	95	8	90		bedding partings, widely spaced to very closely spaced, planar to undulating, smooth (50%) to rough (50%), generally open, clay infill, fresh					
			18.4														
	200mm hard layer at 20.0m, 50mm hard layer at 20.3 and 20.8m, 75mm hard layer at 20.4m, 150mm hard layer at 20.9 and 21.1m		89.9	12	HQ3	0.06	100	98	0	93		joints and bedding partings, generally horizontal, moderately widely spaced to very closely spaced, planar to stepped, smooth (40%) to rough (60%), open, clay coating, slightly to moderately weathered		153	58	20.4	2.6 [4]
			19.9														
	38mm hard layer at 21.5m, 50mm hard layer at 21.6 and 22.6m, 12mm hard layer at 21.7m, 100mm hard layer at 21.8m, 150mm hard layer at 21.9m, 75mm hard layer at 22.8m		88.4	13	HQ3	0.13	100	88	45	62		horizontal joints and bedding partings, widely spaced to very closely spaced, planar to undulating, smooth (50%) to rough (50%), open, clay coating, fresh to slightly weathered		186	193	19.3	2.7 [3]
			21.4														
				14	HQ3	0.17	100	100	31	90							

Continued Next Page

E = Modulus of Elasticity

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Coffey Representatives

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LOG OF BOREHOLE HF1-17A

SHEET 3 OF 3

Project Name: HANLAN FEEDERMAIN SOUTH CONTRACT 1

Client: CH2M HILL CANADA LTD.

Date: 11 July 2011

Project No.: GEOTMARK00233AA

Drilling Method Used: ROCK CORING HQ3

Northing: 4829159 m

Project Location: DIXIE RD, MISSISSAUGA

Ground Surface Elevation: 109.8 m

Easting: 614578 m

Borehole Location: SEE DRAWING

Datum Elevation: Geodetic

Diameter: 61mm

(m) STRATA ELEV DEPTH	ROCK DESCRIPTION See Soil Logs for soil descriptions.	GROUND WATER CONDITIONS	(m) CORE ELEV DEPTH	CORE SAMPLE			TOTAL CORE RECOVERY (%)	SOLID CORE RECOVERY (%)	HARD LAYER (%)	ROD (%)	FRACTURE INDEX (per 0.3m)	DISCONTINUITIES AND WEATHERING	HYDRAULIC CONDUCTIVITY k (cm/sec) [P (kPa)]	POINT LOAD TEST UCS AXIAL (MPa)	POINT LOAD TEST UCS DIAMETRAL (MPa)	UNIAxIAL COMPRESSION (MPa)	DENSITY (g/cc) [E (GPa)]
				NUMBER	SIZE	CORE RATE (m/min)											
85.3 24.5	GEORGIAN BAY FORMATION grey, SHALE thinly laminated, interbedded with light grey LIMESTONE and SILTSTONE layers, strong to very strong (<i>continued</i>)		86.8 23.0	15	HQ3	0.17	100	100	0	100		horizontal joints and bedding partings, widely spaced to moderately widely spaced, undulating to stepped, smooth, open, clay coating, fresh		33	32		

Date / TimeWater Depth (m)Elevation (m)

E = Modulus of Elasticity

**Additional Notes:**

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Sample Types: A=Auger; DP=Direct Push; G=Grab; RC=Rock Core; SC=Soil Core; SS=Split Barrel (Split Spoon); ST=Shelby Tube.

Coffey Representatives

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LOG OF BOREHOLE HF1-18

SHEET 1 OF 1

Project Name: HANLAN FEEDERMAIN SOUTH CONTRACT 1	Client: CH2M HILL CANADA LTD.	Northing: 4829023 m
Project No.: GEOTMARK00233AA	Drilling Method Used: Hollow Stem Augering 200mm	Easting: 614716 m
Project Location: DIXIE RD, MISSISSAUGA	Date: 17 - 18 August 2011	Ground Surface Elevation: 112.9 m

Depth Scale (m)	Subsurface Conditions		Samples		Penetration / Strength Results		Moisture / Plasticity		Instrumentation Details	Groundwater Conditions	Headspace Vapor (ppm) LEL (%)	Elevation Scale (m)	Comments
	Stratigraphic Symbol	Depth / Elevation (m)	Description	Number Type	Blow Counts / 150mm N Value	Recovery %	Relative Drilling Resistance	Penetration Test Values (Blows / 0.3m) X N Values ♦ Dynamic Cone + Becker Hammer Test (BPT) 20 40 60 80 Undrained Shear Strength Values (kPa) □ Field Vane ○ Unconfined ■ Lab Vane ● Quick Triaxial ▲ Pocket Penetrometer	Plastic Limit Natural Water Content Liquid Limit	PL MC LL			
0.5			Topsoil									112.5	
1.0			FILL sand, pieces of glass to clayey silt, trace sand and gravel compact to firm	1 SS	10 9 8	(17)	78	X				112.0	
1.5												111.5	
2.0				2 SS	3 3 4	(7)	56	X				111.0	
2.5		110.6	SHALE highly weathered hard	3 SS	50	50/13cm	99					110.5	
3.0		2.3										110.0	
3.5				4 SS	50	50/8cm	100					109.5	
4.0													
4.5				5 SS	50	50/8cm	100						
5.0		109.0											
5.5		3.9											

Rock Coring Started

Date / Time	Water Depth (m)	Elevation (m)
28 September 2011	2.3	110.6
14 October 2011	2.2	110.7

Rock Core Log Next Page

**Additional Notes:**

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Sample Types: A=Auger; DP=Direct Push; G=Grab; RC=Rock Core; SC=Soil Core; SS=Split Barrel (Split Spoon); ST=Shelby Tube.

Coffey Representatives

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LOG OF BOREHOLE HF1-18

SHEET 1 OF 2

Project Name: HANLAN FEEDERMAIN SOUTH CONTRACT 1

Client: CH2M HILL CANADA LTD.

Date: 17 - 18 August 2011

Project No.: GEOTMARK00233AA

Drilling Method Used: ROCK CORING HQ3

Northing: 4829023 m

Project Location: DIXIE RD, MISSISSAUGA

Ground Surface Elevation: 112.9 m

Easting: 614716 m

Borehole Location: SEE DRAWING

Datum Elevation: Geodetic

Diameter: 61mm

(m) STRATA ELEV DEPTH	ROCK DESCRIPTION See Soil Logs for soil descriptions.	GROUND WATER CONDITIONS	(m) CORE ELEV DEPTH	CORE SAMPLE			TOTAL CORE RECOVERY (%)	SOLID CORE RECOVERY (%)	HARD LAYER (%)	ROD (%)	FRACTURE INDEX (per 0.3m)	DISCONTINUITIES AND WEATHERING	HYDRAULIC CONDUCTIVITY k (cm/sec) [P (kPa)]	POINT LOAD TEST UCS AXIAL (MPa)	POINT LOAD TEST UCS DIAMETRAL (MPa)	UNIAxIAL COMPRESSION (MPa)	DENSITY (g/cc) [E (GPa)]
				NUMBER	SIZE	CORE RATE (m/min)											
109.0			109.0								2 4 6 8						
3.9	GEORGIAN BAY FORMATION grey, SHALE thinly laminated to thinly bedded, interbedded with light grey LIMESTONE and SILTSTONE layers, strong to very strong Run 1: very weak to weak, 25mm hard layer at 5.2m Run 2: weak 25mm hard layers at 5.8, 5.9, 6.0, and 7.0m 25mm hard layer at 7.2m 75mm hard layer at 7.7m 50mm hard layer at 7.5m 50mm hard layers at 8.8, 9.4, and 9.7m 25mm hard layers at 10.2, 10.3, 10.4, 10.6, and 11.1m 50mm hard layers at 10.7, and 11.3m 100mm hard layer at 10.2m 75mm hard layer at 11.0m 900mm hard layer at 11.2m 25mm hard layer at 11.7m 25mm hard layers at 14.1, and 14.2m		3.9	1	HQ3	0.19	64	46	2	34		horizontal contact and bedding parting, moderately widely spaced, planar, smooth bedding parting, rough contact, open, slightly to moderately weathered		19	2		
			107.5 5.4	2	HQ3	0.31	100	98	7	70		horizontal contacts and bedding partings, moderately widely spaced to very closely spaced, planar to undulating, smooth (60%) to rough (40%), open, occasionally tight, slightly weathered		19	1		
			105.9 7.0	3	HQ3	0.30	100	95	10	85		horizontal contacts and bedding partings, widely spaced to very closely spaced, planar to undulating, smooth (50%) to rough (50%), generally open, occasionally with clay infill, slightly weathered to fresh		255	81		
			104.4 8.5	4	HQ3	0.30	100	100	10	88		contacts and bedding partings, widely spaced to very closely spaced, generally horizontal, planar to undulating, rough, open, fresh		84	115		
			102.9 10.0	5	HQ3	0.38	100	95	28	73				234	71		
			101.4 11.5	6	HQ3	0.25	100	100	2	90		horizontal bedding partings, moderately widely spaced to very closely spaced, planar to stepped, smooth (40%) to rough (60%), open (60%) to tight (40%), slightly weathered	No flow[128] ($k' < 1.00E-8$)	26	4		
			99.8 13.1	7	HQ3	0.12	100	98	4	90		horizontal bedding parting and vertical joint, moderately widely spaced to very closely spaced, planar to undulating, smooth, open (40%) to tight (60%), clay coating, slightly weathered to fresh	No flow[235] ($k' < 1.00E-8$) No flow[343] ($k' < 1.00E-8$)	48	4	10.9	2.6 [1]
			98.6														

Continued Next Page

E = Modulus of Elasticity

Additional Notes:

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Sample Types: A=Auger; DP=Direct Push; G=Grab; RC=Rock Core; SC=Soil Core; SS=Split Barrel (Split Spoon); ST=Shelby Tube.

Coffey Representatives

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AC	Prepared By
IL	Checked By

LOG OF BOREHOLE HF1-18

SHEET 2 OF 2

Project Name: HANLAN FEEDERMAIN SOUTH CONTRACT 1

Client: CH2M HILL CANADA LTD.

Date: 17 - 18 August 2011

Project No.: GEOTMARK00233AA

Drilling Method Used: ROCK CORING HQ3

Northing: 4829023 m

Project Location: DIXIE RD, MISSISSAUGA

Ground Surface Elevation: 112.9 m

Easting: 614716 m

Borehole Location: SEE DRAWING

Datum Elevation: Geodetic

Diameter: 61mm

(m) STRATA ELEV DEPTH	ROCK DESCRIPTION See Soil Logs for soil descriptions.	GROUND WATER CONDITIONS	(m) CORE ELEV DEPTH	CORE SAMPLE			TOTAL CORE RECOVERY (%)	SOLID CORE RECOVERY (%)	HARD LAYER (%)	ROD (%)	FRACTURE INDEX (per 0.3m)	DISCONTINUITIES AND WEATHERING	HYDRAULIC CONDUCTIVITY k (cm/sec) [P (kPa)]	POINT LOAD TEST UCS AXIAL (MPa)	POINT LOAD TEST UCS DIAMETRAL (MPa)	UNIAxIAL COMPRESSION (MPa)	DENSITY (g/cc) [E (GPa)]
				NUMBER	SIZE	CORE RATE (m/min)											
	25mm hard layers at 14.4, 14.8, 15.4, and 15.5m GEORGIAN BAY FORMATION grey, SHALE thinly laminated to thinly bedded, interbedded with light grey LIMESTONE and SILTSTONE layers, strong to very strong (continued)		14.3	8	HQ3	0.30	100	98	7	88		horizontal contacts and bedding partings, moderately widely spaced, planar to undulating, smooth (50%) to rough (50%), open (70%) to tight (30%), clay coating, slightly weathered to fresh (continued)	No flow[167] ($k' < 1.00E-8$)	32	1		
	200mm hard layer at 15.8m 100mm hard layer at 16.7m 75mm hard layer at 17.0m 150mm hard layer at 17.2m		15.8	9	HQ3	0.19	100	100	35	82		horizontal joints, contacts, and bedding partings, occasional vertical joints, moderately widely spaced to very closely spaced, planar to undulating, rough, occasionally smooth, open, occasionally tight, clay coating, slightly weathered	No flow[304] ($k' < 1.00E-8$) No flow[441] ($k' < 1.00E-8$)	156	155		
	50mm hard layers at 17.4, 17.6, and 17.9m 25mm hard layers at 17.8, 18.0, 18.2, and 18.3m 75mm hard layer at 18.6m 150mm crushed zone/clay seam at 17.5m, ppt = 0.2 tons/ft2, very soft		17.4	10	HQ3	0.22	100	88	23	62		horizontal joints, contacts, and bedding partings, occasional vertical joints, moderately widely spaced to very closely spaced, planar to undulating, rough, generally open, clay coating, slightly to moderately weathered		116	141		
	25mm crushed zone at 19.0m 25mm clay seam at 19.1m, ppt = 0.25 to 0.5 tons/ft2, soft		19.2	11	HQ3	0.15	100	75	0	0		horizontal bedding parting, slightly to moderately weathered	No flow[206] ($k' < 1.00E-8$)	21	5		
	25mm crushed zone at 20.2m 25mm hard layers at 19.4, 19.6, 19.7, and 19.8m 100mm hard layer at 20.4m		20.4	12	HQ3	0.24	100	96	17	85		horizontal contacts, and bedding parting, moderately widely spaced, undulating, generally rough, open, clay coating, slightly to moderately weathered	No flow[343] ($k' < 1.00E-8$) No flow[510] ($k' < 1.00E-8$)	122	121	7.6	2.65 [1]
	50mm crushed zone at 20.9m 12mm hard layer at 20.4m 125mm hard layer at 20.7m 25mm hard layers at 20.9, 21.6, and 21.8m 50 mm hard layer at 21.2m		21.9	13	HQ3	0.19	100	93	18	82		joints, contacts, and bedding partings, moderately widely spaced to very closely spaced, generally horizontal, occasional vertical joints, planar to undulating, rough, occasionally smooth, open, occasionally tight, slightly weathered to fresh		16	14		
	25mm hard layer at 23.2m 100mm hard layer at 23.3m		23.4	14	HQ3	0.21	97	97	9	97		horizontal contacts and bedding parting, widely spaced to moderately widely spaced, undulating, rough, open, clay coating, fresh		34	2		

Date / Time	Water Depth (m)	Elevation (m)
28 September 2011	2.3	110.6
14 October 2011	2.2	110.7

E = Modulus of Elasticity



Additional Notes:

This log is to be read in conjunction with accompanying general notes and borehole log symbols sheet. Stratification lines represent approximate boundary lines between material types, vertical and lateral transitions may be gradual. Water level readings were made at time(s) noted, fluctuations of groundwater levels may occur and should be expected.

Sample Types: A=Auger; DP=Direct Push; G=Grab; RC=Rock Core; SC=Soil Core; SS=Split Barrel (Split Spoon); ST=Shelby Tube.

Coffey Representatives

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IL	Checked By

LOG OF BOREHOLE HF1-19

SHEET 1 OF 1

Project Name: HANLAN FEEDERMAIN SOUTH CONTRACT 1	Client: CH2M HILL CANADA LTD.	Northing: 4828957 m
Project No.: GEOTMARK00233AA	Drilling Method Used: Hollow Stem Augering 200mm	Easting: 614792 m
Project Location: DIXIE RD, MISSISSAUGA	Date: 12 - 13 July 2011	Ground Surface Elevation: 112.7 m

Depth Scale (m)	Stratigraphic Symbol	Subsurface Conditions		Samples		Penetration / Strength Results		Moisture / Plasticity		Instrumentation Details	Groundwater Conditions	Headspace Vapor (ppm) LEL (%)	Elevation Scale (m)	Comments
		Depth / Elevation (m)	Description	Number	Type	Blow Counts / 150mm	N Value	Recovery %	Relative Drilling Resistance					
			100mm Asphalt 500mm Granular Base											
0.5			FILL silty sand brown, compact	1	SS	8 10 15	(25)	67						
1.0														
1.5		111.2	SILTY CLAY some fine to coarse sand to sandy, trace gravel, (Glacial Till), grey, very stiff to hard	2	SS	8 12 15	(27)	83						
2.0														
2.5				3	SS	8 14 20	(34)	100						
3.0														
3.5				4	SS	9 18 39	(57)	100						
4.0														
4.5		108.1		5	SS	50	50/8cm	67						
5.0		4.6	SHALE extremely weathered, hard	6	SS	50	50/8cm	100						
		107.2		7	SS	50	50/5cm	49						
5.5														

Rock Coring Started

Rock Core Log Next Page

Additional Notes:

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Sample Types: A=Auger; DP=Direct Push; G=Grab; RC=Rock Core; SC=Soil Core; SS=Split Barrel (Split Spoon); ST=Shelby Tube.

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LOG OF BOREHOLE HF1-19

SHEET 1 OF 2

Project Name: HANLAN FEEDERMAIN SOUTH CONTRACT 1

Client: CH2M HILL CANADA LTD.

Date: 12 - 13 July 2011

Project No.: GEOTMARK00233AA

Drilling Method Used: ROCK CORING HQ3

Northing: 4828957 m

Project Location: DIXIE RD, MISSISSAUGA

Ground Surface Elevation: 112.7 m

Easting: 614792 m

Borehole Location: SEE DRAWING

Datum Elevation: Geodetic

Diameter: 61mm

(m) STRATA ELEV DEPTH	ROCK DESCRIPTION See Soil Logs for soil descriptions.	GROUND WATER CONDITIONS	(m) CORE ELEV DEPTH	CORE SAMPLE			TOTAL CORE RECOVERY (%)	SOLID CORE RECOVERY (%)	HARD LAYER (%)	RQD (%)	FRACTURE INDEX (per 0.3m)	DISCONTINUITIES AND WEATHERING	HYDRAULIC CONDUCTIVITY k (cm/sec) [P' (kPa)]	POINT LOAD TEST UCS AXIAL (MPa)	POINT LOAD TEST UCS DIAMETRAL (MPa)	UNIAxIAL COMPRESSION (MPa)	DENSITY (g/cc) [E (GPa)]		
				NUMBER	SIZE	CORE RATE (m/min)													
107.2			107.2								2 4 6 8								
5.5	GEORGIAN BAY FORMATION grey, SHALE thinly laminated, interbedded with light grey LIMESTONE and SILTSTONE layers, strong to very strong Run1: very weak Run 2: very weak to weak 75mm hard layers at 6.0 and 6.8m Run3: 12mm hard layer at 8.0m 75mm hard layer at 8.5m 75mm hard layers at 9.2 and 9.7m 175mm hard layer at 9.9m 35mm hard layer at 10.5m 12mm clay seam at 10.6m 50mm hard layer at 13.2m weak Run8: 12mm clay seam at 15.3m 100mm hard layer at 16.0m 330mm hard layer at 16.3m		5.5	1	HQ3	0.10	100	0	0	0		completely weathered		26	4				
			106.7															joints and bedding partings, moderately widely spaced to very closely spaced, generally horizontal, some 45 to 90 degree joints, planar to undulating, smooth (50%) to rough (50%), generally open, clay coating, moderately to highly weathered	
			6.0	2	HQ3	0.10	78	40	10	30									
			105.2															horizontal joints, contacts, and bedding partings, moderately widely spaced to very closely spaced, planar to stepped, smooth, occasionally rough, generally open, clay coating, moderately to slightly weathered	
			7.5	3	HQ3	0.19	100	98	6	70									
			103.7															joints, contacts, and bedding partings, moderately widely spaced to extremely closely spaced, generally horizontal, some vertical joints, some 45 degree bedding partings, planar to stepped, smooth (35%) to rough (65%), open (70%) to tight (30%), clay coating, moderately to slightly weathered	
			9.0	4	HQ3	0.15	100	80	24	37									horizontal joints and bedding partings, moderately widely spaced to very closely spaced, planar to undulating, smooth (45%) to rough (55%), open (55%) to tight (45%), clay coating, moderately to slightly weathered
			102.1																horizontal joints and bedding partings, moderately widely spaced to very closely spaced, planar to stepped, smooth (60%) to rough (40%), open (40%) to tight (60%), clay coating, moderately to slightly weathered
			10.6	5	HQ3	0.13	100	97	0	67									joints and bedding partings, moderately widely spaced to very closely spaced, generally horizontal, some 10 degree joints, planar to stepped, smooth, occasionally rough, open (50%) to tight (50%), clay coating, fresh to slightly weathered
			100.6																
			12.1	6	HQ3	0.14	100	98	3	88			9.96E-5 [157]	14	4				
			99.1																
			13.6	7	HQ3	0.08	100	98	0	92									
			97.6										9.80E-5 [265] 1.50E-4 [373]	17	2				
			15.1																

Continued Next Page

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Additional Notes:

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Sample Types: A=Auger; DP=Direct Push; G=Grab; RC=Rock Core; SC=Soil Core; SS=Split Barrel (Split Spoon); ST=Shelby Tube.

E = Modulus of Elasticity

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Additional Notes:

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Sample Types: A=Auger; DP=Direct Push; G=Grab; RC=Rock Core; SC=Soil Core; SS=Split Barrel (Split Spoon); ST=Shelby Tube.

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LOG OF BOREHOLE HF1-19

SHEET 2 OF 2

Project Name: HANLAN FEEDERMAIN SOUTH CONTRACT 1

Client: CH2M HILL CANADA LTD.

Date: 12 - 13 July 2011

Project No.: GEOTMARK00233AA

Drilling Method Used: ROCK CORING HQ3

Northing: 4828957 m

Project Location: DIXIE RD, MISSISSAUGA

Ground Surface Elevation: 112.7 m

Easting: 614792 m

Borehole Location: SEE DRAWING

Datum Elevation: Geodetic

Diameter: 61mm

(m) STRATA ELEV DEPTH	ROCK DESCRIPTION See Soil Logs for soil descriptions.	GROUND WATER CONDITIONS	(m) CORE ELEV DEPTH	CORE SAMPLE			TOTAL CORE RECOVERY (%)	SOLID CORE RECOVERY (%)	HARD LAYER (%)	ROD (%)	FRACTURE INDEX (per 0.3m)	DISCONTINUITIES AND WEATHERING	HYDRAULIC CONDUCTIVITY k (cm/sec) [P (kPa)]	POINT LOAD TEST UCS AXIAL (MPa)	POINT LOAD TEST UCS DIAMETRAL (MPa)	UNIAxIAL COMPRESSION (MPa)	DENSITY (g/cc) [E (GPa)]
				NUMBER	SIZE	CORE RATE (m/min)											
	25mm hard layer at 16.6m GEORGIAN BAY FORMATION grey, SHALE thinly laminated, interbedded with light grey LIMESTONE and SILTSTONE layers, strong to very strong (<i>continued</i>) Run9: 150mm crushed zone at 16.7 and 17.3m 75mm crushed zone at 16.9m 50mm crushed zone at 18.0m 50mm hard layers at 16.8 and 17.4m 25mm hard layer at 17.1m 100mm hard layer at 17.6m		96.0	8	HQ3	0.15	90	87	32	73		contacts and bedding partings, moderately widely spaced to very closely spaced, generally horizontal, some 0 to 10 degree joints and bedding partings, planar to undulating, smooth (30%) to rough (70%), open (70%) to tight (30%), clay coating, fresh to slightly weathered (<i>continued</i>)	3.46E-6 [196]	128	90		
			16.7										2.85E-6 [334]				
			94.5	9	HQ3	0.06	100	63	15	53		vertical joints and horizontal bedding partings, moderately widely spaced to very closely spaced, planar to undulating, generally rough, generally open, clay coating, moderately weathered	5.19E-6 [471]	21	3		
			18.2														
			93.0	10	HQ3	0.08	100	100	0	93		horizontal joints, contacts, and bedding partings, widely spaced to closely spaced, planar to undulating, smooth (40%) to rough (60%), generally open, clay coating, fresh		18	6		
	25mm hard layer at 19.9m 50mm hard layer at 20.8m		19.7														
			91.5	11	HQ3	0.06	100	97	5	88		horizontal joint, contacts, and bedding parting, widely spaced to closely spaced, planar to undulating, smooth bedding parting, rough joint and contacts, open (50%) to tight (50%), clay coating, fresh to slightly weathered		19	2		
			21.2														
	35mm hard layers at 22.3 and 22.5m		89.9	12	HQ3	0.09	100	100	3	97		contacts and bedding partings, closely spaced to very closely spaced, horizontal, occasionally 10 degrees, planar to undulating, rough, occasionally smooth, open (60%) to tight (40%), clay coating, fresh		28	1	14.8	[3]
			22.8														

Date / Time

Water Depth (m)

Elevation (m)

E = Modulus of Elasticity



Additional Notes:

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Sample Types: A=Auger; DP=Direct Push; G=Grab; RC=Rock Core; SC=Soil Core; SS=Split Barrel (Split Spoon); ST=Shelby Tube.

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LOG OF BOREHOLE HF1-20

SHEET 1 OF 1

Project Name: HANLAN FEEDERMAIN SOUTH CONTRACT 1 Client: CH2M HILL CANADA LTD. Northing: 4828859 m
 Project No.: GEOTMARK00233AA Drilling Method Used: Hollow Stem Augering 200mm Easting: 614897 m
 Project Location: DIXIE RD, MISSISSAUGA Date: 20 - 21 July 2011 Ground Surface Elevation: 112.3 m

Depth Scale (m)	Subsurface Conditions		Samples		Penetration / Strength Results		Moisture / Plasticity		Instrumentation Details	Groundwater Conditions	Headspace Vapor (ppm) LEL (%)	Elevation Scale (m)	Comments
	Stratigraphic Symbol	Depth / Elevation (m)	Description	Number Type	Blow Counts / 150mm N Value	Recovery %	Relative Drilling Resistance	Penetration Test Values (Blows / 0.3m) X N Values ♦ Dynamic Cone + Becker Hammer Test (BPT) 20 40 60 80 Undrained Shear Strength Values (kPa) □ Field Vane ○ Unconfined ■ Lab Vane ● Quick Triaxial ▲ Pocket Penetrometer	Plastic Limit Natural Water Content Liquid Limit	PL MC LL			
0.5			25mm Asphalt 600mm Granular Base	1 AS								112.0	
1.0			FILL silty sand, some gravel brown, very loose to compact	1 SS	2 1 2	(3)	78					111.5	
1.5												111.0	
2.0		110.5	CLAYEY SILT TILL firm to very stiff	2 SS	4 7 12	(19)	100					110.5	
2.5		109.7		3 SS	20 27 26	(53)	100					110.0	
3.0		109.2	SHALE completely weathered grey, hard	4 SS	50	50/10cm	126					109.5	
3.1													

Rock Coring Started

BEFORE CORING

Date / Time
20 July 2011Water Depth (m)
1.8Elevation (m)
110.5

Rock Core Log Next Page

Additional Notes:

This log is to be read in conjunction with accompanying general notes and borehole log symbols sheet. Stratification lines represent approximate boundary lines between material types, vertical and lateral transitions may be gradual. Water level readings were made at time(s) noted, fluctuations of groundwater levels may occur and should be expected.
 Sample Types: A=Auger; DP=Direct Push; G=Grab; RC=Rock Core; SC=Soil Core; SS=Split Barrel (Split Spoon); ST=Shelby Tube.

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LOG OF BOREHOLE HF1-20

SHEET 1 OF 2

Project Name: HANLAN FEEDERMAIN SOUTH CONTRACT 1

Client: CH2M HILL CANADA LTD.

Date: 20 - 21 July 2011

Project No.: GEOTMARK00233AA

Drilling Method Used: ROCK CORING HQ3

Northing: 4828859 m

Project Location: DIXIE RD, MISSISSAUGA

Ground Surface Elevation: 112.3 m

Easting: 614897 m

Borehole Location: SEE DRAWING

Datum Elevation: Geodetic

Diameter: 61mm

(m) STRATA ELEV DEPTH	ROCK DESCRIPTION See Soil Logs for soil descriptions.	GROUND WATER CONDITIONS	(m) CORE ELEV DEPTH	CORE SAMPLE			TOTAL CORE RECOVERY (%)	SOLID CORE RECOVERY (%)	HARD LAYER (%)	RQD (%)	FRACTURE INDEX (per 0.3m)	DISCONTINUITIES AND WEATHERING	HYDRAULIC CONDUCTIVITY k (cm/sec) [P (kPa)]	POINT LOAD TEST UCS AXIAL (MPa)	POINT LOAD TEST UCS DIAMETRAL (MPa)	UNIAxIAL COMPRESSION (MPa)	DENSITY (g/cc) [E (GPa)]
				NUMBER	SIZE	CORE RATE (m/min)											
109.2			109.2								2 4 6 8						
3.1	GEORGIAN BAY FORMATION grey, SHALE thinly laminated to thinly bedded, interbedded with light grey LIMESTONE and SILTSTONE layers, strong to very strong		3.1	1	HQ3	0.25	90	67	2	15		contacts and bedding partings, closely to very closely spaced, 0 - 10 degrees, planar, smooth (50%) to rough (50%), open (50%) to tight (50%), occasionally with clay infill, moderately to highly weathered		11	4		
	Run1: very weak to weak 25mm hard layer at 4.2m Run2: weak 25mm hard layers at 4.9 and 5.0m 125mm hard layer at 5.1m 50mm hard layer at 6.0m		107.6 4.7	2	HQ3	0.22	100	92	15	25		horizontal contacts and bedding partings, closely to very closely spaced, planar, smooth (70%) to rough (30%), open, occasionally with clay infill, moderately weathered		202	180		
	50mm hard layer at 6.8m 25mm hard layers at 7.1 and 7.6m		106.1 6.2	3	HQ3	0.25	100	100	7	75		horizontal contacts and bedding partings, moderately closely to very closely spaced, planar to undulating, smooth (40%) to rough (60%), open (60%) to tight (40%), slightly weathered		10	1		
	50mm hard layer at 8.7m 100mm hard layer at 8.5m 75mm hard layers at 8.9 and 9.2m		104.6 7.7	4	HQ3	0.30	98	92	20	70		contacts and bedding partings, moderately closely to very closely spaced, generally horizontal, planar to undulating, smooth (20%) to rough (80%), generally open, slightly to moderately weathered					
	50mm hard layer at 9.6m 75mm hard layers at 9.4 and 10.0m		103.1 9.2	5	HQ3	0.30	100	98	13	98		contacts and bedding partings, moderately closely to very closely spaced, 0 - 10 degrees, planar to undulating, rough, generally open, slightly weathered		225	69		
			101.5 10.8	6	HQ3	0.25	100	100	0	93		horizontal contacts and bedding partings, moderately closely to very closely spaced, planar, smooth (40%) to rough (60%), open, slightly weathered		33	3		
	100mm hard layer at 12.9m 150mm hard layer at 13.7m		100.0 12.3	7	HQ3	0.30	98	98	17	88		horizontal contacts and bedding partings, widely to very closely spaced, planar to undulating, smooth (40%) to rough (60%), generally open, some with clay infill, slightly weathered to fresh		18	1		

Continued Next Page

E = Modulus of Elasticity

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LOG OF BOREHOLE HF1-20

SHEET 2 OF 2

Project Name: HANLAN FEEDERMAIN SOUTH CONTRACT 1

Client: CH2M HILL CANADA LTD.

Date: 20 - 21 July 2011

Project No.: GEOTMARK00233AA

Drilling Method Used: ROCK CORING HQ3

Northing: 4828859 m

Project Location: DIXIE RD, MISSISSAUGA

Ground Surface Elevation: 112.3 m

Easting: 614897 m

Borehole Location: SEE DRAWING

Datum Elevation: Geodetic

Diameter: 61mm

(m) STRATA ELEV DEPTH	ROCK DESCRIPTION See Soil Logs for soil descriptions.	GROUND WATER CONDITIONS	(m) CORE ELEV DEPTH	CORE SAMPLE			TOTAL CORE RECOVERY (%)	SOLID CORE RECOVERY (%)	HARD LAYER (%)	ROD (%)	FRACTURE INDEX (per 0.3m)	DISCONTINUITIES AND WEATHERING	HYDRAULIC CONDUCTIVITY k (cm/sec) [P (kPa)]	POINT LOAD TEST UCS AXIAL (MPa)	POINT LOAD TEST UCS DIAMETRAL (MPa)	UNIAxIAL COMPRESSION (MPa)	DENSITY (g/cc) [E (GPa)]
				NUMBER	SIZE	CORE RATE (m/min)											
	GEORGIAN BAY FORMATION grey, SHALE thinly laminated to thinly bedded, interbedded with light grey LIMESTONE and SILTSTONE layers, strong to very strong (<i>continued</i>) Run8: 100mm hard layers at 14.2 and 15.0m 25mm hard layers at 15.1 and 15.3m		98.5 13.8	8	HQ3	0.30	100	98	17	88		horizontal contacts and bedding partings, widely to very closely spaced, planar to undulating, rough, generally open, slightly weathered to fresh		129	98		
	Run9: 125mm hard layer at 15.3m 75mm hard layers at 15.5, 15.9, and 16.5m 50mm hard layers at 15.6 and 16.0m 25mm hard layer at 16.1m		97.0 15.3	9	HQ3	0.25	100	98	32	58		contacts and bedding partings, moderately closely to very closely spaced, generally horizontal, planar, smooth (20%) to rough (80%), open (80%) to tight (20%), 40% with clay infill, slightly weathered to fresh		211	86	91.1	2.66 [16]
	50mm hard layer at 17.7m		95.4 16.9	10	HQ3	0.30	100	93	3	92		contacts and bedding partings, moderately closely to very closely spaced, generally horizontal, planar to undulating, smooth (50%) to rough (50%), open, occasionally with clay infill, slightly to moderately weathered		30	1		
	170mm clay seam at 18.4m 25mm hard layer at 19.0m 75mm hard layer at 19.3m		93.9 18.4	11	HQ3	0.27	77	59	6	50		horizontal contacts and bedding partings, moderately closely to closely spaced, planar to undulating, rough, open, occasionally with clay infill, moderately weathered Note: Gas present in borehole after Run 11 (dissipated after 17 minutes).		151	111		
	75mm hard layer at 20.0m 50mm hard layer at 20.1m		92.3 20.0	12	HQ3	0.22	100	98	8	85		horizontal contacts and bedding partings, closely to very closely spaced, planar to undulating, smooth (50%) to rough (50%), open, occasionally with clay infill, slightly to moderately weathered		28	2		
	weak to medium strong 50mm hard layer at 22.0m 75mm hard layers at 22.1 and 22.7m		90.8 21.5	13	HQ3	0.25	100	100	13	80		contacts and bedding partings, moderately closely to very closely spaced, 0 - 10 degrees, planar, smooth (30%) to rough (70%), generally open, occasionally with clay infill, slightly to moderately weathered		38	1		
			89.2 23.1														

Date / Time **Water Depth (m)** **Elevation (m)**
 BEFORE CORING 20 July 2011 1.8 110.5

E = Modulus of Elasticity

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LOG OF BOREHOLE HF1-21

SHEET 1 OF 1

Project Name: HANLAN FEEDERMAIN SOUTH CONTRACT 1

Client: CH2M HILL CANADA LTD.

Northing: 4828673 m

Project No.: GEOTMARK00233AA

Drilling Method Used: Hollow Stem Augering 200mm

Easting: 615098 m

Project Location: DIXIE RD, MISSISSAUGA

Date: 12 - 14 July 2011

Ground Surface Elevation: 111.5 m

Depth Scale (m)	Subsurface Conditions		Samples		Penetration / Strength Results		Moisture / Plasticity		Instrumentation Details	Groundwater Conditions	Headspace Vapor (ppm) LEL (%)	Elevation Scale (m)	Comments
	Stratigraphic Symbol	Depth / Elevation (m)	Description	Number Type Blow Counts / 150mm N Value Recovery %	Relative Drilling Resistance	Penetration Test Values (Blows / 0.3m) X N Values + Becker Hammer Test (BPT) 20 40 60 80 Undrained Shear Strength Values (kPa) □ Field Vane ○ Unconfined ■ Lab Vane ● Quick Triaxial ▲ Pocket Penetrometer	Plastic Limit Natural Water Content Liquid Limit PL MC LL						
0.5			110mm Asphalt 320mm Granular base									111.0	
1.0			FILL sand, fine grained, brown, dry, very loose	1 SS 2 1 (2) 94	X							110.5	
1.5		110.0										110.0	
2.0		1.5	SAND some silt, trace clay, fine grained, brown, wet, compact	2 SS 9 12 (28) 83	X							109.5	0 73 19 8
2.5												109.0	spoon wet
3.0		108.5		3 SS 8 11 (24) 100	X							108.5	
3.5		3.0	SILTY SAND fine grained sand, trace clay, trace to some fine to coarse grained gravel brown, wet, dense to very dense	4 SS 18 16 (41) 94	X							108.0	12 50 32 6
4.0												107.5	
4.5				5 SS 9 21 (44) 94	X							107.0	
5.0												106.5	
5.5				6 SS 11 21 (50) 94	X							106.0	
6.0		105.4										105.5	
6.5		6.1	grading to medium to coarse grained sand, trace fine to coarse grained gravel	7 SS 14 32 (57) 89	X							105.0	
7.0		104.3	SHALE highly weathered grey, hard	8 SS 50 50/6cm 99								104.5	
7.2				9 SS 100 100/5cm 98									

Rock Coring Started

BEFORE CORING

Date / Time	Water Depth (m)	Elevation (m)
12 July 2011	1.9	109.6
14 July 2011	2.1	109.4
12 August 2011	2.3	109.2
28 September 2011	2.3	109.2
14 October 2011	2.2	109.3

Rock Core Log Next Page



Additional Notes:

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Sample Types: A=Auger; DP=Direct Push; G=Grab; RC=Rock Core; SC=Soil Core; SS=Split Barrel (Split Spoon); ST=Shelby Tube.

Coffey Representatives

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AC	Prepared By
IL	Checked By

LOG OF BOREHOLE HF1-21

SHEET 1 OF 2

Project Name: HANLAN FEEDERMAIN SOUTH CONTRACT 1

Client: CH2M HILL CANADA LTD.

Date: 12 - 14 July 2011

Project No.: GEOTMARK00233AA

Drilling Method Used: ROCK CORING HQ3

Northing: 4828673 m

Project Location: DIXIE RD, MISSISSAUGA

Ground Surface Elevation: 111.5 m

Easting: 615098 m

Borehole Location: SEE DRAWING

Datum Elevation: Geodetic

Diameter: 61mm

(m) STRATA ELEV DEPTH	ROCK DESCRIPTION See Soil Logs for soil descriptions.	GROUND WATER CONDITIONS	(m) CORE ELEV DEPTH	CORE SAMPLE			TOTAL CORE RECOVERY (%)	SOLID CORE RECOVERY (%)	HARD LAYER (%)	RQD (%)	FRACTURE INDEX (per 0.3m)	DISCONTINUITIES AND WEATHERING	HYDRAULIC CONDUCTIVITY k (cm/sec) [P (kPa)]	POINT LOAD TEST UCS AXIAL (MPa)	POINT LOAD TEST UCS DIAMETRAL (MPa)	UNIAxIAL COMPRESSION (MPa)	DENSITY (g/cc) [E (GPa)]
				NUMBER	SIZE	CORE RATE (m/min)											
104.3			104.3														
7.2	GEORGIAN BAY FORMATION grey, SHALE laminated to thinly laminated, interbedded with light grey LIMESTONE and SILTSTONE layers, strong to very strong Run1: weak, 300mm coarse gravel infill at 7.2m Run2: very weak to weak 200mm fractured zone at 7.5m, 7.9m, and 8.9m, 50mm hard layer at 8.0 and 8.7m, 250mm hard layer at 8.9m Run3: 250mm hard layer at 9.1m, 50mm hard layer at 9.7m		7.2	1	HQ3	0.10	100	0	0	0		highly weathered					
			104.0														
			7.5									horizontal contacts and bedding partings, moderately widely spaced to closely spaced, planar to undulating, smooth, open, clay coating, highly to moderately weathered		20	5		
			102.4	2	HQ3	0.13	100	83	7	42							
			9.1									joints, contacts, and bedding partings, generally horizontal, occasionally vertical, moderately widely spaced to very closely spaced, planar to undulating, smooth, occasionally rough, open, occasionally tight, occasionally with clay coating, highly to moderately weathered	No flow[118] ($k' < 1.00E-8$) No flow[226] ($k' < 1.00E-8$)	162	54		
			100.9	3	HQ3	0.13	97	90	20	48							
			10.6									contacts and bedding partings, generally horizontal, occasionally 10-20 degrees, moderately widely spaced to closely spaced, planar to undulating, generally smooth, open, highly to moderately weathered	No flow[334] ($k' < 1.00E-8$)	26	6		
			99.4	4	HQ3	0.13	100	100	0	83							
	75mm hard layer at 12.5m		12.1									bedding partings, generally horizontal, moderately widely spaced to extremely closely spaced, planar to undulating, smooth (50%) to rough (50%), open, highly to moderately weathered	No flow[118] ($k' < 1.00E-8$) No flow[226] ($k' < 1.00E-8$)	117	70		
			97.9	5	HQ3	0.14	98	97	5	95							
	weak, 50mm clay infill at 14.8m		13.6									horizontal bedding partings, moderately widely spaced to closely spaced, planar to undulating, smooth, open, highly to moderately weathered	No flow[334] ($k' < 1.00E-8$)	27	3		
			96.3	6	HQ3	0.12	95	95	0	83							
			15.2									45 degree joint, horizontal contact and bedding partings, closely spaced to very closely spaced, undulating, rough, generally tight, some with clay coating, moderately weathered		176	108		
	weak to very weak, 150mm hard layer at 15.1m Run8: weak, 500mm fractured zone at 15.4m, 100mm fractured zone at and 16.6m, 50mm clay seam at 16.8m, 50mm hard layer at 15.6 and 16.2m, 150mm hard layer at 16.7m		15.4									joints, contacts and bedding partings, generally horizontal, some 0-5 degrees, moderately widely spaced to closely spaced, planar to stepped, smooth (30%) to rough (70%), generally open, clay coating,		165	89		
			94.5	7	HQ3	0.09	100	41	50	0							
			17.0														
	Run9:			8	HQ3	0.11	100	62	17	43							

Continued Next Page

E = Modulus of Elasticity

Additional Notes:

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Sample Types: A=Auger; DP=Direct Push; G=Grab; RC=Rock Core; SC=Soil Core; SS=Split Barrel (Split Spoon); ST=Shelby Tube.

Coffey Representatives

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AC	Prepared By
IL	Checked By

LOG OF BOREHOLE HF1-21

SHEET 2 OF 2

Project Name: HANLAN FEEDERMAIN SOUTH CONTRACT 1

Client: CH2M HILL CANADA LTD.

Date: 12 - 14 July 2011

Project No.: GEOTMARK00233AA

Drilling Method Used: ROCK CORING HQ3

Northing: 4828673 m

Project Location: DIXIE RD, MISSISSAUGA

Ground Surface Elevation: 111.5 m

Easting: 615098 m

Borehole Location: SEE DRAWING

Datum Elevation: Geodetic

Diameter: 61mm

(m) STRATA ELEV DEPTH	ROCK DESCRIPTION See Soil Logs for soil descriptions.	GROUND WATER CONDITIONS	(m) CORE ELEV DEPTH	CORE SAMPLE			TOTAL CORE RECOVERY (%)	SOLID CORE RECOVERY (%)	HARD LAYER (%)	ROD (%)	FRACTURE INDEX (per 0.3m)				DISCONTINUITIES AND WEATHERING	HYDRAULIC CONDUCTIVITY k (cm/sec) [P (kPa)]	POINT LOAD TEST UCS AXIAL (MPa)	POINT LOAD TEST UCS DIAMETRAL (MPa)	UNIAxIAL COMPRESSION (MPa)	DENSITY (g/cc) [E (GPa)]
				NUMBER	SIZE	CORE RATE (m/min)					2	4	6	8						
90.0 21.5	100mm hard layer at 17.0m, 75mm hard layer at 17.2m, 12mm hard layer at 17.4 and 17.7m GEORGIAN BAY FORMATION grey, SHALE laminated to thinly laminated, interbedded with light grey LIMESTONE and SILTSTONE layers, strong to very strong (<i>continued</i>) Run10: 100mm hard layer at 18.9m, 25mm hard layer at 19.2m, 75mm hard layer at 19.6m 50mm hard layer at 20.0m, 25mm hard layer at 21.4m		93.0	9	HQ3	0.08	100	100	13	88					moderately weathered contacts and bedding partings, generally horizontal, moderately widely spaced to very closely spaced, planar to undulating, smooth (30%) to rough (70%), open (50%) to tight (50%), some with clay coating, slightly weathered to fresh (<i>continued</i>)		8	5	5.9	11.51 [1]
			18.5																	
			91.5	10	HQ3	0.08	100	95	13	80					joints, contacts, and bedding partings, generally horizontal, moderately widely spaced, planar to stepped, smooth (30%) to rough (70%), open, occasionally tight, clay coating, slightly to moderately weathered		13 15	9 3		
			20.0																	
			90.0	11	HQ3	0.11	100	100	5	97					0-10 degree contacts and horizontal bedding partings, widely spaced to closely spaced, undulating, generally rough, occasionally smooth, open, clay coating, fresh					
			21.5																	

	Date / Time	Water Depth (m)	Elevation (m)
BEFORE CORING	12 July 2011	1.9	109.6
	14 July 2011	2.1	109.4
	12 August 2011	2.3	109.2
	28 September 2011	2.3	109.2
	14 October 2011	2.2	109.3

E = Modulus of Elasticity



Additional Notes:

This log is to be read in conjunction with accompanying general notes and borehole log symbols sheet. Stratification lines represent approximate boundary lines between material types, vertical and lateral transitions may be gradual. Water level readings were made at time(s) noted, fluctuations of groundwater levels may occur and should be expected.
Sample Types: A=Auger; DP=Direct Push; G=Grab; RC=Rock Core; SC=Soil Core; SS=Split Barrel (Split Spoon); ST=Shelby Tube.

Coffey Representatives

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IL	Checked By

LOG OF BOREHOLE HF1-22

SHEET 1 OF 1

Project Name: HANLAN FEEDERMAIN SOUTH CONTRACT 1 Client: CH2M HILL CANADA LTD. Northing: 4828538 m
 Project No.: GEOTMARK00233AA Drilling Method Used: Hollow Stem Augering 200mm Easting: 615240 m
 Project Location: DIXIE RD, MISSISSAUGA Date: 18 - 19 July 2011 Ground Surface Elevation: 110.6 m

Depth Scale (m)	Subsurface Conditions		Samples		Penetration / Strength Results		Moisture / Plasticity		Instrumentation Details	Groundwater Conditions	Headspace Vapor (ppm) LEL (%)	Elevation Scale (m)	Comments
	Stratigraphic Symbol	Depth / Elevation (m)	Description	Number Type	Blow Counts / 150mm N Value	Recovery %	Relative Drilling Resistance	Penetration Test Values (Blows / 0.3m) X N Values ♦ Dynamic Cone + Becker Hammer Test (BPT) 20 40 60 80 Undrained Shear Strength Values (kPa) □ Field Vane ○ Unconfined ■ Lab Vane ● Quick Triaxial ▲ Pocket Penetrometer	Plastic Limit Natural Water Content Liquid Limit PL MC LL				
0.5			100mm Asphalt 500mm Granular Base									110.5	
1.0			FILL silty sand, brown, loose to compact	1 SS	3 2 2	(4)	89	X				110.0	
1.5				2 SS	4 10 13	(23)	56	X				109.5	
2.0												109.0	
2.5		108.3 2.3	SILTY SAND fine grained, laminated, dilatant, grey, dense to very dense	3 SS	7 14 17	(31)	78	X				108.5	
3.0												108.0	
3.5		107.4 3.2	SHALE completely weathered, hard	4A 4 SS	3 2 50	50/11cm	63	X				107.5	
4.0				5 SS	50	50/13cm	99					107.0	
4.5												106.5	
5.0				6 SS	50	50/8cm	100					106.0	
5.5												105.5	
5.6		105.0											

Rock Coring Started

DURING DRILLING

Date / Time
18 July 2011Water Depth (m)
2.3Elevation (m)
108.3

Rock Core Log Next Page

Additional Notes:

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 Sample Types: A=Auger; DP=Direct Push; G=Grab; RC=Rock Core; SC=Soil Core; SS=Split Barrel (Split Spoon); ST=Shelby Tube.

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IL	Checked By

LOG OF BOREHOLE HF1-22

SHEET 1 OF 2

Project Name: HANLAN FEEDERMAIN SOUTH CONTRACT 1

Client: CH2M HILL CANADA LTD.

Date: 18 - 19 July 2011

Project No.: GEOTMARK00233AA

Drilling Method Used: ROCK CORING HQ3

Northing: 4828538 m

Project Location: DIXIE RD, MISSISSAUGA

Ground Surface Elevation: 110.6 m

Easting: 615240 m

Borehole Location: SEE DRAWING

Datum Elevation: Geodetic

Diameter: 61mm

(m) STRATA ELEV DEPTH	ROCK DESCRIPTION See Soil Logs for soil descriptions.	GROUND WATER CONDITIONS	(m) CORE ELEV DEPTH	CORE SAMPLE			TOTAL CORE RECOVERY (%)	SOLID CORE RECOVERY (%)	HARD LAYER (%)	RQD (%)	FRACTURE INDEX (per 0.3m)	DISCONTINUITIES AND WEATHERING	HYDRAULIC CONDUCTIVITY k (cm/sec) [P' (kPa)]	POINT LOAD TEST UCS AXIAL (MPa)	POINT LOAD TEST UCS DIAMETRAL (MPa)	UNIAxIAL COMPRESSION (MPa)	DENSITY (g/cc) [E (GPa)]
				NUMBER	SIZE	CORE RATE (m/min)											
105.0			105.0								2 4 6 8						
5.6	GEORGIAN BAY FORMATION grey, SHALE thinly laminated, interbedded with light grey LIMESTONE and SILTSTONE layers, strong to very strong Run1: extremely weak to very weak, 50 mm hard layer at 5.9m, 270mm crushed zone at 5.6m Run2: very weak to weak, 50mm clay seam at 7.5m, 270mm hard layer at 6.1m, 50mm crushed zone at 7.5m, 50mm hard layer at 6.8m, 25mm hard layer at 7.1m, 75mm hard layer at 7.2m Run3: 100mm hard layer at 7.6m, 75mm hard layer at 7.9m & 8.5m, 50mm hard layer at 8.0m & 8.8m, 25mm hard layer at 8.1m, 8.4m, 8.7m & 9.0m 220mm hard layer at 8.2m Run4: 50mm hard layer at 9.1m, 12mm hard layer at 9.4m & 10.3m weak, 25mm fractured zone at 12.1m 50mm fractured zone at 12.7m, 50mm hard layer at 12.8m 25mm hard layer at 13.9m & 14.4m, 200mm hard layer at 14.1m, 230mm hard layer at 14.5m, 50mm hard layer at 14.9m, 75mm hard layer at 15.1m Run8: 12mm clay infill at 15.0m,		5.6	1	HQ3	0.16	100	16	11	0		highly to completely weathered		170	161		
			104.5														
			6.1										contacts and bedding partings, moderately widely spaced to very closely spaced, generally horizontal, some 0-10 degree bedding partings, planar to stepped, smooth (70%) to rough (30%), open (80%) to tight (20%), highly to moderately weathered	31	1		
				2	HQ3	0.11	100	67	28	20							
			103.0														
			7.6										joints, contacts & bedding partings, moderately widely spaced to very closely spaced, 0-5 degrees, planar to undulating, smooth (50%) to rough (50%), open, moderately weathered.	199	202		
				3	HQ3	0.11	100	50	47	27							
			101.5														
			9.1										joints and bedding partings, widely spaced to very closely spaced, generally horizontal, planar to stepped, smooth (40%) to rough (60%), open (50%) to tight (50%), slightly weathered	42	2		
				4	HQ3	0.10	100	95	5	90							
			100.0														
			10.6										joints and bedding partings, widely spaced to very closely spaced, generally horizontal, planar to stepped, smooth (60%) to rough (40%), generally open, slightly weathered	21	1		
				5	HQ3	0.13	100	20	0	60							
			98.4														
			12.2										horizontal contacts & vertical joints, closely spaced to very closely spaced, undulating, open, smooth (50%) to rough (50%), some with clay coating, slightly weathered to fresh	33	7	10.1	2.62 [1]
			6	HQ3	0.10	100	90	3	90								
		96.9															
		13.7										horizontal contacts and bedding partings and vertical joint, moderately widely spaced to very closely spaced, planar to undulating, smooth (60%) to rough (40%), generally open, clay coating, slightly to moderately weathered	182	160	65.8	2.62 [15]	
			7	HQ3	0.15	100	95	40	70								
		95.4															
		15.2															

Continued Next Page

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Additional Notes:

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Sample Types: A=Auger; DP=Direct Push; G=Grab; RC=Rock Core; SC=Soil Core; SS=Split Barrel (Split Spoon); ST=Shelby Tube.

E = Modulus of Elasticity

Coffey Representatives

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E = Modulus of Elasticity

Additional Notes:

This log is to be read in conjunction with accompanying general notes and borehole log symbols sheet. Stratification lines represent approximate boundary lines between material types, vertical and lateral transitions may be gradual. Water level readings were made at time(s) noted, fluctuations of groundwater levels may occur and should be expected.

Sample Types: A=Auger; DP=Direct Push; G=Grab; RC=Rock Core; SC=Soil Core; SS=Split Barrel (Split Spoon); ST=Shelby Tube.

Coffey Representatives

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LOG OF BOREHOLE HF1-22

SHEET 2 OF 2

Project Name: HANLAN FEEDERMAIN SOUTH CONTRACT 1

Client: CH2M HILL CANADA LTD.

Date: 18 - 19 July 2011

Project No.: GEOTMARK00233AA

Drilling Method Used: ROCK CORING HQ3

Northing: 4828538 m

Project Location: DIXIE RD, MISSISSAUGA

Ground Surface Elevation: 110.6 m

Easting: 615240 m

Borehole Location: SEE DRAWING

Datum Elevation: Geodetic

Diameter: 61mm

(m) STRATA ELEV DEPTH	ROCK DESCRIPTION See Soil Logs for soil descriptions.	GROUND WATER CONDITIONS	(m) CORE ELEV DEPTH	CORE SAMPLE			TOTAL CORE RECOVERY (%)	SOLID CORE RECOVERY (%)	HARD LAYER (%)	ROD (%)	FRACTURE INDEX (per 0.3m)	DISCONTINUITIES AND WEATHERING	HYDRAULIC CONDUCTIVITY k (cm/sec) [P (kPa)]	POINT LOAD TEST UCS AXIAL (MPa)	POINT LOAD TEST UCS DIAMETRAL (MPa)	UNIAxIAL COMPRESSION (MPa)	DENSITY (g/cc) [E (GPa)]
				NUMBER	SIZE	CORE RATE (m/min)											
	50mm hard layer at 15.5m, 75mm hard layer at 15.6m, 25mm hard layer at 16.0m GEORGIAN BAY FORMATION grey, SHALE thinly laminated, interbedded with light grey LIMESTONE and SILTSTONE layers, strong to very strong (<i>continued</i>) Run9: 100mm hard layer at 17.8m, 25mm hard layer at 18.2m, 25mm fractured zone at 17.7m		93.9	8	HQ3	0.08	100	95	7	88		horizontal contacts and bedding partings and vertical joints, moderately widely spaced to very closely spaced, planar to undulating, smooth (30%) to rough (70%), open (70%) to tight (30%), slightly weathered (<i>continued</i>)		122	70		
	50mm fractured zone at 19.7m		16.7	9	HQ3	0.07	100	90	8	77		horizontal joints, contacts and bedding partings, some 5-90 degree joints, moderately widely spaced to very closely spaced, planar to stepped, smooth (70%) to rough (30%), open (50%) to tight (50%), moderately to slightly weathered		108	64		
			92.3														
			18.3	10	HQ3	0.05	100	95	5	80		contacts and joints, widely spaced to very closely spaced, 0 to 20 degrees, undulating, generally rough, open, moderately to slightly weathered		26	10		
			90.8														
	very weak to weak, 75mm fractured zone at 20.6m, 25mm hard layer at 19.9m, 20.4m & 20.6m, 12mm hard layer at 20.5m, 170mm hard layer at 20.7m, 50mm hard layer at 21.1m, 75mm hard layer at 21.2m		19.8	11	HQ3	0.10	100	95	26	83		horizontal contacts and bedding partings and vertical joint, moderately widely spaced to very closely spaced, undulating, smooth (40%) to rough (60%), open, moderately to slightly weathered					
			89.3														
			21.3														

Date / Time **Water Depth (m)** **Elevation (m)**
 DURING DRILLING 18 July 2011 2.3 108.3

E = Modulus of Elasticity

**Additional Notes:**

This log is to be read in conjunction with accompanying general notes and borehole log symbols sheet. Stratification lines represent approximate boundary lines between material types; vertical and lateral transitions may be gradual. Water level readings were made at time(s) noted; fluctuations of groundwater levels may occur and should be expected.
 Sample Types: A=Auger; DP=Direct Push; G=Grab; RC=Rock Core; SC=Soil Core; SS=Split Barrel (Split Spoon); ST=Shelby Tube.

Coffey Representatives

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AC	Prepared By
IL	Checked By

LOG OF BOREHOLE HF1-23

SHEET 1 OF 1

Project Name: HANLAN FEEDERMAIN SOUTH CONTRACT 1	Client: CH2M HILL CANADA LTD.	Northing: 4828404 m
Project No.: GEOTMARK00233AA	Drilling Method Used: Solid Stem Augering 150mm	Easting: 615376 m
Project Location: DIXIE RD, MISSISSAUGA	Date: 18 - 19 July 2011	Ground Surface Elevation: 109.6 m

Depth Scale (m)	Subsurface Conditions		Samples		Penetration / Strength Results		Moisture / Plasticity		Instrumentation Details	Groundwater Conditions	Headspace Vapor (ppm) LEL (%)	Elevation Scale (m)	Comments
	Stratigraphic Symbol	Depth / Elevation (m)	Description	Number Type	Blow Counts / 150mm N Value	Recovery %	Relative Drilling Resistance	Penetration Test Values (Blows / 0.3m) X N Values + Becker Hammer Test (BPT) 20 40 60 80 Undrained Shear Strength Values (kPa) □ Field Vane ○ Unconfined ■ Lab Vane ● Quick Triaxial ▲ Pocket Penetrometer	Plastic Limit Natural Water Content Liquid Limit PL MC LL				
0.5		107.8	75mm Topsoil	1 SS 2	(5)	72	X					109.5	0 71 22 7
1.0		1.8	FILL silty sand, fine grained, brown, loose	2 SS 3	(6)	89	X					109.0	
1.5				3 SS 3								108.5	
2.0			SAND fine grained, trace silt to silty, brown, loose to very dense	4 SS 9	(40)	94	X					108.0	
2.5				5 SS 12								107.5	
3.0		106.4		6 SS 44								107.0	
3.5		3.2	SHALE weathered, hard	5 SS 12	50/5cm	100						106.5	
4.0		105.5		6 SS 50	50/8cm	89						106.0	

Rock Coring Started

BEFORE CORING	Date / Time	Water Depth (m)	Elevation (m)
	18 July 2011	2.6	107.0
	21 July 2011	2.5	107.1
	12 August 2011	2.5	107.1
	28 September 2011	2.6	107.0
	14 October 2011	2.6	107.0

Rock Core Log Next Page



Additional Notes:

This log is to be read in conjunction with accompanying general notes and borehole log symbols sheet. Stratification lines represent approximate boundary lines between material types; vertical and lateral transitions may be gradual. Water level readings were made at time(s) noted; fluctuations of groundwater levels may occur and should be expected.
Sample Types: A=Auger; DP=Direct Push; G=Grab; RC=Rock Core; SC=Soil Core; SS=Split Barrel (Split Spoon); ST=Shelby Tube.

Coffey Representatives

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AC	Prepared By
IL	Checked By

LOG OF BOREHOLE HF1-23

SHEET 1 OF 2

Project Name: HANLAN FEEDERMAIN SOUTH CONTRACT 1

Client: CH2M HILL CANADA LTD.

Date: 18 - 19 July 2011

Project No.: GEOTMARK00233AA

Drilling Method Used: ROCK CORING HQ3

Northing: 4828404 m

Project Location: DIXIE RD, MISSISSAUGA

Ground Surface Elevation: 109.6 m

Easting: 615376 m

Borehole Location: SEE DRAWING

Datum Elevation: Geodetic

Diameter: 61mm

(m) STRATA ELEV DEPTH	ROCK DESCRIPTION See Soil Logs for soil descriptions.	GROUND WATER CONDITIONS	(m) CORE ELEV DEPTH	CORE SAMPLE			TOTAL CORE RECOVERY (%)	SOLID CORE RECOVERY (%)	HARD LAYER (%)	ROD (%)	FRACTURE INDEX (per 0.3m)	DISCONTINUITIES AND WEATHERING	HYDRAULIC CONDUCTIVITY k (cm/sec) [P (kPa)]	POINT LOAD TEST UCS AXIAL (MPa)	POINT LOAD TEST UCS DIAMETRAL (MPa)	UNIAxIAL COMPRESSION (MPa)	DENSITY (g/cc) [E (GPa)]
				NUMBER	SIZE	CORE RATE (m/min)											
105.5 4.1	GEORGIAN BAY FORMATION grey, SHALE thinly laminated to thinly bedded, interbedded with light grey LIMESTONE and SILTSTONE layers, strong to very strong Run1: weak weak to medium strong, 50mm hard layer at 6.4m and 6.9m, 100mm hard layer at 7.3m 75mm hard layer at 8.2m, 25mm hard layer at 8.6m and 9.0m medium strong, 50mm hard layer at 9.5 and 10.6m, 25mm hard layer at 9.9m, 75mm hard layer at 10.2m and 10.8m, 150mm hard layer at 10.4m medium strong to strong, 75mm hard layer at 11.1m, 25mm hard layer at 11.2m, 50mm hard layer at 11.5m 50mm hard layer at 12.4m and 13.9m Run8: strong		105.5 4.1	1	HQ3	0.20	91	37	0	28	2 4 6 8	horizontal bedding partings, planar, rough, open, highly weathered	1.87E-5 [108]	13	2		
			104.7 4.9	2	HQ3		100	93	0	83		horizontal bedding partings, widely spaced to closely spaced, planar, rough, open, slightly weathered					
			103.2 6.4	3	HQ3	0.38	100	92	13	68		horizontal contact, planar, rough, tight, slightly weathered					
			101.7 7.9	4	HQ3	0.30	100	100	8	100		horizontal contacts and bedding partings, moderately widely spaced to very closely spaced, planar to undulating, generally rough, generally open, slightly weathered					
			100.2 9.4	5	HQ3	0.30	98	98	28	90		contacts and bedding partings, moderately widely spaced to closely spaced, generally horizontal, planar, smooth (30%) to rough (70%), open, slightly weathered to fresh					
			98.6 11.0	6	HQ3	0.29	100	100	10	98		horizontal bedding partings, moderately widely spaced, planar to undulating, rough, open, fresh					
			97.2 12.4	7	HQ3	0.39	100	100	7	100		horizontal contacts, widely spaced, planar, rough, open, slightly weathered					
			95.6										2.57E-6 [147]	52	7		
													2.97E-6 [255]	21	3		
													2.15E-6 [353]				

Continued Next Page

E = Modulus of Elasticity

Additional Notes:

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Sample Types: A=Auger; DP=Direct Push; G=Grab; RC=Rock Core; SC=Soil Core; SS=Split Barrel (Split Spoon); ST=Shelby Tube.

Coffey Representatives

AA	Originated By
AC	Prepared By
IL	Checked By

LOG OF BOREHOLE HF1-23

SHEET 2 OF 2

Project Name: HANLAN FEEDERMAIN SOUTH CONTRACT 1

Client: CH2M HILL CANADA LTD.

Date: 18 - 19 July 2011

Project No.: GEOTMARK00233AA

Drilling Method Used: ROCK CORING HQ3

Northing: 4828404 m

Project Location: DIXIE RD, MISSISSAUGA

Ground Surface Elevation: 109.6 m

Easting: 615376 m

Borehole Location: SEE DRAWING

Datum Elevation: Geodetic

Diameter: 61mm

(m) STRATA ELEV DEPTH	ROCK DESCRIPTION See Soil Logs for soil descriptions.	GROUND WATER CONDITIONS	(m) CORE ELEV DEPTH	CORE SAMPLE			TOTAL CORE RECOVERY (%)	SOLID CORE RECOVERY (%)	HARD LAYER (%)	ROD (%)	FRACTURE INDEX (per 0.3m)	DISCONTINUITIES AND WEATHERING	HYDRAULIC CONDUCTIVITY k (cm/sec) [P (kPa)]	POINT LOAD TEST UCS AXIAL (MPa)	POINT LOAD TEST UCS DIAMETRAL (MPa)	UNIAxIAL COMPRESSION (MPa)	DENSITY (g/cc) [E (GPa)]
				NUMBER	SIZE	CORE RATE (m/min)											
	GEORGIAN BAY FORMATION grey, SHALE thinly laminated to thinly bedded, interbedded with light grey LIMESTONE and SILTSTONE layers, strong to very strong (<i>continued</i>)		14.0	8	HQ3	0.37	100	100	0	97		horizontal contact and bedding parting, widely spaced, planar, smooth, tight, fresh (<i>continued</i>)		20	1		
	Run9: medium strong to strong		94.1 15.5	9	HQ3	0.38	100	100	0	85		horizontal contacts and bedding partings, widely spaced to very closely spaced, planar, smooth (60%) to rough (40%), open, slightly weathered to fresh		14	5		
	weak to medium strong		92.6 17.0	10	HQ3	0.37	100	91	0	74		horizontal contacts and bedding partings, moderately widely spaced to very closely spaced, planar, smooth (40%) to rough (60%), open, some with clay infill, slightly weathered		131	102		
	25mm hard layer at 18.7m and 19.6m		91.1 18.5	11	HQ3	0.30	100	93	3	55		Note: Gas present in borehole after Run 10 (dissipated after 10 minutes). horizontal contacts and bedding partings, moderately widely spaced to very closely spaced, planar, smooth (70%) to rough (30%), open, some with clay infill, moderately to highly weathered		13	1		
	25mm hard layer at 20.1m and 20.7m, 50mm hard layer at 20.2m		89.6 20.0	12	HQ3	0.36	100	100	7	91		horizontal contacts and bedding partings, closely spaced to very closely spaced, planar, smooth (70%) to rough (30%), open, some with clay infill, moderately to slightly weathered		23	1		
			88.2 21.4														

	Date / Time	Water Depth (m)	Elevation (m)
BEFORE CORING	18 July 2011	2.6	107.0
	21 July 2011	2.5	107.1
	12 August 2011	2.5	107.1
	28 September 2011	2.6	107.0
	14 October 2011	2.6	107.0

E = Modulus of Elasticity



Additional Notes:

This log is to be read in conjunction with accompanying general notes and borehole log symbols sheet. Stratification lines represent approximate boundary lines between material types, vertical and lateral transitions may be gradual. Water level readings were made at time(s) noted, fluctuations of groundwater levels may occur and should be expected.
Sample Types: A=Auger; DP=Direct Push; G=Grab; RC=Rock Core; SC=Soil Core; SS=Split Barrel (Split Spoon); ST=Shelby Tube.

Coffey Representatives

AA	Originated By
AC	Prepared By
IL	Checked By

LOG OF BOREHOLE HF1-24

SHEET 1 OF 1

Project Name: HANLAN FEEDERMAIN SOUTH CONTRACT 1	Client: CH2M HILL CANADA LTD.	Northing: 4828325 m
Project No.: GEOTMARK00233AA	Drilling Method Used: Hollow Stem Augering 200mm	Easting: 615468 m
Project Location: DIXIE RD, MISSISSAUGA	Date: 19 - 20 July 2011	Ground Surface Elevation: 108.2 m

Depth Scale (m)	Subsurface Conditions			Samples			Penetration / Strength Results				Moisture / Plasticity			Instrumentation Details	Groundwater Conditions	Headspace Vapor (ppm) LEL (%)	Elevation Scale (m)	Comments																			
	Stratigraphic Symbol	Depth / Elevation (m)	Description	Number	Type	Blow Counts / 150mm	N Value	Recovery %	Relative Drilling Resistance	Penetration Test Values (Blows / 0.3m)									Plastic Limit Natural Liquid Limit Water Limit Content																		
										× N Values	◆ Dynamic Cone	+ Becker Hammer Test (BPT)	20						40	60	80	PL	MC	LL													
									Undrained Shear Strength Values (kPa)																												
									□ Field Vane ○ Unconfined ■ Lab Vane ● Quick Triaxial ▲ Pocket Penetrometer																												
0.5		106.7	125mm Asphalt 225mm Granular Base 50mm Asphalt FILL silty sand, compact	1	SS	2 5 11	(16)	67		20	40	60	80	10	20	30	40				108.0																
1.0																																				107.5	
1.5																																					107.0
2.0		1.5	SILTY SAND fine grained, brown, dense to very dense	2	SS	15 23 28	(51)	89		20	40	60	80	10	20	30	40				106.5																
2.5																																				106.0	
3.0																																					105.5
3.5		105.2	SHALE highly weathered, hard	4	SS	38 50	50/8cm	100		20	40	60	80	10	20	30	40				105.0																
4.0																																				104.5	
4.5																																					104.0
5.0		3.0	SHALE highly weathered, hard	5	SS	46 50	50/5cm	100		20	40	60	80	10	20	30	40				103.5																
5.5																																				103.0	
6.0																																					102.5
6.0	102.1			6	SS	50	50/8cm	100																													

Rock Coring Started

BEFORE CORING **Date / Time** 19 July 2011 **Water Depth (m)** 1.6 **Elevation (m)** 106.6

Rock Core Log Next Page



Additional Notes:
This log is to be read in conjunction with accompanying general notes and borehole log symbols sheet. Stratification lines represent approximate boundary lines between material types; vertical and lateral transitions may be gradual. Water level readings were made at time(s) noted; fluctuations of groundwater levels may occur and should be expected.
Sample Types: A=Auger; DP=Direct Push; G=Grab; RC=Rock Core; SC=Soil Core; SS=Split Barrel (Split Spoon); ST=Shelby Tube.

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SOIL LOG FOR CH2M GEOTMARK00233AA_BH13 TO BH24.GPJ COFFEY STANDARD.GDT 29/5/12

LOG OF BOREHOLE HF1-24

SHEET 1 OF 2

Project Name: HANLAN FEEDERMAIN SOUTH CONTRACT 1

Client: CH2M HILL CANADA LTD.

Date: 19 - 20 July 2011

Project No.: GEOTMARK00233AA

Drilling Method Used: ROCK CORING HQ3

Northing: 4828325 m

Project Location: DIXIE RD, MISSISSAUGA

Ground Surface Elevation: 108.2 m

Easting: 615468 m

Borehole Location: SEE DRAWING

Datum Elevation: Geodetic

Diameter: 61mm

(m) STRATA ELEV DEPTH	ROCK DESCRIPTION See Soil Logs for soil descriptions.	GROUND WATER CONDITIONS	(m) CORE ELEV DEPTH	CORE SAMPLE			TOTAL CORE RECOVERY (%)	SOLID CORE RECOVERY (%)	HARD LAYER (%)	ROD (%)	FRACTURE INDEX (per 0.3m)	DISCONTINUITIES AND WEATHERING	HYDRAULIC CONDUCTIVITY k (cm/sec) [P (kPa)]	POINT LOAD TEST UCS AXIAL (MPa)	POINT LOAD TEST UCS DIAMETRAL (MPa)	UNIAxIAL COMPRESSION (MPa)	DENSITY (g/cc) [E (GPa)]
				NUMBER	SIZE	CORE RATE (m/min)											
102.1			102.1								2 4 6 8						
6.1	GEORGIAN BAY FORMATION grey, SHALE thinly laminated, interbedded with light grey LIMESTONE and SILTSTONE layers, strong to very strong Run1: weak to medium strong, 25mm hard layers at 6.3m, 6.4m, 6.5m & 7.0m 50mm hard layers at 7.3m Run2: 12mm hard layers at 7.6m, 8.2m & 8.7m, 50mm hard layers at 7.7m & 8.3m, 25mm hard layer at 8.0m		6.1	1	HQ3	0.10	100	75	10	70		horizontal contacts and bedding partings, moderately widely spaced to extremely closely spaced, planar to undulating, smooth (30%) to rough (70%), open (70%) to tight (30%), some with clay coating, slightly to highly weathered		138	60		
			100.6														
			7.6	2	HQ3	0.13	100	95	12	80		contacts, joints and bedding partings, moderately widely spaced to extremely closely spaced, planar to stepped, smooth (50%) to rough (50%), open, slightly to highly weathered		28	2		
			99.1														
	50mm hard layer at 9.1m, 25mm hard layer at 9.2m, 9.4m, 9.5m & 9.9m, 35mm hard layer at 9.7m, 300mm hard layer at 10.2m		9.1	3	HQ3	0.17	100	98	33	80		joints, contacts and bedding partings, moderately widely spaced to extremely closely spaced, generally horizontal, occasionally vertical joints, planar to stepped, smooth (30%) to rough (70%), open (80%) to tight (20%), slightly to highly weathered		14	4		
			97.6														
	90mm hard layer at 10.7m, 12mm hard layer at 10.9m, 25mm hard layer at 11.1m		10.6	4	HQ3	0.14	97	95	8	93		horizontal joints, contacts and bedding partings, moderately widely spaced to extremely closely spaced, planar to undulating, smooth (50%) to rough (50%), open (70%) to tight (30%), slightly weathered		30	1		
			96.0														
	25mm clay seam at 12.2m, 25mm hard layer at 12.1m, 50mm hard layer at 13.5m		12.2	5	HQ3	0.15	100	98	5	90		horizontal bedding partings, widely spaced to extremely closely spaced, planar to stepped, smooth, tight, slightly weathered to fresh		40	2	18.5	2.62 [2]
			94.5														
	25mm hard layer at 14.1m, 15.0m & 15.1m, 12mm hard layer at 14.7m		13.7	6	HQ3	0.22	100	95	7	78		horizontal joints and contacts, widely spaced to extremely closely spaced, undulating, smooth (70%) to rough (30%), open (70%) to tight (30%), s lightly weathered to fresh		21	1		
			93.0														
	25mm clay seam at 16.6m, 25mm hard layer at 15.8m, 75mm hard layer at 16.1m & 16.5m, 50mm hard layer at 16.7m		15.2	7	HQ3	0.12	100	98	15	83							

Continued Next Page

E = Modulus of Elasticity

Additional Notes:

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Sample Types: A=Auger; DP=Direct Push; G=Grab; RC=Rock Core; SC=Soil Core; SS=Split Barrel (Split Spoon); ST=Shelby Tube.

Coffey Representatives

BB	Originated By
AC	Prepared By
IL	Checked By

LOG OF BOREHOLE HF1-24

SHEET 2 OF 2

Project Name: HANLAN FEEDERMAIN SOUTH CONTRACT 1

Client: CH2M HILL CANADA LTD.

Date: 19 - 20 July 2011

Project No.: GEOTMARK00233AA

Drilling Method Used: ROCK CORING HQ3

Northing: 4828325 m

Project Location: DIXIE RD, MISSISSAUGA

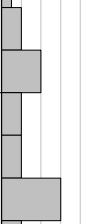

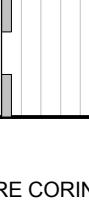

Ground Surface Elevation: 108.2 m

Easting: 615468 m

Borehole Location: SEE DRAWING

Datum Elevation: Geodetic

Diameter: 61mm

(m) STRATA ELEV DEPTH	ROCK DESCRIPTION See Soil Logs for soil descriptions.	GROUND WATER CONDITIONS	(m) CORE ELEV DEPTH	CORE SAMPLE			TOTAL CORE RECOVERY (%)	SOLID CORE RECOVERY (%)	HARD LAYER (%)	RQD (%)	FRACTURE INDEX (per 0.3m)				DISCONTINUITIES AND WEATHERING	HYDRAULIC CONDUCTIVITY k (cm/sec) [P (kPa)]	POINT LOAD TEST UCS AXIAL (MPa)	POINT LOAD TEST UCS DIAMETRAL (MPa)	UNIAXIAL COMPRESSION (MPa)	DENSITY (g/cc) [E (GPa)]
				NUMBER	SIZE	CORE RATE (m/min)					2	4	6	8						
	GEORGIAN BAY FORMATION grey, SHALE thinly laminated, interbedded with light grey LIMESTONE and SILTSTONE layers, strong to very strong (<i>continued</i>) Run8: 25mm hard layer at 16.8m, 17.1m & 17.3m, 50mm hard layer at 17.0m, 17.2m & 17.4m, 75mm hard layer at 17.5m & 17.9m, 130mm hard layer at 17.6m Run9: 25mm clay seam at 18.3m, 50mm hard layer at 19.3m, 100mm hard layer at 19.7m 25mm hard layer at 19.8m, 20.5m, 20.6m 50mm hard layer at 20.0m		91.5 16.7	8	HQ3	0.13	100	100	33	73		joints and bedding partings, moderately widely spaced to extremely closely spaced, generally horizontal, some 10-20 degree joints and bedding partings, undulating to stepped, smooth (40%) to rough (60%), open, slightly weathered (<i>continued</i>) joints, contacts and bedding partings, moderately widely spaced to extremely closely spaced, generally horizontal, occasional 10 degree joints, planar to stepped, smooth (40%) to rough (60%), open, slightly weathered horizontal joints and bedding partings, moderately widely spaced to extremely closely spaced, planar to stepped, smooth (70%) to rough (30%), open (70%) to tight (30%), slightly weathered bedding partings, moderately widely spaced, 0-10 degrees, undulating, generally smooth, generally open, fresh		150	128					
			89.9 18.3	9	HQ3	0.09	100	98	10	88				189	71					
			88.4 19.8											162	64					
			86.9 21.3	10	HQ3	0.11	98	98	8	98				38	5					

Date / Time **Water Depth (m)** **Elevation (m)**
 BEFORE CORING 19 July 2011 1.6 106.6

E = Modulus of Elasticity

**Additional Notes:**

This log is to be read in conjunction with accompanying general notes and borehole log symbols sheet. Stratification lines represent approximate boundary lines between material types, vertical and lateral transitions may be gradual. Water level readings were made at time(s) noted, fluctuations of groundwater levels may occur and should be expected.
 Sample Types: A=Auger; DP=Direct Push; G=Grab; RC=Rock Core; SC=Soil Core; SS=Split Barrel (Split Spoon); ST=Shelby Tube.

Coffey Representatives

BB	Originated By
AC	Prepared By
IL	Checked By

LOG OF BOREHOLE HF1-25

SHEET 1 OF 1

Project Name: HANLAN FEEDERMAIN SOUTH CONTRACT 1	Client: CH2M HILL CANADA LTD.	Northing: 4828227 m
Project No.: GEOTMARK00233AA	Drilling Method Used: Hollow Stem Augering 200mm	Easting: 615568 m
Project Location: DIXIE RD, MISSISSAUGA	Date: 20 - 26 July 2011	Ground Surface Elevation: 107.7 m

Depth Scale (m)	Stratigraphic Symbol	Subsurface Conditions		Samples		Penetration / Strength Results		Moisture / Plasticity		Instrumentation Details	Groundwater Conditions	Headspace Vapor (ppm) LEL (%)	Elevation Scale (m)	Comments
		Depth / Elevation (m)	Description	Number	Type	Blow Counts / 150mm	N Value	Recovery %	Relative Drilling Resistance	Penetration Test Values (Blows / 0.3m)	Undrained Shear Strength Values (kPa)	Plastic Limit	Natural Water Content	Liquid Limit
			100mm Topsoil											
1		106.2	FILL silty sand, brown, trace rootlets, loose	1	SS	2 2 5	(7)	67						
2		106.2	SAND fine grained sand, trace to some silt, trace clay, brown, dense	2	SS	7 12 20	(32)	89						
			wet, compact	3	SS	5 10 13	(23)	100						
3		104.3	gravelly	4	SS	12 29 36	(65)	100						
4		104.3	SHALE weathered, grey, hard	4A										
				5	SS	38 50	50/8cm	89						
				6	SS	50	50/13cm	99						
5		102.2												

Rock Coring Started

Date / Time	Water Depth (m)	Elevation (m)
BEFORE CORING		
20 July 2011	3.3	104.4
12 August 2011	0.5	107.2
28 September 2011	3.9	103.8
14 October 2011	3.9	103.8

Rock Core Log Next Page

Additional Notes:

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Sample Types: A=Auger; DP=Direct Push; G=Grab; RC=Rock Core; SC=Soil Core; SS=Split Barrel (Split Spoon); ST=Shelby Tube.

Coffey Representatives

BB	Originated By
AC	Prepared By
IL	Checked By

LOG OF BOREHOLE HF1-25

SHEET 1 OF 2

Project Name: HANLAN FEEDERMAIN SOUTH CONTRACT 1

Client: CH2M HILL CANADA LTD.

Date: 20 - 26 July 2011

Project No.: GEOTMARK00233AA

Drilling Method Used: ROCK CORING HQ3

Northing: 4828227 m

Project Location: DIXIE RD, MISSISSAUGA

Ground Surface Elevation: 107.7 m

Easting: 615568 m

Borehole Location: SEE DRAWING

Datum Elevation: Geodetic

Diameter: 61mm

(m) STRATA ELEV DEPTH	ROCK DESCRIPTION See Soil Logs for soil descriptions.	GROUND WATER CONDITIONS	(m) CORE ELEV DEPTH	CORE SAMPLE			TOTAL CORE RECOVERY (%)	SOLID CORE RECOVERY (%)	HARD LAYER (%)	RQD (%)	FRACTURE INDEX INDEX (per 0.3m)	DISCONTINUITIES AND WEATHERING	HYDRAULIC CONDUCTIVITY k (cm/sec) [P (kPa)]	POINT LOAD TEST UCS AXIAL (MPa)	POINT LOAD TEST UCS DIAMETRAL (MPa)	UNIAxIAL COMPRESSION (MPa)	DENSITY (g/cc) [E (GPa)]
				NUMBER	SIZE	CORE RATE (m/min)											
102.2			102.2								2 4 6 8						
5.5	GEORGIAN BAY FORMATION SHALE grey, thinly laminated		5.5	1	HQ3	0.10	100	35	0	0		highly weathered					
			101.7														
	interbedded with light grey LIMESTONE and SILTSTONE layers, strong to very strong		6.0									contacts, bedding partings and joint, closely spaced, planar to undulating, smooth to rough, open to tight, with clay coating, moderately weathered		15		3	
	Run1: extremely to very weak 500mm fractured zone at 5.5m Run 2: very weak, 500mm fractured zone at 6.0m, 75mm hard layer at 6.2m, 50mm hard layer at 6.4m, 25mm hard layer at 7.4m and 7.5m			2	HQ3	0.19	100	75	12	27					16		7
	very weak to weak 75mm hard layer at 7.6m, 50mm hard layer at 7.9m, 25mm hard layer at 8.2m		100.2														
			7.5									contacts, bedding partings and joints, closely to moderately closely spaced, planar to undulating, smooth (70%) to rough (30%), generally open, some with clay coating, moderately to slightly weathered					
				3	HQ3	0.15	100	95	10	60				20		1	
	75mm hard layer at 8.8m and 10.1m, 50mm hard layer at 9.3m and 10.2m, 25mm hard layer at 9.7m, 100mm hard layer at 9.8m		98.7														
			9.0									horizontal contacts, bedding partings and joint, closely spaced, planar to undulating, smooth to rough, open to tight, with clay coating		194		105	
				4	HQ3	0.15	100	80	25	52			1.78E-5 [137]				
	weak 175mm hard layer at 10.6m, 50mm hard layer at 10.8m, 25mm hard layer at 10.9m, 125mm hard layer at 11.3m		97.1										2.20E-5 [216]				
			10.6									contacts, bedding partings and joints, closely to moderately closely spaced, planar to undulating, smooth (50%) to rough (50%), open to tight, some with clay coating					
				5	HQ3	0.12	100	78	25	70			3.10E-5 [284]		128		
			95.6														
	25mm hard layer at 14.8m and 15.1m		12.1									horizontal bedding partings and joints, closely to moderately closely spaced, planar, undulating and stepped, smooth (60%) to rough (40%), generally open, with clay coating, fresh to slightly weathered					
				6	HQ3	0.09	100	100	0	85			No flow[137] (k' < 1.00E-8)	14		2	
			94.1										1.08E-6 [245]				
			13.6									horizontal bedding partings and joint, closely to moderately closely spaced, planar, undulating and stepped, smooth (70%) to rough (30%), tight to open, with clay coating					
				7	HQ3	0.14	100	98	3	92			2.25E-6 [353]	11		1	
	75mm hard layer at 15.9m, 25mm hard layer at 16.2m and 16.4m, 150mm hard layer at 16.2m, 50mm hard layer at 16.6m		92.6														
			15.1									horizontal contacts, bedding partings and joint, closely to moderately closely spaced, planar to undulating, smooth (50%) to rough (50%), open to tight, with clay coating					
				8	HQ3	0.14	100	100	22	90			No flow[177]	12		10	
Continued Next Page																	
E = Modulus of Elasticity																	
Coffey Representatives																	
BB Originated By																	
AC Prepared By																	
IL Checked By																	
Additional Notes: This log is to be read in conjunction with accompanying general notes and borehole log symbols sheet. Stratification lines represent approximate boundary lines between material types, vertical and lateral transitions may be gradual. Water level readings were made at time(s) noted, fluctuations of groundwater levels may occur and should be expected. Sample Types: A=Auger; DP=Direct Push; G=Grab; RC=Rock Core; SC=Soil Core; SS=Split Barrel (Split Spoon); ST=Shelby Tube.																	
coffey geotechnics																	

Continued Next Page

E = Modulus of Elasticity

Additional Notes:

This log is to be read in conjunction with accompanying general notes and borehole log symbols sheet. Stratification lines represent approximate boundary lines between material types, vertical and lateral transitions may be gradual. Water level readings were made at time(s) noted, fluctuations of groundwater levels may occur and should be expected.

Sample Types: A=Auger; DP=Direct Push; G=Grab; RC=Rock Core; SC=Soil Core; SS=Split Barrel (Split Spoon); ST=Shelby Tube.

Coffey Representatives

BB	Originated By
AC	Prepared By
IL	Checked By

LOG OF BOREHOLE HF1-25

SHEET 2 OF 2

Project Name: HANLAN FEEDERMAIN SOUTH CONTRACT 1

Client: CH2M HILL CANADA LTD.

