Summary of Fiscal Year 2015 and 2016 Field Investigations– Cross Valley Dam and Intermediate Dam Ponds Field Data Faro Mine Remediation Project

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FIELD SAMPLING PLAN NAME:	CVP and ID Pond CPT and Sonic borings

Overview

This technical memorandum (TM) presents a summary of field investigations performed by CH2M HILL Canada Limited (CH2M) in Fiscal Year (FY) 2015 and FY 2016 at the Faro Mine Complex (FMC) in support of remediation design for the Cross Valley Dam (CVD) Pond and Intermediate Dam (ID) Pond. The program included Cone Penetration Test (CPT) soundings, sonic borings, and soil sampling, geotechnical and geochemical laboratory testing, as well as bathymetry, and sub-bottom profiling surveys.

Background

This section provides background information that influenced the planning of the field and laboratory investigations that are summarized in this TM.

Cross Valley Dam Pond

As a result of water treatment processes over the years, sludge materials were discharged into and accumulated on the bottom of the CVD Pond. The majority of deposited sludge is expected to have originated from the Down Valley Treatment System (DVTS). The DVTS was constructed in 2002 to treat siphoned ID Pond water through agitation with a lime slurry. Treatment comprised of lime slurry added to raise the pH, which led to the precipitation of metals (mainly ferrous and ferric iron oxyhydroxides) because of lower solubility at higher pH. Treated effluent water was then discharged into the CVD Pond, where water was retained to allow precipitated solids to settle out of suspension. These settled solids from the DVTS are referred to in this report as sludge. Evidence of the sludge deposits on the bottom of the CVD Pond include observations during seasonably low water levels, and periodic discoloration of the pond water and effluent to Rose Creek. Photographs, aerial photos, and visual observations of orange discolorations suggest that oxidative dissolution of ferrous iron in the sludge could be occurring, resulting in a suspended ferric oxyhydroxide.

According to D. Duivenvoorden, a long-time FMC employee, from approximately 1997 to 1999, lime was added at the southern shore of the CVD Pond via a slurry tank (Duivenvoorden, pers. Comm, 2016). The lime-rich water was then pumped into the ID Pond, which at that time was operated with a much higher water level in the pond. As a result, the high pH water would migrate towards the spillway and flow down it, back into the CVD Pond. He also indicated that, between approximately 1998 and 2009, sludge

and sediment was dredged from the CVD Pond using an excavator to make room for additional inputs. The dredging area was limited to the reach of an excavator arm from the peninsula on the north shore of the CVD Pond. An estimated 2,500 cubic metres (m^3) of excavated material was transported to the tailings sludge cells each year. No dredging was performed from the southern shore.

Although the closure plan for the CVD Pond is being developed, one alternative includes dewatering and sludge removal, as well as using the pond as temporary storage during construction and then emergency storage for long-term care and maintenance. Furthermore, to improve current site operations, it may also be warranted to address total suspended solids formation from ferrous iron sludge oxidation.

The depth to the CVD Pond bottom, sludge volume, and sludge distribution were poorly defined or unknown. Furthermore, the chemical and physical characteristics of the sludge had not yet been determined, resulting in unknowns for potential disposal to either Faro Pit or the Rose Creek Tailings Area. In addition, the volume of water in the CVD Pond was defined and although there was a coarse-resolution stage-storage curve available, there was significant uncertainty in the pond volume. A more accurate stage-storage curve was necessary to assist with pond operation and estimating dewatering requirements for the CVD probable maximum flood spillway plunge pool.

Therefore, it was determined that field investigations were needed to: (1) update and generate higher resolution stage and storage curves to support water management options, and (2) collect physical and geochemical data to characterize sludge material and support sludge volume and distribution estimates.

Intermediate Dam Pond

Although the closure plan for the ID Pond is being developed, one alternative includes filling the pond area, placing a soil cover, and vegetating the ID Pond. As part of this work, a seepage collection system would be designed to collect mine-impacted water from within the pond's tailings and convey it to the water treatment plant for treatment. Designing fill for the ID Pond requires estimates for fill volume and for the volume and physical characteristics of the tailings and sediment within the pond. In addition, there were significant uncertainties with respect to the volume and physical characteristics of tailings and sediment within the pond, such as compressibility and strength parameters. Because these uncertainties needed to be addressed for remediation alternative design, it was determined that investigations were needed.

Field Investigations

The following field investigations were performed in the FY 2015 and FY 2016:

- October 2015 - A bathymetry survey was conducted in the CVD Pond using a multi-beam sonar investigation, supplemented by a single-beam sonar survey in shallow areas and Real-Time Kinematic Global Positioning System (RTK-GPS) survey to define the shoreline.
- October 2015 - Acoustic sub-bottom profiling was conducted in the CVD pond, using a line spacing of 10 metres (m).
- January and March 2016 - Ice roads were constructed on the frozen CVD Pond and ID Pond to provide access for field investigations.
- March 2016 - CPTs were performed in the CVD Pond and ID Pond, including eight gamma seismic cone penetration test (GSCPT) soundings and three gamma flow (ball) penetration test (BGCPT) soundings (where relatively softer sediments were encountered).
- March 2016 - Sonic borings were drilled at eight locations within the CVD Pond to log materials and obtain core samples for laboratory testing.

- March 2016 - Geotechnical and geochemical laboratory testing was conducted on: (1) samples collected from the borings in the CVD Pond and (2) several grab samples recovered from the mudline of the ID Pond during the progress of the CPT soundings.
- March 2016 - A supplemental sample of sludge sediment was collected using a hand probe from one location in the CVD Pond.
- May 2016 - The geophysical transects for the ID Pond spillway were surveyed for location and elevation.
- June 2016 - A bathymetry survey was conducted in the ID Pond using a multi-beam sonar investigation, supplemented by a single-beam sonar survey in shallow areas and RTK-GPS survey to define the shoreline.
- June 2016 - Acoustic sub-bottom profiling was conducted in the ID Pond, using a line spacing of 5 m.
- July 2016 - Four samples of suspected sludge from the CVD Pond with high total iron content were submitted to the laboratory to determine the ferrous iron content of the solids.
- Pond water elevations were monitored by Tlicho Engineering & Environmental Services Ltd. (TEES) up to April 1, 2016, and thereafter by Parsons as the Care & Maintenance Contractor for the site.

Ground Survey of Intermediate Dam Spillway Geophysical Lines

In FY 2015, Frontier Geosciences Inc. completed geophysical surveys of seven transects in the ID Pond spillway area for a total length of approximately 2.5 kilometres. The results of this investigation are included in a separate report (CH2M, 2016c; Frontier, 2015). As a result of snowfall, a ground survey of the transect locations could not be performed until FY 2016, when these geophysical lines were surveyed by Challenger Geomatics Ltd. at 5-m intervals to obtain the X,Y,Z coordinates. The horizontal datum was North American Datum of 1983 CSRS Epoch 2002, and the vertical datum was Canadian Geodetic Vertical Datum of 1928 (HT v2.0 Geoid). The coordinate projection was Universal Transverse Mercator (UTM) Zone 8 North, m. All surveys were tied to the onsite permanent control as specified in Standard Operating Procedure (SOP) MSR006, *Geographic Land Surveying and Field Surveying Procedures* (CH2M, March 2012g).

Frontier re-issued their report in June 2016 to reflect the improved ground survey information; however, the report remains dated as October 2015 (Frontier, 2015). This updated report is provided as Attachment 1.

Pond Water Elevations

TEES/Parsons makes periodic measurements of pond water elevations using a rod and level from a known benchmark. The water elevations in the CVD and ID Ponds that were recorded around the time of the FY 2015 and FY 2016 field investigations are summarized in Table 1. The water surface elevation was generally observed to be approximately 10 to 12 centimetres (cm) below the top of ice during the work performed in March 2016.

Table 1. Pond Water Surface Elevations Measured During the Field Work
Faro Mine Remediation Project

Date	Water Surface Elevation (m)	
	CVD Pond	ID Pond
October 20, 2015	1028.808	1045.126
October 22, 2015	1028.768	1045.098

Table 1. Pond Water Surface Elevations Measured During the Field Work
Faro Mine Remediation Project

Date	Water Surface Elevation (m)	
	CVD Pond	ID Pond
October 26, 2015	1028.681	1045.057
October 27, 2015	1028.676	1045.023
February 29, 2016	1029.740	1046.528
March 7, 2016	1029.868	1046.562
March 14, 2016	1029.934	1046.592
June 9, 2016	1030.168	1046.062
June 16, 2016	1030.065	1046.059
June 20, 2016	1030.094	1046.004
June 30, 2016	1030.102	1046.327

Ice Road Construction and Working on Ice

Ice roads were constructed at the CVD and ID Ponds to provide vehicle access for subcontractor ConeTec to perform CPT soundings and sonic borings at multiple locations distributed across the pond areas (see Figure 1). The ice roads were designed by CH2M and Norex Ice Engineering, Inc. (Norex) of Kamloops, British Columbia.

The top of the ice road was selected as the reference elevation for CPT soundings and sonic borings; this was typically 12 cm above the pond water level observed in holes cored through the ice.

Procedures for safe working on ice were prepared that detailed requirements for ice cover construction, maintenance, and monitoring, as well as worker safety and recommendations made by a professional engineer. Daily ice inspections consisted of tasks such as surveying the total ice thickness, white ice, blue ice, and snow cover. The ice depth needed to meet design specifications for equipment and personnel safety on the ice was considered on a case-by-case basis. Norex was contracted to conduct a detailed stress analysis confirming the minimum recommended ice thickness to support the ConeTec equipment on the ice drill pads.

Cone Penetrometer Test Soundings

In March 2016, ConeTec conducted a total of eight GSCPT and three BGCPT soundings in the CVD Pond and ID Pond, working from the ice road. Attachment 2 contains ConeTec's summary report, which includes a description of their equipment, procedures, and results of the investigation.

Three CPT soundings (two GSCPT and one BGCPT) were conducted in the CVD Pond, and eight CPT soundings (six GSCPT and two BGCPT) were conducted in the ID Pond. To avoid transporting contamination from the ID Pond to the CVD Pond, the CPT soundings and sonic borings were completed in the cleaner CVD Pond before mobilizing the equipment to the ID Pond.

The details of location and depths for each sounding are summarized in Table 2, and the sounding locations are shown on Figure 1. ConeTec surveyed all exploration locations using a Trimble RTK system with datum: WGS84/UTM Zone 8 North, and the elevations were referenced to the ice surface elevation.

Table 2. Cone Penetration Test Details
Faro Mine Remediation Project

CPT Sounding Number	Northing	Easting	Location	Ice Surface Elevation (m)	Depth to Mudline Below Top of Ice (m)	Final Depth (m)
GSCPT Soundings						
CH16-201-CP014	6914053.79	580670.30	ID Pond	1046.63	3.20	[c]18.95
CH16-201-CP015	6914144.44	580594.24	ID Pond	1046.61	6.70	[c]16.40
CH16-201-CP016	6913921.32	580410.85	ID Pond	1046.62	7.85	[c]18.95
CH16-201-CP017	6913870.65	580528.32	ID Pond	1046.64	5.25	[c]20.68
CH16-201-CP018	6914262.66	580678.76	ID Pond	1046.59	5.10	[c]14.08
CH16-201-CP019	6914022.78	580483.02	ID Pond	1046.61	7.80	[c]14.63
CH16-201-CP022	6914145.57	580247.33	CVD Pond	1029.95	6.20	[c]4.03
CH16-201-CP025	6914430.77	580201.00	CVD Pond	1030.02	12.10	[c]0.75
BGCPT Soundings						
CH16-201-CP015A	6914142.55	580594.03	ID Pond	1046.63	[a]6.70	[d]14.43
CH16-201-CP017A	6913869.52	580529.26	ID Pond	1046.64	[a]5.25	[d]14.00
CH16-201-CP026	6914405.12	580344.68	CVD Pond	1029.91	[b]7.20	[d]8.90

Notes:

[a] Depth to mudline assumed equal to adjacent GSCPT Sounding.
[b] Depth to mudline assumed equal to that estimated for adjacent Boring CH16-201-BH011 sonic borings.
[c] Final depth referenced to estimated mudline elevation.
[d] Final depth referenced to ice surface elevation.

ConeTec performed the CPT soundings according to ASTM International (ASTM) D5778, *Standard Test Method for Electronic Friction Cone and Piezocone Penetration Testing of Soils*. The probe had a cross-sectional area of 15 square centimetres (cm^2), with a rated tip capacity of 375 bars, a sleeve capacity of 10 bars, and a pore pressure capacity of 1.4 megapascals. Pore pressure measurements were obtained using a porous stone located immediately above the cone tip. At depths selected by CH2M, ConeTec stopped advancing the CPT probe and monitored the dissipation of excess pore pressures. While it was not required by the field sampling plan (FSP), ConeTec elected to collect and report passive gamma radiation data, which can be used to indicate variations in clay content.

For GSCPT soundings, seismic shear wave velocity measurements were obtained at intervals of every 1.5 m. The shear wave was generated using a remote-controlled source that was lowered to the mudline of the pond, and offset by a horizontal distance of typically 3 m from the CPT sounding. It was common for the seismic source to sink below the mudline under its own weight. At CH16-201-CP016, CH16-201-CP017, and CH16-201-CP018, a grab sample of sediment was recovered from the top of the seismic source after it was returned to the surface of the ice road following completion of the CPT sounding. Samples from CH16-201-CP016 and CH16-201-CP017 were submitted for laboratory testing.

For BGCPT soundings, flow (ball) penetration testing was performed by mounting a sphere with a projected plan area of 150 cm^2 onto the end of the probe. The purpose was to provide increased sensitivity for very soft sediment with a tip resistance less than 300 kiloPascals (kPa). The modified probe was also cycled vertically up and down over a 1-m interval to allow correlations with residual strength parameters.

Sonic Borehole Drilling and Sampling

In March 2016, ConeTec also advanced a total of fourteen boreholes at the CVD Pond using sonic drilling equipment, again working from the ice road. Attachment 2 presents ConeTec's summary report, which describes this drilling work, including equipment, procedures, generalized borehole logs, and sample photographs.

The location and depths of the boreholes drilled during the field investigation are summarized in Table 3, and the borehole locations are shown on Figure 1.

Table 3. Sonic Borehole Details
Faro Mine Remediation Project

Sonic Borehole Number	Northing (m)	Easting (m)	Location	Ice Surface Elevation (m)	[a]Depth to Mudline (m)	Final Depth (m)
CH16-201-BH005	6914249.55	580349.28	CVD Pond	1029.95	9.23	9.85
CH16-201-BH005A	6914248.55	580349.31	CVD Pond	1029.95	9.30	11.40
CH16-201-BH005B	6914247.60	580349.33	CVD Pond	1029.92	9.35	11.45
CH16-201-BH006	6914347.55	580167.99	CVD Pond	1029.95	13.35	15.40
CH16-201-BH006A	6914346.09	580167.45	CVD Pond	1029.94	13.33	17.40
CH16-201-BH007	6914140.78	580284.42	CVD Pond	1030.04	7.10	23.80
CH16-201-BH008	6914402.21	580198.07	CVD Pond	1029.94	15.21	19.30
CH16-201-BH009	6914353.08	580392.41	CVD Pond	1029.96	9.67	13.40
CH16-201-BH010	6914421.36	580213.61	CVD Pond	1029.98	15.50	17.80
CH16-201-BH010A	6914420.14	580212.81	CVD Pond	1029.97	15.72	19.80
CH16-201-BH011	6914403.53	580346.27	CVD Pond	1029.93	7.20	9.40
CH16-201-BH011A	6914404.38	580345.48	CVD Pond	1029.99	6.90	8.00
CH16-201-BH012	6914322.36	580372.08	CVD Pond	1030.04	14.51	15.63
CH16-201-BH012A	6914327.27	580366.12	CVD Pond	1029.90	13.45	15.60

Notes:

[a.] Depth to mudline estimated based on results of sounding with weighted tape and/or sonar (fish finder) measurements. See sonic borehole logs in Attachment 3 for more information.

ConeTec used a Fraste, track-mounted, sonic drill rig and AquaLock piston samplers with inside diameters of 50 or 70 millimetres (mm) and sampler lengths of 1 or 2 m. The sampling process consisted of the following:

1. Advance the sample barrel to the desired top of sample elevation.
2. Push the inner drill rod to open a valve located at the top of the sample barrel, thereby releasing pressure behind a plug initially located at the bottom of the barrel.
3. Advance the sample barrel to the desired bottom of sample elevation; the plug floats above the sample.
4. Remove the inner drill rod, which closes the valve at the top of the barrel, locks the plug in place, and imparts suction to the sample.

The FSP called for continuous sampling with a minimum recovery of 70 percent. ConeTec varied their procedures in response to difficulties with poor sample recovery, as follows:

- Trimming tines from the sample catcher located in the sampler shoe
- Embedding the sampler at least 10 cm below the estimated mudline elevation to avoid filling the piston with water above the soil profile
- Using the larger 70-mm-diameter barrel (starting March 12, 2016)

Because the samples were commonly very disturbed by the sonic drilling and sampling process, they were extruded into a tray to allow visual descriptions, then placed in plastic bags for shipment to the laboratory for testing. At a few locations, the samples were extruded into clear, acrylic liners, and visual descriptions were made before capping the ends of the sample. ConeTec developed generalized boring logs based on their observations (Attachment 2). CH2M's field engineer also prepared logs for the borings, which include descriptions and approximate depths for subdivisions of the recovered samples. CH2M logs and photographs of the samples and field work are presented in Attachments 3 and 4, respectively.

A total of six borings, extending to a maximum depth of 23 m below the ice surface, were planned within the CVD Pond to characterize sludge deposits. As shown in Table 3, a total of fourteen borings was drilled at essentially seven locations. Most of the borings were terminated less than 3 m below the estimated mudline elevation because recovery was poor or native soil was encountered. Boring CH16-201-BH007 was terminated 23.8 m below the ice surface and 16.7 m below the estimated mudline elevation, and encountered a native, sand and gravel profile. The purpose of extending this boring deeper into the native soil profile was to provide a basis for correlations with the sub-bottom profiling survey.

Grab Samples

Grab samples were collected at the following locations for observation and possible laboratory testing:

- At CH16-201-CP016, CH16-201-CP017, and CH16-201-CP018 (all located in the ID Pond), grab samples were taken from the top of the seismic source after it was returned to the ice road surface following completion of the CPT sounding. The seismic source is estimated to have sunk between 25 and 50 cm below the mudline at these locations; therefore, considering the height of the seismic source is approximately 0.2 m, these grab samples are representative of soil conditions within about 0.3 m of the estimated mudline elevations at these locations.
- CH16-201-GS001 was taken near the northern shoreline (N 6914436.0 m, E 580350.3 m) of the CVD Pond. The sample was obtained using a sample cup mounted on the end of a wooden pole. This location is in the area, as described by D. Duivenvoorden, where sludge was historically excavated (Duivenvoorden, pers. Comm, 2016).

Bathymetry

Aurora Geosciences (Aurora) conducted a bathymetry survey of the CVD Pond in FY 2015, and later conducted a similar investigation for the ID Pond in June of FY 2016. Concurrent or consecutive survey of the ID Pond was not possible because the onset of ice required the field crew to stop their work on the CVD Pond and prevented access to the ID Pond. Aurora prepared data and interpretation reports following each investigation, which are presented in Attachment 5. A summary of the work is presented here; and a more detailed description is presented in Aurora's report.

A multi-beam sonar investigation, coupled with a supplemental single-beam sonar survey in shallow areas, was used to cover the bathymetry of the ponds. RTK-GPS survey, conducted with a Leica GS15

rover, was used to define the shoreline, water elevation, and to stream positional data to the multi-beam and single-beam bathymetry systems.

The multi-beam data collection was required to generate a detailed Digital Terrain Model of the underwater survey area of each pond. The multi-beam data (3.6-cm data density) provides a high resolution depth database for the ponds. A single-beam sonar survey, with a lower data density than the multi-beam, was used to supplement multi-beam data in shallower water. Two pond traverses were also surveyed using the single-beam equipment to compare with the multi-beam data. Two northern areas of the CVD Pond could not be surveyed because of shallow water and obstacles in the water.

Aurora used permanent control monument 2010-P5, as specified in the SOP MSR006, *Geographic Land Surveying and Field Surveying Procedures* (CH2M, March 2012g). For both the CVD Pond and ID Pond surveys, the Leica GS15 antenna was mounted over the permanent control marker at 2010-P5 (6914557.921 N, 581635.174 E with an orthometric height above the HT2 Geoid Model of 1060.480 m) at the CVD Pond as a primary control. Secondary control monuments were not established as Aurora determined they had a continuous RTK link with the GPS setup on permanent marker 2010-P5. Although secondary control points are preferred for quality assurance/quality control (QA/QC) checks, the absence of the secondary control does not directly affect the data quality. Aurora based their data quality on the quality-reporting capabilities of their acquisition equipment and post processing software together with comparisons between single-beam and multi-beam elevation values and comparison with their lead-line checks.

The multi-beam sonar data was collected using an Odom Teledyne MB1 multi-beam echo-sounder for areas of the pond with depths greater than approximately 1 m. The sonar was capable of monitoring water velocity changes from temperature and water purity fluctuations. A daily calibrated motion sensor was also used to monitor the heave, pitch, and roll of the boat, and a hemisphere marine GPS unit with wide antennae was positioned perpendicular to the sonar head for bearings, along with the Leica GS15 rover 1.09 m directly above the sonar head for high-accuracy positional data. Onboard computers controlled and monitored the instruments on the vessel while recording data.

The multi-beam sonar was capable of covering a 120-degree (°) -wide swath. For QC purposes, there was a 33 percent coverage overlap, where insufficient overlap was to be cleaned up upon completion of the survey. In practice, however, there was only an 80° useful data swath. This, along with the pond being shallower than expected, required Aurora to conduct extra passes with the vessel using single-beam sonar.