Date: 20 - 26 July 2011

Project No.: GEOTMARK00233AA

Drilling Method Used: ROCK CORING HQ3

Northing: 4828227 m

Project Location: DIXIE RD, MISSISSAUGA

Ground Surface Elevation: 107.7 m

Easting: 615568 m

Borehole Location: SEE DRAWING

Datum Elevation: Geodetic

Diameter: 61mm

(m) STRATA ELEV DEPTH	ROCK DESCRIPTION See Soil Logs for soil descriptions.	GROUND WATER CONDITIONS	(m) CORE ELEV DEPTH	CORE SAMPLE			TOTAL CORE RECOVERY (%)	SOLID CORE RECOVERY (%)	HARD LAYER (%)	RQD (%)	FRACTURE INDEX (per 0.3m)	DISCONTINUITIES AND WEATHERING	HYDRAULIC CONDUCTIVITY k (cm/sec) [P (kPa)]	POINT LOAD TEST UCS AXIAL (MPa)	POINT LOAD TEST UCS DIAMETRAL (MPa)	UNIAxIAL COMPRESSION (MPa)	DENSITY (g/cc) [E (GPa)]
				NUMBER	SIZE	CORE RATE (m/min)											
	GEORGIAN BAY FORMATION SHALES grey, thinly laminated		91.0 16.7									contacts, bedding partings and joints, generally horizontal (one 90 degree joint), closely to moderately closely spaced, generally undulating, rough, open to tight, occasional clay coating, slightly to moderately weathered	1.00E-8 6.06E-6 [314]	18	3		
	interbedded with light grey LIMESTONE and SILTSTONE layers, strong to very strong (continued) Run 9: 75mm hard layer at 17.1m and at 17.2m, 125mm hard layer at 16.8m, 25mm hard layer at 17.3m, 17.6m (2) and 18.0m, 50mm hard layer at 17.7m and 18.1m Run 10: 25mm hard layer at 18.3m, 18.4m and 19.6m		89.5 18.2	9	HQ3	0.12	100	85	35	72			9.33E-6 [451]				
	75mm hard layer at 19.9m 25mm hard layer at 20.7m and 21.2m		88.0 19.7									horizontal bedding partings, very closely spaced, planar to undulating, smooth, tight, fresh to slightly weathered	No flow[216] (k' < 1.00E-8)	29	2		
	weak to medium strong 25mm hard layer at 21.4m, 22.3m and 22.7m, 50mm hard layer at 22.6m		86.5 21.2	10	HQ3	0.09	100	95	5	92		horizontal bedding parting and joint, very closely spaced, planar to undulating, smooth, open to tight, fresh	No flow[353] (k' < 1.00E-8) No flow[520] (k' < 1.00E-8)	31	2	21.1	2.61 [4]
	medium strong 50mm hard layer at 22.9m, 23.6m and 24.2m, 75mm hard layer at 23.1m, 25mm hard layer at 23.7m and 23.9m and 24.1m		84.9 22.8									horizontal bedding parting and joint, moderately closely spaced, planar to undulating, smooth to rough, open to tight		29	1		
	25mm hard layer at 24.5m, 50mm hard layer at 24.5m, 24.8m and 24.9m, 13mm hard layer at 24.9m, 75mm hard layer at 25m, and 25.5m		83.4 24.3	11	HQ3	0.13	100	100	8	95		horizontal bedding partings and joint, moderately closely spaced, undulating, smooth, tight to open, with clay coating		34	10		
			81.9 25.8	12	HQ3	0.12	100	100	8	98		contacts, bedding partings and joints, generally horizontal (one 90 degree joint), closely to moderately closely spaced, generally undulating, smooth to rough, open to tight, some with clay coating		102	30		
				13	HQ3	0.08	100	100	20	97							
				14	HQ3	0.08	100	97	23	90							

Date / Time	Water Depth (m)	Elevation (m)
BEFORE CORING 20 July 2011	3.3	104.4
12 August 2011	0.5	107.2
28 September 2011	3.9	103.8
14 October 2011	3.9	103.8

E = Modulus of Elasticity



Additional Notes:

This log is to be read in conjunction with accompanying general notes and borehole log symbols sheet. Stratification lines represent approximate boundary lines between material types, vertical and lateral transitions may be gradual. Water level readings were made at time(s) noted, fluctuations of groundwater levels may occur and should be expected.
Sample Types: A=Auger; DP=Direct Push; G=Grab; RC=Rock Core; SC=Soil Core; SS=Split Barrel (Split Spoon); ST=Shelby Tube.

Coffey Representatives

BB	Originated By
AC	Prepared By
IL	Checked By

LOG OF BOREHOLE HF1-25-1

SHEET 1 OF 1

Project Name: HANLAN FEEDERMAIN SOUTH CONTRACT 1

Client: CH2M HILL CANADA LTD.

Northing: 4828226 m

Project No.: GEOTMARK00233AA

Drilling Method Used: Hollow Stem Augering 200mm

Easting: 615569 m

Project Location: DIXIE RD, MISSISSAUGA

Date: 27 July 2011

Ground Surface Elevation: 107.7 m

Depth Scale (m)	Subsurface Conditions		Samples		Penetration / Strength Results		Moisture / Plasticity		Instrumentation Details	Groundwater Conditions	Headspace Vapor (ppm) LEL (%)	Elevation Scale (m)	Comments
	Stratigraphic Symbol	Depth / Elevation (m)	Description	Number Type	Blow Counts / 150mm N Value	Recovery %	Relative Drilling Resistance	Penetration Test Values (Blows / 0.3m) X N Values ♦ Dynamic Cone + Becker Hammer Test (BPT) 20 40 60 80 Undrained Shear Strength Values (kPa) □ Field Vane ○ Unconfined ■ Lab Vane ● Quick Triaxial ▲ Pocket Penetrometer	Plastic Limit Natural Water Content Liquid Limit PL MC LL				
0.5			See log of Borehole HF1-25 for stratigraphy.									107.5	
1.0												107.0	
1.5												106.5	
2.0												106.0	
2.5												105.5	
3.0												105.0	
3.5												104.5	
4.0												104.0	

BOREHOLE HF1-25-1
TERMINATED AT 4.0m BGL

Date / Time	Water Depth (m)	Elevation (m)
12 August 2011	2.7	105.0
28 September 2011	2.8	104.9
14 October 2011	2.8	104.9

SOIL LOG FOR CH2M GEOTMARK00233AA_BH25 TO BH37.GPJ COFFEY STANDARD.GDT 30/5/12



Additional Notes:

This log is to be read in conjunction with accompanying general notes and borehole log symbols sheet. Stratification lines represent approximate boundary lines between material types, vertical and lateral transitions may be gradual. Water level readings were made at time(s) noted, fluctuations of groundwater levels may occur and should be expected.
Sample Types: A=Auger; DP=Direct Push; G=Grab; RC=Rock Core; SC=Soil Core; SS=Split Barrel (Split Spoon); ST=Shelby Tube.

Coffey Representatives

BB	Originated By
AC	Prepared By
IL	Checked By

LOG OF BOREHOLE HF1-26

SHEET 1 OF 1

Project Name: HANLAN FEEDERMAIN SOUTH CONTRACT 1	Client: CH2M HILL CANADA LTD.	Northing: 4828108 m
Project No.: GEOTMARK00233AA	Drilling Method Used: Hollow Stem Augering 200mm	Easting: 615576 m
Project Location: DIXIE RD, MISSISSAUGA	Date: 24 August - 1 September 2011	Ground Surface Elevation: 106.9 m

Depth Scale (m)	Subsurface Conditions		Samples		Penetration / Strength Results		Moisture / Plasticity		Instrumentation Details	Groundwater Conditions	Headspace Vapor (ppm) LEL (%)	Elevation Scale (m)	Comments
	Stratigraphic Symbol	Depth / Elevation (m)	Description	Number Type	Blow Counts / 150mm N Value	Recovery %	Relative Drilling Resistance	Penetration Test Values (Blows / 0.3m) X N Values ♦ Dynamic Cone + Becker Hammer Test (BPT) 20 40 60 80 Undrained Shear Strength Values (kPa) □ Field Vane ○ Unconfined ■ Lab Vane ● Quick Triaxial ▲ Pocket Penetrometer	Plastic Limit Natural Water Content Liquid Limit PL MC LL				
1		105.4	125mm Asphalt FILL silty sand, fine to coarse grained sand, trace fine gravel, brown, loose	1 SS 4 4 5 (9) 78								106	
2		105.4	SAND fine grained, some silt, laminated, brown, compact wet, dilatant	2 SS 5 10 16 (26) 94								105	Water Level measured at 2.29m below ground level (bgl).
3		103.1	 fine to medium grained sand	3 SS 8 12 15 (27) 56								104	0 80 14 6
4		103.1	SHALE weathered, grey, trace oxidation	4 SS 2 6 7 (13) 22								103	0 81 12 7
		102.3		5 SS 36 50 50/8cm 100									
		102.3		6 SS 50 50/10cm 101									

Rock Coring Started

	Date / Time	Water Depth (m)	Elevation (m)
BEFORE CORING	24 August 2011	2.3	104.6
	28 September 2011	3.3	103.6
	14 October 2011	3.6	103.3

Rock Core Log Next Page

Additional Notes:

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Sample Types: A=Auger; DP=Direct Push; G=Grab; RC=Rock Core; SC=Soil Core; SS=Split Barrel (Split Spoon); ST=Shelby Tube.

Coffey Representatives

BB	Originated By
AC	Prepared By
IL	Checked By

LOG OF BOREHOLE HF1-26

SHEET 1 OF 2

Project Name: HANLAN FEEDERMAIN SOUTH CONTRACT 1

Client: CH2M HILL CANADA LTD.

Date: 24 August - 1 September 2011

Project No.: GEOTMARK00233AA

Drilling Method Used: ROCK CORING HQ3

Northing: 4828108 m

Project Location: DIXIE RD, MISSISSAUGA

Ground Surface Elevation: 106.9 m

Easting: 615576 m

Borehole Location: SEE DRAWING

Datum Elevation: Geodetic

Diameter: 61mm

(m) STRATA ELEV DEPTH	ROCK DESCRIPTION See Soil Logs for soil descriptions.	GROUND WATER CONDITIONS	(m) CORE ELEV DEPTH	CORE SAMPLE			TOTAL CORE RECOVERY (%)	SOLID CORE RECOVERY (%)	HARD LAYER (%)	ROD (%)	FRACTURE INDEX (per 0.3m)	DISCONTINUITIES AND WEATHERING	HYDRAULIC CONDUCTIVITY k (cm/sec) [P (kPa)]	POINT LOAD TEST UCS AXIAL (MPa)	POINT LOAD TEST UCS DIAMETRAL (MPa)	UNIAxIAL COMPRESSION (MPa)	DENSITY (g/cc) [E (GPa)]
				NUMBER	SIZE	CORE RATE (m/min)											
102.3 4.6	GEORGIAN BAY FORMATION SHALE grey, thinly laminated interbedded with light grey LIMESTONE and SILTSTONE layers, strong to very strong Run 1: 300mm very weak zone at 4.6m, 850mm fractured zone at 4.9m, 125mm hard layer at 4.9m, 200mm hard layer at 5.8m Run 2: 300mm fractured zone at 6.1m, 50mm hard layer at 6.2m and 7.0m, 25mm hard layer at 6.7m and 6.9m, 75mm fractured zone at 7.0m, 75mm hard layer at 7.5m 25mm hard layer at 7.7m and 7.8m, 50mm hard layer at 7.7m 50mm hard layer at 7.9m and 8.8m, 75mm hard layer at 8.7m, 25mm hard layer at 9.3m 50mm hard layer at 9.8m, 9.9m, 10.2m and 10.3m, 125mm hard layer at 10.0m, 25mm hard layer at 10.5m and 10.8m 50mm hard layer at 11.2m 25mm fractured zone at 12.1m 50mm hard layer at 13.0m and 13.2m, 25mm hard layer at 13.1m, 25mm fractured zone at 13.5m 25mm hard layer at 14.4m(2), 15.1m and 15.4m		102.3 4.6									horizontal contacts and bedding partings, extremely closely to closely spaced, undulating, rough, open, with clay coating, highly weathered		19	3		
			100.8 6.1	1	HQ3	0.19	100	50	22	0							
			99.3 7.6 99.0	2	HQ3	0.22	100	80	15	47							
			7.9	3	HQ3	0.15	100	100	33	67							
			97.5 9.4	4	HQ3	0.14	100	92	13	73							
			95.9 11.0	5	HQ3	0.22	100	98	25	78							
			94.4 12.5	6	HQ3	0.13	100	98	3	93							
			92.9 14.0	7	HQ3	0.13	100	98	8	93							
			91.4	8	HQ3	0.17	97	97	7	92		horizontal bedding partings, closely to moderately closely spaced, planar, smooth, tight to open, with clay coating	No flow[353] ('k' < 1.00E-8)	31	8	8.8	2.61 [1]

Continued Next Page

E = Modulus of Elasticity

Additional Notes:

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Sample Types: A=Auger; DP=Direct Push; G=Grab; RC=Rock Core; SC=Soil Core; SS=Split Barrel (Split Spoon); ST=Shelby Tube.

Coffey Representatives

BB	Originated By
AC	Prepared By
IL	Checked By

LOG OF BOREHOLE HF1-26

SHEET 2 OF 2

Project Name: HANLAN FEEDERMAIN SOUTH CONTRACT 1

Client: CH2M HILL CANADA LTD.

Date: 24 August - 1 September 2011

Project No.: GEOTMARK00233AA

Drilling Method Used: ROCK CORING HQ3

Northing: 4828108 m

Project Location: DIXIE RD, MISSISSAUGA

Ground Surface Elevation: 106.9 m

Easting: 615576 m

Borehole Location: SEE DRAWING

Datum Elevation: Geodetic

Diameter: 61mm

(m) STRATA ELEV DEPTH	ROCK DESCRIPTION See Soil Logs for soil descriptions.	GROUND WATER CONDITIONS	(m) CORE ELEV DEPTH	CORE SAMPLE			TOTAL CORE RECOVERY (%)	SOLID CORE RECOVERY (%)	HARD LAYER (%)	ROD (%)	FRACTURE INDEX (per 0.3m)	DISCONTINUITIES AND WEATHERING	HYDRAULIC CONDUCTIVITY k (cm/sec) [P (kPa)]	POINT LOAD TEST UCS AXIAL (MPa)	POINT LOAD TEST UCS DIAMETRAL (MPa)	UNIAxIAL COMPRESSION (MPa)	DENSITY (g/cc) [E (GPa)]
				NUMBER	SIZE	CORE RATE (m/min)											
	25mm hard layer at 15.9m, 16.1m, 16.4m, 16.8m and 16.9m, 50mm hard layer at 16.3m, 75mm hard layer at 16.6m and 17.0m GEORGIAN BAY FORMATION SHALE grey, thinly laminated		15.5	9	HQ3	0.17	100	100	22	97		bedding partings, contacts and joint, generally 0-20 degrees (one 90 degree joint), very closely to moderately closely spaced, undulating, rough, open, with clay coating (continued)	No flow[177] ($k' < 1.00E-8$) No flow[314] ($k' < 1.00E-8$) 1.59E-6 [451]	119	68		
	interbedded with light grey LIMESTONE and SILTSTONE layers, strong to very strong (continued) 100mm hard layer at 17.1m, 50mm hard layer at 17.3m and 17.6m, 25mm hard layer at 17.5m and 18.1m		89.8 17.1	10	HQ3	0.14	100	85	17	70		horizontal bedding partings and contacts, joints (45-90 degrees), very closely to closely spaced, undulating, rough, open, with clay coating, slightly weathered		37	14		
	25mm hard layer at 18.9m and 19.0m, 50mm hard layer at 19.3m and 19.6m		88.3 18.6	11	HQ3	0.15	100	98	10	95		horizontal bedding partings and contact, closely to moderately closely spaced, undulating to planar, smooth to rough, open to tight, with clay coating		31	4		
	25mm hard layer at 20.5m, 50mm hard layer at 20.8m		86.8 20.1	12	HQ3	0.15	100	100	5	100		horizontal bedding partings, moderately closely spaced, planar, smooth to rough, open to tight, with clay coating, fresh		18	8		
	25mm hard layer at 22.0m, 22.5m, 50mm hard layer at 22.8m, 22.9m and 23.1m, 125mm hard layer at 22.1m, 250mm hard layer at 22.3m, 150mm hard layer at 22.6m		85.3 21.6	13	HQ3	0.17	100	98	48	97		bedding partings and contact, generally horizontal (one 30 degree contact), closely to moderately closely spaced, generally undulating, rough, open to tight, with clay coating		111	62		
	150mm hard layer at 23.2m, 25mm hard layer at 23.6m and 24.6m, 50mm hard layer at 23.6m and 23.7m, 75mm hard layer at 23.8m, 100mm hard layer at 24.4m		83.7 23.2	14	HQ3	0.22	100	87	32	83		bedding partings, contacts and joints, generally horizontal (two 90 degree joints), very closely to moderately closely spaced, generally planar, rough, open to tight, with clay coating		6	8		
			82.2 24.7														

Date / Time	Water Depth (m)	Elevation (m)
BEFORE CORING 24 August 2011	2.3	104.6
28 September 2011	3.3	103.6
14 October 2011	3.6	103.3

E = Modulus of Elasticity



Additional Notes:

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Sample Types: A=Auger; DP=Direct Push; G=Grab; RC=Rock Core; SC=Soil Core; SS=Split Barrel (Split Spoon); ST=Shelby Tube.

Coffey Representatives

BB	Originated By
AC	Prepared By
IL	Checked By

LOG OF BOREHOLE HF1-26-1

SHEET 1 OF 1

Project Name: HANLAN FEEDERMAIN SOUTH CONTRACT 1

Client: CH2M HILL CANADA LTD.

Northing: 4828109 m

Project No.: GEOTMARK00233AA

Drilling Method Used: Hollow Stem Augering 200mm

Easting: 615576 m

Project Location: DIXIE RD, MISSISSAUGA

Date: 2 September 2011

Ground Surface Elevation: 106.9 m

Depth Scale (m)	Subsurface Conditions		Samples		Penetration / Strength Results		Moisture / Plasticity		Instrumentation Details	Groundwater Conditions	Headspace Vapor (ppm) LEL (%)	Elevation Scale (m)	Comments
	Stratigraphic Symbol	Depth / Elevation (m)	Description	Number Type	Blow Counts / 150mm N Value	Recovery %	Relative Drilling Resistance	Penetration Test Values (Blows / 0.3m) X N Values + Becker Hammer Test (BPT) 20 40 60 80 Undrained Shear Strength Values (kPa) □ Field Vane ○ Unconfined ■ Lab Vane ● Quick Triaxial ▲ Pocket Penetrometer	Plastic Limit Natural Water Content Liquid Limit PL MC LL				
0.5			See log of Borehole HF1-26 for stratigraphy.									106.5	
1.0												106.0	
1.5												105.5	
2.0												105.0	
2.5												104.5	
3.0												104.0	
3.5												103.5	
4.0												103.0	
4.5												102.5	
4.6													

BOREHOLE HF1-26-1
TERMINATED AT 4.6m BGL

Date / Time
28 September 2011
14 October 2011

Water Depth (m)
2.8
2.8

Elevation (m)
104.1
104.1

SOIL LOG FOR CH2M GEOTMARK00233AA_BH25 TO BH37.GPJ COFFEY STANDARD.GDT 30/5/12



Additional Notes:

This log is to be read in conjunction with accompanying general notes and borehole log symbols sheet. Stratification lines represent approximate boundary lines between material types; vertical and lateral transitions may be gradual. Water level readings were made at time(s) noted; fluctuations of groundwater levels may occur and should be expected.
Sample Types: A=Auger; DP=Direct Push; G=Grab; RC=Rock Core; SC=Soil Core; SS=Split Barrel (Split Spoon); ST=Shelby Tube.

Coffey Representatives

BB	Originated By
AC	Prepared By
IL	Checked By

LOG OF BOREHOLE HF1-27

SHEET 1 OF 1

Project Name: HANLAN FEEDERMAIN SOUTH CONTRACT 1	Client: CH2M HILL CANADA LTD.	Northing: 4827961 m
Project No.: GEOTMARK00233AA	Drilling Method Used: Hollow Stem Augering 200mm	Easting: 615676 m
Project Location: DIXIE RD, MISSISSAUGA	Date: 22 - 24 August 2011	Ground Surface Elevation: 105.1 m

Depth Scale (m)	Stratigraphic Symbol	Subsurface Conditions		Samples		Penetration / Strength Results	Moisture / Plasticity			Instrumentation Details	Groundwater Conditions	Headspace Vapor (ppm) LEL (%)	Elevation Scale (m)	Comments
		Depth / Elevation (m)	Description	Number	Type	Blow Counts / 150mm	N Value	Recovery %	Relative Drilling Resistance					
			50mm Asphalt 375mm Concrete 200mm Granular Base											
			FILL silty sand, fine grained sand, brown, compact, trace oxidation	1	SS	3 6 5	(11)	94						
			trace clay, wet, dilatant	2	SS	4 8 9	(17)	89						
		102.8 2.3	SILTY CLAY some shale gravel, grey, very stiff	3	SS	4 9 17	(26)	89						
		102.1 3.0	SHALE weathered, grey	4	SS	50	50/13cm	99						
				5	SS	50	50/13cm	99						

Rock Coring Started

BEFORE CORING

Date / Time

22 August 2011

Water Depth (m)

1.5

Elevation (m)

103.6

Rock Core Log Next Page

Additional Notes:

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Sample Types: A=Auger; DP=Direct Push; G=Grab; RC=Rock Core; SC=Soil Core; SS=Split Barrel (Split Spoon); ST=Shelby Tube.

Coffey Representatives

BB	Originated By
AC	Prepared By
IL	Checked By

LOG OF BOREHOLE HF1-27

SHEET 1 OF 2

Project Name: HANLAN FEEDERMAIN SOUTH CONTRACT 1

Client: CH2M HILL CANADA LTD.

Date: 22 - 24 August 2011

Project No.: GEOTMARK00233AA

Drilling Method Used: ROCK CORING HQ3

Northing: 4827961 m

Project Location: DIXIE RD, MISSISSAUGA

Ground Surface Elevation: 105.1 m

Easting: 615676 m

Borehole Location: SEE DRAWING

Datum Elevation: Geodetic

Diameter: 61mm

(m) STRATA ELEV DEPTH	ROCK DESCRIPTION See Soil Logs for soil descriptions.	GROUND WATER CONDITIONS	(m) CORE ELEV DEPTH	CORE SAMPLE			TOTAL CORE RECOVERY (%)	SOLID CORE RECOVERY (%)	HARD LAYER (%)	ROD (%)	FRACTURE INDEX (per 0.3m)	DISCONTINUITIES AND WEATHERING	HYDRAULIC CONDUCTIVITY k (cm/sec) [P (kPa)]	POINT LOAD TEST UCS AXIAL (MPa)	POINT LOAD TEST UCS DIAMETRAL (MPa)	UNIAxIAL COMPRESSION (MPa)	DENSITY (g/cc) [E (GPa)]
				NUMBER	SIZE	CORE RATE (m/min)											
100.6			100.6														
4.5	GEORGIAN BAY FORMATION SHALES grey, thinly laminated interbedded with light grey LIMESTONE and SILTSTONE layers, strong to very strong Run 1: 25mm fractured zone at 4.5m, 50mm hard layer at 4.5m Run 2: 75mm core loss at 4.6m, 450mm fractured zone at 4.6m, 50mm hard layer at 4.7m and 5.9m, 25mm hard layer at 5.2m, 5.5m, 5.8m and 6.1m Run 3: 25mm hard layer at 6.2m and 6.9m, 50mm hard layer at 6.3m, 25mm fractured zone at 6.9m, 100mm hard layer at 7.3m Run 4: 75mm hard layer at 7.7m, 7.9m, 8.2m, 8.8m and 8.9 50mm hard layer at 8.0m and 8.3m, 25mm fractured zone at 8.4m weak 75mm hard layer at 9.2m, 25mm hard layer at 10.4m 50mm hard layer at 11.3m and 11.5m extremely weak to very weak 550mm crushed zone at 12.4m very weak to weak, 175mm fractured zone at 14.9m, 50mm hard layer at 14.2m, 14.4m, 14.6 and 14.7m, 125mm hard layer at 15.1m		14.55 4.6	1	HQ3	0.04	100	67	83	0		moderately weathered bedding partings, contacts and joints, generally horizontal (two 90 degree joints), very closely to moderately closely spaced, generally undulating, smooth to rough, open (75%) to tight (25%), with clay coating		189	102		
				2	HQ3	0.19	95	77	13	67				12	2		
			99.0 6.1	3	HQ3	0.30	100	95	13	85		horizontal bedding partings and contacts, very closely to moderately closely spaced, generally undulating, smooth (50%) to rough (50%), open (75%) to tight (25%), with clay coating		16	3		
			97.5 7.6	4	HQ3	0.30	100	93	32	73		bedding partings, contacts, and joints, generally horizontal (two 90 degree joints), very closely to closely spaced, generally undulating, rough, open /occasionally tight, with clay coating		162	81		
			96.0 9.1	5	HQ3	0.22	100	95	7	93		bedding parting, contacts, and joint, generally horizontal (one 90 degree joints), very closely to widely spaced, undulating to planar, smooth to rough, open, with clay coating, slightly weathered to fresh					
			94.4 10.7	6	HQ3	0.19	100	100	7	97		horizontal bedding partings and contact, closely to moderately closely spaced, undulating, smooth (25%) to rough (75%), open, with clay coating		14	9		
			92.9 12.2	7	HQ3	0.19	100	60	0	57		joints, 0-90 degrees, closely to moderately closely spaced, undulating, rough, open, with clay coating, highly to moderately weathered	No flow[137] (k' < 1.00E-8) No flow[245] (k' < 1.00E-8) No flow[353] (k' < 1.00E-8)	10	12		
			91.4 13.7											217	107		

Continued Next Page

E = Modulus of Elasticity

Additional Notes:

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Sample Types: A=Auger; DP=Direct Push; G=Grab; RC=Rock Core; SC=Soil Core; SS=Split Barrel (Split Spoon); ST=Shelby Tube.

Coffey Representatives

BB	Originated By
AC	Prepared By
IL	Checked By

LOG OF BOREHOLE HF1-27

SHEET 2 OF 2

Project Name: HANLAN FEEDERMAIN SOUTH CONTRACT 1

Client: CH2M HILL CANADA LTD.

Date: 22 - 24 August 2011

Project No.: GEOTMARK00233AA

Drilling Method Used: ROCK CORING HQ3

Northing: 4827961 m

Project Location: DIXIE RD, MISSISSAUGA

Ground Surface Elevation: 105.1 m

Easting: 615676 m

Borehole Location: SEE DRAWING

Datum Elevation: Geodetic

Diameter: 61mm

(m) STRATA ELEV DEPTH	ROCK DESCRIPTION See Soil Logs for soil descriptions.	GROUND WATER CONDITIONS	(m) CORE ELEV DEPTH	CORE SAMPLE			TOTAL CORE RECOVERY (%)	SOLID CORE RECOVERY (%)	HARD LAYER (%)	ROD (%)	FRACTURE INDEX (per 0.3m)	DISCONTINUITIES AND WEATHERING	HYDRAULIC CONDUCTIVITY k (cm/sec) [P (kPa)]	POINT LOAD TEST UCS AXIAL (MPa)	POINT LOAD TEST UCS DIAMETRAL (MPa)	UNIAxIAL COMPRESSION (MPa)	DENSITY (g/cc) [E (GPa)]
				NUMBER	SIZE	CORE RATE (m/min)											
	GEORGIAN BAY FORMATION SHALE grey, thinly laminated			8	HQ3	0.25	100	85	22	78		bedding partings, contacts and joints, generally horizontal (two 90 degree joints), closely to moderately closely spaced, undulating, rough, open, with clay coating, moderately weathered (continued)	No flow[177] ('k' < 1.00E-8)				
	interbedded with light grey LIMESTONE and SILTSTONE layers, strong to very strong (continued) 50mm hard layer at 15.3m, 15.8m and 16.1m, 25mm crushed zone at 15.5m, 175mm hard layer at 15.6m,		89.9 15.2													28.6	2.69 [8]
	25mm hard layer at 17.5m, 17.9m, 18.1m, 18.2m and 18.3m		88.3 16.8	9	HQ3	0.25	100	95	27	85		bedding partings, contacts and joint, generally horizontal (one 90 degree joint), very closely to closely spaced, undulating, rough/ occasionally smooth, open, with clay coating	No flow[284] ('k' < 1.00E-8)	195	62		
	12mm clay seams at 18.4m and 18.5m(2), 50mm hard layer at 18.5m and 19.4m, 225mm crushed zone at 19.2m		86.8 18.3									bedding partings, contact and joint, generally horizontal (one 90 degree joint), very closely to moderately closely spaced, undulating, rough to smooth, open to healed, with clay coating, slightly weathered		10	3	10.5	2.63 [1]
	50mm hard layer at 20.0m, 20.6m, 20.7m, 20.8m and 21.1m, 225mm hard layer at 20.75m		85.3 19.8	10	HQ3		100	98	8	93		horizontal bedding partings and contact, very closely to moderately closely spaced, undulating, rough to smooth, open to healed, with clay coating/infill (<15mm), fresh to slightly weathered		17	5	13.8	2.63 [1]
	25mm hard layer at 21.5m, 21.6m and 21.7m, 100mm hard layer at 21.9m, 50mm extremely weak zone at 21.7m and 22.0m, 75mm extremely weak zone at 22.1m, 50mm hard layer at 22.3m, 75mm hard layer at 22.6m		83.8 21.3	11	HQ3	0.22	100	80	7	70		horizontal bedding partings and contacts, closely to moderately closely spaced, undulating, rough to smooth, open, with clay coating		142	38	82.3	2.68 [17]
			82.2 22.9	12	HQ3	0.30	100	95	28	88		bedding partings, contacts, and joints, generally 0-20 degrees (one 90 degree joint), closely spaced, stepped to planar, rough to smooth, open, with clay coating		131	92		
				13	HQ3	0.30	100	90	22	47							

Date / Time Water Depth (m) Elevation (m)
BEFORE CORING22 August 2011 1.5 103.6

E = Modulus of Elasticity



Additional Notes:

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Sample Types: A=Auger; DP=Direct Push; G=Grab; RC=Rock Core; SC=Soil Core; SS=Split Barrel (Split Spoon); ST=Shelby Tube.

Coffey Representatives

BB	Originated By
AC	Prepared By
IL	Checked By

LOG OF BOREHOLE HF1-27-1

SHEET 1 OF 1

Project Name: HANLAN FEEDERMAIN SOUTH CONTRACT 1

Client: CH2M HILL CANADA LTD.

Northing: 4827961 m

Project No.: GEOTMARK00233AA

Drilling Method Used: Hollow Stem Augering 200mm

Easting: 615675 m

Project Location: DIXIE RD, MISSISSAUGA

Date: 27 August 2011

Ground Surface Elevation: 105.1 m

Depth Scale (m)	Subsurface Conditions		Samples		Penetration / Strength Results		Moisture / Plasticity		Instrumentation Details	Groundwater Conditions	Headspace Vapor (ppm) LEL (%)	Elevation Scale (m)	Comments
	Stratigraphic Symbol	Depth / Elevation (m)	Description	Number Type	Blow Counts / 150mm N Value	Recovery %	Relative Drilling Resistance	Penetration Test Values (Blows / 0.3m) X N Values + Becker Hammer Test (BPT) 20 40 60 80 Undrained Shear Strength Values (kPa) □ Field Vane ■ Lab Vane ▲ Pocket Penetrometer	Moisture / Plasticity Plastic Limit Natural Water Content Liquid Limit PL MC LL				
0.5			See log of Borehole HF1-27 for stratigraphy.									105.0	
1.0												104.5	
1.5												104.0	
2.0												103.5	
2.5												103.0	
3.0												102.5	

BOREHOLE HF1-27-1
TERMINATED AT 3.0m BGL

Date / Time
28 September 2011
14 October 2011

Water Depth (m)
2.4
2.4

Elevation (m)
102.7
102.7

SOIL LOG FOR CH2M GEOTMARK00233AA_BH25 TO BH37.GPJ COFFEY STANDARD.GDT 30/5/12



Additional Notes:

This log is to be read in conjunction with accompanying general notes and borehole log symbols sheet. Stratification lines represent approximate boundary lines between material types, vertical and lateral transitions may be gradual. Water level readings were made at time(s) noted, fluctuations of groundwater levels may occur and should be expected.
Sample Types: A=Auger; DP=Direct Push; G=Grab; RC=Rock Core; SC=Soil Core; SS=Split Barrel (Split Spoon); ST=Shelby Tube.

Coffey Representatives

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LOG OF BOREHOLE HF1-28

SHEET 1 OF 1

Project Name: HANLAN FEEDERMAIN SOUTH CONTRACT 1 Client: CH2M HILL CANADA LTD. Northing: 4827794 m
 Project No.: GEOTMARK00233AA Drilling Method Used: Hollow Stem Augering 200mm Easting: 615849 m
 Project Location: DIXIE RD, MISSISSAUGA Date: 22 - 27 July 2011 Ground Surface Elevation: 103.5 m

Depth Scale (m)	Stratigraphic Symbol	Subsurface Conditions		Samples		Penetration / Strength Results				Moisture / Plasticity			Instrumentation Details	Groundwater Conditions	Headspace Vapor (ppm) LEL (%)	Elevation Scale (m)	Comments
		Depth / Elevation (m)	Description	Number	Type	Blow Counts / 150mm	N Value	Recovery %	Relative Drilling Resistance	Penetration Test Values (Blows / 0.3m)	Undrained Shear Strength Values (kPa)	Plastic Limit	Natural Water Content	Liquid Limit			
0.5			175mm Asphalt 75mm Concrete Granular Base	1	AS					×							
1.0			FILL silty sand, fine grained sand, brown, compact to dense	2	SS	6 6 5	(11)	100	×								
1.5				3	SS	3 14 23	(37)	100		×							
2.0																	
2.5			trace fine to medium gravel	4	SS	6 4 6	(10)	78	×								
3.0		100.5															
3.5		3.0	SILTY SAND fine grained sand, grey, wet, compact	5	SS	7 12 17	(29)	89	×								
4.0		99.7															
4.5		3.8	SILTY CLAY trace sand, grey, stiff	6	SS	7 6 5	(11)	78	×								
5.0		98.6															
		4.9	trace fine gravel, hard, (Glacial Till)	7	SS	3 7 40	(47)	94		×							
		98.0	SHALE weathered, grey	8	SS	50		100									

Rock Coring Started

BEFORE CORING

Date / Time
22 July 2011Water Depth (m)
2.4Elevation (m)
101.1

Rock Core Log Next Page

Additional Notes:

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 Sample Types: A=Auger; DP=Direct Push; G=Grab; RC=Rock Core; SC=Soil Core; SS=Split Barrel (Split Spoon); ST=Shelby Tube.

Coffey Representatives

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LOG OF BOREHOLE HF1-28

SHEET 1 OF 2

Project Name: HANLAN FEEDERMAIN SOUTH CONTRACT 1

Client: CH2M HILL CANADA LTD.

Date: 22 - 27 July 2011

Project No.: GEOTMARK00233AA

Drilling Method Used: ROCK CORING HQ3

Northing: 4827794 m

Project Location: DIXIE RD, MISSISSAUGA

Ground Surface Elevation: 103.5 m

Easting: 615849 m

Borehole Location: SEE DRAWING

Datum Elevation: Geodetic

Diameter: 61mm

(m) STRATA ELEV DEPTH	ROCK DESCRIPTION See Soil Logs for soil descriptions.	GROUND WATER CONDITIONS	(m) CORE ELEV DEPTH	CORE SAMPLE			TOTAL CORE RECOVERY (%)	SOLID CORE RECOVERY (%)	HARD LAYER (%)	ROD (%)	FRACTURE INDEX (per 0.3m)	DISCONTINUITIES AND WEATHERING	HYDRAULIC CONDUCTIVITY k (cm/sec) [P (kPa)]	POINT LOAD TEST UCS AXIAL (MPa)	POINT LOAD TEST UCS DIAMETRAL (MPa)	UNIAxIAL COMPRESSION (MPa)	DENSITY (g/cc) [E (GPa)]
				NUMBER	SIZE	CORE RATE (m/min)											
98.0			98.0								2 4 6 8						
5.5	650mm fractured zone at 5.5m GEORGIAN BAY FORMATION SHALE grey, thinly laminated		5.5	1	HQ3	0.13	88	27	0	19		completely to highly weathered		21	4		
	interbedded with light grey LIMESTONE and SILTSTONE layers, strong to very strong 25mm hard layer at 6.8m, 6.5m, 6.9m, and 7.1m, 75mm hard layer at 6.2m, 125mm hard layer at 7.3m		97.4 6.1	2	HQ3	0.26	97	87	21	37		horizontal bedding partings and contacts, very closely to closely spaced, planar, smooth (25%) to rough (75%), open (80%) to tight (20%), with clay coating, moderately weathered		44	5		
	weak, 25mm hard layer at 8.1m,		95.8 7.7	3	HQ3	0.30	100	98	2	87		horizontal bedding partings and contact, closely to moderately closely spaced, planar, smooth (30%) to rough (70%), open (85%) to tight (15%), some with clay coating,		18	1		
	50mm hard layer at 10.1m		94.3 9.2	4	HQ3	0.30	100	98	3	90		horizontal bedding partings and contact, closely to moderately closely spaced, undulating, rough, open		14	<1		
	25mm hard layer at 11.7m		92.8 10.7	5	HQ3	0.25	95	93	2	86		horizontal bedding partings and contact, closely to moderately closely spaced, planar to undulating, smooth to rough, open, slightly weathered to fresh		17	4		
	25mm hard layer at 13.4m, 13.5m		91.3 12.2	6	HQ3	0.30	100	67	3	40		horizontal bedding partings and contact, very closely to moderately closely spaced, stepped to planar, smooth (20%) to rough (80%), open, some with clay infill, slightly to moderately weathered		13	1		
	225mm lost core at 13.8m, 100mm hard layer at 14m, 50mm hard layer at 14.5m, 125mm hard layer at 14.8m, 75mm hard layer at 15.0m		89.7 13.8	7	HQ3	0.39	82	79	23	82		horizontal bedding partings and contacts, very closely to moderately closely spaced, planar (75%) to undulating (25%), smooth (20%) to rough (80%), open, occasional clay infill, slightly weathered to fresh		262	99		
	50mm hard layer at 15.9m and 16.8m.		88.2 15.3														

Continued Next Page

E = Modulus of Elasticity



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Sample Types: A=Auger; DP=Direct Push; G=Grab; RC=Rock Core; SC=Soil Core; SS=Split Barrel (Split Spoon); ST=Shelby Tube.

Coffey Representatives

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LOG OF BOREHOLE HF1-28

SHEET 2 OF 2

Project Name: HANLAN FEEDERMAIN SOUTH CONTRACT 1

Client: CH2M HILL CANADA LTD.

Date: 22 - 27 July 2011

Project No.: GEOTMARK00233AA

Drilling Method Used: ROCK CORING HQ3

Northing: 4827794 m

Project Location: DIXIE RD, MISSISSAUGA

Ground Surface Elevation: 103.5 m

Easting: 615849 m

Borehole Location: SEE DRAWING

Datum Elevation: Geodetic

Diameter: 61mm

(m) STRATA ELEV DEPTH	ROCK DESCRIPTION See Soil Logs for soil descriptions.	GROUND WATER CONDITIONS	(m) CORE ELEV DEPTH	CORE SAMPLE			TOTAL CORE RECOVERY (%)	SOLID CORE RECOVERY (%)	HARD LAYER (%)	ROD (%)	FRACTURE INDEX (per 0.3m)				DISCONTINUITIES AND WEATHERING	HYDRAULIC CONDUCTIVITY k (cm/sec) [P (kPa)]	POINT LOAD TEST UCS AXIAL (MPa)	POINT LOAD TEST UCS DIAMETRAL (MPa)	UNIAxIAL COMPRESSION (MPa)	DENSITY (g/cc) [E (GPa)]
				NUMBER	SIZE	CORE RATE (m/min)					2	4	6	8						
	25mm hard layer at 16.7m GEORGIAN BAY FORMATION SHALE grey, thinly laminated interbedded with light grey LIMESTONE and SILTSTONE layers, strong to very strong (<i>continued</i>)			8	HQ3	0.25	100	100	8	88					horizontal bedding partings, closely to moderately closely spaced, planar, smooth (50%) to rough (50%), open (<i>continued</i>)		13	5		
	150mm mechanically fractured zone 75mm hard layer at 17.0m, 25mm hard layer at 17.2m and 18.4m, 50mm hard layer at 17.5m and 17.4m		86.6 16.9 86.5 17.0	9	HQ3	0.03	100	0	0	0					mechanically fractured horizontal bedding partings and contact, closely to moderately closely spaced, planar, generally rough, open		68	45	13.4	[2]
	25mm hard layer at 19.4m, 50mm hard layer at 19.6m, 125mm hard layer at 19.9m		85.0 18.5	11	HQ3		100	100	13	100					horizontal bedding partings and contact, closely to moderately closely spaced, generally planar, generally rough, open, fresh		14	1		
	125mm hard layer at 20.0m, 50mm hard layer at 20.2m, 20.5m, 20.6m, 20.6m, 21.2m and 21.4m, 100mm hard layer at 20.7m		83.5 20.0	12	HQ3		100	100	35	100					horizontal bedding partings and contacts, closely to moderately closely spaced, planar, rough, open					
			82.0 21.5														176	64		

Date / Time Water Depth (m) Elevation (m)
 BEFORE CORING 22 July 2011 2.4 101.1

E = Modulus of Elasticity



Additional Notes:

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Coffey Representatives

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AC	Prepared By
IL	Checked By

LOG OF BOREHOLE HF1-29

SHEET 1 OF 1

Project Name: HANLAN FEEDERMAIN SOUTH CONTRACT 1

Client: CH2M HILL CANADA LTD.

Northing: 4827561 m

Project No.: GEOTMARK00233AA

Drilling Method Used: Hollow Stem Augering 200mm

Easting: 616102 m

Project Location: DIXIE RD, MISSISSAUGA

Date: 27 - 29 July 2011

Ground Surface Elevation: 99.5 m

Depth Scale (m)	Stratigraphic Symbol	Subsurface Conditions		Samples		Penetration / Strength Results		Moisture / Plasticity		Instrumentation Details	Groundwater Conditions	Headspace Vapor (ppm) LEL (%)	Elevation Scale (m)	Comments
		Depth / Elevation (m)	Description	Number	Type	Blow Counts / 150mm	N Value	Recovery %	Relative Drilling Resistance					
			200mm Asphalt 225mm Granular Base											
			FILL silty sand, fine grained sand, brown, loose	1	SS	4 5 4	(9)	72						
1		98.0												
		1.5	SILTY SAND fine grained sand, wet, dilatant, brown, compact to loose	2	SS	4 6 8	(14)	50						
2														
				3	SS	2 4 5	(9)	89						
3														
			laminated	4	SS	2 5 11	(16)	61						
4														
				5	SS	6 10 13	(23)	72						
5														
			brown to grey	6	SS	4 7 7	(14)	94						
6														
			to sandy silt, grey	7	SS	5 10 11	(21)	89						
7														
				8	SS	3 4 5	(9)	100						
8														
		91.9												
		7.6	CLAY trace silt, trace gravel, trace shale fragments, grey, wet, soft	9	SS	1 1 2	(3)	100						
9														
		91.0												
		8.5	SHALE weathered, grey											
10														
				10	SS	50	50/8cm	100						
		89.2												
		10.3												

Rock Coring Started

Date / Time

Water Depth (m)

Elevation (m)

12 August 2011
28 September 2011
14 October 2011

1.9
4.9
5.1

97.6
94.6
94.4

Rock Core Log Next Page



Additional Notes:

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Coffey Representatives

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SOIL LOG FOR CH2M GEOTMARK00233AA_BH25 TO BH37.GPJ COFFEY STANDARD GDT 30/5/12

LOG OF BOREHOLE HF1-29

SHEET 1 OF 2

Project Name: HANLAN FEEDERMAIN SOUTH CONTRACT 1

Client: CH2M HILL CANADA LTD.

Date: 27 - 29 July 2011

Project No.: GEOTMARK00233AA

Drilling Method Used: ROCK CORING HQ3

Northing: 4827561 m

Project Location: DIXIE RD, MISSISSAUGA

Ground Surface Elevation: 99.5 m

Easting: 616102 m

Borehole Location: SEE DRAWING

Datum Elevation: Geodetic

Diameter: 61mm

(m) STRATA ELEV DEPTH	ROCK DESCRIPTION See Soil Logs for soil descriptions.	GROUND WATER CONDITIONS	(m) CORE ELEV DEPTH	CORE SAMPLE			TOTAL CORE RECOVERY (%)	SOLID CORE RECOVERY (%)	HARD LAYER (%)	ROD (%)	FRACTURE INDEX (per 0.3m)	DISCONTINUITIES AND WEATHERING	HYDRAULIC CONDUCTIVITY k (cm/sec) [P (kPa)]	POINT LOAD TEST UCS AXIAL (MPa)	POINT LOAD TEST UCS DIAMETRAL (MPa)	UNIAxIAL COMPRESSION (MPa)	DENSITY (g/cc) [E (GPa)]
				NUMBER	SIZE	CORE RATE (m/min)											
89.2			89.2														
10.3	GEORGIAN BAY FORMATION SHALES grey, thinly laminated		10.3	1	HQ3	0.08	100	69	6	25		horizontal bedding partings, joint and contact, closely spaced, undulating to planar, smooth to rough, open, with clay coating, highly to moderately weathered		91	125		
	interbedded with light grey LIMESTONE and SILTSTONE layers, strong to very strong		88.8														
	Run 1: weak to very weak 100mm fractured zone at 10.3m, 25mm hard layer at 10.5m		10.7	2	HQ3	0.22	100	90	37	50		bedding partings, contacts and joint, 0-10 degrees (two 90 degree joints), closely to moderately closely spaced, generally undulating, smooth to rough, open, occasionally tight, often with clay coating, moderately weathered		150	54		
	Run 2: 75mm hard layer at 12.0m, 12.3m and 13.0m, 100mm fractured zone at 12.2m, 25mm hard layer at 12.2m, 12.8m, and 13.6m(2), 225mm hard layer at 13.2m		87.3														
	Run 3: 25mm hard layer at 12.3m, 75mm hard layer at 12.4m, 50mm hard layer at 12.9m and 13.5m		12.2	3	HQ3	0.13	98	98	13	80		bedding partings and contacts, 0-10 degrees, closely to moderately closely spaced, stepped to planar, smooth (30%) to rough (70%), generally open, some with clay coating, moderately to slightly weathered	No flow[137] ('k' < 1.00E-8) 2.45E-6 [216]	12	16		
	weak, 75mm hard layer at 14.3m, 50mm hard layer at 14.8m		85.8														
			13.7	4	HQ3	0.12	100	98	8	95		bedding partings and contacts, closely to moderately closely spaced, undulating to planar, smooth to rough, open (75%) to tight (25%), with clay coating	3.49E-6 [284]	12	4		
	50mm hard layer at 15.2m, 100mm hard layer at 16.6m		84.2														
			15.3	5	HQ3	0.08	100	98	10	83		bedding partings, contacts and joints, generally horizontal (one 90 degree joint), closely to widely spaced, stepped to planar, smooth to rough, generally open, some with clay coating, slightly weathered	2.17E-5 [137]	13	13	18.3	2.59 [5]
	75mm hard layer at 16.8m, 17.4m, 225mm hard layer at 16.9m, 25mm hard layer at 17.3m, 18.0, 18.3m, 125mm hard layer at 17.7m		82.7														
			16.8	6	HQ3	0.09	100	95	38	72		bedding partings, contacts and joint, generally horizontal (one 90 degree joint), very closely to closely spaced, stepped to planar, smooth (50%) to rough (50%), generally open (70%) to tight (30%), often with clay coating	2.21E-5 [245] 2.31E-5 [353]	161	84		
	150mm hard layer at 18.3m, 50mm hard layer at 18.9m and 19.2m, 225mm hard layer at 19.1m, 25mm hard layer 19.5m		81.2														
			18.3	7	HQ3	0.08	100	95	33	93		bedding partings, 0-20 degrees, closely to moderately closely spaced, planar to undulating, smooth to rough, generally open to tight, some with clay coating,				33.5	2.62 [7]
			79.7														
			19.8	8	HQ3	0.10	100	100	0	100		bedding partings, 0-20 degrees, closely to moderately closely spaced, planar to undulating, smooth to rough, generally open to tight, some with clay coating, slightly weathered to fresh		12	9		
			78.1														

Continued Next Page

E = Modulus of Elasticity

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Coffey Representatives

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AC	Prepared By
IL	Checked By

LOG OF BOREHOLE HF1-29

SHEET 2 OF 2

Project Name: HANLAN FEEDERMAIN SOUTH CONTRACT 1

Client: CH2M HILL CANADA LTD.

Date: 27 - 29 July 2011

Project No.: GEOTMARK00233AA

Drilling Method Used: ROCK CORING HQ3

Northing: 4827561 m

Project Location: DIXIE RD, MISSISSAUGA

Ground Surface Elevation: 99.5 m

Easting: 616102 m

Borehole Location: SEE DRAWING

Datum Elevation: Geodetic

Diameter: 61mm

(m) STRATA ELEV DEPTH	ROCK DESCRIPTION See Soil Logs for soil descriptions.	GROUND WATER CONDITIONS	(m) CORE ELEV DEPTH	CORE SAMPLE			TOTAL CORE RECOVERY (%)	SOLID CORE RECOVERY (%)	HARD LAYER (%)	ROD (%)	FRACTURE INDEX (per 0.3m)	DISCONTINUITIES AND WEATHERING	HYDRAULIC CONDUCTIVITY k (cm/sec) [P (kPa)]	POINT LOAD TEST UCS AXIAL (MPa)	POINT LOAD TEST UCS DIAMETRAL (MPa)	UNIAxIAL COMPRESSION (MPa)	DENSITY (g/cc) [E (GPa)]
				NUMBER	SIZE	CORE RATE (m/min)											
	50mm hard layer at 21.8m, 22.2m and 22.5m, 25mm hard layer at 22.5m and 22.7m, GEORGIAN BAY FORMATION SHALE grey, thinly laminated		21.4	9	HQ3	0.12	100	100	11	95		horizontal contacts and bedding parting, moderately closely spaced, undulating to planar, generally rough, generally open to tight, with clay coating, (continued)					
	interbedded with light grey LIMESTONE and SILTSTONE layers, strong to very strong (continued) 25mm hard layer at 23.2m, 23.5m, 50mm hard layer at 23.4m, 175mm hard layer at 23.5m, 75mm hard layer at 23.8m, 125mm hard layer at 24.0m, 200mm hard layer at 24.1m		76.6 22.9	10	HQ3	0.10	100	98	45	90		horizontal bedding partings and joint, moderately closely spaced, undulating to planar, smooth, open, with clay coating,		132	6		
			75.1 24.4													76.67	2.64 [14]

Date / Time	Water Depth (m)	Elevation (m)
12 August 2011	1.9	97.6
28 September 2011	4.9	94.6
14 October 2011	5.1	94.4

E = Modulus of Elasticity



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Coffey Representatives

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AC	Prepared By
IL	Checked By

LOG OF BOREHOLE HF1-29-1

SHEET 1 OF 1

Project Name: HANLAN FEEDERMAIN SOUTH CONTRACT 1

Client: CH2M HILL CANADA LTD.

Northing: 4827560 m

Project No.: GEOTMARK00233AA

Drilling Method Used: Hollow Stem Augering 200mm

Easting: 616103 m

Project Location: DIXIE RD, MISSISSAUGA

Date: 28 July 2011

Ground Surface Elevation: 99.5 m

Depth Scale (m)	Subsurface Conditions		Samples		Penetration / Strength Results				Moisture / Plasticity			Instrumentation Details	Groundwater Conditions	Headspace Vapor (ppm) LEL (%)	Elevation Scale (m)	Comments
	Stratigraphic Symbol	Depth / Elevation (m)	Description	Number Type	Blow Counts / 150mm N Value	Recovery %	Relative Drilling Resistance	Penetration Test Values (Blows / 0.3m) X N Values ♦ Dynamic Cone + Becker Hammer Test (BPT) 20 40 60 80	Undrained Shear Strength Values (kPa) □ Field Vane ○ Unconfined ■ Lab Vane ● Quick Triaxial ▲ Pocket Penetrometer	PL	MC	LL				
0.5			See log of Borehole HF1-29 for stratigraphy.				hard								99.0	
1.0							easy								98.5	
1.5							easy								98.0	
2.0															97.5	
2.5							very easy								97.0	
3.0							easy								96.5	
3.5															96.0	
4.0							easy								95.5	
4.5															95.0	
5.0															94.5	

94.3

5.2

BOREHOLE HF1-29-1
TERMINATED AT 5.2m BGL

Date / Time
12 August 2011
28 September 2011
14 October 2011

Water Depth (m)
3.0
3.1
3.1

Elevation (m)
96.5
96.4
96.4

SOIL LOG FOR CH2M GEOTMARK00233AA_BH25 TO BH37.GPJ COFFEY STANDARD.GDT 30/5/12



Additional Notes:

This log is to be read in conjunction with accompanying general notes and borehole log symbols sheet. Stratification lines represent approximate boundary lines between material types, vertical and lateral transitions may be gradual. Water level readings were made at time(s) noted, fluctuations of groundwater levels may occur and should be expected.
Sample Types: A=Auger; DP=Direct Push; G=Grab; RC=Rock Core; SC=Soil Core; SS=Split Barrel (Split Spoon); ST=Shelby Tube.

Coffey Representatives

BB	Originated By
AC	Prepared By
IL	Checked By

LOG OF BOREHOLE HF1-30

SHEET 1 OF 2

Project Name: HANLAN FEEDERMAIN SOUTH CONTRACT 1

Client: CH2M HILL CANADA LTD.

Northing: 4827431 m

Project No.: GEOTMARK00233AA

Drilling Method Used: Hollow Stem Augering 200mm

Easting: 616247 m

Project Location: DIXIE RD, MISSISSAUGA

Date: 28 - 29 July 2011

Ground Surface Elevation: 99.5 m

Depth Scale (m)	Subsurface Conditions		Samples		Penetration / Strength Results				Moisture / Plasticity			Instrumentation Details	Groundwater Conditions	Headspace Vapor (ppm) LEL (%)	Elevation Scale (m)	Comments
	Stratigraphic Symbol	Depth / Elevation (m)	Description	Number Type	Blow Counts / 150mm N Value	Recovery %	Relative Drilling Resistance	Penetration Test Values (Blows / 0.3m) X N Values + Becker Hammer Test (BPT) 20 40 60 80	Undrained Shear Strength Values (kPa) □ Field Vane ■ Lab Vane ▲ Pocket Penetrometer	Moisture / Plasticity Plastic Limit Natural Water Content Liquid Limit PL MC LL						
1			160mm Asphalt													
1			FILL fine grained sand, trace silt, trace clay, brown, loose to compact	1 SS 4 4 4	(8)	83		X								
2				2 SS 2 4 4	(8)	100		X								
3				3 SS 5 4 5	(9)	100		X								
4				4 SS 3 4 7	(11)	94		X								
4		95.7														
4		3.8	SILTY SAND fine grained sand, trace clay, brown, wet, dense	5 SS 12 15 18	(33)	100		X								
5			grey	6 SS 18 19 21	(40)	94		X								
6				7 SS 15 19 26	(45)	100		X								
7				8 SS 7 11 13	(24)	100		X								
8			compact	9 SS 13 13 14	(27)	100		X								
9		90.4														
9		9.1	SANDY SILT fine grained sand, trace clay, grey, wet, compact	10 SS 7 11 15	(26)	100		X								
10																
10		88.8														
10		10.7		11 SS	(0)	100		X								

Continued Next Page

Additional Notes:

This log is to be read in conjunction with accompanying general notes and borehole log symbols sheet. Stratification lines represent approximate boundary lines between material types, vertical and lateral transitions may be gradual. Water level readings were made at time(s) noted, fluctuations of groundwater levels may occur and should be expected.
Sample Types: A=Auger; DP=Direct Push; G=Grab; RC=Rock Core; SC=Soil Core; SS=Split Barrel (Split Spoon); ST=Shelby Tube.

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IL	Checked By

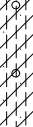

LOG OF BOREHOLE HF1-30

SHEET 2 OF 2

Project Name: HANLAN FEEDERMAIN SOUTH CONTRACT 1
Project No.: GEOTMARK00233AA
Project Location: DIXIE RD, MISSISSAUGA

Client: CH2M HILL CANADA LTD.
Drilling Method Used: Hollow Stem Augering 200mm
Date: 28 - 29 July 2011

Northing: 4827431 m
Easting: 616247 m
Ground Surface Elevation: 99.5 m

Depth Scale (m)	Subsurface Conditions		Samples		Penetration / Strength Results		Moisture / Plasticity		Instrumentation Details	Groundwater Conditions	Headspace Vapor (ppm) LEL (%)	Elevation Scale (m)	Comments
	Stratigraphic Symbol	Depth / Elevation (m)	Description	Number Type	Blow Counts / 150mm N Value	Recovery %	Relative Drilling Resistance	Penetration Test Values (Blows / 0.3m) X N Values ♦ Dynamic Cone + Becker Hammer Test (BPT) 20 40 60 80 Undrained Shear Strength Values (kPa) □ Field Vane ○ Unconfined ■ Lab Vane ● Quick Triaxial ▲ Pocket Penetrometer	Plastic Limit Natural Water Content Liquid Limit	PL MC LL			
12		87.5 12.0 87.2 12.3	SILTY CLAY TILL trace sand, trace gravel, grey, wet, very soft (<i>continued</i>)	11 SS	0 0 0	100							
			SHALE weathered, grey	12 SS	50	50/5cm	98						

Rock Coring Started

BEFORE CORING

Date / Time
28 July 2011Water Depth (m)
3.5Elevation (m)
96.0

Rock Core Log Next Page



Additional Notes:

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Sample Types: A=Auger; DP=Direct Push; G=Grab; RC=Rock Core; SC=Soil Core; SS=Split Barrel (Split Spoon); ST=Shelby Tube.

Coffey Representatives

AA	Originated By
AC	Prepared By
IL	Checked By

LOG OF BOREHOLE HF1-30

SHEET 1 OF 1

Project Name: HANLAN FEEDERMAIN SOUTH CONTRACT 1

Client: CH2M HILL CANADA LTD.

Date: 28 - 29 July 2011

Project No.: GEOTMARK00233AA

Drilling Method Used: ROCK CORING HQ3

Northing: 4827431 m

Project Location: DIXIE RD, MISSISSAUGA

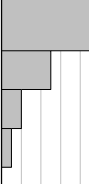
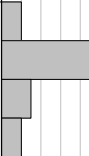
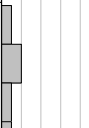
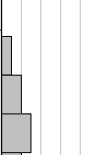
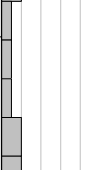
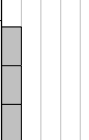

Ground Surface Elevation: 99.5 m

Easting: 616247 m

Borehole Location: SEE DRAWING

Datum Elevation: Geodetic

Diameter: 61mm

(m) STRATA ELEV DEPTH	ROCK DESCRIPTION See Soil Logs for soil descriptions.	GROUND WATER CONDITIONS	(m) CORE ELEV DEPTH	CORE SAMPLE			TOTAL CORE RECOVERY (%)	SOLID CORE RECOVERY (%)	HARD LAYER (%)	RQD (%)	FRACTURE INDEX (per 0.3m)	DISCONTINUITIES AND WEATHERING	HYDRAULIC CONDUCTIVITY k (cm/sec) [P (kPa)]	POINT LOAD TEST UCS AXIAL (MPa)	POINT LOAD TEST UCS DIAMETRAL (MPa)	UNIAxIAL COMPRESSION (MPa)	DENSITY (g/cc) [E (GPa)]
				NUMBER	SIZE	CORE RATE (m/min)											
87.2 12.3	GEORGIAN BAY FORMATION SHALE grey, thinly laminated interbedded with light grey LIMESTONE and SILTSTONE layers, strong to very strong Run 1: very weak, 100mm fractured zone at 12.3m Run 2: medium strong, 75mm fractured zone at 14.3m, 75mm clay layer at 14.7m, 50mm hard layer at 14.9m and 15.1m, 25mm hard layer at 15.4m weak, 50mm hard layer at 15.5m 100mm hard layer at 17.4m and 17.7m, 175mm hard layer at 18.2m, 25mm hard layer at 18.0 50mm hard layer at 18.6m, 19.4m, 19.7m and 20.0m, 100mm hard layer at 19.0m and 19.7m, 75mm hard layer at 19.4m weak to medium strong, 50mm hard layer at 20.2m, 25mm hard layer at 20.4m		87.2 12.3	1	HQ3	0.27	88	77	0	58		horizontal bedding partings, very closely to closely spaced, planar (75%) to undulating (25%), rough (75%) to smooth (25%), open, with clay coating, highly to moderately weathered		20	1		
			85.5 14.0	2	HQ3	0.30	97	81	8	59		horizontal bedding partings and contact, very closely to closely spaced, planar (75%) to undulating (25%), smooth to rough, open, some with clay coating, slightly weathered		138	56		
			84.0 15.5	3	HQ3	0.25	100	97	3	97		horizontal bedding partings and contact, closely to moderately closely spaced, planar, smooth, open to tight		26	2		
			82.5 17.0	4	HQ3	0.26	100	100	25	89		horizontal bedding partings and contacts, very closely to closely spaced, planar, generally rough, generally open, slightly weathered to fresh		138	126	9.2	2.58 [1]
			81.0 18.5	5	HQ3	0.25	100	98	32	98		horizontal bedding partings and contacts, closely to moderately closely spaced, generally planar, rough (50%) to smooth (50%), open, occasionally with clay infill		167	41	108.4	2.64 [24]
			79.5 20.0	6	HQ3	0.26	100	100	5	95		horizontal bedding partings, very closely to closely spaced, planar, rough (60%) to smooth (40%), open, some with clay infill, fresh		30	2		
			77.9 21.6	7	HQ3	0.18	100	100	0	96		horizontal bedding partings, closely spaced, planar, rough, open		27	1	7.2	2.58 [1]
			77.2 22.3														

Date / Time **Water Depth (m)** **Elevation (m)**
 BEFORE CORING 28 July 2011 3.5 96.0

E = Modulus of Elasticity

**Additional Notes:**

This log is to be read in conjunction with accompanying general notes and borehole log symbols sheet. Stratification lines represent approximate boundary lines between material types, vertical and lateral transitions may be gradual. Water level readings were made at time(s) noted, fluctuations of groundwater levels may occur and should be expected.
 Sample Types: A=Auger; DP=Direct Push; G=Grab; RC=Rock Core; SC=Soil Core; SS=Split Barrel (Split Spoon); ST=Shelby Tube.

Coffey Representatives

AA	Originated By
AC	Prepared By
IL	Checked By

LOG OF BOREHOLE HF1-31

SHEET 1 OF 2

Project Name: HANLAN FEEDERMAIN SOUTH CONTRACT 1

Client: CH2M HILL CANADA LTD.

Northing: 4827361 m

Project No.: GEOTMARK00233AA

Drilling Method Used: Hollow Stem Augering 200mm

Easting: 616313 m

Project Location: DIXIE RD, MISSISSAUGA

Date: 2 - 3 August 2011

Ground Surface Elevation: 99.6 m

Depth Scale (m)	Subsurface Conditions		Samples		Penetration / Strength Results		Moisture / Plasticity		Instrumentation Details	Groundwater Conditions	Headspace Vapor (ppm) LEL (%)	Elevation Scale (m)	Comments
	Stratigraphic Symbol	Depth / Elevation (m)	Description	Number Type	Blow Counts / 150mm N Value	Recovery %	Relative Drilling Resistance	Penetration Test Values (Blows / 0.3m) X N Values + Becker Hammer Test (BPT) 20 40 60 80 Undrained Shear Strength Values (kPa) □ Field Vane ■ Lab Vane ▲ Pocket Penetrometer	Moisture / Plasticity Plastic Limit Natural Water Content Liquid Limit PL MC LL				
0.5			200mm Asphalt									99.5	
1.0			FILL fine sand, trace fine gravel, brown, compact to loose	1 SS	14 11 7	(18)	89	X				99.0	
1.5												98.5	
2.0				2 SS	2 1 5	(6)	100	X				98.0	
2.5												97.5	
3.0				3 SS	6 8 10	(18)	100	X				97.0	
3.5												96.5	
4.0				4 SS	5 6 8	(14)	100	X				96.0	
4.5												95.5	
5.0				5 SS	8 8 10	(18)	100	X				95.0	
5.5												94.5	
6.0				6 SS	4 6 7	(13)	100	X				94.0	
6.5												93.5	
7.0				7 SS	10 13 20	(33)	100	X				93.0	
7.5												92.5	
8.0				8 SS	12 23 28	(51)	83	X				92.0	
8.5												91.5	
9.0				9 SS	15 30 50	50/13cm	100	X				91.0	
9.5												90.5	
10.0				10 SS	16 20 22	(42)	100	X				90.0	

Continued Next Page

Additional Notes:

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Sample Types: A=Auger; DP=Direct Push; G=Grab; RC=Rock Core; SC=Soil Core; SS=Split Barrel (Split Spoon); ST=Shelby Tube.

Coffey Representatives

AA	Originated By
AC	Prepared By
IL	Checked By

LOG OF BOREHOLE HF1-31

SHEET 2 OF 2

Project Name: HANLAN FEEDERMAIN SOUTH CONTRACT 1 Client: CH2M HILL CANADA LTD. Northing: 4827361 m
 Project No.: GEOTMARK00233AA Drilling Method Used: Hollow Stem Augering 200mm Easting: 616313 m
 Project Location: DIXIE RD, MISSISSAUGA Date: 2 - 3 August 2011 Ground Surface Elevation: 99.6 m

Depth Scale (m)	Subsurface Conditions		Samples		Penetration / Strength Results		Moisture / Plasticity		Instrumentation Details	Groundwater Conditions	Headspace Vapor (ppm) LEL (%)	Elevation Scale (m)	Comments
	Stratigraphic Symbol	Depth / Elevation (m)	Description	Number Type	Blow Counts / 150mm N Value	Recovery %	Relative Drilling Resistance	Penetration Test Values (Blows / 0.3m) X N Values ♦ Dynamic Cone + Becker Hammer Test (BPT) 20 40 60 80 Undrained Shear Strength Values (kPa) □ Field Vane ○ Unconfined ■ Lab Vane ● Quick Triaxial ▲ Pocket Penetrometer	Plastic Limit Natural Water Content Liquid Limit PL MC LL				
10.5			SANDY SILT fine grained sand, grey, wet, dense (continued)	11	SS	21						89.5	
11.0				22		(46)						89.0	
11.5				24								88.5	
12.0												88.0	
12.5												87.5	
13.0												87.0	
13.5												86.5	
13.7												86.0	
87.4													
12.2			SHALE weathered, grey	12	SS	50	50/13cm	99					
85.9													
13.7													

Rock Coring Started

BEFORE CORING

Date / Time
2 August 2011Water Depth (m)
4.0Elevation (m)
95.6

Rock Core Log Next Page

Additional Notes:

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 Sample Types: A=Auger; DP=Direct Push; G=Grab; RC=Rock Core; SC=Soil Core; SS=Split Barrel (Split Spoon); ST=Shelby Tube.

Coffey Representatives

AA	Originated By
AC	Prepared By
IL	Checked By

LOG OF BOREHOLE HF1-31

SHEET 1 OF 1

Project Name: HANLAN FEEDERMAIN SOUTH CONTRACT 1

Client: CH2M HILL CANADA LTD.

Date: 2 - 3 August 2011

Project No.: GEOTMARK00233AA

Drilling Method Used: ROCK CORING HQ3

Northing: 4827361 m

Project Location: DIXIE RD, MISSISSAUGA

Ground Surface Elevation: 99.6 m

Easting: 616313 m

Borehole Location: SEE DRAWING

Datum Elevation: Geodetic

Diameter: 61mm

(m) STRATA ELEV DEPTH	ROCK DESCRIPTION See Soil Logs for soil descriptions.	GROUND WATER CONDITIONS	(m) CORE ELEV DEPTH	CORE SAMPLE			TOTAL CORE RECOVERY (%)	SOLID CORE RECOVERY (%)	HARD LAYER (%)	ROD (%)	FRACTURE INDEX (per 0.3m)	DISCONTINUITIES AND WEATHERING	HYDRAULIC CONDUCTIVITY k (cm/sec) [P (kPa)]	POINT LOAD TEST UCS AXIAL (MPa)	POINT LOAD TEST UCS DIAMETRAL (MPa)	UNIAxIAL COMPRESSION (MPa)	DENSITY (g/cc) [E (GPa)]
				NUMBER	SIZE	CORE RATE (m/min)											
85.9			85.9								2 4 6 8						
13.7	GEORGIAN BAY FORMATION SHALES grey, thinly laminated interbedded with light grey LIMESTONE and SILTSTONE layers, strong to very strong very weak weak		13.7	1	HQ3	0.27	94	89	0	88		horizontal bedding partings, moderately closely spaced, planar to undulating, rough, open, highly to moderately weathered					
			84.3														
			15.3	2	HQ3	0.27	97	97	0	97		horizontal bedding parting, widely spaced, planar, smooth, tight, slightly weathered		28	1	5.4	2.63 [1]
			82.6														
	100mm hard layer at 17.5m, 75mm hard layer at 24.4m, 250mm hard layer at 17.7m		17.0	3	HQ3	0.25	100	97	29	86		horizontal contacts and bedding partings, closely spaced, planar, rough, open, slightly weathered to fresh		12	18		
			81.2														
	25mm hard layer at 19.0m, 75mm hard layer at 19.1m, 125mm hard layer at 18.4m		18.4	4	HQ3	0.25	100	100	15	87		horizontal contacts and bedding partings, closely to moderately closely spaced, generally planar, smooth (40%) to rough (60%), open, some with clay infill		202	146		
			79.6														
	100mm hard layer at 20.0m, 150mm hard layer at 20.2m, 25mm hard layer at 20.5m		20.0	5	HQ3	0.25	100	98	18	95		horizontal bedding partings, closely to moderately closely spaced, generally planar, smooth (40%) to rough (60%), open (60%) to tight (40%), occasionally with clay infill		13	6		
			78.1														
	25mm hard layer at 22.7m		21.5	6	HQ3	0.32	98	97	2	93		horizontal bedding partings, closely to moderately closely spaced, planar, rough, open (70%) to tight (30%)					
			76.5											22	11		
			23.1														

Date / Time Water Depth (m) Elevation (m)
BEFORE CORING 2 August 2011 4.0 95.6

E = Modulus of Elasticity



Additional Notes:

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Sample Types: A=Auger; DP=Direct Push; G=Grab; RC=Rock Core; SC=Soil Core; SS=Split Barrel (Split Spoon); ST=Shelby Tube.

Coffey Representatives

AA	Originated By
AC	Prepared By
IL	Checked By

LOG OF BOREHOLE HF1-32

SHEET 1 OF 2

Project Name: HANLAN FEEDERMAIN SOUTH CONTRACT 1

Client: CH2M HILL CANADA LTD.

Northing: 4827235 m

Project No.: GEOTMARK00233AA

Drilling Method Used: Hollow Stem Augering 200mm

Easting: 616447 m

Project Location: DIXIE RD, MISSISSAUGA

Date: 2 - 4 August 2011

Ground Surface Elevation: 96.8 m

Depth Scale (m)	Stratigraphic Symbol	Depth / Elevation (m)	Subsurface Conditions	Samples				Penetration / Strength Results				Moisture / Plasticity			Instrumentation Details	Groundwater Conditions	Headspace Vapor (ppm) LEL (%)	Elevation Scale (m)	Comments
				Number	Type	Blow Counts / 150mm	N Value	Recovery %	Relative Drilling Resistance	Penetration Test Values (Blows / 0.3m)	Undrained Shear Strength Values (kPa)	Plastic Limit	Natural Water Content	Liquid Limit					
										X N Values + Becker Hammer Test (BPT)	□ Field Vane ■ Lab Vane ▲ Pocket Penetrometer								
										20 40 60 80	20 40 60 80	PL	MC	LL					
0.5			Asphalt 225mm															96.5	
1.0			FILL silty sand, fine grained sand, compact to very loose	1	SS	7 7 6	(13)	89										96.0	
1.5																		95.5	
2.0				2	SS	1 1 2	(3)	72										95.0	
2.5		94.5 2.3	SILTY SAND fine grained sand, trace to some clay, trace oxidation laminated, brown, wet, dilatant, compact	3	SS	3 8 11	(19)	67										94.5	Water Level measured at 2.29m bgl.
3.0																		94.0	0 52 37 11
3.5				4	SS	5 11 12	(23)	83										93.5	
4.0			occasional fine gravel	5	SS	10 12 17	(29)	94										93.0	1 59 33 7
4.5																		92.5	
5.0			dense	6	SS	15 17 17	(34)	100										92.0	
5.5		91.5 5.3	SANDY SILT fine grained sand, trace to some clay, brown to grey, wet, dense	7	SS	9 20 27	(47)	94										91.5	
6.0			brown															91.0	
6.5			grey	8A	SS	12 22 23	(45)	100										90.5	
7.0																		90.0	
7.5																		89.5	
8.0		89.2 7.6	SILTY CLAY trace silt pockets, grey, stiff	9	SS	2 5 6	(11)	100										89.0	PP, Cu = 187 to > 241 kPa
8.5																		88.5	
9.0																		88.0	
9.5				10	SS	3 5 8	(13)	100										87.5	PP, Cu = 187 to > 241 kPa
																		87.0	

Continued Next Page

Additional Notes:

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Sample Types: A=Auger; DP=Direct Push; G=Grab; RC=Rock Core; SC=Soil Core; SS=Split Barrel (Split Spoon); ST=Shelby Tube.

Coffey Representatives

BB	Originated By
AC	Prepared By
IL	Checked By

LOG OF BOREHOLE HF1-32

SHEET 2 OF 2

Project Name: HANLAN FEEDERMAIN SOUTH CONTRACT 1	Client: CH2M HILL CANADA LTD.	Northing: 4827235 m
Project No.: GEOTMARK00233AA	Drilling Method Used: Hollow Stem Augering 200mm	Easting: 616447 m
Project Location: DIXIE RD, MISSISSAUGA	Date: 2 - 4 August 2011	Ground Surface Elevation: 96.8 m

Depth Scale (m)	Stratigraphic Symbol	Subsurface Conditions Description	Samples				Penetration / Strength Results	Moisture / Plasticity			Instrumentation Details	Groundwater Conditions	Headspace Vapor (ppm) LEL (%)	Elevation Scale (m)	Comments
			Number	Type	Blow Counts / 150mm	N Value		Plastic Limit	Natural Water Content	Liquid Limit					
							Penetration Test Values (Blows / 0.3m) X N Values ♦ Dynamic Cone + Becker Hammer Test (BPT) 20 40 60 80								
							Undrained Shear Strength Values (kPa) □ Field Vane ○ Unconfined ■ Lab Vane ● Quick Triaxial ▲ Pocket Penetrometer								
							Relative Drilling Resistance								
10.5		SILTY CLAY trace silt pockets, grey, stiff (continued)												86.5	
11.0		85.8 trace fine gravel, trace sand, very soft	11	SS	0	(29)	100							86.0	PP, Cu = < 13.5 kPa
		85.4 SHALE weathered, grey, trace limestone fragments	11A	SS	29										
			12	SS	50	50/5cm	98							85.5	
		11.4 Rock Coring Started													

BEFORE CORING	Date / Time	Water Depth (m)	Elevation (m)
	3 August 2011	1.5	95.3
	12 August 2011	10.8	86.0
	28 September 2011	11.9	84.9
	14 October 2011	10.8	86.0

Rock Core Log Next Page

Additional Notes:

This log is to be read in conjunction with accompanying general notes and borehole log symbols sheet. Stratification lines represent approximate boundary lines between material types; vertical and lateral transitions may be gradual. Water level readings were made at time(s) noted; fluctuations of groundwater levels may occur and should be expected.

Sample Types: A=Auger; DP=Direct Push; G=Grab; RC=Rock Core; SC=Soil Core; SS=Split Barrel (Split Spoon); ST=Shelby Tube.

Coffey Representatives

BB	Originated By
AC	Prepared By
IL	Checked By

LOG OF BOREHOLE HF1-32

SHEET 1 OF 2

Project Name: HANLAN FEEDERMAIN SOUTH CONTRACT 1

Client: CH2M HILL CANADA LTD.

Date: 2 - 4 August 2011

Project No.: GEOTMARK00233AA

Drilling Method Used: ROCK CORING HQ3

Northing: 4827235 m

Project Location: DIXIE RD, MISSISSAUGA

Ground Surface Elevation: 96.8 m

Easting: 616447 m

Borehole Location: SEE DRAWING

Datum Elevation: Geodetic

Diameter: 61mm

(m) STRATA ELEV DEPTH	ROCK DESCRIPTION See Soil Logs for soil descriptions.	GROUND WATER CONDITIONS	(m) CORE ELEV DEPTH	CORE SAMPLE			TOTAL CORE RECOVERY (%)	SOLID CORE RECOVERY (%)	HARD LAYER (%)	ROD (%)	FRACTURE INDEX (per 0.3m)	DISCONTINUITIES AND WEATHERING	HYDRAULIC CONDUCTIVITY k (cm/sec) [P (kPa)]	POINT LOAD TEST UCS AXIAL (MPa)	POINT LOAD TEST UCS DIAMETRAL (MPa)	UNIAxIAL COMPRESSION (MPa)	DENSITY (g/cc) [E (GPa)]
				NUMBER	SIZE	CORE RATE (m/min)											
85.4			85.4								2 4 6 8						
11.4	GEORGIAN BAY FORMATION SHALE grey, thinly laminated, interbedded with light grey LIMESTONE and SILTSTONE layers, strong to very strong Run 1: very weak, 300mm fractured zone at 11.4m, 150mm fractured zone at 12.2m Run 2: 75mm hard layer at 12.8m, 25mm hard layer at 13.0m very weak to weak, 25mm hard layer at 13.8m, 14.6m and 14.8m 75mm hard layer at 15.2m and 16.7m, 50mm hard layer at 15.4m, 15.9m and 16.1m, 100mm hard layer at 15.7m, 25mm hard layer at 16.0m, 16.3m, 16.4m, 16.5m and 16.6m weak, 25mm hard layer at 16.9m, 17.8m and 18.0m, 75mm hard layer at 17.0m, 75mm fractured zone at 17.1m 50mm hard layer at 17.2m, 18.0m and 18.2m 225mm fractured zone at 17.8m, 25mm fractured zone at 18.3m 25mm hard layer at 20.8m, 21.0m(2), 50mm hard layer at 21.3m		11.4	1	HQ3	0.15	100	60	0	33		horizontal bedding partings, closely spaced, stepped to planar, smooth to rough, open to tight, highly to moderately weathered		22	1		
			84.6														
			12.2	2	HQ3	0.19	100	85	7	80		bedding partings and joints, 0-20 degrees (two 90 degree joints), very closely to closely spaced, stepped to planar, smooth to rough, open to tight, moderately weathered		24	10		
			83.1														
			13.7	3	HQ3	0.10	100	100	5	100		horizontal bedding partings, moderately closely spaced, stepped to planar, smooth (75%) to rough (25%), tight, slightly weathered to fresh	No flow[118] ($k' < 1.00E-8$) No flow[196] ($k' < 1.00E-8$) No flow[265] ($k' < 1.00E-8$)	25	23		
			81.6														
			15.2	4	HQ3	0.11	100	83	35	57		bedding partings, contacts and joints, 0-10 degrees (two 90 degree joints), very closely to closely spaced, generally undulating, smooth (25%) to rough (75%), open, some with clay coating, moderately to slightly weathered		196	147		
			80.0														
			16.8	5	HQ3	0.07	100	72	20	70		bedding partings, contact and joint, generally horizontal (one 90 degree joint), closely spaced, stepped to planar, smooth to rough, open to tight, some with clay coating	No flow[118] ($k' < 1.00E-8$) No flow[226] ($k' < 1.00E-8$) No flow[334] ($k' < 1.00E-8$)	13	4		
			78.5														
			18.3	6	HQ3	0.08	100	90	0	90		bedding partings and joint, generally horizontal (one 90 degree joint), very closely to moderately closely spaced, generally planar, smooth to rough, open to tight, with clay coating, slightly weathered		42	12	9.4	2.6 [1]
			77.0														
			19.8	7	HQ3	0.05	100	100	8	90		horizontal bedding partings and contact, closely to moderately closely spaced, planar to undulating, smooth, open to tight, with clay coating, slightly weathered to fresh		25	<1		
			75.5														

Continued Next Page

E = Modulus of Elasticity

Additional Notes:

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Sample Types: A=Auger; DP=Direct Push; G=Grab; RC=Rock Core; SC=Soil Core; SS=Split Barrel (Split Spoon); ST=Shelby Tube.

Coffey Representatives

BB	Originated By
AC	Prepared By
IL	Checked By

LOG OF BOREHOLE HF1-32

SHEET 2 OF 2

Project Name: HANLAN FEEDERMAIN SOUTH CONTRACT 1

Client: CH2M HILL CANADA LTD.

Date: 2 - 4 August 2011

Project No.: GEOTMARK00233AA

Drilling Method Used: ROCK CORING HQ3

Northing: 4827235 m

Project Location: DIXIE RD, MISSISSAUGA

Ground Surface Elevation: 96.8 m

Easting: 616447 m

Borehole Location: SEE DRAWING

Datum Elevation: Geodetic

Diameter: 61mm

(m) STRATA ELEV DEPTH	ROCK DESCRIPTION See Soil Logs for soil descriptions.	GROUND WATER CONDITIONS	(m) CORE ELEV DEPTH	CORE SAMPLE			TOTAL CORE RECOVERY (%)	SOLID CORE RECOVERY (%)	HARD LAYER (%)	ROD (%)	FRACTURE INDEX (per 0.3m)	DISCONTINUITIES AND WEATHERING	HYDRAULIC CONDUCTIVITY k (cm/sec) [P (kPa)]	POINT LOAD TEST UCS AXIAL (MPa)	POINT LOAD TEST UCS DIAMETRAL (MPa)	UNIAxIAL COMPRESSION (MPa)	DENSITY (g/cc) [E (GPa)]
				NUMBER	SIZE	CORE RATE (m/min)											
	25mm hard layer at 22.0m, 22.1m, 22.2m and 22.7m, 50mm hard layer at 22.2m, 50mm hard layer at 22.3m and 22.8m, 200mm hard layer at 22.4m GEORGIAN BAY FORMATION SHALE grey, thinly laminated,		21.3	8	HQ3	0.07	100	93	27	77		horizontal bedding partings and joint, very closely to moderately closely spaced, stepped to planar, rough to smooth, open to tight, with clay coating, slightly weathered (<i>continued</i>)		21	5		
	interbedded with light grey LIMESTONE and SILTSTONE layers, strong to very strong (<i>continued</i>) 50mm hard layer at 22.9m, 23.2m, 23.3m and 24.3m, 175mm hard layer at 23.0m, 75mm hard layer at 23.5m and 24.2m, 125mm hard layer at 23.7m		73.9 22.9	9	HQ3	0.08	100	100	43	92		horizontal bedding partings and contacts, closely to moderately closely spaced, undulating to planar, generally smooth, generally open, with clay coating, slightly weathered to fresh		172	82	30.6	2.63 [8]
	150mm hard layer at 24.4m, 100mm hard layer at 24.5m, 25mm hard layer at 24.7m, 24.8m, 25.3m, 75mm hard layer at 24.9m and 25.7m, 50mm hard layer at 25.1m, 25.3m and 25.5m		72.4 24.4	10	HQ3	0.10	100	95	42	88		horizontal bedding partings and contacts, closely to moderately closely spaced, undulating to planar, rough to smooth, open, with clay coating		16	11	11.8	2.61 [1]
			70.9 25.9														

Date / Time	Water Depth (m)	Elevation (m)
BEFORE CORING 3 August 2011	1.5	95.3
12 August 2011	10.8	86.0
28 September 2011	11.9	84.9
14 October 2011	10.8	86.0

E = Modulus of Elasticity



Additional Notes:

This log is to be read in conjunction with accompanying general notes and borehole log symbols sheet. Stratification lines represent approximate boundary lines between material types, vertical and lateral transitions may be gradual. Water level readings were made at time(s) noted, fluctuations of groundwater levels may occur and should be expected.
Sample Types: A=Auger; DP=Direct Push; G=Grab; RC=Rock Core; SC=Soil Core; SS=Split Barrel (Split Spoon); ST=Shelby Tube.

Coffey Representatives

BB	Originated By
AC	Prepared By
IL	Checked By

LOG OF BOREHOLE HF1-33

SHEET 1 OF 1

Project Name: HANLAN FEEDERMAIN SOUTH CONTRACT 1

Client: CH2M HILL CANADA LTD.

Northing: 4827159 m

Project No.: GEOTMARK00233AA

Drilling Method Used: Hollow Stem Augering 200mm

Easting: 616538 m

Project Location: DIXIE RD, MISSISSAUGA

Date: 4 - 5 August 2011

Ground Surface Elevation: 92.8 m

Depth Scale (m)	Stratigraphic Symbol	Subsurface Conditions		Samples		Penetration / Strength Results		Moisture / Plasticity		Instrumentation Details	Groundwater Conditions	Headspace Vapor (ppm) LEL (%)	Elevation Scale (m)	Comments
		Depth / Elevation (m)	Description	Number	Type	Blow Counts / 150mm	N Value	Recovery %	Relative Drilling Resistance					
									Penetration Test Values (Blows / 0.3m) X N Values ♦ Dynamic Cone + Becker Hammer Test (BPT) 20 40 60 80					
									Undrained Shear Strength Values (kPa) □ Field Vane ○ Unconfined ■ Lab Vane ● Quick Triaxial ▲ Pocket Penetrometer					
									PL MC LL					
0.5			190mm Asphalt 400mm Granular Base										92.5	
1.0			FILL fine sand, brown, compact to dense	1	SS	12 15 15	(30)	83					92.0	
1.5		91.3											91.5	
2.0		1.5	SAND fine grained, trace to some silt, brown, wet, dense to very dense	2	SS	6 17 23	(40)	100					91.0	
2.5													90.5	
3.0													90.0	
3.5		89.8											89.5	
4.0		3.0	SANDY SILT fine grained sand, brown to grey, wet, dense	4	SS	10 13 17	(30)	100					89.0	
4.5													88.5	
5.0		88.8											88.0	
5.5		4.0	SILTY SAND fine grained sand, grey, wet, dense to compact	5A 5	SS	14 18 18	(36)	100					87.5	
6.0													87.0	
6.5			trace clay	6	SS	12 15 18	(33)	100					86.5	
7.0													86.0	
7.5													85.5	
8.0													85.0	
8.5													84.5	
8.5		85.2												
8.5		7.6	SILTY CLAY sandy, trace fine gravel, grey, hard	9	SS	8 50	50/10cm	100						PP, Cu > 241 kPa
8.5		7.8												
8.5			SHALE weathered, grey											
8.5		84.4												
8.5		8.4												

Rock Coring Started

Rock Core Log Next Page

Additional Notes:

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Sample Types: A=Auger; DP=Direct Push; G=Grab; RC=Rock Core; SC=Soil Core; SS=Split Barrel (Split Spoon); ST=Shelby Tube.

Coffey Representatives

AA	Originated By
AC	Prepared By
IL	Checked By

LOG OF BOREHOLE HF1-33

SHEET 1 OF 2

Project Name: HANLAN FEEDERMAIN SOUTH CONTRACT 1

Client: CH2M HILL CANADA LTD.

Date: 4 - 5 August 2011

Project No.: GEOTMARK00233AA

Drilling Method Used: ROCK CORING HQ3

Northing: 4827159 m

Project Location: DIXIE RD, MISSISSAUGA

Ground Surface Elevation: 92.8 m

Easting: 616538 m

Borehole Location: SEE DRAWING

Datum Elevation: Geodetic

Diameter: 61mm

(m) STRATA ELEV DEPTH	ROCK DESCRIPTION See Soil Logs for soil descriptions.	GROUND WATER CONDITIONS	(m) CORE ELEV DEPTH	CORE SAMPLE			TOTAL CORE RECOVERY (%)	SOLID CORE RECOVERY (%)	HARD LAYER (%)	RQD (%)	FRACTURE INDEX (per 0.3m)	DISCONTINUITIES AND WEATHERING	HYDRAULIC CONDUCTIVITY k (cm/sec) [P (kPa)]	POINT LOAD TEST UCS AXIAL (MPa)	POINT LOAD TEST UCS DIAMETRAL (MPa)	UNIAXIAL COMPRESSION (MPa)	DENSITY (g/cc) [E (GPa)]	
				NUMBER	SIZE	CORE RATE (m/min)												
84.4			84.4								2 4 6 8							
8.4	GEORGIAN BAY FORMATION SHALE grey, thinly laminated, interbedded with light grey LIMESTONE and SILTSTONE layers, strong to very strong extremely to very weak, 25mm hard layer at 9.1m, weak, 25mm hard layer at 10.3m and 11.0m extremely to very weak, 100mm lost core at 11.1m, 1200mm fractured zone at 11.2m, 50mm lost core at 12.4m weak, 75mm hard layer at 17.6m, 50mm hard layer at 17.9m, 25mm hard layer at 18.0m 50mm hard layer at 14.3m, 25mm hard layer at 17.9m, 50mm hard layer at 17.8m and 18.2m, 25mm hard layer at 18.0m and 18.5m, 75mm hard layer at 18.1m, 125mm hard layer at 18.3m		8.4									horizontal bedding partings and contact, very closely to closely spaced, planar, generally rough, open, highly to slightly weathered	14	1				
			83.3	1	HQ3	0.36	83	57	2	40								
			9.5															horizontal bedding partings and contact, very closely to moderately closely spaced, planar, generally smooth, open to tight, fresh
			81.7	2	HQ3	0.26	100	100	3	100								
			11.1															horizontal bedding partings, very closely spaced (fractured zone), stepped, smooth, open, highly weathered
			80.3	3	HQ3	0.36	89	46	10	7								
			12.5															horizontal bedding partings and contacts, very closely to moderately closely spaced, planar, rough, open, occasionally with clay coating, moderately to slightly weathered
			78.8	4	HQ3	0.30	100	98	0	82								
			14.0															horizontal bedding partings and contact, closely to moderately closely spaced, planar, rough (75%) to smooth (25%), open (60%) to tight (40%), some with clay coating, slightly weathered to fresh
			77.3	5	HQ3	0.25	95	87	3	80								
15.5											bedding partings and contact, 0-10 degrees, very closely to moderately closely spaced, generally planar, rough (40%) to smooth (60%), open (80%) to tight (20%), occasionally with clay coating, fresh							
75.7																		
17.1												horizontal bedding parting and contacts, closely to widely spaced, undulating to planar, smooth to rough, open (80%) to tight (20%), some with clay coating	65	77				
	7	HQ3	0.30	98	98	23	92											

Continued Next Page

E = Modulus of Elasticity

Additional Notes:

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Sample Types: A=Auger; DP=Direct Push; G=Grab; RC=Rock Core; SC=Soil Core; SS=Split Barrel (Split Spoon); ST=Shelby Tube.