To provide a check to compare multi-beam data for the CVD Pond, single-beam sonar surveys were completed along two east and west reference lines, spaced 75 m apart; however, four planned reference lines were not completed because of cold temperatures and the onset of pond ice. Single-beam sonar was also conducted in shallower areas where multi-beam sonar was not possible.

For the ID Pond, single-beam sonar surveys were completed along six reference lines; four of these lines spanned the width of the pond spaced 150 m apart and the two other lines spanned the length of the pond spaced 175 m apart and coincidental with two of the sub-bottom profiling lines. Thirty-four (34) lead line check measurements were also taken throughout the ID Pond bathymetry area. Single-beam sonar was also conducted in shallower areas where multi-beam sonar was not possible. Attempts to fill in shallow areas at the southeastern edge of the pond were met with limited success because of the extreme shallowness of the pond there.

Sub-bottom Profiling

Aurora conducted a sub-bottom profile investigation of the CVD Pond in FY 2015, and later conducted a similar investigation for the ID Pond in June of FY 2016. Concurrent or consecutive survey of the ID Pond

was not possible because of the onset of ice and cold weather when the CVD Pond work was conducted. Aurora prepared data and interpretation reports, which are presented in Attachment 5.

An Edgetech SB-424 towfish, 3100P topside unit and Discover software were used for the sub-bottom profiling for both ponds. Frequency Modulated chirps from the SB-424 unit were tested to determine the frequency range with the best resolution for the local conditions. It was determined that this range was between 4 and 24 kilohertz for the CVD Pond. The CVD Pond sub-bottom profiling was performed along 54 lines with 10-m spacing between the lines to identify changes in the subsurface material density and unconsolidated material thickness.

For the ID Pond, the sub-bottom profiling was performed along 75 lines running 41 degrees across the pond, and along 6 perpendicular tie-lines for cross reference. Survey line spacing was 5 m with tie-lines being profiled at uneven spacing, in an attempt to profile different features that appeared during the initial passes.

Bathymetry and Sub-bottom Profiling Data Validity

There were several challenges associated with acquiring the bathymetry and sub-bottom profiling data. During the CVD Pond fieldwork, the greatest challenge was the development of ice on the pond surface that prevented the completion of the single-beam surveys and lead-line check measurement. These surveys were intended to provided secondary checks to the multiple beam data, and although the completion of the surveys would have complemented the dataset, data quality is not specifically impacted as a result of the surveys not being conducted.

A tertiary QC check was the completion of periodic lead-line measurements during the survey. For the CVD Pond, only six lead-line measurements were taken in FY 2016 because of the onset of high winds. Forty-nine lead line measurement were taken during the ID Pond survey. When compared to the multi-beam bathymetric data in the ID Pond, which has a better dataset, the lead-line measurements showed a negative bias (-0.26 m) implying the lead line measured a deeper pond bottom than the multi-beam. The discrepancy between the lead-line measurements and the multi-beam dataset could have been related to different factors, including the following:

- High winds moving the boat around, which would have contributed to a longer line measurement.
- Sinking of the lead weight into unconsolidated fine material.
- Sediment and sludge distribution changing over time since the CVD Pond bathymetric survey in the fall of 2015. (Although this last point is highly unlikely, it is still a possibility and worth noting.)

A more detailed evaluation of the bathymetric and sub-bottom profiling surveys is provided in the *Summary of the 2015-2016 Bathymetry and Sub-Bottom Data Review and Stage Storage Curve Development for the Faro Mine Remediation Project* (CH2M, 2016).

Laboratory Analyses

Laboratory analyses were conducted by ALS Environmental (ALS) on samples selected by the field technical manager, field sampling manager, and technical lead based on the data required, samples available, and engineering judgement. The following geochemical tests were conducted:

- Paste pH (CSSS/APHA 4500H)
- Total metals (U.S. Environmental Protection Agency 200.2/E1631E/SW6010B/SW6020A)
- Modified Neutralization Potential (Modified Sobek)
- Ferrous Iron (Lovely/Phillips Modified)

The following geotechnical tests were conducted:

- Moisture content (ASTM 2216)
- Atterberg Limits (ASTM 4318)
- Gradation with hydrometer (ASTM D422-63)

Geochemical test results for the soil samples are summarized in Table 4. Geotechnical laboratory test results for the sludge and soil samples are summarized in Table 5. The geochemical and geotechnical laboratory reports are located in Attachment 6.

Data validation was performed on all geochemical analytical data and three equipment blanks. A summary of the validation methodologies, issues encountered, and flags assigned to the data are provided in the *2016 Faro Mine CVD and ID Ponds Drilling Investigation Data Quality Evaluation Report*, included as Attachment 7.

Findings

Geotechnical Conditions

Cross Valley Dam Pond Cone Penetration Test Soundings

A total of six CPT soundings extending to a depth of 23 m below the ice surface were planned within the CVD Pond to characterize sludge deposits. However, CPT testing for the CVD Pond was abbreviated because initial results were not effective for this purpose. The first CPT sounding, CH16-201-CP025, encountered refusal only 0.75 m below the mudline elevation that was estimated using a sonar (fish finder) instrument. ConeTec then advanced CH16-201-CP022, which encountered practical refusal in relatively granular native soils approximately 4.03 m below the estimated mudline. CH2M hypothesized that either sludge deposits were not present at these locations or the sludge was too soft to be detected by the CPT equipment that was used, and it was decided to abbreviate the CPT program and proceed with sonic borings.

After possible sludge deposits were identified at CH16-201-BH011 and CH16-201-BH011A, a BGCPT was performed (CH16-201-CP026) adjacent to that location in an effort to characterize the consistency of the material. Results of the ball penetrometer test indicated almost zero shear strength to a depth of approximately 8.5 m (1.3 m below mudline), followed by sharply increasing resistance and practical refusal at 8.9 m (1.7 m below mudline). Therefore, possible sludge materials at the sounding location were approximately 1.3 m thick, and appear to have the consistency of a viscous fluid. The observed thickness of sludge in CH16-201-BH011 was 1.5 m thick, similar to the results of the CPT. The thickness of sludge at CH16-201-BH011A was not fully penetrated, but was observed to be greater than 1.1 m.

Intermediate Dam Pond Cone Penetration Test Soundings

A total of six CPT soundings extending to a maximum depth of 30 m below the ice surface were planned within the ID Pond to characterize tailings deposits. Soundings were completed at all six planned locations, and were terminated because of practical refusal at final depths ranging from 19.2 to 26.8 m below the ice surface. As shown on the CPT logs in Attachment 2, the soil profiles primarily consisted of silt to sandy silt that is saturated and relatively soft and loose. The shear wave velocities ranged between 100 and 300 m per second, as shown in Figure 2. Because the measured cone tip resistance was commonly less than about 300 kPa in the upper portion of the profiles, BGCPT testing was performed at CH16-201-015A and CH16-201-017A to depths of 14.43 and 14.00 m, respectively.

Table 4. Total Metals Analysis and General Chemical Parameter
Results : Faro Mine Complex CVD/IP Ponds
Faro Mine Remediation Project

Location ID				CH16-201-BH005B		CH16-201-BH006A		CH16-201-BH006A		CH16-201-BH007		CH16-201-BH007		CH16-201-BH008		CH16-201-BH008		CH16-201-BH008		CH16-201-BH008		CH16-201-BH009		CH16-201-BH009		CH16-201-BH010A		CH16-201-BH010A	
Sample ID				CH16-201-BH005B_SOA1		CH16-201-BH006A_SOA1		BH006A_SOA3		CH16-201-BH007_SOA1		CH16-201-BH007_SOE2		CH16-201-BH008_SOA1		CH16-201-BH008_SOA2		CH16-201-BH008_SOA3		CH16-201-BH008_SOB1		CH16-201-BH009_SOA2		CH16-201-BH009_SOB2		CH16-201-BH010A_SOA1		CH16-201-BH010A_SOA2	
Sample Interval (mbgs)	12x Median	10x Crustal		9.45 - 9.9		13.4 - 13.88		13.98 - 14.04		7.05 - 7.55		14.8 - 15.8		15.3 - 15.92		15.92 - 16.64		16.64 - 17.01		17.3-18.26		9.65 - 11.4		11.4 - 13.4		15.8 - 16.7		16.7 - 17.75	
Sample Date	Soil Content [a]	Abundance[b]		3/12/2016		3/10/2016		3/10/2016		3/8/2016		3/8/2016		3/10/2016		3/10/2016		3/10/2016		3/10/2016		3/9/2016		3/9/2016		3/10/2016		3/10/2016	
Analyte	**Unit**			**Result**	**Qualifier**	**Result**	**Qualifier**	**Result**	**Qualifier**	**Result**	**Qualifier**	**Result**	**Qualifier**	**Result**	**Qualifier**	**Result**	**Qualifier**	**Result**	**Qualifier**	**Result**	**Qualifier**	**Result**	**Qualifier**	**Result**	**Qualifier**	**Result**	**Qualifier**	**Result**	**Qualifier**
Aluminum	mg/kg	**852,000**	823,000	12400		11700		11800		12200		16300		29800		19000		14200				13100		14400		16600		12900	
Antimony	mg/kg	**60**	2	4.58		1.85		3.13		0.59		0.38		2.51		1.67		0.76				0.49		0.45		1.08		0.46	
Arsenic	mg/kg	**72**	18	13.9		28.1		36.5		7.52		15.5	J	31.2		27.1		16				8.15		11.2		21.9		13.7	
Barium	mg/kg	**6,000**	4,250	365		553		320		190		106		642		485		316				128		80.9		303		188	
Beryllium	mg/kg	**72**	30	0.45		0.57		0.59		0.49		0.7		1.33		0.81		0.67				0.51		0.58		0.7		0.57	
Bismuth	mg/kg	-	**0.085**	0.33		0.31		1.12		0.22		0.26		0.66		0.39		0.32				0.39		0.3		0.34		0.25	
Boron	mg/kg	-	**100**	5	U	5	U	5	U	5	U	5	U	5	U	5	U	5	U			5	U	5	U	5	U	5	U
Cadmium	mg/kg	**4.2**	1.5	0.7		0.509		0.331		0.511		0.313	J	0.916		0.65		0.691				0.195		0.305		0.681		0.45	
Calcium	mg/kg	180,000	**415,000**	20900		6430		4900		19200		6100		15900		13000	J	8220				3510		4580		8470		6090	
Chromium	mg/kg	840	**1,020**	27.4		29.2		32.7		48		95.9	J	135		79		45.5				27.1		38.5		49.4		36.5	
Cobalt	mg/kg	96	**250**	16.8		11.7		12.9		13.4		13.3	J	33.4		23.4		12.6				8.62		10.8		24.4		9.03	
Copper	mg/kg	360	**600**	57.7		50.5		102		32.8		34.9	J	105		62.7		38.5				20.6		21.5		51.9		27.8	
Iron	mg/kg	480,000	**563,000**	24400		25700		35800		23100		30100		56600		40000		23400		15000		18700		23400		23300		17100	
Ferrous Iron	mg/kg															811	J			38.5	J					816	J		
Lead	mg/kg	**420**	140	137		270		711		37.7		15.3	J	144		84.7		44.6				18.8		24.8		66.7		19.4	
Lithium	mg/kg	**300**	200	22		23.4		22.8		20.9		23.7		50.2		28.6		24.4				21.1		22.2		29.9		24.3	
Magnesium	mg/kg	60,000	**233,000**	6380		5340		5060		7070		7770		18800		12100		7370				5080		6600		7810		6040	
Manganese	mg/kg	**12,000**	9,500	760		535		585		580		458	J	850		719		767				264		357		762		449	
Mercury	mg/kg	0.72	**0.85**	0.112		0.247		0.656		0.0401		0.0226		0.135		0.0935		0.0545				0.0158		0.0214		0.0721		0.0396	
Molybdenum	mg/kg	**24**	12	3.18		1.16		1.35		1.52		1.49		2.28		2.01		1.64				1.01		0.75		2.93		1.8	
Nickel	mg/kg	600	**840**	40.5		26.1		26.8		39		58.2		136		87.7		47.4				25		32.1		50.3		30	
Phosphorus	mg/kg	9,600	**10,500**	518		694		707		531		701		686		611		629				565		604		653		802	
Potassium	mg/kg	168,000	**208,500**	1410		1200		1900		1600		1840		2920		1460		1040				1230		1360		1360		1190	
Selenium	mg/kg	**4.8**	0.5	0.37		0.3		0.38		0.2	U	0.2	U	0.79		1.02		1.76				0.21		0.24		2.07		1.92	
Silver	mg/kg	-	**0.75**	0.3		0.59		1.52		0.14		0.11		0.49		0.32		0.2				0.1	U	0.1	U	0.26		0.15	
Sodium	mg/kg	60,000	**235,500**	380		252		234		306		562	J	402		291		232				309		299		329		256	
Strontium	mg/kg	3,000	**3,700**	83.6		40.3		35.8		75.2		58.9		60.4		50.3		42.4				35.6		33.6		43.7		37.6	
Sulfur	mg/kg	**8,400**	3,500	6200		6200		10300		1100		900		3500		3600		2200				1500		1300		5000		5400	
Thallium	mg/kg	**108**	8.5	0.257		0.306		0.705		0.15		0.18		0.404		0.242		0.19				0.143		0.152		0.264		0.155	
Tin	mg/kg	**48**	23	2.0	U	2.0	U	2.0	U	2.0	U	2.0	U	2.0	U	2.0	U	2.0	U			2 U	U	2.0	U	2.0	U	2.0	U
Titanium	mg/kg	-	**56,500**	329		446		514		341		480		571		388	J	392				412		480		493		445	
Uranium (U)	mg/kg	24	**27**	0.987		1.53		1.46		0.901		1.57		1.57		3.28	J	4.39				0.95		0.96		5.51		3.81	
Vanadium	mg/kg	1,080	**1,200**	27.4		29.4		34.9		28.9		36.5		72.2		43.6		33.1				31.9		33.9		40.4		31.2	
Zinc	mg/kg	**1,080**	700	488		236		300		121		67.6		407		261		167				75.1		81.9		257		105	
Zirconium	mg/kg	**-**	-	3.1		1.8		2.6		3.5		3		5.8		4.2		3.3				1 U	U	1.3		3		3.3	
Organic Matter	%																							1	U	9.2			
Organic Matter_LOI	%																							1	U	11.4			
Paste pH	pH			7.41		7.28				7.69		7.78		7.44		7.32		6.75				7.42		7.18		6.33		5.9	
pH (1:2 soil:water)	pH			8.04		7.55		6.99		8.22		8.13	J	7.54		7.39		6.8				7.79		7.52		6.52		6.11	
Neutralization Potential (as CaCO3 Equivalent)	T CaCO3/kT			74		17		12		64		13	J	30		36		17				13		20		15		10	

Notes:

[a] 12x the Median world soil content retrieved from Bowen, H.J.M. (1979) Environmental Chemistry of the Elements. Academic Press, London

[b] Values from Price, W.A. 1997. Draft *Guidelines and Recommended Methods for the Prediction of Metal Leaching and Acid Rock Drainage at Mine Sites in British Columbia* (Appendix 3).

12x Median World Soil Content values and 10x Continental Crustal Abundance values that are bolded and underlined indicate the highest value between the two.

Laboratory data has been validated by CH2M before importing to EquIS. This summary table has been through QA/QC.

Values indicated in black text with a grey background were identified at concentrations that are greater than 12x the Median World Soil Content.

Values indicated in white text with a grey background were identified at concentrations that are greater than 10x the crustal abundance.

Values indicated in white text with a black background were identified at concentrations that are greater than both 12x the Mediam World Soil Content***and*** 10x the crustal abundance.

$CaCO_3$ = calcium carbonate

J = This analyte was present but the reported value may not be accurate or precise

mbgs = metre below ground surface

mg/kg = milligram per kilogram

NT = not tested

QA/QC = Quality Assurance and Quality Control

R = Data rejected

U = This analyte was analyzed for but not detected at the specified detection limit

Table 4. Total Metals Analysis and General Chemical Parameter
Results : Faro Mine Complex CVD/IP Ponds
Faro Mine Remediation Project

Location ID				CH16-201-BH010A		CH16-201-BH010A		CH16-201-BH011		CH16-201-BH011		CH16-201-BH011A		CH16-201-BH011A		CH16-201-BH012		CH16-201-BH012A		CH16-201-BH012A		CH16-201-BH012A		CH16-201-BH007		CH16-201-BH008		CH16-201-CP016	
Sample ID				CH16-201-BH010A_SOB2		CH16-201-BH010A_SOB4		CH16-201-BH011_SOA1		CH16-201-BH011_SOA2		CH16-201-BH011A_SOA		CH16-201-BH011A_SOB		CH16-201-BH012_SOB		CH16-201-BH012A_SOA1		CH16-201-BH012A_SOA2		CH16-201-BH012A_SOA4		CH16-201-BH907_SOE2		CH16-201-BH908_SOA2		CH16-201-CP016_SOA	
Sample Interval (mbgs)				17.93 - 18.16		18.24 - 19.15		8.55 - 8.7		8.7 - 8.9		7.5 - 7.5		8 - 8		15.13 - 15.63		14 - 14.5		14 - 14.5		14.5 - 15.1		14.8 - 15.8		15.92 - 16.64		0 - 0	
Sample Date		12x Median Soil Content [a]	10x Crustal Abundance[b]	3/10/2016		3/10/2016		3/11/2016		3/11/2016		3/12/2016		3/12/2016		3/11/2016		3/12/2016		3/12/2016		3/12/2016		3/8/2016		3/10/2016		3/15/2016	
Analyte	**Unit**			**Result**	**Qualifier**	**Result**	**Qualifier**	**Result**	**Qualifier**	**Result**	**Qualifier**	**Result**	**Qualifier**	**Result**	**Qualifier**	**Result**	**Qualifier**	**Result**	**Qualifier**	**Result**	**Qualifier**	**Result**	**Qualifier**	**Result**	**Qualifier**	**Result**	**Qualifier**	**Result**	**Qualifier**
Aluminum	mg/kg	**852,000**	823,000	10400				10300		17600		3460		2190		11600		12000		11600		14900		11800		18200		6460	
Antimony	mg/kg	**60**	2	0.99				1.7		2.42		0.49		0.77		0.61		0.88		0.53		0.67		0.25		1.91		58.6	
Arsenic	mg/kg	**72**	18	44.6				22.7		40.7		9.03		9.75		10.7		14		10.3		12.7		7.87	J	20.2		1100	
Barium	mg/kg	**6,000**	4,250	299				304		171		70.2		202		168		233		111		170		65.2		329		344	
Beryllium	mg/kg	**72**	30	0.59				0.51		0.71		0.38		0.14		0.46		0.54		0.42		0.56		0.46		0.73		0.38	
Bismuth	mg/kg	-	**0.085**	0.31				0.2	U	0.29		0.2	U	0.2	U	0.22		0.26		0.27		0.28		0.44		0.32		0.87	
Boron	mg/kg	-	**100**	5	U			5	U	5	U	5	U	5	U	5	U	5	U	5	U	5	U	5	U	5	U	5	U
Cadmium	mg/kg	**4.2**	1.5	0.77				23		0.811		29.9		29.6		0.514		0.455		0.314		0.377		0.167	J	0.454		22.1	
Calcium	mg/kg	180,000	**415,000**	120000				71800		15900		49300		126000		8110		7860		5230		6220		4000		7630	J	8260	
Chromium	mg/kg	840	**1,020**	27.7				29.5		53.3		13.4		30.7		29.9		26.6		26.1		29.4		39.3	J	123		36.7	
Cobalt	mg/kg	96	**250**	18.5				101		18.1		152		159		10.6		12.4		9.62		11.6		7.96	J	25.2		90.4	
Copper	mg/kg	360	**600**	32.7				100		39		292		109		37.3		35.3		21.7		30.9		19.7	J	54.6		1340	
Iron	mg/kg	480,000	**563,000**	26800		25400		30100		34500		69000		24700		19700		24200		21300		24500		21300		42600		173000	
Ferrous Iron	mg/kg					174	J																						
Lead	mg/kg	**420**	140	47.5				197		32.3		783		164		33.1		57.8		27.5		34.7		8.75	J	48.3	J	6680	
Lithium	mg/kg	**300**	200	20.9				19.3		36.6		2.5		2.1		21.6		20.2		23.3		25.5		21.1		25.4		5.5	
Magnesium	mg/kg	60,000	**233,000**	6490				43100		11100		93500		105000		5740		5860		5800		7240		6110		14000		6090	
Manganese	mg/kg	**12,000**	9,500	611				20800		939		32800		44900		769		705		470		607		272	J	596		5150	
Mercury	mg/kg	0.72	**0.85**	0.0532				0.0759		0.0364		0.0373		0.0437		0.0371		0.054		0.0255		0.028		0.013		0.0537	J	7.77	
Molybdenum	mg/kg	**24**	12	3.11				1.9		1.41		3.02		10.2		2.43		1.35		0.87		1.21		1.06		1.48		8.96	
Nickel	mg/kg	600	**840**	32.4				147		62.9		166		186		27.9		30.9		24.9		32.1		28.2	J	131		48.1	
Phosphorus	mg/kg	9,600	**10,500**	553				395		702		84		99		728		579		519		783		420	J	530		358	
Potassium	mg/kg	168,000	**208,500**	1510				1110		2470		330		250		990		1040		990		1240		1220		890		880	
Selenium	mg/kg	**4.8**	0.5	2.76				0.43		0.27		0.2	U	0.2	U	0.95		0.26		0.2	U	0.22		0.2	U	0.61		0.78	
Silver	mg/kg	-	**0.75**	0.21				0.21		0.16		0.11		0.1		0.14		0.16		0.1	U	0.12		0.1		0.23		16.8	
Sodium	mg/kg	60,000	**235,500**	228				316		405		490		308		257		203		185		237		317	J	191		81	
Strontium	mg/kg	3,000	**3,700**	217				152		64.1		111		251		39.3		34.2		26.9		34.8		35.7		35		48.1	
Sulfur	mg/kg	**8,400**	3,500	3700				3300		2500		18000		4400		11400		1800		2000		1800		700		2000	J	180000	
Thallium	mg/kg	**108**	8.5	0.2				0.772		0.256		0.359		1.36		0.133		0.172		0.129	U	0.172		0.113		0.17		7.88	
Tin	mg/kg	**48**	23	2.0	U			2.0	U	2.0	U	2.0	U	2.0	U	2.0	U	2.0	U	2.0	U	2.0	U	2.0	U	2.0	U	4.4	
Titanium	mg/kg	-	**56,500**	462				306		553		57.7		64.4		338		336		325		423		335		179	J	65.5	
Uranium (U)	mg/kg	24	**27**	6.69				4.28		0.961		5.64		4.39		1.26		1.07		0.817		1.06		1.02		1.49	J	3.04	
Vanadium	mg/kg	1,080	**1,200**	32.7				31.7		44.9		22.6		17.8		29.1		30		24		33.5		29.1		38.7		29.1	
Zinc	mg/kg	**1,080**	700	259				31600		602		46600		45400		138		189		109		131		47.5		167		15400	
Zirconium	mg/kg	**-**	-	4.2				1.6		2.3		1.9		2.3		1.2		1	U	1	U	1	U	2.8		3.6		6.9	
Organic Matter	%					2.4										12		1.7		1	U								
Organic Matter_LOI	%					2.7										15		1.8		1	U								
Paste pH	pH			7.32						8.21		9.17		9.42		7.13		7.37		7.45		7.39		7.94		7.23		5.67	
pH (1:2 soil:water)	pH			7.45				9.06		8.57						7.26		7.69		7.88		7.82		8.23	J	7.46		6.29	
Neutralization Potential (as CaCO3 Equivalent)	T CaCO3/kT			437						35		511		623		22		24		16		24		11	J	27		32	