Coffey Representatives

AA	Originated By
AC	Prepared By
IL	Checked By

LOG OF BOREHOLE HF1-33

SHEET 2 OF 2

Project Name: HANLAN FEEDERMAIN SOUTH CONTRACT 1

Client: CH2M HILL CANADA LTD.

Date: 4 - 5 August 2011

Project No.: GEOTMARK00233AA

Drilling Method Used: ROCK CORING HQ3

Northing: 4827159 m

Project Location: DIXIE RD, MISSISSAUGA

Ground Surface Elevation: 92.8 m

Easting: 616538 m

Borehole Location: SEE DRAWING

Datum Elevation: Geodetic

Diameter: 61mm

(m) STRATA ELEV DEPTH	ROCK DESCRIPTION See Soil Logs for soil descriptions.	GROUND WATER CONDITIONS	(m) CORE ELEV DEPTH	CORE SAMPLE			TOTAL CORE RECOVERY (%)	SOLID CORE RECOVERY (%)	HARD LAYER (%)	ROD (%)	FRACTURE INDEX (per 0.3m)	DISCONTINUITIES AND WEATHERING	HYDRAULIC CONDUCTIVITY k (cm/sec) [P (kPa)]	POINT LOAD TEST UCS AXIAL (MPa)	POINT LOAD TEST UCS DIAMETRAL (MPa)	UNIAxIAL COMPRESSION (MPa)	DENSITY (g/cc) [E (GPa)]
				NUMBER	SIZE	CORE RATE (m/min)											
	GEORGIAN BAY FORMATION SHALE grey, thinly laminated, interbedded with light grey LIMESTONE and SILTSTONE layers, strong to very strong (<i>continued</i>) 150mm hard layer at 18.8m and 19.8m, 50mm hard layer at 19.2m, 425mm hard layer at 19.3m		74.2 18.6									horizontal contact, widely spaced, planar, smooth, open, some with clay coating		45	45		
	weak to medium strong, 50mm hard layer at 20.2m, 20.6m and 21.6m, 25mm hard layer at 20.4m		72.7 20.1	8	HQ3	0.31	100	100	31	100		horizontal contacts and bedding parting, closely to moderately closely spaced, planar, rough to smooth, open		95	28		
	75mm hard layer at 22.6m, 200mm hard layer at 22.9m		71.2 21.6	9	HQ3	0.30	100	100	10	100		horizontal bedding partings and contact, closely to moderately closely spaced, planar, rough, open, some with clay infill		25	29	69.3	2.66 [20]
	50mm hard layer at 23.2m, 23.5m and 24.4m, 25mm hard layer at 23.4m, 23.6m and 24.6m		69.6 23.2	10	HQ3	0.26	98	98	18	97		horizontal bedding partings and contact, closely to moderately closely spaced, planar to undulating, smooth (30%) to rough (70%), generally open, some with clay infill		190	70		
	100mm hard layer at 24.9m, 75mm hard layer at 25.2m, 150mm hard layer at 25.4m, 25mm hard layer at 25.6m and 26.0m		68.0 24.8	11	HQ3	0.27	100	97	20	88		horizontal bedding partings and contacts, closely spaced, generally planar, smooth (60%) to rough (40%), open, some with clay infill		224	170	60.8	2.69 [13]
			66.6 26.2	12	HQ3	0.28	100	100	27	87							

Date / Time

Water Depth (m)

Elevation (m)

E = Modulus of Elasticity



Additional Notes:

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Sample Types: A=Auger; DP=Direct Push; G=Grab; RC=Rock Core; SC=Soil Core; SS=Split Barrel (Split Spoon); ST=Shelby Tube.

Coffey Representatives

AA	Originated By
AC	Prepared By
IL	Checked By

LOG OF BOREHOLE HF1-34

SHEET 1 OF 1

Project Name: HANLAN FEEDERMAIN SOUTH CONTRACT 1

Client: CH2M HILL CANADA LTD.

Northing: 4827093 m

Project No.: GEOTMARK00233AA

Drilling Method Used: Hollow Stem Augering 200mm

Easting: 616607 m

Project Location: DIXIE RD, MISSISSAUGA

Date: 10 - 15 August 2011

Ground Surface Elevation: 90.4 m

Depth Scale (m)	Stratigraphic Symbol	Subsurface Conditions		Samples		Penetration / Strength Results				Moisture / Plasticity			Instrumentation Details	Groundwater Conditions	Headspace Vapor (ppm) LEL (%)	Elevation Scale (m)	Comments
		Depth / Elevation (m)	Description	Number	Type	Blow Counts / 150mm	N Value	Recovery %	Relative Drilling Resistance	Penetration Test Values (Blows / 0.3m)	Plastic Limit	Natural Water Content	Liquid Limit				
										X N Values + Becker Hammer Test (BPT) 20 40 60 80							
										Undrained Shear Strength Values (kPa) □ Field Vane ○ Unconfined ■ Lab Vane ● Quick Triaxial ▲ Pocket Penetrometer	PL	MC	LL				
0.5			175mm Asphalt 250mm Granular Base														
1.0			FILL silty sand, fine to coarse sand, wet, brown to grey, compact	1	SS	4 6 7	(13)	78									
1.5		88.9	CLAYEY SILT trace to some fine sand, grey, very stiff to hard	2	SS	5 6 10	(16)	89									
2.0																	
2.5			thinly laminated	3	SS	6 8 10	(18)	89									
3.0																	
3.5				4	SS	12 15 16	(31)	100									
4.0		86.6	SILT trace to some clay, trace to some fine sand, grey, very stiff	5	SS	9 13 14	(27)	100									
4.5																	
5.0				6	SS	8 10 11	(21)	100									
5.5		85.1	SILTY CLAY grey, soft	7	SS	1 1 2	(3)	100									
6.0																	
6.5		84.3	SHALE weathered, grey	8	SS	50	50/13cm	99									
7.0																	
7.4				9	SS	50	50/5cm	98									

Rock Coring Started

	Date / Time	Water Depth (m)	Elevation (m)
BEFORE CORING	10 August 2011	1.4	89.0
	28 September 2011	5.7	84.7
	14 October 2011	5.6	84.8

Rock Core Log Next Page



Additional Notes:

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Sample Types: A=Auger; DP=Direct Push; G=Grab; RC=Rock Core; SC=Soil Core; SS=Split Barrel (Split Spoon); ST=Shelby Tube.

Coffey Representatives

BB	Originated By
AC	Prepared By
IL	Checked By

LOG OF BOREHOLE HF1-34

SHEET 1 OF 2

Project Name: HANLAN FEEDERMAIN SOUTH CONTRACT 1

Client: CH2M HILL CANADA LTD.

Date: 10 - 15 August 2011

Project No.: GEOTMARK00233AA

Drilling Method Used: ROCK CORING HQ3

Northing: 4827093 m

Project Location: DIXIE RD, MISSISSAUGA

Ground Surface Elevation: 90.4 m

Easting: 616607 m

Borehole Location: SEE DRAWING

Datum Elevation: Geodetic

Diameter: 61mm

(m) STRATA ELEV DEPTH	ROCK DESCRIPTION See Soil Logs for soil descriptions.	GROUND WATER CONDITIONS	(m) CORE DEPTH	CORE SAMPLE			TOTAL CORE RECOVERY (%)	SOLID CORE RECOVERY (%)	HARD LAYER (%)	ROD (%)	FRACTURE INDEX (per 0.3m)	DISCONTINUITIES AND WEATHERING	HYDRAULIC CONDUCTIVITY k (cm/sec) [P (kPa)]	POINT LOAD TEST UCS AXIAL (MPa)	POINT LOAD TEST UCS DIAMETRAL (MPa)	UNIAxIAL COMPRESSION (MPa)	DENSITY (g/cc) [E (GPa)]
				NUMBER	SIZE	CORE RATE (m/min)											
83.0			83.0														
7.4	GEORGIAN BAY FORMATION SHALE grey, thinly laminated		7.4	1	HQ3	0.13	100	10	0	0		fractured zone with clay infill, highly weathered					
			82.8														
			7.6									horizontal bedding partings and joints, closely to moderately closely spaced, planar to undulating, rough to smooth, open to tight, some with clay coating, moderately to slightly weathered		13	2		
	interbedded with light grey LIMESTONE and SILTSTONE layers, strong to very strong Run 1: very weak to weak, 250mm fractured zone at 7.4m, Run 2: 75mm fractured zone at 7.7m, 50mm hard layer at 7.6m		81.3	2	HQ3	0.06	100	95	3	68							
			9.1									bedding partings, contacts and joints, 0-45 degrees (three 90 degree joints), very closely to closely spaced, generally undulating, rough and open, some with clay coating		31	52		
	75mm hard layer at 9.4m, 225mm hard layer at 9.5m, 25mm hard layer at 9.8m, 102m, 10.3m and 10.4m, 50mm hard layer at 9.8m, 100mm hard layer at 10.0m		79.7	3	HQ3	0.11	100	90	37	62							
			10.7									bedding partings, contacts and joint, 0-10 degrees, very closely to closely spaced, generally undulating, rough, open to healed, some with clay coating, slightly weathered	No flow[147] ($k' < 1.00E-8$) No flow[226] ($k' < 1.00E-8$) No flow[294] ($k' < 1.00E-8$)	7	3		
	125mm hard layer at 10.7m, 25mm hard layer at 11.1m, 11.2m and 11.8m, 50mm hard layer at 11.5m		78.2	4	HQ3	0.08	100	100	17	60							
			12.2									horizontal bedding partings, closely spaced, generally planar, generally smooth, open (30%) to tight (70%), some with clay coating (30%)		10	2		
	25mm hard layer at 12.9m		76.7	5	HQ3	0.08	100	100	3	93				9	3		
			13.7									horizontal bedding partings and contact, closely to moderately closely spaced, generally planar, generally smooth (60%), open (60%) to tight (40%), with clay coating, slightly weathered to fresh	1.80E-6 [147]			21.9	2.59 [4]
	25mm hard 14.2m, 14.6m and 14.9m		75.2	6	HQ3	0.08	100	98	3	95							
			15.2									contacts, joints and bedding parting, generally horizontal (one 90 degree joint), very closely to closely spaced, undulating to planar, smooth to rough, open to healed, some with clay coating, slightly to moderately weathered	5.19E-6 [255] 9.34E-6 [363]				
	25mm hard layer at 15.6m, 50mm hard layer at 15.2m and 16.6m, 300mm hard layer at 16.0m, 100mm hard layer at 16.4m		73.6	7	HQ3	0.05	100	95	35	58				70	38		
			16.8														
	25mm fractured zone at 16.8m, 50mm hard layer at 17.3m, 75mm hard layer at 17.5m and 17.7m															93.4	2.63 [21]

Continued Next Page

E = Modulus of Elasticity



Additional Notes:

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Sample Types: A=Auger; DP=Direct Push; G=Grab; RC=Rock Core; SC=Soil Core; SS=Split Barrel (Split Spoon); ST=Shelby Tube.

Coffey Representatives

BB	Originated By
AC	Prepared By
IL	Checked By

LOG OF BOREHOLE HF1-34

SHEET 2 OF 2

Project Name: HANLAN FEEDERMAIN SOUTH CONTRACT 1

Client: CH2M HILL CANADA LTD.

Date: 10 - 15 August 2011

Project No.: GEOTMARK00233AA

Drilling Method Used: ROCK CORING HQ3

Northing: 4827093 m

Project Location: DIXIE RD, MISSISSAUGA

Ground Surface Elevation: 90.4 m

Easting: 616607 m

Borehole Location: SEE DRAWING

Datum Elevation: Geodetic

Diameter: 61mm

(m) STRATA ELEV DEPTH	ROCK DESCRIPTION See Soil Logs for soil descriptions.	GROUND WATER CONDITIONS	(m) CORE ELEV DEPTH	CORE SAMPLE			TOTAL CORE RECOVERY (%)	SOLID CORE RECOVERY (%)	HARD LAYER (%)	ROD (%)	FRACTURE INDEX (per 0.3m)	DISCONTINUITIES AND WEATHERING	HYDRAULIC CONDUCTIVITY k (cm/sec) [P (kPa)]	POINT LOAD TEST UCS AXIAL (MPa)	POINT LOAD TEST UCS DIAMETRAL (MPa)	UNIAxIAL COMPRESSION (MPa)	DENSITY (g/cc) [E (GPa)]
				NUMBER	SIZE	CORE RATE (m/min)											
	GEORGIAN BAY FORMATION SHALE grey, thinly laminated interbedded with light grey LIMESTONE and SILTSTONE layers, strong to very strong (<i>continued</i>) 75mm hard layer at 16.3m, 16.7m, 18.9m and 19.6m, 50mm hard layer at 16.5m and 18.6m, 225mm hard layer at 18.3m, 25mm hard layer at 18.7m, 125mm hard layer at 19.7m 75mm hard layer at 19.9m and 20.9m, 25mm hard layer at 20.4m, 20.5m, 20.7m, 21.1m and 21.1m, 50mm hard layer at 20.8m weak to medium strong, 75mm hard layer at 21.3m, 25mm hard layer at 21.5m, 22.1m, 22.4m, 50mm hard layer at 21.8m and 22.5m, 125mm hard layer at 22.2m 25mm hard layer at 23.1m, 23.3m, 23.5m and 24.0m, 50mm hard layer at 23.5m, 23.7m and 24.2m			8	HQ3	0.11	100	97	42	70		contacts and bedding partings, 0-10 degrees, closely to moderately closely spaced, planar to undulating, generally smooth, open to tight, some with clay coating (<i>continued</i>)	No flow[186] ('k' < 1.00E-8) No flow[324] ('k' < 1.00E-8) No flow[461] ('k' < 1.00E-8)	85	57		
			72.1 18.3									horizontal bedding partings and contact, closely to moderately closely spaced, undulating to planar, smooth, open, some with clay coating, slightly weathered to fresh		13	10		
			70.6 19.8	9	HQ3	0.11	100	100	52	95		bedding partings, 0-10 degrees, moderately closely spaced, undulating to planar, smooth to rough, tight to open, with clay coating		24	3	13.8	2.62 [2]
			69.1 21.3									bedding partings and contact, 0-45 degrees, closely to moderately closely spaced, planar to stepped, smooth to rough, open, with clay coating		57	109		
			67.5 22.9	11	HQ3	0.08	100	98	25	98		horizontal bedding partings and joint, moderately closely spaced, undulating, smooth (50%) to rough (50%), open to tight, with clay coating		8	8		
			66.0 24.4	12	HQ3		98	98	17	93							

Date / Time	Water Depth (m)	Elevation (m)
BEFORE CORING 10 August 2011	1.4	89.0
28 September 2011	5.7	84.7
14 October 2011	5.6	84.8

E = Modulus of Elasticity



Additional Notes:

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Coffey Representatives

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LOG OF BOREHOLE HF1-34-1

SHEET 1 OF 1

Project Name: HANLAN FEEDERMAIN SOUTH CONTRACT 1

Client: CH2M HILL CANADA LTD.

Northing: 4827092 m

Project No.: GEOTMARK00233AA

Drilling Method Used: Hollow Stem Augering 200mm

Easting: 616609 m

Project Location: DIXIE RD, MISSISSAUGA

Date: 15 August 2011

Ground Surface Elevation: 90.4 m

Depth Scale (m)	Subsurface Conditions		Samples		Penetration / Strength Results		Moisture / Plasticity		Instrumentation Details	Groundwater Conditions	Headspace Vapor (ppm) LEL (%)	Elevation Scale (m)	Comments
	Stratigraphic Symbol	Depth / Elevation (m)	Description	Number Type	Blow Counts / 150mm N Value	Recovery %	Relative Drilling Resistance	Penetration Test Values (Blows / 0.3m) X N Values ♦ Dynamic Cone + Becker Hammer Test (BPT) Undrained Shear Strength Values (kPa) □ Field Vane ○ Unconfined ■ Lab Vane ● Quick Triaxial ▲ Pocket Penetrometer	Plastic Limit Natural Water Content Liquid Limit				
0.5			See log of Borehole HF1-29 for stratigraphy.									90.0	
1.0												89.5	
1.5												89.0	
2.0												88.5	
2.5												88.0	
3.0												87.5	
3.5												87.0	
4.0												86.5	
4.5												86.0	
5.0												85.5	

85.1
5.3

BOREHOLE HF1-34-1
TERMINATED AT 5.3m BGL

Date / Time
28 September 2011
14 October 2011

Water Depth (m)
1.9
1.8

Elevation (m)
88.5
88.6

SOIL LOG FOR CH2M GEOTMARK00233AA_BH25 TO BH37.GPJ COFFEY STANDARD.GDT 30/5/12



Additional Notes:

This log is to be read in conjunction with accompanying general notes and borehole log symbols sheet. Stratification lines represent approximate boundary lines between material types, vertical and lateral transitions may be gradual. Water level readings were made at time(s) noted, fluctuations of groundwater levels may occur and should be expected.
Sample Types: A=Auger; DP=Direct Push; G=Grab; RC=Rock Core; SC=Soil Core; SS=Split Barrel (Split Spoon); ST=Shelby Tube.

Coffey Representatives

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AC	Prepared By
IL	Checked By

LOG OF BOREHOLE HF1-35

SHEET 1 OF 1

Project Name: HANLAN FEEDERMAIN SOUTH CONTRACT 1	Client: CH2M HILL CANADA LTD.	Northing: 4826982 m
Project No.: GEOTMARK00233AA	Drilling Method Used: Hollow Stem Augering 200mm	Easting: 616720 m
Project Location: DIXIE RD, MISSISSAUGA	Date: 8 - 10 August 2011	Ground Surface Elevation: 83.0 m

Depth Scale (m)	Subsurface Conditions		Samples		Penetration / Strength Results		Moisture / Plasticity		Instrumentation Details	Groundwater Conditions	Headspace Vapor (ppm) LEL (%)	Elevation Scale (m)	Comments
	Stratigraphic Symbol	Depth / Elevation (m)	Description	Number Type	Blow Counts / 150mm N Value	Recovery %	Relative Drilling Resistance	Penetration Test Values (Blows / 0.3m) X N Values ♦ Dynamic Cone + Becker Hammer Test (BPT) 20 40 60 80 Undrained Shear Strength Values (kPa) □ Field Vane ○ Unconfined ■ Lab Vane ● Quick Triaxial ▲ Pocket Penetrometer	Plastic Limit Natural Water Content Liquid Limit PL MC LL				
0.5		82.2	200mm Asphalt Granular Base									82.5	
1.0		0.8	SHALE weathered, grey, hard	1 SS	30	50/3cm	86					82.0	
1.5		81.5		2 SS	50	50/8cm	100					81.5	Borehole dry on completion before coring.

Rock Coring Started

Rock Core Log Next Page

Additional Notes:

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Sample Types: A=Auger; DP=Direct Push; G=Grab; RC=Rock Core; SC=Soil Core; SS=Split Barrel (Split Spoon); ST=Shelby Tube.

Coffey Representatives

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IL	Checked By

LOG OF BOREHOLE HF1-35

SHEET 1 OF 2

Project Name: HANLAN FEEDERMAIN SOUTH CONTRACT 1

Client: CH2M HILL CANADA LTD.

Date: 8 - 10 August 2011

Project No.: GEOTMARK00233AA

Drilling Method Used: ROCK CORING HQ3

Northing: 4826982 m

Project Location: DIXIE RD, MISSISSAUGA

Ground Surface Elevation: 83.0 m

Easting: 616720 m

Borehole Location: SEE DRAWING

Datum Elevation: Geodetic

Diameter: 61mm

(m) STRATA ELEV DEPTH	ROCK DESCRIPTION See Soil Logs for soil descriptions.	GROUND WATER CONDITIONS	(m) CORE ELEV DEPTH	CORE SAMPLE			TOTAL CORE RECOVERY (%)	SOLID CORE RECOVERY (%)	HARD LAYER (%)	RQD (%)	FRACTURE INDEX (per 0.3m)	DISCONTINUITIES AND WEATHERING	HYDRAULIC CONDUCTIVITY k (cm/sec) [P (kPa)]	POINT LOAD TEST UCS AXIAL (MPa)	POINT LOAD TEST UCS DIAMETRAL (MPa)	UNIAxIAL COMPRESSION (MPa)	DENSITY (g/cc) [E (GPa)]
				NUMBER	SIZE	CORE RATE (m/min)											
81.5			81.5								2 4 6 8						
1.5	GEORGIAN BAY FORMATION SHALE		1.5 81.3	1	HQ3	0.10	75	25	0	0		highly weathered		10	5		
	grey, thinly laminated		1.7									horizontal contacts and bedding partings, closely to moderately closely spaced, planar, smooth (50%) to rough (50%), open, slightly weathered					
	interbedded with light grey LIMESTONE and SILTSTONE layers, strong to very strong Run1: extremely weak, 200mm fractured zone at 1.5m Run2: weak 25mm hard layer at 2.4m, 50mm hard layer at 2.5m and 3.2m, 200mm hard layer at 2.8m Run 3: 25mm hard layer at 3.7m, 3.9m and 4.3m, 50mm hard layer at 3.3m and 3.5m, 150mm hard layer at 3.7m and 4.0m,		79.7	2	HQ3	0.22	98	93	22	77							
	25mm hard layer at 4.7m, 4.8m and 5.1m, 50mm hard layer at 5.0m and 5.2m		3.3	3	HQ3	0.12	92	85	36	67		horizontal contacts and bedding partings, very closely to moderately closely spaced, planar, smooth (20%) to rough (80%), open, slightly weathered					
	75mm hard layer at 6.1m, 150mm hard layer at 7.4m		78.4	4	HQ3	0.08	100	98	12	65		horizontal contacts and bedding partings, very closely to moderately closely spaced, planar, smooth (50%) to rough (50%), generally open, fresh to slightly weathered					
	25mm highly weathered zone at 7.8m and 7.9m, 75mm hard layer at 8.0m, 100mm hard layer at 8.9m		76.9	5	HQ3	0.13	100	100	16	84		horizontal contacts and bedding partings, closely to moderately closely spaced, planar, smooth (80%) to rough (20%), generally open, fresh					
	75mm hard layer at 9.1m		75.5	6	HQ3	0.09	100	98	11	79		horizontal contacts and bedding partings, very closely to closely spaced, planar, smooth (50%) to rough (50%), open, fresh to slightly weathered					
	Run 8: 50mm hard layer at 9.4m, 10.5m and 10.8m, 25mm hard layer at 9.5m, 9.6m, 9.7m, 10.0m and 10.1m, 100mm hard layer at 9.8m, 300mm fractured zone at 10.0m and 10.6m 175mm hard layer at 10.2m, 75mm hard layer at 10.7m		73.9	7	HQ3	0.10	100	100	38	100		unfractured					
	Run 9: 25mm hard layer at 10.9m and 12.2m, 50mm hard layer at 11.0m and 12.0m, 175mm hard layer at 11.1m,		9.1 73.7 9.3	8	HQ3	0.22	100	92	43	92		horizontal contact, undulating, rough, open, with clay infill					
			72.1 10.9														

Continued Next Page

E = Modulus of Elasticity

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Sample Types: A=Auger; DP=Direct Push; G=Grab; RC=Rock Core; SC=Soil Core; SS=Split Barrel (Split Spoon); ST=Shelby Tube.

Coffey Representatives

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AC	Prepared By
IL	Checked By

LOG OF BOREHOLE HF1-35

SHEET 2 OF 2

Project Name: HANLAN FEEDERMAIN SOUTH CONTRACT 1

Client: CH2M HILL CANADA LTD.

Date: 8 - 10 August 2011

Project No.: GEOTMARK00233AA

Drilling Method Used: ROCK CORING HQ3

Northing: 4826982 m

Project Location: DIXIE RD, MISSISSAUGA

Ground Surface Elevation: 83.0 m

Easting: 616720 m

Borehole Location: SEE DRAWING

Datum Elevation: Geodetic

Diameter: 61mm

(m) STRATA ELEV DEPTH	ROCK DESCRIPTION See Soil Logs for soil descriptions.	GROUND WATER CONDITIONS	(m) CORE ELEV DEPTH	CORE SAMPLE			TOTAL CORE RECOVERY (%)	SOLID CORE RECOVERY (%)	HARD LAYER (%)	ROD (%)	FRACTURE INDEX (per 0.3m)	DISCONTINUITIES AND WEATHERING	HYDRAULIC CONDUCTIVITY k (cm/sec) [P (kPa)]	POINT LOAD TEST UCS AXIAL (MPa)	POINT LOAD TEST UCS DIAMETRAL (MPa)	UNIAxIAL COMPRESSION (MPa)	DENSITY (g/cc) [E (GPa)]
				NUMBER	SIZE	CORE RATE (m/min)											
	150mm hard layer at 11.5m GEORGIAN BAY FORMATION SHALE grey, thinly laminated			9	HQ3	0.25	100	100	33	93		contacts, bedding partings and joint, generally horizontal (one 90 degree joint 125mm), closely to moderately closely spaced, planar, smooth to rough, open to tight, fresh (<i>continued</i>)		22	64	16.8	2.59 [3]
	interbedded with light grey LIMESTONE and SILTSTONE layers, strong to very strong (<i>continued</i>) Run 10: 25mm hard layer at 12.5m, 12.9m, 13.2m and 13.7m 150mm hard layer at 13.3m		70.7 12.3									horizontal bedding partings, closely to moderately closely spaced, planar, smooth (50%) to rough (50%), open to tight, fresh		12	4		
	75mm vertical fracture at 14.1m, 100mm hard layer at 14.1m, 25mm hard layer at 14.2m, 14.3m, 14.4m, 14.6m and 14.7m, 75mm hard layer at 14.5m and 15.1m		69.1 13.9	11	HQ3	0.30	100	100	25	98		contacts, bedding partings and joint, generally horizontal (one 90 degree joint 75mm) closely to moderately closely spaced, planar, smooth, open to tight, fresh		82	62		
	75mm hard layer at 15.4m and 16.8m, 25mm hard layer at 15.5m, 15.6m, 16.0m, 16.4m and 16.7m, 50mm hard layer at 16.1m, 100mm hard layer at 15.7m and 16.3m		67.6 15.4	12	HQ3	0.31	100	100	34	100		horizontal bedding partings, closely to moderately closely spaced, planar to undulating, smooth (70%) to rough (30%), open, some with clay infill, fresh		134	111		
	75mm hard layer at 17.0m, 25mm hard layer at 17.3m, 17.4m and 18.3m 25mm highly weathered at 17.3m, 17.5m and 17.6m, 50mm hard layer at 17.5m		66.0 17.0	13	HQ3	0.21	100	98	14	83		horizontal contacts and bedding partings, closely to moderately closely spaced, planar, generally smooth, open to tight, occasional clay infill, fresh		41	35	16.7	2.59 [3]
	25mm hard layer at 18.5m, 18.6m and 18.7m, 100mm hard layer at 18.9m		64.5 18.5 64.0 19.1	14	HQ3		100	100	30	91		horizontal bedding partings, closely to moderately closely spaced, planar, smooth to rough, open, some with clay infill, fresh		31	78		

Date / Time

Water Depth (m)

Elevation (m)

E = Modulus of Elasticity



Additional Notes:

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Coffey Representatives

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LOG OF BOREHOLE HF1-35A

SHEET 1 OF 1

Project Name: HANLAN FEEDERMAIN SOUTH CONTRACT 1

Client: CH2M HILL CANADA LTD.

Northing: 4826947 m

Project No.: GEOTMARK00233AA

Drilling Method Used: Hollow Stem Augering 200mm

Easting: 616759 m

Project Location: DIXIE RD, MISSISSAUGA

Date: 2 - 6 September 2011

Ground Surface Elevation: 82.8 m

Depth Scale (m)	Subsurface Conditions		Samples		Penetration / Strength Results		Moisture / Plasticity		Instrumentation Details	Groundwater Conditions	Headspace Vapor (ppm) LEL (%)	Elevation Scale (m)	Comments
	Stratigraphic Symbol	Depth / Elevation (m)	Description	Number Type	Blow Counts / 150mm N Value	Recovery %	Relative Drilling Resistance	Penetration Test Values (Blows / 0.3m) X N Values ♦ Dynamic Cone + Becker Hammer Test (BPT) 20 40 60 80 Undrained Shear Strength Values (kPa) □ Field Vane ○ Unconfined ■ Lab Vane ● Quick Triaxial ▲ Pocket Penetrometer	Plastic Limit Natural Water Content Liquid Limit				
0.5		82.0	100mm Asphalt 500mm Granular Base									82.5	
1.0		0.8	SHALE weathered, grey, hard	1 SS 37 50	50/10cm 100							82.0	
1.5				2 SS 42 50	50/8cm 100							81.5	
2.0												81.0	
2.5				3 SS 50	50/8cm 100							80.5	
2.7		80.1		4 SS 50	50/2cm 104							80.5	Water Level measured at 2.29m bgl.

Rock Coring Started

	Date / Time	Water Depth (m)	Elevation (m)
BEFORE CORING	2 September 2011	1.4	81.4
ARTESIAN	28 September 2011	0.0	82.8
ARTESIAN	14 October 2011	0.0	82.8

Rock Core Log Next Page



Additional Notes:

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Sample Types: A=Auger; DP=Direct Push; G=Grab; RC=Rock Core; SC=Soil Core; SS=Split Barrel (Split Spoon); ST=Shelby Tube.

Coffey Representatives

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AC	Prepared By
IL	Checked By

LOG OF BOREHOLE HF1-35A

SHEET 1 OF 2

Project Name: HANLAN FEEDERMAIN SOUTH CONTRACT 1

Client: CH2M HILL CANADA LTD.

Date: 2 - 6 September 2011

Project No.: GEOTMARK00233AA

Drilling Method Used: ROCK CORING HQ3

Northing: 4826947 m

Project Location: DIXIE RD, MISSISSAUGA

Ground Surface Elevation: 82.8 m

Easting: 616759 m

Borehole Location: SEE DRAWING

Datum Elevation: Geodetic

Diameter: 61mm

(m) STRATA ELEV DEPTH	ROCK DESCRIPTION See Soil Logs for soil descriptions.	GROUND WATER CONDITIONS	(m) CORE ELEV DEPTH	CORE SAMPLE			TOTAL CORE RECOVERY (%)	SOLID CORE RECOVERY (%)	HARD LAYER (%)	ROD (%)	FRACTURE INDEX (per 0.3m)	DISCONTINUITIES AND WEATHERING	HYDRAULIC CONDUCTIVITY k (cm/sec) [P (kPa)]	POINT LOAD TEST UCS AXIAL (MPa)	POINT LOAD TEST UCS DIAMETRAL (MPa)	UNIAxIAL COMPRESSION (MPa)	DENSITY (g/cc) [E (GPa)]
				NUMBER	SIZE	CORE RATE (m/min)											
80.1			80.1														
2.7	GEORGIAN BAY FORMATION SHALE grey, thinly laminated		2.7	1	HQ3	0.20	100	0	17	0		highly weathered					
	interbedded with light grey LIMESTONE and SILTSTONE layers, strong to very strong		79.5														
	Run 1: weak, 600mm fractured zone at 2.7m, 25mm hard layer at 2.8m and 3.0m, 50mm hard layer at 3.3m		3.3	2	HQ3	0.22	100	90	42	33		horizontal contacts, bedding partings and joint, very closely to moderately closely spaced, planar to undulating, smooth to rough, tight to open, occasional clay infill, slightly to moderately weathered		134 214	9 60		
	Run 2: 75mm hard layer at 3.3m, 3.6m and 4.3m, 450mm hard layer at 3.8m, 50mm fractured zone at 4.2m, 25mm hard layer at 4.5m		78.0														
	Run 3: very weak to weak, 50mm fractured zone at 4.8m, 125mm hard layer at 4.9m, 75mm hard layer at 5.4m,		4.8	3	HQ3	0.25	100	97	13	87		horizontal contacts and bedding partings, closely to moderately closely spaced, planar to undulating, smooth 50% to rough (50%), open to tight, slightly weathered		16	7		
	75mm fractured zone at 6.5m, 25mm hard layer at 7.4m 50mm fractured zone at 7.4m		76.5														
			6.3	4	HQ3	0.19	100	97	2	58		horizontal bedding partings, closely spaced, planar to undulating, generally smooth, tight to open, some clay coating on bedding partings, slightly weathered to fresh.	No flow[69] ($k' < 1.00E-8$) No flow[137] ($k' < 1.00E-8$)	17	2		
	250mm fractured zone at 7.9m, 100mm hard layer at 7.9m and 9.1m 25mm fractured zone at 8.3m, 50mm hard layer at 8.5m and 8.7m 25mm hard layer at 8.8m, 9.3m		74.9														
			7.9	5	HQ3	0.10	100	92	23	53		horizontal contacts and bedding partings, very closely to moderately closely spaced, stepped to undulating, smooth to rough, open	No flow[206] ($k' < 1.00E-8$)	9			
	25mm hard layer at 9.5m, 10.3m, 10.8m and 10.9m 50mm hard layer at 9.5m, 9.7m, 10.4m and 10.7m 250mm hard layer at 10.0m, 75mm hard layer at 10.5m and 10.6m		73.4														
			9.4	6	HQ3	0.15	100	100	47	87		horizontal contacts and bedding parting, closely to moderately closely spaced, planar to undulating, smooth (30%) to rough (70%), tight to open, occasional clay infill, fresh to slightly weathered		28	3	7	2.58 [1]
	75mm hard layer at 10.9m and 12.0m, 125mm hard layer at 11.0m, 150mm hard layer at 11.6m, 25mm hard layer at 11.7m, 50mm hard layer at 11.8m, 12.2m and 12.3m		71.9														
			10.9	7	HQ3	0.15	100	98	40	83		horizontal contacts, bedding parting and joint, closely spaced, undulating, rough	No flow[98] ($k' < 1.00E-8$) No flow[206] ($k' < 1.00E-8$) No	48	37		
	50mm hard layer at 12.6m, 13.0m and		70.4														
			12.4														

Continued Next Page

E = Modulus of Elasticity

Additional Notes:

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Sample Types: A=Auger; DP=Direct Push; G=Grab; RC=Rock Core; SC=Soil Core; SS=Split Barrel (Split Spoon); ST=Shelby Tube.

Coffey Representatives

BB	Originated By
AC	Prepared By
IL	Checked By

LOG OF BOREHOLE HF1-35A

SHEET 2 OF 2

Project Name: HANLAN FEEDERMAIN SOUTH CONTRACT 1

Client: CH2M HILL CANADA LTD.

Date: 2 - 6 September 2011

Project No.: GEOTMARK00233AA

Drilling Method Used: ROCK CORING HQ3

Northing: 4826947 m

Project Location: DIXIE RD, MISSISSAUGA

Ground Surface Elevation: 82.8 m

Easting: 616759 m

Borehole Location: SEE DRAWING

Datum Elevation: Geodetic

Diameter: 61mm

(m) STRATA ELEV DEPTH	ROCK DESCRIPTION See Soil Logs for soil descriptions.	GROUND WATER CONDITIONS	(m) CORE ELEV DEPTH	CORE SAMPLE			TOTAL CORE RECOVERY (%)	SOLID CORE RECOVERY (%)	HARD LAYER (%)	ROD (%)	FRACTURE INDEX (per 0.3m)	DISCONTINUITIES AND WEATHERING	HYDRAULIC CONDUCTIVITY k _t (cm/sec) [P (kPa)]	POINT LOAD TEST UCS AXIAL (MPa)	POINT LOAD TEST UCS DIAMETRAL (MPa)	UNIAxIAL COMPRESSION (MPa)	DENSITY (g/cc) [E (GPa)]
				NUMBER	SIZE	CORE RATE (m/min)											
	13.3m, 25mm hard layer at 12.7m, 12.9m, 13.0m, 13.1m, 13.4m and 13.5m 100mm hard layer at 13.9m GEORGIAN BAY FORMATION SHALE grey, thinly laminated			8	HQ3	0.12	100	100	27	100		horizontal bedding partings, moderately closely spaced, planar to undulating, smooth, open, with clay coating (continued)	flow[314] (k' < 1.00E-8)	18	18		
	interbedded with light grey LIMESTONE and SILTSTONE layers, strong to very strong (continued) 25mm hard layer at 14.0m, 14.1m(2), 50mm hard layer at 14.2m, 14.8m, 100mm hard layer at 14.3m, 14.6m and 15.4, 250mm hard layer at 15.1m		68.8 14.0	9	HQ3	0.17	100	100	48	100		contacts and bedding parting, 0 to 10 degrees, closely to moderately closely spaced, planar, to undulating, rough, open, fresh					
	50mm hard layer at 15.7m(2), 16.0m, 16.1m, 16.3m, 25mm hard layer at 15.8m, 75mm hard layer at 16.4m, 25mm fractures zone at 16.5m, 300mm hard layer at 16.5m		67.3 15.5	10	HQ3	0.15	100	98	43	98		horizontal bedding parting, joint and contacts, closely to moderately closely spaced, undulating to stepped, smooth (50%) to rough (50%), open		103	121		
	75mm hard layer at 17.3m and 19.7m, 25mm hard layer at 17.3m and 19.3m, 50mm hard layer at 17.6m		65.8 17.0	11	HQ3	0.10	100	97	17	97		contacts, bedding partings and joint, generally horizontal (one 90 degree joint), closely to moderately closely spaced, planar, smooth, open to tight, with clay coating		12	18		
	50mm hard layer at 18.6m and 18.9m, 25mm hard layer at 18.9m and 20.0m, 75mm hard layer at 19.7m, 100mm hard layer at 19.9m		64.3 18.5	12	HQ3	0.11	100	100	22	83		horizontal bedding partings and contacts, closely to moderately closely spaced, generally planar, generally rough, open, some with clay coating		34	54	115.6	2.65 [21]
	75mm hard layer at 20.6m and 20.9m, 50mm hard layer at 21.0m, 25mm hard layer at 21.3m and 21.4m.		62.7 20.1	13	HQ3	0.10	100	98	19	89		bedding partings and joint, closely spaced, undulating, rough, open to tight, some with clay coating					
			61.4 21.4														

Date / Time	Water Depth (m)	Elevation (m)
BEFORE CORING 2 September 2011	1.4	81.4
ARTESIAN 28 September 2011	0.0	82.8
ARTESIAN 14 October 2011	0.0	82.8

E = Modulus of Elasticity



Additional Notes:

This log is to be read in conjunction with accompanying general notes and borehole log symbols sheet. Stratification lines represent approximate boundary lines between material types, vertical and lateral transitions may be gradual. Water level readings were made at time(s) noted, fluctuations of groundwater levels may occur and should be expected.
Sample Types: A=Auger; DP=Direct Push; G=Grab; RC=Rock Core; SC=Soil Core; SS=Split Barrel (Split Spoon); ST=Shelby Tube.

Coffey Representatives

BB	Originated By
AC	Prepared By
IL	Checked By

LOG OF BOREHOLE HF1-36

SHEET 1 OF 1

Project Name: HANLAN FEEDERMAIN SOUTH CONTRACT 1

Client: CH2M HILL CANADA LTD.

Northing: 4826885 m

Project No.: GEOTMARK00233AA

Drilling Method Used: Hollow Stem Augering 200mm

Easting: 616824 m

Project Location: DIXIE RD, MISSISSAUGA

Date: 11 - 15 August 2011

Ground Surface Elevation: 86.5 m

Depth Scale (m)	Subsurface Conditions		Samples		Penetration / Strength Results		Moisture / Plasticity		Instrumentation Details	Groundwater Conditions	Headspace Vapor (ppm) LEL (%)	Elevation Scale (m)	Comments
	Stratigraphic Symbol	Depth / Elevation (m)	Description	Number Type	Blow Counts / 150mm N Value	Recovery %	Relative Drilling Resistance	Penetration Test Values (Blows / 0.3m) X N Values ♦ Dynamic Cone + Becker Hammer Test (BPT) 20 40 60 80 Undrained Shear Strength Values (kPa) □ Field Vane ○ Unconfined ■ Lab Vane ● Quick Triaxial ▲ Pocket Penetrometer	Plastic Limit Natural Water Content Liquid Limit	PL MC LL			
0.5		85.6	Asphalt Granular Base									86.0	
1.0		0.9	SILT trace to some clay, trace fine sand, occasional fine gravel, brown, stiff to very stiff	1 SS	7 8 6	(14)	100	X				85.5	
1.5			grey	2 SS	10 14 13	(27)	89	X				85.0	0 3 79 18
2.0		84.2	SILTY CLAY trace sand, grey, very stiff	3 SS	10 8 9	(17)	100	X				84.0	PP, Cu = 241 kPa
2.5		83.5	SILTY CLAY TILL trace sand, trace gravel, grey, firm	4 SS	4 3 3	(6)	100	X				83.5	
3.0		83.0	SHALE weathered, grey, trace limestone fragments	5 SS	48 28 50	50/6cm	57					83.0	
3.5												82.5	Borehole dry upon completion before coring.
4.0												82.0	
4.5		81.8		6 SS	50	50/10cm	76						
4.7													

Rock Coring Started

Rock Core Log Next Page



Additional Notes:

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Sample Types: A=Auger; DP=Direct Push; G=Grab; RC=Rock Core; SC=Soil Core; SS=Split Barrel (Split Spoon); ST=Shelby Tube.

Coffey Representatives

AA	Originated By
AC	Prepared By
IL	Checked By

LOG OF BOREHOLE HF1-36

SHEET 1 OF 2

Project Name: HANLAN FEEDERMAIN SOUTH CONTRACT 1

Client: CH2M HILL CANADA LTD.

Date: 11 - 15 August 2011

Project No.: GEOTMARK00233AA

Drilling Method Used:

Northing: 4826885 m

Project Location: DIXIE RD, MISSISSAUGA

Ground Surface Elevation: 86.5 m

Easting: 616824 m

Borehole Location: SEE DRAWING

Datum Elevation: Geodetic

Diameter: 61mm

(m) STRATA ELEV DEPTH	ROCK DESCRIPTION See Soil Logs for soil descriptions.	GROUND WATER CONDITIONS	(m) CORE ELEV DEPTH	CORE SAMPLE			TOTAL CORE RECOVERY (%)	SOLID CORE RECOVERY (%)	HARD LAYER (%)	ROD (%)	FRACTURE INDEX (per 0.3m)	DISCONTINUITIES AND WEATHERING	HYDRAULIC CONDUCTIVITY k (cm/sec) [P (kPa)]	POINT LOAD TEST UCS AXIAL (MPa)	POINT LOAD TEST UCS DIAMETRAL (MPa)	UNIAxIAL COMPRESSION (MPa)	DENSITY (g/cc) [E (GPa)]
				NUMBER	SIZE	CORE RATE (m/min)											
81.8			81.8														
4.7	Run 1: very weak to weak, 25mm hard layer at 6.1m GEORGIAN BAY FORMATION SHALE grey, thinly laminated, interbedded with light grey LIMESTONE and SILTSTONE layers, strong to very strong Run 2: 50mm hard layer at 6.1m, 6.9m and 7.0m, 100mm hard layer at 6.7m, 25mm hard layer at 7.1m, 7.5m and 6.9m 125mm fractured zone at 7.5m, 50mm hard layer at 7.8m and 8.5m, 25mm hard layer at 8.2m, 8.4m, 8.7m, 9.0m and 9.1m weak		4.7	1	HQ3	0.24	100	95	2	89		horizontal bedding parting and contact, widely spaced, undulating, rough, open, slightly weathered to fresh		95	50		
			80.4														
			6.1	2	HQ3	0.27	100	91	30	59		contacts, bedding partings and joint, generally horizontal (one 90 degree joint), closely to moderately closely spaced, planar to undulating, smooth to rough, open, occasionally with clay coating		9	8		
			79.0														
			7.5	3	HQ3	0.28	81	74	25	35		contacts and bedding parting, 0-15 degrees, closely to moderately closely spaced, planar (80%) to undulating (20%), generally rough, open, occasionally with clay coating		72	67		
			77.4														
			9.1	4	HQ3	0.26	100	100	0	92		horizontal bedding partings, closely to moderately closely spaced, planar, smooth to rough, open, slightly weathered to fresh		215	87		
			75.8														
			10.7	5	HQ3	0.30	100	97	0	87		bedding partings, 0-30 degrees, very closely to closely spaced, generally planar, smooth to rough, open (80%) to tight (20%)		13	3	8.8	2.57 [1]
			74.3														
	25mm hard layer at 12.6m, 75mm hard layer at 12.8m, 50mm hard layer at 13.1m, 100mm hard layer at 13.2m, 175mm hard layer at 13.3m, 200mm hard layer at 13.6m		12.2	6	HQ3	0.25	100	98	42	98		horizontal bedding partings and contact, closely to moderately closely spaced, planar, smooth to rough, open, fresh		9	2		
			72.7														
	50mm hard layer at 13.9m, 14.5m and 14.9m, 100mm hard layer at 14.0m, 25mm hard layer at 14.2m, 14.7m, 14.9m, 15.1m, 15.2m(2) and 15.2m		13.8	7	HQ3	0.21	100	97	29	87		horizontal bedding partings and contacts, planar (80%) to undulating (20%), rough to smooth, open, fresh to slightly weathered		127	123		

Continued Next Page

E = Modulus of Elasticity

Additional Notes:

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Coffey Representatives

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LOG OF BOREHOLE HF1-36

SHEET 2 OF 2

Project Name: HANLAN FEEDERMAIN SOUTH CONTRACT 1

Client: CH2M HILL CANADA LTD.

Date: 11 - 15 August 2011

Project No.: GEOTMARK00233AA

Drilling Method Used:

Northing: 4826885 m

Project Location: DIXIE RD, MISSISSAUGA

Ground Surface Elevation: 86.5 m

Easting: 616824 m

Borehole Location: SEE DRAWING

Datum Elevation: Geodetic

Diameter: 61mm

(m) STRATA ELEV DEPTH	ROCK DESCRIPTION See Soil Logs for soil descriptions.	GROUND WATER CONDITIONS	(m) CORE ELEV DEPTH	CORE SAMPLE			TOTAL CORE RECOVERY (%)	SOLID CORE RECOVERY (%)	HARD LAYER (%)	RQD (%)	FRACTURE INDEX (per 0.3m)				DISCONTINUITIES AND WEATHERING	HYDRAULIC CONDUCTIVITY k (cm/sec) [P (kPa)]	POINT LOAD TEST UCS AXIAL (MPa)	POINT LOAD TEST UCS DIAMETRAL (MPa)	UNIAxIAL COMPRESSION (MPa)	DENSITY (g/cc) [E (GPa)]
				NUMBER	SIZE	CORE RATE (m/min)					2	4	6	8						
	GEORGIAN BAY FORMATION SHALE grey, thinly laminated, interbedded with light grey LIMESTONE and SILTSTONE layers, strong to very strong (<i>continued</i>) 50mm hard layer at 15.3m, 25mm hard layer at 15.3m, 15.5m, 15.6m, 15.7m, 16.0m, 16.3m, 16.6m(2) and 16.8m 25mm hard layer at 17.1m, 17.2m, 17.3m, 17.8m, 18.0m(2) and 18.2m 25mm hard layer at 18.6m and 19.5m, 50mm hard layer at 18.6m and 19.6m, 125mm hard layer at 18.8m, 75mm hard layer at 19.1m, 25mm hard layer at 20.1m and 20.4m, 100mm hard layer at 21.2m, 75mm hard layer at 20.6m 25mm hard layer at 22.0m		71.2 15.3 69.7 16.8 68.1 18.4 66.6 19.9 65.1 21.4 64.5 22.0												58	18				
				8	HQ3	0.26	100	100	18	100				horizontal bedding partings and contacts, closely to moderately closely spaced, planar, rough, open, fresh		38	10	21.2	2.6 [5]	
				9	HQ3	0.30	100	100	12	97				horizontal bedding partings and contacts, very closely to moderately closely spaced, planar, smooth (20%) to rough (80%), open		38	31	19.8	2.6 [4]	
				10	HQ3	0.30	98	98	35	98				horizontal bedding parting and contact, moderately closely spaced, planar, smooth, open		61	18			
				11	HQ3	0.31	100	100	15	100				bedding partings and contacts, 0-10 degrees, closely spaced, generally planar, rough, open, occasionally with clay coating		20	133			
				12	HQ3	0.29	100	100	4	100				unfractured		57	1			

Date / Time Water Depth (m) Elevation (m)

E = Modulus of Elasticity



Additional Notes:

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Sample Types: A=Auger; DP=Direct Push; G=Grab; RC=Rock Core; SC=Soil Core; SS=Split Barrel (Split Spoon); ST=Shelby Tube.

Coffey Representatives

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AC	Prepared By
IL	Checked By

Project Name: HANLAN FEEDERMAIN SOUTH CONTRACT 1

Client: CH2M HILL CANADA LTD.

Northing: 4826785 m

Project No.: GEOTMARK00233AA

Drilling Method Used: Hollow Stem Augering 200mm

Easting: 616927 m

Project Location: DIXIE RD, MISSISSAUGA

Date: 16 - 18 August 2011

Ground Surface Elevation: 85.2 m

[illegible]

Rock Core Log Next Page



Additional Notes:

Additional Notes:
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Sample Types: A=Auger; DP=Direct Push; G=Grab; RC=Rock Core; SC=Soil Core; SS=Split Barrel (Split Spoon); ST=Shelby Tube.

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LOG OF BOREHOLE HF1-37

SHEET 1 OF 2

Project Name: HANLAN FEEDERMAIN SOUTH CONTRACT 1

Client: CH2M HILL CANADA LTD.

Date: 16 - 18 August 2011

Project No.: GEOTMARK00233AA

Drilling Method Used: ROCK CORING HQ3

Northing: 4826785 m

Project Location: DIXIE RD, MISSISSAUGA

Ground Surface Elevation: 85.2 m

Easting: 616927 m

Borehole Location: SEE DRAWING

Datum Elevation: Geodetic

Diameter: 61mm

(m) STRATA ELEV DEPTH	ROCK DESCRIPTION See Soil Logs for soil descriptions.	GROUND WATER CONDITIONS	(m) CORE ELEV DEPTH	CORE SAMPLE			TOTAL CORE RECOVERY (%)	SOLID CORE RECOVERY (%)	HARD LAYER (%)	RQD (%)	FRACTURE INDEX (per 0.3m)	DISCONTINUITIES AND WEATHERING	HYDRAULIC CONDUCTIVITY k (cm/sec) [P (kPa)]	POINT LOAD TEST UCS AXIAL (MPa)	POINT LOAD TEST UCS DIAMETRAL (MPa)	UNIAxIAL COMPRESSION (MPa)	DENSITY (g/cc) [E (GPa)]
				NUMBER	SIZE	CORE RATE (m/min)											
80.8			80.8														
4.4	GEORGIAN BAY FORMATION SHALE grey, thinly laminated, interbedded with light grey LIMESTONE and SILTSTONE layers, strong to very strong Run 1: extremely to very weak, 275mm fractured zone with clay infill at 4.4m Run 2: 25mm fractured zone at 4.8m, 25mm very stiff clay infill at 5.4m, 25mm crushed zone at 5.9m, 75mm hard layer at 5.2m, 5.3m and 6.0m, 175mm hard layer at 5.5m, 50mm ahrd layer at 5.7m, 5.8m and 5.9m Run 3: very weak to weak, 50mm hard layer at 6.3m, 6.4m, and 6.5m, 100mm hard layer at 6.6m, 100mm fractured zone at 6.7m, 175mm hard layer at 6.8m, 25mm very soft clay infill at 7.0m, very stiff clay infill at 7.2m, 50mm fractured zone at 7.2m, 125mm fractured zone at 7.4m, 150mm hard layer at 7.3m, 75mm hard layer at 7.5m Run 4: 50mm fractured zone at 7.9m, 50mm hard layer at 7.9m and 8.4m, 25mm hard layer at 8.2m, 50mm crushed zone with clay infill at 8.3m, 75mm fractured zone at 8.4m, Run 5: 125mm crushed zone at 10.0m, 300mm fractured zone at 10.3m, 25mm hard layer at 10.4m, 75mm crushed zone at 10.4m, 25mm stiff clay infill at 10.0m weak, 100mm core loss at 10.5m, 50mm fractured zone at 11.3m, 50mm hard layer at 11.4m, 25mm hard layer at 11.5m, 11.6m, 11.7m and 11.8m, 25mm fractured zone at 11.9m and 12.0m, 75mm hard layer at 12.0m 250mm hard layer at 12.3m, 25mm hard layer at 12.6m, 175mm hard layer at 12.9m, 100mm hard layer at 13.1m, 13.4m and 13.5m, 50mm hard layer at 13.2m and 13.3m 75mm hard layer at 13.9m and 15.1m, 25mm hard layer at 14.1m, 14.6m and 14.7m, 50mm hard layer at 14.3m, 14.7m,		4.4 80.5	1	HQ3	0.09	100	0	0	0		fractured zone, completely to highly weathered					
			4.7									bedding partings, contacts and joints, 0-10 degrees (one 90 degree joint), closely spaced, undulating, rough to smooth, open, with clay coating, moderately weathered	94	81			
			79.0	2	HQ3	0.19	100	85	37	40							
			6.2									horizontal contacts and fractured zones, very closely to closely spaced, undulating, rough, open, with clay coating	195	172			
			77.5	3	HQ3	0.09	100	80	43	63							
			7.7									horizontal bedding partings and contact, closely to moderately closely spaced, undulating, undulating, rough to smooth, open, with clay coating	22	1			
			76.0	4	HQ3	0.11	100	88	8	63							
			9.2									bedding partings and joints, closely spaced, horizontal (two 45 degree joints), undulating to planar, generally smooth, generally open, with clay coating, moderately to slightly weathered	24	1			
			74.4	5	HQ3	0.12	93	50	2	47							
			10.8									bedding partings and joints, horizontal (two 45 degree joints), closely to moderately closely spaced, undulating to planar, smooth to rough, open, with clay coating	16	1			
			72.9	6	HQ3	0.07	100	75	15	63							
			12.3									horizontal bedding partings, contacts and joint, closely spaced, undulating to planar, smooth (80%) to rough (20%), open to tight, with clay coating, slightly weathered	143	134			
			71.4	7	HQ3	0.12	97	97	57	87							
			13.8														

Continued Next Page

E = Modulus of Elasticity

Additional Notes:

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Sample Types: A=Auger; DP=Direct Push; G=Grab; RC=Rock Core; SC=Soil Core; SS=Split Barrel (Split Spoon); ST=Shelby Tube.

Coffey Representatives

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AC	Prepared By
IL	Checked By

LOG OF BOREHOLE HF1-37

SHEET 2 OF 2

Project Name: HANLAN FEEDERMAIN SOUTH CONTRACT 1

Client: CH2M HILL CANADA LTD.

Date: 16 - 18 August 2011

Project No.: GEOTMARK00233AA

Drilling Method Used: ROCK CORING HQ3

Northing: 4826785 m

Project Location: DIXIE RD, MISSISSAUGA

Ground Surface Elevation: 85.2 m

Easting: 616927 m

Borehole Location: SEE DRAWING

Datum Elevation: Geodetic

Diameter: 61mm

(m) STRATA ELEV DEPTH	ROCK DESCRIPTION See Soil Logs for soil descriptions.	GROUND WATER CONDITIONS	(m) CORE ELEV DEPTH	CORE SAMPLE			TOTAL CORE RECOVERY (%)	SOLID CORE RECOVERY (%)	HARD LAYER (%)	ROD (%)	FRACTURE INDEX (per 0.3m)	DISCONTINUITIES AND WEATHERING	HYDRAULIC CONDUCTIVITY k (cm/sec) [P (kPa)]	POINT LOAD TEST UCS AXIAL (MPa)	POINT LOAD TEST UCS DIAMETRAL (MPa)	UNIAxIAL COMPRESSION (MPa)	DENSITY (g/cc) [E (GPa)]
				NUMBER	SIZE	CORE RATE (m/min)											
	15.2m and 14.8m, 100mm hard layer at 14.4m and 14.9m GEORGIAN BAY FORMATION SHALE grey, thinly laminated, interbedded with light grey LIMESTONE and SILTSTONE layers, strong to very strong (<i>continued</i>) 25mm hard layer at 15.5m, 15.8m, 16.2m, 16.4m, 16.6m and 16.6m, 50mm hard layer at 15.7m, 175mm hard layer at 16.0m		69.9 15.3	8	HQ3	0.13	100	100	42	90		horizontal bedding partings and contacts, closely spaced, undulating to planar, rough, generally open, with clay coating, slightly weathered to fresh (<i>continued</i>)		160	100		
	25mm hard layer at 17.1m, 150mm hard layer at 17.2m, 50mm hard layer at 17.4m, 17.5m and 18.2m, 250mm hard layer at 17.6m		68.3 16.9	9	HQ3	0.08	100	100	25	100		bedding partings and contact, 0-10 degrees, closely spaced, undulating, smooth to rough, open, with clay coating		98	67	12.9	2.61 [2]
	weak to medium strong, 75mm hard layer at 18.5m, 25mm hard layer at 18.6m, 19.5m and 19.6m, 100mm hard layer at 18.7m and 19.3m, 175mm hard layer at 18.9m, 125mm hard layer at 19.1m		66.8 18.4	10	HQ3	0.08	100	100	38	87		horizontal bedding partings and contacts, closely to moderately closely spaced, generally undulating, smooth to rough, open, occasionally tight, with clay coating		28	4		
	125mm hard layer at 18.4m, 50mm hard layer at 18.6m, 100mm hard layer at 18.7m, 25mm hard layer at 19.2m, 19.3m, 19.4m, 19.7m and 19.8m		65.3 19.9	11	HQ3	0.10	100	100	43	95		horizontal bedding partings and contacts, closely to moderately closely spaced, planar to undulating, smooth to rough, tight to open, with clay coating, fresh		162	27	68.5	2.61 [12]
			63.8 21.4	12	HQ3	0.04	100	100	20	80		bedding partings and contacts, 0-10 degrees, closely to moderately closely spaced, planar to undulating, smooth to rough, tight to open, with clay coating, fresh to slightly weathered		25	3		

Date / Time Water Depth (m) Elevation (m)
 BEFORE CORING 17 August 2011 0.1 85.1

E = Modulus of Elasticity



Additional Notes:

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 Sample Types: A=Auger; DP=Direct Push; G=Grab; RC=Rock Core; SC=Soil Core; SS=Split Barrel (Split Spoon); ST=Shelby Tube.

Coffey Representatives

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IL	Checked By

LOG OF BOREHOLE HF1-38

SHEET 1 OF 1

Project Name: HANLAN FEEDERMAIN SOUTH CONTRACT 1	Client: CH2M HILL CANADA LTD.	Northing: 4826729 m
Project No.: GEOTMARK00233AA	Drilling Method Used: Hollow Stem Augering 200mm	Easting: 617012 m
Project Location: Lakeshore Road East, Mississauga	Date: 7 - 8 September 2011	Ground Surface Elevation: 84.2 m

Depth Scale (m)	Stratigraphic Symbol	Subsurface Conditions		Samples		Penetration / Strength Results		Moisture / Plasticity		Instrumentation Details	Groundwater Conditions	Headspace Vapor (ppm) LEL (%)	Elevation Scale (m)	Comments
		Depth / Elevation (m)	Description	Number	Type	Blow Counts / 150mm	N Value	Recovery %	Relative Drilling Resistance					
									Penetration Test Values (Blows / 0.3m) X N Values ♦ Dynamic Cone + Becker Hammer Test (BPT) 20 40 60 80					
									Undrained Shear Strength Values (kPa) □ Field Vane ○ Unconfined ■ Lab Vane ● Quick Triaxial ▲ Pocket Penetrometer	PL MC LL 10 20 30 40				
0.5			200mm Topsoil										84.0	
1.0		83.0	FILL silty sand, fine grained sand, trace clay, brown, loose	1	SS	2	(4)	94					83.5	
1.5		1.2	CLAYEY SILT trace fine grained sand, laminated, trace oxidation, brown, very stiff	2	SS	10	(25)	72					83.0	
2.0						12							82.5	0 6 81 13
2.5		81.9	SILTY CLAY grey, very stiff to stiff	3	SS	4	(23)	94					82.0	PP, Cu = 187 to 241 kPa
3.0		2.3				11							81.5	
3.5			some fine to coarse subrounded to angular gravel	4	SS	3	(14)	100					81.0	Water Level measured at 4.6m bgl. PP, Cu > 241 kPa
4.0		80.4	SHALE weathered, grey	5	SS	50	50/10cm	126					80.5	
4.5		3.8											80.0	
5.0			wet	6	SS	50	50/5cm	98					79.5	
5.1		79.1												

Rock Coring Started

	Date / Time	Water Depth (m)	Elevation (m)
BEFORE CORING	7 September 2011	3.6	80.6
BEFORE CORING	8 September 2011	3.0	81.2
	28 September 2011	2.9	81.3
	14 October 2011	2.9	81.3

Rock Core Log Next Page



Additional Notes:

This log is to be read in conjunction with accompanying general notes and borehole log symbols sheet. Stratification lines represent approximate boundary lines between material types, vertical and lateral transitions may be gradual. Water level readings were made at time(s) noted, fluctuations of groundwater levels may occur and should be expected.
Sample Types: A=Auger; DP=Direct Push; G=Grab; RC=Rock Core; SC=Soil Core; SS=Split Barrel (Split Spoon); ST=Shelby Tube.

Coffey Representatives

BB	Originated By
AC	Prepared By
IL	Checked By

LOG OF BOREHOLE HF1-38

SHEET 1 OF 2

Project Name: HANLAN FEEDERMAIN SOUTH CONTRACT 1

Client: CH2M HILL CANADA LTD.

Date: 7 - 8 September 2011

Project No.: GEOTMARK00233AA

Drilling Method Used: ROCK CORING HQ3

Northing: 4826729 m

Project Location: Lakeshore Road East, Mississauga

Ground Surface Elevation: 84.2 m

Easting: 617012 m

Borehole Location: SEE DRAWING

Datum Elevation: Geodetic

Diameter: 61mm

(m) STRATA ELEV DEPTH	ROCK DESCRIPTION See Soil Logs for soil descriptions.	GROUND WATER CONDITIONS	(m) CORE ELEV DEPTH	CORE SAMPLE			TOTAL CORE RECOVERY (%)	SOLID CORE RECOVERY (%)	HARD LAYER (%)	ROD (%)	FRACTURE INDEX (per 0.3m)	DISCONTINUITIES AND WEATHERING	HYDRAULIC CONDUCTIVITY k (cm/sec) [P (kPa)]	POINT LOAD TEST UCS AXIAL (MPa)	POINT LOAD TEST UCS DIAMETRAL (MPa)	UNIAxIAL COMPRESSION (MPa)	DENSITY (g/cc) [E (GPa)]
				NUMBER	SIZE	CORE RATE (m/min)											
79.1			79.1														
5.1	GEORGIAN BAY FORMATION SHALES grey, thinly laminated interbedded with light grey LIMESTONE and SILTSTONE layers, strong to very strong Run 1: very weak, 500mm fractured zone at 5.1m, 75mm hard layer at 5.6m, 25mm hard layer at 5.7m, 225mm hard layer at 5.7m, 100mm crushed zone at 5.9m, 50mm hard layer at 6.1m and 6.3m, 50mm extremely weak zone at 6.2m Run 2: 300mm hard layer at 6.5m, 12mm soft clay infill at 6.8m, 25mm crushed zone at 6.9m, 7.2m, 7.3m, 7.4m and 7.9m, 25mm hard layer at 7.1m and 8.0m, 75mm hard layer at 7.5m, 7.6m and 7.8m Run 3: weak, 50mm hard layer at 8.7m 25mm crushed zone at 10.3m, 50mm hard layer at 10.6m, 25mm hard layer at 10.7m and 11.0m 25mm hard layer at 11.6m, 11.8m, and 12.0m, 50mm hard layer at 11.7m, 75mm hard layer at 11.9, 12.1m 100mm hard layer at 12.2m 150mm hard layer at 12.6m, 100mm hard layer at 13.0m and 13.8m, 75mm hard layer at 13.2m, 50mm hard layer at 13.3m (2) and 14.0m, 200mm hard layer at 13.5m 75mm hard layer at 14.2m, 100mm hard layer at 14.4m, 14.6m and 14.8m, 50mm hard layer at 14.6m, 14.8m and 15.3m		5.1														
			77.7	1	HQ3	0.23	100	51	31	15		horizontal bedding partings and contacts, closely spaced, undulating, smooth to rough, open, with clay coating, highly weathered		212	176		
			6.5	2	HQ3	0.19	100	90	38	45		bedding partings, contacts and joint, generally horizontal (one 90 degree joint), very closely to closely spaced, planar to stepped, smooth (15%) to rough (85%), open (60%) to tight (40%), with clay coating, highly weathered		121	83		
			76.2														
			8.0	3	HQ3	0.10	100	98	3	83		horizontal bedding partings, contacts and joint, closely to moderately closely spaced, planar (20%) to undulating (80%), smooth (20%) to rough (80%), open, some with clay coating, slightly weathered to fresh		10	2		
			74.7														
			9.5	4	HQ3	0.08	100	98	7	75		bedding partings, contacts and joints, 0-20 degrees (two 90 degree joints), very closely to moderately closely spaced, planar (20%) to undulating (80%), smooth (20%) to rough (80%), open, some with clay coating, slightly weathered to fresh	2.29E-6 [78] 3.05E-6 [147] 5.53E-6 [216]	36	2		
			73.1														
			11.1	5	HQ3	0.15	100	100	27	95		bedding partings and contacts, 0-10 degrees, closely to moderately closely spaced, planar (25%) to undulating (75%), smooth (50%) to rough (50%), open (75%) to tight (25%), with clay coating		153	80		
			71.6														
			12.6	6	HQ3	0.12	100	100	53	90		horizontal bedding partings and contacts, closely to moderately closely spaced, planar (20%) to undulating (80%), smooth to rough, open, with clay coating	No flow[108] ('k' < 1.00E-8) No flow[216] ('k' < 1.00E-8) No flow[324] ('k' < 1.00E-8)	130	139		
			70.1														
			14.1	7	HQ3	0.13	100	100	35	100		horizontal bedding partings and contact, closely to moderately closely spaced, planar to undulating, smooth to rough, open, with clay coating		31	46		

Continued Next Page

E = Modulus of Elasticity

Additional Notes:

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Sample Types: A=Auger; DP=Direct Push; G=Grab; RC=Rock Core; SC=Soil Core; SS=Split Barrel (Split Spoon); ST=Shelby Tube.

Coffey Representatives

BB	Originated By
AC	Prepared By
IL	Checked By

LOG OF BOREHOLE HF1-38

SHEET 2 OF 2

Project Name: HANLAN FEEDERMAIN SOUTH CONTRACT 1

Client: CH2M HILL CANADA LTD.

Date: 7 - 8 September 2011

Project No.: GEOTMARK00233AA

Drilling Method Used: ROCK CORING HQ3

Northing: 4826729 m

Project Location: Lakeshore Road East, Mississauga

Ground Surface Elevation: 84.2 m

Easting: 617012 m

Borehole Location: SEE DRAWING

Datum Elevation: Geodetic

Diameter: 61mm

(m) STRATA ELEV DEPTH	ROCK DESCRIPTION See Soil Logs for soil descriptions.	GROUND WATER CONDITIONS	(m) CORE ELEV DEPTH	CORE SAMPLE			TOTAL CORE RECOVERY (%)	SOLID CORE RECOVERY (%)	HARD LAYER (%)	ROD (%)	FRACTURE INDEX (per 0.3m)				DISCONTINUITIES AND WEATHERING	HYDRAULIC CONDUCTIVITY k (cm/sec) [P (kPa)]	POINT LOAD TEST UCS AXIAL (MPa)	POINT LOAD TEST UCS DIAMETRAL (MPa)	UNIAxIAL COMPRESSION (MPa)	DENSITY (g/cc) [E (GPa)]
				NUMBER	SIZE	CORE RATE (m/min)					2	4	6	8						
	GEORGIAN BAY FORMATION SHALE grey, thinly laminated	H	68.6													No flow[147] ($k' < 1.00E-8$)				
	interbedded with light grey LIMESTONE and SILTSTONE layers, strong to very strong (<i>continued</i>) 100mm hard layer at 15.8m and 16.0m, 50mm hard layer at 16.2m and 16.8m, 25mm hard layer at 16.5m, 175mm hard layer at 16.6m, 75mm hard layer at 16.9m and 17.1m		15.6	8	HQ3	0.10	100	100	43	98					bedding partings, contacts and joint, 0-20 degrees (one 90 degree joint), closely to moderately closely spaced, undulating to planar, smooth to rough, open to healed, with clay coating	No flow[284] ($k' < 1.00E-8$)	14	12		
	125mm hard layer at 17.3m and 17.8m, 50mm hard layer at 17.7m and 18.0m, 75mm hard layer at 18.1m and 18.3m, 25mm hard layer at 18.1m and 18.6m		67.0												horizontal bedding partings, contacts and joint, closely to moderately closely spaced, undulating, smooth (70%) to rough (30%), open to healed, with clay coating	No flow[392] ($k' < 1.00E-8$)				
			17.2	9	HQ3	0.12	100	100	37	100							156	49		
			65.5																	
			18.7																	

Date / Time	Water Depth (m)	Elevation (m)
BEFORE CORING 7 September 2011	3.6	80.6
BEFORE CORING 8 September 2011	3.0	81.2
28 September 2011	2.9	81.3
14 October 2011	2.9	81.3

E = Modulus of Elasticity



Additional Notes:

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Sample Types: A=Auger; DP=Direct Push; G=Grab; RC=Rock Core; SC=Soil Core; SS=Split Barrel (Split Spoon); ST=Shelby Tube.

Coffey Representatives

BB	Originated By
AC	Prepared By
IL	Checked By

SHEET 1 OF 1

Northing: 4826729 m

Easting: 617011 m

Ground Surface Elevation: 84.2 m

0.5
1.0
1.5
2.0
2.5
3.0

Date / Time
14 October 2011

Water Depth (m)
2.7

Elevation (m)
81.5

SHEET 1 OF 1

Ground Surface Elevation: 83.9 m

Rock Coring Started

BB	Originated By
AC	Prepared By
IL	Checked By

LOG OF BOREHOLE HF1-39

SHEET 1 OF 2

Project Name: HANLAN FEEDERMAIN SOUTH CONTRACT 1

Client: CH2M HILL CANADA LTD.

Date: 19 - 21 September 2011

Project No.: GEOTMARK00233AA

Drilling Method Used: ROCK CORING HQ3

Northing: 4826579 m

Project Location: Lakeshore Road East, Mississauga

Ground Surface Elevation: 83.9 m

Easting: 616877 m

Borehole Location: SEE DRAWING

Datum Elevation: Geodetic

Diameter: 61mm

(m) STRATA ELEV DEPTH	ROCK DESCRIPTION See Soil Logs for soil descriptions.	GROUND WATER CONDITIONS	(m) CORE ELEV DEPTH	CORE SAMPLE			TOTAL CORE RECOVERY (%)	SOLID CORE RECOVERY (%)	HARD LAYER (%)	ROD (%)	FRACTURE INDEX (per 0.3m)	DISCONTINUITIES AND WEATHERING	HYDRAULIC CONDUCTIVITY k (cm/sec) [P (kPa)]	POINT LOAD TEST UCS AXIAL (MPa)	POINT LOAD TEST UCS DIAMETRAL (MPa)	UNIAxIAL COMPRESSION (MPa)	DENSITY (g/cc) [E (GPa)]
				NUMBER	SIZE	CORE RATE (m/min)											
79.9 4.0	GEORGIAN BAY FORMATION SHALE grey, thinly laminated interbedded with light grey LIMESTONE and SILTSTONE layers, strong to very strong Run 1: extremely to very weak, 125mm crushed zone at 4.0m, 275mm crushed zone at 4.4m, 25mm hard layer at 4.0m and 4.6m Run 2: 400mm fractured zone at 5.2m, 25mm hard layer at 5.3m, 50mm extremely weak zone at 5.9m, 75mm hard layer at 5.5m, 5.7m and 6.1m, 100mm hard layer at 6.4m Run 3: weak, 275mm hard layer at 6.8m, 75mm hard layer at 7.3m and 7.7m, 150mm hard layer at 7.5m, 50mm hard layer at 7.9m 75mm hard layer at 8.1m and 8.2m, 50mm hard layer at 8.5m, 25mm hard layer at 9.0m 125mm fractured zone at 9.6m, 125mm hard layer at 10.4m, 25mm hard layer at 10.6m 12mm very soft to soft clay infill at 11.1m, 50mm hard layer at 11.9m, 25mm hard layer at 12.3m, 125mm hard layer at 12.1m and 12.3m 5mm clay infill at 12.7m, 25mm fractured zone at 12.8m, 775mm hard layer at 12.8m, 75mm hard layer at 13.6m and 14.0m		79.9 4.0	1	HQ3	0.25	100	59	5	33	2 4 6 8	horizontal bedding partings, very closely to closely spaced, planar to undulating, smooth to rough, open to tight, with clay coating, highly weathered		20	5		
			78.9 5.0	2	HQ3	0.22	100	90	23	23		bedding partings, contacts and joints, 0-30 degrees (one 90 degree joint), very closely to closely spaced, undulating, generally rough, open (80%) to tight (20%), with clay coating, highly to moderately weathered					
			77.4 6.5	3	HQ3	0.17	100	95	42	47		bedding partings, contacts and joints, 0 degrees (three 90 degree joints), closely to moderately closely spaced, undulating, rough to smooth, open, with clay coating, moderately weathered					
			75.9 8.0	4	HQ3	0.10	100	98	15	78		horizontal bedding partings and contacts, closely to moderately closely spaced, planar (30%) to undulating (70%), smooth (30%) to rough (70%), open, with clay coating, slightly weathered to fresh					
			74.4 9.5	5	HQ3	0.10	100	90	10	83		bedding parting and contacts, 0-45 degrees, closely to moderately closely spaced, undulating (80%) to stepped (20%), smooth (20%) to rough (80%), open, with clay coating					
			72.9 11.0	6	HQ3	0.25	100	98	24	93		horizontal contacts and bedding parting, closely to moderately closely spaced, undulating (90%) to stepped (10%), smooth (20%) to rough (80%), open, with clay coating					
			71.4 12.5	7	HQ3	0.13	100	97	62	72		horizontal contacts, closely to moderately closely spaced, undulating, rough, open, with clay coating					

Continued Next Page

E = Modulus of Elasticity

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Sample Types: A=Auger; DP=Direct Push; G=Grab; RC=Rock Core; SC=Soil Core; SS=Split Barrel (Split Spoon); ST=Shelby Tube.

Coffey Representatives

BB	Originated By
AC	Prepared By
IL	Checked By

LOG OF BOREHOLE HF1-39

SHEET 2 OF 2

Project Name: HANLAN FEEDERMAIN SOUTH CONTRACT 1

Client: CH2M HILL CANADA LTD.

Date: 19 - 21 September 2011

Project No.: GEOTMARK00233AA

Drilling Method Used: ROCK CORING HQ3

Northing: 4826579 m

Project Location: Lakeshore Road East, Mississauga

Ground Surface Elevation: 83.9 m

Easting: 616877 m

Borehole Location: SEE DRAWING

Datum Elevation: Geodetic

Diameter: 61mm

(m) STRATA ELEV DEPTH	ROCK DESCRIPTION See Soil Logs for soil descriptions.	GROUND WATER CONDITIONS	(m) CORE ELEV DEPTH	CORE SAMPLE			TOTAL CORE RECOVERY (%)	SOLID CORE RECOVERY (%)	HARD LAYER (%)	ROD (%)	FRACTURE INDEX (per 0.3m)	DISCONTINUITIES AND WEATHERING	HYDRAULIC CONDUCTIVITY k (cm/sec) [P (kPa)]	POINT LOAD TEST UCS AXIAL (MPa)	POINT LOAD TEST UCS DIAMETRAL (MPa)	UNIAxIAL COMPRESSION (MPa)	DENSITY (g/cc) [E (GPa)]
				NUMBER	SIZE	CORE RATE (m/min)											
	GEORGIAN BAY FORMATION SHALE grey, thinly laminated interbedded with light grey LIMESTONE and SILTSTONE layers, strong to very strong (<i>continued</i>) 200mm hard layer at 14.2m, 50mm hard layer at 14.4m and 15.0m, 100mm hard layer at 14.6m, 300mm hard layer at 14.7m, 25mm crushed zone at 15.3m 25mm hard layer at 15.6m and 17.1m, 50mm hard layer at 15.8m, 16.5m, 16.8m and 17.0m, 125mm hard layer at 16.5m 200mm hard layer at 17.1m, 50mm fractured zone at 17.3m, 50mm hard layer at 17.4m and 18.1m, 25mm hard layer at 17.6m, 18.4m and 18.5m, 75mm extremely weak zone at 17.6m, 75mm fractured zone with clay infill at 18.1m, 125mm hard layer at 18.2m 50mm hard layer at 18.7m and 19.4m, 75mm hard layer at 18.8m and 18.9m(2), 25mm hard layer at 19.2m and 20.1m, 50mm fractured zone at 19.2m, 150mm hard layer at 19.3m, 100mm hard layer at 19.9m 100mm hard layer at 20.3m and 21.0m, 25mm hard layer at 20.5m, 20.6m(2), 20.8m, 20.9m, 21.3m(2), 21.4m, 21.5m and 21.6m 50mm hard layer at 21.2m		69.9 14.0	8	HQ3		100	93	47	62		bedding partings and contacts, 0-20 degrees, closely spaced, planar (10%) to undulating (90%), smooth (10%) to rough (90%), tight (10%) to open (90%), with clay coating		163	76		
			68.3 15.6	9	HQ3	0.22	100	100	25	80		horizontal bedding partings and contacts, closely to moderately spaced, undulating, smooth (30%) to rough (70%), open, with clay coating		19	1	7.8	2.6 [1]
			66.8 17.1	10	HQ3	0.15	100	87	33	55		horizontal bedding partings and contacts, closely spaced, undulating, smooth (20%) to rough (80%), open, with clay coating		100 13	115 13		
			65.3 18.6	11	HQ3	0.13	100	95	48	70		bedding partings and contacts, 0-10 degrees, closely to moderately closely spaced, undulating, smooth (15%) to rough (85%), open, with clay coating		177	66		
			63.8 20.1	12	HQ3	0.09	100	100	34	100		horizontal contacts and joint, closely to moderately closely spaced, undulating (75%) to planar (25%), smooth to rough, open, with clay coating, fresh		30	1		
			62.3 21.6														

Date / Time Water Depth (m) Elevation (m)

E = Modulus of Elasticity



Additional Notes:

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Coffey Representatives

BB	Originated By
AC	Prepared By
IL	Checked By

LOG OF BOREHOLE HF1-40

SHEET 1 OF 1

Project Name: HANLAN FEEDERMAIN SOUTH CONTRACT 1		Client: CH2M HILL CANADA LTD.		Northing: 4826454 m	
Project No.: GEOTMARK00233AA		Drilling Method Used: Hollow Stem Augering 200mm		Easting: 616791 m	
Project Location: Lakeshore Road East, Mississauga		Date: 21 - 23 September 2011		Ground Surface Elevation: 84.4 m	

Depth Scale (m)	Stratigraphic Symbol	Depth / Elevation (m)	Subsurface Conditions		Samples		Penetration / Strength Results	Moisture / Plasticity			Instrumentation Details	Groundwater Conditions	Headspace Vapor (ppm) LEL (%)	Elevation Scale (m)	Comments
			Description	Number	Type	Blow Counts / 150mm		N Value	Recovery %	Plastic Limit					
0.5			250mm Asphalt 100mm Concrete 75mm Granular Base												
1.0			FILL silty sand, trace fine gravel, brown, loose	1	SS	4	(7)	100							
1.5			clayey silt trace to some sand, brown, firm	1A		3									
2.0		82.6	SILTY CLAY trace coarse sand and fine gravel, laminated, trace oxidation, brown, firm to hard	2	SS	2	(6)	100							
2.5		1.8	trace fine sand	2A		4									
3.0															
3.5			interbedded with shale, weathered, grey	3	SS	6	(22)	100							
4.0															
4.3		80.6	SHALE weathered, grey	4	SS	30	(51)	100							
		3.8													
		80.1		5	SS	50	50/13cm	99							

Rock Coring Started		Date / Time 28 September 2011 14 October 2011	Water Depth (m) 3.6 3.6	Elevation (m) 80.8 80.8
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Rock Core Log Next Page

Additional Notes:

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Coffey Representatives

BB	Originated By
AC	Prepared By
IL	Checked By

LOG OF BOREHOLE HF1-40

SHEET 1 OF 2

Project Name: HANLAN FEEDERMAIN SOUTH CONTRACT 1

Client: CH2M HILL CANADA LTD.

Date: 21 - 23 September 2011

Project No.: GEOTMARK00233AA

Drilling Method Used: ROCK CORING HQ3

Northing: 4826454 m

Project Location: Lakeshore Road East, Mississauga

Ground Surface Elevation: 84.4 m

Easting: 616791 m

Borehole Location: SEE DRAWING

Datum Elevation: Geodetic

Diameter: 61mm

(m) STRATA ELEV DEPTH	ROCK DESCRIPTION See Soil Logs for soil descriptions.	GROUND WATER CONDITIONS	(m) CORE ELEV DEPTH	CORE SAMPLE			TOTAL CORE RECOVERY (%)	SOLID CORE RECOVERY (%)	HARD LAYER (%)	RQD (%)	FRACTURE INDEX (per 0.3m)	DISCONTINUITIES AND WEATHERING	HYDRAULIC CONDUCTIVITY k (cm/sec) [P (kPa)]	POINT LOAD TEST UCS AXIAL (MPa)	POINT LOAD TEST UCS DIAMETRAL (MPa)	UNIAxIAL COMPRESSION (MPa)	DENSITY (g/cc) [E (GPa)]
				NUMBER	SIZE	CORE RATE (m/min)											
80.1			80.1														
4.3	GEORGIAN BAY FORMATION SHALE grey, thinly laminated		4.3	1	HQ3	0.24	100	37	5	0		horizontal bedding partings, closely spaced, undulating, rough, open, with clay coating, highly weathered		37	6		
	interbedded with light grey LIMESTONE and SILTSTONE layers, strong to very strong Run 1: very weak, 325mm fractured zone at 4.3m and 4.8m, 25mm hard layer at 4.3m Run 2: 75mm core loss at 4.9m, 50mm very soft clay layer at 5.0m, 12mm very soft clay infill at 5.5m, 25mm extremely weak zone at 6.1m, 25mm hard layer at 5.2m Run 3: 25mm hard layer at 6.7m and 7.5m, 75mm hard layer at 7.0m, 7.1m, 7.3m, 50mm fractured zone at 7.0m, 50mm core loss at 7.1m, 425mm fractured zone at 7.3m, 100mm hard layer at 7.6m		79.6														
			4.8	2	HQ3	0.15	95	75	2	55		bedding partings and joint, generally horizontal (one 45 degree joint), closely to moderately closely spaced, undulating to planar, rough (30%) to smooth (70%), open, with clay coating, highly to moderately weathered					
			78.1														
			6.3	3	HQ3	0.18	97	65	26	31		horizontal bedding partings and contacts, very closely to closely spaced, undulating, rough (60%) to smooth (40%), open, with clay coating	2	4	191	107	
			76.6														
	Run 4: 50mm hard layer at 8.0m and 8.2m, 50mm extremely weak zone at 8.3m, 100mm hard layer at 8.3m, 125mm hard layer at 8.6m, 75mm hard layer at 8.9m, 75mm fractured zone at 8.9m		7.8	4	HQ3	0.13	98	78	28	33		bedding partings, contacts and joints, closely spaced, generally undulating, rough (60%) to smooth (40%), open, with clay coating	171	66			
			75.1														
	Run 5: very weak to weak, 175mm hard layer at 9.3m, 100mm hard layer at 9.5m, 75mm crushed zone at 9.8m, 75mm hard layer at 9.9m and 10.6		9.3	5	HQ3	0.10	98	90	28	56		bedding partings and contacts, 0-10 degrees, closely spaced, undulating (80%) to planar (20%), rough (60%) to smooth (40%), open, with clay coating, slightly weathered	108	101			
			73.6														
	25mm very soft clay layer at 10.9m, 25mm extremely weak zone at 11.1m, 25mm hard layer at 11.8m		10.8	6	HQ3	0.14	100	93	2	87		bedding partings, contact and joint, generally horizontal (one 90 degree joint), very closely to moderately closely spaced, undulating (80%) to planar (20%), rough to smooth, open, with clay coating	22	1			
			72.0														
	100mm hard layer at 12.7m, 13.5m and 13.7m, 50mm fractured zone at 13.0m 50mm hard layer at 13.5m and 13.6m		12.4	7	HQ3	0.14	100	95	27	60		horizontal bedding partings and contacts, closely to moderately closely spaced, undulating, rough (60%) to smooth (40%), open, with clay coating, slightly weathered to fresh	25	1			
			70.5														
	25mm hard layer at 13.9m, 100mm hard layer at 14.1m, 150mm fractured zone at 14.2m		13.9														

Continued Next Page

E = Modulus of Elasticity

Additional Notes:

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Sample Types: A=Auger; DP=Direct Push; G=Grab; RC=Rock Core; SC=Soil Core; SS=Split Barrel (Split Spoon); ST=Shelby Tube.

Coffey Representatives

BB	Originated By
AC	Prepared By
IL	Checked By

LOG OF BOREHOLE HF1-40

SHEET 2 OF 2

Project Name: HANLAN FEEDERMAIN SOUTH CONTRACT 1

Client: CH2M HILL CANADA LTD.

Date: 21 - 23 September 2011

Project No.: GEOTMARK00233AA

Drilling Method Used: ROCK CORING HQ3

Northing: 4826454 m

Project Location: Lakeshore Road East, Mississauga

Ground Surface Elevation: 84.4 m

Easting: 616791 m

Borehole Location: SEE DRAWING

Datum Elevation: Geodetic

Diameter: 61mm

(m) STRATA ELEV DEPTH	ROCK DESCRIPTION See Soil Logs for soil descriptions.	GROUND WATER CONDITIONS	(m) CORE ELEV DEPTH	CORE SAMPLE			TOTAL CORE RECOVERY (%)	SOLID CORE RECOVERY (%)	HARD LAYER (%)	ROD (%)	FRACTURE INDEX (per 0.3m)	DISCONTINUITIES AND WEATHERING	HYDRAULIC CONDUCTIVITY k (cm/sec) [P (kPa)]	POINT LOAD TEST UCS AXIAL (MPa)	POINT LOAD TEST UCS DIAMETRAL (MPa)	UNIAxIAL COMPRESSION (MPa)	DENSITY (g/cc) [E (GPa)]
				NUMBER	SIZE	CORE RATE (m/min)											
	75mm hard layer at 14.4m, 50mm fractured zone at 14.5m, 150mm hard layer at 14.5m and 15.2m, 75mm crushed zone at 14.9m GEORGIAN BAY FORMATION SHALE grey, thinly laminated		69.0	8	HQ3	0.12	100	85	34	59		horizontal bedding parting and contact, closely spaced, undulating, rough to smooth, open, with clay coating (continued)		148	65		
	interbedded with light grey LIMESTONE and SILTSTONE layers, strong to very strong (continued) Run 9: 150mm hard layer at 15.4m and 15.6m, 175mm fractured zone at 15.8m, 50mm hard layer at 15.8m and 16.3m, 400mm hard layer at 15.8m, 50mm fractured zone at 16.0m, 75mm hard layer at 16.2m, 300mm hard layer at 16.6m Run 10: weak, 25mm very soft clay layer at 17.0m, 75mm hard layer at 17.1m and 17.7m, 25mm hard layer at 17.5m(2), 125mm hard layer at 18.0		15.4														
			67.5	9	HQ3	0.14	100	87	78	57		bedding partings, contacts and joint, 0-10 degrees (one 90 degree joint), closely spaced, undulating, rough (90%) to smooth (10%), open, with clay coating, slightly weathered		195	218		
			16.9														
			65.9	10	HQ3	0.17	100	95	22	70		horizontal bedding partings and contacts, closely spaced, undulating, rough to smooth, open, with clay coating		12	16		
			18.5														
	75mm hard layer at 18.5m and 19.7m, 25mm hard layer at 18.7m, 25mm fractured zone at 18.7m, 50mm fractured zone at 18.8m, 18.9m and 19.5m		64.5	11	HQ3	0.13	100	96	23	55		bedding partings and contacts, 0-10 degrees, closely to moderately closely spaced, planar (20%) to undulating (80%), rough (70%) to smooth (30%), open, with clay coating		139	58		
			19.9														
	125mm crushed zone with clay infill at 20.4m 75mm crushed zone with clay infill at 20.7m, 300mm fractured zone at 21.1m		63.0	12	HQ3	0.13	100	67	0	79		bedding partings, contact and joint, closely spaced, planar (80%) to undulating (20%), rough (20%) to smooth (80%), open (20%) to tight (80%), with clay coating, slightly to moderately weathered		47	7		
			21.4														

Date / Time	Water Depth (m)	Elevation (m)
28 September 2011	3.6	80.8
14 October 2011	3.6	80.8

E = Modulus of Elasticity



Additional Notes:

This log is to be read in conjunction with accompanying general notes and borehole log symbols sheet. Stratification lines represent approximate boundary lines between material types, vertical and lateral transitions may be gradual. Water level readings were made at time(s) noted, fluctuations of groundwater levels may occur and should be expected.

Sample Types: A=Auger; DP=Direct Push; G=Grab; RC=Rock Core; SC=Soil Core; SS=Split Barrel (Split Spoon); ST=Shelby Tube.

Coffey Representatives

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AC	Prepared By
IL	Checked By

LOG OF BOREHOLE HF1-41

SHEET 1 OF 1

Project Name: HANLAN FEEDERMAIN SOUTH CONTRACT 1	Client: CH2M HILL CANADA LTD.	Northing: 4826354 m
Project No.: GEOTMARK00233AA	Drilling Method Used: Hollow Stem Augering 200mm	Easting: 616790 m
Project Location: Lakeshore Road East, Mississauga	Date: 12 - 16 September 2011	Ground Surface Elevation: 84.7 m

Depth Scale (m)	Stratigraphic Symbol	Subsurface Conditions		Samples		Penetration / Strength Results		Moisture / Plasticity		Instrumentation Details	Groundwater Conditions	Headspace Vapor (ppm) LEL (%)	Elevation Scale (m)	Comments
		Depth / Elevation (m)	Description	Number	Type	Blow Counts / 150mm	N Value	Recovery %	Relative Drilling Resistance					
			150mm Asphalt 50mm Granular Base											
0.5		83.9												
1.0		0.8	SILTY CLAY trace sand and fine gravel, laminated, trace oxidation, grey, very stiff	1	SS	5 13	(18)	89	×	>>▲	○			PP, Cu > 241 kPa
1.5			----- brown to grey	2	SS	6 13 15	(28)	89	×	>>▲	○			PP, Cu > 241 kPa
2.0														
2.5			----- trace fine to coarse angular to subrounded sand and gravel, brown	3	SS	7 12 16	(28)	100	×	>>▲	○			PP, Cu > 241 kPa
3.0														
3.5		81.3		4	SS	7 10	(33)	100	×		○			
3.5		3.4	SHALE weathered, grey	4A		23					○			
4.0		80.7	----- trace siltstone fragments	5	SS	50	50/13cm	99			○			Borehole dry upon completion before coring.
4.0														

Rock Coring Started

Rock Core Log Next Page

Additional Notes:

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Coffey Representatives

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LOG OF BOREHOLE HF1-41

SHEET 1 OF 2

Project Name: HANLAN FEEDERMAIN SOUTH CONTRACT 1

Client: CH2M HILL CANADA LTD.

Date: 12 - 16 September 2011

Project No.: GEOTMARK00233AA

Drilling Method Used: ROCK CORING HQ3

Northing: 4826354 m

Project Location: Lakeshore Road East, Mississauga

Ground Surface Elevation: 84.7 m

Easting: 616790 m

Borehole Location: SEE DRAWING

Datum Elevation: Geodetic

Diameter: 61mm

(m) STRATA ELEV DEPTH	ROCK DESCRIPTION See Soil Logs for soil descriptions.	GROUND WATER CONDITIONS	(m) CORE ELEV DEPTH	CORE SAMPLE			TOTAL CORE RECOVERY (%)	SOLID CORE RECOVERY (%)	HARD LAYER (%)	ROD (%)	FRACTURE INDEX (per 0.3m)	DISCONTINUITIES AND WEATHERING	HYDRAULIC CONDUCTIVITY k (cm/sec) [P (kPa)]	POINT LOAD TEST UCS AXIAL (MPa)	POINT LOAD TEST UCS DIAMETRAL (MPa)	UNIAxIAL COMPRESSION (MPa)	DENSITY (g/cc) [E (GPa)]
				NUMBER	SIZE	CORE RATE (m/min)											
80.7 4.0	GEORGIAN BAY FORMATION SHALE grey, thinly laminated interbedded with light grey LIMESTONE and SILTSTONE layers, strong to very strong Run 1: very weak, 775mm fractured zone with clay infill at 4.0m, 50mm hard layer at 4.3m, 25mm hard layer at 4.7m Run 2: very weak to weak, 50mm crushed zone at 4.9m, 75mm fractured zone at 5.2m, 175mm hard layer at 5.0m, 25mm hard layer at 5.2m, 12mm soft clay infill at 6.0m Run 3: 75mm hard layer at 7.5m(2), 25mm fractured zone with clay infill at 7.6m and 7.8m, 25mm very soft clay layer at 8.0m, 75mm hard layer at 8.2m and 9.3m, 125mm hard layer at 8.3m, 50mm hard layer at 8.5m, 8.7m and 9.0m, 100mm hard layer at 9.1m 25mm fractured zone with clay infill at 9.4m, 50mm hard layer at 9.5m, 9.7m, 10.2m and 10.6m, 75mm crushed zone at 9.6m, 25mm hard layer at 10.4m and 10.5m 75mm fractured zone with clay infill at 4.7m, 50mm hard layer at 13.4m		80.7 4.0	1	HQ3	0.13	100	16	10	0		fractured zone, highly weathered		105	21		
			79.9 4.8	2	HQ3	0.17	100	90	13	62		horizontal bedding partings and contacts, closely to moderately closely spaced, undulating, rough, open, with clay coating, moderately to slightly weathered		17	6		
			78.4 6.3	3	HQ3	0.10	100	95	10	70		horizontal bedding partings and contact, closely to moderately closely spaced, planar (10%) to undulating (90%), rough, open, with clay coating, slightly weathered to fresh		176	134		
			76.9 7.8	4	HQ3	0.17	100	90	35	37		bedding partings, contacts and joints, generally horizontal (one 90 degree joint), very closely to closely spaced, undulating, rough, open, with clay coating, slightly weathered		13	4		
			75.3 9.4	5	HQ3	0.12	100	94	16	49		bedding partings, contacts and joint, 0-10 degrees (one 90 degree joint), very closely to moderately closely spaced, undulating, rough, generally open, with clay coating		144	58		
			73.8 10.9	6	HQ3	0.15	100	98	0	80		bedding partings, 0-45 degrees, very closely to moderately closely spaced, undulating, rough, generally open, with clay coating	2.18E-6 [128] 6.39E-6 [235] 8.09E-6 [343]	18 17	1 3		
			72.3 12.4	7	HQ3	0.19	100	95	3	82		horizontal bedding partings and contact, closely to moderately closely spaced, undulating, rough, open, with clay coating, fresh		57	133		
			70.8														

Continued Next Page

E = Modulus of Elasticity

Additional Notes:

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LOG OF BOREHOLE HF1-41

SHEET 2 OF 2

Project Name: HANLAN FEEDERMAIN SOUTH CONTRACT 1

Client: CH2M HILL CANADA LTD.

Date: 12 - 16 September 2011

Project No.: GEOTMARK00233AA

Drilling Method Used: ROCK CORING HQ3

Northing: 4826354 m

Project Location: Lakeshore Road East, Mississauga

Ground Surface Elevation: 84.7 m

Easting: 616790 m

Borehole Location: SEE DRAWING

Datum Elevation: Geodetic

Diameter: 61mm

(m) STRATA ELEV DEPTH	ROCK DESCRIPTION See Soil Logs for soil descriptions.	GROUND WATER CONDITIONS	(m) CORE ELEV DEPTH	CORE SAMPLE			TOTAL CORE RECOVERY (%)	SOLID CORE RECOVERY (%)	HARD LAYER (%)	ROD (%)	FRACTURE INDEX (per 0.3m)	DISCONTINUITIES AND WEATHERING	HYDRAULIC CONDUCTIVITY k (cm/sec) [P (kPa)]	POINT LOAD TEST UCS AXIAL (MPa)	POINT LOAD TEST UCS DIAMETRAL (MPa)	UNIAxIAL COMPRESSION (MPa)	DENSITY (g/cc) [E (GPa)]
				NUMBER	SIZE	CORE RATE (m/min)											
	50mm hard layer at 14.5m, 14.9m, 15.0m and 15.4m, 125mm hard layer at 14.6m, 50mm fractured zone at 15.0m, 150mm hard layer at 15.1m, 100mm fractured zone at 15.3m GEORGIAN BAY FORMATION SHALE grey, thinly laminated		13.9									bedding partings and contacts, 0-45 degrees, closely spaced, undulating, smooth (20%) to rough (80%), open, with clay coating, slightly weathered (<i>continued</i>)					
			69.2														
	interbedded with light grey LIMESTONE and SILTSTONE layers, strong to very strong (<i>continued</i>) Run 9: weak to medium strong, 75mm crushed zone at 15.6m and 16.2m, 125mm hard layer at 15.6 and 16.0m, 50mm fractured zone at 15.8m and 16.6m, 175mm hard layer at 15.9m, 100mm fractured zone at 16.0m, 75mm hard layer at 16.2m, 225mm hard layer at 16.3m, 425mm hard layer at 16.5m Run 10: 75mm hard layer at 17.0m, 100mm hard layer at 17.2m, 50mm hard layer at 17.4m and 18.0m, 25mm hard layer at 18.3m		15.5									bedding partings and joint, 0-30 degrees (one 90 degree joint), very closely to closely spaced, undulating, smooth to rough, tight to healed, slightly weathered		101	128		
			67.7														
			17.0									bedding partings, 0-30 degrees, closely to moderately closely spaced, undulating (70%) to planar (30%), smooth (30%) to rough (70%), open (70%) to tight (30%), fresh		16	3		
			66.1														
	Run 11: 25mm hard layer at 18.6m, 19.5m and 19.8m, 75mm hard layer at 18.7m and 18.9m, 175mm hard layer at 19.1m, 50mm hard layer at 19.8m and 19.9m		18.6									bedding partings, contacts and joints, 0-45 degrees (one 90 degree joint), closely to moderately closely spaced, undulating (70%) to planar (30%), smooth (30%) to rough (70%), open (70%) to tight (30%), fresh		68	127		
			64.6														
	175mm hard layer at 20.1m, 225mm hard layer at 20.4m, 100mm hard layer at 20.7m, 25mm hard layer at 21.0m, 50mm hard layer at 21.3m and 21.5m		20.1									bedding partings, contacts and joints, 0-30 degrees (one 90 degree joint), very closely to moderately closely spaced, undulating (50%) to planar (50%), smooth (60%) to rough (40%), open to healed		199	87		
			63.1														
			21.6														

Date / Time

Water Depth (m)

Elevation (m)

E = Modulus of Elasticity



Additional Notes:

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Sample Types: A=Auger; DP=Direct Push; G=Grab; RC=Rock Core; SC=Soil Core; SS=Split Barrel (Split Spoon); ST=Shelby Tube.

Coffey Representatives

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LOG OF BOREHOLE HF1-42

SHEET 1 OF 1

Project Name: HANLAN FEEDERMAIN SOUTH CONTRACT 1	Client: CH2M HILL CANADA LTD.	Northing: 4826203 m
Project No.: GEOTMARK00233AA	Drilling Method Used: Hollow Stem Augering 200mm	Easting: 616622 m
Project Location: Lakeshore Road East, Mississauga	Date: 3 - 5 October 2011	Ground Surface Elevation: 84.3 m

Depth Scale (m)	Subsurface Conditions		Samples		Penetration / Strength Results		Moisture / Plasticity		Instrumentation Details	Groundwater Conditions	Headspace Vapor (ppm) LEL (%)	Elevation Scale (m)	Comments
	Stratigraphic Symbol	Depth / Elevation (m)	Description	Number Type	Blow Counts / 150mm N Value	Recovery %	Relative Drilling Resistance	Penetration Test Values (Blows / 0.3m) X N Values ♦ Dynamic Cone + Becker Hammer Test (BPT) 20 40 60 80 Undrained Shear Strength Values (kPa) □ Field Vane ○ Unconfined ■ Lab Vane ● Quick Triaxial ▲ Pocket Penetrometer	Plastic Limit Natural Water Content Liquid Limit PL MC LL				
0.5			75mm Asphalt 50mm Granular Base									84.0	
1.0			FILL clayey silt, trace coarse sand and fine gravel, trace oxidation, brown to grey, stiff	1 SS 4 5	(9)	67		X	>>▲			83.5	PP, Cu = 214 to 241 kPa
1.5		82.8	SILTY CLAY TILL trace to some coarse sand and fine gravel, trace oxidation, very stiff to hard	2 SS 11 12	(23)	89		X	>>▲			82.5	PP, Cu > 241 kPa
2.0			trace siltstone fragments									82.0	
2.5				3 SS 15 15 15	(30)	28		X				81.5	
3.0		81.3	SHALE weathered, grey	4 SS 12 16 50	50/13cm	100		X				81.0	
3.5												80.5	Borehole dry upon completion before coring
4.0		80.2		5 SS 50	50/8cm	100							

Rock Coring Started

Date / Time
14 October 2011Water Depth (m)
2.9Elevation (m)
81.4

Rock Core Log Next Page

Additional Notes:

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Sample Types: A=Auger; DP=Direct Push; G=Grab; RC=Rock Core; SC=Soil Core; SS=Split Barrel (Split Spoon); ST=Shelby Tube.

Coffey Representatives

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IL	Checked By

LOG OF BOREHOLE HF1-42

SHEET 1 OF 2

Project Name: HANLAN FEEDERMAIN SOUTH CONTRACT 1

Client: CH2M HILL CANADA LTD.

Date: 3 - 5 October 2011

Project No.: GEOTMARK00233AA

Drilling Method Used: ROCK CORING HQ3

Northing: 4826203 m

Project Location: Lakeshore Road East, Mississauga

Ground Surface Elevation: 84.3 m

Easting: 616622 m

Borehole Location: SEE DRAWING

Datum Elevation: Geodetic

Diameter: 61mm

(m) STRATA ELEV DEPTH	ROCK DESCRIPTION See Soil Logs for soil descriptions.	GROUND WATER CONDITIONS	(m) CORE ELEV DEPTH	CORE SAMPLE			TOTAL CORE RECOVERY (%)	SOLID CORE RECOVERY (%)	HARD LAYER (%)	ROD (%)	FRACTURE INDEX (per 0.3m)	DISCONTINUITIES AND WEATHERING	HYDRAULIC CONDUCTIVITY k (cm/sec) [P (kPa)]	POINT LOAD TEST UCS AXIAL (MPa)	POINT LOAD TEST UCS DIAMETRAL (MPa)	UNIAxIAL COMPRESSION (MPa)	DENSITY (g/cc) [E (GPa)]
				NUMBER	SIZE	CORE RATE (m/min)											
80.2 4.1	GEORGIAN BAY FORMATION SHALE grey, thinly laminated interbedded with light grey LIMESTONE and SILTSTONE layers, strong to very strong Run 1: very weak 250mm core loss at 4.1m, 475mm fractured zone at 4.3m, 50mm very soft to soft clay layer at 4.5m, 50mm hard layer at 4.6m Run 2: 100mm very soft clay layer at 4.8m 100mm fractured zone with clay infill at 6.4m, 25mm fractured zone with clay infill at 7.0m, 100mm hard layer at 7.2m, 50mm hard layer at 7.6m 25mm very soft clay layer at 7.9m, 50mm core loss at 8.0m, 50mm extremely weak zone at 8.7m, 75mm fractured zone at 9.2m 50mm hard layer at 9.5m, 100mm hard layer at 9.7m, 50mm fractured zone with clay infill at 9.8m, 25mm fractured zone at 10.1m, 75mm hard layer at 10.2m, 25mm hard layer at 10.7m Run 6: weak, 25mm hard layer at 11.7m, 125mm hard layer at 12.2m 25mm hard layer at 13.1m, 13.3m and 13.4m, 50mm hard layer at 13.6m and 13.9m		80.2 4.1	1	HQ3	0.24	66	21	7	0		highly weathered		155	73		
			79.5 4.8	2	HQ3	0.22	100	93	0	88		bedding partings, 0-45 degrees, closely to moderately closely spaced, undulating (80%) to planar (20%), rough (60%) to smooth (40%), open, occasionally with clay coating, slightly weathered to fresh		48	13	8.8	[1]
			77.9 6.4	3	HQ3	0.19	100	80	10	53		bedding partings, contact and joints, generally horizontal (one 90 degree joint), very closely to closely spaced, undulating (70%) to planar (30%), rough (80%) to smooth (20%), generally open, some with clay coating, moderately weathered	3.67E-4 [69]	122	45		
			76.4 7.9	4	HQ3	0.12	97	75	31	53		contacts and joint, generally horizontal (one 90 degree joint), closely to moderately closely spaced, undulating (45%) to planar (55%), rough (45%) to smooth (55%), tight (45%) to open (55%), some with clay coating	2.84E-4 [137] 2.38E-4 [177]	132	52		
			74.9 9.4	5	HQ3	0.13	100	94	16	61		horizontal bedding partings and contact, very closely to moderately closely spaced, undulating (70%) to planar (30%), rough (75%) to smooth (25%), open, with clay coating, moderately to slightly weathered		33	9		
			73.4 10.9	6	HQ3	0.15	100	100	10	100		bedding parting and contacts, 0-45 degrees, very closely to moderately closely spaced, undulating (70%) to planar (30%), smooth, open (70%) to tight (30%), with clay coating, slightly weathered to fresh	6.95E-5 [98]	27	5		
			71.9 12.4	7	HQ3	0.30	100	100	12	90		bedding partings, 0-10 degrees, closely to moderately closely spaced, planar, smooth, open (60%) to tight (40%), with clay coating, fresh	4.67E-5 [177] 3.92E-5 [275]	35	3		
			70.3														

Continued Next Page

E = Modulus of Elasticity

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Sample Types: A=Auger; DP=Direct Push; G=Grab; RC=Rock Core; SC=Soil Core; SS=Split Barrel (Split Spoon); ST=Shelby Tube.

Coffey Representatives

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LOG OF BOREHOLE HF1-42

SHEET 2 OF 2

Project Name: HANLAN FEEDERMAIN SOUTH CONTRACT 1

Client: CH2M HILL CANADA LTD.

Date: 3 - 5 October 2011

Project No.: GEOTMARK00233AA

Drilling Method Used: ROCK CORING HQ3

Northing: 4826203 m

Project Location: Lakeshore Road East, Mississauga

Ground Surface Elevation: 84.3 m

Easting: 616622 m

Borehole Location: SEE DRAWING

Datum Elevation: Geodetic

Diameter: 61mm

(m) STRATA ELEV DEPTH	ROCK DESCRIPTION See Soil Logs for soil descriptions.	GROUND WATER CONDITIONS	(m) CORE ELEV DEPTH	CORE SAMPLE			TOTAL CORE RECOVERY (%)	SOLID CORE RECOVERY (%)	HARD LAYER (%)	ROD (%)	FRACTURE INDEX (per 0.3m)	DISCONTINUITIES AND WEATHERING	HYDRAULIC CONDUCTIVITY k (cm/sec) [P (kPa)]	POINT LOAD TEST UCS AXIAL (MPa)	POINT LOAD TEST UCS DIAMETRAL (MPa)	UNIAxIAL COMPRESSION (MPa)	DENSITY (g/cc) [E (GPa)]
				NUMBER	SIZE	CORE RATE (m/min)											
	25mm crushed zone at 14.5m, 25mm hard layer at 14.1m, 14.3m, 14.4m, 14.5m, 50mm hard layer 14.5m, 600mm hard layer at 14.6m GEORGIAN BAY FORMATION SHALE grey, thinly laminated		14.0	8	HQ3	0.19	100	78	50	80		contacts and joints, generally horizontal (two 90 degree joints), very closely to moderately closely spaced, undulating (60%) to planar (40%), smooth to rough, open (60%) to tight (40%), with clay coating (<i>continued</i>)		37	42	35.5	[11]
	interbedded with light grey LIMESTONE and SILTSTONE layers, strong to very strong (<i>continued</i>) Run 9: 75mm hard layer at 15.6m and 15.9m, 50mm hard layer at 15.8m(2), 16.0m, 16.3m, 16.5m and 16.7m, 50mm extremely weak zone at 16.0m, 150mm hard layer at 16.1m, 25mm hard layer at 16.4m(2) and 16.7m		68.8 15.5	9	HQ3	0.19	100	97	48	78		horizontal contacts and bedding partings, closely spaced, undulating (80%) to planar (20%), smooth (20%) to rough (80%), open, with clay coating	2.19E-4 [137]	126	86		
	50mm hard layer at 17.0m, 17.2m, 17.7m and 18.3m, 75mm hard layer at 17.5m and 18.4m, 25mm hard layer at 18.0m, 18.1m and 18.3m		67.3 17.0	10	HQ3	0.26	100	100	28	92		bedding partings, contacts and joint, 0-10 degrees (one 90 degree joint), very closely to moderately closely spaced, undulating (80%) to planar (20%), smooth (20%) to rough (80%), open to healed, often with clay coating	3.00E-4 [275] 4.51E-4 [412]	27	4		
	25mm hard layer at 18.9m, 19.1m, 19.3m and 19.8m, 50mm hard layer at 19.0m, 300mm fractured zone with clay infill at 19.1m, 50mm very soft to soft clay layer at 19.1m, 300mm hard layer at 19.4m, 75mm hard layer at 20.0m		65.7 18.6	11	HQ3	0.13	100	85	33	72		horizontal bedding parting and contacts, very closely to closely spaced, undulating (30%) to planar (70%), smooth (70%) to rough (30%), open, with clay coating		28	32	112.4	[18]
	Run 12: weak to medium strong, 25mm crushed zoned at 20.8m, 25mm hard layer at 20.3m and 20.4m, 100mm hard layer at 20.5m and 20.6m, 50mm hard layer at 20.7m and 21.6m, 75mm hard layer at 20.8m, 125mm hard layer at 21.3m		64.2 20.1	12	HQ3	0.14	100	97	37	73		contacts and joint, generally horizontal (one 90 degree joint), very closely to closely spaced, undulating, smooth (10%) to rough (90%), open, with clay coating		138	98		
			62.7 21.6														

Date / Time 14 October 2011 Water Depth (m) 2.9 Elevation (m) 81.4

E = Modulus of Elasticity



Additional Notes:

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IL	Checked By

LOG OF BOREHOLE HF1-42-1

SHEET 1 OF 1

Project Name: HANLAN FEEDERMAIN SOUTH CONTRACT 1

Client: CH2M HILL CANADA LTD.

Northing: 4826204 m

Project No.: GEOTMARK00233AA

Drilling Method Used: Hollow Stem Augering 200mm

Easting: 616622 m

Project Location: Lakeshore Road East, Mississauga

Date: 6 October 2011

Ground Surface Elevation: 84.3 m

Depth Scale (m)	Subsurface Conditions		Samples		Penetration / Strength Results		Moisture / Plasticity		Instrumentation Details	Groundwater Conditions	Headspace Vapor (ppm) LEL (%)	Elevation Scale (m)	Comments
	Stratigraphic Symbol	Depth / Elevation (m)	Description	Number Type	Blow Counts / 150mm N Value	Recovery %	Relative Drilling Resistance	Penetration Test Values (Blows / 0.3m) X N Values ♦ Dynamic Cone + Becker Hammer Test (BPT) 20 40 60 80 Undrained Shear Strength Values (kPa) □ Field Vane ○ Unconfined ■ Lab Vane ● Quick Triaxial ▲ Pocket Penetrometer	Plastic Limit Natural Water Content Liquid Limit PL MC LL				
0.5			See log of Borehole HF1-42 for stratigraphy.				— fsec —					84.0	GRAIN SIZE DISTRIBUTION (%) GR SA SI CL
1.0							— wuj —					83.5	
1.5							— pnt —					83.0	
2.0							— pnt —					82.5	
2.5							— wuj —					82.0	
3.0												81.5	
3.5												81.0	
4.0												80.5	
4.5												80.0	
5.0												79.5	
5.5												79.0	
6.0												78.5	
6.5												78.0	
7.0												77.5	
7.5												77.0	
8.0												76.5	
8.5												76.0	
9.0												75.5	

75.2
9.1 BOREHOLE HF1-42-1
TERMINATED AT 9.1m BGL

Date / Time
14 October 2011

Water Depth (m)
2.4

Elevation (m)
81.9

SOIL LOG FOR CH2M GEOTMARK00233AA BH38 TO BH46.GPJ COFFEY STANDARD GDT 30/5/12



Additional Notes:

This log is to be read in conjunction with accompanying general notes and borehole log symbols sheet. Stratification lines represent approximate boundary lines between material types; vertical and lateral transitions may be gradual. Water level readings were made at time(s) noted; fluctuations of groundwater levels may occur and should be expected.
Sample Types: A=Auger; DP=Direct Push; G=Grab; RC=Rock Core; SC=Soil Core; SS=Split Barrel (Split Spoon); ST=Shelby Tube.

Coffey Representatives

BB	Originated By
AC	Prepared By
IL	Checked By

LOG OF BOREHOLE HF1-43

SHEET 1 OF 1

Project Name: HANLAN FEEDERMAIN SOUTH CONTRACT 1

Client: CH2M HILL CANADA LTD.

Northing: 4826084 m

Project No.: GEOTMARK00233AA

Drilling Method Used: Hollow Stem Augering 200mm

Easting: 616511 m

Project Location: Lakeshore Road East, Mississauga

Date: 28 - 30 September 2011

Ground Surface Elevation: 84.7 m

Depth Scale (m)	Subsurface Conditions		Samples		Penetration / Strength Results		Moisture / Plasticity		Instrumentation Details	Groundwater Conditions	Headspace Vapor (ppm) LEL (%)	Elevation Scale (m)	Comments
	Stratigraphic Symbol	Depth / Elevation (m)	Description	Number Type	Blow Counts / 150mm N Value	Recovery %	Relative Drilling Resistance	Penetration Test Values (Blows / 0.3m) X N Values + Becker Hammer Test (BPT) 20 40 60 80 Undrained Shear Strength Values (kPa) □ Field Vane ○ Unconfined ■ Lab Vane ● Quick Triaxial ▲ Pocket Penetrometer	Plastic Limit Natural Water Content Liquid Limit PL MC LL				
0.5			150mm Asphalt 300mm Concrete				hard					84.5	
1.0			FILL clayey silt to silty clay, trace fine to coarse sand, trace fine gravel, dark grey, very stiff	1 SS	8 15 9	(24) 72		X				84.0	
1.5			soft, trace wood pieces	2 SS	1 1 2	(3) 56	very easy	X				83.5	
2.0												83.0	
2.5			brown to grey, trace oxidation, stiff	3 SS	3 3 7	(10) 67	easy	X				82.5	
3.0		81.7										82.0	7 16 44 33
3.5		3.0	CLAYEY SILT TILL trace fine to coarse sand and gravel, trace siltstone fragments, brown, hard	4 SS	6 12 45	(57) 83		X				81.5	
4.0		80.9										81.0	
4.5		3.8	SHALE weathered, grey	5 SS	33 50	50/10cm 100	firm					80.5	
5.0												80.0	Borehole dry upon completion before coring.
5.3		79.4										79.5	

Rock Coring Started

Rock Core Log Next Page

Additional Notes:

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Sample Types: A=Auger; DP=Direct Push; G=Grab; RC=Rock Core; SC=Soil Core; SS=Split Barrel (Split Spoon); ST=Shelby Tube.

Coffey Representatives

BB	Originated By
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IL	Checked By

LOG OF BOREHOLE HF1-43

SHEET 1 OF 2

Project Name: HANLAN FEEDERMAIN SOUTH CONTRACT 1

Client: CH2M HILL CANADA LTD.

Date: 28 - 30 September 2011

Project No.: GEOTMARK00233AA

Drilling Method Used: ROCK CORING HQ3

Northing: 4826084 m

Project Location: Lakeshore Road East, Mississauga

Ground Surface Elevation: 84.7 m

Easting: 616511 m

Borehole Location: SEE DRAWING

Datum Elevation: Geodetic

Diameter: 61mm

(m) STRATA ELEV DEPTH	ROCK DESCRIPTION See Soil Logs for soil descriptions.	GROUND WATER CONDITIONS	(m) CORE ELEV DEPTH	CORE SAMPLE			TOTAL CORE RECOVERY (%)	SOLID CORE RECOVERY (%)	HARD LAYER (%)	ROD (%)	FRACTURE INDEX (per 0.3m)	DISCONTINUITIES AND WEATHERING	HYDRAULIC CONDUCTIVITY k (cm/sec) [P (kPa)]	POINT LOAD TEST UCS AXIAL (MPa)	POINT LOAD TEST UCS DIAMETRAL (MPa)	UNIAxIAL COMPRESSION (MPa)	DENSITY (g/cc) [E (GPa)]
				NUMBER	SIZE	CORE RATE (m/min)											
79.4			79.4								2 4 6 8						
5.3	GEORGIAN BAY FORMATION SHALES grey, thinly laminated interbedded with light grey LIMESTONE and SILTSTONE layers, strong to very strong Run 1: very weak, 25mm fractured zone at 5.3m, 275mm fractured zone at 5.5m, 175mm fractured zone at 5.9m, 25mm hard layer at 6.2m Run 2: 50mm hard clay layer at 6.4m, 100mm fractured zone at 6.9m, 25mm hard layer at 7.6m 25mm clay layer at 7.9m, 50mm clay layer at 8.2m and 9.1m, 100mm fractured zone with clay infill at 8.5m, 75 mm extremely weak zone at 8.6m, 75mm hard layer at 8.7m and 8.9m, 175mm hard layer at 9.1m, 50mm fractured zone with clay infill at 9.4m 25mm clay layer at 9.5m, 50mm hard layer at 9.6m, 75mm crushed zone at 9.7m, 25mm hard layer at 10.4m(2), 100mm hard layer at 10.8m 25mm clay layer at 11.1m, 75mm hard layer at 11.1m, 25mm crushed zone with clay infill at 11.3m, 50mm hard layer at 12.0m, 150mm crushed zone with clay infill at 12.1m, 25mm hard layer at 12.4m 25mm hard layer at 13.2m 50mm hard layer at 14.2m, 75mm hard layer at 15.2m and 15.4m		5.3									horizontal bedding partings, very closely to closely spaced, undulating, rough, open, with clay coating, highly weathered		<1	5		
			78.4														
			6.3	2	HQ3	0.23	100	90	2	84		bedding partings and joint, generally horizontal (one 45 degree joint), very closely to moderately closely spaced, undulating (80%) to planar (20%), rough (80%) to smooth (20%), open, with clay coating, highly to moderately weathered		12	11	8.5	2.6 [1]
			76.8														
			7.9	3	HQ3	0.30	100	78	22	53		bedding partings and contacts, 0-10 degrees, closely to moderately closely spaced, undulating, rough, open, with clay coating/infill, moderately weathered		150	58		
			75.3														
			9.4	4	HQ3	0.25	100	87	13	67		bedding partings, contacts, and joints, generally horizontal (two 45 degree joints), very closely to closely spaced, undulating, rough, tight (45%) to open (55%), with clay coating, moderately to slightly weathered		29	10		
			73.8														
			10.9	5	HQ3	0.26	100	97	10	71		bedding partings, contact, and joint, 0-45 degrees (one 90 degree joint), very closely to moderately closely spaced, undulating, rough, open to healed, with clay coating/infill, slightly weathered to fresh		12	5	10	2.56 [1]
			72.2														
			12.5	6	HQ3	0.21	100	98	2	97		bedding partings and contact, 0-45 degrees, closely to moderately closely spaced, undulating (75%) to planar (25%), rough, open, with clay coating, fresh		12	2		
			70.7														
			14.0	7	HQ3	0.22	100	94	13	84		bedding partings, contacts and joint, 0-45 degrees (one 90 degree joint), very closely to closely spaced, undulating (90%) to planar (10%), rough (90%) to smooth (10%), open (90%) to tight (10%), with clay coating/infill		13	4		

Continued Next Page

E = Modulus of Elasticity

Additional Notes:

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Sample Types: A=Auger; DP=Direct Push; G=Grab; RC=Rock Core; SC=Soil Core; SS=Split Barrel (Split Spoon); ST=Shelby Tube.

Coffey Representatives

BB	Originated By
AC	Prepared By
IL	Checked By

LOG OF BOREHOLE HF1-43

SHEET 2 OF 2

Project Name: HANLAN FEEDERMAIN SOUTH CONTRACT 1

Client: CH2M HILL CANADA LTD.

Date: 28 - 30 September 2011

Project No.: GEOTMARK00233AA

Drilling Method Used: ROCK CORING HQ3

Northing: 4826084 m

Project Location: Lakeshore Road East, Mississauga

Ground Surface Elevation: 84.7 m

Easting: 616511 m

Borehole Location: SEE DRAWING

Datum Elevation: Geodetic

Diameter: 61mm

(m) STRATA ELEV DEPTH	ROCK DESCRIPTION See Soil Logs for soil descriptions.	GROUND WATER CONDITIONS	(m) CORE ELEV DEPTH	CORE SAMPLE			TOTAL CORE RECOVERY (%)	SOLID CORE RECOVERY (%)	HARD LAYER (%)	ROD (%)	FRACTURE INDEX (per 0.3m)				DISCONTINUITIES AND WEATHERING	HYDRAULIC CONDUCTIVITY k (cm/sec) [P (kPa)]	POINT LOAD TEST UCS AXIAL (MPa)	POINT LOAD TEST UCS DIAMETRAL (MPa)	UNIAxIAL COMPRESSION (MPa)	DENSITY (g/cc) [E (GPa)]
				NUMBER	SIZE	CORE RATE (m/min)					2	4	6	8						
	GEORGIAN BAY FORMATION SHALE grey, thinly laminated interbedded with light grey LIMESTONE and SILTSTONE layers, strong to very strong (<i>continued</i>) 50mm clay layer at 15.6m, 75mm hard layer at 15.7m, 15.9m and 16.0m, 100mm hard layer at 16.2m, 50mm hard layer at 16.4m, 25mm hard layer at 16.4m and 16.5m, 150mm hard layer at 16.7m Run 9: weak to medium strong, 125mm hard layer at 17.0m and 17.7m, 50mm very soft to soft clay layer at 17.1m, 25mm hard layer at 17.3m, 50mm hard layer at 17.5m and 18.3m, 75mm hard layer at 17.6m and 18.1m, 50mm extremely weak zone at 18.4m Run 10: 75mm hard layer at 18.6m, 19.5m and 20.0m, 25mm extremely weak zone at 18.8m, 25mm hard layer at 18.9m, 19.0m, 19.2m and 19.4m, 50mm hard layer at 19.2m and 19.9m 50mm hard layer at 20.1m and 21.5m, 100mm hard layer at 20.3m and 21.3m, 225mm hard layer at 20.4m, 25mm hard layer at 20.7m and 21.4m, 150mm hard layer at 21.0m		69.2 15.5																	
			67.7 17.0	8	HQ3	0.18	96	82	40	44					bedding partings and joint, generally horizontal (one 45 degree bedding parting, one 90 degree joint), very closely to moderately closely spaced, undulating, rough, open, with clay coating		101	30		
			66.2 18.5	9	HQ3	0.10	100	92	34	71					bedding partings and contacts, generally horizontal (one 45 degree bedding parting), very closely to moderately closely spaced, generally undulating, rough (70%) to smooth (30%), generally open, with clay coating		153	60	45.4	2.7 [13]
			64.6 20.1	10	HQ3	0.15	100	98	28	92					horizontal bedding partings and contacts, closely to moderately closely spaced, undulating, rough, open, with clay coating		40	13		
			63.1 21.6	11	HQ3	0.22	100	100	48	97					horizontal bedding partings and contact, moderately closely spaced, undulating (50%) to planar (50%), rough, open, with clay coating		36	1		

Date / Time Water Depth (m) Elevation (m)

E = Modulus of Elasticity



Additional Notes:

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Sample Types: A=Auger; DP=Direct Push; G=Grab; RC=Rock Core; SC=Soil Core; SS=Split Barrel (Split Spoon); ST=Shelby Tube.

Coffey Representatives

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AC	Prepared By
IL	Checked By

LOG OF BOREHOLE HF1-44

SHEET 1 OF 1

Project Name: HANLAN FEEDERMAIN SOUTH CONTRACT 1	Client: CH2M HILL CANADA LTD.	Northing: 4825983 m
Project No.: GEOTMARK00233AA	Drilling Method Used: Hollow Stem Augering 200mm	Easting: 616406 m
Project Location: Lakeshore Road East, Mississauga	Date: 6 - 7 October 2011	Ground Surface Elevation: 85.2 m

Depth Scale (m)	Subsurface Conditions		Samples		Penetration / Strength Results		Moisture / Plasticity		Instrumentation Details	Groundwater Conditions	Headspace Vapor (ppm) LEL (%)	Elevation Scale (m)	Comments
	Stratigraphic Symbol	Depth / Elevation (m)	Description	Number Type	Blow Counts / 150mm N Value	Recovery %	Relative Drilling Resistance	Penetration Test Values (Blows / 0.3m) X N Values ♦ Dynamic Cone + Becker Hammer Test (BPT) 20 40 60 80 Undrained Shear Strength Values (kPa) □ Field Vane ○ Unconfined ■ Lab Vane ● Quick Triaxial ▲ Pocket Penetrometer	Plastic Limit Natural Water Content Liquid Limit PL MC LL				
1		82.9	Asphalt Granular Base									85	
		82.9	FILL clayey silt, trace coarse sand and fine gravel, brown, stiff to very stiff	1 SS	3 4 10	(14)	89	X	>>▲	○		84	PP, Cu > 241 kPa
2		82.9	trace rootlets, trace oxidation	2 SS	8 12 15	(27)	100	X	>>▲	○		83	PP, Cu > 241 kPa
		82.9	CLAYEY SILT TILL trace coarse sand, trace fine to coarse gravel, trace rootlets, brown, hard	3 SS	14 20 50	50/3cm	93	X	>>▲	○		82	PP, Cu > 241 kPa
3		82.2	SHALE weathered, grey	4 SS	50	50/10cm	101					82	spoon wet
4		81.1											

Rock Coring Started

Date / Time	Water Depth (m)	Elevation (m)
BEFORE CORING	3.0	82.2
6 October 2011	2.4	82.8
14 October 2011		

Rock Core Log Next Page

Additional Notes:

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Sample Types: A=Auger; DP=Direct Push; G=Grab; RC=Rock Core; SC=Soil Core; SS=Split Barrel (Split Spoon); ST=Shelby Tube.

Coffey Representatives

BB	Originated By
AC	Prepared By
IL	Checked By

LOG OF BOREHOLE HF1-44

SHEET 1 OF 2

Project Name: HANLAN FEEDERMAIN SOUTH CONTRACT 1

Client: CH2M HILL CANADA LTD.

Date: 6 - 7 October 2011

Project No.: GEOTMARK00233AA

Drilling Method Used: ROCK CORING HQ3

Northing: 4825983 m

Project Location: Lakeshore Road East, Mississauga

Ground Surface Elevation: 85.2 m

Easting: 616406 m

Borehole Location: SEE DRAWING

Datum Elevation: Geodetic

Diameter: 61mm

(m) STRATA ELEV DEPTH	ROCK DESCRIPTION See Soil Logs for soil descriptions.	GROUND WATER CONDITIONS	(m) CORE ELEV DEPTH	CORE SAMPLE			TOTAL CORE RECOVERY (%)	SOLID CORE RECOVERY (%)	HARD LAYER (%)	RQD (%)	FRACTURE INDEX (per 0.3m)	DISCONTINUITIES AND WEATHERING	HYDRAULIC CONDUCTIVITY k (cm/sec) [P (kPa)]	POINT LOAD TEST UCS AXIAL (MPa)	POINT LOAD TEST UCS DIAMETRAL (MPa)	UNIAxIAL COMPRESSION (MPa)	DENSITY (g/cc) [E (GPa)]
				NUMBER	SIZE	CORE RATE (m/min)											
81.1 4.1	GEORGIAN BAY FORMATION SHALE grey, thinly laminated interbedded with light grey LIMESTONE and SILTSTONE layers, strong to very strong Run 1: very weak, 300mm fractured zone with clay infill at 4.1m, 125mm hard layer at 4.4m, 50mm hard layer at 4.5m, 125mm fractured zone with clay infill at 4.6m, 25mm hard layer at 4.8m Run 2: 12mm very soft to soft clay infill at 4.9m, 50mm hard layer at 4.9m and 5.0m, 25mm hard layer at 5.8m and 3.0m Run 3: very weak to weak, 50mm hard layer at 6.7m and 7.9m, 25mm hard layer at 6.8m, 7.8m and 7.9m 25mm hard layer at 9.1m, 50mm hard layer at 9.2m and 9.4m, 75mm hard layer at 9.3m 125mm fractured zone at 9.5m, 75mm hard layer at 9.5m, 150mm hard layer at 9.9m, 25mm hard layer at 10.2m, 50mm hard layer at 10.5m, 10.9m and 10.4m, 25mm hard layer at 11.1m, 11.3m and 11.9m, 75mm hard layer at 11.2m and 11.6m 25mm hard layer at 12.9m and 13.3m 25mm hard layer at 15.0m, 50mm hard layer at 15.2m		81.1 4.1	1	HQ3	0.18	100	36	29	36		fractured zones, highly to moderately weathered		156	70		
			80.3 4.9	2	HQ3	0.22	100	94	10	66		bedding partings, contacts and joint, 0-45 degrees (one 90 degree joint), very closely to moderately closely spaced, undulating (40%) to planar (60%), rough (20%) to smooth (80%), open, with clay coating, moderately to slightly weathered		16 30	2		
			78.8 6.4	3	HQ3	0.15	100	98	11	82		bedding partings, contacts and joint, generally horizontal (one 20 degree joint), closely to moderately closely spaced, undulating (80%) to planar (20%), rough (80%) to smooth (20%), open (80%) to tight (20%), with clay coating, slightly weathered		34	3		
			77.3 7.9	4	HQ3	0.17	100	98	13	83		bedding parting and contacts, 0-10 degrees, closely to moderately closely spaced, undulating (80%) to planar (20%), rough (80%) to smooth (20%), open (80%) to tight (20%), with clay coating, slightly weathered to fresh		27	<1		
			75.7 9.5	5	HQ3	0.18	100	86	28	64		bedding partings, contacts and joint, generally horizontal (one 90 degree joint), very closely to moderately closely spaced, undulating, rough, open (90%) to healed (10%), with clay coating		139	48		
			74.2 11.0	6	HQ3	0.19	100	98	15	98		horizontal bedding partings and contacts, closely spaced, undulating, rough, open (70%) to tight (30%), with clay coating		14	1		
			72.7 12.5	7	HQ3	0.15	100	98	3	95		horizontal bedding partings and contact, moderately closely spaced, undulating, rough, open, some with clay coating		48	23		
			71.2 14.0	8	HQ3	0.14	100	98	5	87		horizontal bedding partings, closely to moderately closely spaced, undulating to planar, rough (25%) to smooth (75%), open, with clay coating		18	1	8.1	2.61 [1]

Continued Next Page

E = Modulus of Elasticity

Additional Notes:

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Sample Types: A=Auger; DP=Direct Push; G=Grab; RC=Rock Core; SC=Soil Core; SS=Split Barrel (Split Spoon); ST=Shelby Tube.

Coffey Representatives

BB	Originated By
AC	Prepared By
IL	Checked By

LOG OF BOREHOLE HF1-44

SHEET 2 OF 2

Project Name: HANLAN FEEDERMAIN SOUTH CONTRACT 1

Client: CH2M HILL CANADA LTD.

Date: 6 - 7 October 2011

Project No.: GEOTMARK00233AA

Drilling Method Used: ROCK CORING HQ3

Northing: 4825983 m

Project Location: Lakeshore Road East, Mississauga

Ground Surface Elevation: 85.2 m

Easting: 616406 m

Borehole Location: SEE DRAWING

Datum Elevation: Geodetic

Diameter: 61mm

(m) STRATA ELEV DEPTH	ROCK DESCRIPTION See Soil Logs for soil descriptions.	GROUND WATER CONDITIONS	(m) CORE ELEV DEPTH	CORE SAMPLE			TOTAL CORE RECOVERY (%)	SOLID CORE RECOVERY (%)	HARD LAYER (%)	ROD (%)	FRACTURE INDEX (per 0.3m)	DISCONTINUITIES AND WEATHERING	HYDRAULIC CONDUCTIVITY k (cm/sec) [P (kPa)]	POINT LOAD TEST UCS AXIAL (MPa)	POINT LOAD TEST UCS DIAMETRAL (MPa)	UNIAxIAL COMPRESSION (MPa)	DENSITY (g/cc) [E (GPa)]
				NUMBER	SIZE	CORE RATE (m/min)											
	GEORGIAN BAY FORMATION SHALE grey, thinly laminated		69.7														
	interbedded with light grey LIMESTONE and SILTSTONE layers, strong to very strong (<i>continued</i>) 25mm hard layer at 15.6m, 16.8m and 16.9m, 50mm hard layer at 16.1m, 16.2m, 16.3m, 16.8m and 17.0m, 125mm hard layer at 16.6m weak to medium strong, 150mm hard layer at 17.1m, 75mm hard layer at 17.5m and 18.3m, 25mm hard layer at 17.7m and 18.0m, 50mm hard layer at 17.9m, 125mm hard layer at 18.5m		15.5	9	HQ3	0.11	100	100	30	97		horizontal bedding partings and contacts, closely to moderately closely spaced, undulating (20%) to planar (80%), rough (20%) to smooth (80%), open, with clay coating		77	6		
	Run 11: 125mm hard layer at 18.6m, 25mm hard layer at 18.7m and 18.9m, 100mm hard layer at 18.9m and 19.8m, 75mm hard layer at 19.2m, 150mm hard layer at 19.4m, 12mm very soft clay infill at 19.7m, 50mm very soft to soft clay layer at 19.9m, 50mm hard layer at 19.9m		68.1									horizontal contacts and bedding partings, closely spaced, undulating (80%) to planar (20%), rough (80%) to smooth (20%), open, with clay coating		39	6		
	Run 12: 25mm hard layer at 20.4m and 21.0m, 50mm hard layer at 20.5m, 21.2m and 21.3m, 100mm hard layer at 21.4m, 125mm hard layer at 21.5m		17.1	10	HQ3	0.12	100	98	36	75		bedding partings and joint, generally horizontal (one 90 degree joint), closely to moderately closely spaced, undulating (80%) to planar (20%), rough (70%) to smooth (30%), open, with clay coating (joint with iron oxide infill)		32	41		
	25mm hard layer at 21.5m, 22.0m, 22.2m, 22.8m and 22.9m, 50mm hard layer at 21.9m and 23.0m, 75mm hard layer at 22.3m, 22.5m and 22.6m, 100mm hard layer at 22.4m		66.6									horizontal bedding parting and contacts, closely to moderately closely spaced, undulating, rough (70%) to smooth (30%), open (80%) to tight (20%), often with clay coating		29	11		
	100mm hard layer at 23.2m, 50mm hard layer at 23.4m and 23.7m, 75mm hard layer at 23.7m and 24.3m, 25mm hard layer at 24.5m and 24.6m, 50mm very soft to firm clay layer at 24.5m, 12mm very soft to soft clay infill at 24.7m		65.1									contacts and bedding parting, 0-10 degrees, moderately closely spaced, undulating, rough (70%) to smooth (30%), open, with clay coating.		200	107		
			63.6	13	HQ3	0.14	100	100	35	100		bedding partings and contacts, 0-10 degrees, very closely to moderately closely spaced, undulating (30%) to planar (70%), smooth, open (90%) to tight (10%), with clay coating/infill.		88	57		
			62.0	14	HQ3	0.10	100	97	26	75							
			23.2														
			60.5														
			24.7														

Date / Time **Water Depth (m)** **Elevation (m)**
 BEFORE CORING 6 October 2011 3.0 82.2
 14 October 2011 2.4 82.8

E = Modulus of Elasticity



Additional Notes:

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Coffey Representatives

BB	Originated By
AC	Prepared By
IL	Checked By

LOG OF BOREHOLE HF1-45

SHEET 1 OF 1

Project Name: HANLAN FEEDERMAIN SOUTH CONTRACT 1	Client: CH2M HILL CANADA LTD.	Northing: 4825849 m
Project No.: GEOTMARK00233AA	Drilling Method Used: Hollow Stem Augering 200mm	Easting: 616358 m
Project Location: Lakeshore Road East, Mississauga	Date: 3 - 4 November 2011	Ground Surface Elevation: 86.0 m

Depth Scale (m)	Subsurface Conditions		Samples		Penetration / Strength Results		Moisture / Plasticity		Instrumentation Details	Groundwater Conditions	Headspace Vapor (ppm) LEL (%)	Elevation Scale (m)	Comments
	Stratigraphic Symbol	Depth / Elevation (m)	Description	Number Type	Blow Counts / 150mm N Value	Recovery %	Relative Drilling Resistance /5000 kPa	Penetration Test Values (Blows / 0.3m) X N Values ♦ Dynamic Cone + Becker Hammer Test (BPT) 20 40 60 80 Undrained Shear Strength Values (kPa) □ Field Vane ○ Unconfined ■ Lab Vane ● Quick Triaxial ▲ Pocket Penetrometer	Plastic Limit Natural Water Content Liquid Limit PL MC LL				
0.5			Topsoil 200mm										
1.0			FILL clayey silt, trace fine to coarse sand, brown to grey, stiff	1 SS	2 4 6	(10) 67		X	>>▲			85.5	PP, Cu = 214 to 241 kPa
1.5		84.5	CLAYEY SILT thinly laminated, trace oxidation, grey, hard	2 SS	3 9 13	(22) 72		X	>>▲			84.5	PP, Cu > 241 kPa
2.0			trace fine to coarse sand									84.0	
2.5		83.4		3 SS	10 21	50/13cm 88		X	>>▲			83.5	PP, Cu > 241 kPa
3.0		2.6	SHALE weathered, grey	3A SS	50							83.0	
3.5			interbedded with weathered, light grey siltstone	4 SS	26 27 31	(58) 100		X				82.5	hydrocarbon-like odour detected at 4.3m bgl.
4.0				5 SS	50	50/8cm 100						82.0	borehole dry upon completion before coring.
4.4													

Rock Coring Started

Rock Core Log Next Page

Additional Notes:

This log is to be read in conjunction with accompanying general notes and borehole log symbols sheet. Stratification lines represent approximate boundary lines between material types, vertical and lateral transitions may be gradual. Water level readings were made at time(s) noted, fluctuations of groundwater levels may occur and should be expected.

Sample Types: A=Auger; DP=Direct Push; G=Grab; RC=Rock Core; SC=Soil Core; SS=Split Barrel (Split Spoon); ST=Shelby Tube.

Coffey Representatives

BB	Originated By
AC	Prepared By
IL	Checked By

LOG OF BOREHOLE HF1-45

SHEET 1 OF 2

Project Name: HANLAN FEEDERMAIN SOUTH CONTRACT 1

Client: CH2M HILL CANADA LTD.

Date: 3 - 4 November 2011

Project No.: GEOTMARK00233AA

Drilling Method Used: ROCK CORING HQ3

Northing: 4825849 m

Project Location: Lakeshore Road East, Mississauga

Ground Surface Elevation: 86.0 m

Easting: 616358 m

Borehole Location: SEE DRAWING

Datum Elevation: Geodetic

Diameter: 61mm

(m) STRATA ELEV DEPTH	ROCK DESCRIPTION See Soil Logs for soil descriptions.	GROUND WATER CONDITIONS	(m) CORE ELEV DEPTH	CORE SAMPLE			TOTAL CORE RECOVERY (%)	SOLID CORE RECOVERY (%)	HARD LAYER (%)	ROD (%)	FRACTURE INDEX (per 0.3m)	DISCONTINUITIES AND WEATHERING	HYDRAULIC CONDUCTIVITY k (cm/sec) [P (kPa)]	POINT LOAD TEST UCS AXIAL (MPa)	POINT LOAD TEST UCS DIAMETRAL (MPa)	UNIAxIAL COMPRESSION (MPa)	DENSITY (g/cc) [E (GPa)]
				NUMBER	SIZE	CORE RATE (m/min)											
81.6 4.4	GEORGIAN BAY FORMATION SHALE grey, thinly laminated interbedded with light grey LIMESTONE and SILTSTONE layers, strong to very strong Run 1: extremely to very weak, 125mm fractured zone with clay infill at 4.4m, 250mm hard layer at 4.5m, 50mm hard layer at 4.8m Run 2: very weak to weak, 500mm fractured zone at 5.5m, 25mm hard layer at 5.5m(2), 5.9m and 6.0m Run 3: 25mm hard layer at 6.5m, 7.0m and 7.4m, 50mm hard layer at 6.9m 25mm hard layer at 8.7m and 9.1m 25mm hard layer at 9.5m, 9.7m, 10.0m and 10.8m(2), 50mm hard layer at 10.2m, 325mm hard layer at 10.4m, 50mm core loss at 10.9m 75mm hard layer at 11.0m, 12.1m and 12.2m, 125mm hard layer at 11.2m, 50mm hard layer at 11.5m, 25mm hard layer at 11.7m and 11.8m, 25mm extremely weak zone at 11.7m 125mm hard layer at 12.6m, 200mm hard layer at 12.7m, 75mm hard layer at 13.2m		81.6 4.4	1	HQ3	0.23	100	72	67	44		joints and contacts, 0-10 degrees (one 90 degree joint), closely spaced, undulating (60%) to planar (40%), rough, open, some with clay coating, highly to moderately weathered bedding partings, contacts and joints, generally horizontal (two 90 degree joint), very closely to closely spaced, undulating (70%) to planar (30%), rough (20%) to smooth (80%), open (80%) to healed (20%), some with clay coating, moderately to slightly weathered		119	57		
			81.1 4.9											38	6		
			79.6 6.4	2	HQ3	0.17	100	62	7	55							
			78.1 7.9	3	HQ3	0.10	100	80	8	85				31	3		
			76.6 9.4	4	HQ3	0.08	100	0	3	50				18	3		
			75.0 11.0	5	HQ3	0.09	97	95	33	80				168	80		
			73.5 12.5	6	HQ3		100	90	30	45				153	69		
			72.0 14.0	7	HQ3	0.08	100	90	27	83				151	136	8.7	2.59 [1]
				8	HQ3	0.08	100	100	0	100		horizontal bedding parting and joint, closely spaced, planar, smooth, open, some with clay coating, slightly weathered to fresh		14	8		

Continued Next Page

E = Modulus of Elasticity

Additional Notes:

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Sample Types: A=Auger; DP=Direct Push; G=Grab; RC=Rock Core; SC=Soil Core; SS=Split Barrel (Split Spoon); ST=Shelby Tube.

Coffey Representatives

BB	Originated By
AC	Prepared By
IL	Checked By

LOG OF BOREHOLE HF1-45

SHEET 2 OF 2

Project Name: HANLAN FEEDERMAIN SOUTH CONTRACT 1

Client: CH2M HILL CANADA LTD.

Date: 3 - 4 November 2011

Project No.: GEOTMARK00233AA

Drilling Method Used: ROCK CORING HQ3

Northing: 4825849 m

Project Location: Lakeshore Road East, Mississauga

Ground Surface Elevation: 86.0 m

Easting: 616358 m

Borehole Location: SEE DRAWING

Datum Elevation: Geodetic

Diameter: 61mm

(m) STRATA ELEV DEPTH	ROCK DESCRIPTION See Soil Logs for soil descriptions.	GROUND WATER CONDITIONS	(m) CORE ELEV DEPTH	CORE SAMPLE			TOTAL CORE RECOVERY (%)	SOLID CORE RECOVERY (%)	HARD LAYER (%)	ROD (%)	FRACTURE INDEX (per 0.3m)				DISCONTINUITIES AND WEATHERING	HYDRAULIC CONDUCTIVITY k (cm/sec) [P (kPa)]	POINT LOAD TEST UCS AXIAL (MPa)	POINT LOAD TEST UCS DIAMETRAL (MPa)	UNIAxIAL COMPRESSION (MPa)	DENSITY (g/cc) [E (GPa)]
				NUMBER	SIZE	CORE RATE (m/min)					2	4	6	8						
	GEORGIAN BAY FORMATION SHALE grey, thinly laminated																			
	interbedded with light grey LIMESTONE and SILTSTONE layers, strong to very strong (<i>continued</i>) Run 9: 50mm crushed zone with clay infill at 15.5m, 75mm hard layer at 16.0m and 17.0m, 50mm hard layer at 16.1m, 25mm hard layer at 16.4m, 150mm hard layer at 16.6m, 25mm fractured zone with clay infill at 16.7m Run 10: 50mm hard layer at 17.2m, 175mm hard layer at 16.0m, 100mm hard layer at 16.3m, 75mm hard layer at 16.7m		70.5 15.5	9	HQ3	0.07	100	95	25	78					horizontal bedding partings and contacts, closely to moderately closely spaced, planar (60%) to undulating (40%), smooth (90%) to rough (10%), open, some with clay coating/infill		47	58	46.8	[10]
	50mm hard layer at 18.8m, 19.0m and 19.1m, 25mm hard layer at 19.4m, 19.7m and 19.8m, 75mm hard layer at 19.5m and 19.9m		68.9 17.1	10	HQ3	0.14	100	90	27	90					contacts, joints and bedding parting, 0-10 degrees (two 90 degree joints), closely to moderately closely spaced, planar (60%) to undulating (40%), smooth 940% to rough (60%), open (85%) to tight (15%), some with clay coating/infill		27	6		
	75mm hard layer at 20.7m, 50mm hard layer at 21.2m, 21.3m and 21.4m		67.4 18.6	11	HQ3	0.10	100	95	25	78					bedding partings, contacts and joint, 0-20 degrees (one 90 degree joint), very closely to moderately closely spaced, planar to stepped, smooth (60%) to rough (40%), open (90%) to tight (10%), occasionally with clay coating		134	56		
	125mm hard layer at 21.8m, 100mm hard layer at 22.0m, 25mm hard layer at 22.1m, 175mm hard layer at 22.3m, 50mm hard layer at 22.8m and 23.0m		65.9 20.1	12	HQ3	0.09	100	95	15	87					contacts, bedding parting and joint, generally horizontal (one 90 degree joint), closely to moderately closely spaced, planar (20%) to undulating (80%), smooth (70%) to rough (30%), open (90%) to tight (10%)		177	73		
	75mm hard layer at 23.2m and 23.9m, 150mm hard layer at 23.3m, 25mm hard layer at 23.6m and 24.3m, 50mm hard layer at 23.7m, 23.8m, 24.4m and 24.6m		64.4 21.6	13	HQ3	0.08	100	100	35	97					horizontal bedding partings and contacts, closely to moderately closely spaced, planar (50%) to undulating (50%), smooth (25%) to rough (75%), open, fresh		230	89	78.2	[15]
			62.8 23.2	14	HQ3	0.07	100	95	37	98					bedding parting, contact and joint, generally horizontal (one 90 degree joint), closely spaced, planar (70%) to undulating (30%), smooth (70%) to rough (30%), open		66	52		
			61.3 24.7																	

Date / Time Water Depth (m) Elevation (m)

E = Modulus of Elasticity



Additional Notes:

This log is to be read in conjunction with accompanying general notes and borehole log symbols sheet. Stratification lines represent approximate boundary lines between material types, vertical and lateral transitions may be gradual. Water level readings were made at time(s) noted, fluctuations of groundwater levels may occur and should be expected.
Sample Types: A=Auger; DP=Direct Push; G=Grab; RC=Rock Core; SC=Soil Core; SS=Split Barrel (Split Spoon); ST=Shelby Tube.

Coffey Representatives

BB	Originated By
AC	Prepared By
IL	Checked By

LOG OF BOREHOLE HF1-46

SHEET 1 OF 1

Project Name: HANLAN FEEDERMAIN SOUTH CONTRACT 1 Client: CH2M HILL CANADA LTD. Northing: 4825661 m
 Project No.: GEOTMARK00233AA Drilling Method Used: Hollow Stem Augering 200mm Easting: 616247 m
 Project Location: Lakeshore Road East, Mississauga Date: 7 - 10 November 2011 Ground Surface Elevation: 85.6 m

Depth Scale (m)	Subsurface Conditions		Samples		Penetration / Strength Results		Moisture / Plasticity		Instrumentation Details	Groundwater Conditions	Headspace Vapor (ppm) LEL (%)	Elevation Scale (m)	Comments
	Stratigraphic Symbol	Depth / Elevation (m)	Description	Number Type	Blow Counts / 150mm N Value	Recovery %	Relative Drilling Resistance	Penetration Test Values (Blows / 0.3m) X N Values ♦ Dynamic Cone + Becker Hammer Test (BPT) 20 40 60 80 Undrained Shear Strength Values (kPa) □ Field Vane ○ Unconfined ■ Lab Vane ● Quick Triaxial ▲ Pocket Penetrometer	Plastic Limit Natural Water Content Liquid Limit	PL MC LL			
0.5			100mm Topsoil									85.5	
1.0			FILL clayey silt, trace to fine coarse sand, some pockets of fine sand, trace oxidation, brown to grey, very stiff to firm	1 SS 7 10 12 (22) 67								85.0	
1.5												84.5	
2.0			trace fine to coarse gravel	2 SS 2 3 4 (7) 56								84.0	PP, Cu = 27 to 80 kPa
2.5			some pockets of silt, trace limestone fragments									83.5	
3.0		82.6		3 SS 7 5 3 (8) 44								83.0	
3.5		3.0	SHALE weathered, grey, dry	4 SS 50 50/13cm 99								82.5	
4.0												82.0	
4.5				5 SS 50 50/5cm 98								81.5	
												81.0	Borehole dry upon completion before coring.
		80.9		6 SS 50 50/8cm 100									

4.7

Rock Coring Started

Rock Core Log Next Page

Additional Notes:

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 Sample Types: A=Auger; DP=Direct Push; G=Grab; RC=Rock Core; SC=Soil Core; SS=Split Barrel (Split Spoon); ST=Shelby Tube.

Coffey Representatives

BB	Originated By
AC	Prepared By
IL	Checked By

SHEET 1 OF 2

Date: 7 - 10 November 2011
Northing: 4825661 m
Easting: 616247 m
Diameter: 61mm

E = Modulus of Elasticity

BB	Originated By
AC	Prepared By
IL	Checked By

LOG OF BOREHOLE HF1-46

SHEET 2 OF 2

Project Name: HANLAN FEEDERMAIN SOUTH CONTRACT 1

Client: CH2M HILL CANADA LTD.

Date: 7 - 10 November 2011

Project No.: GEOTMARK00233AA

Drilling Method Used: ROCK CORING HQ3

Northing: 4825661 m

Project Location: Lakeshore Road East, Mississauga

Ground Surface Elevation: 85.6 m

Easting: 616247 m

Borehole Location: SEE DRAWING

Datum Elevation: Geodetic

Diameter: 61mm

(m) STRATA ELEV DEPTH	ROCK DESCRIPTION See Soil Logs for soil descriptions.	GROUND WATER CONDITIONS	(m) CORE ELEV DEPTH	CORE SAMPLE			TOTAL CORE RECOVERY (%)	SOLID CORE RECOVERY (%)	HARD LAYER (%)	ROD (%)	FRACTURE INDEX (per 0.3m)	DISCONTINUITIES AND WEATHERING	HYDRAULIC CONDUCTIVITY k (cm/sec) [P (kPa)]	POINT LOAD TEST UCS AXIAL (MPa)	POINT LOAD TEST UCS DIAMETRAL (MPa)	UNIAxIAL COMPRESSION (MPa)	DENSITY (g/cc) [E (GPa)]
				NUMBER	SIZE	CORE RATE (m/min)											
	GEORGIAN BAY FORMATION SHALE grey, thinly laminated		70.1														
	interbedded with light grey LIMESTONE and SILTSTONE layers, strong to very strong (<i>continued</i>) 25mm hard layer at 15.5m, 16.1m and 16.5m, 75mm hard layer at 15.6m, 15.8m and 16.7m, 50mm core loss at 17.0m 25mm crushed zone at 17.2m, 50mm hard layer at 17.3m, 17.4m and 18.5m, 825mm hard layer at 17.5m		15.5	9	HQ3	0.08	97	97	20	92		bedding partings and contacts, 0-20 degrees, closely to moderately closely spaced, undulating (30%) to planar (70%), smooth (70%) to rough (30%), open, some with clay coating, fresh	No flow[167] ('k' <1.00E-8) No flow[304] ('k' <1.00E-8)	175	65		
	25mm hard layer at 18.7m, 19.0m and 19.8m, 75mm hard layer at 18.9m, 19.2m and 19.4m, 100mm hard layer at 19.7m, 50mm hard layer at 19.8m, 20.0m and 17.3m		68.5	10	HQ3	0.07	100	98	65	90		bedding partings, contacts and joint, 0-10 degrees (one 90 degree joint), closely to moderately closely spaced, undulating (85%) to planar (15%), smooth (70%) to rough (30%), open, some with clay coating/infill,	No flow[441] ('k' <1.00E-8)	198	67	27.4	2.61 [5]
	75mm hard layer at 20.2m and 21.0m, 100mm hard layer at 20.3m, 50mm hard layer at 20.5m, 20.8m, 21.2m, 21.3m and 21.5m		67.0	11	HQ3	0.08	100	100	37	90		bedding partings, contacts and joint, generally horizontal (one 90 degree joint), closely to moderately closely spaced, undulating (50%) to planar (50%), smooth (50%) to rough (50%), open		134	91		
	25mm hard layer at 21.7m, 75mm hard layer at 21.9m, 100mm hard layer at 22.0m, 300mm hard layer at 22.1m, 50mm hard layer at 22.6m and 22.7m, 150mm hard layer at 22.9m		65.5	12	HQ3	0.08	100	100	33	100		horizontal bedding parting and contacts, closely to moderately closely spaced, undulating, smooth (30%) to rough (70%), open		161	98		
	175mm hard layer at 23.2m, 25mm hard layer at 23.4m, 23.5m, 23.9m and 24.3m, 100mm hard layer at 23.6m, 75mm hard layer at 23.8m, 50mm hard layer at 24.2m		64.0	13	HQ3	0.07	100	100	50	85		horizontal bedding parting and contacts, moderately closely spaced, undulating (50%) to planar (50%), smooth, open		48	14		
			62.4	14	HQ3	0.08	100	100	42	97		horizontal contacts and bedding parting, moderately closely spaced, undulating (80%) to planar (20%), smooth (20%) to rough (80%), open		51	18		
			60.9											44	5		
			24.7														

Date / Time Water Depth (m) Elevation (m)

E = Modulus of Elasticity



Additional Notes:

This log is to be read in conjunction with accompanying general notes and borehole log symbols sheet. Stratification lines represent approximate boundary lines between material types, vertical and lateral transitions may be gradual. Water level readings were made at time(s) noted, fluctuations of groundwater levels may occur and should be expected.

Sample Types: A=Auger; DP=Direct Push; G=Grab; RC=Rock Core; SC=Soil Core; SS=Split Barrel (Split Spoon); ST=Shelby Tube.

Coffey Representatives

BB	Originated By
AC	Prepared By
IL	Checked By

LOG OF BOREHOLE HF1-46-1

SHEET 1 OF 1

Project Name: HANLAN FEEDERMAIN SOUTH CONTRACT 1

Client: CH2M HILL CANADA LTD.

Northing: 4825660 m

Project No.: GEOTMARK00233AA

Drilling Method Used: Hollow Stem Augering 200mm

Easting: 616248 m

Project Location: Lakeshore Road East, Mississauga

Date: 10 November 2011

Ground Surface Elevation: 85.6 m

Depth Scale (m)	Subsurface Conditions		Samples		Penetration / Strength Results				Moisture / Plasticity			Instrumentation Details	Groundwater Conditions	Headspace Vapor (ppm) LEL (%)	Elevation Scale (m)	Comments
	Stratigraphic Symbol	Depth / Elevation (m)	Description	Number Type	Blow Counts / 150mm	N Value	Recovery %	Relative Drilling Resistance	Penetration Test Values (Blows / 0.3m)	Undrained Shear Strength Values (kPa)	Plastic Limit Natural Water Content Liquid Limit					
			See log of Borehole HF1-46 for stratigraphy.						X N Values ♦ Dynamic Cone + Becker Hammer Test (BPT) 20 40 60 80	□ Field Vane ○ Unconfined ■ Lab Vane ● Quick Triaxial ▲ Pocket Penetrometer	PL MC LL 10 20 30 40					
1								1500 kPa								
2								1500 kPa								
3								1500 kPa								
4								1500 kPa								
5								1500 kPa								
6								1500 kPa								
7								1500 kPa								
8								1500 kPa								
9								1500 kPa								
10								1500 kPa								

74.9

10.7

BOREHOLE HF1-46-1
TERMINATED AT 10.7m BGL

SOIL LOG FOR CH2M GEOTMARK00233AA_BH38 TO BH46.GPJ COFFEY STANDARD.GDT 30/5/12



Additional Notes:

This log is to be read in conjunction with accompanying general notes and borehole log symbols sheet. Stratification lines represent approximate boundary lines between material types; vertical and lateral transitions may be gradual. Water level readings were made at time(s) noted; fluctuations of groundwater levels may occur and should be expected.
Sample Types: A=Auger; DP=Direct Push; G=Grab; RC=Rock Core; SC=Soil Core; SS=Split Barrel (Split Spoon); ST=Shelby Tube.

Coffey Representatives

BB	Originated By
AC	Prepared By
IL	Checked By

Appendix B

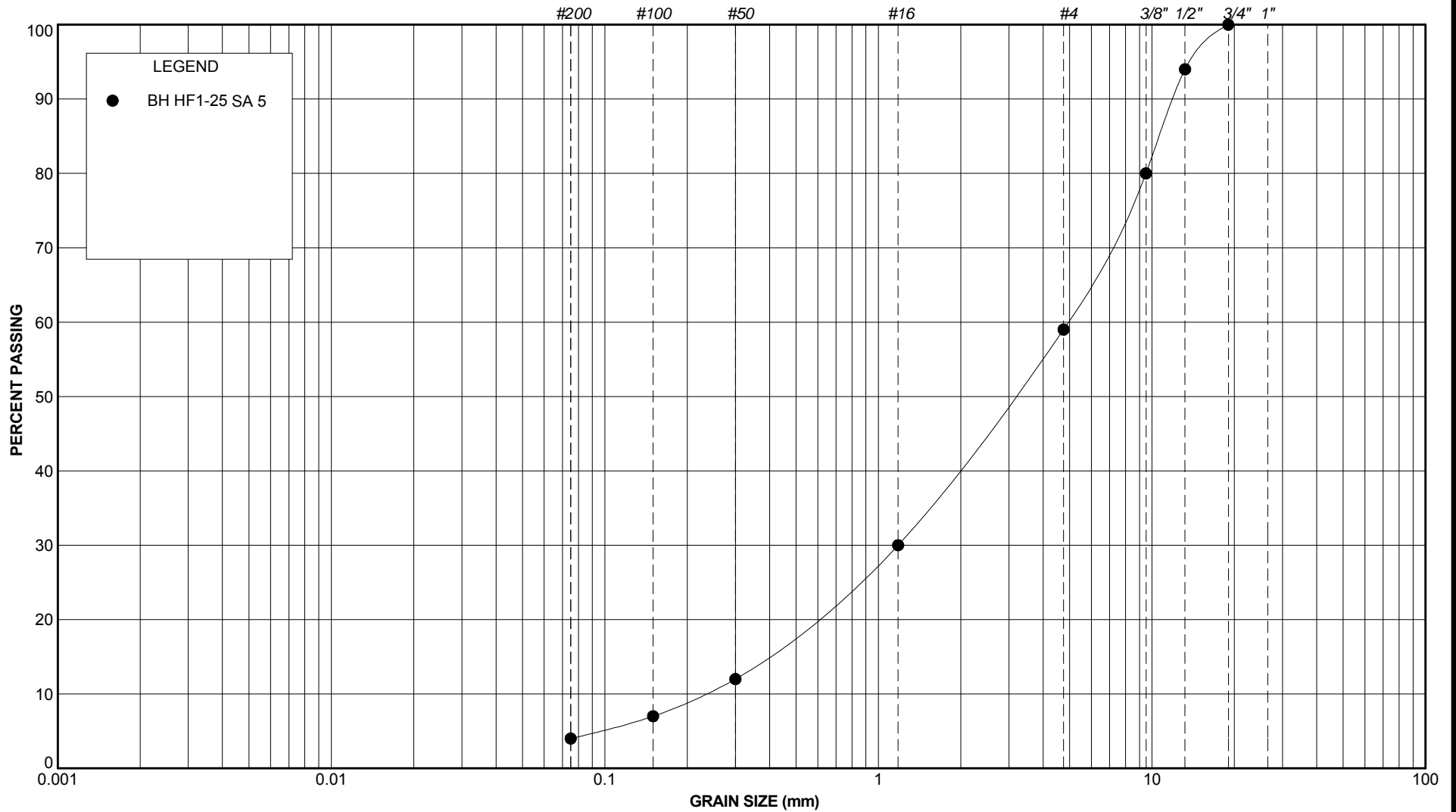
Grain Size Distribution Curves

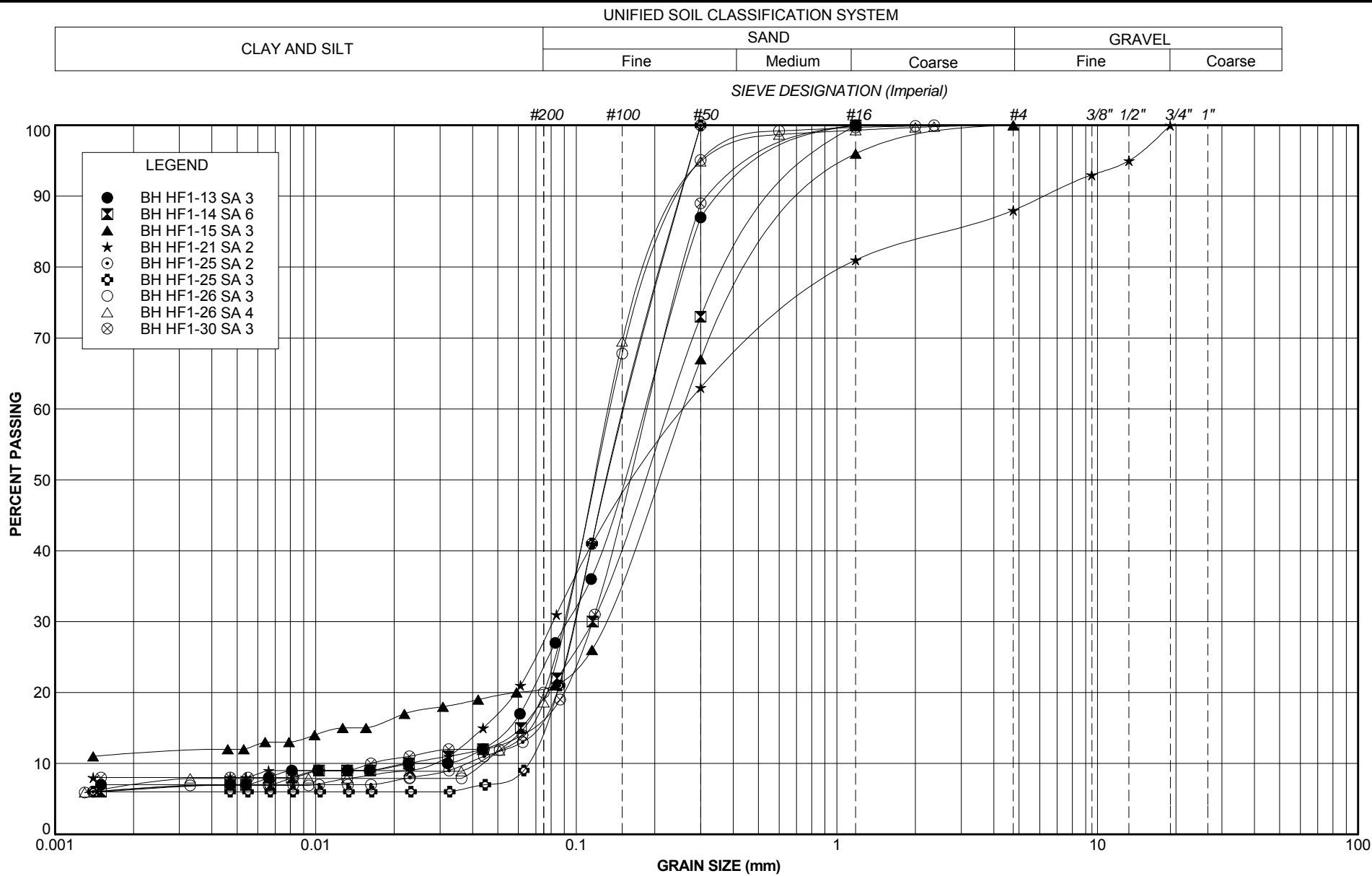
Plasticity Chart

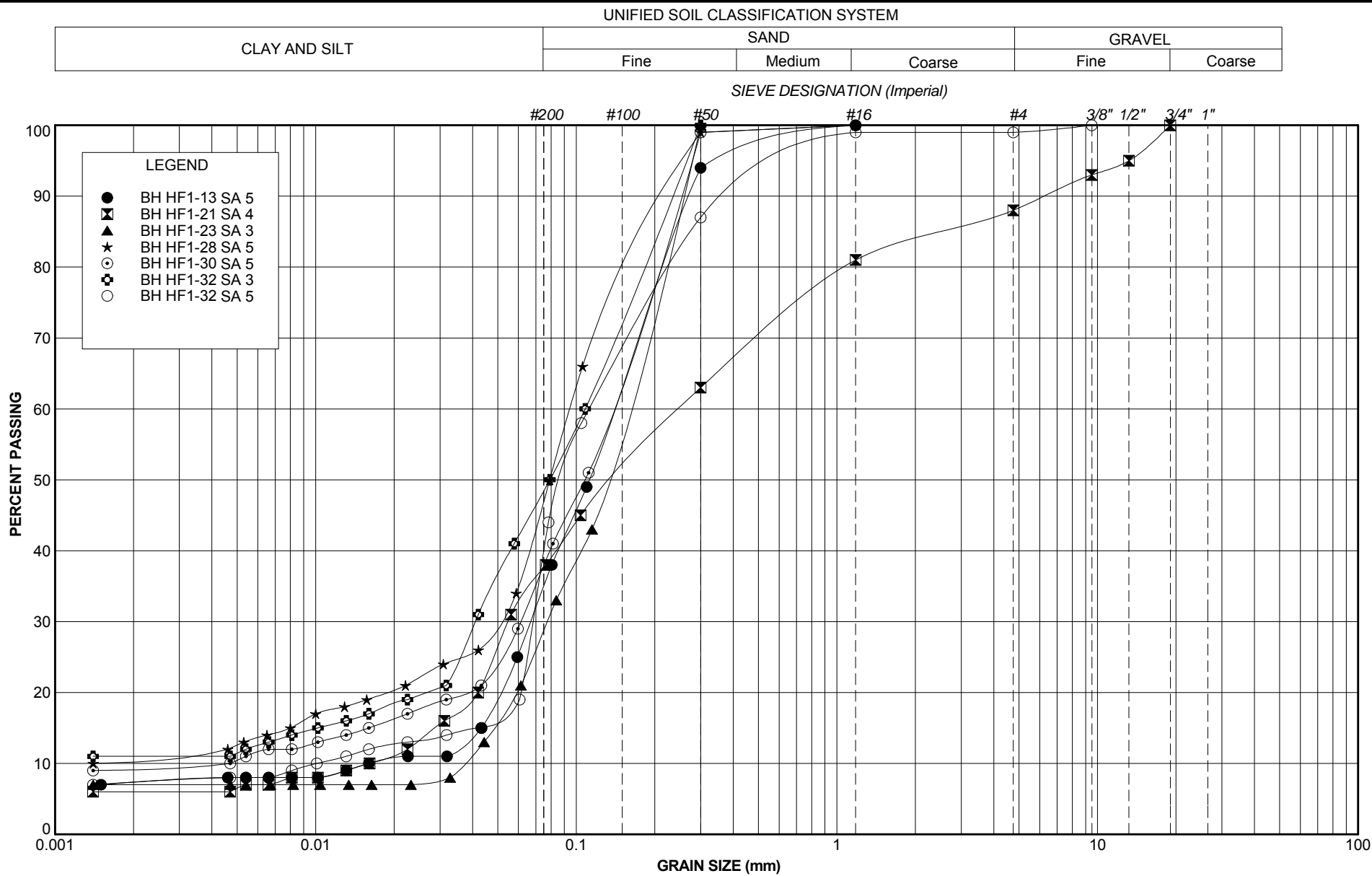
UNIFIED SOIL CLASSIFICATION SYSTEM

CLAY AND SILT	SAND			GRAVEL	
	Fine	Medium	Coarse	Fine	Coarse

SIEVE DESIGNATION (Imperial)



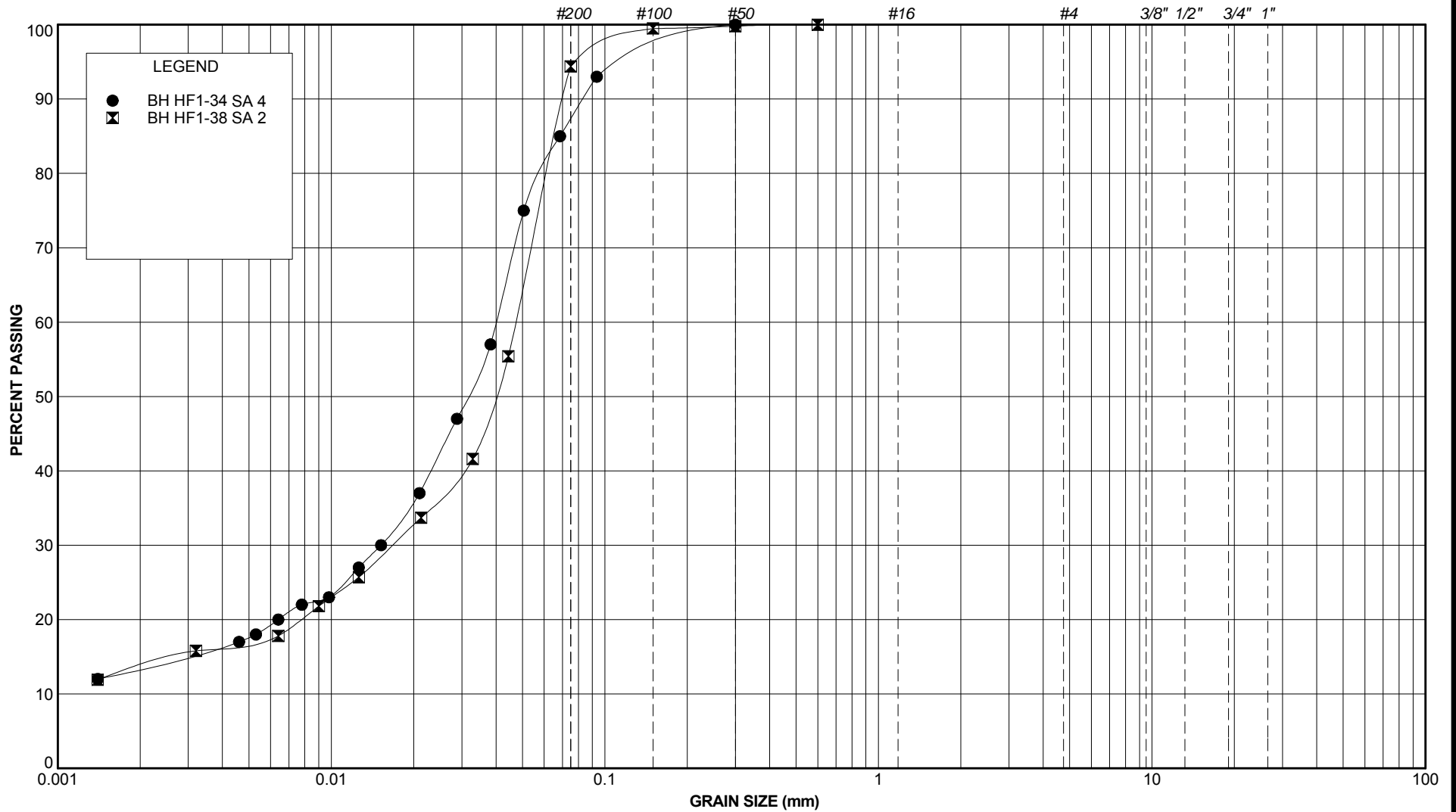




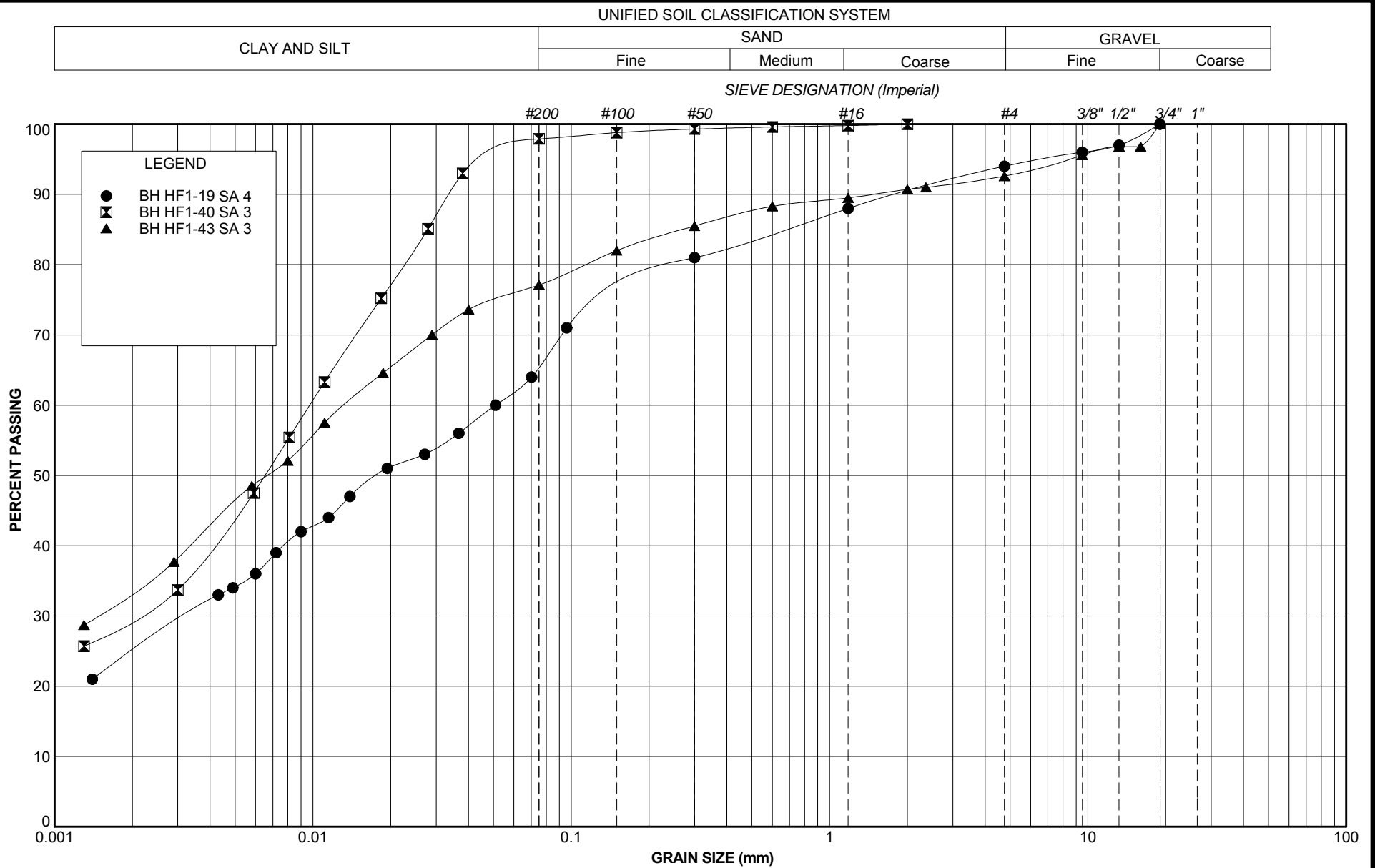
UNIFIED SOIL CLASSIFICATION SYSTEM

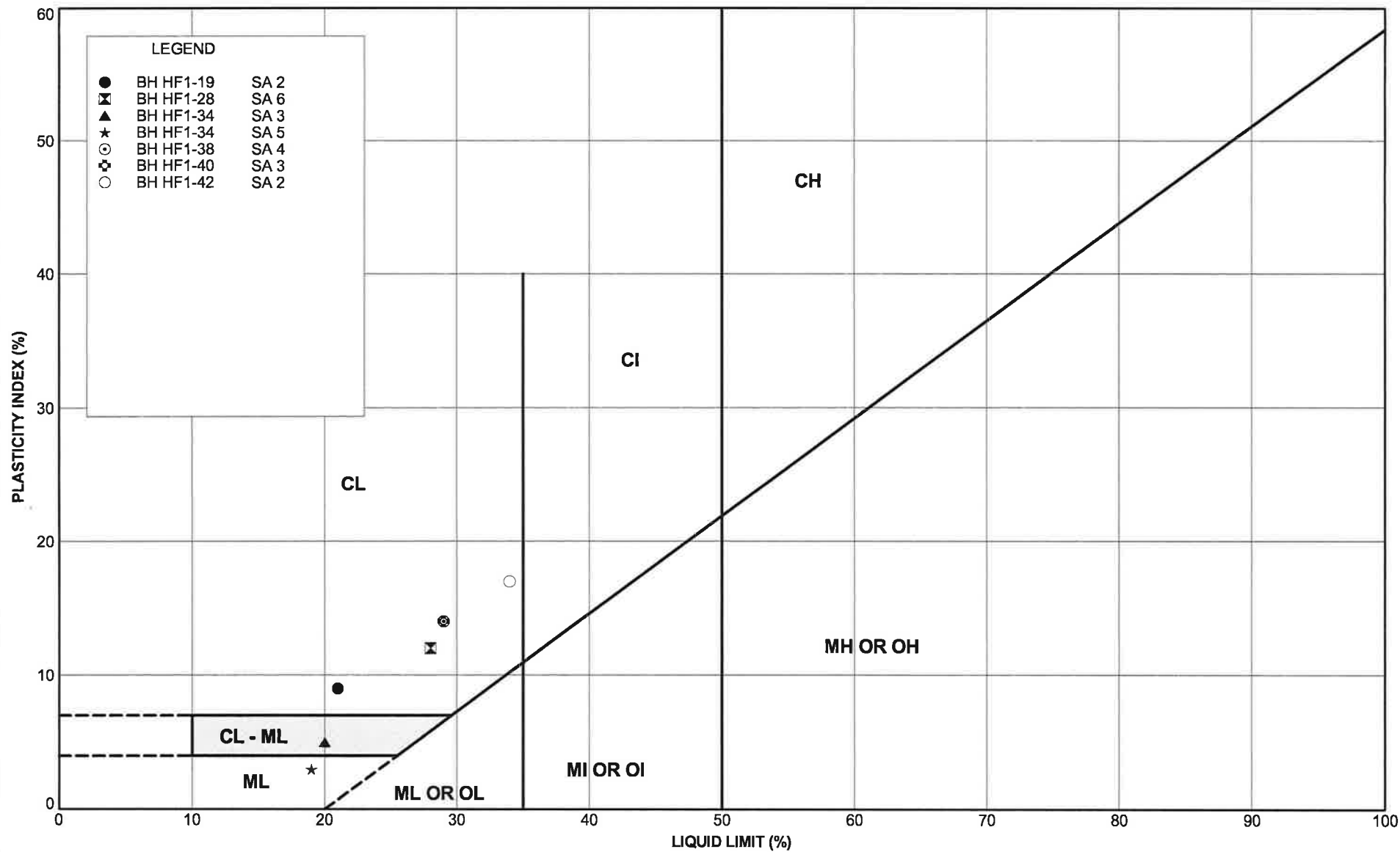
CLAY AND SILT	SAND			GRAVEL	
	Fine	Medium	Coarse	Fine	Coarse