Notes:

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Table 4. Total Metals Analysis and General Chemical Parameter
Results : Faro Mine Complex CVD/IP Ponds
Faro Mine Remediation Project

Location ID				CH16-201-CP017		CH16-201-CP018		CH16-201-CP016		CH16-201-GS001	
Sample ID				CH16-201-CP017_SOA		CH16-201-CP018_SOA		CH16-201-CP916_SOA		CH16-201-GS001_SOA	
Sample Interval (mbgs)		12x Median	10x Crustal	0 - 0		0 - 0		0 - 0		2.99 - 2.99	
Sample Date		Soil Content [a]	Abundance[b]	3/14/2016		3/13/2016		3/15/2016		3/13/2016	
Analyte	**Unit**			**Result**	**Qualifier**	**Result**	**Qualifier**	**Result**	**Qualifier**	**Result**	**Qualifier**
Aluminum	mg/kg	**852,000**	823,000	2630		9080		6560		7100	
Antimony	mg/kg	**60**	2	39.7		55.7		58.6		0.98	
Arsenic	mg/kg	**72**	18	1070		939		1100		18	
Barium	mg/kg	**6,000**	4,250	359		316		372		182	
Beryllium	mg/kg	**72**	30	0.2		0.45		0.35		0.48	
Bismuth	mg/kg	-	**0.085**	0.64		0.98		0.82		0.2	U
Boron	mg/kg	-	**100**	5	U	5	U	5	U	5	U
Cadmium	mg/kg	**4.2**	1.5	9.47		25.7		20.7		21.7	
Calcium	mg/kg	180,000	**415,000**	7740		7910		8170		153000	
Chromium	mg/kg	840	**1,020**	14.9		41.9		36.6		19.1	
Cobalt	mg/kg	96	**250**	105		77.8		89.2		127	
Copper	mg/kg	360	**600**	851		1180		1290		151	
Iron	mg/kg	480,000	**563,000**	234000		168000		169000		66800	
Ferrous Iron	mg/kg										
Lead	mg/kg	**420**	140	4050		6310		6400		377	
Lithium	mg/kg	**300**	200	2		12.3		4.7		10.9	
Magnesium	mg/kg	60,000	**233,000**	3570		7420		5950		21700	
Manganese	mg/kg	**12,000**	9,500	3180		4220		5110		30200	
Mercury	mg/kg	0.72	**0.85**	4.07		0.0855		7.41		0.064	
Molybdenum	mg/kg	**24**	12	4.93		9.53		8.71		0.78	
Nickel	mg/kg	600	**840**	29.7		45.7		44.9		132	
Phosphorus	mg/kg	9,600	**10,500**	262		367		351		234	
Potassium	mg/kg	168,000	**208,500**	290		930		920		830	
Selenium	mg/kg	**4.8**	0.5	0.89		0.8		0.79		0.21	
Silver	mg/kg	-	**0.75**	11.8		15.7		16.4		0.15	
Sodium	mg/kg	60,000	**235,500**	50	U	89		79		535	
Strontium	mg/kg	3,000	**3,700**	42		43.1		51.1		251	
Sulfur	mg/kg	**8,400**	3,500	281000		110000		174000		2100	
Thallium	mg/kg	**108**	8.5	5.49		6.67		7.62		0.509	
Tin	mg/kg	**48**	23	2.3		4.0		4.4		2.0	U
Titanium	mg/kg	-	**56,500**	27.9		77.6		76.9		196	
Uranium (U)	mg/kg	24	**27**	1.49		3.49		2.95		4.63	
Vanadium	mg/kg	1,080	**1,200**	13.7		30.1		29.7		25.8	
Zinc	mg/kg	**1,080**	700	5880		15500		14700		31100	
Zirconium	mg/kg	**-**	-	2.3		7.8		6.9		1.4	
Organic Matter	%										
Organic Matter_LOI	%										
Paste pH	pH			6.38		6.42		5.59		8.2	
pH (1:2 soil:water)	pH			7.21		6.2		6.24			
Neutralization Potential (as CaCO3 Equivalent)	T CaCO3/kT			71				30		435	

Notes:

[a] 12x the Median world soil content retrieved from Bowen, H.J.M. (1979) Environmental Chemistry of the Elements. Academic Press, London

[b] Values from Price, W.A. 1997. Draft *Guidelines and Recommended Methods for the Prediction of Metal Leaching and Acid Rock Drainage at Mine Sites in British Columbia* (Appendix 3).

12x Median World Soil Content values and 10x Continental Crustal Abundance values that are bolded and underlined indicate the highest value between the two.

Laboratory data has been validated by CH2M before importing to EquIS. This summary table has been through QA/QC.

Values indicated in black text with a grey background were identified at concentrations that are greater than 12x the Median World Soil Content.

Values indicated in white text with a grey background were identified at concentrations that are greater than 10x the crustal abundance.

Values indicated in white text with a black background were identified at concentrations that are greater than both 12x the Mediam World Soil Content***and*** 10x the crustal abundance.

$CaCO_3$ = calcium carbonate

J = This analyte was present but the reported value may not be accurate or precise

mbgs = metre below ground surface

mg/kg = milligram per kilogram

NT = not tested

QA/QC = Quality Assurance and Quality Control

R = Data rejected

U = This analyte was analyzed for but not detected at the specified detection limit

Table 5. Geotechnical Laboratory Test Results - CVD/ID Pond Soil Samples

Faro Mine Reclamation Project

Borehole	Depth (meters below Ice Surface)	Depth (meters below Mudline)	Liquid Limit	Plasticity Index	Clay Content (%)	Silt Content (%)	Fine Sand Content (%)	Medium Sand Content (%)	Coarse Sand Content (%)	Gravel Content (%)	Percent Passing No. 200 sieve (%)	Organic Matter (Loss on Ignition) (%)	USCS Classification	USCS Description
		ASTM Standard:	D4318	D4318	D422	D422	D422	D422	D422	D422	D1140	CSSS (1978)	D2487	D2487
CH16-201-BH007	7.05 - 7.75				6.1	2	6.6	61.7	19.5	4.2			SW-SM or SW-SC	Well-graded Sand with Silt or Clay
CH16-201-BH007	9.8 - 11.8				8.4	2.4	18.1	40.8	12.2	18.1			SW-SM or SW-SC	Well-graded Sand with Silt or Clay with Gravel
CH16-201-BH007	13.8 - 14.8				5.5	3.8	20.2	56	10.3	4.3			SW-SM or SW-SC	Well-graded Sand with Silt or Clay
CH16-201-BH008	15.3 - 15.92		53	18	41.4	55.9	1.7	1.1					MH	Elastic Silt
CH16-201-BH008	15.92 - 16.64		43	11	16.2	23.9	18.7	29.2	10.8	1.2			SM	Silty Sand
CH16-201-BH008	17.3 - 18.26				7.4	3.1	8.9	66.7	10.3	3.7			SP-SM or SP-SC	Poorly-graded Sand with Silt or Clay
CH16-201-BH009	9.65 - 10.0				6.2	10.2	12.9	46.6	12.1	12			SC or SM	Silty or Clayey Sand
CH16-201-BH009	11.9 - 12.3		23	2								<1		
CH16-201-BH010A	15.8 - 16.7		62	11	21.9	54.2	21.0	2.1		<1		11.4	MH	Elastic Silt with Sand and Organics
CH16-201-BH010A	18.24 - 19.15		48	10	18.8	56.7	20.9	3.6				2.7	ML	Silt with Sand
CH16-201-BH012	15.13 - 15.38		92	13							33.6	15.0	SM	Silty Sand with Organics
CH16-201-BH012A	14.0 - 14.17		23	2	7.9	17.3	34.1	29.8	9	2		1.8	SM	Silty Sand
CH16-201-BH012A	14.17 - 14.34		NP	NP	6.9	9.5	27.6	42	12.1	2		<1	SM	Silty Sand
CH16-201-BH012A	14.5 - 15.1				4	5.1	14.3	24.9	18	33.7			SW-SM or SW-SC	Well-graded Sand with Silt or Clay with Gravel
CH16-201-CP016	at mudline	0			36.6	63.3							ML or MH	Silt or Elastic Silt
CH16-201-CP017	at mudline	0			10.0	80.7	9.3						ML or MH	Silt or Elastic Silt

Notes:
Blanks indicate no testing was performed, or insufficient information available
% = percent
CSSS = Canadian Society of Soil Science Test Method
m =metre
MH = Elastic Silt
NP = Non-plastic
SC = Clayey Sand
SM = Silty Sand
USCS = Unified Soil Classification System
< = Less than

A ratio of undrained shear strength to estimated effective overburden pressure equal to approximately 0.18 was measured for the sediment in the bottom of the ID Pond. This ratio is typical of normally consolidated material.

Sonic Borings in the CVD Pond

The material encountered in the CVD Pond boreholes generally consisted of sludge deposits, where encountered, overlying native soil. Apparent sludge was encountered in CH16-201-BH008, CH16-201-BH011, and CH16-201-BH011A, extending from the estimated mudline elevation to depths of 0.7 to 1.7 m, as summarized in Table 6. The apparent sludge appeared to consist of silt and clay-sized material that was grey (mixture of ferrous and ferric iron) or rust-colored (ferric iron) and had the consistency of very soft to extremely soft soil, or a viscous fluid. In segments of the recovered sample, distinct dark blue to blackish color, indicative of sludge dominated by ferrous iron, was also evident. A few cm of material suspected to be sludge was also observed at the top of the recovered sample in CH16-201-BH005B. Because of difficulties with poor sample recovery, particularly just below the mudline, there may be some sludge present even where it was not recovered in the samples. The thickness of sludge in these areas can be estimated from the results of the sub-bottom profiling, discussed in a later section of this TM.

Table 6. Sludge Thickness Estimated from Observations at Sonic Boreholes
Faro Mine Remediation Project

Sonic Borehole ID	Sludge Thickness (m)
CH16-201-BH005	Not Observed[b]
CH16-201-BH005A	Not Observed[b]
CH16-201-BH005B	Not Observed[b]
CH16-201-BH006	Not Observed[b]
CH16-201-BH006A	Not Observed[b]
CH16-201-BH007	Not Observed[b]
CH16-201-BH008	0.7
CH16-201-BH009	Not Observed[b]
CH16-201-BH010	Not Observed[b]
CH16-201-BH010A	Not Observed[b]
CH16-201-BH011	[a]1.5 to 1.7
CH16-201-BH011A	[a]>1.1
CH16-201-BH012	Not Observed[b]
CH16-201-BH012A	Not Observed[b]

Notes:

[a.] Sludge thickness of 1.5 to 1.7 m estimated based on mudline sounding data shown on boring logs.

[b.] It is assumed up to 0.3 m thickness of sludge could be present based on sub-bottom profiling results, but was difficult to sample because of the extremely soft consistency.

Native soil was encountered below the possible sludge, or below the mudline where no sludge is present. The native soil profile consisted of interlayered deposits of silt, sand, and gravel, with occasional layers of organic soil or peat. The deeper soil profile encountered by CH16-201-BH007 consisted primarily of sand with silt and gravel.

Geochemical Characteristics

Total metals analyses were performed on select samples from the CVD Pond and the ID Pond. The total metals concentrations are compared with elemental crustal abundance concentrations and median world soil concentrations to identify relative elevated concentrations. Concentrations of elemental crustal abundance are sourced from Price (1997) and presented as 10 times the average value in the continental crust. The median world soil concentrations are from Bowen (1979) as reported in the *Global Acid Rock Drainage Guide* (GARD Guide) (International Network for Acid Prevention [INAP], 2013) and are used to calculate a geochemical abundance index (GAI). The GARD Guide considers any GAI value greater than 3, which corresponds to 12 times the world soil concentration, significant and warranting further examination (INAP, 2013). The total metals results were therefore compared to 12 times the median world soil concentrations. In general, concentrations of arsenic, selenium, and sulphur were higher than background concentrations in the CVD Pond, as indicated by multiple exceedances. Arsenic concentrations in the CVD Pond samples ranged from 7.52 milligrams per kilogram (mg/kg) (below both of the guidelines) to 44.6 mg/kg (exceeding 10 times the crustal abundance), and the exceedances were noted at locations CH16-201-BH006A, CH16-201-BH008, CH16-201-BH010A, and CH16-201-BH011. Selenium concentrations were elevated at locations CH16-201-BH008, CH16-201-BH010A, and CH16-201-BH012, with the highest concentration (2.76 mg/kg) found at location CH16-201-BH010A. Sulphur concentrations were elevated at locations CH16-201-BH005B, CH16-201-BH006A, CH16-201-BH008, CH16-201-BH010A, CH16-201-BH011A, and CH16-201-BH012. Concentrations ranged from 700 to 18,000 mg/kg. The highest concentration, recorded at CH16-201-BH011A, exceeds both of the guidelines. CH16-201-BH011 and CH16-201-BH11A, both on the northern side of the pond, also contain elevated concentrations of cadmium, cobalt, lead, and zinc. Cadmium concentrations are especially high here compared to the rest of the sample locations, with concentrations ranging from 23 to 29.9 mg/kg compared to 0.167 to 0.916 mg/kg at the remaining sample locations.

Ferrous iron analysis was completed on four sediment samples collected from CH16-201-BH008 and CH16-201-BH010A (two samples from each boring). Concentrations of ferrous iron ranged from 38.5 to 816 mg/kg. The proportion of ferrous iron relative to the total iron results from each sample ranged from 0.3 to 3.5 percent, and was higher in the shallower sample intervals at both boring locations. This proportion of ferrous iron is much lower than that measured in the water treatment plant influent water sources since 2012 (CH2M, October 2013a), which is greater than 50 percent. The lower proportion of ferrous iron indicates some oxidation took place either during water treatment and deposition of effluent and sludge to the CVP, during seasonal pond turnover, or during sample collection and storage. However, the results indicate the oxidation was not complete, and a portion of the sludge at the bottom of the CVP consists of low-density ferrous iron hydroxide. The periodic degradation of water quality in the CVP, observed as increased turbidity and orange colouration, is largely attributed to the ferrous iron hydroxide sludge, which becomes mobilized by physical disturbance of the pond (caused by seasonal turnover or wind), and oxidizes to form ferric hydroxide, which is typically suspended in the water column. The zero point of charge for ferric iron oxyhydroxide is approximately 8.0. As the pH of the pond deviates from this value, more iron particles will remain in solution. At slightly acidic values, ferric iron sludge particles may persist in suspension, creating turbidity and discoloration.

Samples collected from the ID Pond have much higher concentrations of metals compared to the CVD Pond samples. Samples analyzed here contain elevated concentrations of 10 different metals, most notably arsenic, cadmium, copper, lead, mercury, sulphur, and zinc, which all have concentrations higher than both of the guidelines. As the material at the bottom of the ID Pond is tailings, these elevated concentrations are to be expected.

Bathymetry Results

For the October 2015 survey of the CVD Pond, Aurora reported a mean shoreline elevation of the pond of 1,028.68 m, the orthometric height above the HT2 geoid, with a standard deviation of 4.6 cm. The total volume of water in the pond was estimated at 1,414,399 m^3, excluding water in relatively shallow areas where no bathymetry data was collected. The survey revealed greater water depths toward the northern and western sides of the pond, with a maximum interpreted depth of 14.68 m, corresponding to a bottom of pond elevation of 1,014.00 m.

For the June 2016 survey of the ID Pond, Aurora reported a mean shoreline of the pond based on RTK shoreline points of 1,045.98 m, the orthometric height above the HT2 geoid, with a standard deviation of 2.6 cm. The total volume of water in the pond was estimated at 781,829 m^3, excluding water in relatively shallow areas where no bathymetry data was collected. The survey revealed greater water depths toward the western end of the pond and parallel to the ID Pond, with a maximum interpreted depth of 7.8 m, corresponding to a bottom of pond elevation of 1,038.20 m. The pond bottom is mostly featureless and is dominated by shallowing slope to the east.

Stage-storage curves for the CVD Pond and ID Pond are presented in *Summary of the 2015-2016 Bathymetry and Sub-Bottom Data Review and Stage Storage Curve Development for the Faro Mine Remediation Project* (CH2M, 2016).

Sub-bottom Profiling Results

For the October 2015 survey of the CVD Pond, Aurora divided the subsurface layers into multiple features from the sub-bottom survey that are interpreted to correspond to layers or packages of materials with similar properties. Aurora provided descriptions of the interpreted features in their report (Attachment 5) that also includes profile figures showing interpreted layering, and plan figures showing contours of material thicknesses for the interpreted features.

According to the results of the sonic and grab sampling in the CVD Pond, it appears that the uppermost layer or package of similar material that Aurora identified as Feature B correlates with sludge material. The thickness of Feature B is portrayed in Figure 3. The thickness of sludge observed in CH15-201-BH011 and CH15-201-BH008 correlated to within plus or minus 0.5 m of the Feature B thickness interpreted from the sub-bottom profiling of the CVD Pond. Details and a presentation of the thicknesses of the identified feature layers in the sub-bottom profiling results can be found in the Aurora geophysical report for the CVD Pond (Attachment 5).

In the ID Pond, Aurora estimated that the uppermost layer or package of similar material, identified as Feature 1 in the sub-bottom profiling results, likely corresponds to tailings deposits on the bottom of the pond. Layers of increasing density and hardness with increasing depth were interpreted from the sub-bottom profile results. The sub-bottom profile results identified a very dense or hard lower layer (Feature 5) that appears to represent the depth at which CPT refusal occurred. Details and a presentation of the thicknesses of the identified feature layers in the sub-bottom profiling results can be found in the Aurora geophysical report for the ID Pond (Attachment 5).

Correlations between the sub-bottom profiling, sonic drilling, and CPT soundings in the CVD and ID Ponds will be further discussed in the Comprehensive Design Road Map Report being prepared separately (CH2M, 2016).