SIEVE DESIGNATION (Imperial)



GRAIN SIZE DISTRIBUTION
CLAYEY SILT, trace to some sand





Appendix C

Records of Boreholes from Previous Investigation

CLIENT: AECOM			METHOD: Augering/Split Spoon Sampling/Coring			BH No.: 27						
PROJECT: Hanlan Feedermain			PROJECT ENGINEER: CA			ELEV. (m) 117.2						
LOCATION: Mississauga, ON			STATION: 9+691 20 m R			PROJECT NO.: 08-015						
SAMPLE TYPE <input type="checkbox"/> AUGER <input checked="" type="checkbox"/> DRIVEN <input checked="" type="checkbox"/> CORING <input type="checkbox"/> DYNAMIC CONE <input type="checkbox"/> SHELBY <input type="checkbox"/> SPLIT SPOON												
DEPTH (m)	INSTRUMENTATION DATA	REMARKS	Shear Strength (kPa)		N-Value (Blows/300mm)	PL W.C. LL	SOIL SYMBOL	SOIL DESCRIPTION	SAMPLE TYPE	SAMPLE NO.	SPT(N)	ELEVATION (m)
			40 80 120 160	20 40 60 80								
0	Bentonite	Water level measured as 2.8 m below ground surface on 5 January 2010.						300 mm TOPSOIL		1A	9	117
0.5										1B		116.5
1								loose, moist brown and dark brown silty sand, trace gravel trace organics, FILL		2	5	116
1.5												
2												
2.5		Hard augering from 2.1 m depth.										
3												
3.5												
4												
4.5	Grout											
5		Sample 6: TCR = 100 % RQD = 4 %										
5.5												
6												
6.5												
7												
7.5												
8		Sample 7: TCR = 100 % RQD = 12 %										
8.5												
9												
9.5												
alston associates inc. consulting engineers						LOGGED BY: KC		DRILLING DATE: 4 Nov. 2009				
						REVIEWED BY: DM		Page 1 of 2				

CLIENT: AECOM			METHOD: Augering/Split Spoon Sampling/Coring			BH No.: 27					
PROJECT: Hanlan Feedermain			PROJECT ENGINEER: CA		ELEV. (m) 117.2						
LOCATION: Mississauga, ON			STATION: 9+691 20 m R			PROJECT NO.: 08-015					
SAMPLE TYPE			<input type="checkbox"/> AUGER <input checked="" type="checkbox"/> DRIVEN <input checked="" type="checkbox"/> CORING <input type="checkbox"/> DYNAMIC CONE <input type="checkbox"/> SHELBY <input type="checkbox"/> SPLIT SPOON								
DEPTH (m)	INSTRUMENTATION DATA	REMARKS	Shear Strength (kPa) 40 80 120 160 N-Value (Blows/300mm) 20 40 60 80		PL W.C. LL	SOIL SYMBOL	SOIL DESCRIPTION	SAMPLE TYPE	SAMPLE NO.	SPT(N)	ELEVATION (m)
10	Grout										107
10.5											106.5
11		Sample 8: TCR = 100 % RQD = 4 %							8		106
11.5							Georgian Bay Formation: grey, horizontally bedded SHALES -occasional limestone seams -occasional clay filling in fractures -weak strength rock -very intensely fractured -highly weathered				105.5
12											105
12.5											104.5
13											104
13.5											103.5
14		Sample 9: TCR = 100 % RQD = 4 %							9		103
14.5							Georgian Bay Formation: grey, horizontally bedded SHALES -occasional limestone seams -occasional fully pulverized zones -occasional clay filling in fractures -weak strength rock -very intensely fractured -highly weathered				102.5
15											102
15.5											101.5
16	Sand										101
16.5											100.5
17	Screen	Sample 10: TCR = 99 % RQD = 21 %							10		100
17.5							Georgian Bay Formation: grey, horizontally bedded SHALES -weak strength rock -very intensely fractured -highly weathered				99.5
18											99
END OF BOREHOLE											
alston associates inc. consulting engineers					LOGGED BY: KC REVIEWED BY: DM		DRILLING DATE: 4 Nov. 2009 Page 2 of 2				

CLIENT: AECOM		METHOD: Augering/Split Spoon Sampling/Coring		BH No.: 27 RC	
PROJECT: Hanlan Feedermain		PROJECT ENGINEER: CA		G.S. ELEV. (m) 117.2	
LOCATION: Mississauga, ON		STATION: 9+691 20 m R		PROJECT NO.: 08-015	
SAMPLE TYPE <input type="checkbox"/> AUGER <input checked="" type="checkbox"/> DRIVEN <input checked="" type="checkbox"/> CORING <input type="checkbox"/> DYNAMIC CONE <input type="checkbox"/> SHELBY <input type="checkbox"/> SPLIT SPOON					

DEPTH (m)	REMARKS	SOIL SYMBOL	ROCK MASS DESCRIPTION	SAMPLE TYPE	SAMPLE NO.	FRACTURES PER 0.3 m FF=Fully Fractured VF=Vertical Fracture	ELEVATION (m)
5	Sample 6: TCR = 100 % RQD = 4 % 4.97 to 5.18 m depth: clay zones		Georgian Bay Formation: grey, horizontally bedded SHALE -occasional limestone seams -weak rock strength -frequent clay zones -very intensely fractured -highly weathered		6	13	112.5
5.5	5.39 to 5.58 m depth: clay zones					FF	112
6	6.0 to 6.2 m depth: fully pulverized shear zones					13	111.5
6.5						FF	111
7						9	110.5
7.5	7.30 to 7.40 m depth: clay zones					13	110.5
8	7.6 to 7.7 m depth: vertical fractures Sample 7: TCR = 100 % RQD = 12 % Unconfined compressive strength of rock sample taken at 7.8 m depth = 73.9 MPa		Georgian Bay Formation: grey, horizontally bedded SHALE -weak rock strength -very intensely fractured -highly weathered -occasional clay gouge		7	7	110
8.5						VF	109.5
9						5	109
9.5						7	108.5
10						9	108
10.5						6	107.5
11	Sample 8: TCR = 100 % RQD = 4 %		Georgian Bay Formation: grey, horizontally bedded SHALE -occasional limestone seams -occasional clay filling in fractures -weak rock strength -very intensely fractured -highly weathered		8	7	107
11.5	11.77 to 11.83 m: clay zone					7	106.5
12	12.24 to 12.41 m depth: limestone					11	106
12.5						9	105.5
13						8	105
13.5	13.40 to 13.58 m depth: limestone					6	104.5
14	Sample 9: TCR = 100 % RQD = 4 %					6	104
						4	103.5
						9	103

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		REVIEWED BY: DM	Page 1 of 2

CLIENT: AECOM		METHOD: Augering/Split Spoon Sampling/Coring		BH No.: 27 RC	
PROJECT: Hanlan Feedermain		PROJECT ENGINEER: CA		G.S. ELEV. (m) 117.2	
LOCATION: Mississauga, ON		STATION: 9+691 20 m R		PROJECT NO.: 08-015	
SAMPLE TYPE <input type="checkbox"/> AUGER <input checked="" type="checkbox"/> DRIVEN <input checked="" type="checkbox"/> CORING <input type="checkbox"/> DYNAMIC CONE <input type="checkbox"/> SHELBY <input type="checkbox"/> SPLIT SPOON					

DEPTH (m)	REMARKS	SOIL SYMBOL	ROCK MASS DESCRIPTION	SAMPLE TYPE	SAMPLE NO.	FRACTURES PER 0.3 m FF=Fully Fractured VF=Vertical Fracture	ELEVATION (m)
14.5	14.63 to 14.75 m depth: limestone		Georgian Bay Formation: grey, horizontally bedded SHALE			9	102.5
15			-occasional limestone seams			8	102
15.5	15.50 to 15.75 m depth: fully pulverized shear zones		-occasional fully pulverized zones		9	7	101.5
16	15.75 to 15.90 m depth: limestone		-occasional clay filling in fractures			FF	101
16.5	16.50 to 16.70 m depth: fully pulverized shear zones		-weak rock strength			FF	100.5
17	Sample 10: TCR = 99 % RQD = 21 %		-very intensely fractured			11	100
17.5	17.53 to 17.59 m depth: fully pulverized shear zones		-highly weathered		10	7	99.5
18			Georgian Bay Formation: grey, horizontally bedded SHALE			FF	99
			-weak rock strength			4	
			-very intensely fractured			5	
			-highly weathered			5	
			END OF BOREHOLE				

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	REVIEWED BY: DM	Page 2 of 2

CLIENT: AECOM			METHOD: Augering and Split Spoon Sampling			BH No.: 28		
PROJECT: Hanlan Feedermain			PROJECT ENGINEER: CA		ELEV. (m) 114.9			
LOCATION: Mississauga, ON			STATION: 9+842 13 m R		PROJECT NO.: 08-015			
SAMPLE TYPE <input type="checkbox"/> AUGER <input checked="" type="checkbox"/> DRIVEN <input checked="" type="checkbox"/> CORING <input type="checkbox"/> DYNAMIC CONE <input type="checkbox"/> SHELBY <input type="checkbox"/>			SPLIT SPOON					

DEPTH (m)	INSTRUMENTATION DATA	REMARKS	Shear Strength (kPa)		N-Value (Blows/300mm)	PL W.C. LL			SOIL SYMBOL	SOIL DESCRIPTION	SAMPLE TYPE	SAMPLE NO.	SPT(N)	ELEVATION (m)			
			40	80		120	160	20							40	60	80
			20	40		60	80	20							40	60	80
0		Borehole open and water level at 5.5 m below ground surface on completion.								50 mm ASPHALTIC CONCRETE		1	23	114.5			
0.5										compact, moist, brown sand and angular gravel FILL		2	14	114			
1										stiff, grey silty clay sand and gravel trace shale fragments trace asphalt pieces FILL		3	11	113.5			
1.5												4	12	113			
2												5	50/75	112.5			
2.5												6	50/50	112			
3										hard grey weathered SHALE occasional thin limestone seam		7	50/50	111.5			
3.5												8	50/100	111			
4												9	50/25	110.5			
4.5														110			
5														109.5			
5.5														109			
6														108.5			
6.5														108			
7														107.5			
7.5										END OF BOREHOLE		9	50/25				

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		REVIEWED BY: DM	Page 1 of 1

CLIENT: AECOM			METHOD: Augering and Split Spoon Sampling			BH No.: 29							
PROJECT: Hanlan Feedermain			PROJECT ENGINEER: CA		ELEV. (m) 109.1								
LOCATION: Mississauga, ON			STATION: 9+989 12 m R			PROJECT NO.: 08-015							
SAMPLE TYPE			<input checked="" type="checkbox"/> AUGER <input checked="" type="checkbox"/> DRIVEN <input checked="" type="checkbox"/> CORING <input type="checkbox"/> DYNAMIC CONE <input type="checkbox"/> SHELBY <input type="checkbox"/> SPLIT SPOON										
DEPTH (m)	INSTRUMENTATION DATA	REMARKS	Shear Strength (kPa)		N-Value (Blows/300mm)			SOIL SYMBOL	SOIL DESCRIPTION	SAMPLE TYPE	SAMPLE NO.	SPT(N)	ELEVATION (m)
			40	80	120	160	20						
0		Borehole dry and open on completion.							70 mm ASPHALTIC CONCRETE compact, brown sand and gravel		1A	24	109
0.5									hard, grey, layered SHALY CLAY to weathered SHALE		1B		108.5
1											2	50/125	108
1.5											3	50/25	107.5
2													107
2.5											4	50/50	106.5
3											5	50/25	106
3.5													105.5
4											6	50/25	105
4.5									hard grey weathered SHALE occasional thin limestone seams fragments		7	50/25	104.5
5													104
5.5													103.5
6											8	50/25	103
6.5													102.5
7		Refusal to advancement of augers at 7.0 m depth.							END OF BOREHOLE				
alston associates inc. consulting engineers								LOGGED BY: KC		DRILLING DATE: 11 Nov. 2009			
								REVIEWED BY: DM		Page 1 of 1			

CLIENT: AECOM			METHOD: Augering and Split Spoon Sampling			BH No.: 30								
PROJECT: Hanlan Feedermain			PROJECT ENGINEER: CA			ELEV. (m) 107.5								
LOCATION: Mississauga, ON			STATION: 11+264 10 m R			PROJECT NO.: 08-015								
SAMPLE TYPE <input type="checkbox"/> AUGER <input checked="" type="checkbox"/> DRIVEN <input checked="" type="checkbox"/> CORING <input type="checkbox"/> DYNAMIC CONE <input type="checkbox"/> SHELBY <input type="checkbox"/> SPLIT SPOON														
DEPTH (m)	INSTRUMENTATION DATA	REMARKS	Shear Strength (kPa)		N-Value (Blows/300mm)		PL W.C. LL		SOIL SYMBOL	SOIL DESCRIPTION	SAMPLE TYPE	SAMPLE NO.	SPT(N)	ELEVATION (m)
			40 80 120 160	20 40 60 80	20 40 60 80	20 40 60 80								
0		Borehole dry and cave-in at 2.7 m below ground surface on completion.	15							ASPHALTIC CONCRETE BOULEVARD		1	15	107.5
0.5										compact, damp, brown sand and angular gravel, FILL				
1			24							compact	SILTY	2	24	106.5
1.5														
2			24							damp to moist brown SAND	some silt	3	24	106
2.5		Split spoon wet on retrieval of sample 4.	42							dense	trace silt	4	42	105.5
3			50/50									5	50/50	105
3.5														
4			50/125									6	50/125	104.5
4.5			50/100									7	50/100	104
5										hard, grey layered SHALY CLAY to weathered SHALE				
5.5														
6			50/25									8	50/25	103.5
6.5														
7														
7.5			50/50									9	50/50	103
										END OF BOREHOLE				
alston associates inc. consulting engineers			LOGGED BY: NW			DRILLING DATE: 26 October 2009								
			REVIEWED BY: DM			Page 1 of 1								

CLIENT: AECOM		METHOD: Augering/Split Spoon Sampling/Coring		BH No.: 202	
PROJECT: Hanlan Feedermain		PROJECT ENGINEER: CA		ELEV. (m) 112.1	
LOCATION: Mississauga, ON		STATION: 10+514 16 m R		PROJECT NO.: 08-015	
SAMPLE TYPE		AUGER		DRIVEN	
		CORING		DYNAMIC CONE	
		SHELBY		SPLIT SPOON	

DEPTH (m)	INSTRUMENTATION DATA	REMARKS	Shear Strength (kPa)		N-Value (Blows/300mm)		PL W.C. LL		SOIL SYMBOL	SOIL DESCRIPTION	SAMPLE TYPE	SAMPLE NO.	SPT(N)	ELEVATION (m)
			40	80	120	160	20	40						
0	Bentonite	Water level measured as 2.0 m below ground surface on _____								150 mm TOPSOIL		1A		112
0.5										very loose		1B	2	111.5
1										loose		2	5	111
1.5										compact		3A	31	110.5
2										compact to dense		3B	31	110
2.5										damp brown and grey GRAVELLY coarse SAND		4	31	109.5
3										trace silt				109
3.5										trace clay				108.5
4		Hard augering from 4.1 m depth.								dense		5	49	108
4.5										trace shale fragments		6	50/125	107.5
5										hard, grey SHALY CLAY to weathered SHALE		7	50/75	107
5.5												8	50/50	106.5
6		Sample 9: TCR = 100 % RQD = 18 %										9		106
6.5														105.5
7														105
7.5										Georgian Bay Formation: grey, horizontally bedded SHALE				104.5
8										-occasional limestone seams				104
8.5										-thinly laminated to thinlt bedded				103.5
9										-occasional clay filling and fully pulverized shear zones				103
9.5	Sand	Sample 10: TCR = 100 % RQD = 12 %								-weak to moderately strong rock strength				102.5
										-very intensely fractured				
										-highly weathered				

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		REVIEWED BY: DM	Page 1 of 2

CLIENT: AECOM		METHOD: Augering/Split Spoon Sampling/Coring		BH No.: 202 RC			
PROJECT: Hanlan Feedermain		PROJECT ENGINEER: CA		G.S. ELEV. (m) 112.1			
LOCATION: Mississauga, ON		STATION: 10+514 16 m R		PROJECT NO.: 08-015			
SAMPLE TYPE <input type="checkbox"/> AUGER <input checked="" type="checkbox"/> DRIVEN <input checked="" type="checkbox"/> CORING <input type="checkbox"/> DYNAMIC CONE <input type="checkbox"/> SHELBY <input type="checkbox"/> SPLIT SPOON							
DEPTH (m)	REMARKS	SOIL SYMBOL	ROCK MASS DESCRIPTION	SAMPLE TYPE	SAMPLE NO.	FRACTURES PER 0.3 m FF=Fully Fractured VF=Vertical Fracture	ELEVATION (m)
6.5	Sample 9: TCR = 100 % RQD = 18 %					8	105.5
7						9	105
7.5	7.57 to 7.69 m depth: fully pulverized shear zone				9	4	104.5
8						5	104
8.5						5	103.5
9	9.20 to 9.30 m depth: fully pulverized shear zone		Georgian Bay Formation: grey, horizontally bedded SHALE			12	103
9.5	Sample 10: TCR = 100 % RQD = 12 % Unconfined compressive strength of rock sample taken at 9.50 m depth = 39.1 MPa		-occasional limestone seams -thinly laminated to thin bedded -occasional clay filling and fully pulverized shear zones -weak to moderately strong rock strength -very intensely fractured -highly weathered			7	102.5
10	9.88 to 9.90 m depth: clay filling 10.20 to 10.25 m depth: fully pulverized shear zone					7	102
10.5						10	101.5
11					10	8	101
11.5						3	100.5
12	12.20 to 12.23 m depth: fully pulverized shear zone					9	100
						5	
						10	
						6	
			END OF BOREHOLE				
alston associates inc. consulting engineers		LOGGED BY: NW REVIEWED BY: DM		DRILLING DATE: 3 Nov. 2009 Page 1 of 1			

CLIENT: AECOM		METHOD: Augering and Split Spoon Sampling		BH No.: 203	
PROJECT: Hanlan Feedermain		PROJECT ENGINEER: CA		ELEV. (m) 111.0	
LOCATION: Mississauga, ON		STATION: 10+889 13 m R		PROJECT NO.: 08-015	
SAMPLE TYPE <input type="checkbox"/> AUGER <input checked="" type="checkbox"/> DRIVEN <input checked="" type="checkbox"/> CORING <input type="checkbox"/> DYNAMIC CONE <input type="checkbox"/> SHELBY		SPLIT SPOON			

DEPTH (m)	INSTRUMENTATION DATA	REMARKS	Shear Strength (kPa)		N-Value (Blows/300mm)		PL W.C. LL		SOIL SYMBOL	SOIL DESCRIPTION	SAMPLE TYPE	SAMPLE NO.	SPT(N)	ELEVATION (m)
			40	80	120	160	20	40						
0	Bentonite	Borehole dry and open on completion. Water level measured as 1.8 m below ground surface on _____								30 mm TOPSOIL		1A	9	111
0.5										loose		1B		110.5
1												2	7	110
1.5										medium to fine SAND				109.5
2												3	43	109
2.5										dense				108.5
3												4	38	108
3.5										very dense		5A	50/25	107.5
4												5B		107
4.5	Sand											6	50/100	106.5
5										hard, grey SHALY CLAY occasional sand seam				106
5.5														105.5
6	Screen													105
6.5												8	50/75	104.5
7										hard, grey weathered SHALE				104
7.5														103.5
										END OF BOREHOLE		9	50/75	

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		REVIEWED BY: DM	Page 1 of 1

CLIENT: AECOM			METHOD: Augering/Split Spoon Sampling/Coring			BH No.: 31								
PROJECT: Hanlan Feedermain			PROJECT ENGINEER: CA		ELEV. (m) 106.7									
LOCATION: Mississauga, ON			STATION: 11+451 36 m R			PROJECT NO.: 08-015								
SAMPLE TYPE <input type="checkbox"/> AUGER <input checked="" type="checkbox"/> DRIVEN <input checked="" type="checkbox"/> CORING <input type="checkbox"/> DYNAMIC CONE <input type="checkbox"/> SHELBY <input type="checkbox"/> SPLIT SPOON														
DEPTH (m)	INSTRUMENTATION DATA	REMARKS	Shear Strength (kPa)		N-Value (Blows/300mm)			PL W.C. LL	SOIL SYMBOL	SOIL DESCRIPTION	SAMPLE TYPE	SAMPLE NO.	SPT(N)	ELEVATION (m)
			40	80	120	160	20							
0	Concrete	Borehole water level and cave-in at 2.5 m below ground surface on completion.	7						12		TOPSOIL	1A	7	106.5
0.5	Bentonite								8			1B		106
1			16						14		compact	2A	16	105.5
1.5									12			2B		105
2			30						17		SAND trace to some silt	3	30	104.5
2.5									17		dense	4A	19	104
3			19						10		compact	4B		103.5
3.5			50/75						4		very stiff, brown faintly layered SILTY CLAY	5	50/75	103
4														102.5
4.5			50/75						5			6	50/75	102
5														101.5
5.5														101
6			50/50						3		hard, grey weathered SHALE occasional clay seam	7	50/50	100.5
6.5														100
7														99.5
7.5			50/50						8			8	50/50	99
8														98.5
8.5														98
9		Sample 9: TCR = 97 % RQD = 0 %												97.5
9.5											SHALE (see top of next page)			97
alston associates inc. consulting engineers									LOGGED BY: NW		DRILLING DATE: 23 Nov. 2009			
									REVIEWED BY: DM		Page 1 of 2			

CLIENT: AECOM			METHOD: Augering/Split Spoon Sampling/Coring			BH No.: 31											
PROJECT: Hanlan Feedermain			PROJECT ENGINEER: CA		ELEV. (m) 106.7												
LOCATION: Mississauga, ON			STATION: 11+451 36 m R			PROJECT NO.: 08-015											
SAMPLE TYPE			<input type="checkbox"/> AUGER	<input checked="" type="checkbox"/> DRIVEN	<input checked="" type="checkbox"/> CORING	<input type="checkbox"/> DYNAMIC CONE	<input type="checkbox"/> SHELBY	<input type="checkbox"/> SPLIT SPOON									
DEPTH (m)	INSTRUMENTATION DATA	REMARKS	Shear Strength (kPa)		N-Value (Blows/300mm)		PL W.C. LL		SOIL SYMBOL	SOIL DESCRIPTION	SAMPLE TYPE	SAMPLE NO.	SPT(N)	ELEVATION (m)			
			40	80	120	160	20	40							60	80	20
10	 Sand Screen													Georgian Bay Formation: grey, horizontally bedded SHALE -occasional very thin to moderately bedded limestone seams -weak strength rock -intensely fractured -moderate weathered	9		96.5
10.5																96	
11																95.5	
11.5																95	
12																	
END OF BOREHOLE																	
alston associates inc. consulting engineers										LOGGED BY: NW		DRILLING DATE: 23 Nov. 2009					
										REVIEWED BY: DM		Page 2 of 2					

CLIENT: AECOM		METHOD: Augering/Split Spoon Sampling/Coring		BH No.: 31 RC			
PROJECT: Hanlan Feedermain		PROJECT ENGINEER: CA G.S. ELEV. (m) 106.7					
LOCATION: Mississauga, ON		STATION: 11+451 36 m R		PROJECT NO.: 08-015			
SAMPLE TYPE <input checked="" type="checkbox"/> AUGER <input checked="" type="checkbox"/> DRIVEN <input checked="" type="checkbox"/> CORING <input type="checkbox"/> DYNAMIC CONE <input type="checkbox"/> SHELBY <input type="checkbox"/> SPLIT SPOON							
DEPTH (m)	REMARKS	SOIL SYMBOL	ROCK MASS DESCRIPTION	SAMPLE TYPE	SAMPLE NO.	FRACTURES PER 0.3 m FF=Fully Fractured VF=Vertical Fracture	ELEVATION (m)
9	Sample 9: TCR = 97 % RQD = 0 %		Georgian Bay Formation: grey, horizontally bedded SHALE -occasional very thin to moderately bedded limestone seams -weak rock strength -intensely fractured -moderate weathered		9	8	97.5
9.5	9.56 to 9.64 m depth: limestone seam					8	
10	9.86 to 10.01 m depth: limestone seam					5	97
10.5						5	96.5
11	Unconfined compressive strength of rock sample taken at 11.0 m depth = 29.2 MPa					7	96
11.5						8	95.5
12						7	95
			END OF BOREHOLE				
alston associates inc. consulting engineers			LOGGED BY: NW	DRILLING DATE: 23 Nov. 2009			
			REVIEWED BY: DM	Page 1 of 1			

CLIENT: AECOM			METHOD: Augering and Split Spoon Sampling			BH No.: 32								
PROJECT: Hanlan Feedermain			PROJECT ENGINEER: CA		ELEV. (m) 106.2									
LOCATION: Mississauga, ON			STATION: 11+560 9 m L			PROJECT NO.: 08-015								
SAMPLE TYPE <input type="checkbox"/> AUGER <input checked="" type="checkbox"/> DRIVEN <input checked="" type="checkbox"/> CORING <input type="checkbox"/> DYNAMIC CONE <input type="checkbox"/> SHELBY <input type="checkbox"/>			SPLIT SPOON											
DEPTH (m)	INSTRUMENTATION DATA	REMARKS	Shear Strength (kPa)		N-Value (Blows/300mm)		PL W.C. LL		SOIL SYMBOL	SOIL DESCRIPTION	SAMPLE TYPE	SAMPLE NO.	SPT(N)	ELEVATION (m)
			40	80	120	160	20	40						
0		Borehole dry and cave-in at 2.4 m below ground surface on completion.										1	12	106
0.5										compact, damp, dark brown sand and angular gravel, FILL				105.5
1										compact		2	12	105
1.5														
2		very loose								SAND		3	3	104.5
2.5														
3														
3.5		Split spoon wet on retrieval of sample 5. Unit weight of sample 5B measured as 22.4 kN/m ³ .										5A	26	103
4												5B		102.5
4.5										very stiff, grey SILTY CLAY, trace sand trace shale fragments occasional sand seam		6	50/75	102
5												7	50/50	101.5
5.5														101
6												8	50/50	100
6.5														99.5
7										hard grey weathered SHALE				99
7.5												9	50/50	98.5
8														98
8.5														97.5
9												10	50/25	97
9.5														96.5
alston associates inc. consulting engineers									LOGGED BY: NW		DRILLING DATE: 21 October 2009			
									REVIEWED BY: DM		Page 1 of 2			

CLIENT: AECOM			METHOD: Augering and Split Spoon Sampling			BH No.: 32				
PROJECT: Hanlan Feedermain			PROJECT ENGINEER: CA		ELEV. (m) 106.2					
LOCATION: Mississauga, ON			STATION: 11+560 9 m L			PROJECT NO.: 08-015				
SAMPLE TYPE			<input type="checkbox"/> AUGER <input checked="" type="checkbox"/> DRIVEN <input checked="" type="checkbox"/> CORING <input type="checkbox"/> DYNAMIC CONE <input type="checkbox"/> SHELBY <input type="checkbox"/> SPLIT SPOON							
DEPTH (m)	INSTRUMENTATION DATA	REMARKS	Shear Strength (kPa) 40 80 120 160 N-Value (Blows/300mm) 20 40 60 80	PL W.C. LL	SOIL SYMBOL	SOIL DESCRIPTION	SAMPLE TYPE	SAMPLE NO.	SPT(N)	ELEVATION (m)
		Refusal to advancement of augers at 9.9 m depth.				END OF BOREHOLE				
alston associates inc. consulting engineers			LOGGED BY: NW REVIEWED BY: DM			DRILLING DATE: 21 October 2009 Page 2 of 2				

CLIENT: AECOM			METHOD: Augering and Split Spoon Sampling			BH No.: 33		
PROJECT: Hanlan Feedermain			PROJECT ENGINEER: CA			ELEV. (m) 104.0		
LOCATION: Mississauga, ON			STATION: 11+805 10 m R			PROJECT NO.: 08-015		
SAMPLE TYPE <input type="checkbox"/> AUGER <input checked="" type="checkbox"/> DRIVEN <input checked="" type="checkbox"/> CORING <input type="checkbox"/> DYNAMIC CONE <input type="checkbox"/> SHELBY <input type="checkbox"/> SPLIT SPOON								

DEPTH (m)	INSTRUMENTATION DATA	REMARKS	Shear Strength (kPa)		N-Value (Blows/300mm)		PL W.C. LL		SOIL SYMBOL	SOIL DESCRIPTION	SAMPLE TYPE	SAMPLE NO.	SPT(N)	ELEVATION (m)
			40	80	120	160	20	40						
0	Concrete	Borehole open and water level at 13.4 m below ground surface on completion. Water level measured as 5.3 m below ground surface on 5 January 2010.										1	6	104
0.5	Bentonite													103.5
1												2	12	103
1.5												3	3	102.5
2														102
2.5												4A	32	101.5
3												4B		
3.5												5	50/100	101
4												6	50/100	100.5
4.5												7	50/50	100
5														99.5
5.5														99
6												8	50/50	98.5
6.5														98
7														97.5
7.5												9	50/25	97
8														96.5
8.5														96
9														95.5
9.5												10	50/0	95
														94.5

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DRILLING DATE: 22 October 2009

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CLIENT: AECOM			METHOD: Augering and Split Spoon Sampling			BH No.: 33																			
PROJECT: Hanlan Feedermain			PROJECT ENGINEER: CA		ELEV. (m) 104.0																				
LOCATION: Mississauga, ON			STATION: 11+805 10 m R			PROJECT NO.: 08-015																			
SAMPLE TYPE <input checked="" type="checkbox"/> AUGER <input checked="" type="checkbox"/> DRIVEN <input checked="" type="checkbox"/> CORING <input checked="" type="checkbox"/> DYNAMIC CONE <input checked="" type="checkbox"/> SHELBY <input type="checkbox"/> SPLIT SPOON																									
DEPTH (m)	INSTRUMENTATION DATA	REMARKS	Shear Strength (kPa)				N-Value (Blows/300mm)			PL W.C. LL			SOIL SYMBOL	SOIL DESCRIPTION	SAMPLE TYPE	SAMPLE NO.	SPT (N)	ELEVATION (m)							
			40	80	120	160	20	40	60	80	20	40							60	80					
10															hard grey weathered SHALE occasional thin limestone seams		11	50/0	94						
10.5																								93.5	
11																									93
11.5																									92.5
12																									92
12.5																									91.5
13																									91
13.5																									90.5
14																									90
Refusal to advancement of augers at 14.2 m below ground surface.																			END OF BOREHOLE						
alston associates inc. consulting engineers										LOGGED BY: NW REVIEWED BY: DM			DRILLING DATE: 22 October 2009 Page 2 of 2												

CLIENT: AECOM			METHOD: Augering and Split Spoon Sampling			BH No.: 34				
PROJECT: Burnhamthorpe Library			PROJECT ENGINEER: CA		ELEV. (m) 101.6					
LOCATION: Mississauga, ON			STATION: 12+085.6 m R			PROJECT NO.: 09-150				
SAMPLE TYPE			AUGER		DRIVEN		CORING			
							DYNAMIC CONE			
							SHELBY			
							SPLIT SPOON			
DEPTH (m)	INSTRUMENTATION DATA	REMARKS	Shear Strength (kPa) 40 80 120 160 N-Value (Blows/300mm) 20 40 60 80	PL W.C. LL 20 40 60 80	SOIL SYMBOL	SOIL DESCRIPTION	SAMPLE TYPE	SAMPLE NO.	SPT(N)	ELEVATION (m)
0		Borehole dry and cave-in at 2.6 m below ground surface on completion.				150 mm ASPHALTIC CONCRETE				101.5
0.5			24	3		500 mm compact, damp, pale brown sand and angular gravel, FILL		1A	24	101.5
1			8	9		loose, moist, brown SILTY SAND occasional clay nodule		1B	8	100.5
1.5				9		firm, brown SILTY CLAY, trace sand		2		
2			40	9				3A	40	100.5
2.5			35	13		dense	damp	3B		99.5
3				11			moist to wet		4	99.5
3.5			69				brown, SILTY		5	98.5
4		Split spoon wet on retrieval of sample 6.	84	8		very dense			6	98.5
4.5				12					7	97.5
5			88				grey			97.5
5.5										96.5
6				9						96.5
6.5		Augers grinding	54	3		very stiff, grey SILTY CLAY trace sand, trace gravel		8A	54	95.5
7						hard, grey SANDY SILTY CLAY occasional shale fragments		8B		95.5
7.5			50/125	2		hard, grey weathered SHALE		9	50/125	94.5
						END OF BOREHOLE				94.5

CLIENT: AECOM			METHOD: Augering and Split Spoon Sampling			BH No.: 35											
PROJECT: Hanlan Feedermain			PROJECT ENGINEER: CA		ELEV. (m) 99.0												
LOCATION: Mississauga, ON			STATION: 12+372 5 m R			PROJECT NO.: 08-015											
SAMPLE TYPE <input type="checkbox"/> AUGER <input checked="" type="checkbox"/> DRIVEN <input checked="" type="checkbox"/> CORING <input type="checkbox"/> DYNAMIC CONE <input type="checkbox"/> SHELBY <input type="checkbox"/> SPLIT SPOON																	
DEPTH (m)	INSTRUMENTATION DATA	REMARKS	Shear Strength (kPa)		N-Value (Blows/300mm)			PL	W.C.	LL	SOIL SYMBOL	SOIL DESCRIPTION	SAMPLE TYPE	SAMPLE NO.	SPT(N)	ELEVATION (m)	
			40	80	120	160	20										40
0		Borehole dry and cave-in at 2.6 m below ground surface on completion.										160 mm ASPHALTIC CONCRETE				99	
0.5												600 mm very dense, damp pale brown, sand and angular gravel, FILL		1	60	98.5	
1												compact, damp, brown fine SAND some silt to SILTY occasional clay nodule		2	11	98	
1.5												loose damp, trace silt		3	7	97.5	
2												brown medium SAND moist, some silt to SILTY, trace clay		4	19	96.5	
2.5												compact		5	18	96	
3														6	17	95.5	
3.5														7A	19	95	
4		Split spoon wet on retrieval of sample 6.										compact moist to wet brown coarse SAND and GRAVEL		7B	19	94.5	
4.5														8	15	94	
5																93.5	
5.5																93	
6												compact moist to wet grey SILTY fine SAND to SANDY SILT				92.5	
6.5																92	
7																91.5	
7.5																91	
8												END OF BOREHOLE					
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										REVIEWED BY: DM		Page 1 of 1					

CLIENT: AECOM			METHOD: Augering and Split Spoon Sampling			BH No.: 36										
PROJECT: Hanlan Feedermain			PROJECT ENGINEER: CA			ELEV. (m) 98.6										
LOCATION: Mississauga, ON			STATION: 12+656 6 m R			PROJECT NO.: 08-015										
SAMPLE TYPE <input type="checkbox"/> AUGER <input checked="" type="checkbox"/> DRIVEN <input checked="" type="checkbox"/> CORING <input type="checkbox"/> DYNAMIC CONE <input type="checkbox"/> SHELBY <input type="checkbox"/> SPLIT SPOON																
DEPTH (m)	INSTRUMENTATION DATA	REMARKS	Shear Strength (kPa)		N-Value (Blows/300mm)			PL	W.C.	LL	SOIL SYMBOL	SOIL DESCRIPTION	SAMPLE TYPE	SAMPLE NO.	SPT(N)	ELEVATION (m)
			40	80	120	160	20									
0												200 mm ASPHALTIC CONCRETE				98.5
0.5					56						very dense	damp, pale brown sand and angular gravel FILL		1	56	98
1			21								compact		2A	21		97.5
1.5											compact		2B			
2			8								loose	damp fine SAND some silt to SILTY		3	8	97
2.5																96.5
3																96
3.5																95.5
4																95
4.5																94.5
5																94
5.5																93.5
6																93
6.5																92.5
7																92
7.5																91.5
8																91
8.5																90.5
9																90
9.5																89.5
												END OF BOREHOLE				
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										REVIEWED BY: DM		Page 1 of 1				

Appendix D

**Summary of Test Results on Rock Core Samples
Tables D1, D2, D3, D4**

Histograms Figures D1, D2, D3

Photographs of Rock Cores

Table D1: Summary of Rock Index and Engineering Properties

HF1-13

Parameter	Minimum	Average (mean)	Standard Deviation	Maximum	# of Data Points
TCR (%)	51	93	14	100	14
SCR (%)	0	86	27	100	14
RQD (%)	0	74	30	100	14
Hard Layers (HL) (%)	0	4	5	15	14
Fracture Index (per 0.3m)	0	1.9	2.4	10	62
Shale Point Loads, Inferred UCS (MPa)	1	22	n/a	54	22
Limestone Point Loads, Inferred UCS (MPa)	n/a	n/a	n/a	n/a	n/a
Siltstone Point Loads, Inferred UCS (MPa)	53	136	n/a	267	6
Hydraulic Conductivity, 'k' (cm/s)	< 1.00E-08	n/a	n/a	2.86E-06	n/a

HF1-14

Parameter	Minimum	Average (mean)	Standard Deviation	Maximum	# of Data Points
TCR (%)	100	100	0	100	12
SCR (%)	0	86	28	100	12
RQD (%)	0	66	31	100	12
Hard Layers (HL) (%)	0	8	10	35	12
Fracture Index (per 0.3m)	0	2.6	2.9	10	56
Shale Point Loads, Inferred UCS (MPa)	1	17	n/a	54	18
Limestone Point Loads, Inferred UCS (MPa)	n/a	n/a	n/a	n/a	n/a
Siltstone Point Loads, Inferred UCS (MPa)	75	149	n/a	256	4
Hydraulic Conductivity, 'k' (cm/s)	n/a	n/a	n/a	n/a	n/a

HF1-15

Parameter	Minimum	Average (mean)	Standard Deviation	Maximum	# of Data Points
TCR (%)	90	99	3	100	14
SCR (%)	22	89	20	100	14
RQD (%)	0	74	26	100	14
Hard Layers (HL) (%)	0	9	8	21	14
Fracture Index (per 0.3m)	0	2.5	2.7	10	66
Shale Point Loads, Inferred UCS (MPa)	1	14	n/a	62	21
Limestone Point Loads, Inferred UCS (MPa)	73	117	n/a	162	2
Siltstone Point Loads, Inferred UCS (MPa)	25	121	n/a	247	4
Hydraulic Conductivity, 'k' (cm/s)	< 1.00E-08	n/a	n/a	7.92E-04	n/a

HF1-16

Parameter	Minimum	Average (mean)	Standard Deviation	Maximum	# of Data Points
TCR (%)	81	98	2	100	14
SCR (%)	9	88	25	100	14
RQD (%)	0	72	29	100	14
Hard Layers (HL) (%)	0	10	8	21	14
Fracture Index (per 0.3m)	0	3	3	10	68
Shale Point Loads, Inferred UCS (MPa)	2	13	n/a	28	12
Limestone Point Loads, Inferred UCS (MPa)	155	155	n/a	155	1
Siltstone Point Loads, Inferred UCS (MPa)	76	151	n/a	269	10
Hydraulic Conductivity, 'k' (cm/s)	n/a	n/a	n/a	n/a	n/a

HF1-16A

Parameter	Minimum	Average (mean)	Standard Deviation	Maximum	# of Data Points
TCR (%)	44	95	15	100	14
SCR (%)	6	90	24	100	14
RQD (%)	0	69	24	97	14
Hard Layers (HL) (%)	0	13	10	25	14
Fracture Index (per 0.3m)	0	2.4	2.2	10	65
Shale Point Loads, Inferred UCS (MPa)	1	18	n/a	44	14
Limestone Point Loads, Inferred UCS (MPa)	130	174	n/a	218	2
Siltstone Point Loads, Inferred UCS (MPa)	42	138	n/a	239	10
Hydraulic Conductivity, 'k' (cm/s)	n/a	n/a	n/a	n/a	n/a

Notes:

1. TCR (%), SCR (%), RQD (%) and HL (%) are all measured per core run.
2. UCS = Point Load Index x 24

Table D1 (continued)

2 of 8

HF1-17

Parameter	Minimum	Average (mean)	Standard Deviation	Maximum	# of Data Points
TCR (%)	78	98	6	100	15
SCR (%)	0	82	32	100	15
RQD (%)	0	67	33	100	15
Hard Layers (HL) (%)	0	9	9	30	15
Fracture Index (per 0.3m)	0	3.6	3.8	10	72
Shale Point Loads, Inferred UCS (MPa)	2	15	n/a	56	23
Limestone Point Loads, Inferred UCS (MPa)	122	122	n/a	122	1
Siltstone Point Loads, Inferred UCS (MPa)	70	163	n/a	247	9
Hydraulic Conductivity, 'k' (cm/s)	< 1.00E-08	n/a	n/a	< 1.00E-08	n/a

HF1-17A

Parameter	Minimum	Average (mean)	Standard Deviation	Maximum	# of Data Points
TCR (%)	80	98	5	100	15
SCR (%)	0	87	26	100	15
RQD (%)	0	74	32	100	15
Hard Layers (HL) (%)	0	12	14	45	15
Fracture Index (per 0.3m)	0	2.4	3	10	71
Shale Point Loads, Inferred UCS (MPa)	1	11	n/a	40	20
Limestone Point Loads, Inferred UCS (MPa)	n/a	n/a	n/a	n/a	n/a
Siltstone Point Loads, Inferred UCS (MPa)	32	119	n/a	216	8
Hydraulic Conductivity, 'k' (cm/s)	1.17E-06	n/a	n/a	9.66E-06	n/a

HF1-18

Parameter	Minimum	Average (mean)	Standard Deviation	Maximum	# of Data Points
TCR (%)	64	97	10	100	14
SCR (%)	46	91	15	100	14
RQD (%)	0	73	26	97	14
Hard Layers (HL) (%)	0	12	11	35	14
Fracture Index (per 0.3m)	0	2.2	2.6	10	62
Shale Point Loads, Inferred UCS (MPa)	1	15	n/a	48	16
Limestone Point Loads, Inferred UCS (MPa)	71	152	n/a	234	2
Siltstone Point Loads, Inferred UCS (MPa)	81	135	n/a	255	10
Hydraulic Conductivity, 'k' (cm/s)	< 1.00E-08	n/a	n/a	< 1.00E-08	n/a

HF1-19

Parameter	Minimum	Average (mean)	Standard Deviation	Maximum	# of Data Points
TCR (%)	78	97	7	100	12
SCR (%)	0	80	31	100	12
RQD (%)	0	66	30	97	12
Hard Layers (HL) (%)	0	8	10	32	12
Fracture Index (per 0.3m)	0	3.8	3.6	10	57
Shale Point Loads, Inferred UCS (MPa)	1	12	n/a	28	16
Limestone Point Loads, Inferred UCS (MPa)	n/a	n/a	n/a	n/a	n/a
Siltstone Point Loads, Inferred UCS (MPa)	29	90	n/a	172	6
Hydraulic Conductivity, 'k' (cm/s)	2.85E-06	n/a	n/a	1.50E-04	n/a

HF1-20

Parameter	Minimum	Average (mean)	Standard Deviation	Maximum	# of Data Points
TCR (%)	77	97	7	100	13
SCR (%)	59	92	13	100	13
RQD (%)	15	71	9	98	13
Hard Layers (HL) (%)	0	12	26	32	13
Fracture Index (per 0.3m)	0	2.5	2.4	10	56
Shale Point Loads, Inferred UCS (MPa)	1	13	n/a	38	16
Limestone Point Loads, Inferred UCS (MPa)	n/a	n/a	n/a	n/a	n/a
Siltstone Point Loads, Inferred UCS (MPa)	69	146	n/a	225	10
Hydraulic Conductivity, 'k' (cm/s)	n/a	n/a	n/a	n/a	n/a

Notes:

1. TCR (%), SCR (%), RQD (%) and HL (%) are all measured per core run.
2. UCS = Point Load Index x 24

Table D1 (continued)

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HF1-21

Parameter	Minimum	Average (mean)	Standard Deviation	Maximum	# of Data Points
TCR (%)	95	99	2	100	11
SCR (%)	0	78	32	100	11
RQD (%)	0	60	36	97	11
Hard Layers (HL) (%)	0	12	14	50	11
Fracture Index (per 0.3m)	0	3.1	3.2	10	47
Shale Point Loads, Inferred UCS (MPa)	3	11	n/a	27	12
Limestone Point Loads, Inferred UCS (MPa)	n/a	n/a	n/a	n/a	n/a
Siltstone Point Loads, Inferred UCS (MPa)	54	117	n/a	176	8
Hydraulic Conductivity, 'k' (cm/s)	< 1.00E-08	n/a	n/a	< 1.00E-08	n/a

HF1-22

Parameter	Minimum	Average (mean)	Standard Deviation	Maximum	# of Data Points
TCR (%)	100	100	0	100	11
SCR (%)	16	73	31	95	11
RQD (%)	0	62	32	90	11
Hard Layers (HL) (%)	0	16	16	47	11
Fracture Index (per 0.3m)	0	3.8	3.7	10	52
Shale Point Loads, Inferred UCS (MPa)	1	17	n/a	42	10
Limestone Point Loads, Inferred UCS (MPa)	59	87	n/a	114	2
Siltstone Point Loads, Inferred UCS (MPa)	64	144	n/a	202	10
Hydraulic Conductivity, 'k' (cm/s)	n/a	n/a	n/a	n/a	n/a

HF1-23

Parameter	Minimum	Average (mean)	Standard Deviation	Maximum	# of Data Points
TCR (%)	91	99	3	100	12
SCR (%)	37	92	18	100	12
RQD (%)	28	81	22	100	12
Hard Layers (HL) (%)	0	6	8	28	12
Fracture Index (per 0.3m)	0	1.9	2.9	10	58
Shale Point Loads, Inferred UCS (MPa)	1	14	n/a	52	16
Limestone Point Loads, Inferred UCS (MPa)	n/a	n/a	n/a	n/a	n/a
Siltstone Point Loads, Inferred UCS (MPa)	16	139	n/a	262	8
Hydraulic Conductivity, 'k' (cm/s)	2.15E-06	n/a	n/a	1.87E-05	

HF1-24

Parameter	Minimum	Average (mean)	Standard Deviation	Maximum	# of Data Points
TCR (%)	97	100	1	100	10
SCR (%)	75	95	7	100	10
RQD (%)	70	83	9	98	10
Hard Layers (HL) (%)	5	14	10	33	10
Fracture Index (per 0.3m)	0	1.9	1.8	10	50
Shale Point Loads, Inferred UCS (MPa)	1	15	n/a	40	12
Limestone Point Loads, Inferred UCS (MPa)	n/a	n/a	n/a	n/a	n/a
Siltstone Point Loads, Inferred UCS (MPa)	60	120	n/a	189	8
Hydraulic Conductivity, 'k' (cm/s)	n/a	n/a	n/a	n/a	n/a

HF1-25

Parameter	Minimum	Average (mean)	Standard Deviation	Maximum	# of Data Points
TCR (%)	100	100	0	100	14
SCR (%)	35	88	18	100	14
RQD (%)	0	73	29	98	14
Hard Layers (HL) (%)	0	14	11	35	14
Fracture Index (per 0.3m)	0	3.2	3.8	10	67
Shale Point Loads, Inferred UCS (MPa)	1	11	n/a	31	21
Limestone Point Loads, Inferred UCS (MPa)	n/a	n/a	n/a	n/a	n/a
Siltstone Point Loads, Inferred UCS (MPa)	30	105	n/a	194	7
Hydraulic Conductivity, 'k' (cm/s)	< 1.00E-08	n/a	n/a	3.10E-05	n/a

Notes:

1. TCR (%), SCR (%), RQD (%) and HL (%) are all measured per core run.
2. UCS = Point Load Index x 24

Table D1 (continued)

4 of 8

HF1-26

Parameter	Minimum	Average (mean)	Standard Deviation	Maximum	# of Data Points
TCR (%)	97	100	1	100	14
SCR (%)	50	92	14	100	14
RQD (%)	0	78	27	100	14
Hard Layers (HL) (%)	3	19	13	48	14
Fracture Index (per 0.3m)	0	2.7	3.2	10	66
Shale Point Loads, Inferred UCS (MPa)	2	14	n/a	37	22
Limestone Point Loads, Inferred UCS (MPa)	68	94	n/a	119	2
Siltstone Point Loads, Inferred UCS (MPa)	57	96	n/a	154	4
Hydraulic Conductivity, 'k' (cm/s)	< 1.00E-08	n/a	n/a	1.59E-06	n/a

HF1-27

Parameter	Minimum	Average (mean)	Standard Deviation	Maximum	# of Data Points
TCR (%)	95	100	1	100	13
SCR (%)	60	87	12	100	13
RQD (%)	0	72	26	97	13
Hard Layers (HL) (%)	0	21	21	83	13
Fracture Index (per 0.3m)	0	3.4	3.8	10	61
Shale Point Loads, Inferred UCS (MPa)	2	10	n/a	17	14
Limestone Point Loads, Inferred UCS (MPa)	81	132	n/a	217	6
Siltstone Point Loads, Inferred UCS (MPa)	38	121	n/a	195	6
Hydraulic Conductivity, 'k' (cm/s)	< 1.00E-08	n/a	n/a	< 1.00E-08	n/a

HF1-28

Parameter	Minimum	Average (mean)	Standard Deviation	Maximum	# of Data Points
TCR (%)	82	97	6	100	12
SCR (%)	0	79	33	100	12
RQD (%)	0	68	35	100	12
Hard Layers (HL) (%)	0	11	11	35	12
Fracture Index (per 0.3m)	0	2.3	2.7	10	51
Shale Point Loads, Inferred UCS (MPa)	0	11	n/a	44	16
Limestone Point Loads, Inferred UCS (MPa)	99	181	n/a	262	2
Siltstone Point Loads, Inferred UCS (MPa)	45	88	n/a	176	4
Hydraulic Conductivity, 'k' (cm/s)	n/a	n/a	n/a	n/a	n/a

HF1-29

Parameter	Minimum	Average (mean)	Standard Deviation	Maximum	# of Data Points
TCR (%)	98	100	1	100	10
SCR (%)	69	94	9	100	10
RQD (%)	25	78	24	100	10
Hard Layers (HL) (%)	0	20	16	45	10
Fracture Index (per 0.3m)	0	2.3	2.4	10	47
Shale Point Loads, Inferred UCS (MPa)	4	11	n/a	18	11
Limestone Point Loads, Inferred UCS (MPa)	54	112	n/a	150	3
Siltstone Point Loads, Inferred UCS (MPa)	32	90	n/a	161	6
Hydraulic Conductivity, 'k' (cm/s)	< 1.00E-08	n/a	n/a	2.31E-05	n/a

HF1-30

Parameter	Minimum	Average (mean)	Standard Deviation	Maximum	# of Data Points
TCR (%)	88	98	4	100	7
SCR (%)	77	93	10	100	7
RQD (%)	58	85	18	98	7
Hard Layers (HL) (%)	0	10	13	32	7
Fracture Index (per 0.3m)	0	1.9	2.3	10	33
Shale Point Loads, Inferred UCS (MPa)	1	14	n/a	30	8
Limestone Point Loads, Inferred UCS (MPa)	n/a	n/a	n/a	n/a	n/a
Siltstone Point Loads, Inferred UCS (MPa)	41	111	n/a	167	6
Hydraulic Conductivity, 'k' (cm/s)	n/a	n/a	n/a	n/a	n/a

Notes:

1. TCR (%), SCR (%), RQD (%) and HL (%) are all measured per core run.
2. UCS = Point Load Index x 24

Table D1 (continued)

5 of 8

HF1-31

Parameter	Minimum	Average (mean)	Standard Deviation	Maximum	# of Data Points
TCR (%)	94	98	2	100	6
SCR (%)	89	96	4	100	6
RQD (%)	86	91	5	97	6
Hard Layers (HL) (%)	0	11	12	29	6
Fracture Index (per 0.3m)	0	1.0	1.0	4	30
Shale Point Loads, Inferred UCS (MPa)	1	14	n/a	28	10
Limestone Point Loads, Inferred UCS (MPa)	n/a	n/a	n/a	n/a	n/a
Siltstone Point Loads, Inferred UCS (MPa)	146	174	n/a	202	2
Hydraulic Conductivity, 'k' (cm/s)	n/a	n/a	n/a	n/a	n/a

HF1-32

Parameter	Minimum	Average (mean)	Standard Deviation	Maximum	# of Data Points
TCR (%)	100	100	0	100	10
SCR (%)	60	88	13	100	10
RQD (%)	33	78	20	100	10
Hard Layers (HL) (%)	0	19	17	43	10
Fracture Index (per 0.3m)	0	3.4	3.5	10	48
Shale Point Loads, Inferred UCS (MPa)	0	16	n/a	42	16
Limestone Point Loads, Inferred UCS (MPa)	147	172	n/a	196	2
Siltstone Point Loads, Inferred UCS (MPa)	82	127	n/a	172	2
Hydraulic Conductivity, 'k' (cm/s)	< 1.00E-08	n/a	n/a	< 1.00E-08	n/a

HF1-33

Parameter	Minimum	Average (mean)	Standard Deviation	Maximum	# of Data Points
TCR (%)	83	97	5	100	12
SCR (%)	46	89	18	100	12
RQD (%)	7	79	28	100	12
Hard Layers (HL) (%)	0	12	11	31	12
Fracture Index (per 0.3m)	0	2.4	3.2	10	59
Shale Point Loads, Inferred UCS (MPa)	1	11	n/a	25	9
Limestone Point Loads, Inferred UCS (MPa)	n/a	n/a	n/a	n/a	n/a
Siltstone Point Loads, Inferred UCS (MPa)	28	111	n/a	224	15
Hydraulic Conductivity, 'k' (cm/s)	n/a	n/a	n/a	n/a	n/a

HF1-34

Parameter	Minimum	Average (mean)	Standard Deviation	Maximum	# of Data Points
TCR (%)	98	100	1	100	12
SCR (%)	10	90	25	100	12
RQD (%)	0	74	28	98	12
Hard Layers (HL) (%)	0	21	17	52	12
Fracture Index (per 0.3m)	0	2.9	3.0	10	56
Shale Point Loads, Inferred UCS (MPa)	2	8	n/a	24	14
Limestone Point Loads, Inferred UCS (MPa)	n/a	n/a	n/a	n/a	n/a
Siltstone Point Loads, Inferred UCS (MPa)	31	62	n/a	109	8
Hydraulic Conductivity, 'k' (cm/s)	< 1.00E-08	n/a	n/a	9.34E-06	n/a

HF1-35

Parameter	Minimum	Average (mean)	Standard Deviation	Maximum	# of Data Points
TCR (%)	75	98	7	100	14
SCR (%)	25	92	20	100	14
RQD (%)	0	81	26	100	14
Hard Layers (HL) (%)	0	24	13	43	14
Fracture Index (per 0.3m)	0	2.3	2.8	10	58
Shale Point Loads, Inferred UCS (MPa)	4	10	n/a	19	8
Limestone Point Loads, Inferred UCS (MPa)	n/a	n/a	n/a	n/a	n/a
Siltstone Point Loads, Inferred UCS (MPa)	22	98	n/a	269	18
Hydraulic Conductivity, 'k' (cm/s)	n/a	n/a	n/a	n/a	n/a

Notes:

1. TCR (%), SCR (%), RQD (%) and HL (%) are all measured per core run.
2. UCS = Point Load Index x 24

Table D1 (continued)

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HF1-35A

Parameter	Minimum	Average (mean)	Standard Deviation	Maximum	# of Data Points
TCR (%)	100	100	0	100	13
SCR (%)	0	90	27	100	13
RQD (%)	0	74	30	100	13
Hard Layers (HL) (%)	2	28	15	48	13
Fracture Index (per 0.3m)	0	3.0	3.1	10	62
Shale Point Loads, Inferred UCS (MPa)	2	13	n/a	28	12
Limestone Point Loads, Inferred UCS (MPa)	60	137	n/a	214	2
Siltstone Point Loads, Inferred UCS (MPa)	29	65	n/a	134	10
Hydraulic Conductivity, 'k' (cm/s)	< 1.00E-08	n/a	n/a	< 1.00E-08	n/a

HF1-36

Parameter	Minimum	Average (mean)	Standard Deviation	Maximum	# of Data Points
TCR (%)	81	98	5	100	12
SCR (%)	74	96	7	100	12
RQD (%)	35	87	15	100	12
Hard Layers (HL) (%)	0	18	20	42	12
Fracture Index (per 0.3m)	0	1.8	2.4	10	59
Shale Point Loads, Inferred UCS (MPa)	1	23	n/a	61	15
Limestone Point Loads, Inferred UCS (MPa)	20	73	n/a	133	4
Siltstone Point Loads, Inferred UCS (MPa)	31	104	n/a	215	7
Hydraulic Conductivity, 'k' (cm/s)	n/a	n/a	n/a	n/a	n/a

HF1-37

Parameter	Minimum	Average (mean)	Standard Deviation	Maximum	# of Data Points
TCR (%)	93	99	2	100	12
SCR (%)	0	81	30	100	12
RQD (%)	0	68	29	100	12
Hard Layers (HL) (%)	0	28	19	57	12
Fracture Index (per 0.3m)	0	3.8	3.8	10	56
Shale Point Loads, Inferred UCS (MPa)	1	13	n/a	28	10
Limestone Point Loads, Inferred UCS (MPa)	100	134	n/a	160	4
Siltstone Point Loads, Inferred UCS (MPa)	27	112	n/a	195	8
Hydraulic Conductivity, 'k' (cm/s)	n/a	n/a	n/a	n/a	n/a

HF1-38

Parameter	Minimum	Average (mean)	Standard Deviation	Maximum	# of Data Points
TCR (%)	100	100	0	100	9
SCR (%)	51	93	16	100	9
RQD (%)	15	78	29	100	9
Hard Layers (HL) (%)	3	30	16	53	9
Fracture Index (per 0.3m)	0	3.0	3.4	10	45
Shale Point Loads, Inferred UCS (MPa)	2	13	n/a	36	6
Limestone Point Loads, Inferred UCS (MPa)	80	148	n/a	212	6
Siltstone Point Loads, Inferred UCS (MPa)	31	81	n/a	156	7
Hydraulic Conductivity, 'k' (cm/s)	< 1.00E-08	n/a	n/a	5.53E-06	n/a

HF1-39

Parameter	Minimum	Average (mean)	Standard Deviation	Maximum	# of Data Points
TCR (%)	100	100	0	100	12
SCR (%)	59	92	11	100	12
RQD (%)	23	66	23	100	12
Hard Layers (HL) (%)	5	31	17	62	12
Fracture Index (per 0.3m)	0	3.6	3.4	10	59
Shale Point Loads, Inferred UCS (MPa)	1	11	n/a	30	11
Limestone Point Loads, Inferred UCS (MPa)	53	118	n/a	177	6
Siltstone Point Loads, Inferred UCS (MPa)	31	118	n/a	247	9
Hydraulic Conductivity, 'k' (cm/s)	n/a	n/a	n/a	n/a	n/a

Notes:

1. TCR (%), SCR (%), RQD (%) and HL (%) are all measured per core run.
2. UCS = Point Load Index x 24

Table D1 (continued)

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HF1-40

Parameter	Minimum	Average (mean)	Standard Deviation	Maximum	# of Data Points
TCR (%)	95	99	2	100	12
SCR (%)	37	80	17	96	12
RQD (%)	0	54	21	87	12
Hard Layers (HL) (%)	0	23	23	78	12
Fracture Index (per 0.3m)	0	5.0	3.7	10	57
Shale Point Loads, Inferred UCS (MPa)	1	15	n/a	47	12
Limestone Point Loads, Inferred UCS (MPa)	65	105	n/a	148	4
Siltstone Point Loads, Inferred UCS (MPa)	58	143	n/a	218	8
Hydraulic Conductivity, 'k' (cm/s)	n/a	n/a	n/a	n/a	n/a

HF1-41

Parameter	Minimum	Average (mean)	Standard Deviation	Maximum	# of Data Points
TCR (%)	97	100	1	100	12
SCR (%)	16	85	23	98	12
RQD (%)	0	64	26	95	12
Hard Layers (HL) (%)	0	24	21	77	12
Fracture Index (per 0.3m)	0	3.9	3.7	10	58
Shale Point Loads, Inferred UCS (MPa)	1	10	n/a	18	10
Limestone Point Loads, Inferred UCS (MPa)	54	95	n/a	128	3
Siltstone Point Loads, Inferred UCS (MPa)	21	109	n/a	199	12
Hydraulic Conductivity, 'k' (cm/s)	2.18E-06	n/a	n/a	8.09E-06	n/a

HF1-42

Parameter	Minimum	Average (mean)	Standard Deviation	Maximum	# of Data Points
TCR (%)	66	97	10	100	12
SCR (%)	21	85	22	100	12
RQD (%)	0	70	27	100	12
Hard Layers (HL) (%)	0	24	17	50	12
Fracture Index (per 0.3m)	0	3.5	3.8	10	58
Shale Point Loads, Inferred UCS (MPa)	3	24	n/a	48	11
Limestone Point Loads, Inferred UCS (MPa)	52	105	n/a	138	6
Siltstone Point Loads, Inferred UCS (MPa)	9	60	n/a	155	9
Hydraulic Conductivity, 'k' (cm/s)	3.92E-05	n/a	n/a	4.51E-04	n/a

HF1-43

Parameter	Minimum	Average (mean)	Standard Deviation	Maximum	# of Data Points
TCR (%)	96	100	1	100	11
SCR (%)	47	88	15	100	11
RQD (%)	24	71	23	97	11
Hard Layers (HL) (%)	2	20	16	48	11
Fracture Index (per 0.3m)	0	3.5	3.5	10	54
Shale Point Loads, Inferred UCS (MPa)	<1	13	n/a	40	16
Limestone Point Loads, Inferred UCS (MPa)	n/a	n/a	n/a	n/a	n/a
Siltstone Point Loads, Inferred UCS (MPa)	30	92	n/a	153	6
Hydraulic Conductivity, 'k' (cm/s)	n/a	n/a	n/a	n/a	n/a

HF1-44

Parameter	Minimum	Average (mean)	Standard Deviation	Maximum	# of Data Points
TCR (%)	100	100	0	100	14
SCR (%)	36	92	17	100	14
RQD (%)	36	81	18	100	14
Hard Layers (HL) (%)	3	22	13	43	14
Fracture Index (per 0.3m)	0	2.2	2.7	10	67
Shale Point Loads, Inferred UCS (MPa)	<1	15	n/a	39	13
Limestone Point Loads, Inferred UCS (MPa)	107	154	n/a	200	2
Siltstone Point Loads, Inferred UCS (MPa)	6	57	n/a	156	15
Hydraulic Conductivity, 'k' (cm/s)	n/a	n/a	n/a	n/a	n/a

Notes:

1. TCR (%), SCR (%), RQD (%) and HL (%) are all measured per core run.
2. UCS = Point Load Index x 24

Table D1 (continued)

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HF1-45

Parameter	Minimum	Average (mean)	Standard Deviation	Maximum	# of Data Points
TCR (%)	97	100	1	100	14
SCR (%)	0	83	26	100	14
RQD (%)	44	76	20	100	14
Hard Layers (HL) (%)	0	24	17	67	14
Fracture Index (per 0.3m)	0	2.3	2.6	10	67
Shale Point Loads, Inferred UCS (MPa)	3	15	n/a	38	10
Limestone Point Loads, Inferred UCS (MPa)	56	105	n/a	168	8
Siltstone Point Loads, Inferred UCS (MPa)	47	108	n/a	230	10
Hydraulic Conductivity, 'k' (cm/s)	n/a	n/a	n/a	n/a	n/a

HF1-46

Parameter	Minimum	Average (mean)	Standard Deviation	Maximum	# of Data Points
TCR (%)	40	89	19	100	14
SCR (%)	0	68	37	100	14
RQD (%)	0	53	40	100	14
Hard Layers (HL) (%)	3	23	20	65	14
Fracture Index (per 0.3m)	0	5.3	4.4	10	66
Shale Point Loads, Inferred UCS (MPa)	<1	19	n/a	48	13
Limestone Point Loads, Inferred UCS (MPa)	91	132	n/a	172	3
Siltstone Point Loads, Inferred UCS (MPa)	18	123	n/a	251	12
Hydraulic Conductivity, 'k' (cm/s)	< 1.00E-08	n/a	n/a	6.89E-04	n/a

Notes:

1. TCR (%), SCR (%), RQD (%) and HL (%) are all measured per core run.
2. UCS = Point Load Index x 24

Table D2: Summary of Point Load Index Strength Testing

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HF1-13

Run	Depth (m)	Elevation (m)	Rock Type	Type of Break Axial or Diametral	D for Axial Break (mm)	Force (kN)	$Is_{(50)}$ (N/mm ²)	Inferred UCS (MPa) *
2	8.18	117.42	S	A	35	1.8	0.739	43
2	8.46	117.14	S	D	-	0.1	0.070	2
3	10.03	115.57	S	D	-	0.2	0.242	6
3	10.06	115.54	S	A	53	1.7	0.700	41
4	11.35	114.25	S	D	-	0.9	0.949	23
4	11.38	114.22	S	A	46	2.3	0.930	54
5	12.93	112.67	S	D	-	0.0	0.007	0
5	12.93	112.67	S	A	32	0.6	0.265	15
6	14.17	111.43	SI	D	-	3.5	3.536	85
6	14.17	111.43	SI	A	35	11.1	4.590	267
7	15.80	109.80	S	D	-	0.2	0.220	5
7	15.83	109.77	S	A	44	2.0	0.831	48
8	17.12	108.48	S	D	-	0.2	0.235	6
8	17.15	108.46	S	A	39	1.3	0.541	32
9	18.44	107.16	S	D	-	0.2	0.197	5
9	18.44	107.16	S	A	30	1.5	0.600	35
10	20.60	105.00	SI	D	-	2.2	2.190	53
10	20.60	105.00	SI	A	40	6.8	2.789	163
11	21.21	104.39	S	D	-	0.2	0.209	5
11	21.18	104.42	S	A	58	1.7	0.711	41
12	21.95	103.65	S	D	-	0.4	0.424	10
12	21.92	103.68	S	A	43	1.3	0.527	31
12	22.61	102.99	SI	D	-	3.7	3.699	89
12	22.63	102.97	SI	A	47	6.8	2.792	163
13	22.96	102.64	S	D	-	0.2	0.191	5
13	22.96	102.64	S	A	25	1.7	0.695	40
14	24.84	100.76	S	D	-	0.3	0.334	8
14	24.84	100.76	S	A	40	1.6	0.677	39

Rock Type: S = SHALE; L = LIMESTONE; SI = SILTSTONE

Note: Inferred UCS = $Is_{(50)} \times 24$

Table D2: Summary of Point Load Index Strength Testing

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HF1-14

Run	Depth (m)	Elevation (m)	Rock Type	Type of Break Axial or Diametral	D for Axial Break (mm)	Force (kN)	Is ₍₅₀₎ (N/mm ²)	Inferred UCS (MPa) *
2	10.24	114.16	S	D	-	0.1	0.032	1
2	10.24	114.16	S	A	35	3.7	1.402	34
3	12.19	112.21	S	D	-	0.9	0.261	6
3	12.19	112.21	S	A	31	4.2	1.747	42
4	13.51	110.89	SI	D	-	10.7	3.133	75
4	13.51	110.89	SI	A	33	27.2	10.658	256
5	15.01	109.39	S	D	-	0.5	0.147	4
5	15.01	109.39	S	A	36	4.2	1.550	37
6	16.33	108.07	S	D	-	0.1	0.043	1
6	16.33	108.07	S	A	31	3.5	1.433	34
7	18.34	106.06	SI	D	-	11.6	3.412	82
7	18.34	106.06	SI	A	30	18.0	7.585	182
8	19.74	104.66	S	D	-	0.4	0.128	3
8	19.74	104.66	S	A	28	0.4	0.172	4
9	20.52	103.88	S	D	-	1.1	0.319	8
9	20.52	103.88	S	A	28	1.8	0.803	19
10	22.25	102.15	S	D	-	2.5	0.732	18
10	22.25	102.15	S	A	28	1.0	0.465	11
11	24.84	99.56	S	D	-	1.0	0.297	7
11	24.84	99.56	S	A	50	2.7	0.755	18
12	26.97	97.43	S	D	-	1.4	0.406	10
12	26.97	97.43	S	A	35	6.0	2.247	54

Rock Type: S = SHALE; L = LIMESTONE; SI = SILTSTONE

Note: Inferred UCS = Is₍₅₀₎ x 24

Table D2: Summary of Point Load Index Strength Testing

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HF1-15

Run	Depth (m)	Elevation (m)	Rock Type	Type of Break Axial or Diametral	D for Axial Break (mm)	Force (kN)	Is ₍₅₀₎ (N/mm ²)	Inferred UCS (MPa) *
1	5.69	117.41	S	D	-	0.3	0.083	2
1	5.69	117.41	S	A	34	4.1	1.570	38
2	7.57	115.53	S	D	-	1.1	0.309	7
2	7.57	115.53	S	A	35	6.9	2.578	62
3	8.94	114.16	S	D	-	0.2	0.050	1
3	8.94	114.16	S	A	30	1.3	0.560	13
4	9.53	113.58	S	D	-	0.2	0.051	1
4	9.53	113.58	S	A	40	2.9	0.973	23
5	11.71	111.39	L	D	-	22.9	6.741	162
5	11.71	111.39	L	A	75	14.7	3.051	73
6	13.11	109.99	S	D	-	0.4	0.107	3
6	13.11	109.99	S	A	26	2.4	1.154	28
7	14.02	109.08	S	A	26	1.5	0.707	17
7	14.02	109.08	S	D	-	0.1	0.029	1
8	16.31	106.79	S	D	-	1.0	0.306	7
8	16.31	106.79	S	A	30	2.7	1.144	27
9	17.37	105.73	S	A	38	0.2	0.053	1
9	17.81	105.29	SI	D	-	14.6	10.298	247
9	17.81	105.29	SI	A	40	30.5	4.288	103
10	19.13	103.97	S	A	95	0.2	0.032	1
10	19.13	103.97	S	D	-	1.2	0.352	8
12	21.41	101.69	S	D	-	1.1	0.325	8
12	21.41	101.69	S	A	45	1.9	0.581	14
13	22.66	100.44	S	D	-	1.4	0.414	10
13	22.66	100.44	S	A	35	1.6	0.611	15
14	24.26	98.84	SI	D	-	3.5	1.037	25
14	24.26	98.84	SI	A	35	12.3	4.607	111

Rock Type: S = SHALE; L = LIMESTONE; SI = SILTSTONE

Note: Inferred UCS = Is₍₅₀₎ × 24

Table D2: Summary of Point Load Index Strength Testing

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HF1-16

Run	Depth (m)	Elevation (m)	Rock Type	Type of Break Axial or Diametral	D for Axial Break (mm)	Force (kN)	$I_{s(50)}$ (N/mm ²)	Inferred UCS (MPa) *
3	7.21	112.09	S	D	-	0.2	0.065	2
3	7.21	112.09	S	A	34	2.2	0.836	20
4	9.17	110.13	SI	D	-	17.9	5.246	126
4	9.17	110.13	SI	A	40	33.2	11.207	269
5	10.46	108.84	S	D	-	0.8	0.230	6
5	10.46	108.84	S	A	33	2.1	0.815	20
6	11.23	108.07	S	D	-	1.4	0.398	10
6	11.23	108.07	S	A	50	1.6	0.447	11
7	13.66	105.64	SI	D	-	10.8	3.162	76
7	13.66	105.64	SI	A	40	21.0	7.088	170
8	14.76	104.54	SI	D	-	16.6	4.876	117
8	14.76	104.54	SI	A	30	20.0	8.463	203
9	15.87	103.43	SI	D	-	20.3	5.979	144
9	15.87	103.43	SI	A	40	9.9	3.336	80
10	18.06	101.24	SI	D	-	21.9	6.428	154
10	18.06	101.24	SI	A	35	18.9	7.072	170
11	19.30	100.00	S	D	-	0.5	0.155	4
11	19.30	100.00	S	A	25	1.3	0.622	15
12	19.84	99.46	S	D	-	0.5	0.161	4
12	19.84	99.46	S	A	33	1.8	0.705	17
13	22.02	97.28	S	A	32	2.9	1.167	28
14	23.16	96.14	S	A	58	4.2	1.075	26
14	24.08	95.22	L	A	36	17.6	6.457	155

Rock Type: S = SHALE; L = LIMESTONE; SI = SILTSTONE

Note: Inferred UCS = $I_{s(50)} \times 24$

Table D2: Summary of Point Load Index Strength Testing

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HF1-16A

Run	Depth (m)	Elevation (m)	Rock Type	Type of Break Axial or Diametral	D for Axial Break (mm)	Force (kN)	Is ₍₅₀₎ (N/mm ²)	Inferred UCS (MPa) *
2	5.56	113.74	SI	D	-	12.4	3.656	88
2	5.56	113.74	SI	A	29	14.8	6.414	154
3	6.65	112.65	SI	D	-	15.5	4.552	109
3	6.65	112.65	SI	A	26	12.0	5.661	136
4	8.43	110.87	SI	D	-	18.9	5.553	133
4	8.43	110.87	SI	A	30	15.6	6.600	158
5	10.67	108.63	SI	D	-	6.0	1.769	42
5	10.67	108.63	SI	A	37	13.1	4.706	113
6	11.99	107.31	S	D	-	0.2	0.046	1
6	11.99	107.31	S	A	28	3.0	1.354	32
7	13.56	105.74	S	D	-	0.1	0.034	1
7	13.56	105.74	S	A	23	0.9	0.454	11
8	14.81	104.49	S	D	-	0.1	0.036	1
8	14.81	104.49	S	A	25	3.7	1.789	43
9	15.85	103.45	SI	D	-	29.2	8.567	206
9	15.85	103.45	SI	A	31	24.1	9.939	239
10	18.01	101.29	S	D	-	0.2	0.072	2
10	18.01	101.29	S	A	47	5.6	1.671	40
11	19.28	100.02	S	D	-	0.6	0.178	4
11	19.28	100.02	S	A	28	1.9	0.864	21
12	20.35	98.95	S	D	-	0.9	0.276	7
12	20.35	98.95	S	A	30	4.4	1.850	44
13	22.17	97.13	S	D	-	0.2	0.052	1
13	22.17	97.13	S	A	39	5.1	1.746	42
14	24.00	95.30	L	D	-	18.4	5.400	130
14	24.00	95.30	L	A	25	18.7	9.085	218

Rock Type: S = SHALE; L = LIMESTONE; SI = SILTSTONE

Note: Inferred UCS = Is₍₅₀₎ × 24

Table D2: Summary of Point Load Index Strength Testing

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HF1-17

Run	Depth (m)	Elevation (m)	Rock Type	Type of Break Axial or Diametral	D for Axial Break (mm)	Force (kN)	Is ₍₅₀₎ (N/mm ²)	Inferred UCS (MPa) *
2	4.29	113.91	S	D	-	1.4	0.398	10
2	4.29	113.91	S	A	30	3.1	1.310	31
3	4.95	113.25	SI	D	-	10.0	2.928	70
3	4.95	113.25	SI	A	30	24.4	10.301	247
4	7.06	111.14	SI	D	-	15.8	4.657	112
4	7.06	111.14	SI	A	30	17.5	7.386	177
5	7.90	110.30	S	A	46	3.5	1.049	25
5	8.94	109.26	S	D	-	2.2	0.648	16
6	8.92	109.28	S	A	50	5.7	1.606	39
6	9.60	108.60	SI	A	57	30.8	7.914	190
6	10.26	107.94	S	D	-	0.4	0.127	3
6	10.24	107.96	S	A	55	1.5	0.400	10
7	11.89	106.31	S	D	-	0.2	0.066	2
7	11.89	106.31	S	A	33	2.2	0.864	21
8	12.75	105.45	S	D	-	0.9	0.256	6
8	12.75	105.45	S	A	29	1.1	0.490	12
9	14.07	104.13	S	D	-	0.4	0.122	3
9	14.07	104.13	S	A	39	1.6	0.545	13
10	15.52	102.68	SI	D	-	23.0	6.765	162
10	15.52	102.68	SI	A	27	15.0	6.864	165
10	16.13	102.07	S	D	-	0.8	0.231	6
10	16.08	102.12	S	A	31	2.7	1.104	26
11	17.27	100.93	S	D	-	0.4	0.116	3
11	17.27	100.93	S	A	32	1.5	0.614	15
12	19.81	98.39	S	D	-	0.5	0.143	3
12	19.81	98.39	S	A	27	5.1	2.328	56
13	21.06	97.14	S	D	-	1.7	0.504	12
13	21.08	97.12	S	A	38	2.5	0.886	21
14	22.68	95.52	SI	D	-	23.7	6.954	167
14	22.66	95.54	SI	A	41	22.5	7.473	179
15	23.14	95.06	L	A	66	22.2	5.079	122
15	24.16	94.04	S	D	-	1.1	0.312	7
15	24.16	94.04	S	A	56	2.5	0.639	15

Rock Type: S = SHALE; L = LIMESTONE; SI = SILTSTONE

Note: Inferred UCS = Is₍₅₀₎ x 24

Table D2: Summary of Point Load Index Strength Testing

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HF1-17A

Run	Depth (m)	Elevation (m)	Rock Type	Type of Break Axial or Diametral	D for Axial Break (mm)	Force (kN)	Is ₍₅₀₎ (N/mm ²)	Inferred UCS (MPa) *
2	3.53	106.27	S	D	-	0.2	0.066	2
2	3.53	106.27	S	A	26	1.0	0.487	12
3	5.82	103.98	SI	D	-	11.3	3.327	80
3	6.07	103.73	SI	A	42	27.7	9.019	216
4	6.53	103.27	S	D	-	0.8	0.245	6
4	6.53	103.27	S	A	36	2.2	0.791	19
5	8.63	101.17	S	D	-	0.3	0.101	2
5	8.63	101.17	S	A	37	1.6	0.577	14
6	9.73	100.07	S	D	-	0.2	0.050	1
6	9.73	100.07	S	A	35	2.1	0.781	19
7	11.07	98.73	S	D	-	0.5	0.155	4
7	11.07	98.73	S	A	27	0.9	0.428	10
8	13.18	96.62	S	D	-	0.8	0.223	5
8	13.18	96.62	S	A	51	2.4	0.670	16
9	15.04	94.76	S	D	-	0.2	0.068	2
9	15.04	94.76	S	A	45	5.4	1.673	40
10	16.31	93.49	S	D	-	0.9	0.263	6
10	16.31	93.49	S	A	38	2.0	0.713	17
11	17.12	92.68	S	D	-	0.5	0.150	4
11	17.12	92.68	S	A	52	2.3	0.635	15
12	17.98	91.82	S	D	-	1.2	0.357	9
12	17.98	91.82	S	A	40	1.7	0.562	13
13	20.83	88.97	SI	D	-	8.3	2.427	58
13	20.83	88.97	SI	A	32	15.9	6.383	153
14	21.85	87.95	SI	D	-	27.3	8.022	193
14	21.85	87.95	SI	A	30	18.3	7.733	186
15	23.16	86.64	SI	D	-	4.5	1.332	32
15	23.19	86.61	SI	A	38	3.9	1.368	33

Rock Type: S = SHALE; L = LIMESTONE; SI = SILTSTONE

Note: Inferred UCS = Is₍₅₀₎ × 24

Table D2: Summary of Point Load Index Strength Testing

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HF1-18

Run	Depth (m)	Elevation (m)	Rock Type	Type of Break Axial or Diametral	D for Axial Break (mm)	Force (kN)	$Is_{(50)}$ (N/mm ²)	Inferred UCS (MPa) *
1	5.08	107.82	S	D	-	0.3	0.091	2
1	5.08	107.82	S	A	22	1.4	0.778	19
2	6.10	106.80	S	D	-	0.1	0.030	1
2	6.10	106.80	S	A	24	1.6	0.800	19
3	7.72	105.18	SI	D	-	11.5	3.370	81
3	7.72	105.18	SI	A	25	21.8	10.624	255
4	9.40	103.50	SI	D	-	16.4	4.811	115
4	9.40	103.50	SI	A	32	8.7	3.480	84
5	10.72	102.18	L	D	-	10.0	2.938	71
5	10.72	102.18	L	A	36	26.6	9.756	234
6	12.50	100.40	S	D	-	0.6	0.162	4
6	12.50	100.40	S	A	30	2.5	1.065	26
7	13.79	99.11	S	D	-	0.6	0.170	4
7	13.79	99.11	S	A	23	3.8	1.985	48
8	15.75	97.15	S	D	-	0.2	0.045	1
8	15.75	97.15	S	A	26	2.8	1.327	32
9	16.76	96.14	SI	D	-	22.0	6.461	155
9	16.76	96.14	SI	A	34	16.9	6.493	156
10	17.88	95.02	SI	D	-	20.0	5.885	141
10	17.88	95.02	SI	A	40	14.3	4.840	116
11	19.15	93.75	S	D	-	0.7	0.219	5
11	19.15	93.75	S	A	23	1.7	0.868	21
12	20.12	92.78	SI	D	-	17.2	5.045	121
12	20.12	92.78	SI	A	27	11.1	5.088	122
13	21.67	91.23	S	D	-	2.0	0.585	14
13	21.67	91.23	S	A	40	2.0	0.680	16
14	22.45	90.45	S	D	-	0.3	0.082	2
14	22.45	90.45	S	A	31	3.5	1.431	34

Rock Type: S = SHALE; L = LIMESTONE; SI = SILTSTONE

Note: Inferred UCS = $Is_{(50)} \times 24$

Table D2: Summary of Point Load Index Strength Testing

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HF1-19

Run	Depth (m)	Elevation (m)	Rock Type	Type of Break Axial or Diametral	D for Axial Break (mm)	Force (kN)	Is ₍₅₀₎ (N/mm ²)	Inferred UCS (MPa) *
2	6.32	106.38	S	D	-	0.6	0.185	4
2	6.32	106.38	S	A	34	2.9	1.101	26
3	8.53	104.17	SI	D	-	22.6	6.633	159
3	8.53	104.17	SI	A	25	14.7	7.146	172
4	10.54	102.16	SI	D	-	4.1	1.204	29
4	10.54	102.16	SI	A	29	5.0	2.174	52
5	10.83	101.87	S	D	-	0.4	0.122	3
5	10.92	101.78	S	A	28	1.5	0.683	16
6	13.05	99.65	S	D	-	0.5	0.155	4
6	13.05	99.65	S	A	30	1.4	0.585	14
7	14.91	97.79	S	D	-	0.3	0.094	2
7	14.91	97.79	S	A	33	1.8	0.720	17
8	16.05	96.65	SI	D	-	12.7	3.730	90
8	16.05	96.65	SI	A	32	13.3	5.329	128
9	17.60	95.10	S	D	-	0.5	0.143	3
9	17.60	95.10	S	A	40	2.6	0.882	21
10	18.57	94.13	S	D	-	0.8	0.238	6
10	18.52	94.18	S	A	32	1.9	0.761	18
11	20.73	91.97	S	D	-	0.2	0.065	2
11	20.73	91.97	S	A	38	2.3	0.794	19
12	22.53	90.17	S	D	-	0.2	0.050	1
12	22.53	90.17	S	A	37	3.3	1.177	28

Rock Type: S = SHALE; L = LIMESTONE; SI = SILTSTONE

Note: Inferred UCS = Is₍₅₀₎ × 24

Table D2: Summary of Point Load Index Strength Testing

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HF1-20

Run	Depth (m)	Elevation (m)	Rock Type	Type of Break Axial or Diametral	D for Axial Break (mm)	Force (kN)	Is ₍₅₀₎ (N/mm ²)	Inferred UCS (MPa) *
1	4.06	108.24	S	D	-	0.6	0.176	4
1	4.06	108.24	S	A	35	1.3	0.475	11
2	5.11	107.19	SI	D	-	25.6	7.517	180
2	5.11	107.19	SI	A	31	20.4	8.404	202
3	6.40	105.90	S	D	-	0.2	0.062	1
3	6.40	105.90	S	A	32	1.0	0.419	10
4	9.17	103.13	SI	D	-	9.8	2.873	69
4	9.17	103.13	SI	A	23	18.1	9.387	225
5	9.55	102.75	S	D	-	0.5	0.139	3
5	9.55	102.75	S	A	42	4.2	1.357	33
6	10.87	101.43	S	D	-	0.6	0.170	4
6	10.87	101.43	S	A	28	1.6	0.699	17
7	12.67	99.63	S	D	-	0.1	0.033	1
7	12.67	99.63	S	A	23	1.5	0.768	18
8	15.06	97.24	SI	D	-	13.9	4.099	98
8	15.06	97.24	SI	A	43	16.8	5.361	129
9	16.56	95.74	SI	D	-	12.2	3.599	86
9	16.56	95.74	SI	A	36	24.0	8.788	211
10	17.12	95.18	S	D	-	0.2	0.046	1
10	17.12	95.18	S	A	39	3.6	1.230	30
11	17.88	94.42	SI	D	-	15.7	4.606	111
11	17.88	94.42	SI	A	37	17.5	6.280	151
12	20.63	91.67	S	D	-	0.2	0.066	2
12	20.63	91.67	S	A	27	2.5	1.167	28
13	22.71	89.59	S	D	-	0.1	0.030	1
13	22.71	89.59	S	A	25	3.3	1.601	38

Rock Type: S = SHALE; L = LIMESTONE; SI = SILTSTONE

Note: Inferred UCS = $I_{s(50)} \times 24$

Table D2: Summary of Point Load Index Strength Testing

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HF1-21

Run	Depth (m)	Elevation (m)	Rock Type	Type of Break Axial or Diametral	D for Axial Break (mm)	Force (kN)	Is ₍₅₀₎ (N/mm ²)	Inferred UCS (MPa) *
2	8.38	103.12	S	D	-	0.7	0.192	5
2	8.38	103.12	S	A	30	1.9	0.813	20
3	9.37	102.13	SI	D	-	7.6	2.242	54
3	9.37	102.13	SI	A	28	15.1	6.739	162
4	11.66	99.84	S	D	-	0.8	0.237	6
4	11.66	99.84	S	A	33	2.7	1.072	26
5	12.50	99.00	SI	D	-	9.9	2.907	70
5	12.50	99.00	SI	A	39	14.1	4.860	117
6	14.94	96.56	S	D	-	0.4	0.117	3
6	14.94	96.56	S	A	38	3.2	1.109	27
7	15.22	96.28	SI	D	-	15.3	4.507	108
7	15.22	96.28	SI	A	30	17.3	7.328	176
8	16.21	95.29	SI	D	-	12.6	3.690	89
8	16.21	95.29	SI	A	31	16.7	6.877	165
9	17.91	93.59	S	D	-	0.7	0.211	5
9	17.91	93.59	S	A	24	0.6	0.318	8
10	19.41	92.09	S	D	-	1.2	0.360	9
10	19.41	92.09	S	A	33	1.4	0.543	13
11	19.58	91.92	S	D	-	0.4	0.127	3
11	19.58	91.92	S	A	38	1.8	0.618	15

Rock Type: S = SHALE; L = LIMESTONE; SI = SILTSTONE

Note: Inferred UCS = Is₍₅₀₎ x 24

Table D2: Summary of Point Load Index Strength Testing

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HF1-22

Run	Depth (m)	Elevation (m)	Rock Type	Type of Break Axial or Diametral	D for Axial Break (mm)	Force (kN)	Is ₍₅₀₎ (N/mm ²)	Inferred UCS (MPa) *
1	5.87	104.73	SI	D	-	22.8	6.715	161
1	5.87	104.73	SI	A	35	18.9	7.094	170
2	6.86	103.74	S	D	-	0.1	0.036	1
2	6.86	103.74	S	A	41	3.9	1.305	31
3	8.21	102.39	SI	D	-	28.7	8.424	202
3	8.21	102.39	SI	A	35	22.1	8.285	199
4	9.78	100.82	S	D	-	0.3	0.083	2
4	9.78	100.82	S	A	36	4.8	1.746	42
5	11.81	98.79	S	D	-	0.2	0.060	1
5	11.81	98.79	S	A	29	2.0	0.875	21
6	12.42	98.18	S	D	-	1.0	0.280	7
6	12.42	98.18	S	A	47	4.6	1.379	33
7	14.17	96.43	SI	D	-	22.7	6.685	160
7	14.17	96.43	SI	A	45	24.5	7.563	182
8	16.38	94.22	SI	D	-	9.9	2.916	70
8	16.38	94.22	SI	A	36	13.9	5.100	122
9	17.88	92.72	SI	D	-	9.1	2.669	64
9	17.88	92.72	SI	A	41	13.5	4.490	108
10	18.59	92.01	S	D	-	1.4	0.415	10
10	18.59	92.01	S	A	43	3.4	1.088	26
11	21.26	89.34	L	D	-	8.3	2.445	59
11	21.26	89.34	L	A	30	11.3	4.766	114

Rock Type: S = SHALE; L = LIMESTONE; SI = SILTSTONE

Note: Inferred UCS = Is₍₅₀₎ x 24

Table D2: Summary of Point Load Index Strength Testing

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HF1-23

Run	Depth (m)	Elevation (m)	Rock Type	Type of Break Axial or Diametral	D for Axial Break (mm)	Force (kN)	Is ₍₅₀₎ (N/mm ²)	Inferred UCS (MPa) *
2	6.25	103.35	S	D	-	0.3	0.099	2
2	6.20	103.40	S	A	33	1.4	0.560	13
3	7.37	102.23	SI	D	-	17.8	5.223	125
3	7.37	102.23	SI	A	43	34.2	10.926	262
3	7.44	102.16	S	D	-	1.0	0.292	7
3	7.44	102.16	S	A	24	3.0	1.516	36
4	8.23	101.37	SI	D	-	2.2	0.648	16
4	8.23	101.37	SI	A	42	14.6	4.752	114
5	10.29	99.31	SI	D	-	26.2	7.695	185
5	10.29	99.31	SI	A	30	17.7	7.489	180
6	11.89	97.71	S	D	-	1.0	0.280	7
6	11.89	97.71	S	A	30	5.1	2.146	52
7	12.88	96.72	S	D	-	0.5	0.138	3
7	12.88	96.72	S	A	27	1.9	0.875	21
8	15.04	94.56	S	D	-	0.2	0.058	1
8	15.04	94.56	S	A	28	1.9	0.842	20
9	16.36	93.24	S	D	-	0.7	0.197	5
9	16.36	93.24	S	A	28	1.3	0.594	14
10	17.83	91.77	SI	D	-	14.5	4.270	102
10	17.83	91.77	SI	A	36	14.8	5.440	131
11	19.48	90.12	S	D	-	0.1	0.036	1
11	19.48	90.12	S	A	26	1.1	0.522	13
12	21.03	88.57	S	D	-	0.1	0.029	1
12	21.03	88.57	S	A	23	1.9	0.960	23

Rock Type: S = SHALE; L = LIMESTONE; SI = SILTSTONE

Note: Inferred UCS = Is₍₅₀₎ x 24

Table D2: Summary of Point Load Index Strength Testing

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HF1-24

Run	Depth (m)	Elevation (m)	Rock Type	Type of Break Axial or Diametral	D for Axial Break (mm)	Force (kN)	$Is_{(50)}$ (N/mm ²)	Inferred UCS (MPa) *
1	6.53	101.67	SI	D	-	8.6	2.519	60
1	6.53	101.67	SI	A	23	11.1	5.769	138
2	8.66	99.54	S	D	-	0.3	0.078	2
2	8.66	99.54	S	A	32	2.9	1.148	28
3	9.65	98.55	S	D	-	0.6	0.166	4
3	9.65	98.55	S	A	35	1.5	0.569	14
4	11.13	97.07	S	D	-	0.2	0.057	1
4	11.13	97.07	S	A	30	3.0	1.251	30
5	13.36	94.84	S	D	-	0.3	0.092	2
5	13.36	94.84	S	A	36	4.6	1.680	40
6	14.27	93.93	S	D	-	0.2	0.045	1
6	14.27	93.93	S	A	41	2.6	0.860	21
7	16.18	92.02	SI	D	-	18.2	5.343	128
7	16.18	92.02	SI	A	41	18.8	6.237	150
8	17.91	90.29	SI	D	-	10.0	2.942	71
8	17.91	90.29	SI	A	35	21.0	7.854	189
9	19.71	88.49	SI	D	-	9.1	2.661	64
9	19.71	88.49	SI	A	30	15.9	6.731	162
10	20.19	88.01	S	D	-	0.7	0.215	5
10	20.19	88.01	S	A	37	4.4	1.584	38

Rock Type: S = SHALE; L = LIMESTONE; SI = SILTSTONE

Note: Inferred UCS = $Is_{(50)} \times 24$

Table D2: Summary of Point Load Index Strength Testing

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HF1-25

Run	Depth (m)	Elevation (m)	Rock Type	Type of Break Axial or Diametral	D for Axial Break (mm)	Force (kN)	Is ₍₅₀₎ (N/mm ²)	Inferred UCS (MPa) *
1	5.82	101.88	S	D	-	0.4	0.113	3
1	6.07	101.63	S	A	27	1.3	0.607	15
2	7.11	100.59	S	D	-	1.0	0.289	7
2	7.11	100.59	S	A	32	1.6	0.652	16
3	8.63	99.07	S	D	-	0.2	0.059	1
3	8.63	99.07	S	A	34	2.1	0.817	20
4	9.30	98.40	SI	D	-	14.9	4.386	105
4	9.30	98.40	SI	A	31	19.6	8.067	194
5	11.61	96.09	SI	D	-	18.2	5.341	128
5	11.84	95.86	SI	A	45	19.1	5.894	141
6	13.36	94.34	S	D	-	0.3	0.084	2
6	13.36	94.34	S	A	36	1.6	0.586	14
7	14.23	93.47	S	D	-	0.2	0.045	1
7	14.23	93.47	S	A	35	1.2	0.454	11
8	15.98	91.72	S	D	-	1.4	0.416	10
8	15.98	91.72	S	A	27	1.1	0.508	12
9	17.02	90.68	S	D	-	0.4	0.115	3
9	17.02	90.68	S	A	42	2.3	0.753	18
10	19.23	88.47	S	D	-	0.3	0.083	2
10	19.23	88.47	S	A	41	3.7	1.217	29
11	20.50	87.20	S	D	-	0.3	0.091	2
11	20.50	87.20	S	A	34	3.4	1.301	31
12	21.54	86.16	S	D	-	0.2	0.061	1
12	21.54	86.16	S	A	33	3.0	1.191	29
13	24.08	83.62	S	D	-	1.4	0.424	10
13	24.08	83.62	SI	A	40	4.2	1.431	34
14	25.22	82.48	SI	D	-	4.3	1.263	30
14	25.22	82.48	SI	A	34	11.1	4.252	102

Rock Type: S = SHALE; L = LIMESTONE; SI = SILTSTONE

Note: Inferred UCS = Is₍₅₀₎ × 24

Table D2: Summary of Point Load Index Strength Testing

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HF1-26

Run	Depth (m)	Elevation (m)	Rock Type	Type of Break Axial or Diametral	D for Axial Break (mm)	Force (kN)	$Is_{(50)}$ (N/mm ²)	Inferred UCS (MPa) *
1	5.79	101.11	S	D	-	8.1	2.384	3
1	5.79	101.11	S	A	28	1.8	0.793	19
2	6.55	100.35	S	D	-	0.8	0.233	6
2	6.55	100.35	S	A	32	1.5	0.593	3
3	7.57	99.33	S	D	-	1.5	0.445	11
3	7.57	99.33	S	A	39	4.5	1.554	37
4	8.46	98.44	S	D	-	0.2	0.063	4
4	8.46	98.44	S	A	38	1.9	0.651	16
5	9.98	96.92	SI	D	-	8.1	2.375	57
5	9.98	96.92	SI	A	32	16.0	6.411	154
6	11.48	95.42	S	D	-	0.3	0.083	2
6	11.48	95.42	S	A	36	1.6	0.578	14
7	13.26	93.64	S	D	-	1.1	0.312	7
7	13.26	93.64	S	A	45	4.2	1.305	31
8	15.11	91.79	S	D	-	1.2	0.346	8
8	15.11	91.79	S	A	33	3.3	1.276	31
9	16.66	90.24	L	D	-	9.6	2.826	68
9	16.66	90.24	L	A	34	13.0	4.969	119
10	18.11	88.79	S	D	-	2.0	0.601	14
10	18.11	88.79	S	A	30	3.6	1.526	37
11	18.90	88.00	S	D	-	0.6	0.165	4
11	18.90	88.00	S	A	43	4.0	1.280	31
12	21.28	85.62	S	D	-	1.2	0.347	8
12	21.28	85.62	S	A	34	2.0	0.752	18
13	22.20	84.70	SI	D	-	8.8	2.588	62
13	22.20	84.70	SI	A	42	14.2	4.635	111
14	23.90	83.00	S	D	-	1.1	0.313	8
14	23.90	83.00	S	A	28	0.5	0.240	6

Rock Type: S = SHALE; L = LIMESTONE; SI = SILTSTONE

Note: Inferred UCS = $Is_{(50)} \times 24$

Table D2: Summary of Point Load Index Strength Testing

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HF1-27

Run	Depth (m)	Elevation (m)	Rock Type	Type of Break Axial or Diametral	D for Axial Break (mm)	Force (kN)	Is ₍₅₀₎ (N/mm ²)	Inferred UCS (MPa) *
1	4.55	100.55	SI	D	-	14.5	4.262	102
1	4.55	100.55	SI	A	28	17.7	7.883	189
2	5.31	99.79	S	D	-	0.3	0.091	2
2	5.31	99.79	S	A	37	1.4	0.503	12
3	6.53	98.57	S	D	-	0.5	0.138	3
3	6.53	98.57	S	A	30	1.6	0.656	16
4	8.84	96.26	L	D	-	11.5	3.387	81
4	8.84	96.26	L	A	28	15.1	6.747	162
5	11.07	94.03	S	D	-	1.3	0.369	9
5	11.07	94.03	S	A	25	1.2	0.573	14
6	11.58	93.52	S	D	-	1.7	0.512	12
6	11.58	93.52	S	A	29	1.0	0.422	10
7	13.01	92.09	S	D	-	2.1	0.605	15
7	13.01	92.09	S	A	26	0.8	0.400	10
8	14.30	90.80	L	D	-	15.1	4.449	107
8	14.30	90.80	L	A	39	26.3	9.051	217
9	15.80	89.30	SI	D	-	8.8	2.589	62
9	15.80	89.30	SI	A	26	17.2	8.140	195
10	17.20	87.90	S	D	-	0.4	0.106	3
10	17.20	87.90	S	A	24	0.8	0.424	10
11	18.90	86.20	S	D	-	0.7	0.211	5
11	18.90	86.20	S	A	37	2.0	0.702	17
12	21.16	83.94	SI	D	-	5.4	1.585	38
12	21.16	83.94	SI	A	30	14.0	5.897	142
13	21.92	83.18	L	D	-	13.1	3.851	92
13	21.92	83.18	L	A	23	10.5	5.473	131

Rock Type: S = SHALE; L = LIMESTONE; SI = SILTSTONE

Note: Inferred UCS = Is₍₅₀₎ × 24

Table D2: Summary of Point Load Index Strength Testing

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HF1-28

Run	Depth (m)	Elevation (m)	Rock Type	Type of Break Axial or Diametral	D for Axial Break (mm)	Force (kN)	Is ₍₅₀₎ (N/mm ²)	Inferred UCS (MPa) *
1	6.04	97.46	S	D	-	0.5	0.158	4
1	6.04	97.46	S	A	41	2.6	0.869	21
2	7.11	96.39	S	D	-	0.7	0.199	5
2	7.11	96.39	S	A	33	4.7	1.850	44
3	8.63	94.87	S	D	-	0.1	0.039	1
3	8.63	94.87	S	A	24	1.5	0.770	18
4	9.65	93.85	S	D	-	0.0	0.005	0
4	9.65	93.85	S	A	30	1.4	0.575	14
5	11.66	91.84	S	D	-	0.6	0.177	4
5	11.66	91.84	S	A	29	1.6	0.701	17
6	12.95	90.55	S	D	-	0.1	0.030	1
6	12.95	90.55	S	A	24	1.1	0.531	13
7	14.91	88.59	L	D	-	14.0	4.126	99
7	14.91	88.59	L	A	42	33.5	10.917	262
8	16.46	87.04	S	D	-	0.7	0.192	5
8	16.46	87.04	S	A	39	1.6	0.553	13
10	17.58	85.92	SI	D	-	6.4	1.887	45
10	17.58	85.92	SI	A	45	9.1	2.821	68
11	18.87	84.63	S	D	-	0.1	0.029	1
11	18.87	84.63	S	A	31	1.4	0.580	14
12	21.34	82.16	SI	D	-	9.1	2.678	64
12	21.34	82.16	SI	A	35	19.6	7.336	176

Rock Type: S = SHALE; L = LIMESTONE; SI = SILTSTONE

Note: Inferred UCS = Is₍₅₀₎ x 24

Table D2: Summary of Point Load Index Strength Testing

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HF1-29

Run	Depth (m)	Elevation (m)	Rock Type	Type of Break Axial or Diametral	D for Axial Break (mm)	Force (kN)	$Is_{(50)}$ (N/mm ²)	Inferred UCS (MPa) *
1	10.52	88.98	SI	D	-	17.7	5.190	125
1	10.52	88.98	SI	A	31	9.2	3.772	91
2	11.23	88.27	L	D	-	7.7	2.255	54
2	11.23	88.27	L	A	32	15.6	6.252	150
3	13.03	86.47	S	D	-	2.3	0.671	16
3	13.03	86.47	S	A	31	1.2	0.487	12
4	14.86	84.64	S	D	-	0.5	0.148	4
4	14.86	84.64	S	A	35	1.3	0.484	12
5	15.75	83.75	S	D	-	1.8	0.538	13
5	15.75	83.75	S	A	49	1.9	0.536	13
6	17.75	81.75	SI	D	-	12.0	3.516	84
6	17.75	81.75	SI	A	32	16.7	6.696	161
7	19.71	79.79	S	D	-	1.3	0.371	9
7	19.71	79.79	S	A	29	1.2	0.511	12
8	20.37	79.13	SI	D	-	6.8	2.000	48
8	20.37	79.13	SI	A	33	3.4	1.340	32
9	20.73	78.77	S	D	-	0.8	0.223	5
9	20.73	78.77	S	A	24	1.5	0.746	18
10	23.14	76.36	S	D	-	0.8	0.233	6
10	23.14	76.36	L	A	30	13.1	5.519	132

Rock Type: S = SHALE; L = LIMESTONE; SI = SILTSTONE

Note: Inferred UCS = $Is_{(50)} \times 24$

Table D2: Summary of Point Load Index Strength Testing

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HF1-30

Run	Depth (m)	Elevation (m)	Rock Type	Type of Break Axial or Diametral	D for Axial Break (mm)	Force (kN)	Is ₍₅₀₎ (N/mm ²)	Inferred UCS (MPa) *
1	13.03	86.47	S	D	-	0.1	0.039	1
1	13.03	86.47	S	A	34	2.1	0.814	20
2	14.91	84.59	SI	D	-	7.9	2.331	56
2	14.91	84.59	SI	A	26	12.1	5.730	138
3	16.66	82.84	S	D	-	0.3	0.086	2
3	16.66	82.84	S	A	34	2.8	1.079	26
4	18.08	81.42	SI	D	-	17.8	5.229	126
4	18.08	81.42	SI	A	35	15.3	5.738	138
5	19.10	80.40	SI	D	-	5.8	1.703	41
5	19.10	80.40	SI	A	32	17.3	6.970	167
6	20.98	78.52	S	D	-	0.3	0.082	2
6	20.98	78.52	S	A	24	2.5	1.266	30
7	21.67	77.83	S	D	-	0.1	0.039	1
7	21.67	77.83	S	A	26	2.4	1.118	27

Rock Type: S = SHALE; L = LIMESTONE; SI = SILTSTONE

Note: Inferred UCS = Is₍₅₀₎ x 24

Table D2: Summary of Point Load Index Strength Testing

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HF1-31

Run	Depth (m)	Elevation (m)	Rock Type	Type of Break Axial or Diametral	D for Axial Break (mm)	Force (kN)	Is ₍₅₀₎ (N/mm ²)	Inferred UCS (MPa) *
1	12.60	87.00	S	D	-	0.2	0.058	1
1	12.60	87.00	S	A	30	2.5	1.042	25
2	15.95	83.65	S	D	-	0.1	0.040	1
2	15.95	83.65	S	A	21	2.1	1.167	28
3	17.43	82.17	S	D	-	2.5	0.744	18
3	17.43	82.17	S	A	35	1.4	0.512	12
4	19.13	80.47	SI	D	-	20.8	6.099	146
4	19.13	80.47	SI	A	27	18.3	8.407	202
5	20.47	79.13	S	D	-	0.9	0.255	6
5	20.47	79.13	S	A	29	1.2	0.525	13
6	22.76	76.84	S	D	-	1.6	0.463	11
6	22.76	76.84	S	A	44	2.9	0.910	22

Rock Type: S = SHALE; L = LIMESTONE; SI = SILTSTONE

Note: Inferred UCS = Is₍₅₀₎ x 24

Table D2: Summary of Point Load Index Strength Testing

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HF1-32

Run	Depth (m)	Elevation (m)	Rock Type	Type of Break Axial or Diametral	D for Axial Break (mm)	Force (kN)	$Is_{(50)}$ (N/mm ²)	Inferred UCS (MPa) *
1	11.76	85.04	S	D	-	0.1	0.029	1
1	11.76	85.04	S	A	22	1.7	0.921	22
2	13.39	83.41	S	D	-	1.4	0.410	10
2	13.39	83.41	S	A	31	2.4	0.993	24
3	14.33	82.47	S	D	-	3.3	0.966	23
3	14.33	82.47	S	A	29	2.4	1.026	25
4	15.67	81.13	L	D	-	20.9	6.138	147
4	15.67	81.13	L	A	32	20.4	8.181	196
5	17.12	79.68	S	D	-	0.5	0.151	4
5	17.12	79.68	S	A	28	1.2	0.539	13
6	19.28	77.52	S	D	-	1.7	0.486	12
6	19.28	77.52	S	A	25	3.6	1.748	42
7	20.42	76.38	S	D	-	0.1	0.019	0
7	20.42	76.38	S	A	34	2.8	1.060	25
8	21.59	75.21	S	D	-	0.8	0.226	5
8	21.59	75.21	S	A	30	2.1	0.880	21
9	23.83	72.97	SI	D	-	11.7	3.432	82
9	23.83	72.97	SI	A	35	19.1	7.153	172
10	24.89	71.91	S	D	-	1.5	0.443	11
10	24.89	71.91	S	A	28	1.5	0.671	16

Rock Type: S = SHALE; L = LIMESTONE; SI = SILTSTONE

Note: Inferred UCS = $Is_{(50)} \times 24$

Table D2: Summary of Point Load Index Strength Testing

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HF1-33

Run	Depth (m)	Elevation (m)	Rock Type	Type of Break Axial or Diametral	D for Axial Break (mm)	Force (kN)	Is ₍₅₀₎ (N/mm ²)	Inferred UCS (MPa) *
1	9.07	83.73	S	D	-	0.1	0.036	1
1	9.07	83.73	S	A	32	1.5	0.587	14
2	10.39	82.41	S	D	-	0.1	0.029	1
2	10.39	82.41	S	A	25	1.1	0.540	13
3	12.47	80.33	S	D	-	0.8	0.240	6
3	12.47	80.33	S	A	26	1.9	0.894	21
4	13.21	79.59	SI	D	-	21.1	6.202	149
4	13.21	79.59	SI	A	27	17.8	8.149	196
5	14.61	78.19	SI	D	-	15.3	4.509	108
5	14.61	78.19	SI	A	28	16.0	7.119	171
6	15.98	76.82	S	D	-	0.6	0.179	4
6	15.98	76.82	S	A	33	1.8	0.714	17
7	18.29	74.51	SI	D	-	10.9	3.213	77
7	18.29	74.51	SI	A	32	6.8	2.714	65
8	19.20	73.60	SI	D	-	6.4	1.889	45
8	19.20	73.60	SI	A	22	3.5	1.867	45
9	20.85	71.95	SI	D	-	3.9	1.159	28
9	20.85	71.95	SI	A	30	9.3	3.944	95
10	22.58	70.22	SI	D	-	4.1	1.217	29
10	22.61	70.19	S	A	29	2.4	1.058	25
11	23.52	69.28	SI	D	-	9.9	2.906	70
11	23.52	69.28	SI	A	37	22.0	7.907	190
12	25.37	67.43	SI	D	-	24.1	7.076	170
12	25.37	67.43	SI	A	30	22.1	9.346	224

Rock Type: S = SHALE; L = LIMESTONE; SI = SILTSTONE

Note: Inferred UCS = Is₍₅₀₎ x 24

Table D2: Summary of Point Load Index Strength Testing

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HF1-34

Run	Depth (m)	Elevation (m)	Rock Type	Type of Break Axial or Diametral	D for Axial Break (mm)	Force (kN)	Is ₍₅₀₎ (N/mm ²)	Inferred UCS (MPa) *
2	8.53	81.87	S	D	-	0.3	0.096	2
2	8.53	81.87	S	A	41	1.6	0.532	13
3	9.73	80.67	SI	D	-	7.4	2.183	52
3	9.73	80.67	SI	A	31	3.1	1.274	31
4	11.53	78.87	S	D	-	0.4	0.117	3
4	11.53	78.87	S	A	28	0.6	0.281	7
5	12.73	77.67	S	D	-	0.2	0.071	2
5	12.73	77.67	S	A	33	1.1	0.419	10
6	13.13	77.27	S	D	-	0.5	0.141	3
6	13.13	77.27	S	A	40	1.2	0.392	9
7	16.25	74.15	SI	D	-	5.4	1.581	38
7	16.25	74.15	SI	A	22	5.4	2.909	70
8	17.88	72.52	SI	D	-	8.1	2.381	57
8	17.88	72.52	SI	A	30	8.4	3.547	85
9	18.85	71.55	S	D	-	1.5	0.437	10
9	18.85	71.55	S	A	23	1.0	0.522	13
10	20.50	69.90	S	D	-	0.4	0.130	3
10	20.50	69.90	S	A	30	2.3	0.990	24
11	22.25	68.15	SI	D	-	15.4	4.523	109
11	22.25	68.15	SI	A	36	6.5	2.369	57
12	23.37	67.03	S	D	-	1.1	0.319	8
12	23.37	67.03	S	A	36	0.9	0.341	8

Rock Type: S = SHALE; L = LIMESTONE; SI = SILTSTONE

Note: Inferred UCS = Is₍₅₀₎ x 24

Table D2: Summary of Point Load Index Strength Testing

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HF1-35

Run	Depth (m)	Elevation (m)	Rock Type	Type of Break Axial or Diametral	D for Axial Break (mm)	Force (kN)	Is ₍₅₀₎ (N/mm ²)	Inferred UCS (MPa) *
2	2.69	80.31	S	D	-	0.8	0.227	5
2	2.69	80.31	S	A	39	1.2	0.421	10
3	4.37	78.63	SI	D	-	34.0	9.978	239
3	4.37	78.63	SI	A	48	28.7	8.427	202
4	5.18	77.82	S	D	-	2.8	0.811	19
4	5.18	77.82	S	A	47	1.6	0.480	12
5	7.26	75.74	S	D	-	1.1	0.311	7
5	7.26	75.74	S	A	32	0.8	0.314	8
6	8.08	74.92	SI	D	-	10.7	3.159	76
6	8.08	74.92	SI	A	22	2.2	1.172	28
7	9.20	73.80	SI	D	-	9.8	2.894	69
7	9.20	73.80	SI	A	33	28.5	11.194	269
8	11.28	71.72	SI	D	-	11.9	3.508	84
8	11.28	71.72	SI	A	40	16.2	5.486	132
9	11.94	71.06	SI	D	-	9.0	2.647	64
9	11.94	71.06	SI	A	33	2.3	0.916	22
10	12.78	70.22	S	D	-	0.5	0.148	4
10	12.78	70.22	S	A	32	1.2	0.483	12
11	14.53	68.47	SI	D	-	8.8	2.576	62
11	14.53	68.47	SI	A	29	7.9	3.413	82
12	16.36	66.64	SI	D	-	15.7	4.628	111
12	16.36	66.64	SI	A	37	15.5	5.580	134
13	17.53	65.47	SI	D	-	4.9	1.450	35
13	17.53	65.47	SI	A	38	4.9	1.726	41
14	19.03	63.97	SI	D	-	11.1	3.261	78
14	19.03	63.97	SI	A	37	3.5	1.274	31

Rock Type: S = SHALE; L = LIMESTONE; SI = SILTSTONE

Note: Inferred UCS = Is₍₅₀₎ x 24

Table D2: Summary of Point Load Index Strength Testing

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HF1-35A

Run	Depth (m)	Elevation (m)	Rock Type	Type of Break Axial or Diametral	D for Axial Break (mm)	Force (kN)	Is ₍₅₀₎ (N/mm ²)	Inferred UCS (MPa) *
2	4.11	78.69	S	D	-	1.3	0.394	9
2	4.11	78.69	SI	A	30	13.2	5.565	134
2	4.19	78.61	L	D	-	8.5	2.512	60
2	4.19	78.61	L	A	40	26.4	8.913	214
3	5.56	77.24	S	D	-	1.0	0.284	7
3	5.56	77.24	S	A	39	1.9	0.664	16
4	7.24	75.56	S	D	-	0.3	0.078	2
4	7.24	75.56	S	A	31	1.8	0.727	17
5	8.69	74.11	S	A	37	1.1	0.389	9
6	10.31	72.49	S	D	-	0.4	0.125	3
6	10.31	72.49	S	A	40	3.5	1.178	28
7	11.89	70.91	SI	D	-	5.2	1.540	37
7	11.89	70.91	SI	A	39	5.8	2.007	48
8	12.95	69.85	S	D	-	2.6	0.759	18
8	12.95	69.85	S	A	43	2.4	0.763	18
9	15.42	67.38	SI	D	-	17.1	5.024	121
9	15.42	67.38	SI	A	36	11.7	4.308	103
10	16.46	66.34	S	D	-	2.6	0.752	18
10	16.46	66.34	S	A	41	1.6	0.519	12
11	17.63	65.17	SI	D	-	5.3	1.555	37
11	17.63	65.17	SI	A	41	7.2	2.402	58
12	18.95	63.85	SI	D	-	7.6	2.236	54
12	18.95	63.85	SI	A	36	3.9	1.414	34
12	18.95	63.85	SI	A	36	3.3	1.214	29

Rock Type: S = SHALE; L = LIMESTONE; SI = SILTSTONE

Note: Inferred UCS = Is₍₅₀₎ x 24

Table D2: Summary of Point Load Index Strength Testing

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HF1-36

Run	Depth (m)	Elevation (m)	Rock Type	Type of Break Axial or Diametral	D for Axial Break (mm)	Force (kN)	Is ₍₅₀₎ (N/mm ²)	Inferred UCS (MPa) *
1	4.67	81.83	SI	D	-	7.1	2.100	50
1	4.67	81.83	SI	A	29	9.1	3.960	95
2	5.56	80.94	S	D	-	1.1	0.314	8
2	5.56	80.94	S	A	38	1.1	0.392	9
3	6.76	79.74	L	D	-	9.4	2.777	67
3	6.76	79.74	L	A	35	8.0	2.987	72
4	8.69	77.81	SI	D	-	12.3	3.625	87
4	8.69	77.81	SI	A	51	31.9	8.945	215
5	9.78	76.72	S	D	-	0.5	0.140	3
5	9.78	76.72	S	A	31	1.3	0.534	13
6	11.89	74.61	S	D	-	0.2	0.065	2
6	11.89	74.61	S	A	25	0.8	0.382	9
7	13.44	73.06	SI	D	-	17.4	5.108	123
7	13.44	73.06	SI	A	28	11.8	5.277	127
8	14.81	71.69	S	D	-	2.5	0.730	18
8	14.81	71.69	S	A	21	4.4	2.432	58
9	15.85	70.65	S	D	-	1.4	0.403	10
9	15.85	70.65	S	A	23	3.0	1.570	38
10	17.81	68.69	SI	D	-	4.4	1.283	31
10	17.81	68.69	S	A	24	3.2	1.585	38
11	19.38	67.12	S	D	-	2.5	0.729	18
11	19.38	67.12	S	A	29	5.8	2.527	61
12	20.65	65.85	L	D	-	18.9	5.540	133
12	20.65	65.85	L	A	41	2.5	0.842	20
13	21.89	64.61	S	D	-	0.1	0.024	1
13	21.89	64.61	S	A	29	5.5	2.385	57

Rock Type: S = SHALE; L = LIMESTONE; SI = SILTSTONE

Note: Inferred UCS = Is₍₅₀₎ x 24

Table D2: Summary of Point Load Index Strength Testing

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HF1-37

Run	Depth (m)	Elevation (m)	Rock Type	Type of Break Axial or Diametral	D for Axial Break (mm)	Force (kN)	Is ₍₅₀₎ (N/mm ²)	Inferred UCS (MPa) *
2	5.18	80.02	SI	D	-	12	3.390	81
2	5.18	80.02	SI	A	24	8	3.911	94
3	7.32	77.88	SI	D	-	24	7.160	172
3	7.32	77.88	SI	A	29	19	8.135	195
4	8.03	77.17	S	D	-	0	0.060	1
4	8.03	77.17	S	A	31	2	0.922	22
5	9.83	75.37	S	D	-	0	0.037	1
5	9.83	75.37	S	A	27	2	1.008	24
6	11.66	73.54	S	D	-	0	0.060	1
6	11.66	73.54	S	A	21	1	0.653	16
7	13.44	71.76	L	D	-	19	5.589	134
7	13.44	71.76	L	A	28	13	5.968	143
8	14.45	70.75	L	D	-	14	4.163	100
8	14.45	70.75	L	A	32	17	6.670	160
9	16.08	69.12	SI	D	-	10	2.812	67
9	16.08	69.12	SI	A	32	10	4.067	98
10	17.12	68.08	S	D	-	1	0.183	4
10	17.12	68.08	S	A	29	3	1.185	28
11	19.30	65.90	SI	D	-	4	1.135	27
11	19.30	65.90	SI	A	33	17	6.768	162
12	20.80	64.40	S	D	-	0	0.109	3
12	20.80	85.20	S	A	50	4	1.055	25

Rock Type: S = SHALE; L = LIMESTONE; SI = SILTSTONE

Note: Inferred UCS = Is₍₅₀₎ x 24

Table D2: Summary of Point Load Index Strength Testing

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HF1-38

Run	Depth (m)	Elevation (m)	Rock Type	Type of Break Axial or Diametral	D for Axial Break (mm)	Force (kN)	$Is_{(50)}$ (N/mm ²)	Inferred UCS (MPa) *
1	6.12	78.08	L	D	-	25.0	7.340	176
1	6.12	78.08	L	A	32	22.0	8.851	212
2	7.52	76.68	SI	D	-	11.7	3.442	83
2	7.52	76.68	SI	A	39	14.7	5.060	121
3	8.31	75.89	S	D	-	0.2	0.069	2
3	8.31	75.89	S	A	26	0.9	0.429	10
4	10.64	73.56	S	D	-	0.3	0.102	2
4	10.64	73.56	S	A	40	4.4	1.488	36
5	11.96	72.24	SI	D	-	11.2	3.281	79
5	11.96	72.24	L	D	-	11.3	3.335	80
5	11.96	72.24	L	A	37	17.7	6.368	153
6	13.18	71.02	L	D	-	19.7	5.777	139
6	13.18	71.02	L	A	34	14.1	5.415	130
7	14.53	69.67	SI	D	-	6.5	1.896	46
7	14.53	69.67	SI	A	47	4.3	1.276	31
8	16.38	67.82	S	D	-	1.7	0.485	12
8	16.38	67.82	S	A	52	2.2	0.599	14
9	17.93	66.27	SI	D	-	7.0	2.046	49
9	17.93	66.27	SI	A	41	19.6	6.498	156

Rock Type: S = SHALE; L = LIMESTONE; SI = SILTSTONE

Note: Inferred UCS = $Is_{(50)} \times 24$

Table D2: Summary of Point Load Index Strength Testing

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HF1-39

Run	Depth (m)	Elevation (m)	Rock Type	Type of Break Axial or Diametral	D for Axial Break (mm)	Force (kN)	$I_{s(50)}$ (N/mm ²)	Inferred UCS (MPa) *
1	5.16	78.74	S	D		0.7	0.209	5
1	5.16	78.74	S	A	30	2.0	0.846	20
2	7.24	76.66	L	D		7.5	2.197	53
2	7.24	76.66	L	A	36	19.9	7.288	175
3	7.26	76.64	SI	D		14.0	4.113	99
3	7.26	76.64	SI	A	33	26.3	10.306	247
4	9.04	74.86	S	D		0.3	0.080	2
4	9.04	74.86	SI	A	26	7.3	3.463	83
5	9.91	73.99	S	D		0.1	0.040	1
5	9.91	73.99	S	A	30	1.9	0.812	19
6	12.12	71.78	SI	A	38	18.2	6.402	154
6	12.12	71.78	SI	D		4.3	1.273	31
6	12.14	71.76	SI	A	35	15.9	5.967	143
7	13.66	70.24	SI	D		8.6	2.518	60
7	13.66	70.24	SI	A	43	14.5	4.638	111
8	14.25	69.65	L	D		10.8	3.184	76
8	14.25	69.65	L	A	35	18.2	6.804	163
9	16.33	67.57	S	D		0.2	0.058	1
9	16.33	67.57	S	A	34	2.1	0.807	19
10	17.73	66.17	S	D		1.9	0.548	13
10	17.73	66.17	S	A	43	1.8	0.560	13
10	17.47	66.43	SI	D		16.3	4.796	115
10	17.47	66.43	SI	A	35	11.2	4.182	100
11	19.38	64.52	L	D		9.3	2.740	66
11	19.38	64.52	L	A	36	20.1	7.362	177
12	20.78	63.12	S	D		0.1	0.021	1
12	20.78	63.12	S	A	38	3.6	1.261	30

Rock Type: S = SHALE; L = LIMESTONE; SI = SILTSTONE

Note: Inferred UCS = $I_{s(50)} \times 24$

Table D2: Summary of Point Load Index Strength Testing

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HF1-40

Run	Depth (m)	Elevation (m)	Rock Type	Type of Break Axial or Diametral	D for Axial Break (mm)	Force (kN)	Is ₍₅₀₎ (N/mm ²)	Inferred UCS (MPa) *
1	4.78	79.62	S	D		0.9	0.257	6
1	4.78	79.62	S	A	39	4.4	1.534	37
2	6.48	77.92	S	D		0.6	0.183	4
2	6.48	77.92	S	A	37	0.2	0.088	2
3	7.16	77.24	SI	D		15.1	4.447	107
3	7.16	77.24	SI	A	47	26.7	7.977	191
4	8.36	76.04	SI	D		9.4	2.763	66
4	8.36	76.04	SI	A	26	15.1	7.115	171
5	9.96	74.44	L	D		14.4	4.218	101
5	9.96	74.44	L	A	43	14.0	4.482	108
6	12.06	72.34	S	D		0.1	0.037	1
6	12.06	72.34	S	A	30	2.2	0.923	22
7	13.34	71.07	S	D		0.2	0.046	1
7	13.34	71.07	S	A	38	2.9	1.029	25
8	14.40	70.00	L	D		9.2	2.698	65
8	14.40	70.00	L	A	45	20.0	6.173	148
9	15.98	68.42	SI	D		30.9	9.090	218
9	15.98	68.42	SI	A	36	22.1	8.110	195
10	17.78	66.62	S	D		2.2	0.650	16
10	17.78	66.62	S	A	40	1.5	0.506	12
11	18.92	65.48	SI	D		8.2	2.422	58
11	18.92	65.48	SI	A	36	15.8	5.799	139
12	20.83	63.57	S	D		1.1	0.311	7
12	20.83	63.57	S	A	37	5.4	1.950	47

Rock Type: S = SHALE; L = LIMESTONE; SI = SILTSTONE

Note: Inferred UCS = Is₍₅₀₎ x 24

Table D2: Summary of Point Load Index Strength Testing

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HF1-41

Run	Depth (m)	Elevation (m)	Rock Type	Type of Break Axial or Diametral	D for Axial Break (mm)	Force (kN)	Is ₍₅₀₎ (N/mm ²)	Inferred UCS (MPa) *
1	4.37	80.33	SI	D		3.0	0.892	21
1	4.37	80.33	SI	A	22	8.1	4.364	105
2	5.49	79.21	S	D		0.9	0.251	6
2	5.49	79.21	S	A	32	1.7	0.695	17
3	7.52	77.18	SI	D		19.0	5.585	134
3	7.52	77.18	SI	A	39	21.2	7.316	176
4	8.63	76.07	S	D		0.5	0.153	4
4	8.63	76.07	S	A	35	1.4	0.530	13
5	10.16	74.54	SI	D		8.2	2.420	58
5	10.16	74.54	SI	A	31	14.6	6.014	144
6	11.91	72.79	S	D		0.1	0.027	1
6	11.91	72.79	S	A	27	1.6	0.751	18
7	12.19	72.51	S	D		0.5	0.139	3
7	12.19	72.51	S	A	34	1.8	0.698	17
8	13.41	71.29	SI	D		18.9	5.541	133
8	13.41	71.29	SI	A	41	7.1	2.363	57
9	15.90	68.80	L	D		7.7	2.267	54
9	15.87	68.83	L	D		18.1	5.326	128
9	15.87	68.83	L	A	50	14.9	4.227	101
10	17.98	66.72	S	D		0.4	0.115	3
10	17.98	66.72	S	A	42	2.1	0.667	16
11	18.95	65.75	SI	D		18.0	5.283	127
11	18.95	65.75	SI	A	44	9.0	2.818	68
12	20.70	64.00	SI	D		12.3	3.616	87
12	20.70	64.00	SI	A	40	24.5	8.272	199

Rock Type: S = SHALE; L = LIMESTONE; SI = SILTSTONE

Note: Inferred UCS = $I_{s(50)} \times 24$

Table D2: Summary of Point Load Index Strength Testing

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HF1-42

Run	Depth (m)	Elevation (m)	Rock Type	Type of Break Axial or Diametral	D for Axial Break (mm)	Force (kN)	Is ₍₅₀₎ (N/mm ²)	Inferred UCS (MPa) *
1	4.67	79.63	SI	D		10.4	3.044	73
1	4.67	79.63	SI	A	28	14.4	6.439	155
2	5.51	78.79	S	D		1.9	0.560	13
2	5.51	78.79	S	A	26	4.2	1.997	48
3	7.19	77.11	SI	D		6.3	1.858	45
3	7.19	77.11	SI	A	30	12.1	5.097	122
4	8.48	75.82	L	D		7.4	2.186	52
4	8.48	75.82	L	A	37	15.3	5.497	132
5	10.26	74.04	SI	D		1.3	0.394	9
5	10.26	74.04	SI	A	27	3.0	1.380	33
6	11.33	72.97	S	D		0.8	0.224	5
6	11.33	72.97	S	A	37	3.1	1.128	27
7	13.18	71.12	S	D		0.5	0.138	3
7	13.18	71.12	S	A	27	3.1	1.438	35
8	14.43	69.87	SI	D		6.0	1.753	42
8	14.43	69.87	S	A	32	3.8	1.541	37
8	14.43	69.87	S	A	47	3.5	1.048	25
8	14.43	69.87	S	A	32	4.6	1.844	44
9	15.93	68.37	L	D		12.2	3.591	86
9	15.93	68.37	L	A	38	14.9	5.230	126
10	17.78	66.52	S	D		0.6	0.185	4
10	17.78	66.52	S	A	30	2.7	1.123	27
11	18.95	65.35	SI	D		4.5	1.333	32
11	18.95	65.35	SI	A	34	3.1	1.172	28
12	20.80	63.50	L	D		13.8	4.065	98
12	20.80	63.50	L	A	27	12.6	5.763	138

Rock Type: S = SHALE; L = LIMESTONE; SI = SILTSTONE

Note: Inferred UCS = Is₍₅₀₎ x 24

Table D2: Summary of Point Load Index Strength Testing

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HF1-43

Run	Depth (m)	Elevation (m)	Rock Type	Type of Break Axial or Diametral	D for Axial Break (mm)	Force (kN)	Is ₍₅₀₎ (N/mm ²)	Inferred UCS (MPa) *
1	5.74	78.96	S	D		0.8	0.226	5
1	5.74	78.96	S	A	56	0.1	0.014	0
2	7.26	77.44	S	D		1.6	0.474	11
2	7.26	77.44	S	A	34	1.3	0.508	12
3	8.74	75.96	SI	D		8.2	2.411	58
3	8.74	75.96	SI	A	31	15.2	6.257	150
4	9.63	75.07	S	D		1.4	0.414	10
4	9.63	75.07	S	A	41	3.6	1.204	29
5	11.45	73.25	S	D		0.7	0.193	5
5	11.45	73.25	S	A	35	1.4	0.507	12
6	13.49	71.21	S	D		0.3	0.096	2
6	13.49	71.21	S	A	42	1.5	0.481	12
7	14.88	69.82	S	D		0.6	0.184	4
7	14.88	69.82	S	A	39	1.6	0.535	13
8	16.66	68.04	SI	D		4.3	1.263	30
8	16.66	68.04	SI	A	37	11.8	4.221	101
9	17.40	67.30	SI	D		8.5	2.501	60
9	17.40	67.30	SI	A	33	16.3	6.378	153
10	19.64	65.06	S	D		1.9	0.558	13
10	19.64	65.06	S	A	35	4.4	1.646	40
11	20.63	64.07	S	D		0.1	0.028	1
11	20.63	64.07	S	A	43	4.7	1.511	36

Rock Type: S = SHALE; L = LIMESTONE; SI = SILTSTONE

Note: Inferred UCS = Is₍₅₀₎ x 24

Table D2: Summary of Point Load Index Strength Testing

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HF1-44

Run	Depth (m)	Elevation (m)	Rock Type	Type of Break Axial or Diametral	D for Axial Break (mm)	Force (kN)	Is ₍₅₀₎ (N/mm ²)	Inferred UCS (MPa) *
1	4.50	80.70	SI	D		9.9	2.903	70
1	4.50	80.70	SI	A	40	19.3	6.520	156
2	5.49	79.71	S	D		0.3	0.098	2
2	5.49	79.71	S	A	23	1.3	0.687	16
2	5.49	79.71	SI	A	25	2.6	1.252	30
3	7.01	78.19	S	D		0.4	0.119	3
3	7.01	78.19	S	A	45	5.3	1.641	39
3	7.01	78.19	S	A	30	3.4	1.421	34
4	8.38	76.82	S	D		0.0	0.009	0
4	8.41	76.79	S	A	31	2.7	1.119	27
5	9.96	75.24	SI	D		6.9	2.016	48
5	9.96	75.24	SI	A	35	15.5	5.799	139
6	12.12	73.08	S	D		0.2	0.052	1
6	12.12	73.08	S	A	31	1.5	0.602	14
7	13.36	71.84	SI	D		3.3	0.978	23
7	13.36	71.84	SI	A	44	6.3	1.991	48
8	14.30	70.90	S	D		0.2	0.053	1
8	14.30	70.90	S	A	29	1.7	0.758	18
9	16.92	68.28	SI	D		0.9	0.257	6
9	16.92	68.28	SI	A	36	8.7	3.199	77
10	17.75	67.45	SI	D		0.8	0.249	6
10	17.75	67.45	SI	A	34	4.2	1.618	39
11	19.05	66.15	SI	D		5.8	1.717	41
11	19.05	66.15	SI	A	33	3.4	1.327	32
12	20.65	64.55	S	D		1.5	0.447	11
12	20.65	64.55	S	A	31	2.9	1.192	29
13	22.40	62.80	L	D		15.2	4.473	107
13	22.40	62.80	L	A	32	20.8	8.353	200
14	24.38	60.82	SI	D		8.1	2.367	57
14	24.38	60.82	SI	A	44	11.7	3.664	88

Rock Type: S = SHALE; L = LIMESTONE; SI = SILTSTONE

Note: Inferred UCS = Is₍₅₀₎ × 24

Table D2: Summary of Point Load Index Strength Testing

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HF1-45

Run	Depth (m)	Elevation (m)	Rock Type	Type of Break Axial or Diametral	D for Axial Break (mm)	Force (kN)	$Is_{(50)}$ (N/mm ²)	Inferred UCS (MPa) *
1	4.72	81.28	L	D		8.1	2.372	57
1	4.72	81.28	L	A	37	13.8	4.963	119
2	5.28	80.72	S	D		0.9	0.265	6
2	5.28	80.72	S	A	30	3.8	1.596	38
3	6.93	79.07	S	D		0.4	0.119	3
3	6.93	79.07	S	A	37	3.6	1.302	31
4	9.20	76.80	S	D		0.4	0.128	3
4	9.20	76.80	S	A	42	2.3	0.762	18
5	10.44	75.56	L	D		11.3	3.314	80
5	10.44	75.56	L	A	52	25.3	6.988	168
6	11.51	74.49	L	D		9.8	2.881	69
6	11.51	74.49	L	A	27	13.9	6.373	153
7	13.26	72.74	SI	D		19.3	5.684	136
7	13.26	72.74	SI	A	37	17.6	6.309	151
8	14.48	71.52	S	D		1.1	0.326	8
8	14.48	71.52	S	A	35	1.5	0.571	14
9	16.00	70.00	SI	D		8.2	2.411	58
9	16.00	70.00	SI	A	41	5.9	1.953	47
10	17.98	68.02	S	D		0.8	0.239	6
10	17.98	68.02	S	A	38	3.2	1.120	27
11	19.03	66.97	L	D		8.0	2.350	56
11	19.03	66.97	L	A	23	10.8	5.603	134
12	21.18	64.82	SI	D		10.4	3.062	73
12	21.18	64.82	SI	A	47	24.8	7.394	177
13	21.85	64.15	SI	D		12.7	3.728	89
13	21.85	64.15	SI	A	31	23.2	9.564	230
14	24.03	61.97	SI	D		7.4	2.183	52
14	24.03	61.97	SI	A	30	6.5	2.738	66

Rock Type: S = SHALE; L = LIMESTONE; SI = SILTSTONE

Note: Inferred UCS = $Is_{(50)} \times 24$

Table D2: Summary of Point Load Index Strength Testing

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HF1-46

Run	Depth (m)	Elevation (m)	Rock Type	Type of Break Axial or Diametral	D for Axial Break (mm)	Force (kN)	Is ₍₅₀₎ (N/mm ²)	Inferred UCS (MPa) *
2	5.05	80.55	S	D		1.5	0.429	10
2	5.05	80.55	S	A	39	4.1	1.422	34
3	7.75	77.85	S	D		1.8	0.526	13
3	7.75	77.85	S	A	21	1.8	0.997	24
4	8.13	77.47	S	D		0.2	0.071	2
4	8.13	77.47	S	A	26	1.8	0.831	20
5	10.44	75.16	S	D		0.1	0.018	0
5	10.69	74.91	L	A	33	18.3	7.173	172
6	12.19	73.41	SI	D		14.1	4.148	100
6	12.19	73.41	SI	A	36	28.6	10.475	251
7	12.90	72.70	SI	D		15.1	4.429	106
7	12.90	72.70	SI	A	37	21.9	7.852	188
8	14.94	70.66	S	D		0.1	0.024	1
8	14.94	70.66	S	A	35	3.8	1.425	34
9	15.77	69.83	SI	D		9.2	2.715	65
9	15.77	69.83	SI	A	34	19.1	7.304	175
10	17.58	68.02	SI	D		9.6	2.810	67
10	17.58	68.02	SI	A	37	22.9	8.230	198
11	19.94	65.66	L	D		12.8	3.776	91
11	19.94	65.66	L	A	29	12.9	5.574	134
12	21.26	64.34	SI	D		13.9	4.074	98
12	21.26	64.34	SI	A	40	19.8	6.693	161
13	22.76	62.84	S	D		2.0	0.596	14
13	22.76	62.84	S	A	44	6.4	2.004	48
14	23.24	62.36	SI	D		2.6	0.771	18
14	23.24	62.36	SI	A	53	7.8	2.130	51
14	24.51	61.09	S	D		0.7	0.217	5
14	24.51	85.60	S	A	34	4.8	1.827	44

Rock Type: S = SHALE; L = LIMESTONE; SI = SILTSTONE

Note: Inferred UCS = Is₍₅₀₎ × 24

Table D3: Summary of laboratory test results on rock core samples

Borehole	Depth (ft)*	Depth (m)*	Elevation (m)	Rock Type	Density (g/cm3)	Young's Modulus (Gpa)	UCS (Mpa)	Poisson's Ratio	Slake Durability Results		Cerchar Abrasivness Results		
									Index Value	Type	CAIS	CAI	Classification
HF1-13	50.25	15.3	110.4	SILTSTONE	2.71	6.888	46.3	0.18	-	-	-	-	-
HF1-13	53.42	16.3	109.4	SILTSTONE	2.68	19.362	133.5	0.10	-	-	-	-	-
HF1-13	70.17	21.4	104.3	SHALE	2.6	2.313	13.7	0.16	-	-	-	-	-
HF1-14	46.5	14.2	109.6	LIMESTONE	-	-	-	-	-	-	0.237	0.7	Low Abrasiveness
HF1-14	48.2	14.7	109.1	SHALE	-	-	-	-	80.2	II	-	-	-
HF1-14	61.83	18.8	105.0	SHALE	2.62	2.035	11.0	0.15	-	-	-	-	-
HF1-15	41.75	12.7	111.2	LIMESTONE	2.62	10.722	53.8	0.22	-	-	-	-	-
HF1-16	57.33	17.5	102.8	SHALE	2.63	2.723	20.4	0.18	-	-	-	-	-
HF1-16	78.8	24.0	96.3	LIMESTONE	-	-	-	-	-	-	0.065	0.5	Very Low to Low Abrasiveness
HF1-16A	24.5	7.5	112.0	LIMESTONE	-	-	120.8	-	-	-	0.143	0.6	Low Abrasiveness
HF1-16A	42.9	13.1	106.4	LIMESTONE	2.7	23.572	104.9	0.11	-	-	-	-	-
HF1-16A	59.8	18.2	101.3	SHALE	2.57	1.916	12.8	-	-	-	-	-	-
HF1-16A	71.0	21.6	97.9	SHALE	2.64	3.148	22.3	-	-	-	-	-	-
HF1-17	47.3	14.4	104.4	SILTSTONE	2.63	5.191	27	0.20	-	-	-	-	-
HF1-17	54.5	16.6	102.2	LIMESTONE	2.78	26.804	115.1	-	-	-	-	-	-
HF1-17	63.3	19.3	99.5	SHALE	2.62	4.003	19	0.12	-	-	-	-	-
HF1-17A	59.1	18.0	95.6	SHALE	2.63	5.345	25.6	0.11	-	-	-	-	-
HF1-17A	65.9	20.1	93.5	SHALE	2.6	4.178	20.4	0.12	-	-	-	-	-
HF1-17A	72.3	22.0	91.6	SHALE	2.7	2.882	19.3	0.16	-	-	-	-	-
HF1-18	42.8	13.1	100.1	SHALE	2.6	1.044	10.9	0.22	-	-	-	-	-
HF1-18	56.5	17.2	96.0	SILTSTONE	-	-	-	-	-	-	0.156	0.6	Low Abrasiveness
HF1-18	64.3	19.6	93.6	SHALE	2.65	0.711	7.6	0.28	-	-	-	-	-
HF1-19	32.8	10.0	102.5	SILTSTONE	2.74	18.894	80.8	0.1	-	-	-	-	-
HF1-19	70.1	21.4	91.1	SHALE	2.67	2.882	14.8	0.14	-	-	-	-	-
HF1-20	54.9	16.7	95.7	SILTSTONE	2.66	15.892	91.1	0.10	-	-	-	-	-
HF1-20	57.3	17.4	95.0	SHALE	-	-	-	-	62.7	II	-	-	-
HF1-21	53.4	16.3	95.9	SHALE	-	-	-	-	-	-	0.018	0.5	Very Low to Low Abrasiveness

* Depth below ground surface

	Samples tested by Queen's University
	Samples tested by AMEC

Table D3: Summary of laboratory test results on rock core samples (continued)

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Borehole	Depth (ft)*	Depth (m)*	Elevation (m)	Rock Type	Density (g/cm ³)	Young's Modulus (Gpa)	UCS (Mpa)	Poisson's Ratio	Slake Durability Results		Cerchar Abrasivness Results		
									Index Value	Type	CAIS	CAI	Classification
HF1-21	58.9	18.0	94.2	SHALE	2.61	0.461	5.9	0.35	-	-	-	-	-
HF1-21	62.0	18.9	93.3	SILTSTONE	-	-	-	-	-	-	0.073	0.5	Very Low to Low Abrasiveness
HF1-22	42.9	13.1	97.8	SHALE	2.62	1.123	10.1	0.20	-	-	-	-	-
HF1-22	48.0	14.6	96.3	SILTSTONE	2.62	14.899	65.8	0.10	-	-	-	-	-
HF1-22	54.0	16.5	94.4	SHALE	-	-	-	-	69.1	II	-	-	-
HF1-24	41.8	12.7	96.1	SHALE	2.62	2.281	18.5	0.15	-	-	-	-	-
HF1-25	65.7	20.0	87.7	SHALE	2.61	3.854	21.1	0.13	-	-	-	-	-
HF1-25	71.3	21.7	-	SHALE	-	-	-	-	82.1	II	-	-	-
HF1-26	36.0	11.0	95.9	SHALE	2.61	0.636	8.1	0.2	-	-	-	-	-
HF1-26	47.6	14.5	92.4	SHALE	2.61	0.793	8.8	0.3	-	-	-	-	-
HF1-27	49.6	15.1	90.0	LIMESTONE	2.69	7.621	28.6	-	-	-	-	-	-
HF1-27	51.2	15.6	-	LIMESTONE	-	-	-	-	-	-	0.223	0.7	Low Abrasiveness
HF1-27	53.3	16.3	-	SHALE	-	-	-	-	73.4	II	-	-	-
HF1-27	55.0	16.8	88.3	SHALE	2.63	0.988	10.5	0.23	-	-	-	-	-
HF1-27	61.1	18.6	86.5	SHALE	2.63	1.283	13.8	0.19	-	-	-	-	-
HF1-27	68.6	20.9	84.2	SILTSTONE	2.68	16.734	82.3	0.12	-	-	-	-	-
HF1-28	48.0	14.6	-	SHALE	-	-	-	-	-	-	0.314	0.8	Low Abrasiveness
HF1-28	57.1	17.4	86.1	SHALE	2.6	2.335	13.4	-	-	-	-	-	-
HF1-29	48.9	14.9	88.6	SHALE	-	-	-	-	71.2	II	-	-	-
HF1-29	52.8	16.1	83.4	SHALE	2.59	4.977	18.3	0.15	-	-	-	-	-
HF1-29	55.5	16.9	-	SILTSTONE	-	-	-	-	-	-	0.27	0.7	Low Abrasiveness
HF1-29	62.4	19.0	80.5	SILTSTONE	2.62	6.737	33.5	0.16	-	-	-	-	-
HF1-29	79.2	24.1	75.4	SILTSTONE	2.64	13.776	76.7	0.11	-	-	-	-	-
HF1-30	55.7	17.0	82.5	SHALE	2.58	0.968	9.2	-	-	-	-	-	-
HF1-30	59.8	18.2	81.3	SILTSTONE	2.64	24.399	108.4	0.1	-	-	-	-	-
HF1-30	67.5	20.6	78.9	SHALE	-	-	-	-	63.8	II	-	-	-
HF1-30	71.6	21.8	77.7	SHALE	2.58	0.506	7.2	-	-	-	-	-	-

* Depth below ground surface

	Samples tested by Queen's University
	Samples tested by AMEC

Table D3: Summary of laboratory test results on rock core samples (continued)

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Borehole	Depth (ft)*	Depth (m)*	Elevation (m)	Rock Type	Density (g/cm ³)	Young's Modulus (Gpa)	UCS (Mpa)	Poisson's Ratio	Slake Durability Results		Cerchar Abrasivness Results		
									Index Value	Type	CAIS	CAI	Classification
HF1-31	53.6	16.3	83.3	SHALE	2.63	0.579	5.4	-	-	-	-	-	-
HF1-31	58.3	17.8	81.8	LIMESTONE	-	-	-	-	-	-	0.221	0.7	Low Abrasiveness
HF1-31	63.0	19.2	80.4	SHALE	-	-	-	-	59.9	II	-	-	-
HF1-32	60.1	18.3	78.5	SHALE	2.6	0.788	9.4	-	-	-	-	-	-
HF1-32	65.3	19.9	-	SHALE	-	-	-	-	80.4	II			
HF1-32	73.5	22.4	-	SILTSTONE	-	-	-	-	-	-	0.215	0.7	Low Abrasiveness
HF1-32	75.3	23.0	73.8	SILTSTONE	-	7.873	30.6	-	-	-	-	-	-
HF1-32	82.5	25.1	71.7	SHALE	2.61	0.945	11.8	-	-	-	-	-	-
HF1-33	32.0	9.8	-	SHALE	-	-	-	-	77.2	II	-	-	-
HF1-33	75.1	22.9	69.9	SILTSTONE	2.66	20.422	69.3	0.1	-	-	-	-	-
HF1-33	81.0	24.7	68.1	LIMESTONE	2.69	12.533	60.8	0.18	-	-	-	-	-
HF1-34	45.2	13.8	76.6	SHALE	2.59	4.112	21.9	0.18	-	-	-	-	-
HF1-34	52.6	16.0	74.4	SILTSTONE	-	-	-	-	-	-	0.293	0.8	Low Abrasiveness
HF1-34	55.3	16.8	73.6	SILTSTONE	2.63	20.889	93.4	0.1	-	-	-	-	-
HF1-34	62.3	19.0	-	SILTSTONE	-	-	-	-	68.1	II	-	-	-
HF1-34	66.0	20.1	70.3	SHALE	2.62	2.253	13.8	-	-	-	-	-	-
HF1-35	33.5	10.2	72.8	SILTSTONE	2.61	14.908	81.1	0.1	-	-	-	-	-
HF1-35	36.6	11.1	71.9	LIMESTONE	-	-	-	-	-	-	0.433	0.9	Low Abrasiveness
HF1-35	38.8	11.8	71.2	SILTSTONE	2.59	2.923	16.8	-	-	-	-	-	-
HF1-35	58.4	17.8	65.2	SHALE	2.59	2.571	16.7	-	-	-	-	-	-
HF1-35A	32.8	10.0	72.8	SILTSTONE	2.65	20.577	115.6	0.22	-	-	-	-	-
HF1-35A	62.3	19.0	63.8	SHALE	2.58	0.419	7	0.1	-	-	-	-	-
HF1-35A	64.3	19.6	63.2	SHALE	-	-	-	-	-	-	0.004	0.5	Very Low to Low Abrasiveness
HF1-36	35.2	10.7	75.8	SHALE	2.57	0.606	8.8	-	-	-	-	-	-
HF1-36	45.8	14.0	72.5	SILTSTONE	-	-	-	-	-	-	0.275	0.8	Low Abrasiveness
HF1-36	53.4	16.3	70.2	SHALE	2.6	4.929	21.2	-	-	-	-	-	-
HF1-36	58.4	17.8	68.7	SHALE	2.6	3.926	19.8	-	-	-	-	-	-

* Depth below ground surface

	Samples tested by Queen's University
	Samples tested by AMEC

Table D3: Summary of laboratory test results on rock core samples (continued)

4 of 4

Borehole	Depth (ft)*	Depth (m)*	Elevation (m)	Rock Type	Density (g/cm3)	Young's Modulus (Gpa)	UCS (Mpa)	Poisson's Ratio	Slake Durability Results		Cerchar Abrasivness Results		
									Index Value	Type	CAIS	CAI	Classification
HF1-37	50.9	15.5	69.7	SHALE	2.61	1.763	12.9	-	-	-	-	-	-
HF1-37	58.7	17.9	-	SHALE	-	-	-	-	75.1	II	-	-	-
HF1-37	61.9	18.9	66.3	LIMESTONE	2.61	11.648	68.5	0.12	-	-	-	-	-
HF1-38	34.2	10.4	73.8	SHALE	-	-	-	-	71.9	III	-	-	-
HF1-39	28.8	8.8	75.1	SHALE	2.57	0.406	5.2	0.22	-	-	-	-	-
HF1-39	52.7	16.1	67.8	SHALE	2.6	0.763	7.8	0.2	-	-	-	-	-
HF1-40	37.8	11.5	72.9	SHALE	-	-	-	-	71.1	III	-	-	-
HF1-40	49.8	15.2	69.2	SILTSTONE	2.63	10.292	65.7	0.18	-	-	-	-	-
HF1-40	51.2	15.6	68.8	LIMESTONE	-	-	-	-	-	-	0.307	0.8	Low Abrasiveness
HF1-42	19.3	5.9	78.4	SHALE	2.58	0.609	8.8	0.24	-	-	-	-	-
HF1-42	48.0	14.6	69.7	SILTSTONE	2.66	10.769	35.5	-	-	-	-	-	-
HF1-42	52.8	16.1	68.2	LIMESTONE	-	-	-	-	-	-	0.074	0.6	Low Abrasiveness
HF1-42	63.7	19.4	64.9	SILTSTONE	2.65	17.548	112.4	0.1	-	-	-	-	-
HF1-43	23.2	7.1	77.6	SHALE	2.6	0.614	8.5	0.2	-	-	-	-	-
HF1-43	37.7	11.5	73.2	SHALE	2.56	0.715	10.0	0.25	-	-	-	-	-
HF1-43	58.1	17.7	67.0	LIMESTONE	2.7	13.145	45.4	0.1	-	-	-	-	-
HF1-44	47.2	14.4	70.8	SHALE	2.61	0.689	8.1	0.19	-	-	-	-	-
HF1-44	54.5	16.6	68.6	LIMESTONE	-	-	-	-	-	-	0.252	0.7	Low Abrasiveness
HF1-45	43.9	13.4	72.6	SHALE	2.59	0.783	8.7	0.15	-	-	-	-	-
HF1-45	44.5	13.6	72.4	SHALE	-	-	-	-	68.8	II	-	-	-
HF1-45	54.3	16.5	69.5	SILTSTONE	2.66	9.937	46.8	0.1	-	-	-	-	-
HF1-45	73.2	22.3	63.7	SILTSTONE	2.68	14.752	78.2	0.15	-	-	-	-	-
HF1-46	43.8	13.3	72.7	SHALE	2.57	0.437	7.6	0.2	-	-	-	-	-
HF1-46	57.8	17.6	68.4	SILTSTONE	-	-	-	-	-	-	0.039	0.5	Low Abrasiveness
HF1-46	59.5	18.1	67.9	SILTSTONE	2.61	5.089	27.4	0.15	-	-	-	-	-

* Depth below ground surface

	Samples tested by Queen's University
	Samples tested by AMEC

GEOTMARK00233AA

Table D4: Summary of Hydraulic Conductivity Test Results

Borehole	Test Zone Top Elevation (m)	Test Zone Bottom Elevation (m)	Test Pressure (kPa)	Hydraulic Conductivity, 'k' (cm/s)
HF1-13	106.7	103.4	167	7.57E-07
			304	1.25E-06
			441	2.86E-06
HF1-13	110.0	106.7	167	< 1.00E-08
			304	2.08E-07
			441	< 1.00E-08
HF1-15	108.1	104.8	128	5.94E-06
			235	5.90E-06
			343	4.78E-06
HF1-15	112.7	109.4	128	< 1.00E-08
			235	7.92E-04
			343	7.47E-05
HF1-17	103.2	99.9	206	< 1.00E-08
			373	< 1.00E-08
			549	< 1.00E-08
HF1-17	100.1	96.9	206	< 1.00E-08
			373	< 1.00E-08
			549	< 1.00E-08
HF1-17A	97.8	94.6	147	9.66E-06
			255	4.56E-06
			353	2.56E-06
HF1-17A	100.9	97.6	108	1.17E-06
			216	1.76E-06
			324	1.17E-06
HF1-18	99.4	96.1	128	< 1.00E-08
			235	< 1.00E-08
			343	< 1.00E-08
HF1-18	96.3	93.1	167	< 1.00E-08
			304	< 1.00E-08
			441	< 1.00E-08
HF1-18	93.3	90.0	206	< 1.00E-08
			343	< 1.00E-08
			510	< 1.00E-08
HF1-19	95.9	92.9	196	3.46E-06
			334	2.85E-06
			471	5.19E-06
HF1-19	99.0	95.9	157	9.96E-05
			265	9.80E-05
			373	1.50E-04

Table D4: Summary of Hydraulic Conductivity Test Results (continued)

Borehole	Test Zone Bottom Elevation (m)	Test Zone Top Elevation (m)	Test Pressure (kPa)	Hydraulic Conductivity (cm/s)
HF1-21	98.0	94.7	118	< 1.00E-08
			226	< 1.00E-08
			334	< 1.00E-08
HF1-21	101.0	97.8	118	< 1.00E-08
			226	< 1.00E-08
			334	< 1.00E-08
HF1-23	97.1	93.8	147	2.57E-06
			255	2.97E-06
			353	2.15E-06
HF1-23	100.1	96.8	108	1.87E-05
			186	1.02E-05
			284	1.02E-05
HF1-25	87.9	84.8	216	< 1.00E-08
			353	< 1.00E-08
			520	< 1.00E-08
HF1-25	90.9	87.9	177	< 1.00E-08
			314	6.06E-06
			451	9.33E-06
HF1-25	94.0	90.9	137	< 1.00E-08
			245	1.08E-06
			353	2.25E-06
HF1-25	97.0	94.0	137	1.78E-05
			216	2.20E-05
			284	3.10E-05
HF1-26	90.1	87.1	177	< 1.00E-08
			314	< 1.00E-08
			451	1.59E-06
HF1-26	93.2	90.1	137	< 1.00E-08
			245	< 1.00E-08
			353	< 1.00E-08
HF1-26	96.2	93.2	108	< 1.00E-08
			177	< 1.00E-08
			245	< 1.00E-08
HF1-27	89.9	86.8	177	< 1.00E-08
			284	< 1.00E-08
			383	< 1.00E-08

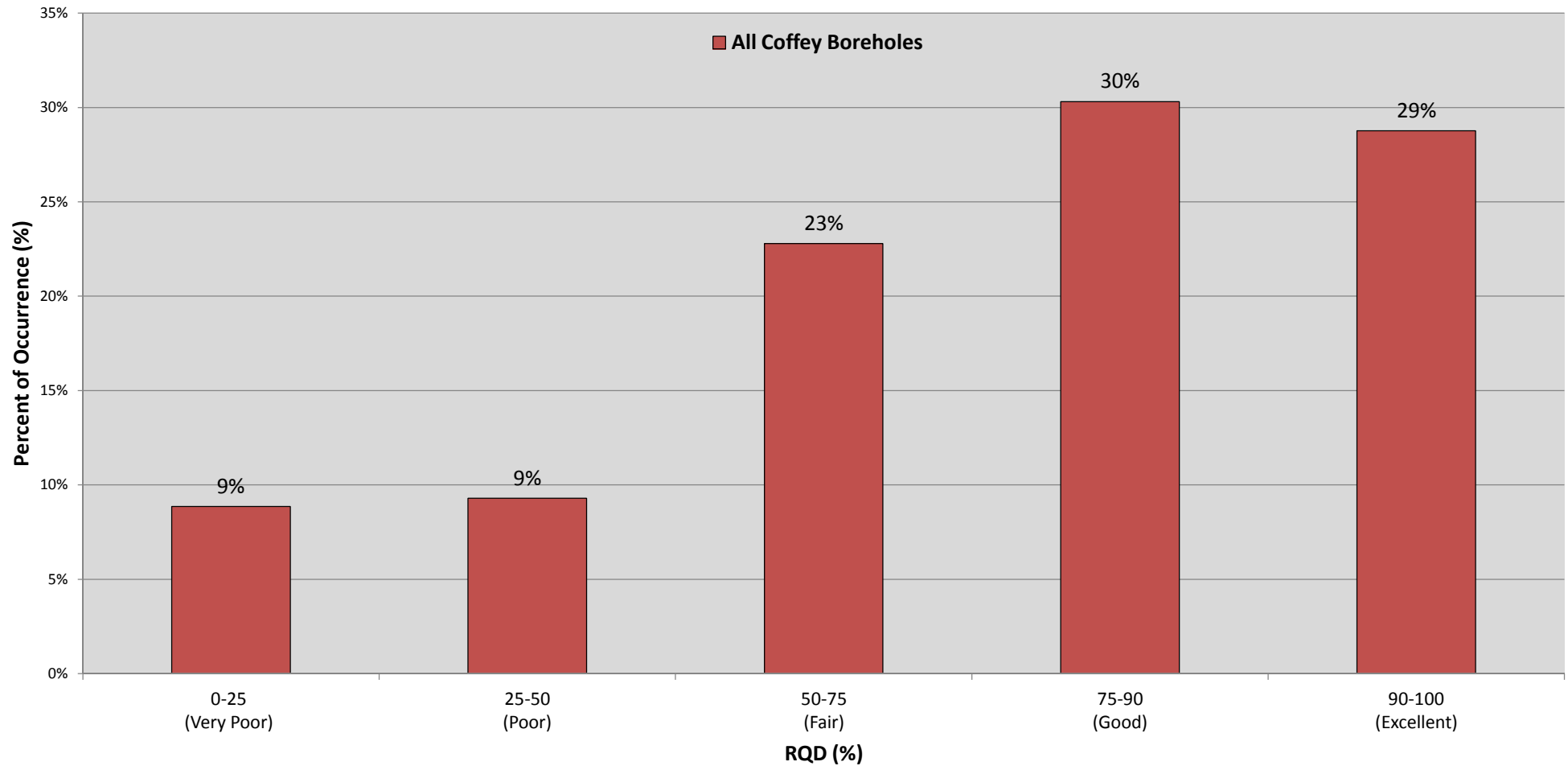
Table D4: Summary of Hydraulic Conductivity Test Results (continued)

Borehole	Test Zone Bottom Elevation (m)	Test Zone Top Elevation (m)	Test Pressure (kPa)	Hydraulic Conductivity (cm/s)
HF1-27	92.9	89.9	137	< 1.00E-08
			245	< 1.00E-08
			353	< 1.00E-08
HF1-29	82.7	79.7	137	2.17E-05
			245	2.21E-05
			353	2.31E-05
HF1-29	85.8	82.7	137	< 1.00E-08
			216	2.45E-06
			284	3.49E-06
HF1-32	78.5	75.5	118	< 1.00E-08
			226	< 1.00E-08
			334	< 1.00E-08
HF1-32	81.6	78.5	118	< 1.00E-08
			196	< 1.00E-08
			265	< 1.00E-08
HF1-34	72.1	69.1	186	< 1.00E-08
			324	< 1.00E-08
			461	< 1.00E-08
HF1-34	75.2	72.1	147	1.80E-06
			255	5.19E-06
			363	9.34E-06
HF1-34	78.2	75.2	147	< 1.00E-08
			226	< 1.00E-08
			294	< 1.00E-08
HF1-35A	70.6	67.6	98	< 1.00E-08
			206	< 1.00E-08
			314	< 1.00E-08
HF1-35A	75.2	72.1	69	< 1.00E-08
			137	< 1.00E-08
			206	< 1.00E-08
HF1-38	68.0	65.5	147	< 1.00E-08
			284	< 1.00E-08
			392	< 1.00E-08
HF1-38	71.1	68.0	108	< 1.00E-08
			216	< 1.00E-08
			324	< 1.00E-08
HF1-38	74.1	71.1	78	2.29E-06
			147	3.05E-06
			216	5.53E-06
HF1-41	73.1	63.1	128	2.18E-06
			235	6.39E-06
			343	8.09E-06

Table D4: Summary of Hydraulic Conductivity Test Results (continued)


Borehole	Test Zone Bottom Elevation (m)	Test Zone Top Elevation (m)	Test Pressure (kPa)	Hydraulic Conductivity (cm/s)
HF1-42	67.2	64.2	137	2.19E-04
			275	3.00E-04
			412	4.51E-04
HF1-42	71.8	68.8	98	6.95E-05
			177	4.67E-05
			275	3.92E-05
HF1-42	76.4	73.3	69	3.67E-04
			137	2.84E-04
			177	2.38E-04
HF1-46	68.8	65.8	167	< 1.00E-08
			304	< 1.00E-08
			441	< 1.00E-08
HF1-46	71.9	68.8	128	< 1.00E-08
			235	< 1.00E-08
			343	< 1.00E-08
HF1-46	74.9	71.9	128	4.02E-04
			206	4.88E-04
			275	4.83E-04
HF1-46	78.0	74.9	98	6.89E-04
			167	6.08E-04
			235	5.51E-04

Histogram of RQD Distribution



Note:

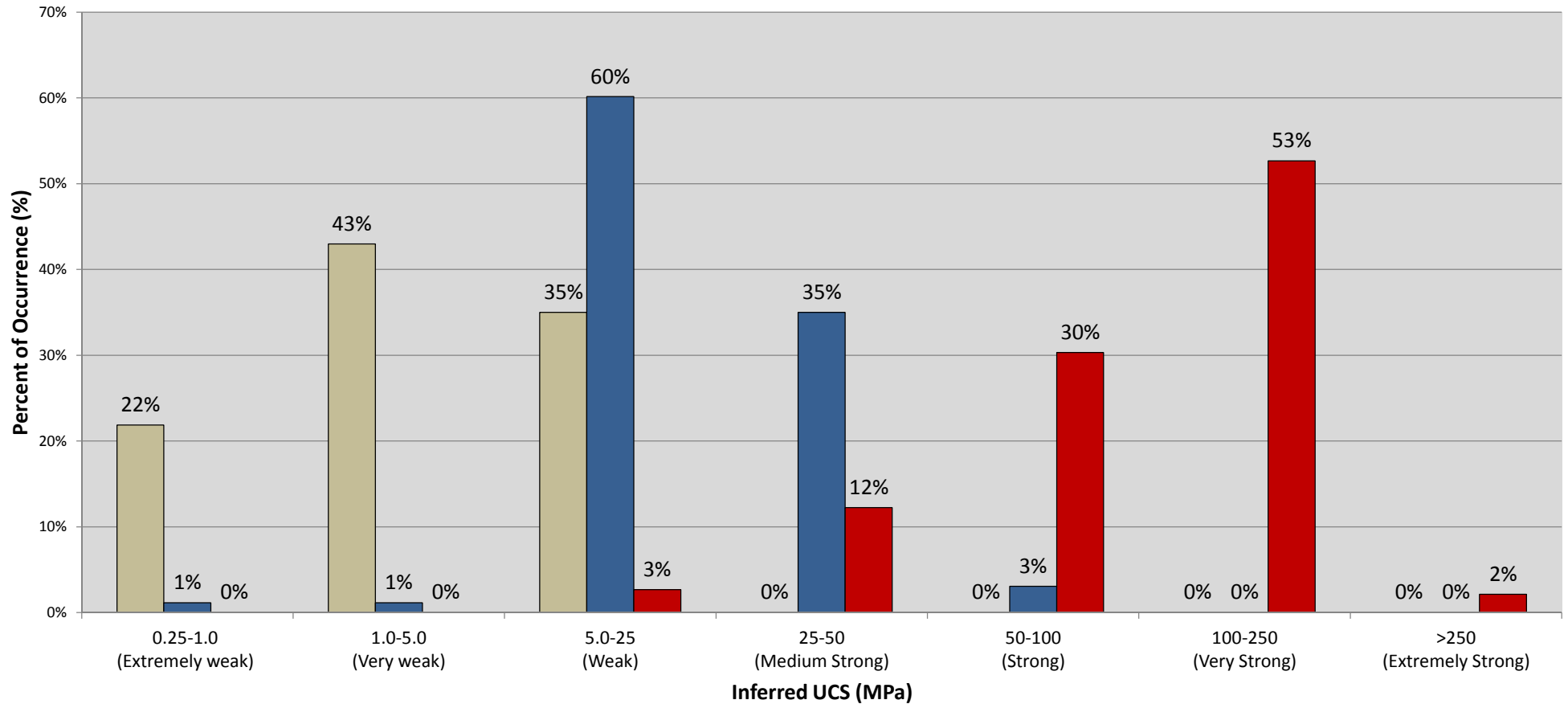
Data taken from 452 core runs in 37 Boreholes from HF1-13 to HF1-46.

drawn	AC	 SPECIALISTS MANAGING THE EARTH	client:	CH2M Hill Canada Ltd.	
approved	IL		project:	HANLAN FEEDERMAIN SOUTH CONTRACT 1	
date	12-Dec-09		title:	RQD Histogram: All Coffey Boreholes	
scale	N.T.S		project no:	GEOTMARK00233AA	figure no: D1
original size	letter				

Histogram of Inferred UCS Distribution

from Point Load Index Tests


■ SHALE - Diametral (256 tests)
 ■ SHALE - Axial (261 tests)
 ■ LIMESTONE & SILTSTONE (376 tests)



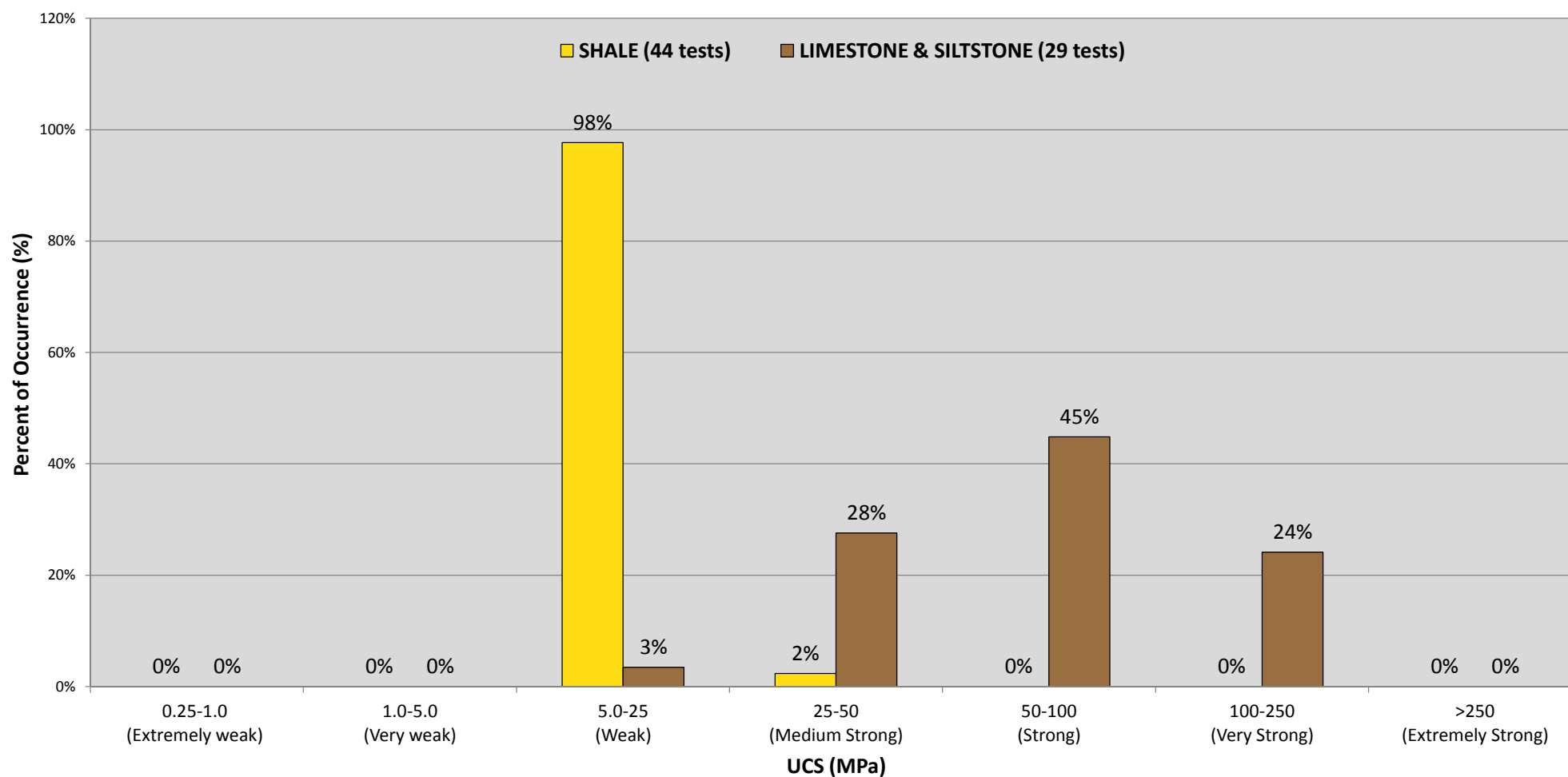
Notes:

1. Data taken from 37 boreholes from HF1-13 to HF1-46.

2. $UCS = I_{s(50)} \times 24$

drawn	AC	 SPECIALISTS MANAGING THE EARTH	client:	CH2M Hill Canada Ltd.	
approved	IL		project:	HANLAN FEEDERMAIN SOUTH CONTRACT 1	
date	12-Dec-09		title:	Inferred UCS Histogram: All Boreholes	
scale	N.T.S		project no:	GEOTMARK00233AA	figure no: D2
original size	letter				

Histogram of UCS Distribution



*** Excludes boreholes HF1-23, HF1-38 and HF1-41,
in which no UCS tests were performed**

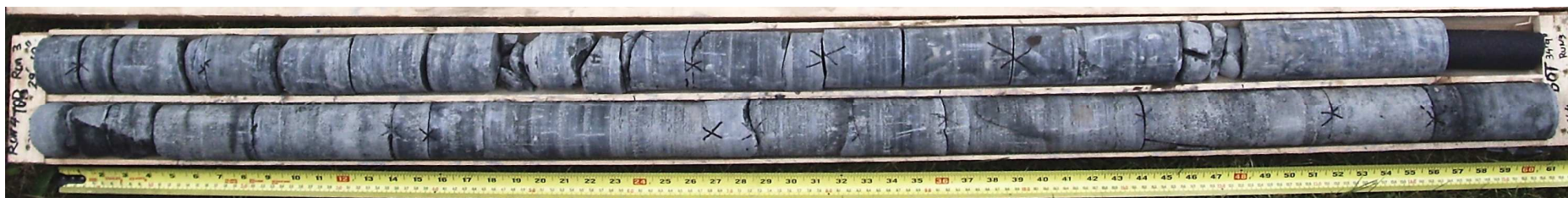
drawn	AC
approved	IL
date	12-Dec-09
scale	N.T.S
original size	letter



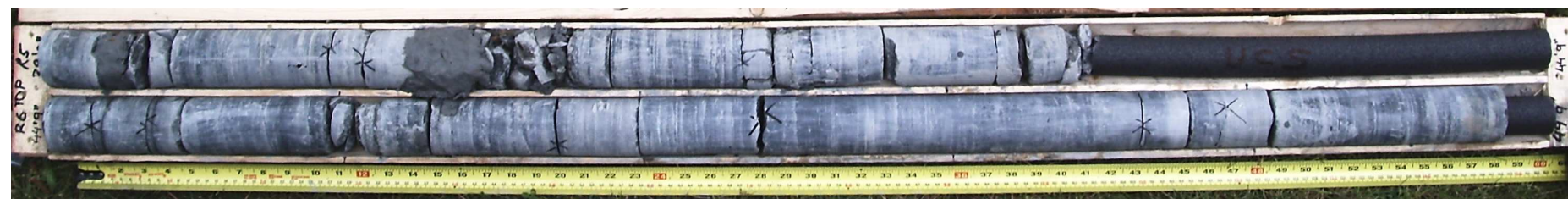
client:	CH2M Hill Canada Ltd.	
project:	HANLAN FEEDERMAIN SOUTH CONTRACT 1	
title:	UCS Histogram: All Coffey Boreholes	
project no:	GEOTMARK00233AA	figure no: D3