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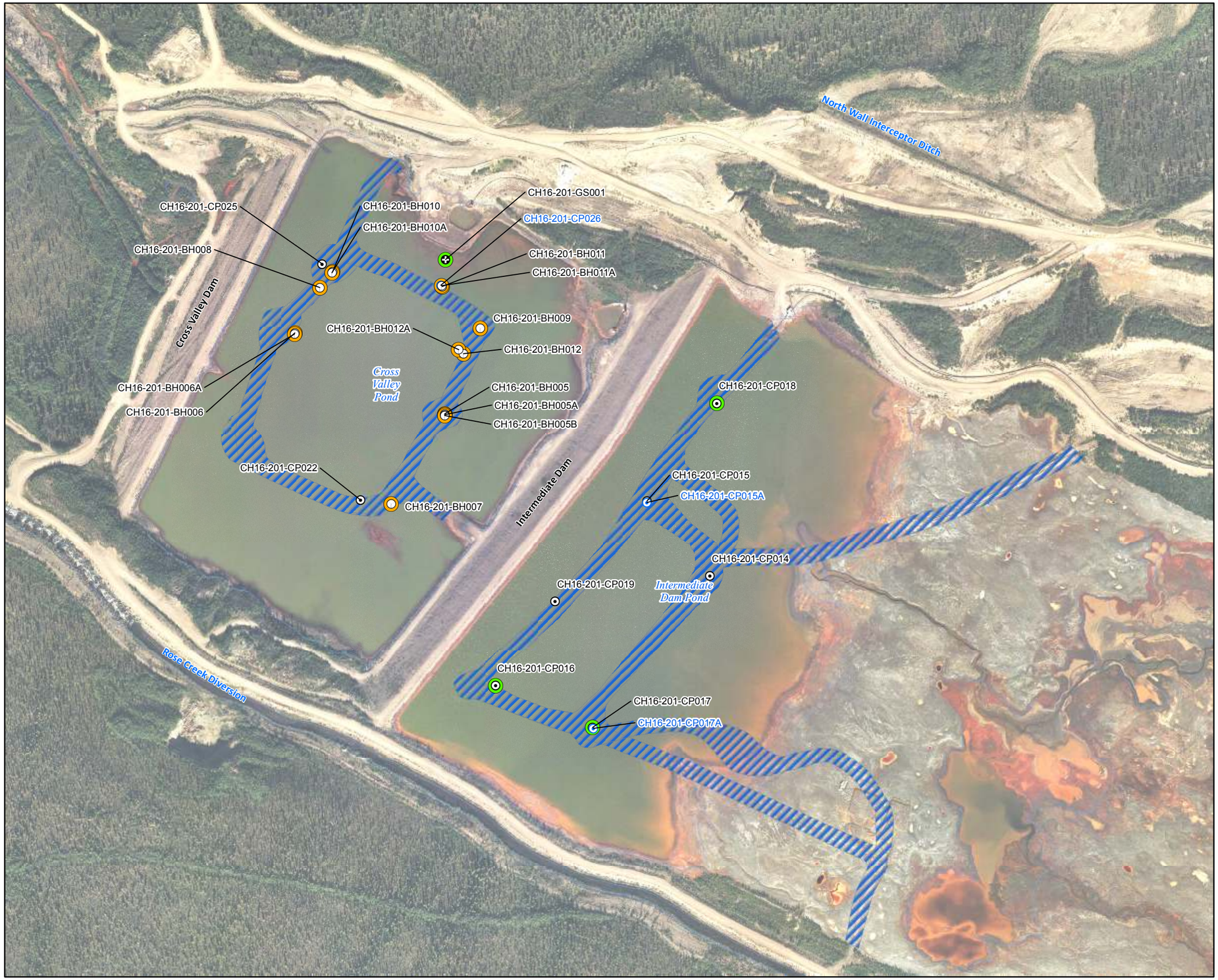
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Figures



VICINITY MAP



SnowClearing

Ice Road (20m Wide)

Exploration Type

- Borehole
- Gamma Flow (Ball) Penetration Test (BGCPT) Cone Penetrometer
- Gamma Seismic Cone Penetration Test (GSCPT) Cone Penetrometer
- Hand Probe

Sample type

- Grab
- Sonic

Notes:
1. Aerial photography acquired by Peregrine Aerial Surveyors Inc. and Eagle Mapping in August 2012.
2. Orthophotography prepared by Critigen Canada Corp.
3. Definitions:
GSCPT: Gamma Seismic Cone Penetration Test
BGCPT: Gamma Flow (Ball) Penetration Test
CVD Pond = Cross Valley Dam Pond
ID = Intermediate Dam

N

0 50 100 150 200
Metres

DRAFT

FIGURE 1
Cross Valley Dam and Intermediate Dam Pond Investigation Locations
Rose Creek Tailings Area
Faro Mine Remediation Project

ch2m.

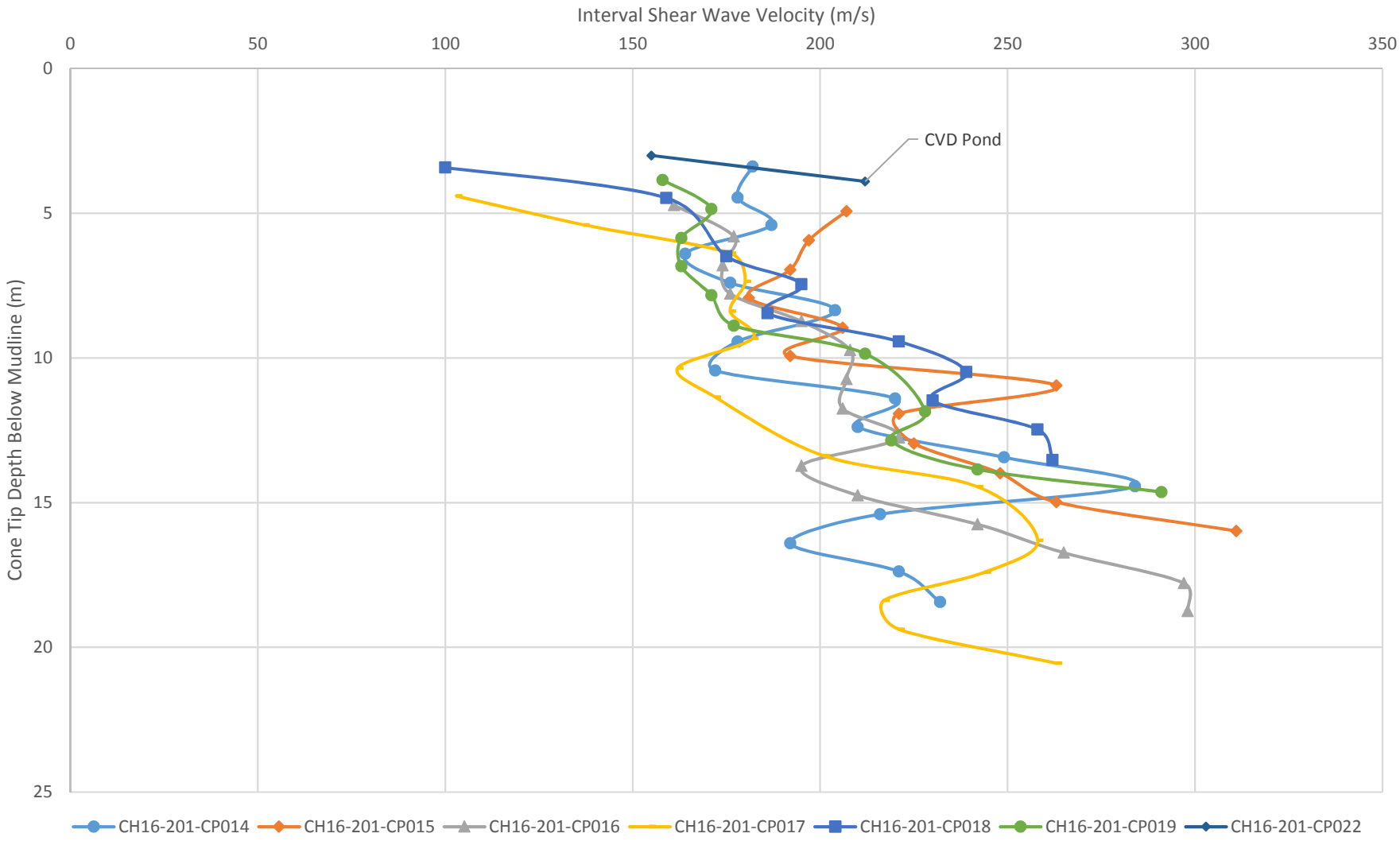
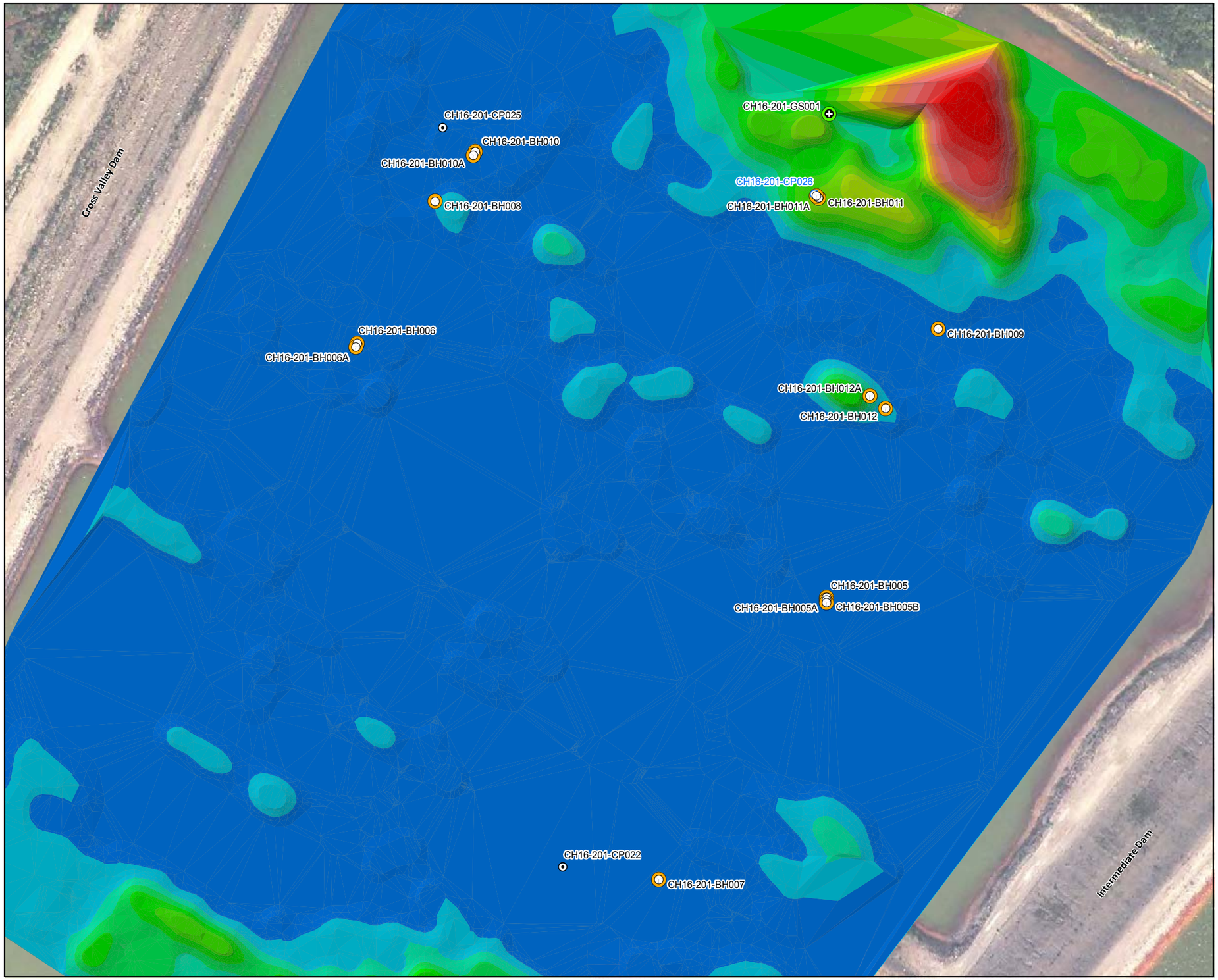


Figure 2
Shear Wave Velocity Profiles Measured with Seismic CPT
Faro Mine Remediation Project



VICINITY MAP



Exploration Type
- Borehole
- Gamma Flow (Ball) Penetration Test (BGCPT) Cone Penetrometer
- Gamma Seismic Cone Penetration Test (GSCPT) Cone Penetrometer
- Hand Probe

Sample type
- Grab
- Sonic

Feature B Thickness (m)
- 5.082 - 5.4
- 4.765 - 5.082
- 4.447 - 4.765
- 4.129 - 4.447
- 3.812 - 4.129
- 3.494 - 3.812
- 3.176 - 3.494
- 2.859 - 3.176
- 2.541 - 2.859
- 2.224 - 2.541
- 1.906 - 2.224
- 1.588 - 1.906
- 1.271 - 1.588
- 0.953 - 1.271
- 0.635 - 0.953
- 0.318 - 0.635
- 0 - 0.318

Notes:
1. Aerial photography acquired by Peregrine Aerial Surveyors Inc. and Eagle Mapping in August 2012.
2. Orthophotography prepared by Critigen Canada Corp.

DRAFT

N

0 15 30 45 60
Metres

FIGURE 3
Cross Valley Dam Pond Interpreted Sludge Thickness and Investigation Locations
Rose Creek Tailings Area
Faro Mine Remediation Project

Attachment 1
Geophysical Surveys at Intermediate Dam Spillway, Updated Report by Frontier 2016

CH2M HILL CANADA LIMITED

REPORT ON

MULTI-ELECTRODE RESISTIVITY, SEISMIC REFLECTION, SEISMIC REFRACTION AND MULTI-SPECTRAL ANALYSIS OF SURFACE WAVES SURVEYS

ID SPILLWAY

FARO MINE REMEDIATION PROJECT

FARO, YUKON

by

Cliff Candy, P.Geo.

Beth Friesen, B.Sc.

October, 2015 **PROJECT FGI-1415-IDS**

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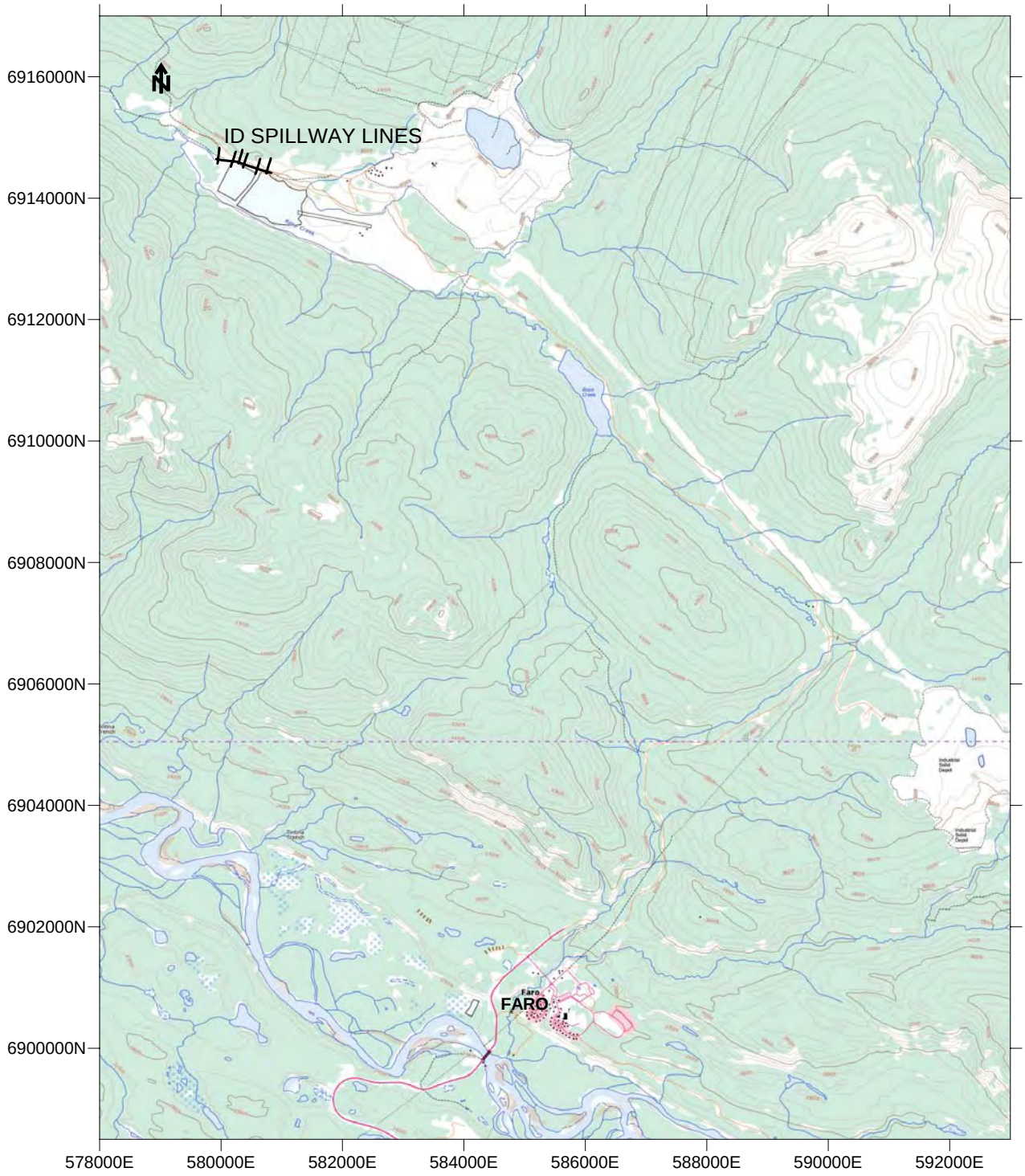
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1. INTRODUCTION

In the periods of October 5 to 9, and October 13 to 17, 2015, Frontier Geosciences Inc. carried out multi-electrode resistivity, seismic reflection, seismic refraction and multi-spectral analysis of surface waves surveys for CH2M Hill Canada Limited at the Faro Mine near Faro, Yukon. The site area is located approximately 12 km north of the town of Faro, and approximately 200 km northeast of Whitehorse, Yukon. A Survey Location Plan of the area is shown at a scale of 1:100,000 in Figure 1.

The purpose of the geophysical surveys was to characterize subsurface conditions to assist in the design and construction of a retention reservoir and dam as part of the Faro Mine remediation project. Additional geophysical investigations were carried out by Frontier Geosciences Inc. at selected survey areas within the Faro Mine Site and discussed in separate reports. A Site Plan of the ID Spillway Area is presented at 1:2,500 scale in Figure 2 in the Appendix.

In all, seven separate geophysical traverses were completed in the ID Spillway Area. A total of approximately 2445 metres of detailed resistivity, 910 metres of seismic reflection, and 1365 metres of compressional wave and surface wave surveying was carried out in the survey area.



CH2MHILL

FARO MINE REMEDIATION PROJECT

GEOPHYSICAL SURVEY

ID SPILLWAY
SURVEY LOCATION PLAN

FRONTIER GEOSCIENCES INC.

DATE: OCT. 2015	SCALE 1:100,000	FIG. 1

2. THE MULTI-ELECTRODE RESISTIVITY SURVEY

2.1 Equipment

The purpose of electrical surveying is to determine the subsurface resistivity distribution by making detailed measurements along survey lines laid out on the ground surface. From these measurements, the true resistivity of the subsurface can be estimated. Ground resistivity is related to various geological parameters such as the sulphide, clay mineral and fluid content, porosity and degree of water saturation in weathered material layering and the underlying materials.

The surface multi-electrode imaging resistivity/I.P. survey was carried out using a full waveform resistivity/I.P. system designed and developed by Frontier Geosciences Inc. The instrument has eight receiver channels, allowing measurements on multiple electrodes to proceed simultaneously, which significantly speeds up the data collection process allowing dense and detailed resistivity and I.P. profiles to be obtained.

During multi-electrode surveying, a central switching system is used to address the array of electrodes. This switching is accomplished using a multiplexer that directs the signals from any of the field electrodes to the eight input channels of the receiver. Similarly, a system of high voltage relays in the central switching system allows the transmitter to utilise any pair of electrodes for current injection. By means of a command file programmed in the receiver, electrode arrays including Schlumberger, Wenner, dipole-dipole, pole-dipole and pole-pole, or multiple combinations of arrays, may be chosen for execution.

The high resolution, full waveform receiver records the entire waveform for eight channels simultaneously. With the full 24 bit waveform available for processing, self-potential drift, transient effects, and several other noise sources are accurately identified and removed from the signal. This results in full waveform data acquisition, providing high resolution information in lower signal level situations such as higher current electrode spacings and corresponding deeper penetration in a dipole-dipole survey, or in geologic settings with unfavourable signal-to-noise levels.

In addition to resistivity measurements, Induced Polarisation readings were collected simultaneously. This measurement records the degree to which the earth materials tend to retain an apparent voltage after removal of the transmitted voltage. The effect is termed Induced Polarisation (I.P.) and has its origins in the electrolytic nature of groundwater and the conductive nature of certain minerals. The system measures the I.P. effect in the time domain by determining the residual decay voltage after the current is switched off. The time domain unit of measurement of chargeability is milliseconds. The I.P. effect is caused by two different mechanisms: membrane and electrode polarisation effects. The membrane polarisation effect is usually created by clay minerals present in the earth. The electrode polarisation effect is largely caused by conductive materials such as sulphides in the rock and (usually) to a lesser extent by graphite. This effect is the basis for application of the I.P. method in surveys for the detection of metallic minerals, such as disseminated sulphides.

2.2 Survey Procedure

Cable layouts for each system were identical, consisting of six 70-metre receiver cables laid out along the survey line and connected to the multiplexing switchbox controller. The switchbox controller allows the electrodes to be in either standby, current or measuring potential modes. Each individual cable consists of 14 electrode takeouts at a spacing of 5 metres, with a full array covering approximately 420 metres.

The system was configured to permit two different data acquisition procedures. The first procedure, typically the initial array of a new line, collects data files encompassing the full sequence of measurements. After the full array reading, three cables were detached from the rear of the receiver line, and three cables were attached to the front of the receiver line, effectively shifting the array 210 metres along the survey line by ‘rolling’ the array. The computer system was shifted to the same relative position within the rolled array, and the process repeated.

Prior to the full survey data collection, an electrode test was carried out along the array to identify and correct any poor electrode contacts. Data quality was monitored in the field through a full-panel display of received waveforms. If the data was suspect, individual channels could be displayed at enhanced scale for closer inspection and field processing.

2.3 Data Processing

The data were downloaded from the instruments and filtered by plotting the apparent resistivity pseudosection for the dipole–dipole array and removing outliers. The remaining values are converted into the input file format for the cell-based inversion method in the RES2DINV program developed by M. H. Loke. In general, 95% of the input data have current measurements greater than the commonly recommended 20 mA minimum. This software utilises a finite difference modelling approach to calculate the resistivity values that best fit the observed data. The model parameters are the resistivity values of the model cell, while the data is the measured apparent resistivity and apparent Induced Polarisation values. The mathematical link between the model parameters and the model response is provided by the finite-difference or finite-element methods. In all optimisation methods, an initial model is modified in an iterative manner so that the difference between the model response and the data values is reduced.

Large, dense data sets, as received during this survey, are expected to produce higher RMS errors during the inversions steps than sparse data.

To increase the accuracy of the modelling process, the elevation of each electrode was incorporated into the input data file.

3. THE SEISMIC SURVEY METHODS

3.1 Equipment

The seismic reflection and refraction investigations were carried out using up to three Geometrics, Geode, 24 channel, signal enhancement seismographs and Oyo Geo Space, 10 Hz geophones. Geophone intervals along the multicored seismic cables were maintained at either 2 or 5 metres in order to produce high resolution data on subsurface layering. A sledge hammer was used for energy input, contacting with a metal plate moving progressively down the line.

3.2 Survey Procedure

In the seismic reflection survey, a 'split spread' configuration was utilized with the energy source located in the middle of a 72 geophone array of receivers. This receiver array with geophone intervals of 2 m, spanned a survey line length of 142 m and captured a broad spatial range of energy reflected from the horizons at depth. The first level of quality control involves the careful planting and inspection of all geophones to ensure a received waveform of high fidelity. The survey procedure entailed collection of a 72 geophone record, then advancing the energy source 2 m down the survey line and repeating the procedure. This method, known as the common mid-point gather (CMP) technique, provides a very high degree of redundancy of sampling of the energy received from a given reflector at depth. The redundancy is used during the data processing procedure to develop an image of the subsurface reflectors of high fidelity. The second level of quality control entails inspection of the acquired seismogram by the field geophysicist to ensure valid data. Criteria include the correct amplitude and polarity of first arrival data, with no geophones absent, a minimum of environment noise overprint, an absence of transient noise presence, and correct seismogram zero timing. If the seismogram does not pass, the shot is repeated. The third level of quality assurance involves the detailed inspection of the entire ensemble of data in the Vancouver office within 24 hours of data collection. More subtle issues are detected at this stage, with recommendations and tuning of the field program passed back to the field geophysicist. If issues are identified at this stage that would compromise the quality of the final sections, re-collection of data-set may be recommended. The seismic data acquired in this survey was generally of good to excellent quality.

For each spread of the seismic refraction survey, the seismic cable was stretched out in a straight line and the geophones implanted. Up to 14 separate 'shots' were then initiated: one at either end of the geophone array, up to ten at intermediate locations along the seismic cable, and one off each end of the line, to ensure adequate coverage of the basal layer. The shots were triggered individually and arrival times for each geophone were recorded digitally in the seismograph. For quality assurance, in field inspection of raw data after each shot was carried out, with additional shots recorded if first arrivals were unclear. Data recorded during field surveying operations was generally of good quality.

Throughout the survey, notes were recorded regarding seismic line positions in relation to topographic and geological features in the area. Individual geophone locations were labelled on pin flags in the field. Relative elevations on the seismic lines were recorded by chain and inclinometer with absolute positions and elevations provided by Challenger Geomatics Ltd. Although geophysical surveying carried out in the field generally had line stationing increasing to the northeast, on traverses where that did not occur the data was processed and reoriented to maintain the perspective of stationing increasing from southwest to northeast.

3.3 Data Reduction and Processing

3.3.1 Seismic Reflection

The data were recorded as a set of 2048 millisecond, SEG2 seismograms. The collected data sets were processed using the Seismic Unix software to provide a SEGY, final, stacked seismic profile. The raw data in the first stage of processing is the assembly of the set of individual seismograms as 'shot gathers'. The first stage of processing involves the inspection of each of these records to reject repeated seismograms and noisy traces.

The second processing step consists of setting the survey geometry headers and sorting the seismic traces using the shot and receiver positions to gather together each of the source and receiver pairs that were centered on a common spatial point. This 'common mid-point' or 'CMP gather' brings together each of the reflection ray paths that redundantly sample a given point on a subsurface reflector. A first arrival mute was then applied to prevent first break energy from entering the reflection profile. In these CMP gathers, seismic reflections appear as a series of hyperbolic arcs.

Incoherent and coherent noise were then filtered using a frequency domain, band-pass filter. Corner frequencies were determined with an investigative iterative loop over the 0 Hz to 250 Hz frequency band, where the frequency limit corresponds to loss of coherent reflector response. As much of the target information is in shallow depth ranges, mitigation of the ground roll is very important. A low frequency array forming method is used to attenuate the ground roll energy. Once the key frequencies in which the reflector energy located are identified, F-K filtering can then be applied to complete the ground roll management.

This was followed by an statics adjustment of the traces using a reference datum in respect to relative elevation at each receiver and shot elevation, as well as refraction static corrections obtained from tomography analysis of the near surface velocity structure. A spherical divergence gain is applied to more closely model true amplitudes and reduce the reliance on a the automatic gain control to balance the trace amplitudes.

The next stage in the processing flow was a determination of the apparent velocities within the CMP gathers from velocity analysis, using a velocity range suggested in the compressional (P-wave) tomography. Confirmation of the velocity values is obtained by reference to the downhole seismic data gathered in the test drillholes. Based on this velocity analysis, a normal move out correction was applied to derive CMP gathers with the hyperbolas flattened to the equivalent of zero offset records. A deconvolution operator is applied to sharpen the reflectors, based on a wavelet sample. Pre-stack migration aids the resolution of dipping structure and is helpful in collapsing diffraction effects at structure edges. The stacking process then adds together the energy in each of the traces of the CMP gather, improving the signal-to-noise ratio while reinforcing the reflector energy. The seismic reflection profile was then assembled from all the CMP traces. Once stacked, the sections are imported into the IHS Kingdom Suite 2D/3D interpretation package. This software provides horizon picking, correlation and map and section production to create the final display products.

3.3.2 Compressional (P-wave) Tomography

Tomographic inversion of compressional wave travel times was achieved by handpicking the onset arrivals of refracted signals at each receiver. The tomographic analysis calculates velocities at points across the grid using the simultaneous iterative reconstruction technique. This modification of the initial velocity values consists of repeated cycles of three steps: forward computation of model travel times, calculation of residuals, and application of velocity corrections. An iterative approach using the Neighborhood Algorithm generates the best resulting model that reveals the velocity structure.

3.3.3 Seismic Refraction Interpretive Method

The final interpretation of the seismic data was arrived at using the method of differences technique. This method utilises the time taken to travel to a geophone from shotpoints located to either side of the geophone. Using the total time, a small vertical time is computed which represents the time taken to travel from the refractor up to the ground surface. This time is then multiplied by the velocity of each overburden layer to obtain the thickness of each layer at that point. For quality control, interpreted data is internally compared to estimated bedrock depths based on critical distances, resistivity results, and confirmed site geology.

3.3.4 Multi-Spectral Analysis of Surface Waves (MASW)

Interpretation of the MASW data involves a wavefield transformation of the seismogram record. This converts the seismogram from a multichannel shot gather to a dispersion curve that shows the phase velocity of the signal as a function of frequency. The fundamental event is picked on the dispersion curve and this data is inputted into the Geopsy modelling program. The resulting model reveals the shear wave layer velocity structure, and is plotted at the centre of geophone array. The individual models produced were then gridded together to produce a shear wave velocity depth section along the survey lines. The depth sections were compared with the seismic refraction results and the ratio of shear to compressional wave velocities were checked for quality control.

4. GEOPHYSICAL RESULTS

4.1 General

The resistivity/I.P. and overlapping seismic lines are arranged in an approximate grid pattern over the northwestern end of the ID Spillway area. The results of the resistivity/I.P. inversions, seismic reflection, P-Wave tomography, seismic refraction and MASW inversions are all shown at a scale of 1:1,000 in Figures 3 to 25 in the Appendix.

4.2 Discussion

4.2.1 Resistivity Results

The results of the interpretations of the inverted resistivity data along lines RL-201-2, RL-201-3, RL-201-4, RL-201-5, RL-201-6, RL-201-7, and RL-201-8 display a generally low resistive environment with maximum resistivities less than 2500 ohm-m. Within this range, zones of higher resistivities are shown in red whereas less resistive, more conductive materials are shown in green and blue. Typical resistivities and chargeabilities of common earth materials (adapted from Palacky, 1987) are shown in Table 1 and Table 2 below.

Table 1: Typical resistivities of common earth materials.

Material	Resistivity (ohm-m)	Material	Resistivity (ohm-m)
Massive sulphides	0.01 - 1	Clays	5 - 100
Saltwater	< 1	Sand and gravel	700 - 10,000
Fresh water	1 - 100	Shales	7 - 70
Permafrost	800 - 100,000	Metamorphic rocks	10 - 2000

Table 2: Typical chargeabilities of common earth materials.

Material	Chargeability (ms)	Material	Chargeability (ms)
8 - 20 % sulphides	1000 - 2000	Shale	50 - 100
2 - 8 % sulphides	500 - 1000	Granite, Granodiorite	10 - 50
Sandstone, siltstone	100 - 500	Schists	5 - 20
Dense volcanics	100 - 500	Ground water	0

Palacky, G.J., 1987, Resistivity characteristics of geologic targets, in Nabighian, M.N.,ed., Electromagnetic Methods in Applied Geophysics Theory: Tulsa, OK.,Society of Exploration Geophysicists, v.1

The results from resistivity line RL-201-2 are shown in Figure 3 in the Appendix. The line intersects with six geophysical crosslines, at approximately 70SE, 310SE, 415SE, 505SE, 735SE, and 900SE. Resistivities range from 80 ohm-m to over 3000 ohm-m. Two main resistive features are apparent, the first beginning at surface at approximately 180SE and extending to depth to the southeast at 340SE. The second resistive feature is apparent from approximately 620SE to 820SE and is at approximately 8 metres depth, extending to the depth of penetration. This feature corresponds to an area of shallow bedrock as identified in the seismic reflection interpretation and Drillholes CH14-201-BH003 and DHKC07-3. The chargeability results for line RL-201-2 display chargeabilities with values ranging from 10 msec to 260 msec.

The results from resistivity line RL-201-3 are shown in Figure 5 in the Appendix. The line intersects line RL-201-2 at approximately 110N. The inversion results show resistivities ranging from 100 ohm-m to approximately 2200 ohm-m. The majority of the line is fairly conductive, with the 250 ohm-m contour coinciding with the interpreted seismic basal layer. The higher resistivities are isolated in the northern part of the profile and are apparent as a surficial resistive layer. The chargeability results for line RL-201-3 display chargeability values ranging from 5 msec to 200 msec. The lowest chargeabilities are in the northern surficial area of the line, in a similar location to the high resistivity response; this may be an indication of frozen or partially frozen overburden.

Resistivity line RL-201-4 traverses southwest to northeast and intersects line RL-201-2 at approximately 135NE. The results of this line are presented in Figure 6 in the Appendix. The resistivity results indicate an area of relatively low resistivity values for most of the profile, within the range of 100 ohm-m to 600 ohm-m. One area of higher resistivity with values over 750 ohm-m is seen near surface at 180NE to 220NE. As this anomaly does not extend to depth or correspond with a high seismic velocity, this response is likely related to ground surface conditions rather than shallow rock. The chargeability shows a general increase with depth from 8 msec to 180 msec.

Resistivity line RL-201-5 runs approximately parallel to line RL-201-4 from southwest to northeast and intersects RL-201-2 at approximately 30NE. The results of the survey line are illustrated in Figure 7. The profile displays slightly higher resistivities than those exhibited on line RL-201-4, with a range of 200 ohm-m to 2000 ohm-m. Similar to lines RL-201-3 and RL-201-4, a surficial higher resistivity zone is apparent at the northeast end of the line. This response, when correlated to the chargeability and seismic refraction results in the same area, indicates that the higher resistivity is most likely related to surficial ground conditions of either dry materials with low clay and silt content, or possibly frozen or partially frozen sands, silts and clays, rather than shallow bedrock. The chargeabilities show a fairly narrow range of values, between 10 msec to 140 msec. The higher chargeabilities are present at the southwest end of the profile and decrease to a minimum of 10 msec at approximately 180NE.

The results from resistivity line RL-201-6 are shown in Figure 8 in the Appendix. The transect is parallel to line RL201-5 and intersects line RL-201-2 at approximately 60NE. The seismic refraction interpretation indicates bedrock at an approximate elevation of 1020 m from the beginning of the line to 180NE. From 180NE to 240NE the bedrock elevation rises to approximately 1055 metres. With the exception of a lower resistivity zone from 110NE to 170NE, the interpreted bedrock delineation is shown in the resistivity results with values over 500 ohm-m extending to depth. The chargeability results show a distinct zone of high chargeability from 100NE to 140NE, which correspond to an area of low resistivity values and also a change in basal layer seismic velocity, indicating a potential change in basement lithology.

Resistivity line RL-201-7 runs from southwest to northeast and intersects RL-201-2 at approximately 135NE. The resulting resistivity and chargeability profiles are illustrated in Figure 9 in the Appendix. From 120NE to the northeast end of the survey traverse, resistivities exceeding 200 ohm-m and extending to depth are exhibited. The overall increase in high resistivity responses corresponds to shallower bedrock interpreted in the seismic data and intersected in Drillhole CH14-201- BH003 and Test Pit TPKC07-2. The variation in resistivity responses below the interpreted basal layer may be an indicator of varying rock conditions and composition. At approximately 120NE below 5 metres depth, the resistivity is relatively conductive, the corresponding chargeability values range are high, up to 125 msec, and the seismic interpretation identifies a high velocity basal layer of 4430 m/s. These geophysical properties suggest a basement rock of only slight weathering, possibly a sedimentary or metamorphic rock.

The results from resistivity line RL-201-8 are shown in Figure 10 in the Appendix. The transect is parallel to line RL201-7 and intersects line RL-201-2 at approximately 70NE. The seismic refraction interpretation indicates bedrock at an average depth of 15 metres from the beginning of the traverse to approximately 180NE, after which bedrock rises to an average depth of 10 metres for the remainder of the survey line. With the exception of a localized, surficial resistivity high at 100NE, the resistivity profile shows a layered configuration of increasing resistivity with depth, also rising to the northeast. The chargeability results also show a layered configuration of increasing chargeability with depth, with the interpreted bedrock interface coinciding with approximately 30 msec for the first 200 metres of the line. From 200NE to the northeast end of the line, a chargeability low extends approximately 10 metres below the interpreted bedrock interface.

4.2.2 Seismic Reflection and P-Wave Tomography Results

The compressional wave reflection profile and tomography profile are displayed in Figures 11 and 12 in the Appendix. In general, the profiles show a prominent reflector that is associated with tomographic model velocities in the 2500 to 3000 metre per second range. The interpreted reflector is correlated with bedrock intersections in the drillhole and interpreted seismic refraction results.

Line SL-201-2 shows an interpreted bedrock top reflector in solid green with additional apparent reflectors within the bedrock marked on the profile in dashed green lines. At the northwest end of the line the interpreted reflector is correlated with a phyllite bedrock in Drillhole CH12-204-MW001B, located approximately 60 metres south of the survey line. Near the southeast end of the profile, the reflector is associated with an intersection of schist in Drillholes CH14-201-BH003, DHKC07-3, and CH14-201-BH004. Between approximately 580E and 760E, where interpreted bedrock is shallowest, the tomography results indicate a slightly higher surficial layer velocity, with an average overburden velocity of 1000 m/s. As overburden thickness increases in the western end of the traverse, a lower surficial layer is more apparent in the tomography results. The dip of the bedrock interface in these boreholes is consistent with the gradual western dip of the interpreted reflector.

4.2.3 Seismic Refraction Results

The results from the six seismic refraction crossline interpretations show the survey area is underlain by up to four distinct velocity layers. The shallow surficial layer with velocities ranging from 340 m/s to 420 m/s is consistent with surface exposures and drillhole intersections of loose surficial silty sands and gravel. This layer is relatively shallow with a maximum thickness of approximately 9 metres interpreted on line SL-201-4 at 195NE.

Underlying the shallow surficial layer, an upper intermediate layer is interpreted with velocities in the range of 650 m/s to 1150 m/s. The velocity range is consistent with more compact overburden of unsaturated sands, gravels, clays and silts; these materials were also intersected in drillholes close to the survey lines. The thickness of this layer varies between approximately 1 metre at the northeastern end of line SL-201-6 up to approximately 11 metres at 85NE on line SL-201-4.

Below the upper intermediate velocity layer, a second, higher velocity layer is interpreted in most of the survey area. For the majority of the survey lines the velocity range is from 1300 m/s to 2150 m/s. These velocities are generally indicative of compact saturated sands, gravels, and till. Drillholes and testpits in relatively close proximity to survey lines SL-201-7 and SL-201-8 intersected weathered bedrock at the top of this velocity layer. This velocity layer is highly variable in thickness. The lines in the western region of the survey area display a greater interpreted thickness of this higher velocity layer. Two drillholes, CH12-204-MW001A and CH12-204-MW001B, located approximately midway between the south ends of seismic lines SL-201-3 and SL-201-4, intersected thick overburden of silty sand, gravel, and clay overlying bedrock at a depth of approximately 30 metres. Seismic line SL-201-4 has the maximum interpreted thickness of 24 metres at 60NE.

The basal layer with a velocity range of 3000 m/s to 4750 m/s is the interpreted competent bedrock surface. The interpreted bedrock surface configuration follows topography. As the ground surfaces rises in elevation to the northeast, the interpreted competent bedrock interface also rises. In general, lower basal velocities indicate a higher degree of weathering and/or fracturing.

4.2.4 MASW Results

The results for the MASW investigation are shown in Figures 19 to 25 in the Appendix. Calculated velocities range from approximately 250 m/s at the surface up to 1300 m/s. Seismic lines SL-201-3, SL-201-4, and the western end of SL-201-2, show a significant amount of overburden with shear wave velocities less than 900 m/s. The MASW results for line SL-201-7 show a thin overburden layer between 120NE and 160NE, with a shear wave velocity of 1000 m/s at approximately 4.5 metres, indicating the onset of bedrock. Over the ID Spillway survey area the MASW velocity contours are in good agreement with the interpreted seismic refraction, and continuously increase in velocity with depth.

5. LIMITATIONS

The multi-electrode resistivity/I.P. method results in repeatable measurements of the geoelectric section. The methods are successful providing adequate contrasts exist in the subsurface in electrical resistivity and chargeability between distinct geological materials. Conductors identified in resistivity surveying are diverse and depending on geological settings, may include mineralisation, graphite, argillite, shear or fault zones, clay beds, marl, saturated materials, clay shale, clay till, mineralised leachate and zones of salt water intrusion. Electrically resistive materials include but are not limited to sand and gravel, dry soils, glacial moraine, coarse glacial till, permafrost, underground voids and competent bedrock. Also affecting resistivity are the degree of saturation of materials and the porosity, the concentration of dissolved electrolytes, the temperature and the amount and composition of colloids. With few exceptions, no unique resistivity value defines a specific geological material.

Sources of I.P. response include almost all the sulphides, oxides such as magnetite, graphite and clay materials. Penetration depths may be affected by the presence of highly conductive surficial materials that may partially mask deeper geological layering. In addition, the resolution of the resistivity and I.P. methods decreases exponentially with depth. Given the diffuse nature of the methods, resolution is inherently poorer at depth. The survey results can also be influenced by electrode coupling, presence of noise such as SP, capacitive coupling, electromagnetic coupling and the presence of power lines.

In the modelling process, a number of limitations constrain modelling of subsurface resistivity and chargeability. For instance, due to non-uniqueness, more than one model can produce the same response that agrees with the observed data. The resulting model thus depends to a significant extent on the constraints used and will closely approximate the true subsurface conditions only if the constraints closely correspond to actual subsurface conditions.

The depths to subsurface boundaries derived from seismic reflection and refraction surveys are generally accepted as accurate to within fifteen percent of the true depths to the boundaries. Scattering effects from lenses of permafrost may reduce the amplitude and continuity of events of interest in the seismic sections. In some cases, unusual geological conditions may produce false or misleading readings with the result that computed depths to subsurfaces boundaries may be less accurate.

For seismic reflection, a range of errors from digitising, velocity modelling and data gridding are expected. Reflections can occur from surfaces not in the plane of the seismic reflection profile. As well, some uncertainty is present in correlating reflectors between profiles where there is a lack of cross points.

Observed anomalies in seismic data result from integration of perturbation in structure along the ray path. Perturbation is a smoothing operation and long-wavelength components of the structure are much easier to recover than short-wavelength ones.

The multi-spectral analysis of surface waves (MASW) method is carried out in the Active or Passive mode with the Active mode generally the most accurate for evaluation of shallow, shear wave velocities. The method entails collection of data over a full seismic spread. Limitations include reflection and scattering of surface and body waves due to extreme surface topography and inhomogeneous conditions in the subsurface such as boulder concentrations or isolated soil lenses with contrasting properties. At the near surface, shear wave velocities may be overstated and in shallow overburden environments results may have higher uncertainty than in areas of thicker overburden. The method is generally accepted as an effective means of determining shear wave velocities of geological units.

A range of errors from digitizing, velocity modelling and data gridding are expected. High reliance was placed on limited geological information in a complex geological environment. Some uncertainty is present in correlating reflectors between profiles where there is a lack of cross points.

The results are interpretive in nature and are considered to be a reasonably accurate representation of existing subsurface conditions within the limitations of the seismic reflection, P-wave tomography and MASW methods.

The information in this report is based upon geophysical measurements and field procedures and our interpretation of the data. The results are interpretive in nature and are considered to be a reasonably accurate presentation of existing subsurface conditions within the limitations of the methods employed.

For: Frontier Geosciences Inc.

Beth Friesen, B.Sc.