HF1-13 RUN 1: 7.37m to 7.57m BGL, RUN 2: 7.57m to 9.09m BGL

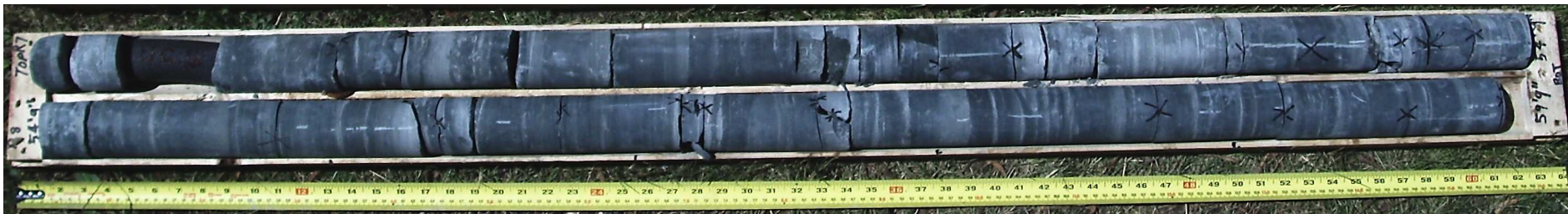


HF1-13 RUN 3: 9.09m to 10.59m BGL, RUN 4: 10.59m to 12.12m BGL

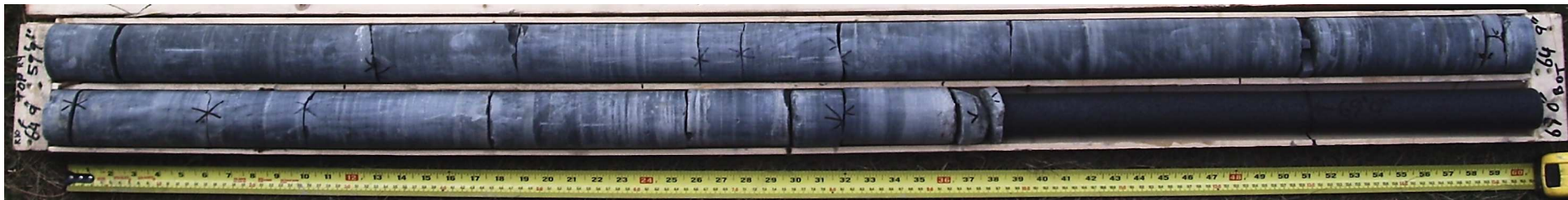


HF1-13 RUN 5: 12.12m to 13.64m BGL, RUN 6: 13.64m to 15.16m BGL

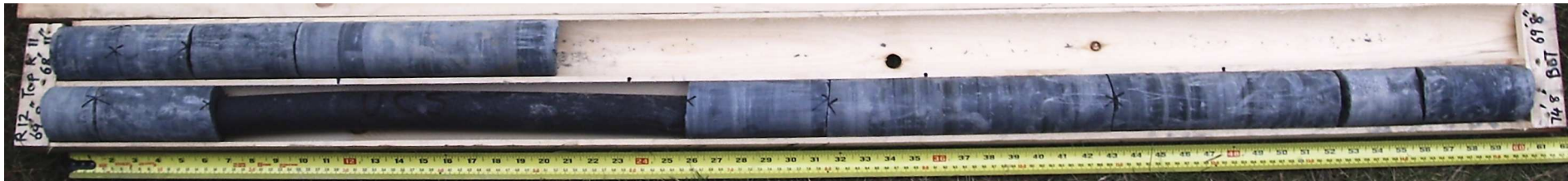
drawn	AC	 SPECIALISTS MANAGING THE EARTH	client:	CH2M Hill Canada Inc.	
approved	IL		project:	Hanlan Feedermain South Contract 1	
date	25-Aug-11		title:	HF1-13 CORE PHOTOGRAPHS	
scale	N.T.S		project no:	GEOTMARK00233AA	figure no:
original size	letter				1 of 3




HF1-13 RUN 7: 15.16m to 16.69m BGL, RUN 8: 16.69m to 18.21m BGL



HF1-13 RUN 9: 18.21m to 19.74m BGL, RUN 10: 19.74m to 21.01m BGL




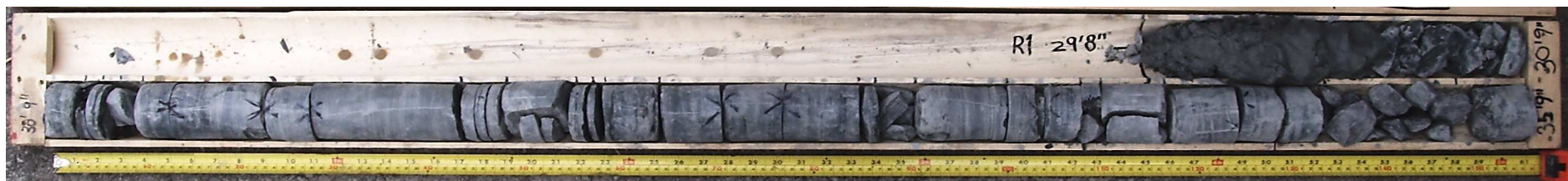
HF1-13 RUN 11: 21.01m to 21.24m BGL, RUN 12: 21.24m to 22.76m BGL

drawn	AC	 SPECIALISTS MANAGING THE EARTH	client:	CH2M Hill Canada Inc.	
approved	IL		project:	Hanlan Feedermain South Contract 1	
date	25-Aug-11		title:	HF1-13 CORE PHOTOGRAPHS	
scale	N.T.S		project no:	GEOTMARK00233AA	figure no:
original size	letter				2 of 3

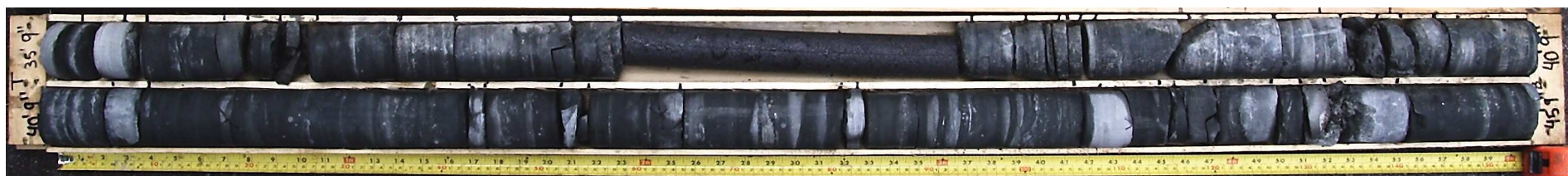


HF1-13 RUN 13: 22.76m to 24.28m BGL, RUN 14: 24.28m to 25.81m BGL

drawn	AC	 coffey geotechnics <small>SPECIALISTS MANAGING THE EARTH</small>	client:	CH2M Hill Canada Inc.	
approved	IL		project:	Hanlan Feedermain South Contract 1	
date	25-Aug-11		title:	HF1-13 CORE PHOTOGRAPHS	
scale	N.T.S		project no:	GEOTMARK00233AA	figure no:
original size	letter				3 of 3




HF1-14 RUN 1: 9.04m to 9.37m BGL, RUN 2: 9.37m to 10.90m BGL



HF1-14 RUN 3: 10.90m to 12.42m BGL, RUN 4: 12.42m to 13.94m BGL

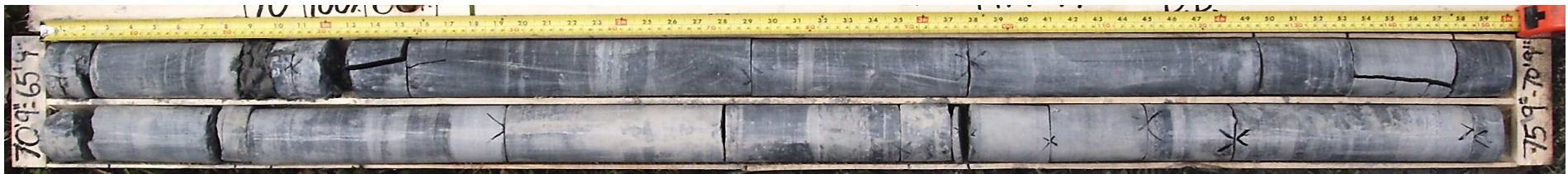


HF1-14 RUN 5: 13.94m to 15.47m BGL, RUN 6: 15.47m to 16.99m BGL

drawn	AC	 coffey geotechnics SPECIALISTS MANAGING THE EARTH	client:	CH2M Hill Canada Inc.	
approved	IL		project:	Hanlan Feedermain South Contract 1	
date	25-Aug-11		title:	HF1-14 CORE PHOTOGRAPHS	
scale	N.T.S		project no:	GEOTMARK00233AA	figure no:
original size	letter				1 of 2




HF1-14 RUN 7: 16.99m to 18.52m BGL, RUN 8: 18.52m to 20.04m BGL



HF1-14 RUN 9: 20.04m to 21.56m BGL, RUN 10: 21.56m to 23.09m BGL

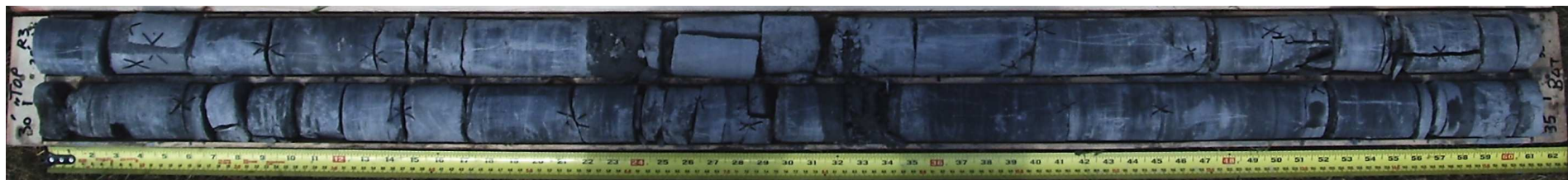


HF1-14 RUN 11: 23.09m to 24.61m BGL, RUN 12: 24.61m to 26.14m BGL

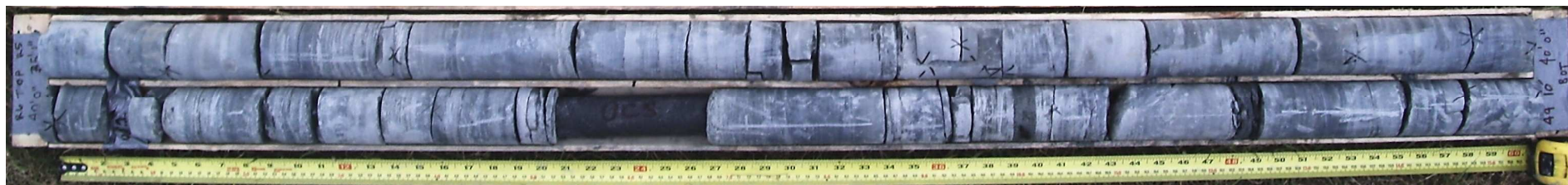
drawn	AC	 coffey geotechnics <small>SPECIALISTS MANAGING THE EARTH</small>	client:	CH2M Hill Canada Inc.	
approved	IL		project:	Hanlan Feedermain South Contract 1	
date	25-Aug-11		title:	HF1-14 CORE PHOTOGRAPHS	
scale	N.T.S		project no:	GEOTMARK00233AA	figure no:
original size	letter				2 of 2




HF1-15 RUN 1: 4.60m to 6.12m BGL, RUN 2: 6.12m to 7.64m BGL



HF1-15 RUN 3: 7.64m to 9.17m BGL, RUN 4: 9.17m to 10.69m BGL

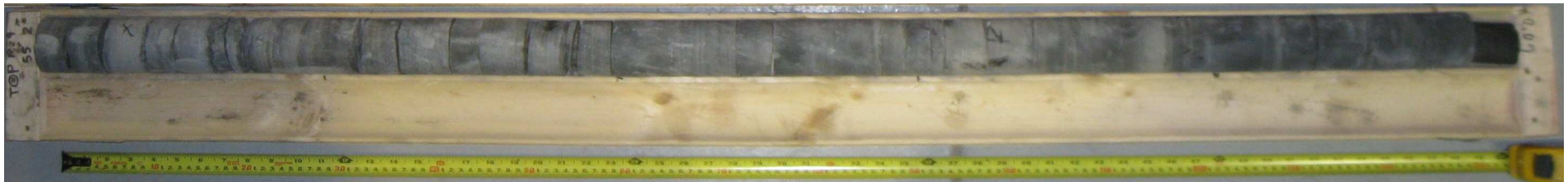


HF1-15 RUN 5: 10.69m to 12.24m BGL, RUN 6: 12.24m to 13.79m BGL

drawn	AC	 coffey geotechnics <small>SPECIALISTS MANAGING THE EARTH</small>	client:	CH2M Hill Canada Inc.	
approved	IL		project:	Hanlan Feedermain South Contract 1	
date	25-Aug-11		title:	HF1-15 CORE PHOTOGRAPHS	
scale	N.T.S		project no:	GEOTMARK00233AA	figure no:
original size	letter				1 of 3




HF1-15 RUN 7: 13.79m to 15.32m BGL, RUN 8: 15.32m to 16.82m BGL



HF1-15 RUN 9: 16.82m to 18.29m BGL



HF1-15 RUN 10: 18.29m to 19.81m BGL, RUN 11: 19.81m to 20.12m BGL


drawn	AC	 coffey geotechnics SPECIALISTS MANAGING THE EARTH	client:	CH2M Hill Canada Inc.	
approved	IL		project:	Hanlan Feedermain South Contract 1	
date	25-Aug-11		title:	HF1-15 CORE PHOTOGRAPHS	
scale	N.T.S		project no:	GEOTMARK00233AA	figure no:
original size	letter				2 of 3

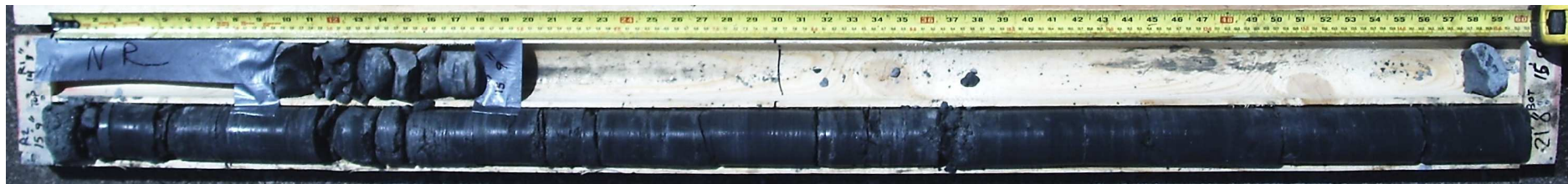


HF1-15 RUN 12: 20.12m to 21.64m BGL, RUN 13: 21.64m to 23.16m BGL

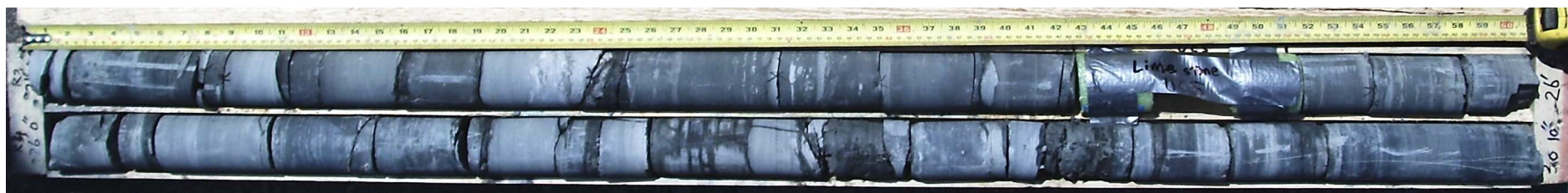


HF1-15 RUN 14: 23.16m to 24.69m BGL

drawn	AC	 coffey geotechnics <small>SPECIALISTS MANAGING THE EARTH</small>	client:	CH2M Hill Canada Inc.	
approved	IL		project:	Hanlan Feedermain South Contract 1	
date	25-Aug-11		title:	HF1-15 CORE PHOTOGRAPHS	
scale	N.T.S		project no:	GEOTMARK00233AA	figure no:
original size	letter				3 of 3




HF1-16A RUN 1: 4.34m to 4.80m BGL, RUN 2: 4.80m to 6.40m BGL



HF1-16A RUN 3: 6.40m to 7.92m BGL, RUN 4: 7.92m to 9.40m BGL

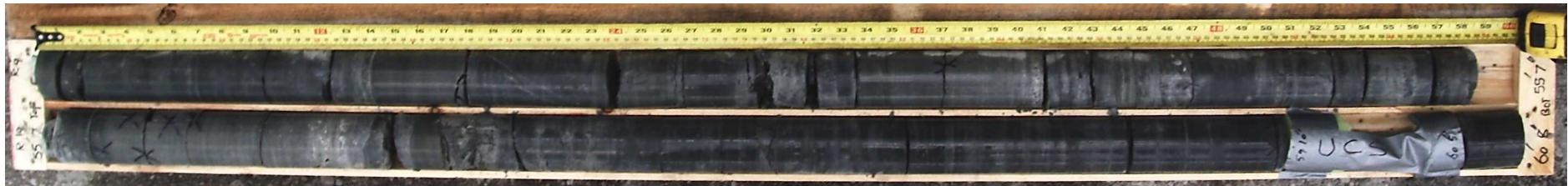


HF1-16A RUN 5: 9.40m to 10.90m BGL, RUN 6: 10.90m to 12.44m BGL

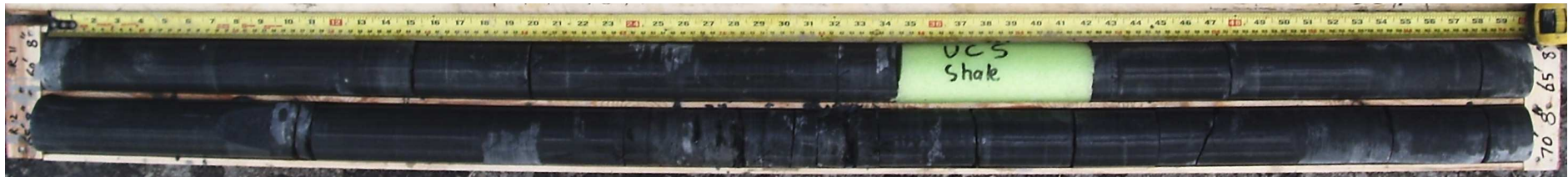
drawn	AC	 coffey geotechnics SPECIALISTS MANAGING THE EARTH	client:	CH2M Hill Canada Inc.	
approved	IL		project:	Hanlan Feedermain South Contract 1	
date	25-Aug-11		title:	HF1-16A CORE PHOTOGRAPHS	
scale	N.T.S		project no:	GEOTMARK00233AA	figure no:
original size	letter				1 of 3




HF1-16A RUN 7: 12.44m to 13.94m BGL, RUN 8: 13.94m to 15.47m BGL

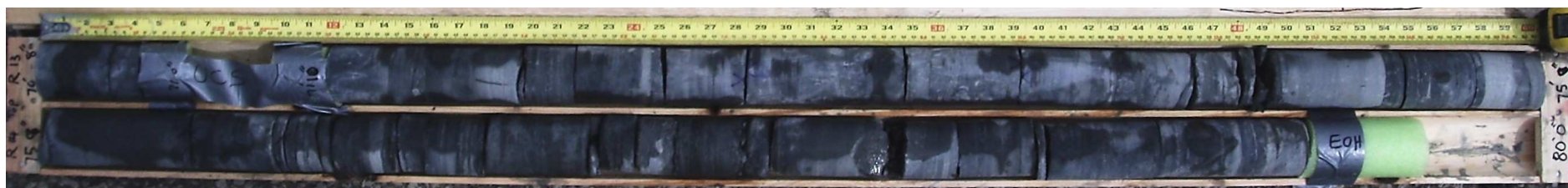


HF1-16A RUN 9: 15.47m to 16.94m BGL, RUN 10: 16.94m to 18.49m BGL




HF1-16A RUN 11: 18.49m to 20.02m BGL, RUN 12: 20.02m to 21.54m BGL

drawn	AC	 coffey geotechnics SPECIALISTS MANAGING THE EARTH	client:	CH2M Hill Canada Inc.	
approved	IL		project:	Hanlan Feedermain South Contract 1	
date	25-Aug-11		title:	HF1-16A CORE PHOTOGRAPHS	
scale	N.T.S		project no:	GEOTMARK00233AA	figure no:
original size	letter				2 of 3

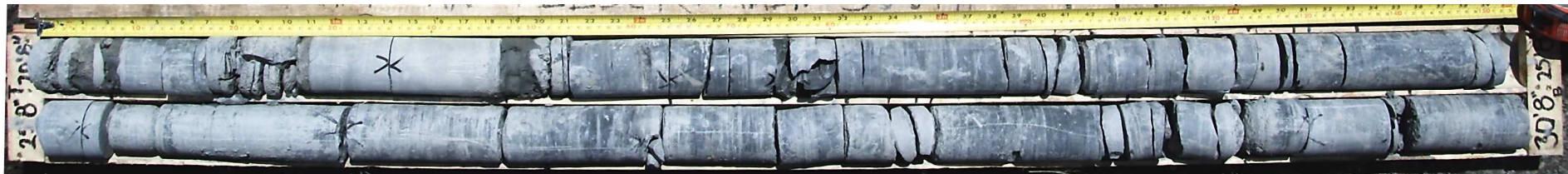


HF1-16A RUN 13: 21.54m to 23.09m BGL, RUN 14: 23.09m to 24.38m BGL

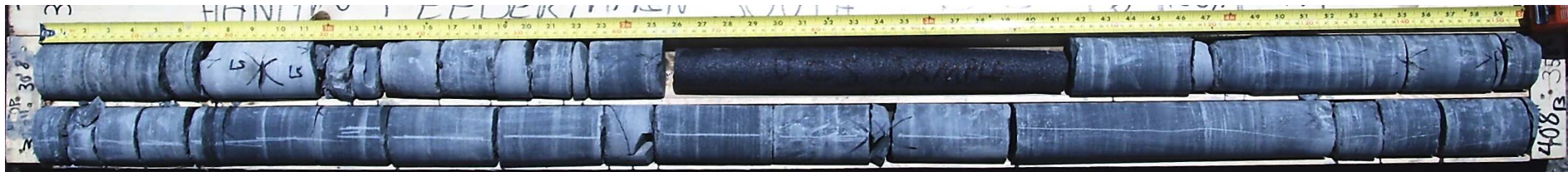
drawn	AC	 SPECIALISTS MANAGING THE EARTH	client:	CH2M Hill Canada Inc.	
approved	IL		project:	Hanlan Feedermain South Contract 1	
date	25-Aug-11		title:	HF1-16A CORE PHOTOGRAPHS	
scale	N.T.S		project no:	GEOTMARK00233AA	figure no:
original size	letter				3 of 3




HF1-16 RUN 1: 3.96m to 4.78m BGL, RUN 2: 4.78m to 6.30m BGL

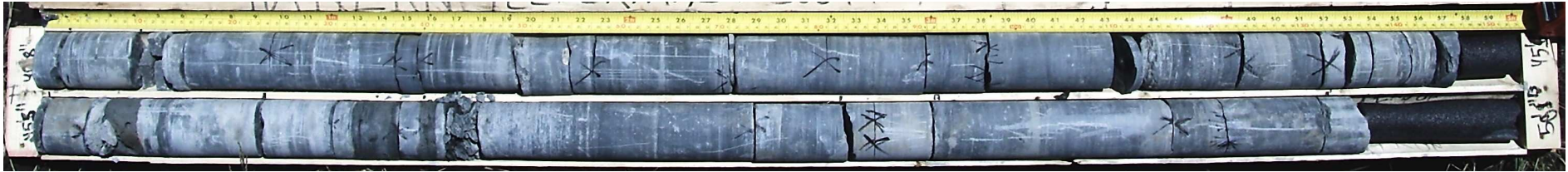


HF1-16 RUN 3: 6.30m to 7.82m BGL, RUN 4: 7.82m to 9.35m BGL

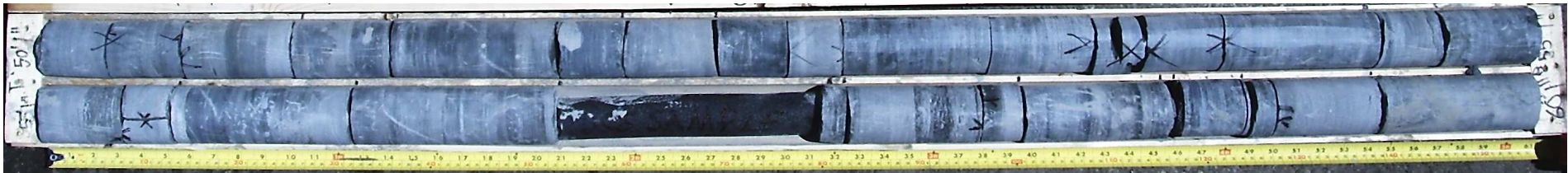


HF1-16 RUN 5: 9.35m to 10.87m BGL, RUN 6: 10.87m to 12.40m BGL

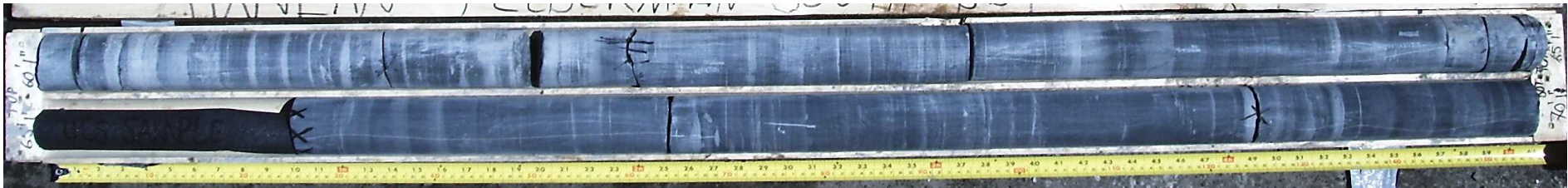
drawn	AC	 coffey geotechnics SPECIALISTS MANAGING THE EARTH	client:	CH2M Hill Canada Inc.	
approved	IL		project:	Hanlan Feedermain South Contract 1	
date	25-Aug-11		title:	HF1-16 CORE PHOTOGRAPHS	
scale	N.T.S		project no:	GEOTMARK00233AA	figure no:
original size	letter				1 of 3




HF1-16 RUN 7: 12.40m to 13.84m BGL, RUN 8: 13.84m to 15.26m BGL



HF1-16 RUN 9: 15.26m to 16.79m BGL, RUN 10: 16.79m to 18.31m BGL




HF1-16 RUN 11: 18.31m to 19.84m BGL, RUN 12: 19.84m to 21.36m BGL

drawn	AC		client:	CH2M Hill Canada Inc.	
approved	IL		project:	Hanlan Feedermain South Contract 1	
date	25-Aug-11		title:	HF1-16 CORE PHOTOGRAPHS	
scale	N.T.S		project no:	GEOTMARK00233AA	figure no:
original size	letter				2 of 3

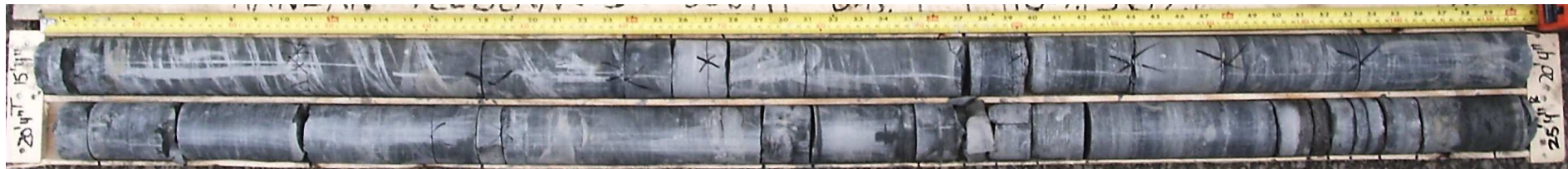


HF1-16 RUN 13: 21.36m to 22.88m BGL, RUN 14: 22.88m to 24.41m BGL

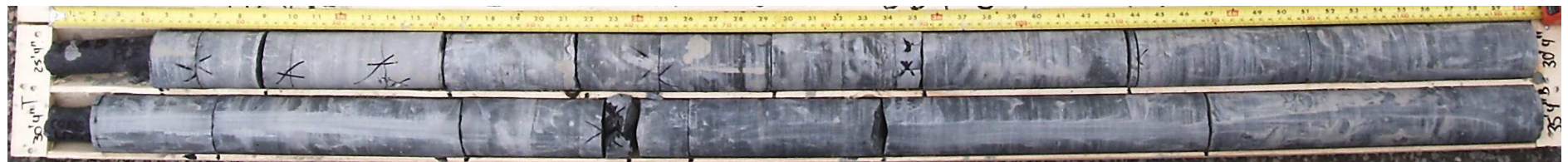
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approved	IL		project:	Hanlan Feedermain South Contract 1	
date	25-Aug-11		title:	HF1-16 CORE PHOTOGRAPHS	
scale	N.T.S		project no:	GEOTMARK00233AA	figure no:
original size	letter				3 of 3




HF1-17A RUN 1: 2.90m to 3.15m BGL, RUN 2: 3.15m to 4.67m BGL

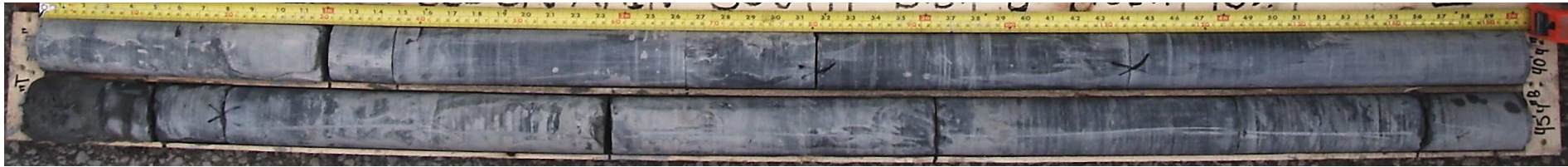


HF1-17A RUN 3: 4.67m to 6.20m BGL, RUN 4: 6.20m to 7.72m BGL

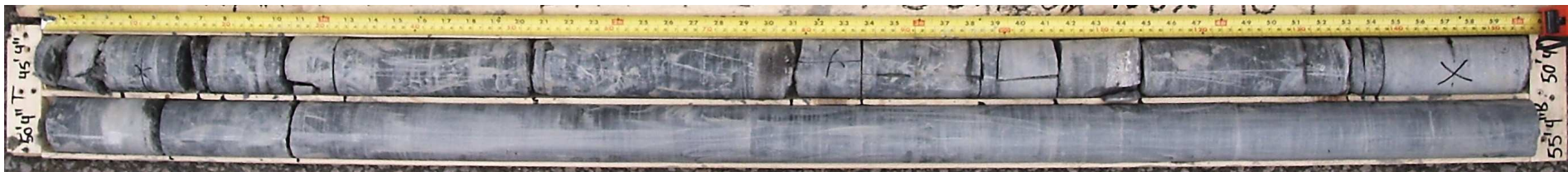


HF1-17A RUN 5: 7.72m to 9.24m BGL, RUN 6: 9.24m to 10.77m BGL

drawn	AC	 coffey geotechnics <small>SPECIALISTS MANAGING THE EARTH</small>	client:	CH2M Hill Canada Inc.	
approved	IL		project:	Hanlan Feedermain South Contract 1	
date	25-Aug-11		title:	HF1-17A CORE PHOTOGRAPHS	
scale	N.T.S		project no:	GEOTMARK00233AA	figure no:
original size	letter				1 of 3




HF1-17A RUN 7: 10.77m to 12.29m BGL, RUN 8: 12.29m to 13.82m BGL

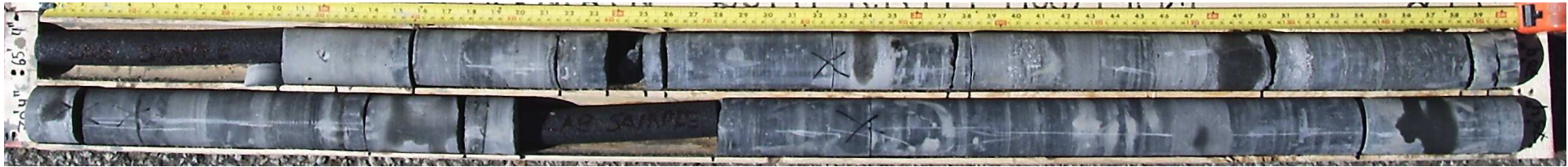


HF1-17A RUN 9: 13.82m to 15.34m BGL, RUN 10: 15.34m to 16.86m BGL

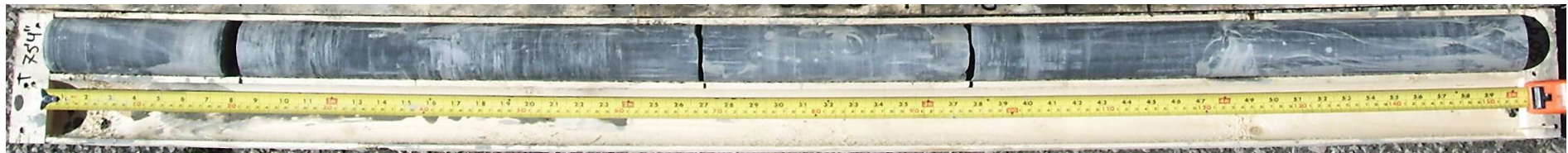


HF1-17A RUN 11: 16.86m to 18.39m BGL, RUN 12: 18.39m to 19.91m BGL


drawn	AC		client:	CH2M Hill Canada Inc.	
approved	IL		project:	Hanlan Feedermain South Contract 1	
date	25-Aug-11		title:	HF1-17A CORE PHOTOGRAPHS	
scale	N.T.S		project no:	GEOTMARK00233AA	figure no:
original size	letter				2 of 3



HF1-17A RUN 13: 19.91m to 21.44m BGL, RUN 14: 21.44m to 22.96m BGL



HF1-17A RUN 15: 22.96m to 24.48m BGL

drawn	AC	 SPECIALISTS MANAGING THE EARTH	client:	CH2M Hill Canada Inc.	
approved	IL		project:	Hanlan Feedermain South Contract 1	
date	25-Aug-11		title:	HF1-17A CORE PHOTOGRAPHS	
scale	N.T.S		project no:	GEOTMARK00233AA	figure no:
original size	letter				3 of 3




HF1-17 RUN 1: 2.41m to 3.10m BGL, RUN 2: 3.10m to 4.62m BGL



HF1-17 RUN 3: 4.62m to 6.15m BGL, RUN 4: 6.15m to 7.67m BGL



HF1-17 RUN 5: 7.67m to 9.20m BGL, RUN 6: 9.20m to 10.72m BGL

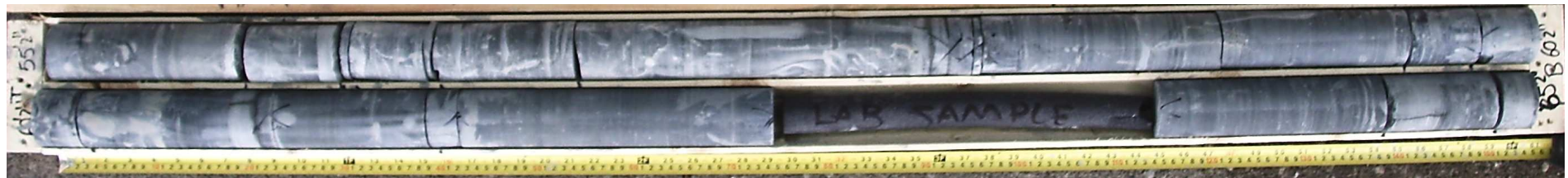
drawn	AC	 coffey geotechnics <small>SPECIALISTS MANAGING THE EARTH</small>	client:	CH2M Hill Canada Inc.	
approved	IL		project:	Hanlan Feedermain South Contract 1	
date	25-Aug-11		title:	HF1-17 CORE PHOTOGRAPHS	
scale	N.T.S		project no:	GEOTMARK00233AA	figure no:
original size	letter				1 of 3




HF1-17 RUN 7: 10.72m to 12.24m BGL, RUN 8: 12.24m to 13.77m BGL



HF1-17 RUN 9: 13.77m to 15.29m BGL, RUN 10: 15.29m to 16.82m BGL



HF1-17 RUN 11: 16.82m to 18.34m BGL, RUN 12: 18.34m to 19.86m BGL


drawn	AC	 coffey geotechnics SPECIALISTS MANAGING THE EARTH	client:	CH2M Hill Canada Inc.	
approved	IL		project:	Hanlan Feedermain South Contract 1	
date	25-Aug-11		title:	HF1-17 CORE PHOTOGRAPHS	
scale	N.T.S		project no:	GEOTMARK00233AA	figure no:
original size	letter				2 of 3

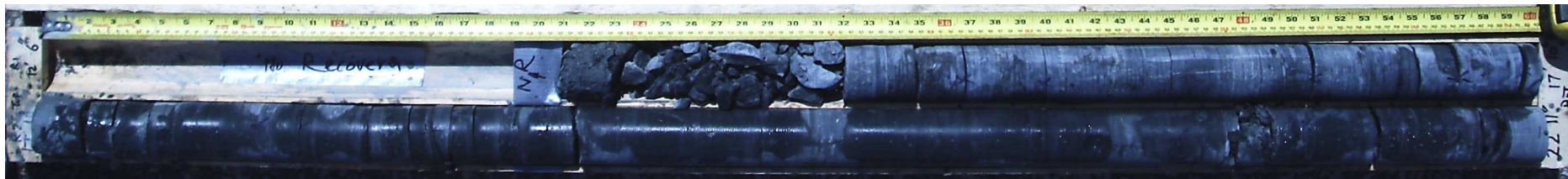


HF1-17 RUN 13: 19.86m to 21.39m BGL, RUN 14: 21.39m to 22.91m BGL

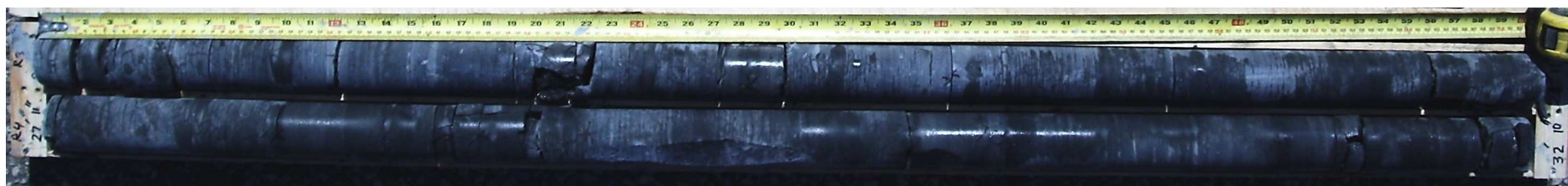


HF1-17 RUN 15: 22.91m to 24.44m BGL

drawn	AC		client:	CH2M Hill Canada Inc.	
approved	IL		project:	Hanlan Feedermain South Contract 1	
date	25-Aug-11		title:	HF1-17 CORE PHOTOGRAPHS	
scale	N.T.S		project no:	GEOTMARK00233AA	figure no:
original size	letter				3 of 3




HF1-18 RUN 1: 3.81m to 5.43m BGL, RUN 2: 5.43m to 6.99m BGL

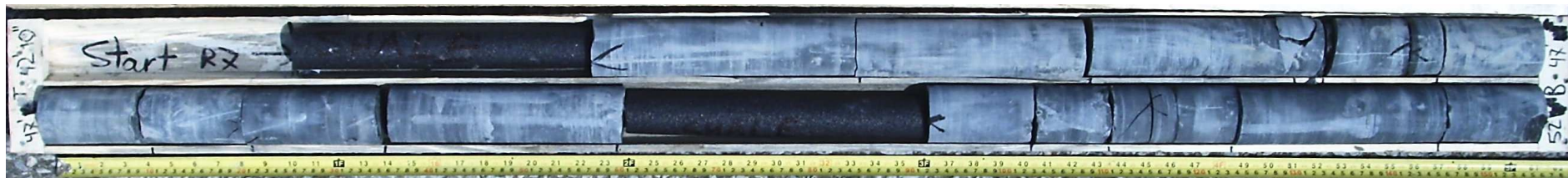


HF1-18 RUN 3: 6.99m to 8.51m BGL, RUN 4: 8.51m to 10.01m BGL



HF1-18 RUN 5: 10.01m to 11.53m BGL, RUN 6: 11.53m to 13.05m BGL

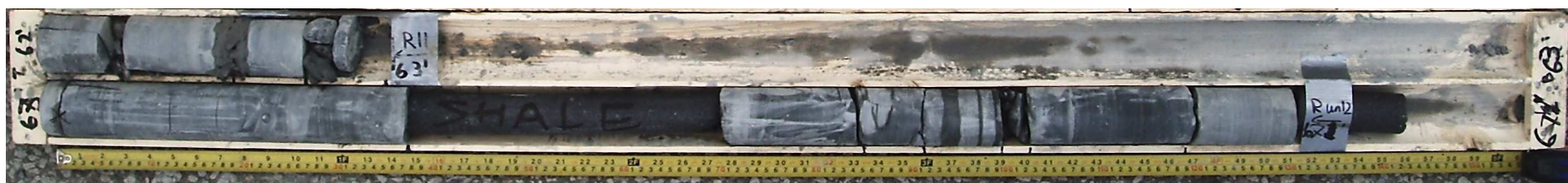
drawn	AC	 coffey geotechnics <small>SPECIALISTS MANAGING THE EARTH</small>	client:	CH2M Hill Canada Inc.	
approved	IL		project:	Hanlan Feedermain South Contract 1	
date	25-Aug-11		title:	HF1-18 CORE PHOTOGRAPHS	
scale	N.T.S		project no:	GEOTMARK00233AA	figure no:
original size	letter				1 of 3




HF1-18 RUN 7: 13.05m to 14.33m BGL, RUN 8: 14.33m to 15.85m BGL



HF1-18 RUN 9: 15.85m to 17.37m BGL, RUN 10: 17.37m to 18.90m BGL




HF1-18 RUN 11: 18.90m to 19.20m BGL, RUN 12: 19.20m to 20.42m BGL

drawn	AC	 coffey geotechnics SPECIALISTS MANAGING THE EARTH	client:	CH2M Hill Canada Inc.	
approved	IL		project:	Hanlan Feedermain South Contract 1	
date	25-Aug-11		title:	HF1-18 CORE PHOTOGRAPHS	
scale	N.T.S		project no:	GEOTMARK00233AA	figure no:
original size	letter				2 of 3

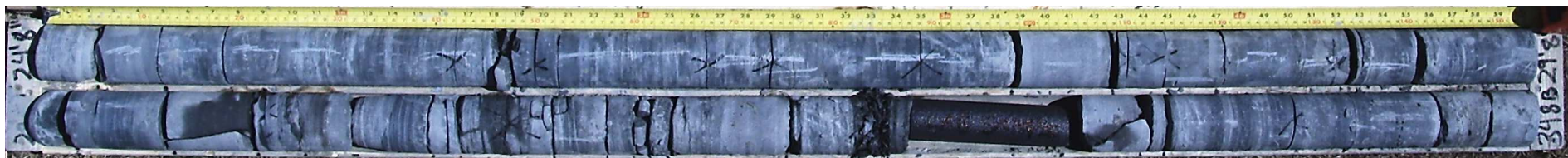


HF1-18 RUN 13: 20.42m to 21.95m BGL, RUN 14: 21.95m to 23.45m BGL

drawn	AC		client:	CH2M Hill Canada Inc.	
approved	IL		project:	Hanlan Feedermain South Contract 1	
date	25-Aug-11		title:	HF1-18 CORE PHOTOGRAPHS	
scale	N.T.S		project no:	GEOTMARK00233AA	figure no:
original size	letter				3 of 3




HF1-19 RUN 1: 5.49m to 6.00m BGL, RUN 2: 6.00m to 7.52m BGL



HF1-19 RUN 3: 7.52m to 9.04m BGL, RUN 4: 9.04m to 10.57m BGL

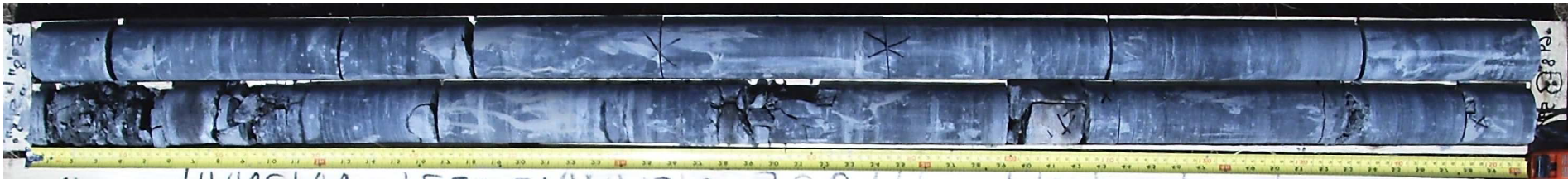


HF1-19 RUN 5: 10.57m to 12.09m BGL, RUN 6: 12.09m to 13.62m BGL

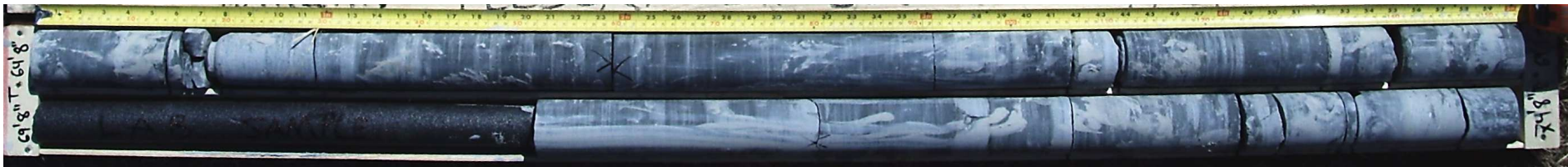
drawn	AC	 coffey geotechnics <small>SPECIALISTS MANAGING THE EARTH</small>	client:	CH2M Hill Canada Inc.	
approved	IL		project:	Hanlan Feedermain South Contract 1	
date	25-Aug-11		title:	HF1-19 CORE PHOTOGRAPHS	
scale	N.T.S		project no:	GEOTMARK00233AA	figure no:
original size	letter				1 of 2




HF1-19 RUN 7: 13.62m to 15.14m BGL, RUN 8: 15.14m to 16.66m BGL



HF1-19 RUN 9: 16.66m to 18.19m BGL, RUN 10: 18.19m to 19.71m BGL



HF1-19 RUN 11: 19.71m to 21.24m BGL, RUN 12: 21.24m to 22.76m BGL

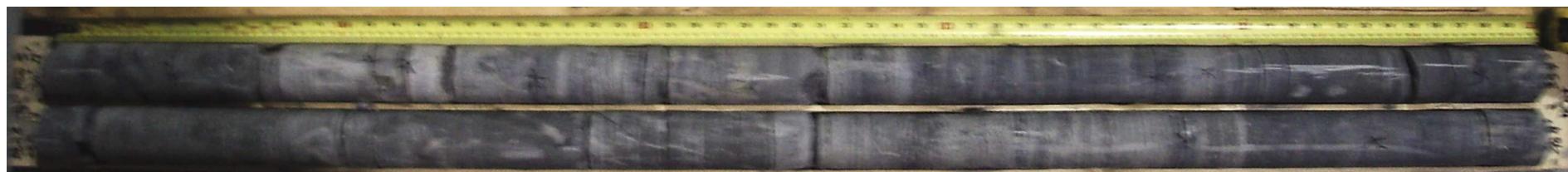
drawn	AC	 coffey geotechnics SPECIALISTS MANAGING THE EARTH	client:	CH2M Hill Canada Inc.	
approved	IL		project:	Hanlan Feedermain South Contract 1	
date	25-Aug-11		title:	HF1-19 CORE PHOTOGRAPHS	
scale	N.T.S		project no:	GEOTMARK00233AA	figure no:
original size	letter				2 of 2




HF1-20 RUN 1: 3.15m to 4.67m BGL, RUN 2: 4.67m to 6.20m BGL

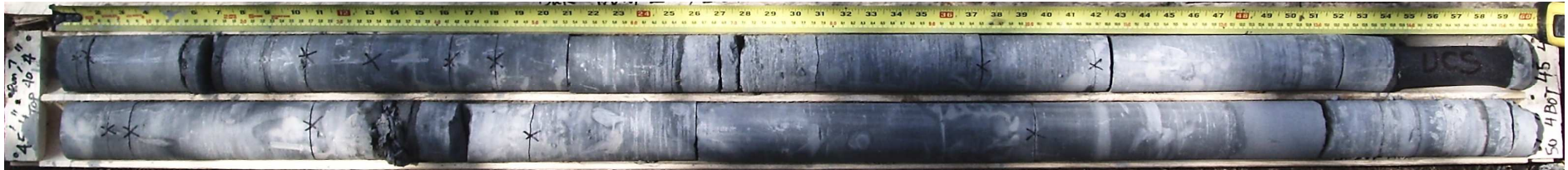


HF1-20 RUN 3: 6.20m to 7.72m BGL, RUN 4: 7.72m to 9.24m BGL



HF1-20 RUN 5: 9.24m to 10.77m BGL, RUN 6: 10.77m to 12.29m BGL

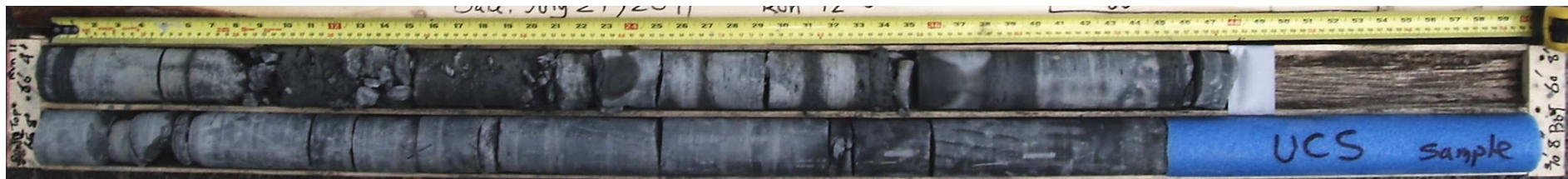
drawn	AC	 coffey geotechnics <small>SPECIALISTS MANAGING THE EARTH</small>	client:	CH2M Hill Canada Inc.	
approved	IL		project:	Hanlan Feedermain South Contract 1	
date	25-Aug-11		title:	HF1-20 CORE PHOTOGRAPHS	
scale	N.T.S		project no:	GEOTMARK00233AA	figure no:
original size	letter				1 of 2




HF1-20 RUN 7: 12.29m to 13.82m BGL, RUN 8: 13.82m to 15.34m BGL



HF1-20 RUN 9: 15.34m to 16.86m BGL, RUN 10: 16.86m to 18.39m BGL




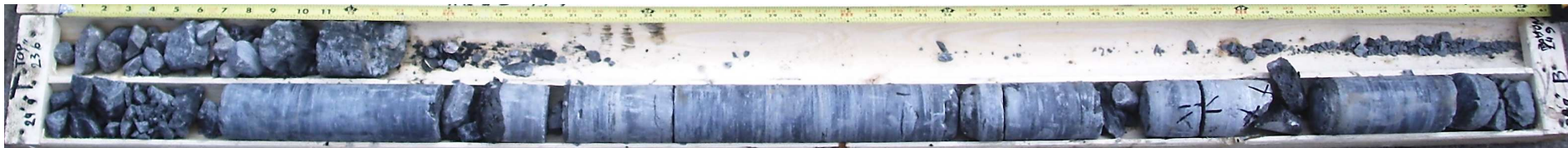
HF1-20 RUN 11: 18.39m to 19.91m BGL, RUN 12: 19.91m to 21.54m BGL

drawn	AC	 coffey geotechnics <small>SPECIALISTS MANAGING THE EARTH</small>	client:	CH2M Hill Canada Inc.	
approved	IL		project:	Hanlan Feedermain South Contract 1	
date	25-Aug-11		title:	HF1-20 CORE PHOTOGRAPHS	
scale	N.T.S		project no:	GEOTMARK00233AA	figure no:
original size	letter				2 of 3



HF1-20 RUN 13: 21.54m to 23.06m BGL

drawn	AC		client:	CH2M Hill Canada Inc.	
approved	IL		project:	Hanlan Feedermain South Contract 1	
date	25-Aug-11		title:	HF1-20 CORE PHOTOGRAPHS	
scale	N.T.S		project no:	GEOTMARK00233AA	figure no:
original size	letter				3 of 3




HF1-21 RUN 1: 7.16m to 7.54m BGL, RUN 2: 7.54m to 9.07m BGL

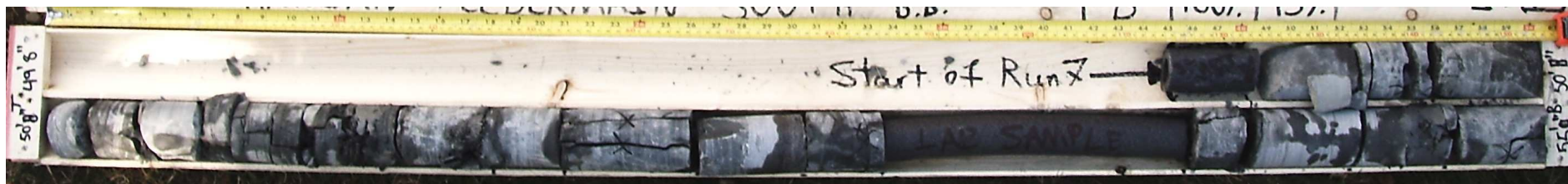


HF1-21 RUN 3: 9.07m to 10.59m BGL, RUN 4: 10.59m to 12.12m BGL



HF1-21 RUN 5: 12.12m to 13.64m BGL, RUN 6: 13.64m to 15.16m BGL

drawn	AC		client:	CH2M Hill Canada Inc.	
approved	IL		project:	Hanlan Feedermain South Contract 1	
date	25-Aug-11		title:	HF1-21 CORE PHOTOGRAPHS	
scale	N.T.S		project no:	GEOTMARK00233AA	figure no:
original size	letter				1 of 2




HF1-21 RUN 7: 15.16m to 15.44m BGL, RUN 8: 15.44m to 16.97m BGL



HF1-21 RUN 9: 16.97m to 18.49m BGL, RUN 10: 18.49m to 20.02m BGL



HF1-21 RUN 11: 20.02m to 21.54m BGL

drawn	AC	 coffey geotechnics <small>SPECIALISTS MANAGING THE EARTH</small>	client:	CH2M Hill Canada Inc.	
approved	IL		project:	Hanlan Feedermain South Contract 1	
date	25-Aug-11		title:	HF1-21 CORE PHOTOGRAPHS	
scale	N.T.S		project no:	GEOTMARK00233AA	figure no:
original size	letter				2 of 2




HF1-22 RUN 1: 5.59m to 6.07m BGL, RUN 2: 6.07m to 7.60m BGL

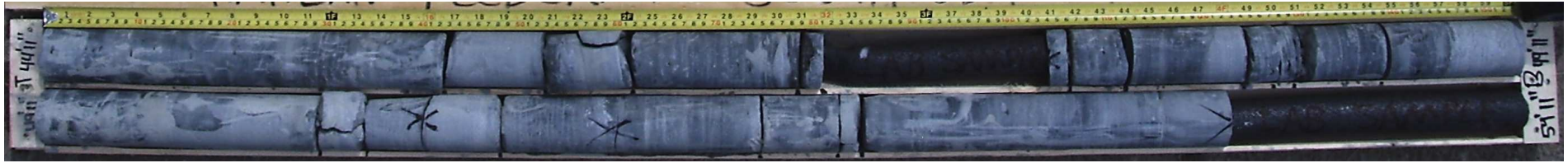


HF1-22 RUN 3: 7.60m to 9.12m BGL, RUN 4: 9.12m to 10.64m BGL



HF1-22 RUN 5: 10.64m to 12.17m BGL, RUN 6: 12.17m to 13.69m BGL

drawn	AC	 coffey geotechnics <small>SPECIALISTS MANAGING THE EARTH</small>	client:	CH2M Hill Canada Inc.	
approved	IL		project:	Hanlan Feedermain South Contract 1	
date	25-Aug-11		title:	HF1-22 CORE PHOTOGRAPHS	
scale	N.T.S		project no:	GEOTMARK00233AA	figure no:
original size	letter				1 of 2




HF1-22 RUN 7: 13.69m to 15.22m BGL, RUN 8: 15.22m to 16.74m BGL



HF1-22 RUN 9: 16.74m to 18.26m BGL, RUN 10: 18.26m to 19.79m BGL



HF1-22 RUN 11: 19.79m to 21.31m BGL

drawn	AC	 coffey geotechnics <small>SPECIALISTS MANAGING THE EARTH</small>	client:	CH2M Hill Canada Inc.	
approved	IL		project:	Hanlan Feedermain South Contract 1	
date	25-Aug-11		title:	HF1-22 CORE PHOTOGRAPHS	
scale	N.T.S		project no:	GEOTMARK00233AA	figure no:
original size	letter				2 of 2




HF1-23 RUN 1: 4.06m to 4.88m BGL, RUN 2: 4.88m to 6.40m BGL

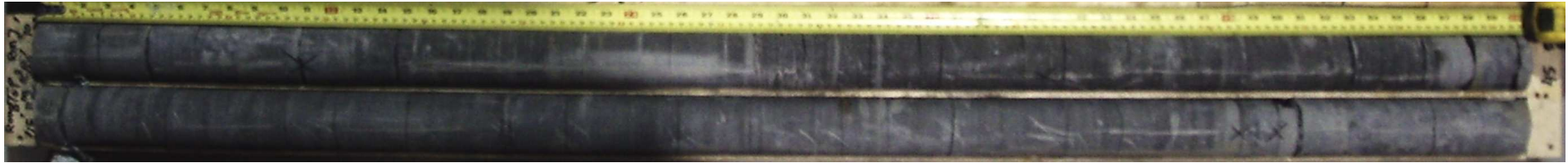


HF1-23 RUN 3: 6.40m to 7.92m BGL, RUN 4: 7.92m to 9.45m BGL



HF1-23 RUN 5: 9.45m to 10.97m BGL, RUN 6: 10.97m to 12.44m BGL

drawn	AC		client:	CH2M Hill Canada Inc.	
approved	IL		project:	Hanlan Feedermain South Contract 1	
date	25-Aug-11		title:	HF1-23 CORE PHOTOGRAPHS	
scale	N.T.S		project no:	GEOTMARK00233AA	figure no:
original size	letter				1 of 2




HF1-23 RUN 7: 12.44m to 14.00m BGL, RUN 8: 14.00m to 15.49m BGL



HF1-23 RUN 9: 15.49m to 17.02m BGL, RUN 10: 17.02m to 18.49m BGL

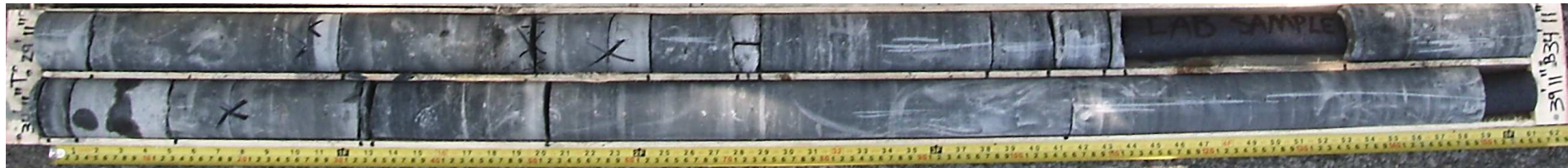


HF1-23 RUN 11: 18.49m to 20.02m BGL, RUN 12: 20.02m to 21.44m BGL

drawn	AC		client:	CH2M Hill Canada Inc.	
approved	IL		project:	Hanlan Feedermain South Contract 1	
date	25-Aug-11		title:	HF1-23 CORE PHOTOGRAPHS	
scale	N.T.S		project no:	GEOTMARK00233AA	figure no:
original size	letter				2 of 2




HF1-24 RUN 1: 6.07m to 7.60m BGL, RUN 2: 7.60m to 9.12m BGL

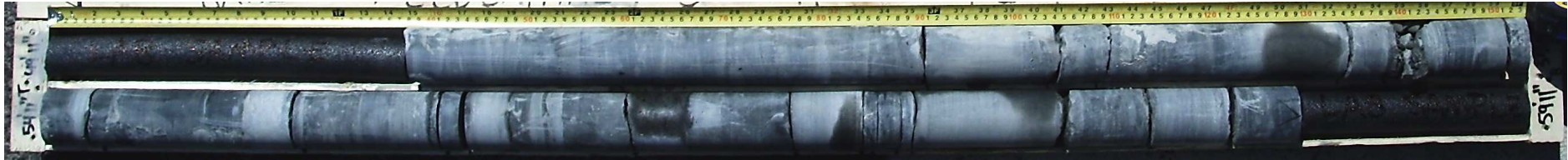


HF1-24 RUN 3: 9.12m to 10.64m BGL, RUN 4: 10.64m to 12.17m BGL



HF1-24 RUN 5: 12.17m to 13.69m BGL, RUN 6: 13.69m to 15.22m BGL


drawn	AC	 coffey geotechnics SPECIALISTS MANAGING THE EARTH	client:	CH2M Hill Canada Inc.	
approved	IL		project:	Hanlan Feedermain South Contract 1	
date	25-Aug-11		title:	HF1-24 CORE PHOTOGRAPHS	
scale	N.T.S		project no:	GEOTMARK00233AA	figure no:
original size	letter				1 of 2



HF1-24 RUN 7: 15.22m to 16.74m BGL, RUN 8: 16.74m to 18.26m BGL

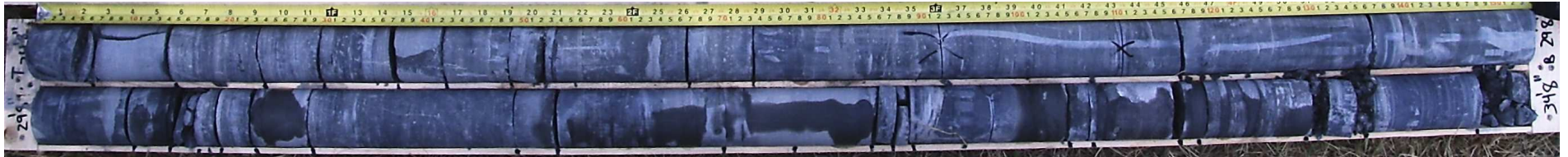


HF1-24 RUN 9: 18.26m to 19.79m BGL, RUN 10: 19.79m to 21.31m BGL

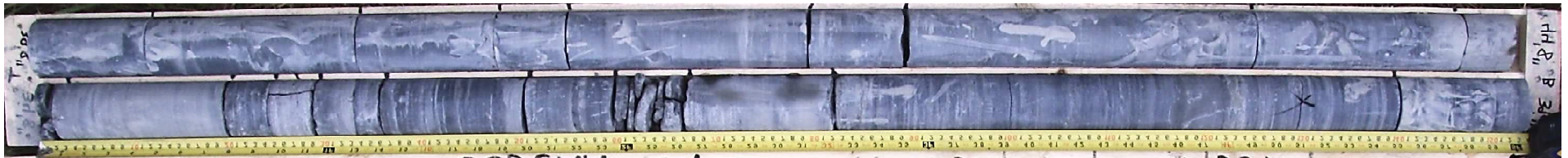
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approved	IL		project:	Hanlan Feedermain South Contract 1	
date	25-Aug-11		title:	HF1-24 CORE PHOTOGRAPHS	
scale	N.T.S		project no:	GEOTMARK00233AA	figure no:
original size	letter				2 of 2




HF1-25 RUN 1: 5.49m to 6.00m BGL, RUN 2: 6.00m to 7.52m BGL

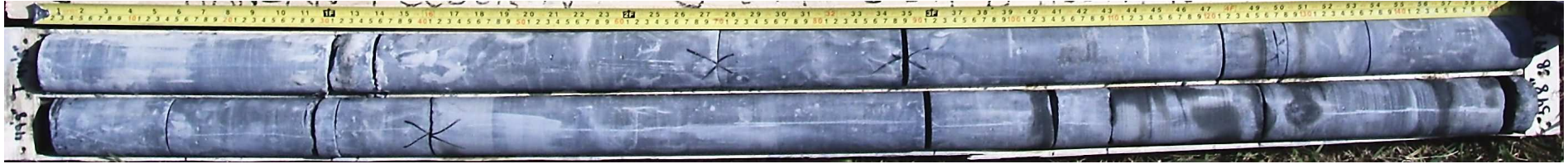


HF1-25 RUN 3: 7.52m to 9.04m BGL, RUN 4: 9.04m to 10.57m BGL

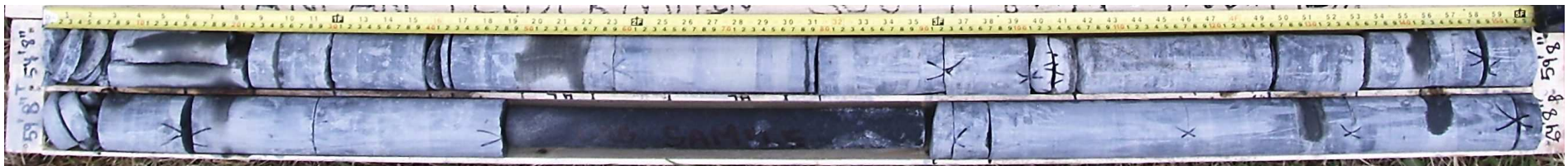


HF1-25 RUN 5: 10.57m to 12.09m BGL, RUN 6: 12.09m to 13.62m BGL

drawn	AC	 coffey geotechnics <small>SPECIALISTS MANAGING THE EARTH</small>	client:	CH2M Hill Canada Inc.	
approved	IL		project:	Hanlan Feedermain South Contract 1	
date	24-Oct-11		title:	HF1-25 CORE PHOTOGRAPHS	
scale	N.T.S		project no:	GEOTMARK00233AA	figure no:
original size	letter				1 of 3




HF1-25 RUN 7: 13.62m to 15.14m BGL, RUN 8: 15.14m to 16.66m BGL



HF1-25 RUN 9: 16.66m to 18.19m BGL, RUN 10: 18.19m to 19.71m BGL




HF1-25 RUN 11: 19.71 to 21.24m BGL, RUN 12: 21.24m to 22.76m BGL

drawn	AC	 coffey geotechnics SPECIALISTS MANAGING THE EARTH	client:	CH2M Hill Canada Inc.	
approved	IL		project:	Hanlan Feedermain South Contract 1	
date	24-Oct-11		title:	HF1-25 CORE PHOTOGRAPHS	
scale	N.T.S		project no:	GEOTMARK00233AA	figure no:
original size	letter				2 of 3

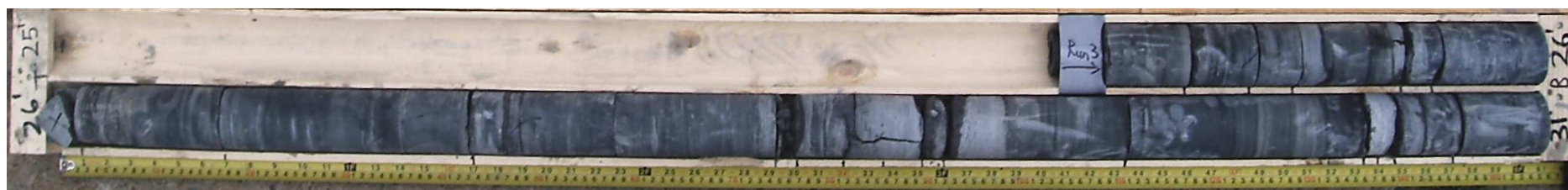


HF1-13 RUN 13: 22.76m to 24.28m BGL, RUN 14: 24.28m to 25.81m BGL

drawn	AC	 coffey geotechnics <small>SPECIALISTS MANAGING THE EARTH</small>	client:	CH2M Hill Canada Inc.	
approved	IL		project:	Hanlan Feedermain South Contract 1	
date	24-Oct-11		title:	HF1-25 CORE PHOTOGRAPHS	
scale	N.T.S		project no:	GEOTMARK00233AA	figure no:
original size	letter				3 of 3




HF1-26 RUN 1: 4.57m to 6.10m BGL, RUN 2: 6.10m to 7.62m BGL

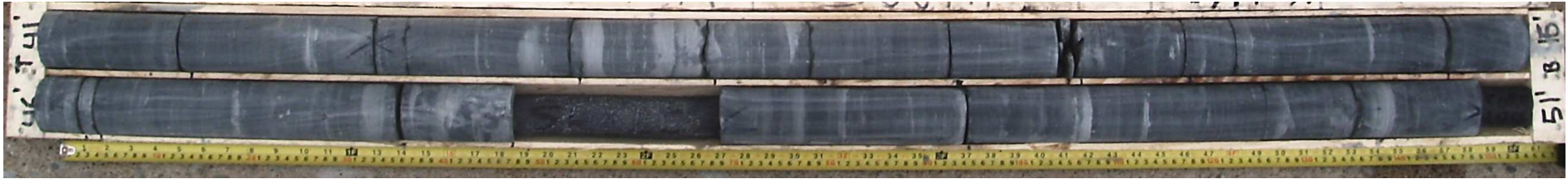


HF1-26 RUN 3: 7.62m to 7.92m BGL, RUN 4: 7.92m to 9.45m BGL



HF1-26 RUN 5: 10.57m to 12.09m BGL, RUN 6: 12.09m to 13.62m BGL

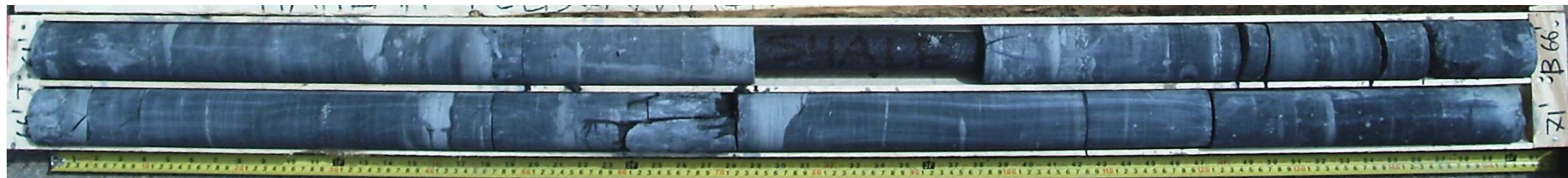
drawn	AC	 coffey geotechnics SPECIALISTS MANAGING THE EARTH	client:	CH2M Hill Canada Inc.	
approved	IL		project:	Hanlan Feedermain South Contract 1	
date	24-Oct-11		title:	HF1-26 CORE PHOTOGRAPHS	
scale	N.T.S		project no:	GEOTMARK00233AA	figure no:
original size	letter				1 of 3




HF1-26 RUN 7: 12.50m to 14.02m BGL, RUN 8: 14.02m to 15.54m BGL

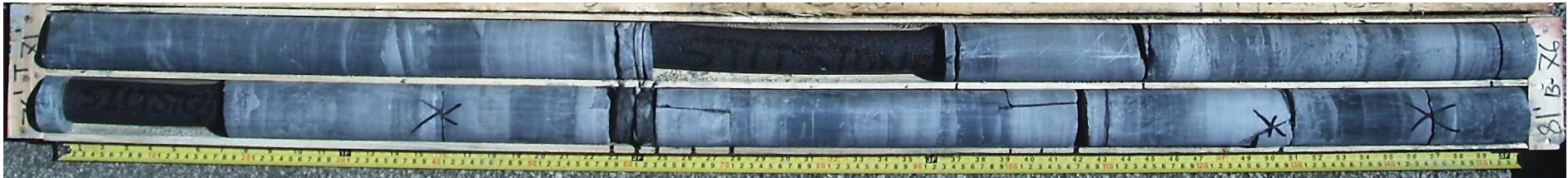


HF1-26 RUN 9: 15.54m to 17.07m BGL, RUN 10: 17.07m to 18.59m BGL




HF1-26 RUN 11: 18.59 to 20.12m BGL, RUN 12: 20.12m to 21.64m BGL

drawn	AC	 coffey geotechnics <small>SPECIALISTS MANAGING THE EARTH</small>	client:	CH2M Hill Canada Inc.	
approved	IL		project:	Hanlan Feedermain South Contract 1	
date	24-Oct-11		title:	HF1-26 CORE PHOTOGRAPHS	
scale	N.T.S		project no:	GEOTMARK00233AA	figure no:
original size	letter				2 of 3



HF1-26 RUN 13: 21.64m to 23.16m BGL, RUN 14: 23.16m to 24.69m BGL

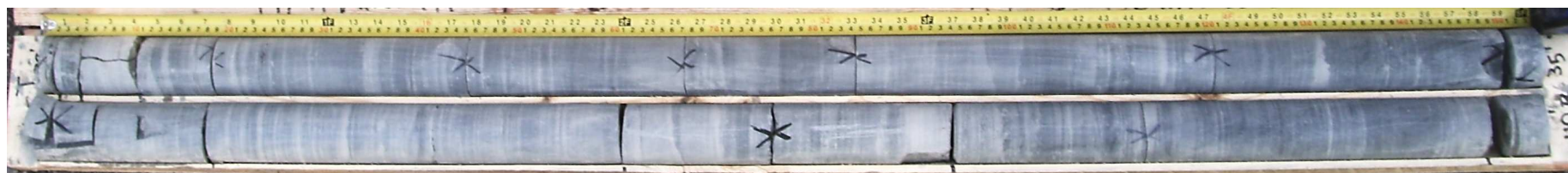
drawn	AC	 coffey geotechnics SPECIALISTS MANAGING THE EARTH	client:	CH2M Hill Canada Inc.	
approved	IL		project:	Hanlan Feedermain South Contract 1	
date	24-Oct-11		title:	HF1-26 CORE PHOTOGRAPHS	
scale	N.T.S		project no:	GEOTMARK00233AA	figure no:
original size	letter				3 of 3




HF1-27 RUN 1: 4.50m to 4.57m BGL, RUN 2: 4.57m to 6.10m BGL



HF1-27 RUN 3: 6.10m to 7.62m BGL, RUN 4: 7.62m to 9.14m BGL



HF1-27 RUN 5: 9.14m to 10.67m BGL, RUN 6: 10.67m to 12.19m BGL

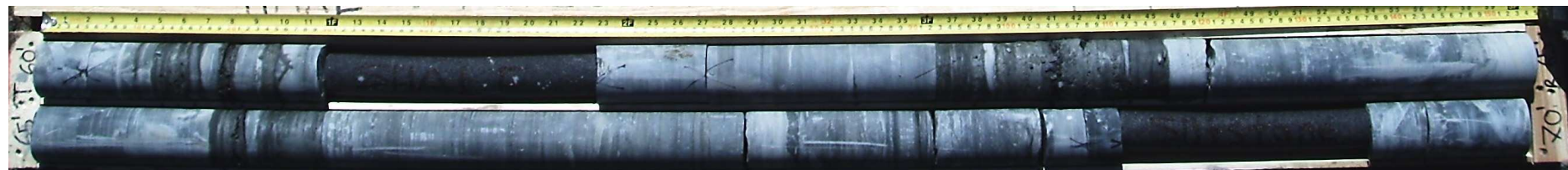
drawn	AC	 coffey geotechnics <small>SPECIALISTS MANAGING THE EARTH</small>	client:	CH2M Hill Canada Inc.	
approved	IL		project:	Hanlan Feedermain South Contract 1	
date	24-Oct-11		title:	HF1-27 CORE PHOTOGRAPHS	
scale	N.T.S		project no:	GEOTMARK00233AA	figure no:
original size	letter				1 of 3




HF1-27 RUN 7: 12.19m to 13.72m BGL, RUN 8: 13.72m to 15.24m BGL



HF1-27 RUN 9: 15.24m to 16.76m BGL, RUN 10: 16.76m to 18.29m BGL




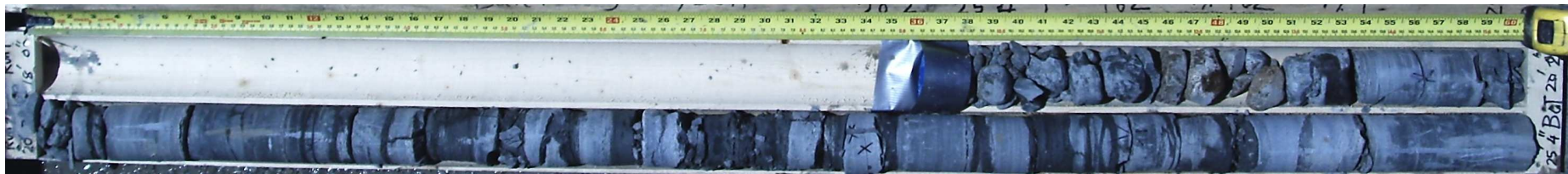
HF1-27 RUN 11: 18.29 to 19.81m BGL, RUN 12: 19.81m to 21.34m BGL

drawn	AC	 coffey geotechnics <small>SPECIALISTS MANAGING THE EARTH</small>	client:	CH2M Hill Canada Inc.	
approved	IL		project:	Hanlan Feedermain South Contract 1	
date	24-Oct-11		title:	HF1-27 CORE PHOTOGRAPHS	
scale	N.T.S		project no:	GEOTMARK00233AA	figure no:
original size	letter				2 of 3

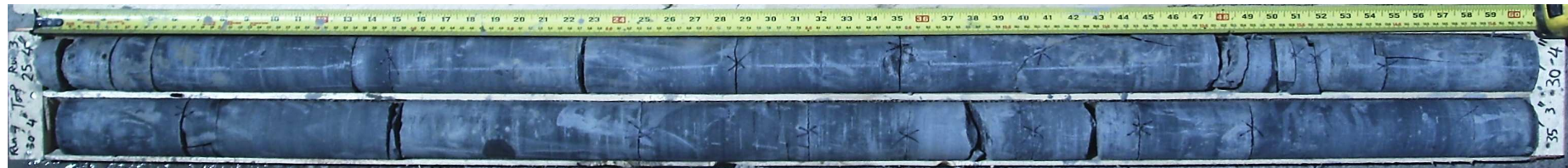


HF1-27 RUN 13: 21.34m to 22.86m BGL

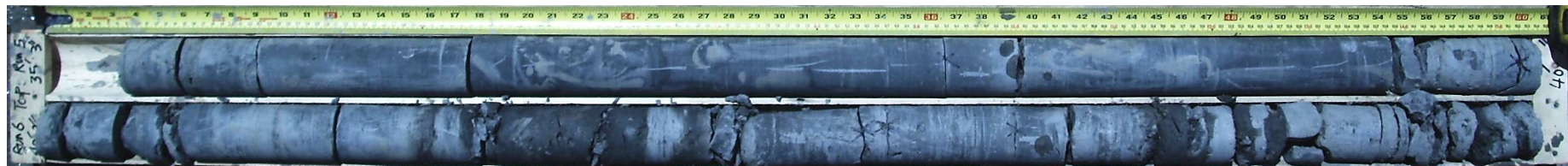
drawn	AC	 coffey geotechnics <small>SPECIALISTS MANAGING THE EARTH</small>	client:	CH2M Hill Canada Inc.	
approved	IL		project:	Hanlan Feedermain South Contract 1	
date	24-Oct-11		title:	HF1-27 CORE PHOTOGRAPHS	
scale	N.T.S		project no:	GEOTMARK00233AA	figure no:
original size	letter				3 of 3




HF1-28 RUN 1: 5.49m to 6.15m BGL, RUN 2: 6.15m to 7.72m BGL

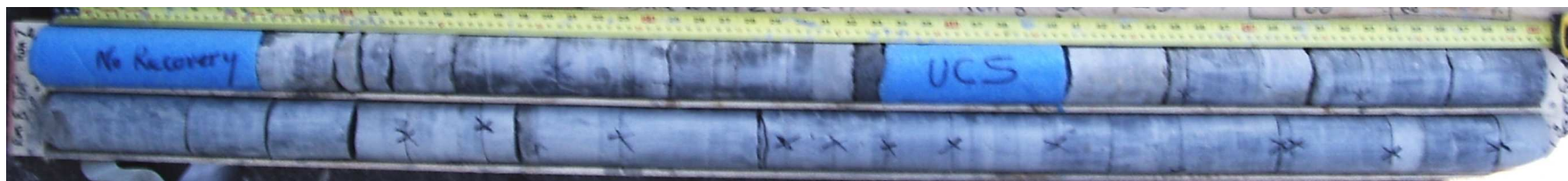


HF1-28 RUN 3: 7.72m to 9.24m BGL, RUN 4: 9.24m to 10.74m BGL



HF1-28 RUN 5: 10.74m to 12.24m BGL, RUN 6: 12.24m to 13.77m BGL

drawn	AC	 SPECIALISTS MANAGING THE EARTH	client:	CH2M Hill Canada Inc.	
approved	IL		project:	Hanlan Feedermain South Contract 1	
date	24-Oct-11		title:	HF1-28 CORE PHOTOGRAPHS	
scale	N.T.S		project no:	GEOTMARK00233AA	figure no:
original size	letter				1 of 2




HF1-28 RUN 7: 13.77m to 15.34m BGL, RUN 8: 15.34m to 16.86m BGL

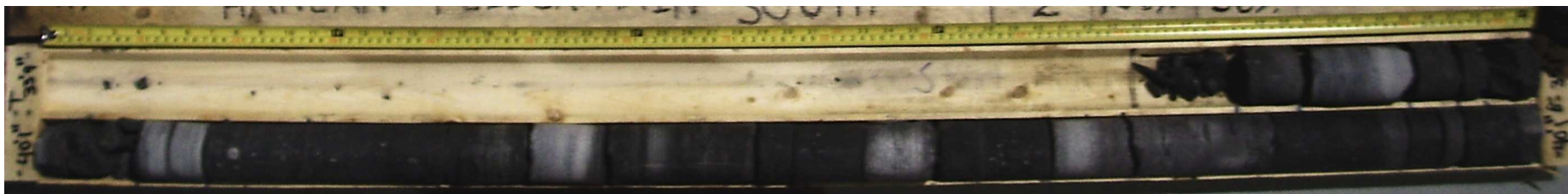


HF1-28 RUN 9: 16.86m to 17.02m BGL, RUN 10: 17.02m to 18.46m BGL



HF1-28 RUN 11: 18.46 to 19.99m BGL, RUN 12: 19.99m to 21.51m BGL

drawn	AC		client:	CH2M Hill Canada Inc.	
approved	IL		project:	Hanlan Feedermain South Contract 1	
date	24-Oct-11		title:	HF1-28 CORE PHOTOGRAPHS	
scale	N.T.S		project no:	GEOTMARK00233AA	figure no:
original size	letter				2 of 2




HF1-29 RUN 1: 10.29m to 10.69m BGL, RUN 2: 10.69m to 12.22m BGL



HF1-29 RUN 3: 12.22m to 13.74m BGL, RUN 4: 13.74m to 15.26m BGL

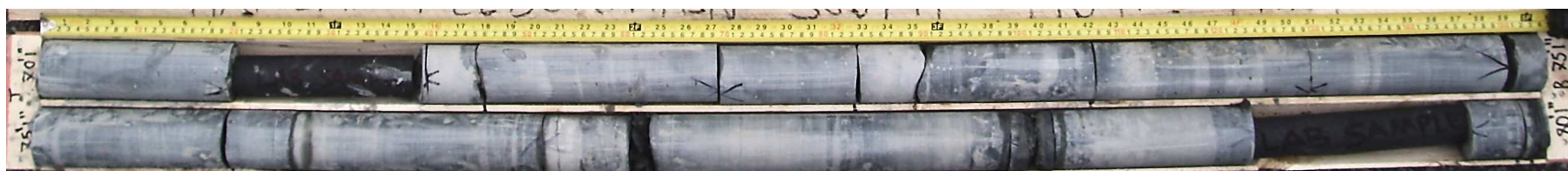


HF1-29 RUN 5: 15.26m to 16.79m BGL, RUN 6: 16.79m to 18.31m BGL


drawn	AC	 coffey geotechnics <small>SPECIALISTS MANAGING THE EARTH</small>	client:	CH2M Hill Canada Inc.	
approved	IL		project:	Hanlan Feedermain South Contract 1	
date	24-Oct-11		title:	HF1-29 CORE PHOTOGRAPHS	
scale	N.T.S		project no:	GEOTMARK00233AA	figure no:
original size	letter				1 of 2



HF1-29 RUN 7: 18.31m to 19.84m BGL, RUN 8: 19.84m to 21.36m BGL



HF1-29 RUN 9: 21.36m to 22.88m BGL, RUN 10: 22.88m to 24.41m BGL

drawn	AC	 coffey geotechnics SPECIALISTS MANAGING THE EARTH	client:	CH2M Hill Canada Inc.	
approved	IL		project:	Hanlan Feedermain South Contract 1	
date	24-Oct-11		title:	HF1-29 CORE PHOTOGRAPHS	
scale	N.T.S		project no:	GEOTMARK00233AA	figure no:
original size	letter				2 of 2




HF1-30 RUN 1: 12.34m to 13.97m BGL, RUN 2: 13.97m to 15.47m BGL



HF1-30 RUN 3: 15.47m to 16.97m BGL, RUN 4: 16.97m to 18.52m BGL




HF1-30 RUN 5: 18.52m to 20.02m BGL, RUN 6: 20.02m to 21.59m BGL

drawn	AC		client:	CH2M Hill Canada Inc.	
approved	IL		project:	Hanlan Feedermain South Contract 1	
date	25-Oct-11		title:	HF1-30 CORE PHOTOGRAPHS	
scale	N.T.S		project no:	GEOTMARK00233AA	figure no:
original size	letter				1 of 2



HF1-30 RUN 7: 21.59m to 22.23m BGL

drawn	AC		client:	CH2M Hill Canada Inc.	
approved	IL		project:	Hanlan Feedermain South Contract 1	
date	25-Oct-11		title:	HF1-30 CORE PHOTOGRAPHS	
scale	N.T.S		project no:	GEOTMARK00233AA	figure no:
original size	letter				2 of 2




HF1-31 RUN 1: 13.72m to 15.34m BGL, RUN 2: 15.34m to 16.97m BGL



HF1-31 RUN 3: 16.97m to 18.44m BGL, RUN 4: 18.44m to 19.84m BGL



HF1-31 RUN 5: 19.84m to 21.49m BGL, RUN 6: 21.49m to 23.06m BGL

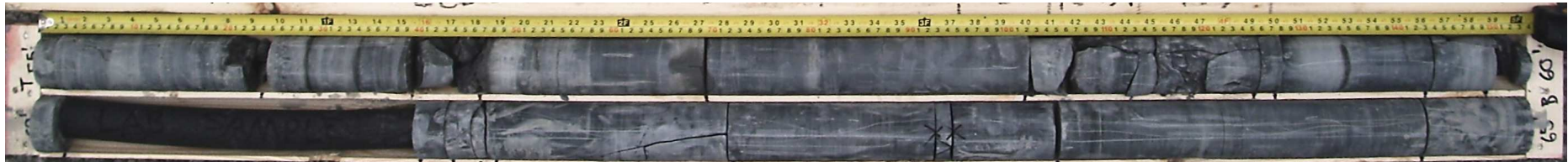
drawn	AC	 coffey geotechnics <small>SPECIALISTS MANAGING THE EARTH</small>	client:	CH2M Hill Canada Inc.	
approved	IL		project:	Hanlan Feedermain South Contract 1	
date	25-Oct-11		title:	HF1-31 CORE PHOTOGRAPHS	
scale	N.T.S		project no:	GEOTMARK00233AA	figure no:
original size	letter				1 of 1