Cliff Candy, P.Geo

LINE 201-1
LINE 201-2
LINE 201-3
LINE 201-4
LINE 201-5
LINE 201-6
LINE 201-7
LINE 201-8

CH12-204-MW001B
CH12-204-MW001A
CH15-201-MW009
CH15-201-MW008
CH14-201-BH003
CH15-201-BH007A
CH14-201-BH004
CH15-201-MW010
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579950E 580000E 580050E 580100E 580150E 580200E 580250E 580300E 580350E 580400E 580450E 580500E 580550E 580600E 580650E 580700E 580750E 580800E 580850E

RESISTIVITY / SEISMIC LINE

BOREHOLE

0 25 50 75 100

METRES

CH2MHILL

ID SPILLWAY, FARO MINE REMEDIATION PROJECT

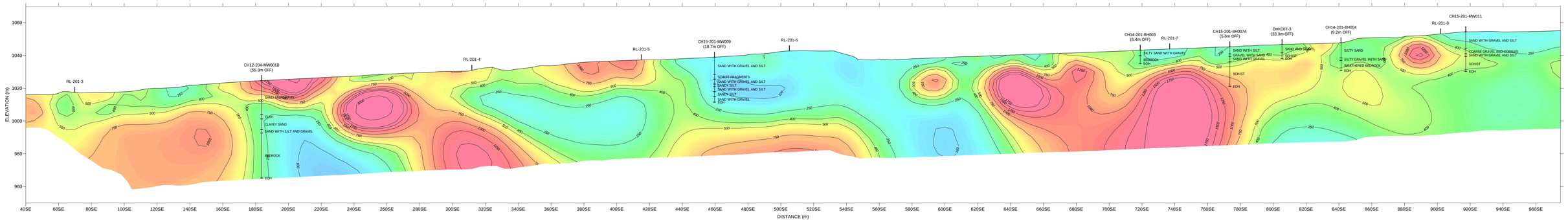
GEOPHYSICAL SURVEY

ID SPILLWAY SITE PLAN

FRONTIER GEOSCIENCES INC.

DATE: OCT. 2015	SCALE 1:2,500	FIG. 2

RL-201-2 RESISTIVITY PROFILE





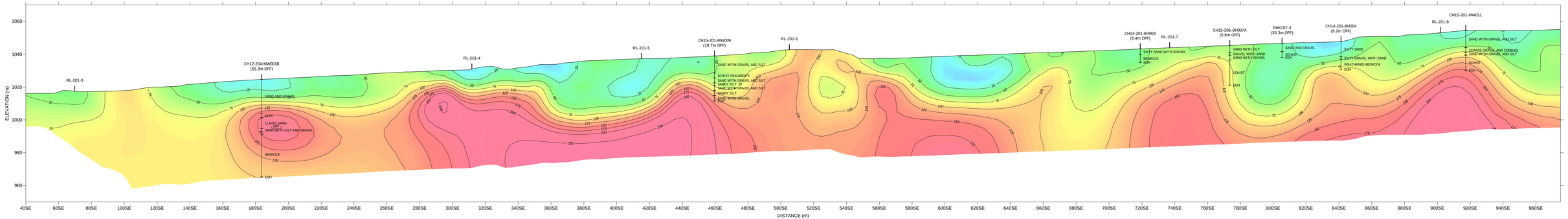


NOTE: THIS DRAWING MUST BE READ WITH REFERENCE TO PROJECT REPORT FGI-1415-FC
ELEVATIONS SURVEYED MAY 2016

CH2MHILL
ID SPILLWAY, FARO MINE REMEDIATION PROJECT
RESISTIVITY/CHARGEABILITY SURVEY
INVERTED
RESISTIVITY PROFILE
RL-201-2
FRONTIER GEOSCIENCES INC.

DATE: OCT. 2015	SCALE: 1:1,000	FIG. 3

RL-201-2 CHARGEABILITY PROFILE



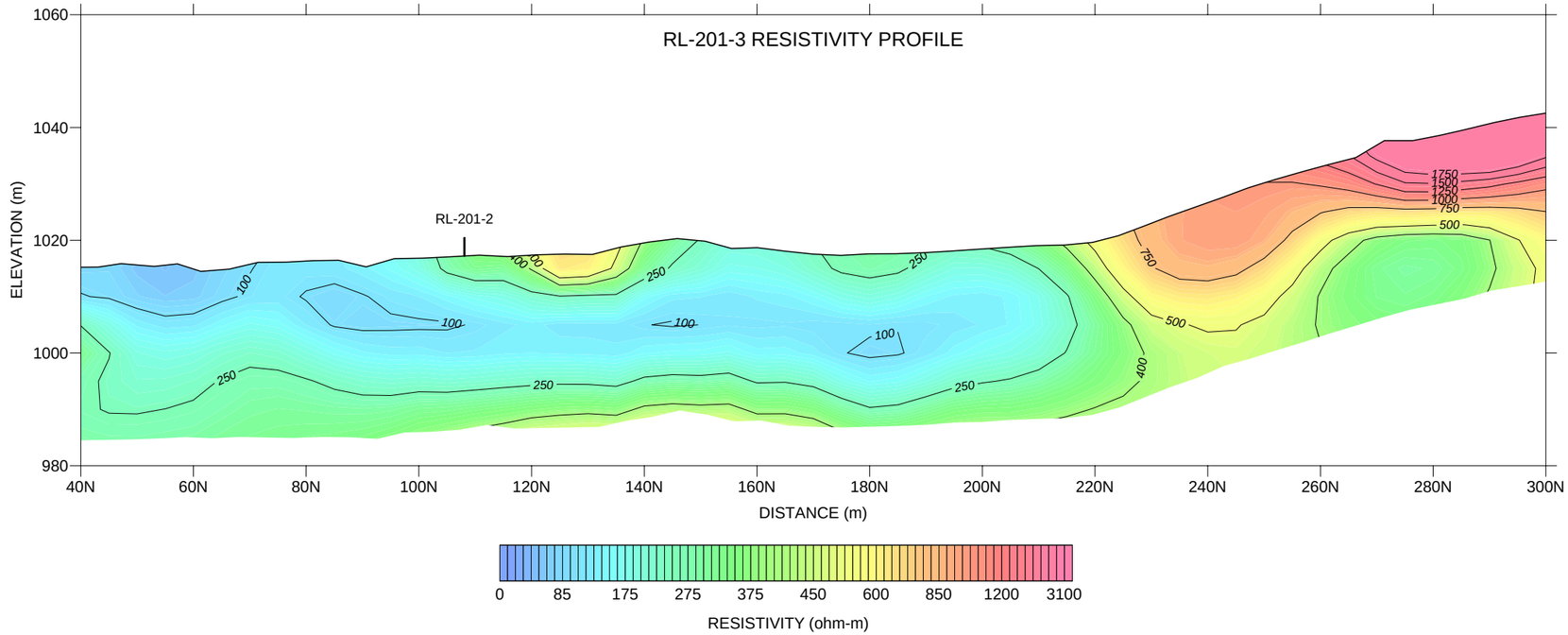


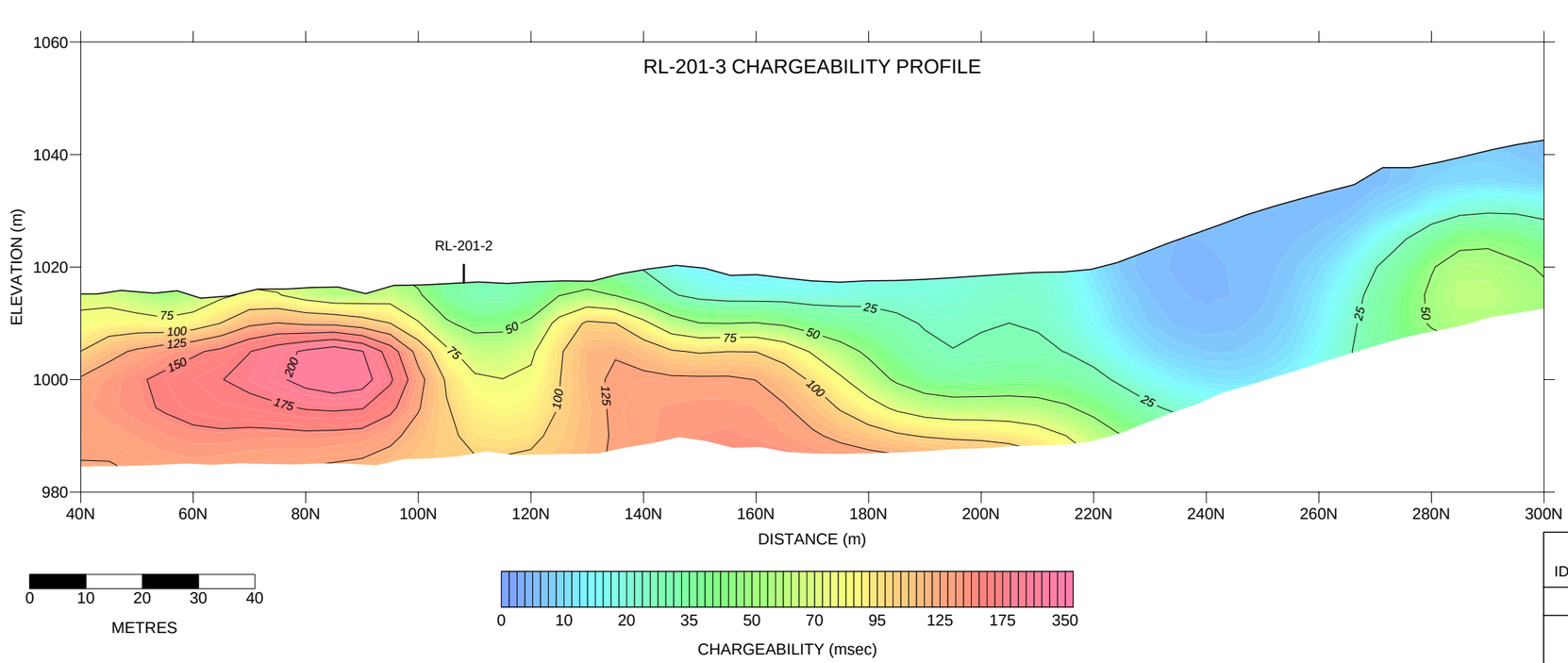


NOTE: THIS DRAWING MUST BE READ WITH REFERENCE TO PROJECT REPORT FGI-1415-FC
ELEVATIONS SURVEYED MAY 2016

CH2MHILL
ID SPILLWAY, FARO MINE REMEDIATION PROJECT
RESISTIVITY/CHARGEABILITY SURVEY
INVERTED
CHARGEABILITY PROFILE
RL-201-2
FRONTIER GEOSCIENCES INC.

DATE: OCT. 2015	SCALE: 1:1,000	FIG. 4





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ELEVATIONS SURVEYED MAY 2016

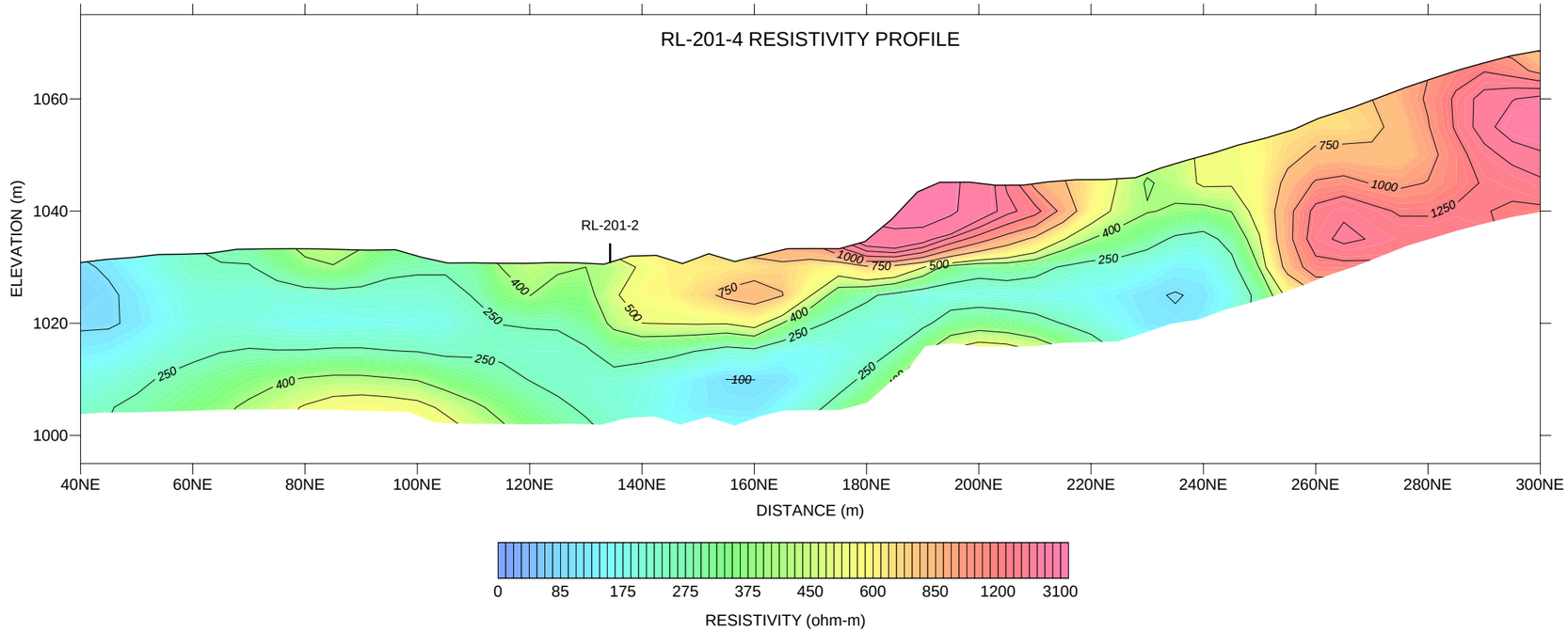
CH2MHILL
ID SPILLWAY, FARO MINE REMEDIATION PROJECT

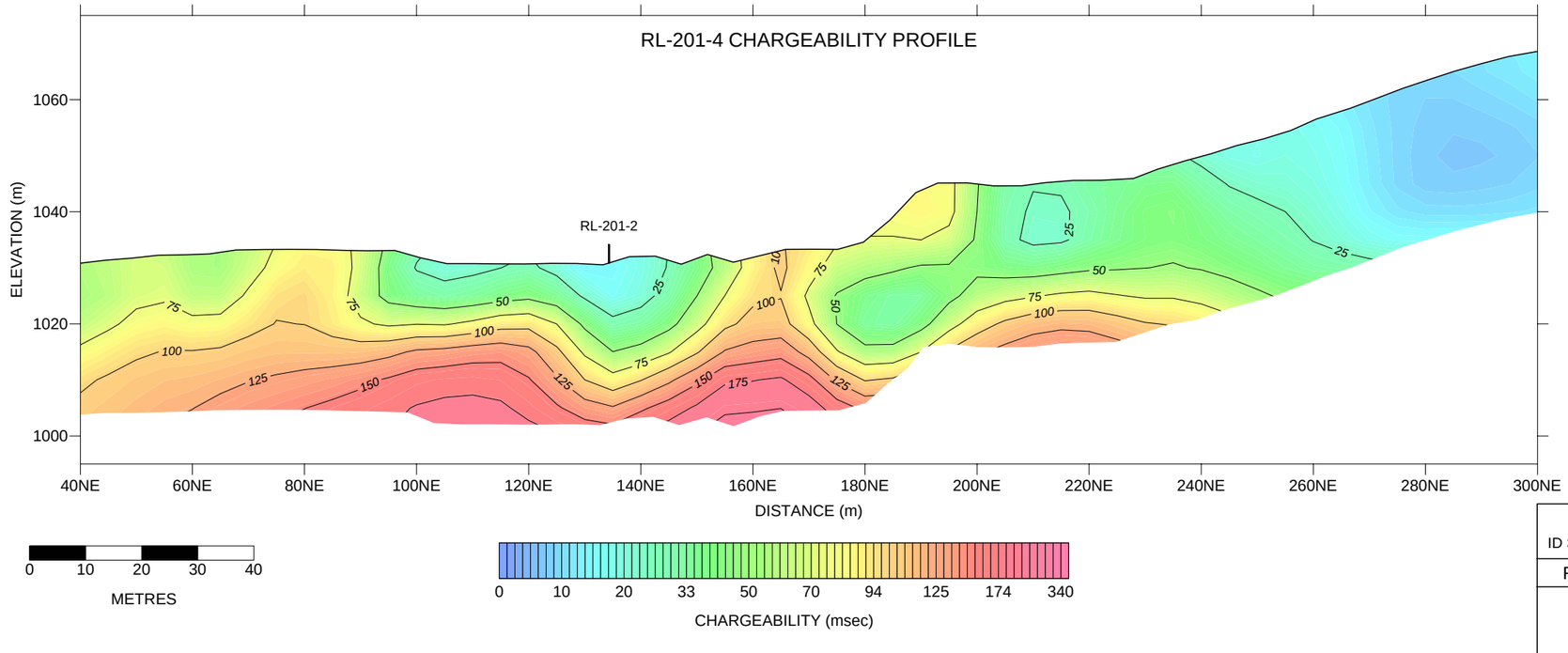
RESISTIVITY/CHARGEABILITY SURVEY

INVERTED RESISTIVITY
AND CHARGEABLITY PROFILES
RL-201-3

FRONTIER GEOSCIENCES INC.

DATE: OCT. 2015	SCALE 1:1,000	FIG. 5





NOTE: THIS DRAWING MUST BE READ WITH REFERENCE TO PROJECT REPORT FGI-1415-FC
ELEVATIONS SURVEYED MAY 2016

CH2MHILL

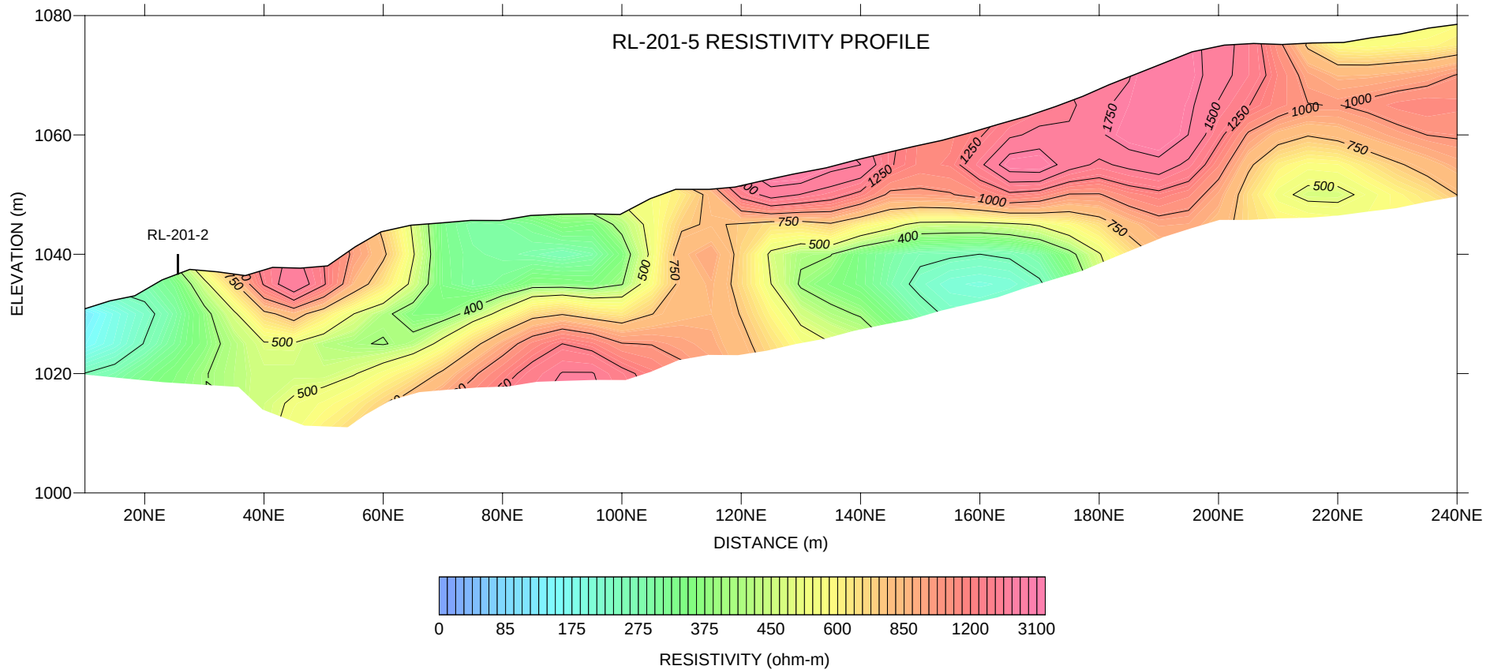
ID SPILLWAY, FARO MINE REMEDIATION PROJECT

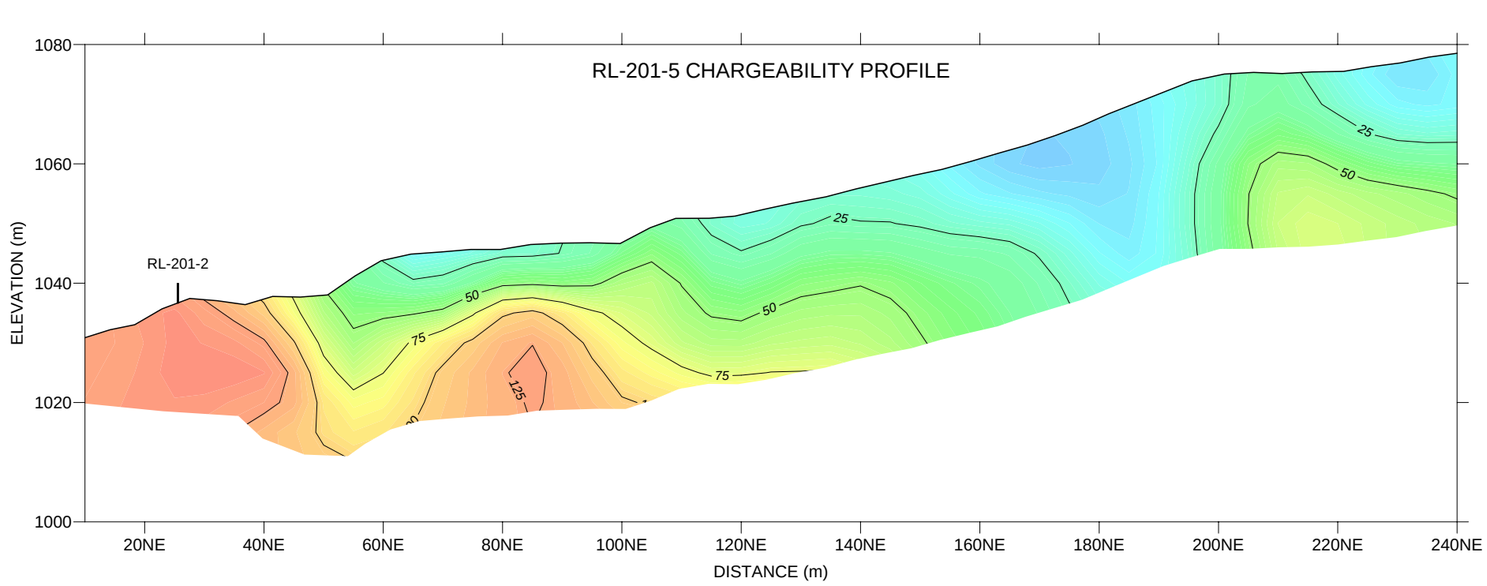
RESISTIVITY/CHARGEABILITY SURVEY

INVERTED RESISTIVITY AND CHARGEABLITY PROFILES RL-201-4

FRONTIER GEOSCIENCES INC.

DATE: OCT. 2015	SCALE 1:1,000	FIG. 6





NOTE: THIS DRAWING MUST BE READ WITH REFERENCE TO PROJECT REPORT FGI-1415-FC
ELEVATIONS SURVEYED MAY 2016

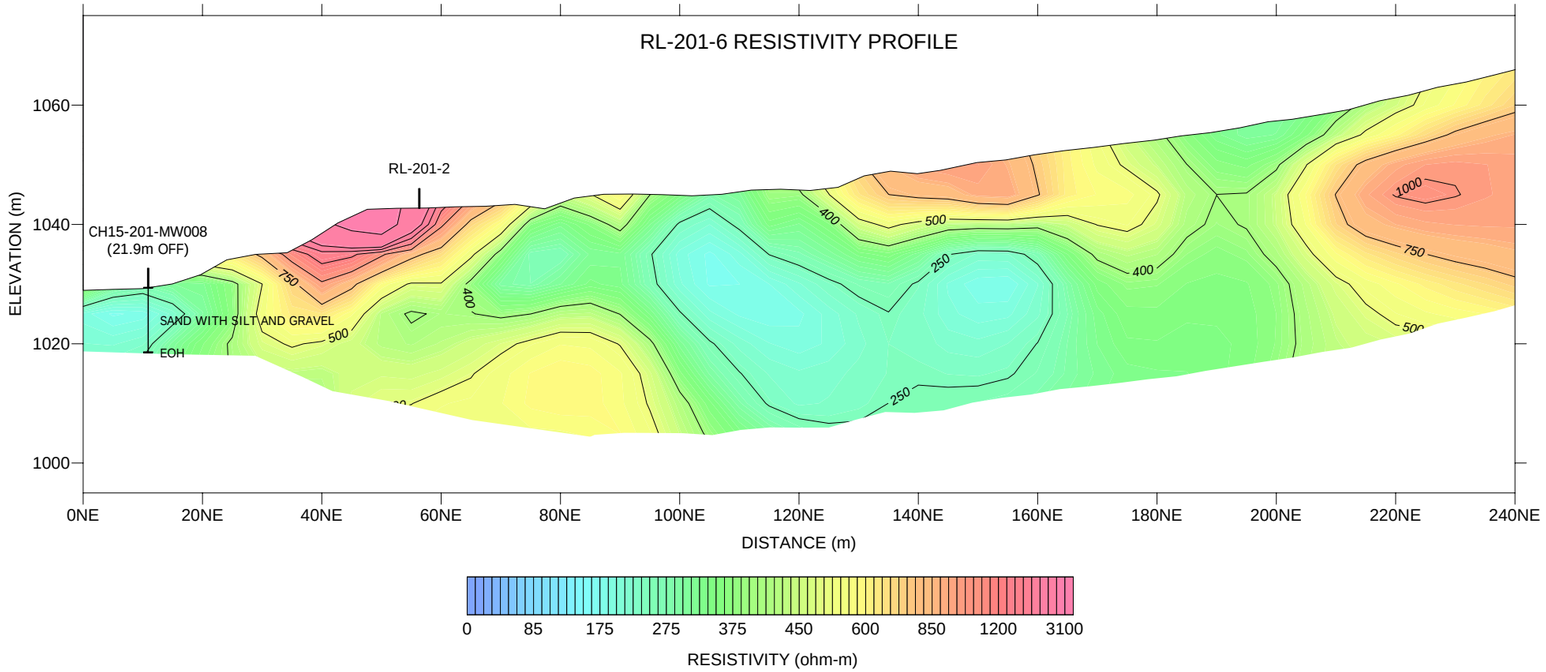
CH2MHILL
ID SPILLWAY, FARO MINE REMEDIATION PROJECT

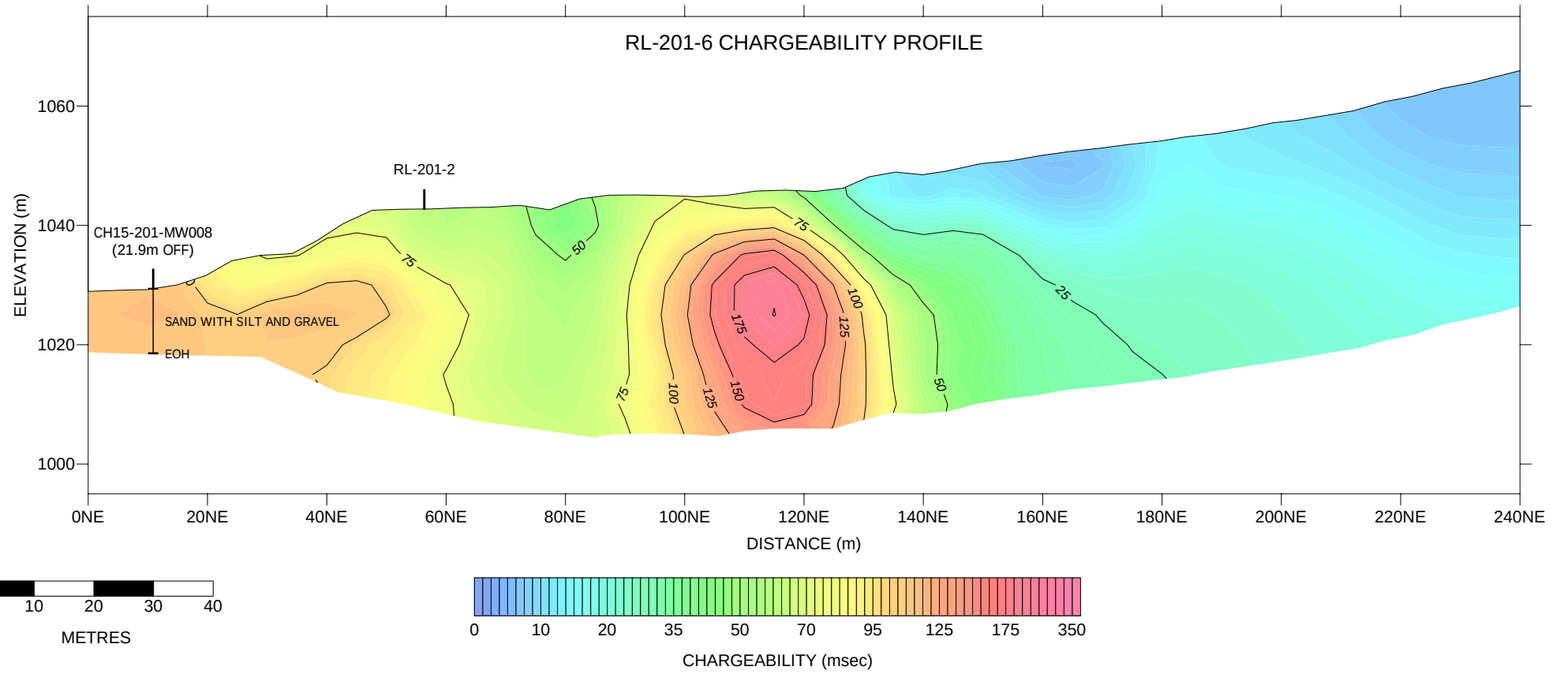
RESISTIVITY/CHARGEABILITY SURVEY

INVERTED RESISTIVITY
AND CHARGEABLITY PROFILES
RL-201-5

FRONTIER GEOSCIENCES INC.

DATE: OCT. 2015	SCALE 1:1,000	FIG. 7





NOTE: THIS DRAWING MUST BE READ WITH REFERENCE TO PROJECT REPORT FGI-1415-FC
ELEVATIONS SURVEYED MAY 2016

CH2MHILL

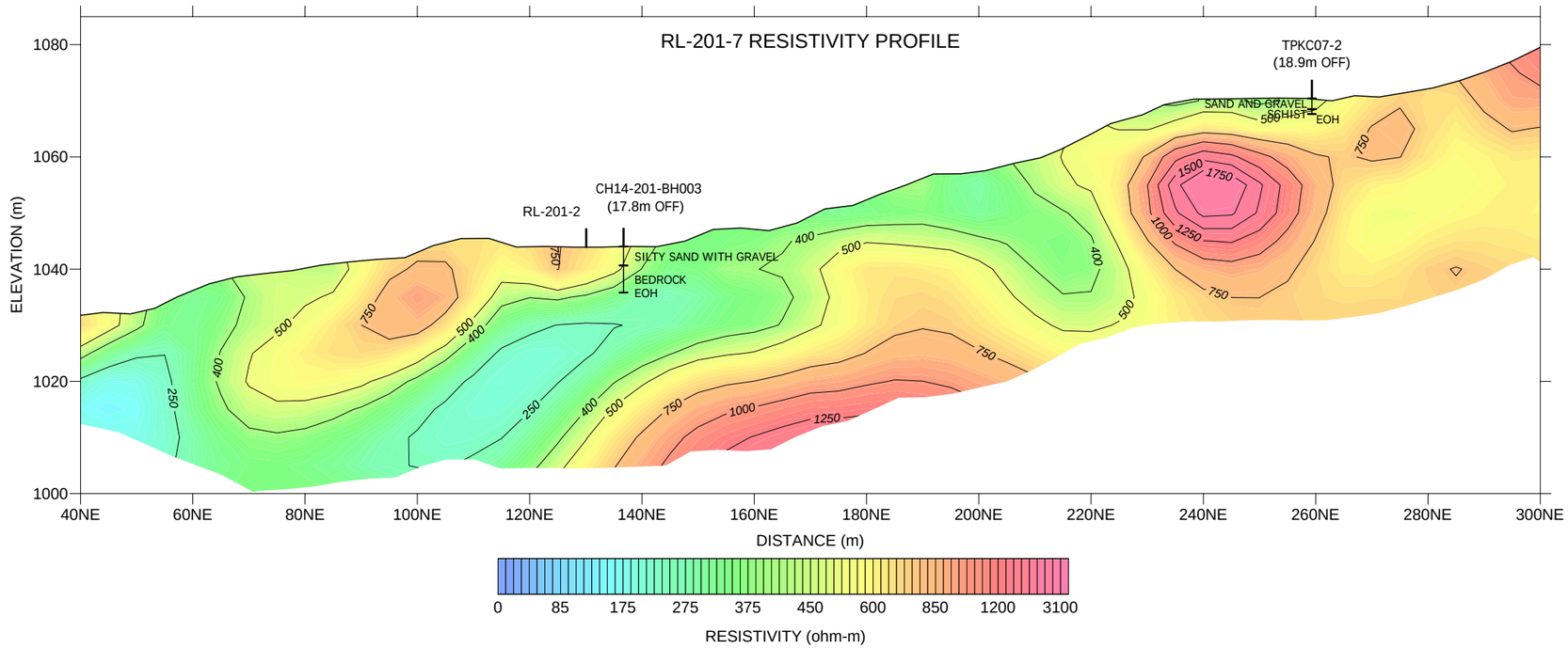
ID SPILLWAY, FARO MINE REMEDIATION PROJECT

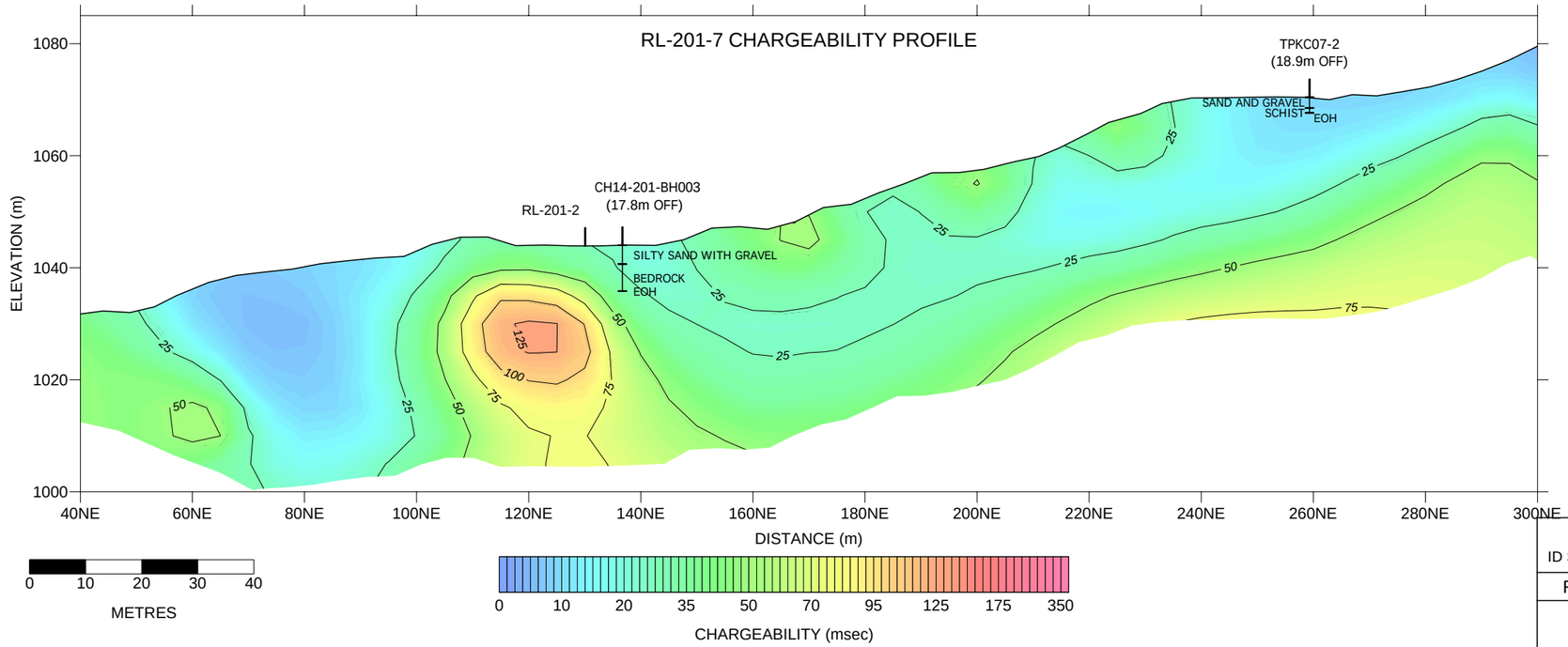
RESISTIVITY/CHARGEABILITY SURVEY

INVERTED RESISTIVITY
AND CHARGEABLITY PROFILES
RL-201-6

FRONTIER GEOSCIENCES INC.

DATE: OCT. 2015	SCALE 1:1,000	FIG. 8





NOTE: THIS DRAWING MUST BE READ WITH REFERENCE TO PROJECT REPORT FGI-1415-FC
ELEVATIONS SURVEYED MAY 2016

CH2MHILL

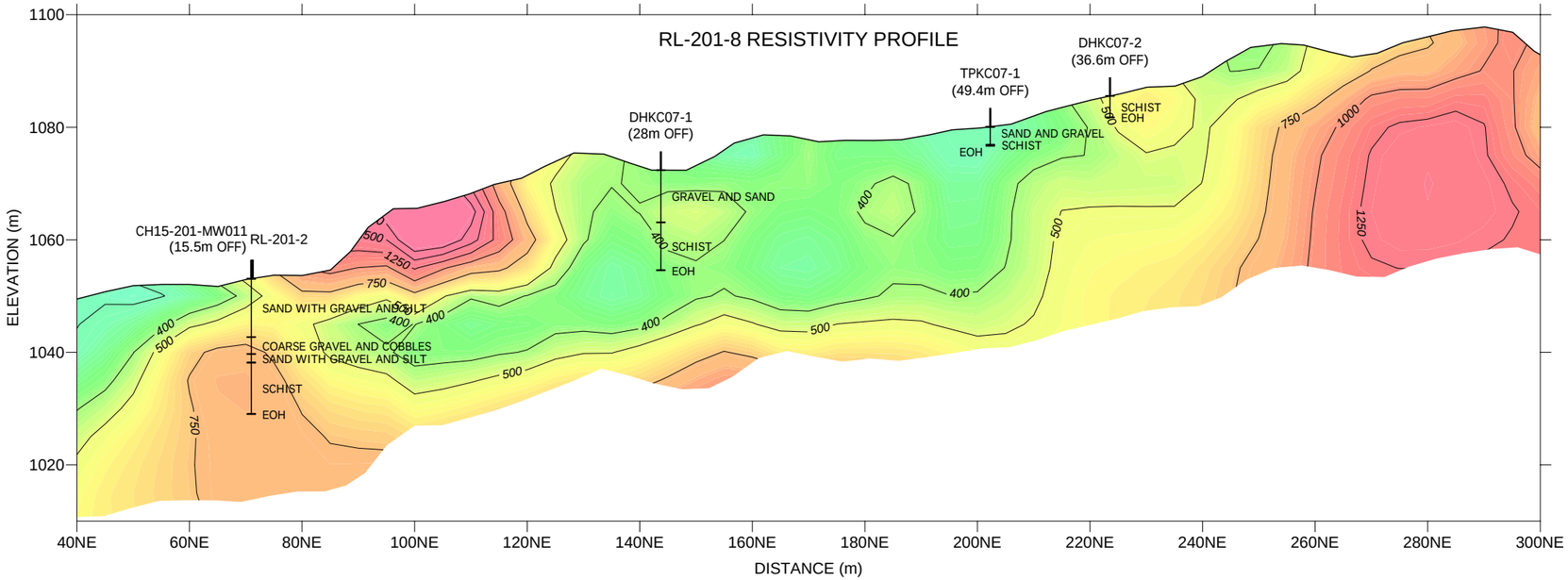
ID SPILLWAY, FARO MINE REMEDIATION PROJECT

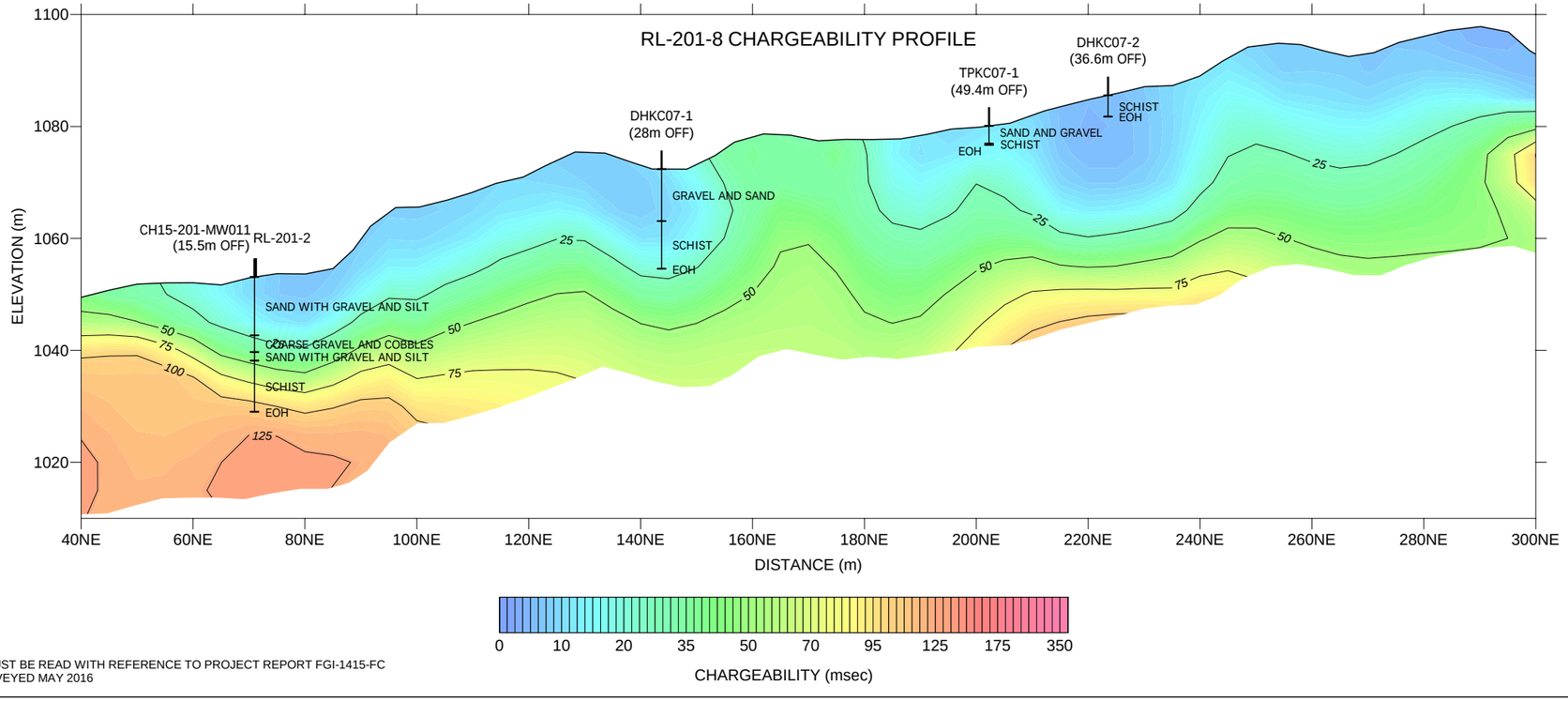
RESISTIVITY/CHARGEABILITY SURVEY

INVERTED RESISTIVITY AND CHARGEABLITY PROFILES RL-201-7

FRONTIER GEOSCIENCES INC.