HF1-32 RUN 1: 11.43m to 12.19m BGL, RUN 2: 12.19m to 13.72m BGL

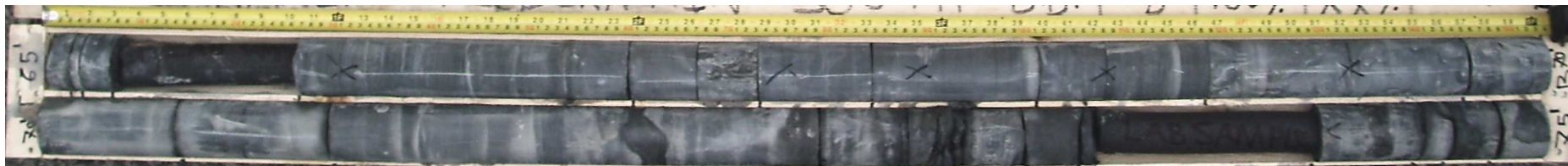


HF1-32 RUN 3: 13.72m to 15.24m BGL, RUN 4: 15.24m to 16.76m BGL

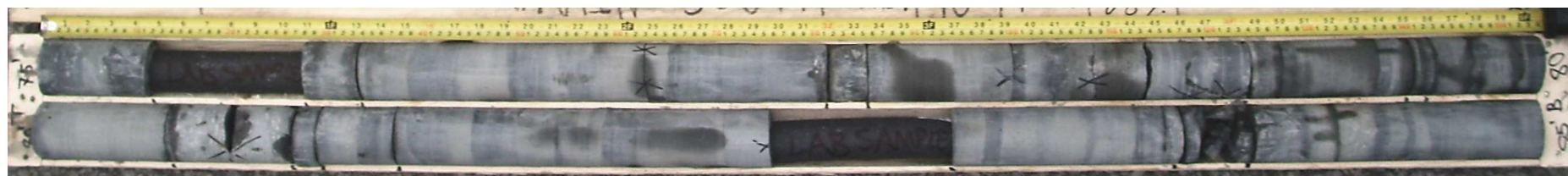


HF1-32 RUN 5: 16.76m to 18.29m BGL, RUN 6: 18.29m to 19.81m BGL


drawn	AC	 SPECIALISTS MANAGING THE EARTH	client:	CH2M Hill Canada Inc.	
approved	IL		project:	Hanlan Feedermain South Contract 1	
date	25-Oct-11		title:	HF1-32 CORE PHOTOGRAPHS	
scale	N.T.S		project no:	GEOTMARK00233AA	figure no:
original size	letter				1 of 2



HF1-32 RUN 7: 19.81m to 21.34m BGL, RUN 8: 21.34m to 22.86m BGL



HF1-32 RUN 9: 22.86m to 24.38m BGL, RUN 10: 24.38m to 25.91m BGL

drawn	AC		client:	CH2M Hill Canada Inc.	
approved	IL		project:	Hanlan Feedermain South Contract 1	
date	25-Oct-11		title:	HF1-32 CORE PHOTOGRAPHS	
scale	N.T.S		project no:	GEOTMARK00233AA	figure no:
original size	letter				2 of 2




HF1-33 RUN 1: 8.43m to 9.50m BGL, RUN 2: 9.50m to 11.07m BGL

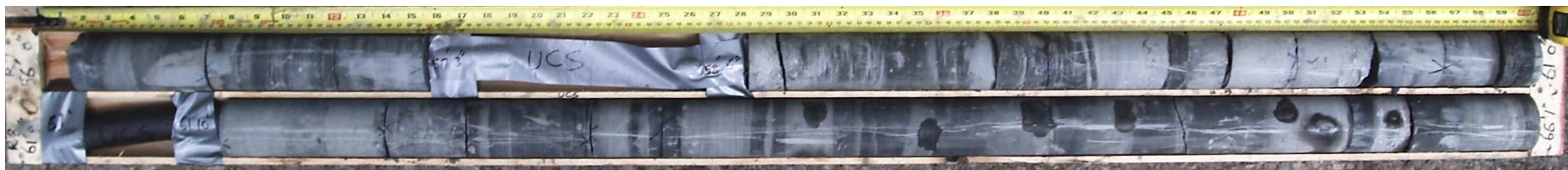


HF1-33 RUN 3: 11.07m to 12.50m BGL, RUN 4: 12.50m to 14.02m BGL



HF1-33 RUN 5: 14.02m to 15.54m BGL, RUN 6: 15.54m to 17.07m BGL

drawn	AC	 coffey geotechnics <small>SPECIALISTS MANAGING THE EARTH</small>	client:	CH2M Hill Canada Inc.	
approved	IL		project:	Hanlan Feedermain South Contract 1	
date	25-Oct-11		title:	HF1-33 CORE PHOTOGRAPHS	
scale	N.T.S		project no:	GEOTMARK00233AA	figure no:
original size	letter				1 of 2




HF1-33 RUN 7: 17.07m to 18.59m BGL, RUN 8: 18.59m to 20.17m BGL

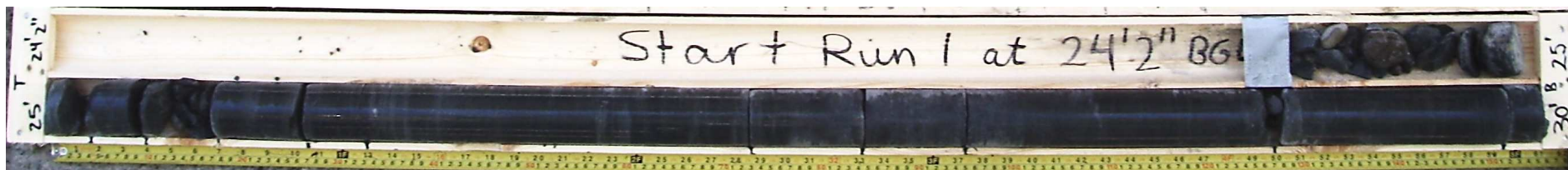


HF1-33 RUN 9: 20.14m to 21.62 m BGL, RUN 10: 21.62m to 23.16m BGL



HF1-33 RUN 11: 23.16m to 24.79m BGL, RUN 12: 24.79m to 26.21m BGL

drawn	AC	 coffey geotechnics <small>SPECIALISTS MANAGING THE EARTH</small>	client:	CH2M Hill Canada Inc.	
approved	IL		project:	Hanlan Feedermain South Contract 1	
date	25-Oct-11		title:	HF1-33 CORE PHOTOGRAPHS	
scale	N.T.S		project no:	GEOTMARK00233AA	figure no:
original size	letter				2 of 2




HF1-34 RUN 1: 7.37m to 7.62m BGL, RUN 2: 7.62m to 9.14m BGL

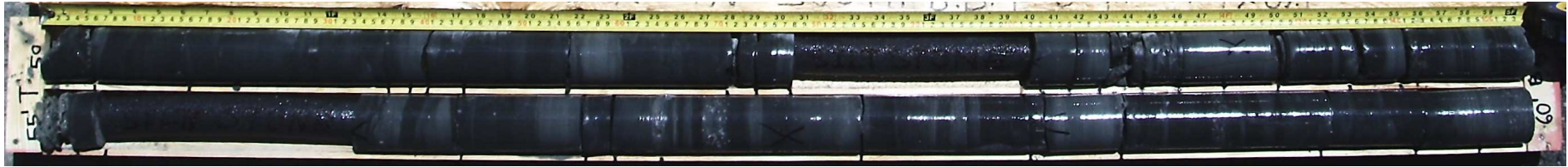


HF1-34 RUN 3: 9.14m to 10.67m BGL, RUN 4: 10.67m to 12.19m BGL



HF1-34 RUN 5: 12.19m to 13.72m BGL, RUN 6: 13.72m to 15.24m BGL

drawn	AC	 coffey geotechnics SPECIALISTS MANAGING THE EARTH	client:	CH2M Hill Canada Inc.	
approved	IL		project:	Hanlan Feedermain South Contract 1	
date	25-Oct-11		title:	HF1-34 CORE PHOTOGRAPHS	
scale	N.T.S		project no:	GEOTMARK00233AA	figure no:
original size	letter				1 of 2




HF1-34 RUN 7: 15.24m to 16.76m BGL, RUN 8: 16.76m to 18.29m BGL



HF1-34 RUN 9: 18.29m to 19.81 m BGL, RUN 10: 19.81m to 21.34m BGL



HF1-34 RUN 11: 21.34m to 22.86m BGL, RUN 12: 22.86m to 24.38m BGL

drawn	AC		client:	CH2M Hill Canada Inc.	
approved	IL		project:	Hanlan Feedermain South Contract 1	
date	25-Oct-11		title:	HF1-34 CORE PHOTOGRAPHS	
scale	N.T.S		project no:	GEOTMARK00233AA	figure no:
original size	letter				2 of 2




HF1-35 RUN 1: 1.52m to 1.73m BGL, RUN 2: 1.730m to 3.25m BGL

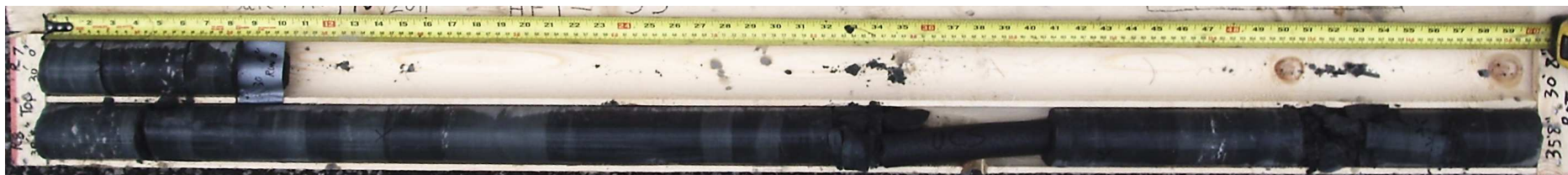


HF1-35 RUN 3: 3.25m to 4.57m BGL, RUN 4: 4.57m to 6.10m BGL

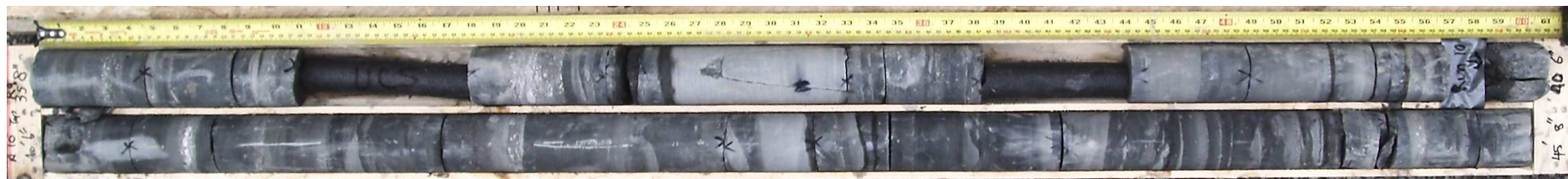


HF1-35 RUN 5: 6.10m to 7.54m BGL, RUN 6: 7.54m to 9.14m BGL

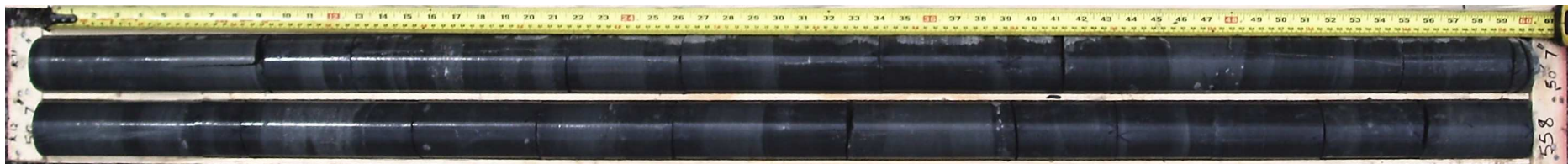
drawn	AC	 coffey geotechnics SPECIALISTS MANAGING THE EARTH	client:	CH2M Hill Canada Inc.	
approved	IL		project:	Hanlan Feedermain South Contract 1	
date	24-Oct-11		title:	HF1-35 CORE PHOTOGRAPHS	
scale	N.T.S		project no:	GEOTMARK00233AA	figure no:
original size	letter				1 of 3




HF1-35 RUN 7: 9.14m to 9.35m BGL, RUN 8: 9.35m to 10.87m BGL



HF1-35 RUN 9: 10.87m to 12.34m BGL, RUN 10: 12.34m to 13.92m BGL




HF1-35 RUN 11: 13.92 to 15.42m BGL, RUN 12: 15.42m to 16.97m BGL

drawn	AC	 coffey geotechnics SPECIALISTS MANAGING THE EARTH	client:	CH2M Hill Canada Inc.	
approved	IL		project:	Hanlan Feedermain South Contract 1	
date	24-Oct-11		title:	HF1-35 CORE PHOTOGRAPHS	
scale	N.T.S		project no:	GEOTMARK00233AA	figure no:
original size	letter				2 of 3




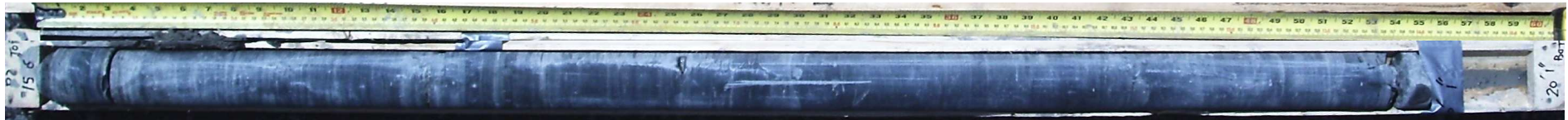
HF1-35 RUN 13: 16.97m to 18.46m BGL, RUN 14: 18.46m to 19.05m BGL

drawn	AC	 coffey geotechnics <small>SPECIALISTS MANAGING THE EARTH</small>	client:	CH2M Hill Canada Inc.	
approved	IL		project:	Hanlan Feedermain South Contract 1	
date	24-Oct-11		title:	HF1-35 CORE PHOTOGRAPHS	
scale	N.T.S		project no:	GEOTMARK00233AA	figure no:
original size	letter				3 of 3

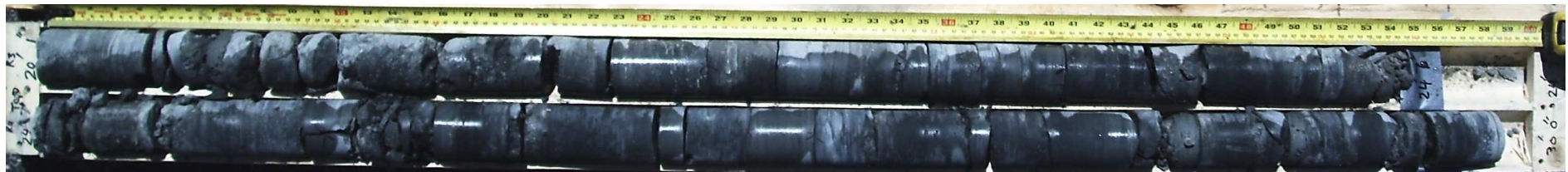


HF1-35A RUN 13: 20.06m to 21.41m BGL

drawn	AC		client:	CH2M Hill Canada Inc.	
approved	IL		project:	Hanlan Feedermain South Contract 1	
date	24-Oct-11		title:	HF1-35A CORE PHOTOGRAPHS	
scale	N.T.S		project no:	GEOTMARK00233AA	figure no:
original size	letter				3 of 3




HF1-36 RUN 1: 4.67m to 6.12m BGL



HF1-36 RUN 2: 6.12m to 7.49m BGL, RUN 3: 7.49m to 9.14m BGL



HF1-36 RUN 4: 9.14m to 10.72m BGL, RUN 5: 10.72m to 12.24m BGL

drawn	AC	 coffey geotechnics SPECIALISTS MANAGING THE EARTH	client:	CH2M Hill Canada Inc.	
approved	IL		project:	Hanlan Feedermain South Contract 1	
date	24-Oct-11		title:	HF1-36 CORE PHOTOGRAPHS	
scale	N.T.S		project no:	GEOTMARK00233AA	figure no:
original size	letter				1 of 3




HF1-36 RUN 7: 12.24m to 13.77m BGL, RUN 8: 13.77m to 15.26m BGL



HF1-36 RUN 9: 15.26m to 16.84m BGL, RUN 10: 16.84m to 18.36m BGL




HF1-36 RUN 11: 18.36m to 19.89m BGL, RUN 12: 19.89m to 21.44m BGL

drawn	AC	 coffey geotechnics SPECIALISTS MANAGING THE EARTH	client:	CH2M Hill Canada Inc.	
approved	IL		project:	Hanlan Feedermain South Contract 1	
date	24-Oct-11		title:	HF1-36 CORE PHOTOGRAPHS	
scale	N.T.S		project no:	GEOTMARK00233AA	figure no:
original size	letter				2 of 3



HF1-36 RUN 13: 21.44 to 22.02m BGL

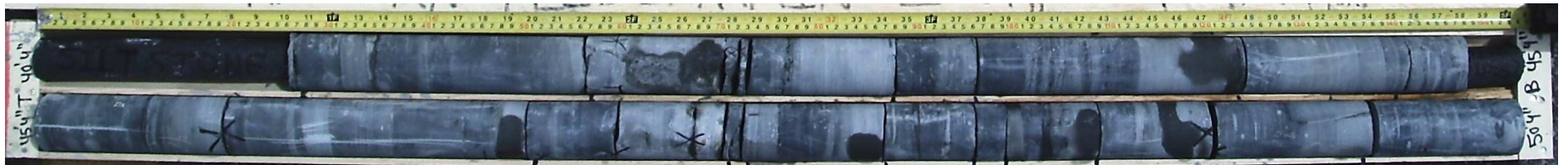
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approved	IL		project:	Hanlan Feedermain South Contract 1	
date	24-Oct-11		title:	HF1-36 CORE PHOTOGRAPHS	
scale	N.T.S		project no:	GEOTMARK00233AA	figure no:
original size	letter				3 of 3




HF1-37 RUN 1: 4.40m to 4.67m BGL, RUN 2: 4.67m to 6.20m BGL

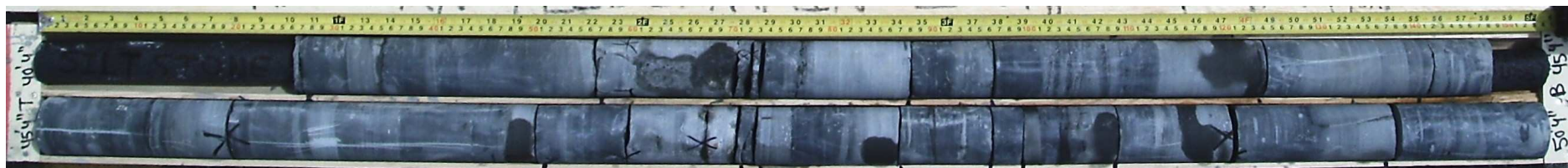


HF1-37 RUN 3: 6.20m to 7.72m BGL, RUN 4: 7.72m to 9.24m BGL



HF1-37 RUN 5: 9.24m to 10.77m BGL, RUN 6: 10.77m to 12.29m BGL

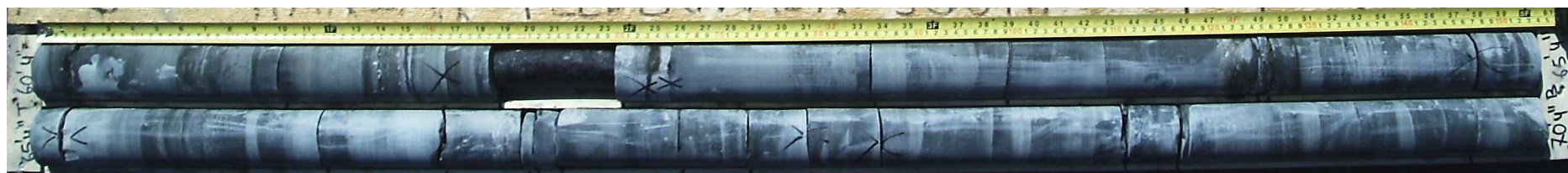
drawn	AC	 coffey geotechnics SPECIALISTS MANAGING THE EARTH	client:	CH2M Hill Canada Inc.	
approved	IL		project:	Hanlan Feedermain South Contract 1	
date	24-Oct-11		title:	HF1-37 CORE PHOTOGRAPHS	
scale	N.T.S		project no:	GEOTMARK00233AA	figure no:
original size	letter				1 of 3




HF1-37 RUN 7: 12.29m to 13.82m BGL, RUN 8: 13.82m to 15.34m BGL



HF1-37 RUN 9: 15.34m to 16.86m BGL, RUN 10: 16.86m to 18.39m BGL



HF1-37 RUN 11: 18.39m to 19.91m BGL, RUN 12: 19.91m to 21.44m BGL

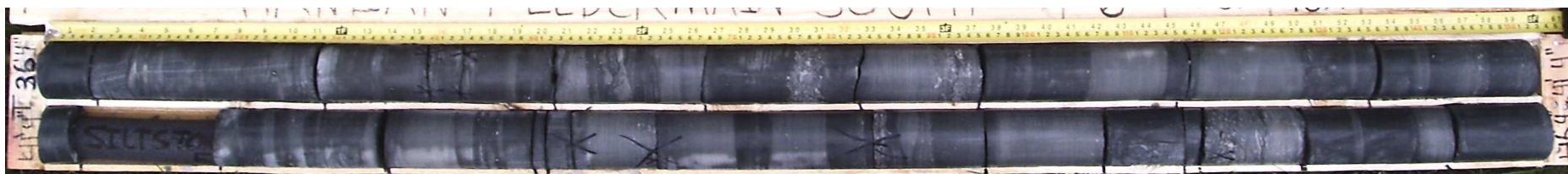
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approved	IL		project:	Hanlan Feedermain South Contract 1	
date	24-Oct-11		title:	HF1-37 CORE PHOTOGRAPHS	
scale	N.T.S		project no:	GEOTMARK00233AA	figure no:
original size	letter				2 of 2




HF1-38 RUN 1: 5.11m to 6.50m BGL, RUN 2: 6.50m to 8.03m BGL

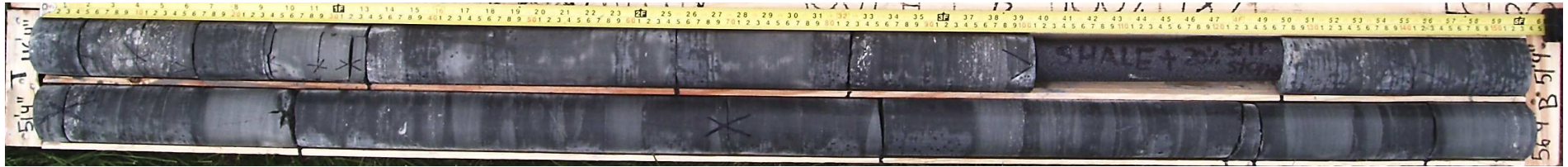


HF1-38 RUN 3: 8.03m to 9.55m BGL, RUN 4: 9.55m to 11.07m BGL



HF1-38 RUN 5: 11.07m to 12.60m BGL, RUN 6: 12.60m to 14.12m BGL


drawn	AC	 coffey geotechnics SPECIALISTS MANAGING THE EARTH	client:	CH2M Hill Canada Inc.	
approved	IL		project:	Hanlan Feedermain South Contract 1	
date	4-Nov-11		title:	HF1-38 CORE PHOTOGRAPHS	
scale	N.T.S		project no:	GEOTMARK00233AA	figure no:
original size	letter				1 of 2



HF1-38 RUN 7: 14.12m to 15.65m BGL, RUN 8: 15.65m to 17.17m BGL



HF1-38 RUN 9: 17.17m to 18.67m BGL

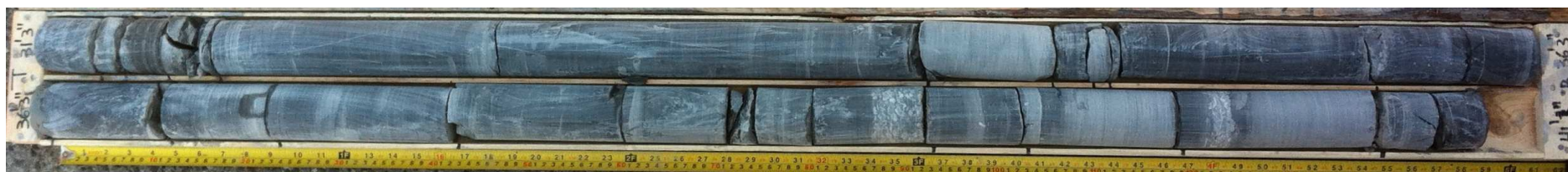
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approved	IL		project:	Hanlan Feedermain South Contract 1	
date	4-Nov-11		title:	HF1-38 CORE PHOTOGRAPHS	
scale	N.T.S		project no:	GEOTMARK00233AA	figure no:
original size	letter				2 of 2




HF1-39 RUN 1: 3.96m to 4.95m BGL, RUN 2: 4.95m to 6.48m BGL



HF1-39 RUN 3: 6.48m to 8.00m BGL, RUN 4: 8.00m to 9.53m BGL



HF1-39 RUN 5: 9.53m to 11.05m BGL, RUN 6: 11.05m to 12.52m BGL

drawn	AC	 coffey geotechnics <small>SPECIALISTS MANAGING THE EARTH</small>	client:	CH2M Hill Canada Inc.	
approved	IL		project:	Hanlan Feedermain South Contract 1	
date	4-Nov-11		title:	HF1-39 CORE PHOTOGRAPHS	
scale	N.T.S		project no:	GEOTMARK00233AA	figure no:
original size	letter				1 of 2




HF1-39 RUN 7: 12.52m to 14.05m BGL, RUN 8: 14.05m to 15.57m BGL

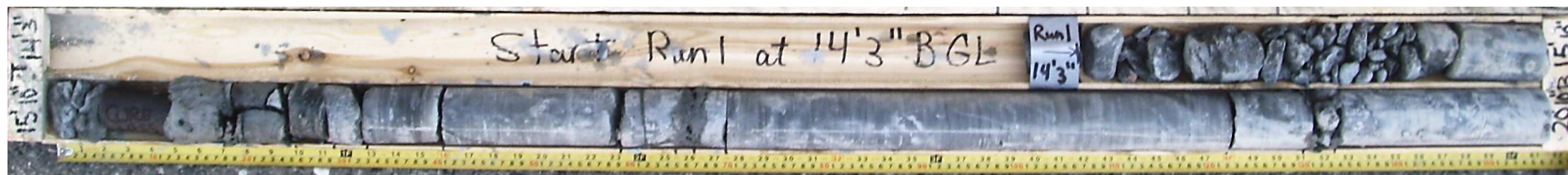


HF1-39 RUN 9: 15.57m to 17.09m BGL, RUN 10: 17.09m to 18.62m BGL



HF1-39 RUN 11: 18.62m to 20.14m BGL, RUN 12: 20.14m to 21.64m BGL

drawn	AC	 coffey geotechnics SPECIALISTS MANAGING THE EARTH	client:	CH2M Hill Canada Inc.	
approved	IL		project:	Hanlan Feedermain South Contract 1	
date	4-Nov-11		title:	HF1-39 CORE PHOTOGRAPHS	
scale	N.T.S		project no:	GEOTMARK00233AA	figure no:
original size	letter				2 of 2




HF1-40 RUN 1: 4.34m to 4.82m BGL, RUN 2: 4.95m to 6.48m BGL



HF1-40 RUN 3: 6.35m to 7.82m BGL, RUN 4: 7.82m to 9.30m BGL



HF1-40 RUN 5: 9.30m to 10.84m BGL, RUN 6: 10.84m to 12.40m BGL

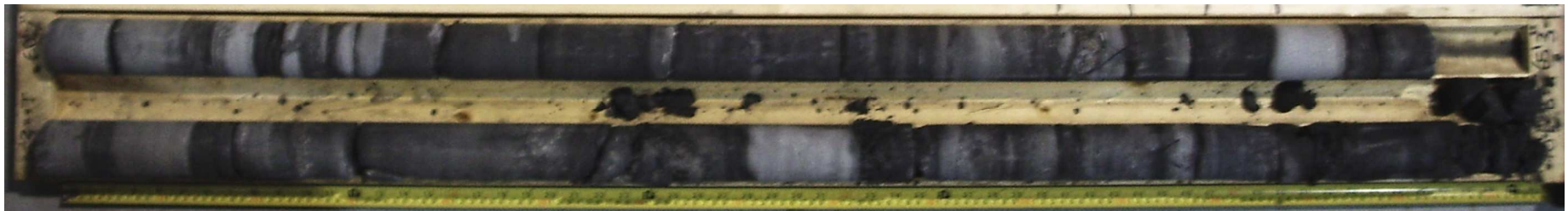
drawn	AC	 coffey geotechnics SPECIALISTS MANAGING THE EARTH	client:	CH2M Hill Canada Inc.	
approved	IL		project:	Hanlan Feedermain South Contract 1	
date	4-Nov-11		title:	HF1-40 CORE PHOTOGRAPHS	
scale	N.T.S		project no:	GEOTMARK00233AA	figure no:
original size	letter				1 of 2




HF1-40 RUN 7: 12.40m to 13.92m BGL, RUN 8: 13.92m to 15.42m BGL



HF1-40 RUN 9: 15.42m to 16.94m BGL, RUN 10: 16.94m to 18.46m BGL

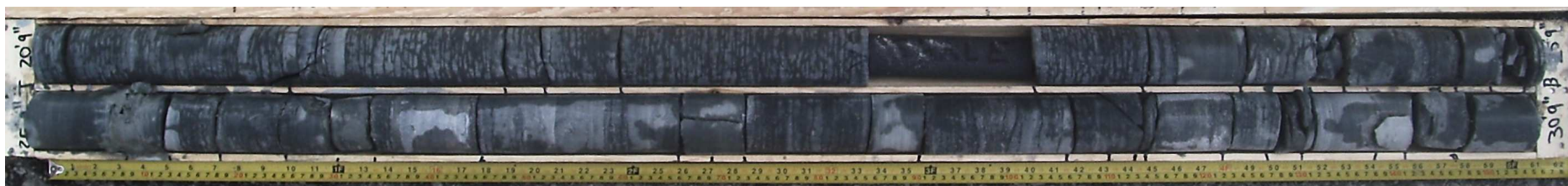


HF1-40 RUN 11: 18.46m to 19.89m BGL, RUN 12: 19.89m to 21.44m BGL

drawn	AC	 coffey geotechnics <small>SPECIALISTS MANAGING THE EARTH</small>	client:	CH2M Hill Canada Inc.	
approved	IL		project:	Hanlan Feedermain South Contract 1	
date	4-Nov-11		title:	HF1-40 CORE PHOTOGRAPHS	
scale	N.T.S		project no:	GEOTMARK00233AA	figure no:
original size	letter				2 of 2




HF1-41 RUN 1: 4.01m to 4.80m BGL, RUN 2: 4.80m to 6.32m BGL

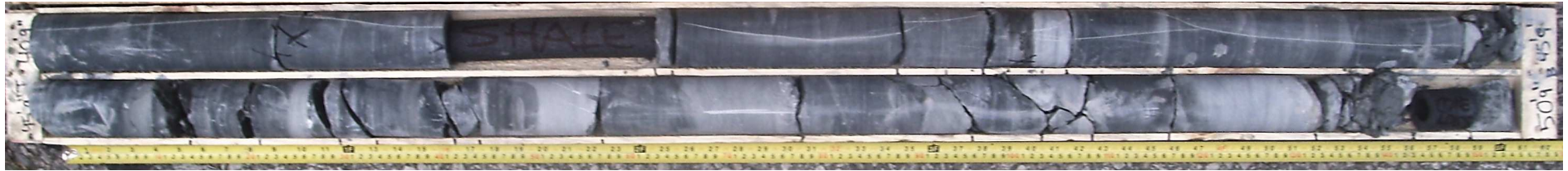


HF1-41 RUN 3: 6.32m to 7.85m BGL, RUN 4: 7.85m to 9.37m BGL



HF1-41 RUN 5: 9.37m to 10.92m BGL, RUN 6: 10.92m to 12.42m BGL

drawn	AC	 coffey geotechnics SPECIALISTS MANAGING THE EARTH	client:	CH2M Hill Canada Inc.	
approved	IL		project:	Hanlan Feedermain South Contract 1	
date	4-Nov-11		title:	HF1-41 CORE PHOTOGRAPHS	
scale	N.T.S		project no:	GEOTMARK00233AA	figure no:
original size	letter				1 of 2




HF1-41 RUN 7: 12.42m to 13.94m BGL, RUN 8: 13.94m to 15.47m BGL



HF1-41 RUN 9: 15.47m to 16.99m BGL, RUN 10: 16.99m to 18.57m BGL



HF1-41 RUN 11: 18.57m to 20.06m BGL, RUN 12: 20.06m to 21.56m BGL

drawn	AC	 coffey geotechnics <small>SPECIALISTS MANAGING THE EARTH</small>	client:	CH2M Hill Canada Inc.	
approved	IL		project:	Hanlan Feedermain South Contract 1	
date	4-Nov-11		title:	HF1-41 CORE PHOTOGRAPHS	
scale	N.T.S		project no:	GEOTMARK00233AA	figure no:
original size	letter				2 of 2




HF1-42 RUN 1: 4.09m to 4.82m BGL, RUN 2: 4.82m to 6.38m BGL



HF1-42 RUN 3: 6.38m to 7.90m BGL, RUN 4: 7.90m to 9.37m BGL



HF1-42 RUN 5: 9.37m to 10.92m BGL, RUN 6: 10.92m to 12.44m BGL

drawn	AC	 SPECIALISTS MANAGING THE EARTH	client:	CH2M Hill Canada Inc.	
approved	IL		project:	Hanlan Feedermain South Contract 1	
date	4-Nov-11		title:	HF1-42 CORE PHOTOGRAPHS	
scale	N.T.S		project no:	GEOTMARK00233AA	figure no:
original size	letter				1 of 2




HF1-42 RUN 7: 12.44m to 13.97m BGL, RUN 8: 13.97m to 15.49m BGL



HF1-42 RUN 9: 15.49m to 17.02m BGL, RUN 10: 17.02m to 18.57m BGL



HF1-42 RUN 11: 18.57m to 20.12m BGL, RUN 12: 20.12m to 21.62m BGL

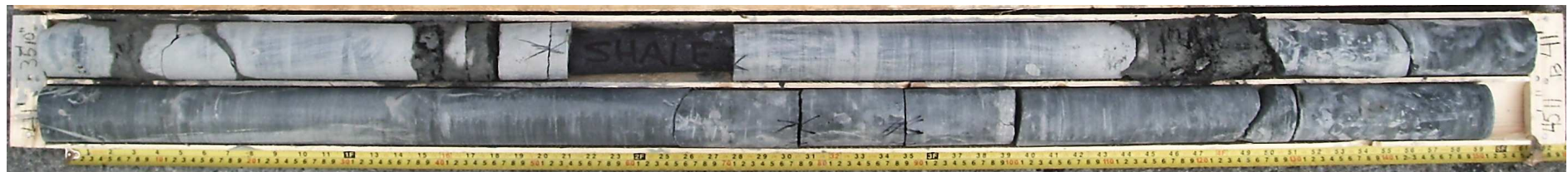
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date	4-Nov-11		title:	HF1-42 CORE PHOTOGRAPHS	
scale	N.T.S		project no:	GEOTMARK00233AA	figure no:
original size	letter				2 of 2




HF1-43 RUN 1: 5.31m to 6.27m BGL, RUN 2: 6.27m to 7.87m BGL



HF1-43 RUN 3: 7.87m to 9.4m BGL, RUN 4: 9.4m to 10.92m BGL



HF1-43 RUN 5: 10.92m to 12.50m BGL, RUN 6: 12.50m to 14.00m BGL

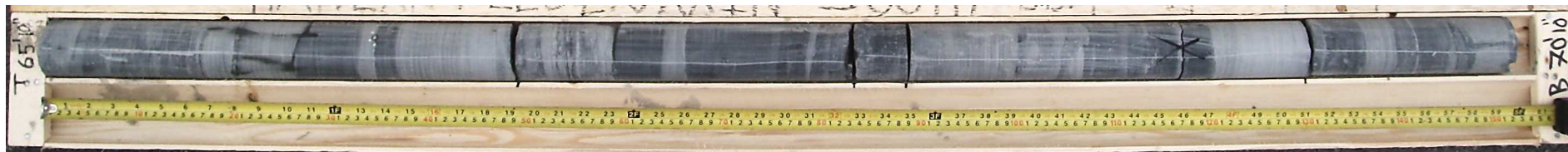
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date	4-Nov-11		title:	HF1-43 CORE PHOTOGRAPHS	
scale	N.T.S		project no:	GEOTMARK00233AA	figure no:
original size	letter				1 of 2




HF1-43 RUN 7: 14.00m to 15.54m BGL, RUN 8: 15.54m to 16.99m BGL



HF1-43 RUN 9: 16.99m to 18.54m BGL, RUN 10: 18.54m to 20.06m BGL

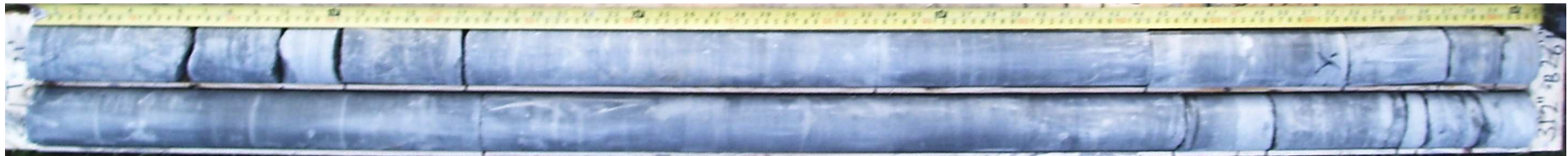


HF1-43 RUN 11: 20.06m to 21.59m BGL

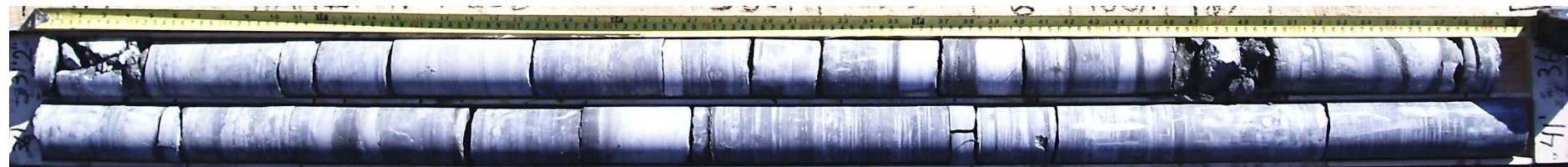
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date	4-Nov-11		title:	HF1-43 CORE PHOTOGRAPHS	
scale	N.T.S		project no:	GEOTMARK00233AA	figure no:
original size	letter				2 of 2




HF1-44 RUN 1: 4.14m to 4.85m BGL, RUN 2: 4.85m to 6.40m BGL

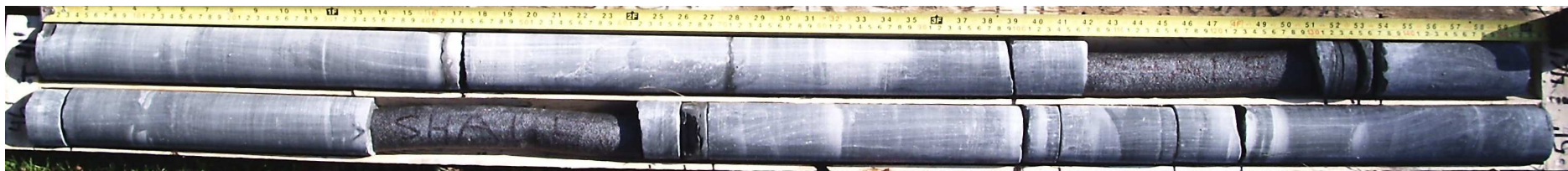


HF1-44 RUN 3: 6.40m to 7.95m BGL, RUN 4: 7.95m to 9.50m BGL

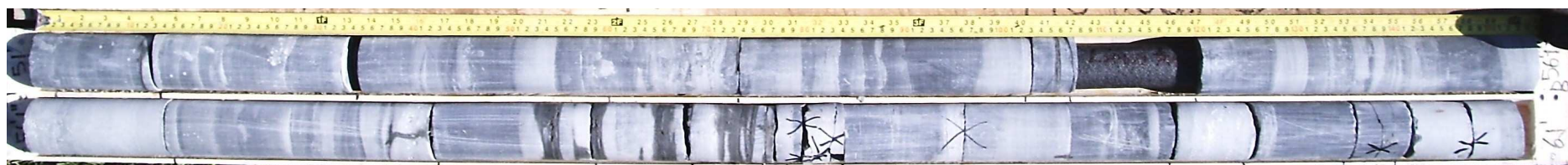


HF1-44 RUN 5: 9.50m to 10.97m BGL, RUN 6: 10.97m to 12.50m BGL

drawn	AC	 coffey geotechnics <small>SPECIALISTS MANAGING THE EARTH</small>	client:	CH2M Hill Canada Inc.	
approved	IL		project:	Hanlan Feedermain South Contract 1	
date	4-Nov-11		title:	HF1-44 CORE PHOTOGRAPHS	
scale	N.T.S		project no:	GEOTMARK00233AA	figure no:
original size	letter				1 of 3




HF1-44 RUN 7: 12.50m to 14.02m BGL, RUN 8: 14.02m to 15.54m BGL



HF1-44 RUN 9: 15.54m to 17.09m BGL, RUN 10: 17.09m to 18.59m BGL




HF1-44 RUN 11: 18.59m to 20.12m BGL, RUN 12: 20.12m to 21.64m BGL

drawn	AC	 coffey geotechnics SPECIALISTS MANAGING THE EARTH	client:	CH2M Hill Canada Inc.	
approved	IL		project:	Hanlan Feedermain South Contract 1	
date	4-Nov-11		title:	HF1-44 CORE PHOTOGRAPHS	
scale	N.T.S		project no:	GEOTMARK00233AA	figure no:
original size	letter				2 of 3

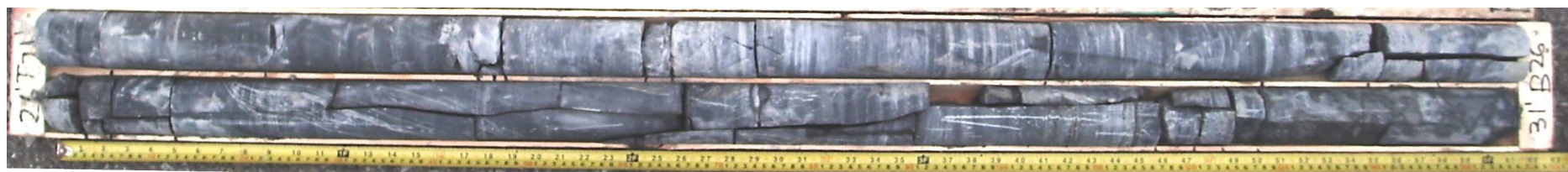


HF1-44 RUN 13: 21.64m to 23.16m BGL, RUN 14: 23.16m to 24.71m BGL

drawn	AC		client:	CH2M Hill Canada Inc.	
approved	IL		project:	Hanlan Feedermain South Contract 1	
date	4-Nov-11		title:	HF1-44 CORE PHOTOGRAPHS	
scale	N.T.S		project no:	GEOTMARK00233AA	figure no:
original size	letter				3 of 3




HF1-45 RUN 1: 4.42m to 4.88m BGL, RUN 2: 4.88m to 6.40m BGL

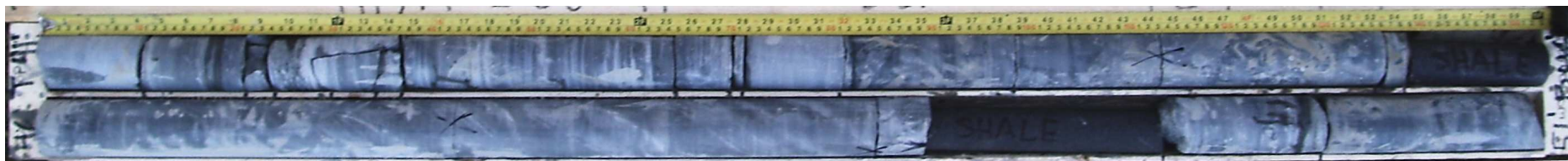


HF1-45 RUN 3: 6.40m to 7.92m BGL, RUN 4: 7.92m to 9.45m BGL



HF1-45 RUN 5: 9.45m to 10.97m BGL, RUN 6: 10.97m to 12.50m BGL

drawn	AC	 coffey geotechnics <small>SPECIALISTS MANAGING THE EARTH</small>	client:	CH2M Hill Canada Inc.	
approved	IL		project:	Hanlan Feedermain South Contract 1	
date	4-Nov-11		title:	HF1-45 CORE PHOTOGRAPHS	
scale	N.T.S		project no:	GEOTMARK00233AA	figure no:
original size	letter				1 of 3




HF1-45 RUN 7: 12.50m to 14.02m BGL, RUN 8: 14.02m to 15.54m BGL

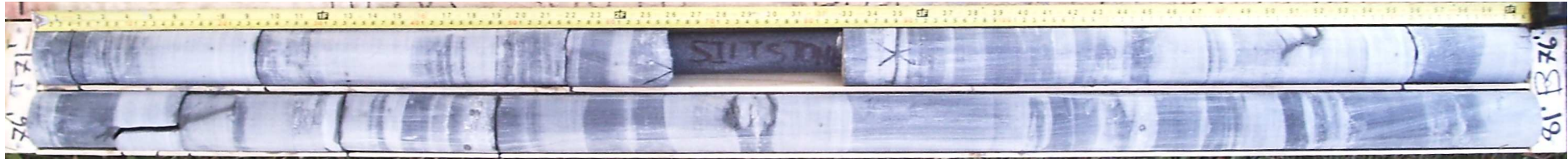


HF1-45 RUN 9: 15.54m to 17.07m BGL, RUN 10: 17.07m to 18.59m BGL




HF1-45 RUN 11: 18.59m to 20.12m BGL, RUN 12: 20.12m to 21.64m BGL

drawn	AC	 coffey geotechnics <small>SPECIALISTS MANAGING THE EARTH</small>	client:	CH2M Hill Canada Inc.	
approved	IL		project:	Hanlan Feedermain South Contract 1	
date	4-Nov-11		title:	HF1-45 CORE PHOTOGRAPHS	
scale	N.T.S		project no:	GEOTMARK00233AA	figure no:
original size	letter				2 of 3



HF1-45 RUN 13: 21.64m to 23.16m BGL, RUN 14: 23.16m to 24.69m BGL

drawn	AC	 SPECIALISTS MANAGING THE EARTH	client:	CH2M Hill Canada Inc.	
approved	IL		project:	Hanlan Feedermain South Contract 1	
date	4-Nov-11		title:	HF1-45 CORE PHOTOGRAPHS	
scale	N.T.S		project no:	GEOTMARK00233AA	figure no:
original size	letter				3 of 3




HF1-46 RUN 1: 4.70m to 4.88m BGL, RUN 2: 4.88m to 6.40m BGL

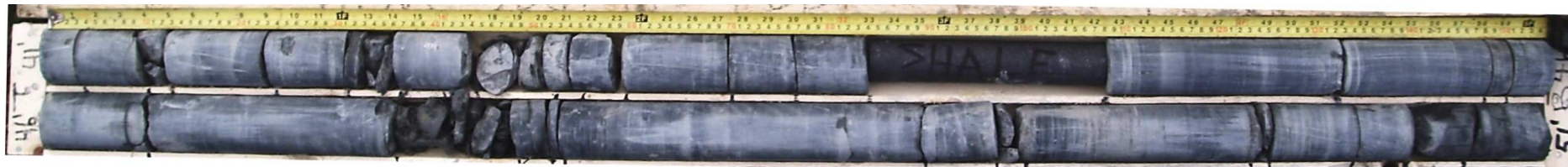


HF1-46 RUN 3: 6.40m to 7.92m BGL, RUN 4: 7.92m to 9.45m BGL



HF1-46 RUN 5: 9.45m to 10.97m BGL, RUN 6: 10.97m to 12.50m BGL

drawn	AC	 coffey geotechnics <small>SPECIALISTS MANAGING THE EARTH</small>	client:	CH2M Hill Canada Inc.	
approved	IL		project:	Hanlan Feedermain South Contract 1	
date	4-Nov-11		title:	HF1-46 CORE PHOTOGRAPHS	
scale	N.T.S		project no:	GEOTMARK00233AA	figure no:
original size	letter				1 of 3




HF1-46 RUN 7: 12.50m to 14.02m BGL, RUN 8: 14.02m to 15.54m BGL

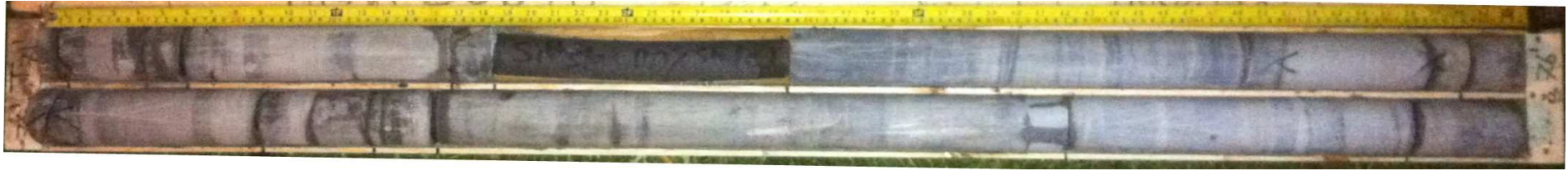


HF1-46 RUN 9: 15.54m to 17.07m BGL, RUN 10: 17.07m to 18.59m BGL




HF1-46 RUN 11: 18.59m to 20.12m BGL, RUN 12: 20.12m to 21.64m BGL

drawn	AC		client:	CH2M Hill Canada Inc.	
approved	IL		project:	Hanlan Feedermain South Contract 1	
date	4-Nov-11		title:	HF1-46 CORE PHOTOGRAPHS	
scale	N.T.S		project no:	GEOTMARK00233AA	figure no:
original size	letter				2 of 3



HF1-46 RUN 13: 21.64m to 23.16m BGL, RUN 14: 23.16m to 24.69m BGL

drawn	AC	 coffey geotechnics <small>SPECIALISTS MANAGING THE EARTH</small>	client:	CH2M Hill Canada Inc.	
approved	IL		project:	Hanlan Feedermain South Contract 1	
date	4-Nov-11		title:	HF1-46 CORE PHOTOGRAPHS	
scale	N.T.S		project no:	GEOTMARK00233AA	figure no:
original size	letter				3 of 3

Appendix E

Environmental and Chemical Test Results



Certificate of Analysis

AGAT WORK ORDER: 11T513561

PROJECT NO: GEOTMARK00233AA

5835 COOPERS AVENUE
MISSISSAUGA, ONTARIO
CANADA L4Z 1Y2
TEL (905)712-5100
FAX (905)712-5122
<http://www.agatlabs.com>

CLIENT NAME: COFFEY GEOTECHNICS

ATTENTION TO: Oxana Matiiuc

O. Reg. 153(511) - Metals & Inorganics (Soil)

DATE SAMPLED:

DATE RECEIVED: Jul 26, 2011

DATE REPORTED: Aug 03, 2011

SAMPLE TYPE: Soil

Parameter	Unit	G / S	RDL	HF1-13 SS1	HF1-13 SS6	HF1-25 SS1
				2570282	2570284	2570285
Antimony	µg/g	7.5	0.8	<0.8	<0.8	<0.8
Arsenic	µg/g	18	1	4	1	1
Barium	µg/g	390	2	49	9	17
Beryllium	µg/g	4	0.5	0.6	<0.5	<0.5
Boron	µg/g	120	5	5	<5	<5
Boron (Hot Water Soluble)	µg/g	1.5	0.10	0.13	<0.10	0.34
Cadmium	µg/g	1.2	0.5	<0.5	<0.5	<0.5
Chromium	µg/g	160	2	16	5	9
Cobalt	µg/g	22	0.5	7.7	2.2	2.5
Copper	µg/g	140	1	15	5	6
Lead	µg/g	120	1	15	2	15
Molybdenum	µg/g	6.9	0.5	1.0	<0.5	<0.5
Nickel	µg/g	100	1	13	2	4
Selenium	µg/g	2.4	0.4	<0.4	<0.4	<0.4
Silver	µg/g	20	0.2	<0.2	<0.2	<0.2
Thallium	µg/g	1	0.4	<0.4	<0.4	<0.4
Uranium	ug/g	23	0.5	0.5	0.6	<0.5
Vanadium	µg/g	86	1	29	11	18
Zinc	µg/g	340	5	53	11	17
Chromium VI	µg/g	8	0.2	<0.2	<0.2	<0.2
Cyanide	µg/g	0.051	0.05	<0.05	<0.05	<0.05
Mercury	µg/g	0.27	0.01	0.02	<0.01	0.02
Electrical Conductivity	mS/cm	0.7	0.002	4.34	0.612	0.298
Sodium Adsorption Ratio (2:1)	N/A	5	N/A	61.0	2.38	0.817
pH, 2:1 CaCl2 Extraction	pH Units			7.98	8.05	7.78

Comments: RDL - Reported Detection Limit; G / S - Guideline / Standard: Refers to T2(RPI) - New

2570282-2570285 EC & SAR were determined on the DI water extract obtained from the 2:1 leaching procedure (2 parts DI water:1 part soil). pH was determined on the 0.01M CaCl2 extract prepared at 2:1 ratio.

Certified By:



AGAT Laboratories

Guideline Violation

AGAT WORK ORDER: 11T513561

PROJECT NO: GEOTMARK00233AA

5835 COOPERS AVENUE
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<http://www.agatlabs.com>

CLIENT NAME: COFFEY GEOTECHNICS

ATTENTION TO: Oxana Matiiuc

SAMPLEID	SAMPLE TITLE	GUIDELINE	ANALYSIS PACKAGE	PARAMETER	GUIDEVALUE	RESULT
2570282	HF1-13 SS1	T2(RPI) - New	O. Reg. 153(511) - Metals & Inorganics (Soil)	Electrical Conductivity	0.7	4.34
2570282	HF1-13 SS1	T2(RPI) - New	O. Reg. 153(511) - Metals & Inorganics (Soil)	Sodium Adsorption Ratio (2:1)	5	61.0



Certificate of Analysis

AGAT WORK ORDER: 11T513561

PROJECT NO: GEOTMARK00233AA

5835 COOPERS AVENUE
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CLIENT NAME: COFFEY GEOTECHNICS

ATTENTION TO: Oxana Matiiuc

O. Reg. 558 Metals and Inorganics

DATE SAMPLED:

DATE RECEIVED: Jul 26, 2011

DATE REPORTED: Aug 03, 2011

SAMPLE TYPE: Soil

Parameter	Unit	G / S	RDL	HF1-13 SS1	HF1-13 SS6	HF1-25 SS3
				2570282	2570284	2570286
Arsenic Leachate	mg/L	2.5	0.010	<0.010	<0.010	<0.010
Barium Leachate	mg/L	100	0.100	0.347	0.243	0.156
Boron Leachate	mg/L	500	0.050	0.056	<0.050	0.057
Cadmium Leachate	mg/L	0.5	0.010	<0.010	<0.010	<0.010
Chromium Leachate	mg/L	5	0.010	<0.010	0.020	0.014
Lead Leachate	mg/L	5.0	0.010	<0.010	0.024	0.011
Mercury Leachate	mg/L	0.1	0.005	<0.005	<0.005	<0.005
Selenium Leachate	mg/L	1.0	0.010	<0.010	<0.010	<0.010
Silver Leachate	mg/L	5	0.010	<0.010	<0.010	<0.010
Uranium Leachate	mg/L	10	0.050	<0.050	<0.050	<0.050
Fluoride Leachate	mg/L	150	0.05	0.15	0.21	0.18
Cyanide Leachate	mg/L	20	0.05	<0.05	<0.05	<0.05
(Nitrate + Nitrite) as N Leachate	mg/L	1000	0.70	<0.70	<0.70	<0.70

Comments: RDL - Reported Detection Limit; G / S - Guideline / Standard: Refers to Reg. 558

Certified By:



Certificate of Analysis

AGAT WORK ORDER: 11T520410
PROJECT NO: GEOTMARK00233AA

5835 COOPERS AVENUE
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FAX (905)712-5122
<http://www.agatlabs.com>

CLIENT NAME: COFFEY GEOTECHNICS

ATTENTION TO: Oxana Matiuc

O. Reg. 153(511) - Metals & Inorganics (Soil)

DATE SAMPLED:				DATE RECEIVED: Aug 18, 2011				DATE REPORTED: Aug 29, 2011				SAMPLE TYPE: Soil	
Parameter	Unit	G / S	RDL	HF1-14 SS2 2627821	HF1-14 SS5 2627822	HF1-16 SS1A 2627823	HF1-19 SS1 2627824	HF1-19 SS3 2627825	HF1-22 SS1 2627826	HF1-22 SS3 2627827	HF1-24 SS1 2627828		
Antimony	µg/g	7.5	0.8	<0.8	<0.8	<0.8	<0.8	<0.8	<0.8	<0.8	<0.8		
Arsenic	µg/g	18	1	3	2	6	1	2	2	1	2		
Barium	µg/g	390	2	24	9	47	11	81	15	8	13		
Beryllium	µg/g	4	0.5	<0.5	<0.5	0.6	<0.5	<0.5	<0.5	<0.5	<0.5		
Boron	µg/g	120	5	<5	<5	7	<5	7	<5	<5	<5		
Boron (Hot Water Soluble)	µg/g	1.5	0.10	0.11	0.12	0.25	0.14	0.48	0.13	<0.10	<0.10		
Cadmium	µg/g	1.2	0.5	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5		
Chromium	µg/g	160	2	6	5	16	4	17	11	3	10		
Cobalt	µg/g	22	0.5	3.4	2.5	10.3	2.0	7.1	2.9	1.6	2.5		
Copper	µg/g	140	1	13	10	26	5	17	4	4	8		
Lead	µg/g	120	1	6	6	9	2	6	4	2	3		
Molybdenum	µg/g	6.9	0.5	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5		
Nickel	µg/g	100	1	6	5	20	3	14	5	2	5		
Selenium	µg/g	2.4	0.4	<0.4	<0.4	<0.4	<0.4	<0.4	<0.4	<0.4	<0.4		
Silver	µg/g	20	0.2	<0.2	<0.2	<0.2	<0.2	<0.2	<0.2	<0.2	<0.2		
Thallium	µg/g	1	0.4	<0.4	<0.4	<0.4	<0.4	<0.4	<0.4	<0.4	<0.4		
Uranium	ug/g	23	0.5	<0.5	<0.5	<0.5	<0.5	0.6	<0.5	<0.5	<0.5		
Vanadium	µg/g	86	1	12	11	24	10	25	30	8	29		
Zinc	µg/g	340	5	26	19	49	9	37	11	7	11		
Chromium VI	µg/g	8	0.2	<0.2	<0.2	<0.2	<0.2	<0.2	<0.2	<0.2	<0.2		
Cyanide	µg/g	0.051	0.05	<0.05	<0.05	<0.05	<0.05	<0.05	<0.05	<0.05	<0.05		
Mercury	µg/g	0.27	0.01	0.01	<0.01	0.02	<0.01	<0.01	<0.01	<0.01	0.01		
Electrical Conductivity	mS/cm	0.7	0.002	0.175	0.433	1.15	0.181	0.380	0.383	0.837	0.308		
Sodium Adsorption Ratio (2:1)	N/A	5	N/A	1.74	3.37	11.6	3.47	0.732	5.07	6.32	4.72		
pH, 2:1 CaCl2 Extraction	pH Units			8.02	7.96	7.82	7.84	7.73	7.54	7.90	7.65		

Certified By:



Certificate of Analysis

AGAT WORK ORDER: 11T520410
PROJECT NO: GEOTMARK00233AA

5835 COOPERS AVENUE
MISSISSAUGA, ONTARIO
CANADA L4Z 1Y2
TEL (905)712-5100
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<http://www.agatlabs.com>

CLIENT NAME: COFFEY GEOTECHNICS

ATTENTION TO: Oxana Matiuc

O. Reg. 153(511) - Metals & Inorganics (Soil)

DATE SAMPLED:				DATE RECEIVED: Aug 18, 2011		DATE REPORTED: Aug 29, 2011			SAMPLE TYPE: Soil	
Parameter	Unit	G / S	RDL	HF1-24 SS3 2627829	HF1-28 SS2 2627830	HF1-28 SS4 2627831	HF1-30 SS2 2627832	HF1-33 SS1 2627833	HF1-33 SS3 2627834	HF1-36 SS4 2627835
Antimony	µg/g	7.5	0.8	<0.8	<0.8	<0.8	<0.8	<0.8	<0.8	<0.8
Arsenic	µg/g	18	1	1	1	5	2	2	2	5
Barium	µg/g	390	2	6	8	45	12	15	13	122
Beryllium	µg/g	4	0.5	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5	0.7
Boron	µg/g	120	5	<5	<5	6	<5	<5	<5	11
Boron (Hot Water Soluble)	µg/g	1.5	0.10	<0.10	<0.10	<0.10	<0.10	0.13	<0.10	0.59
Cadmium	µg/g	1.2	0.5	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5
Chromium	µg/g	160	2	3	5	12	6	4	4	23
Cobalt	µg/g	22	0.5	1.4	1.8	8.7	3.9	2.3	2.8	13.1
Copper	µg/g	140	1	6	4	51	14	7	6	24
Lead	µg/g	120	1	2	3	15	4	3	2	8
Molybdenum	µg/g	6.9	0.5	<0.5	<0.5	0.5	<0.5	<0.5	<0.5	<0.5
Nickel	µg/g	100	1	2	4	17	7	4	4	28
Selenium	µg/g	2.4	0.4	<0.4	<0.4	<0.4	<0.4	<0.4	<0.4	<0.4
Silver	µg/g	20	0.2	<0.2	<0.2	<0.2	<0.2	<0.2	<0.2	<0.2
Thallium	µg/g	1	0.4	<0.4	<0.4	<0.4	<0.4	<0.4	<0.4	<0.4
Uranium	ug/g	23	0.5	<0.5	<0.5	0.5	<0.5	<0.5	<0.5	0.5
Vanadium	µg/g	86	1	8	12	19	13	8	10	33
Zinc	µg/g	340	5	7	9	49	18	9	11	63
Chromium VI	µg/g	8	0.2	<0.2	<0.2	<0.2	<0.2	<0.2	<0.2	<0.2
Cyanide	µg/g	0.051	0.05	<0.05	<0.05	<0.05	<0.05	<0.05	<0.05	<0.05
Mercury	µg/g	0.27	0.01	<0.01	0.01	0.02	<0.01	0.01	<0.01	0.01
Electrical Conductivity	mS/cm	0.7	0.002	0.628	4.29	0.250	3.09	1.68	0.118	0.358
Sodium Adsorption Ratio (2:1)	N/A	5	N/A	6.46	40.0	3.79	53.8	42.3	0.506	0.707
pH, 2:1 CaCl2 Extraction	pH Units			7.99	7.17	7.95	8.01	7.86	7.84	7.84

Comments: RDL - Reported Detection Limit; G / S - Guideline / Standard: Refers to T2(RPI) - New

2627821-2627835 EC & SAR were determined on the DI water extract obtained from the 2:1 leaching procedure (2 parts DI water:1 part soil). pH was determined on the 0.01M CaCl2 extract prepared at 2:1 ratio.

Certified By:



Guideline Violation

AGAT WORK ORDER: 11T520410

PROJECT NO: GEOTMARK00233AA

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CLIENT NAME: COFFEY GEOTECHNICS

ATTENTION TO: Oxana Matiiuc

SAMPLEID	SAMPLE TITLE	GUIDELINE	ANALYSIS PACKAGE	PARAMETER	GUIDEVALUE	RESULT
2627823	HF1-16 SS1A	T2(RPI) - New	O. Reg. 153(511) - Metals & Inorganics (Soil)	Electrical Conductivity	0.7	1.15
2627823	HF1-16 SS1A	T2(RPI) - New	O. Reg. 153(511) - Metals & Inorganics (Soil)	Sodium Adsorption Ratio (2:1)	5	11.6
2627826	HF1-22 SS1	T2(RPI) - New	O. Reg. 153(511) - Metals & Inorganics (Soil)	Sodium Adsorption Ratio (2:1)	5	5.07
2627827	HF1-22 SS3	T2(RPI) - New	O. Reg. 153(511) - Metals & Inorganics (Soil)	Electrical Conductivity	0.7	0.837
2627827	HF1-22 SS3	T2(RPI) - New	O. Reg. 153(511) - Metals & Inorganics (Soil)	Sodium Adsorption Ratio (2:1)	5	6.32
2627829	HF1-24 SS3	T2(RPI) - New	O. Reg. 153(511) - Metals & Inorganics (Soil)	Sodium Adsorption Ratio (2:1)	5	6.46
2627830	HF1-28 SS2	T2(RPI) - New	O. Reg. 153(511) - Metals & Inorganics (Soil)	Electrical Conductivity	0.7	4.29
2627830	HF1-28 SS2	T2(RPI) - New	O. Reg. 153(511) - Metals & Inorganics (Soil)	Sodium Adsorption Ratio (2:1)	5	40.0
2627832	HF1-30 SS2	T2(RPI) - New	O. Reg. 153(511) - Metals & Inorganics (Soil)	Electrical Conductivity	0.7	3.09
2627832	HF1-30 SS2	T2(RPI) - New	O. Reg. 153(511) - Metals & Inorganics (Soil)	Sodium Adsorption Ratio (2:1)	5	53.8
2627833	HF1-33 SS1	T2(RPI) - New	O. Reg. 153(511) - Metals & Inorganics (Soil)	Electrical Conductivity	0.7	1.68
2627833	HF1-33 SS1	T2(RPI) - New	O. Reg. 153(511) - Metals & Inorganics (Soil)	Sodium Adsorption Ratio (2:1)	5	42.3



Certificate of Analysis

AGAT WORK ORDER: 11T520410
PROJECT NO: GEOTMARK00233AA

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CLIENT NAME: COFFEY GEOTECHNICS

ATTENTION TO: Oxana Matiuc

O. Reg. 558 Metals and Inorganics

DATE SAMPLED:				DATE RECEIVED: Aug 18, 2011				DATE REPORTED: Aug 29, 2011				SAMPLE TYPE: Soil	
Parameter	Unit	G / S	RDL	HF1-14 SS2 2627821	HF1-14 SS5 2627822	HF1-16 SS1A 2627823	HF1-19 SS1 2627824	HF1-19 SS3 2627825	HF1-22 SS1 2627826	HF1-22 SS3 2627827	HF1-24 SS1 2627828		
Arsenic Leachate	mg/L	2.5	0.010	<0.010	<0.010	<0.010	<0.010	<0.010	<0.010	<0.010	<0.010		
Barium Leachate	mg/L	100	0.100	0.282	0.156	0.963	0.283	1.50	0.204	0.184	0.210		
Boron Leachate	mg/L	500	0.050	<0.050	<0.050	<0.050	<0.050	0.068	<0.050	<0.050	<0.050		
Cadmium Leachate	mg/L	0.5	0.010	<0.010	<0.010	<0.010	<0.010	<0.010	<0.010	<0.010	<0.010		
Chromium Leachate	mg/L	5.0	0.010	0.011	0.017	0.019	0.015	0.023	0.015	0.013	0.014		
Lead Leachate	mg/L	5.0	0.010	<0.010	<0.010	<0.010	<0.010	0.020	<0.010	<0.010	<0.010		
Mercury Leachate	mg/L	0.1	0.005	<0.005	<0.005	<0.005	<0.005	<0.005	<0.005	<0.005	<0.005		
Selenium Leachate	mg/L	1.0	0.010	<0.010	<0.010	<0.010	<0.010	<0.010	<0.010	<0.010	<0.010		
Silver Leachate	mg/L	5.0	0.010	<0.010	<0.010	<0.010	<0.010	<0.010	<0.010	<0.010	<0.010		
Uranium Leachate	mg/L	10.0	0.050	<0.050	<0.050	<0.050	<0.050	<0.050	<0.050	<0.050	<0.050		
Fluoride Leachate	mg/L	150	0.05	0.22	0.24	0.17	0.21	0.33	0.13	0.23	0.07		
Cyanide Leachate	mg/L	20.0	0.05	<0.05	<0.05	<0.05	<0.05	<0.05	<0.05	<0.05	<0.05		
(Nitrate + Nitrite) as N Leachate	mg/L	1000	0.70	<0.70	<0.70	<0.70	<0.70	<0.70	<0.70	<0.70	<0.70		
Parameter	Unit	G / S	RDL	HF1-24 SS3 2627829	HF1-28 SS2 2627830	HF1-28 SS4 2627831	HF1-30 SS2 2627832	HF1-33 SS1 2627833	HF1-33 SS3 2627834	HF1-36 SS4 2627835			
Arsenic Leachate	mg/L	2.5	0.010	<0.010	<0.010	<0.010	<0.010	<0.010	<0.010	<0.010			
Barium Leachate	mg/L	100	0.100	0.151	0.185	0.418	0.203	0.260	0.297	1.62			
Boron Leachate	mg/L	500	0.050	<0.050	<0.050	<0.050	<0.050	<0.050	<0.050	0.062			
Cadmium Leachate	mg/L	0.5	0.010	<0.010	<0.010	<0.010	<0.010	<0.010	<0.010	<0.010			
Chromium Leachate	mg/L	5.0	0.010	0.020	0.014	0.021	0.019	0.012	0.022	0.025			
Lead Leachate	mg/L	5.0	0.010	<0.010	<0.010	<0.010	<0.010	<0.010	<0.010	0.053			
Mercury Leachate	mg/L	0.1	0.005	<0.005	<0.005	<0.005	<0.005	<0.005	<0.005	<0.005			
Selenium Leachate	mg/L	1.0	0.010	<0.010	<0.010	<0.010	<0.010	<0.010	<0.010	<0.010			
Silver Leachate	mg/L	5.0	0.010	<0.010	<0.010	<0.010	<0.010	<0.010	<0.010	<0.010			
Uranium Leachate	mg/L	10.0	0.050	<0.050	<0.050	<0.050	<0.050	<0.050	<0.050	<0.050			
Fluoride Leachate	mg/L	150	0.05	0.25	0.06	0.42	0.19	0.06	0.25	0.20			
Cyanide Leachate	mg/L	20.0	0.05	<0.05	<0.05	<0.05	<0.05	<0.05	<0.05	<0.05			
(Nitrate + Nitrite) as N Leachate	mg/L	1000	0.70	<0.70	<0.70	<0.70	<0.70	<0.70	<0.70	<0.70			

Comments: RDL - Reported Detection Limit; G / S - Guideline / Standard: Refers to Regulation 558

Certified By:

CLIENT NAME: COFFEY GEOTECHNICS
351 STEELCASE ROAD WEST, UNIT 10-12
MARKHAM, ON L3R4H9

ATTENTION TO: Oxana Matiiuc

PROJECT NO: GEOTMARK00233AA

AGAT WORK ORDER: 11T541661

SOIL ANALYSIS REVIEWED BY: Anthony Dapaah, PhD (Chem), Inorganic Lab Manager

DATE REPORTED: Oct 31, 2011

PAGES (INCLUDING COVER): 7

VERSION*: 1

Should you require any information regarding this analysis please contact your client services representative at (905) 712-5100

*NOTES

All samples will be disposed of within 30 days following analysis. Please contact the lab if you require additional sample storage time.



Certificate of Analysis

AGAT WORK ORDER: 11T541661
PROJECT NO: GEOTMARK00233AA

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CLIENT NAME: COFFEY GEOTECHNICS

ATTENTION TO: Oxana Matiiuc

O. Reg. 153(511) - Metals & Inorganics (Soil)

DATE SAMPLED: Sep 07, 2011

DATE RECEIVED: Oct 21, 2011

DATE REPORTED: Oct 31, 2011

SAMPLE TYPE: Soil

Parameter	Unit	G / S	RDL	HF1-38 SS1	HF1-38 SS3	HF1-38 SS5/6	HF1-43 SS1
				2831855	2831856	2831857	2831858
Antimony	µg/g	7.5	0.8	<0.8	<0.8	<0.8	<0.8
Arsenic	µg/g	18	1	2	3	7	3
Barium	µg/g	390	2	27	42	46	56
Beryllium	µg/g	4	0.5	<0.5	0.5	1.2	<0.5
Boron	µg/g	120	5	<5	9	18	6
Boron (Hot Water Soluble)	µg/g	1.5	0.10	0.14	0.25	1.24	0.40
Cadmium	µg/g	1.2	0.5	<0.5	<0.5	<0.5	<0.5
Chromium	µg/g	160	2	9	17	29	12
Cobalt	µg/g	22	0.5	3.7	8.1	16.9	5.8
Copper	µg/g	140	1	9	21	52	23
Lead	µg/g	120	1	4	6	6	14
Molybdenum	µg/g	6.9	0.5	<0.5	<0.5	0.5	0.5
Nickel	µg/g	100	1	8	16	32	12
Selenium	µg/g	2.4	0.4	<0.4	<0.4	<0.4	<0.4
Silver	µg/g	20	0.2	<0.2	<0.2	<0.2	<0.2
Thallium	µg/g	1	0.4	<0.4	<0.4	<0.4	<0.4
Uranium	ug/g	23	0.5	<0.5	0.7	0.6	<0.5
Vanadium	µg/g	86	1	15	24	34	18
Zinc	µg/g	340	5	17	41	72	48
Chromium VI	µg/g	8	0.2	<0.2	<0.2	<0.2	<0.2
Cyanide	µg/g	0.051	0.05	<0.05	<0.05	<0.05	<0.05
Mercury	µg/g	0.27	0.01	0.01	0.02	0.02	0.15
Electrical Conductivity	mS/cm	0.7	0.002	0.336	0.501	1.02	2.14
Sodium Adsorption Ratio	N/A	5	N/A	0.489	0.230	4.49	11.9
pH, 2:1 CaCl2 Extraction	pH Units			6.89	7.66	7.92	7.65

Comments: RDL - Reported Detection Limit; G / S - Guideline / Standard: Refers to T2(RPI) - Current

2831855-2831858 EC & SAR were determined on the DI water extract obtained from the 2:1 leaching procedure (2 parts DI water:1 part soil). pH was determined on the 0.01M CaCl2 extract prepared at 2:1 ratio.

Certified By:



Certificate of Analysis

AGAT WORK ORDER: 11T541661

PROJECT NO: GEOTMARK00233AA

5835 COOPERS AVENUE
MISSISSAUGA, ONTARIO
CANADA L4Z 1Y2
TEL (905)712-5100
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<http://www.agatlabs.com>

CLIENT NAME: COFFEY GEOTECHNICS

ATTENTION TO: Oxana Matiiuc

O. Reg. 558 Metals and Inorganics

DATE SAMPLED: Sep 07, 2011

DATE RECEIVED: Oct 21, 2011

DATE REPORTED: Oct 31, 2011

SAMPLE TYPE: Soil

Parameter	Unit	G / S	RDL	HF1-38 SS1	HF1-38 SS3	HF1-38 SS5/6	HF1-43 SS1
				2831855	2831856	2831857	2831858
Arsenic Leachate	mg/L	2.5	0.010	<0.010	<0.010	<0.010	<0.010
Barium Leachate	mg/L	100	0.100	0.214	0.781	0.331	0.530
Boron Leachate	mg/L	500	0.050	<0.050	0.063	0.088	0.058
Cadmium Leachate	mg/L	0.5	0.010	<0.010	<0.010	<0.010	<0.010
Chromium Leachate	mg/L	5.0	0.010	0.012	<0.010	<0.010	<0.010
Lead Leachate	mg/L	5.0	0.010	<0.010	<0.010	<0.010	<0.010
Mercury Leachate	mg/L	0.1	0.005	<0.005	<0.005	<0.005	<0.005
Selenium Leachate	mg/L	1.0	0.010	<0.010	<0.010	<0.010	<0.010
Silver Leachate	mg/L	5.0	0.010	<0.010	<0.010	<0.010	<0.010
Uranium Leachate	mg/L	10.0	0.050	<0.050	<0.050	<0.050	<0.050
Fluoride Leachate	mg/L	150	0.05	0.11	0.25	0.17	0.18
Cyanide Leachate	mg/L	20.0	0.05	<0.05	<0.05	<0.05	<0.05
(Nitrate + Nitrite) as N Leachate	mg/L	1000	0.70	2.28	<0.70	<0.70	<0.70

Comments: RDL - Reported Detection Limit; G / S - Guideline / Standard: Refers to Regulation 558

Certified By:



AGAT Laboratories

Guideline Violation

AGAT WORK ORDER: 11T541661

PROJECT NO: GEOTMARK00233AA

5835 COOPERS AVENUE
MISSISSAUGA, ONTARIO
CANADA L4Z 1Y2
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FAX (905)712-5122
<http://www.agatlabs.com>

CLIENT NAME: COFFEY GEOTECHNICS

ATTENTION TO: Oxana Matiiuc

SAMPLEID	SAMPLE TITLE	GUIDELINE	ANALYSIS PACKAGE	PARAMETER	GUIDEVALUE	RESULT
2831857	HF1-38 SS5/6	T2(RPI) - Current	O. Reg. 153(511) - Metals & Inorganics (Soil)	Electrical Conductivity	0.7	1.02
2831858	HF1-43 SS1	T2(RPI) - Current	O. Reg. 153(511) - Metals & Inorganics (Soil)	Electrical Conductivity	0.7	2.14
2831858	HF1-43 SS1	T2(RPI) - Current	O. Reg. 153(511) - Metals & Inorganics (Soil)	Sodium Adsorption Ratio	5	11.9

Quality Assurance

CLIENT NAME: COFFEY GEOTECHNICS

AGAT WORK ORDER: 11T541661

PROJECT NO: GEOTMARK00233AA

ATTENTION TO: Oxana Matiuc

Soil Analysis															
RPT Date: Oct 31, 2011			DUPLICATE			Method Blank	REFERENCE MATERIAL			METHOD BLANK SPIKE			MATRIX SPIKE		
PARAMETER	Batch	Sample Id	Dup #1	Dup #2	RPD		Measured Value	Acceptable Limits		Recovery	Acceptable Limits		Recovery	Acceptable Limits	
								Lower	Upper		Lower	Upper		Lower	Upper

O. Reg. 153(511) - Metals & Inorganics (Soil)

Antimony	1	2831855	< 0.8	< 0.8	0.0%	< 0.8	110%	70%	130%	86%	80%	120%	89%	70%	130%
Arsenic	1	2831855	2	2	0.0%	< 1	111%	70%	130%	101%	80%	120%	110%	70%	130%
Barium	1	2831855	27	27	0.0%	< 2	99%	70%	130%	94%	80%	120%	98%	70%	130%
Beryllium	1	2831855	< 0.5	< 0.5	0.0%	< 0.5	125%	70%	130%	113%	80%	120%	129%	70%	130%
Boron	1	2831855	< 5	< 5	0.0%	< 5	83%	70%	130%	108%	80%	120%	113%	70%	130%
Boron (Hot Water Soluble)	1	2831856	0.25	0.23	8.3%	< 0.10	106%	60%	140%	108%	70%	130%	108%	60%	140%
Cadmium	1	2831855	< 0.5	< 0.5	0.0%	< 0.5	99%	70%	130%	103%	80%	120%	97%	70%	130%
Chromium	1	2831855	9	9	0.0%	< 2	100%	70%	130%	99%	80%	120%	105%	70%	130%
Cobalt	1	2831855	3.7	3.6	2.7%	< 0.5	101%	70%	130%	93%	80%	120%	97%	70%	130%
Copper	1	2831855	9	9	0.0%	< 1	102%	70%	130%	99%	80%	120%	98%	70%	130%
Lead	1	2831855	4	4	0.0%	< 1	102%	70%	130%	95%	80%	120%	96%	70%	130%
Molybdenum	1	2831855	< 0.5	< 0.5	0.0%	< 0.5	100%	70%	130%	98%	80%	120%	105%	70%	130%
Nickel	1	2831855	8	8	0.0%	< 1	101%	70%	130%	92%	80%	120%	93%	70%	130%
Selenium	1	2831855	< 0.4	< 0.4	0.0%	< 0.4	106%	70%	130%	90%	80%	120%	99%	70%	130%
Silver	1	2831855	< 0.2	< 0.2	0.0%	< 0.2	108%	70%	130%	118%	80%	120%	121%	70%	130%
Thallium	1	2831855	< 0.4	< 0.4	0.0%	< 0.4	95%	70%	130%	96%	80%	120%	97%	70%	130%
Uranium	1	2831855	< 0.5	< 0.5	0.0%	< 0.5	102%	70%	130%	93%	80%	120%	97%	70%	130%
Vanadium	1	2831855	15	14	6.9%	< 1	98%	70%	130%	92%	80%	120%	98%	70%	130%
Zinc	1	2831855	17	18	5.7%	< 5	102%	70%	130%	99%	80%	120%	98%	70%	130%
Chromium VI	1		< 0.2	< 0.2	0.0%	< 0.2	96%	70%	130%	90%	80%	120%	101%	70%	130%
Cyanide	1		< 0.05	< 0.05	0.0%	< 0.05	102%	70%	130%	102%	80%	120%	96%	70%	130%
Mercury	1	2831858	0.15	0.15	0.0%	< 0.01	94%	70%	130%	105%	80%	120%	113%	70%	130%
Electrical Conductivity	1	2831855	0.336	0.295	13.0%	< 0.002	94%	90%	110%						
Sodium Adsorption Ratio	1	2831855	0.489	0.477	2.3%	N/A									
pH, 2:1 CaCl2 Extraction	1		7.69	7.70	0.1%	<	102%	90%	110%						

O. Reg. 558 Metals and Inorganics

Arsenic Leachate	1	2831855	< 0.010	< 0.010	0.0%	< 0.010	94%	90%	110%	105%	90%	110%	106%	70%	130%
Barium Leachate	1	2831855	0.214	0.223	4.1%	< 0.100	93%	90%	110%	94%	90%	110%	97%	70%	130%
Boron Leachate	1	2831855	< 0.050	< 0.050	0.0%	< 0.050	99%	90%	110%	101%	90%	110%	103%	70%	130%
Cadmium Leachate	1	2831855	< 0.010	< 0.010	0.0%	< 0.010	91%	90%	110%	102%	90%	110%	95%	70%	130%
Chromium Leachate	1	2831855	0.012	0.012	0.0%	< 0.010	104%	90%	110%	105%	90%	110%	105%	70%	130%
Lead Leachate	1	2831855	< 0.010	< 0.010	0.0%	< 0.010	91%	90%	110%	92%	90%	110%	90%	70%	130%
Mercury Leachate	1	2831855	< 0.005	< 0.005	0.0%	< 0.005	101%	90%	110%	94%	90%	110%	95%	70%	130%
Selenium Leachate	1	2831855	< 0.010	< 0.010	0.0%	< 0.010	91%	90%	110%	90%	90%	110%	90%	70%	130%
Silver Leachate	1	2831855	< 0.010	< 0.010	0.0%	< 0.010	108%	90%	110%	118%	80%	120%	128%	70%	130%
Uranium Leachate	1	2831855	< 0.050	< 0.050	0.0%	< 0.050	94%	90%	110%	96%	90%	110%	95%	70%	130%
Fluoride Leachate	1	2831855	0.11	0.10	9.5%	< 0.05	104%	90%	110%	106%	90%	110%	113%	70%	130%
Cyanide Leachate	1	2831855	< 0.05	< 0.05	0.0%	< 0.05	92%	90%	110%	108%	90%	110%	103%	70%	130%
(Nitrate + Nitrite) as N Leachate	1	2831855	2.28	2.30	0.9%	< 0.70	98%	90%	110%	98%	90%	110%	92%	90%	110%

Quality Assurance

CLIENT NAME: COFFEY GEOTECHNICS

AGAT WORK ORDER: 11T541661

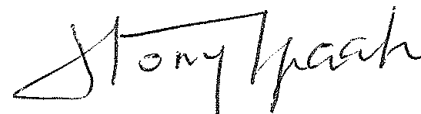
PROJECT NO: GEOTMARK00233AA

ATTENTION TO: Oxana Matiuc

Soil Analysis (Continued)

RPT Date: Oct 31, 2011			DUPLICATE			Method Blank	REFERENCE MATERIAL		METHOD BLANK SPIKE			MATRIX SPIKE			
PARAMETER	Batch	Sample Id	Dup #1	Dup #2	RPD		Measured Value	Acceptable Limits		Recovery	Acceptable Limits		Recovery	Acceptable Limits	
								Lower	Upper		Lower	Upper		Lower	Upper

Certified By:



Method Summary

CLIENT NAME: COFFEY GEOTECHNICS

AGAT WORK ORDER: 11T541661

PROJECT NO: GEOTMARK00233AA

ATTENTION TO: Oxana Matiuc

PARAMETER	AGAT S.O.P	LITERATURE REFERENCE	ANALYTICAL TECHNIQUE
Soil Analysis			
Antimony	MET-93-6103	EPA SW-846 3050B & 6020A	ICP-MS
Arsenic	MET-93-6103	EPA SW-846 3050B & 6020A	ICP-MS
Barium	MET-93-6103	EPA SW-846 3050B & 6020A	ICP-MS
Beryllium	MET-93-6103	EPA SW-846 3050B & 6020A	ICP-MS
Boron	MET-93-6103	EPA SW-846 3050B & 6020A	ICP-MS
Boron (Hot Water Soluble)	MET-93-6104	EPA SW 846 6010C; MSA, Part 3, Ch.21	ICP/OES
Cadmium	MET-93-6103	EPA SW-846 3050B & 6020A	ICP-MS
Chromium	MET-93-6103	EPA SW-846 3050B & 6020A	ICP-MS
Cobalt	MET-93-6103	EPA SW-846 3050B & 6020A	ICP-MS
Copper	MET-93-6103	EPA SW-846 3050B & 6020A	ICP-MS
Lead	MET-93-6103	EPA SW-846 3050B & 6020A	ICP-MS
Molybdenum	MET-93-6103	EPA SW-846 3050B & 6020A	ICP-MS
Nickel	MET-93-6103	EPA SW-846 3050B & 6020A	ICP-MS
Selenium	MET-93-6103	EPA SW-846 3050B & 6020A	ICP-MS
Silver	MET-93-6103	EPA SW-846 3050B & 6020A	ICP-MS
Thallium	MET-93-6103	EPA SW-846 3050B & 6020A	ICP-MS
Uranium	MET-93-6103	EPA SW-846 3050B & 6020A	ICP-MS
Vanadium	MET-93-6103	EPA SW-846 3050B & 6020A	ICP-MS
Zinc	MET-93-6103	EPA SW-846 3050B & 6020A	ICP-MS
Chromium VI	INOR-93-6029	SM 3500 B; MSA Part 3, Ch. 25	SPECTROPHOTOMETER
Cyanide	INOR-93-6052	MOE CN-3015 & E 3009 A; SM 4500 CN	TECHNICON AUTO ANALYZER
Mercury	MET-93-6101	EPA SW 846 7471A 245.5	CVAAS
Electrical Conductivity	INOR-93-6036	McKeague 4.12, SM 2510 B	EC METER
Sodium Adsorption Ratio	INOR-93-6007	McKeague 4.12 & 3.26 & EPA SW-846 6010C	ICP/OES
pH, 2:1 CaCl ₂ Extraction	INOR-93-6031	MSA part 3 & SM 4500-H+ B	PH METER
Arsenic Leachate	MET-93-6103	EPA SW-846 1311 & 3010A & 6020A	ICP-MS
Barium Leachate	MET-93-6103	EPA SW-846 1311 & 3010A & 6020A	ICP-MS
Boron Leachate	MET-93-6103	EPA SW-846 1311 & 3010A & 6020A	ICP-MS
Cadmium Leachate	MET-93-6103	EPA SW-846 1311 & 3010A & 6020A	ICP-MS
Chromium Leachate	MET-93-6103	EPA SW-846 1311 & 3010A & 6020A	ICP-MS
Lead Leachate	MET-93-6103	EPA SW-846 1311 & 3010A & 6020A	ICP-MS
Mercury Leachate	MET-93-6100	EPA SW-846 1311 & 7470, 245.1	CVAAS
Selenium Leachate	MET-93-6103	EPA SW-846 1311 & 3010A & 6020A	ICP-MS
Silver Leachate	MET-93-6103	EPA SW-846 1311 & 3010A & 6020A	ICP-MS
Uranium Leachate	MET-93-6103	EPA SW-846 1311 & 3010A & 6020A	ICP-MS
Fluoride Leachate	INOR-93-6018	EPA SW-846-1311 & SM4500-F- C	ION SELECTIVE ELECTRODE
Cyanide Leachate	INOR-93-6052	EPA SW-846-1311 & MOE 3015 & SM 4500 CN- I	TECHNICON AUTO ANALYZER
(Nitrate + Nitrite) as N Leachate	INOR 1053	EPA SW 846-1311 & SM 4500 - NO ₃ - I	LACHAT FIA