DATE: OCT. 2015	SCALE 1:1,000	FIG. 9





NOTE: THIS DRAWING MUST BE READ WITH REFERENCE TO PROJECT REPORT FGI-1415-FC
ELEVATIONS SURVEYED MAY 2016

CH2MHILL
ID SPILLWAY, FARO MINE REMEDIATION PROJECT

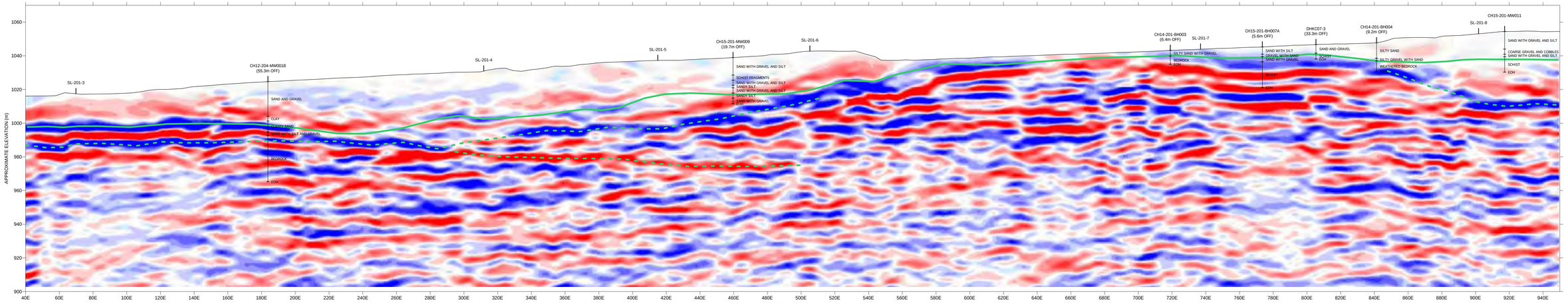
RESISTIVITY/CHARGEABILITY SURVEY

INVERTED RESISTIVITY
AND CHARGEABLITY PROFILES
RL-201-8

FRONTIER GEOSCIENCES INC.

DATE: OCT. 2015	SCALE 1:1,000	FIG. 10

SL-202-2 SEISMIC REFLECTION PROFILE



INTERPRETED BEDROCK TOP REFECTOR

INTERPRETED REFLECTOR WITHIN BEDROCK

0 10 20 30 40

METRES

NOTE: THIS DRAWING MUST BE READ WITH REFERENCE TO PROJECT REPORT FGI-1415-FC
ELEVATIONS SURVEYED MAY 2016

CH2MHILL

ID SPILLWAY, FARO MINE REMEDIATION PROJECT

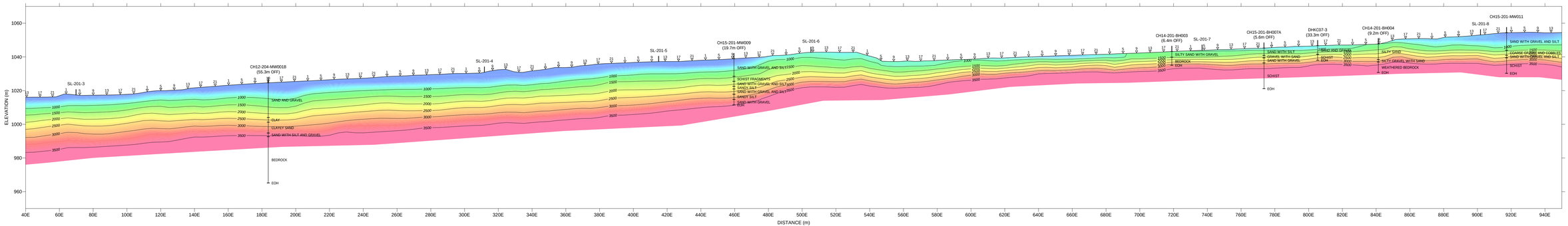
SEISMIC REFLECTION SURVEY

SEISMIC REFLECTION PROFILE
SL-201-2

FRONTIER GEOSCIENCES INC.

DATE: OCT. 2015	SCALE: 1:1,000	FIG. 11

SL-202-2 TOMOGRPAHY PROFILE



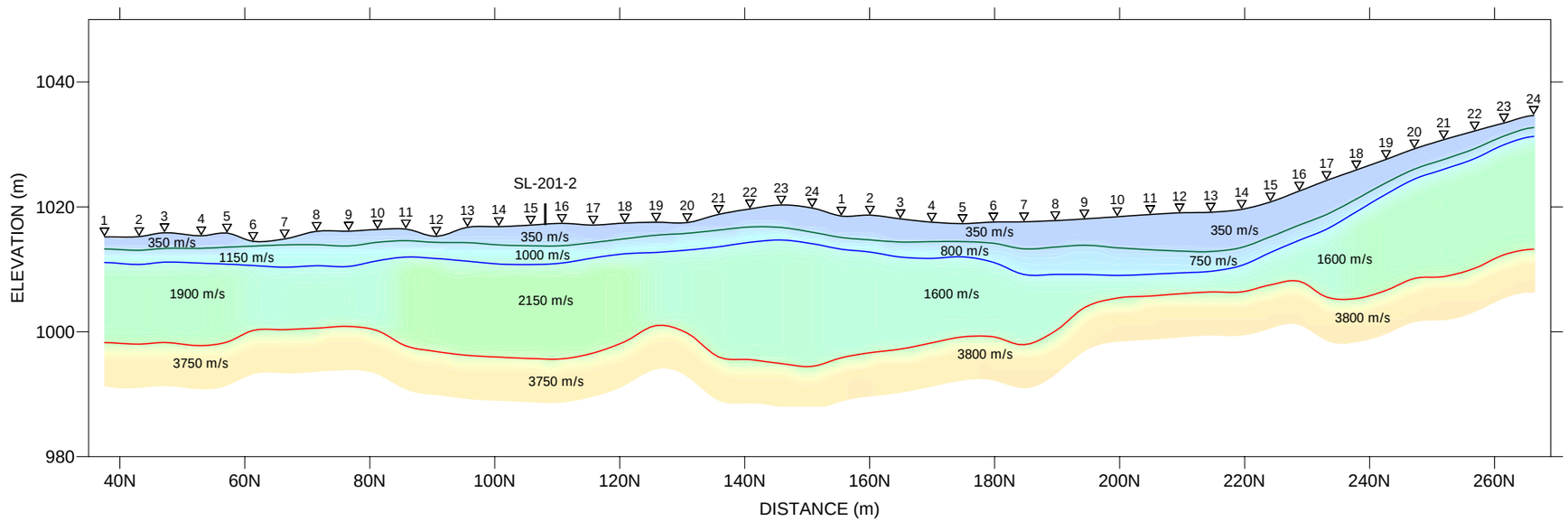


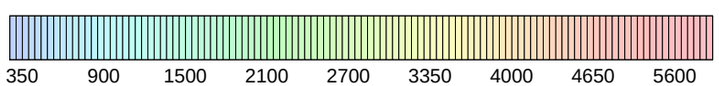


NOTE: THIS DRAWING MUST BE READ WITH REFERENCE TO PROJECT REPORT FGI-1415-FC
ELEVATIONS SURVEYED MAY 2016

CH2MHILL		
ID SPILLWAY, FARO MINE REMEDIATION PROJECT		
SEISMIC REFLECTION SURVEY		
INVERTED P-WAVE TOMOGRAPHY PROFILE SL-201-2		
FRONTIER GEOSCIENCES INC.		
DATE: OCT. 2015	SCALE: 1:1,000	FIG. 12

SL-201-3 SEISMIC REFRACTION PROFILE

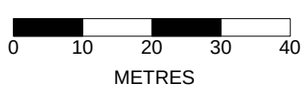




FIRST SEISMIC VELOCITY LAYER

SECOND SEISMIC VELOCITY LAYER

SEISMIC BASAL VELOCITY LAYER



NOTE: THIS DRAWING MUST BE READ WITH REFERENCE TO PROJECT REPORT FGI-1415-FC
ELEVATIONS SURVEYED MAY 2016

CH2MHILL

ID SPILLWAY, FARO MINE REMEDIATION PROJECT

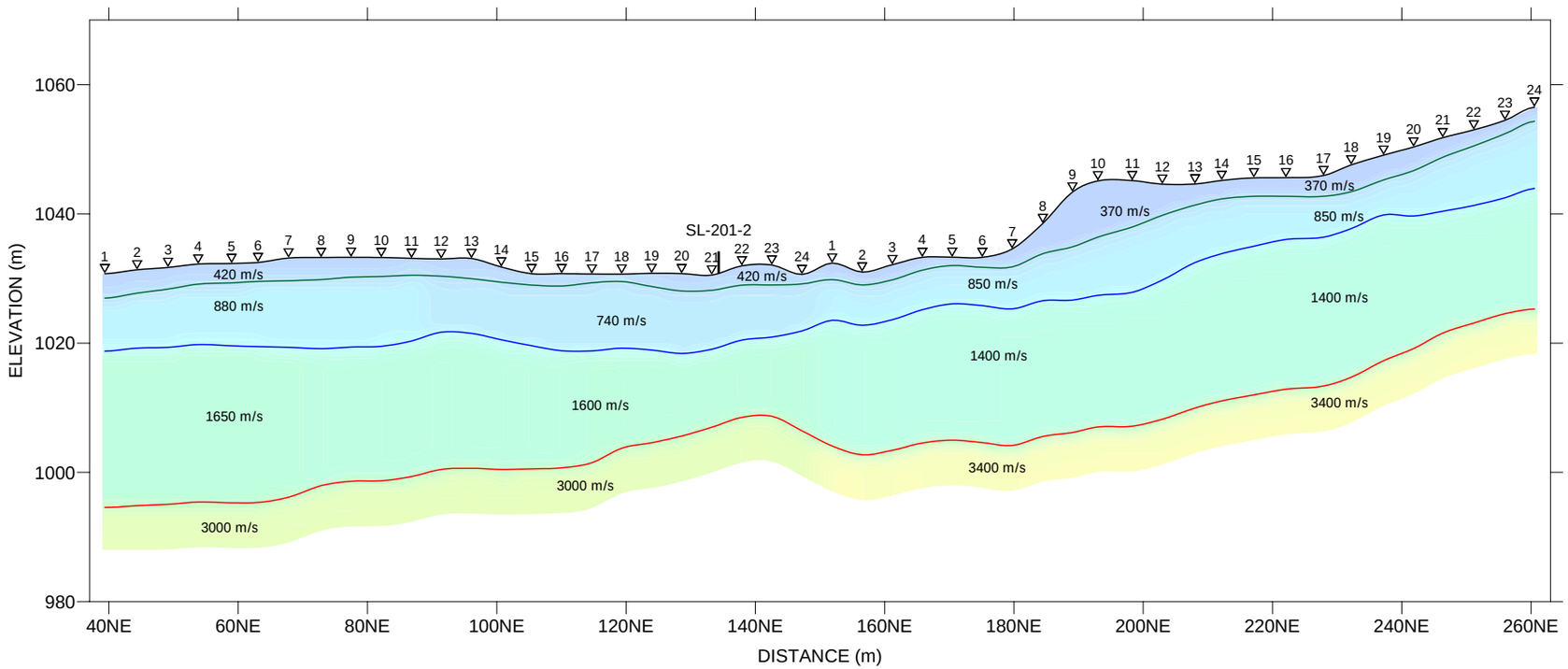
SEISMIC REFRACTION SURVEY

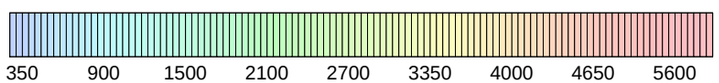
INTERPRETED DEPTH PROFILE
SL-201-3

FRONTIER GEOSCIENCES INC.

DATE: OCT. 2015	SCALE 1:1,000	FIG. 13

SL-201-4 SEISMIC REFRACTION PROFILE





P-WAVE VELOCITY (m/s)

FIRST SEISMIC VELOCITY LAYER

SECOND SEISMIC VELOCITY LAYER

SEISMIC BASAL VELOCITY LAYER



METRES

NOTE: THIS DRAWING MUST BE READ WITH REFERENCE TO PROJECT REPORT FGI-1415-FC
ELEVATIONS SURVEYED MAY 2016

CH2MHILL

ID SPILLWAY, FARO MINE REMEDIATION PROJECT

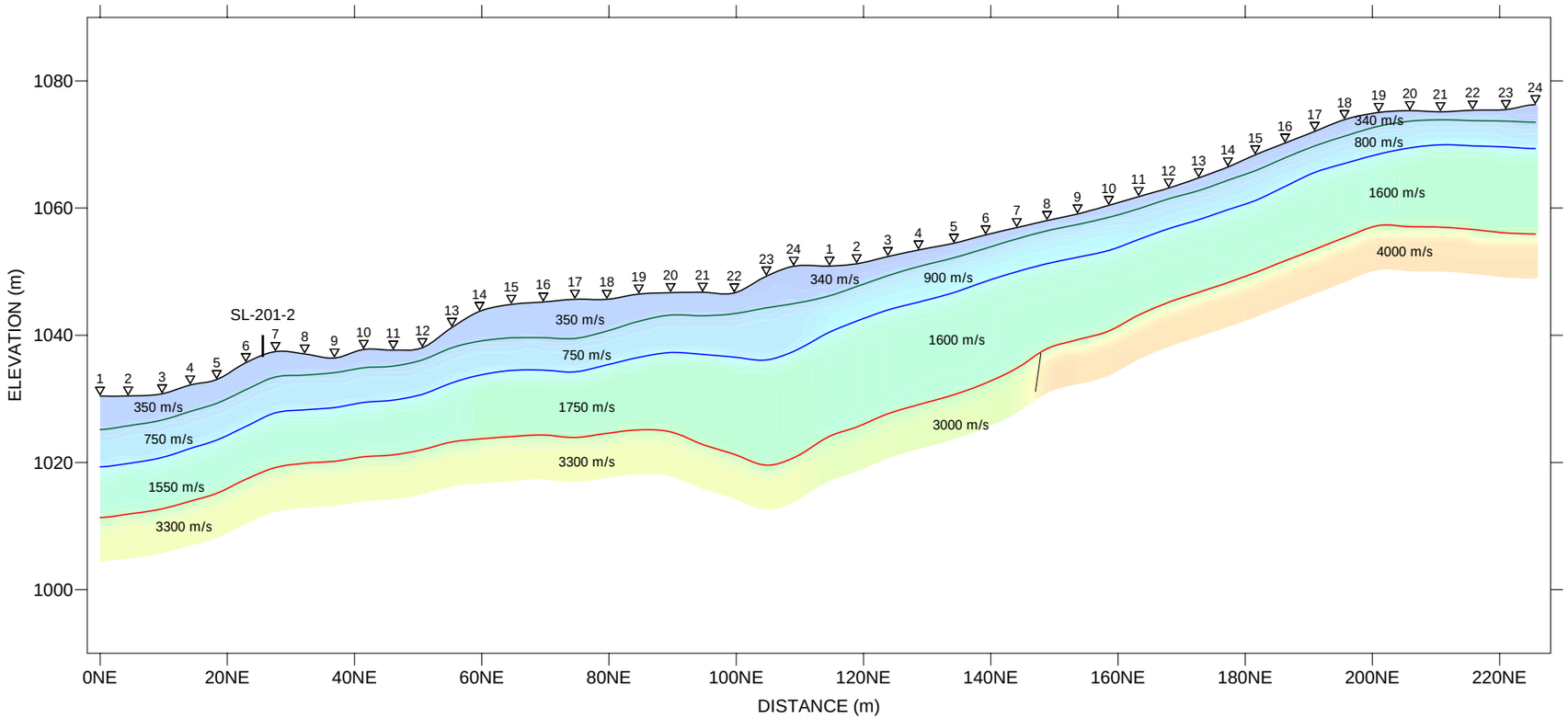
SEISMIC REFRACTION SURVEY

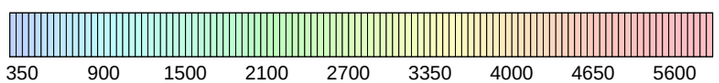
INTERPRETED DEPTH PROFILE
SL-201-4

FRONTIER GEOSCIENCES INC.

DATE: OCT. 2015	SCALE 1:1,000	FIG. 14

SL-201-5 SEISMIC REFRACTION PROFILE





P-WAVE VELOCITY (m/s)

FIRST SEISMIC VELOCITY LAYER

SECOND SEISMIC VELOCITY LAYER

SEISMIC BASAL VELOCITY LAYER



METRES

NOTE: THIS DRAWING MUST BE READ WITH REFERENCE TO PROJECT REPORT FGI-1415-FC
ELEVATIONS SURVEYED MAY 2016

CH2MHILL

ID SPILLWAY, FARO MINE REMEDIATION PROJECT

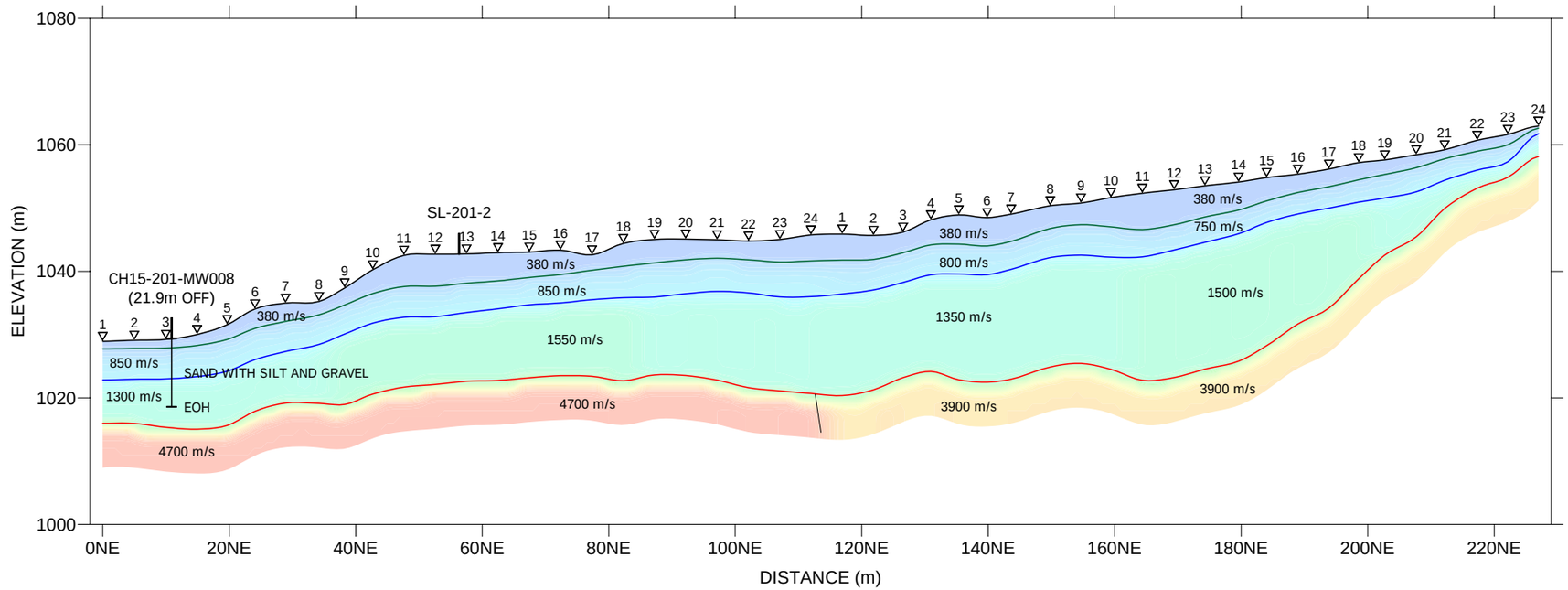
SEISMIC REFRACTION SURVEY

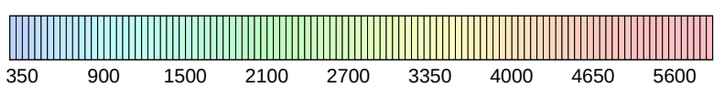
INTERPRETED DEPTH PROFILE
SL-201-5

FRONTIER GEOSCIENCES INC.

DATE: OCT. 2015	SCALE 1:1,000	FIG. 15

SL-201-6 SEISMIC REFRACTION PROFILE



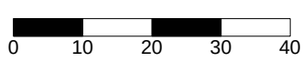


P-WAVE VELOCITY (m/s)

FIRST SEISMIC VELOCITY LAYER

SECOND SEISMIC VELOCITY LAYER

SEISMIC BASAL VELOCITY LAYER



METRES

NOTE: THIS DRAWING MUST BE READ WITH REFERENCE TO PROJECT REPORT FGI-1415-FC
ELEVATIONS SURVEYED MAY 2016

CH2MHILL

ID SPILLWAY, FARO MINE REMEDIATION PROJECT

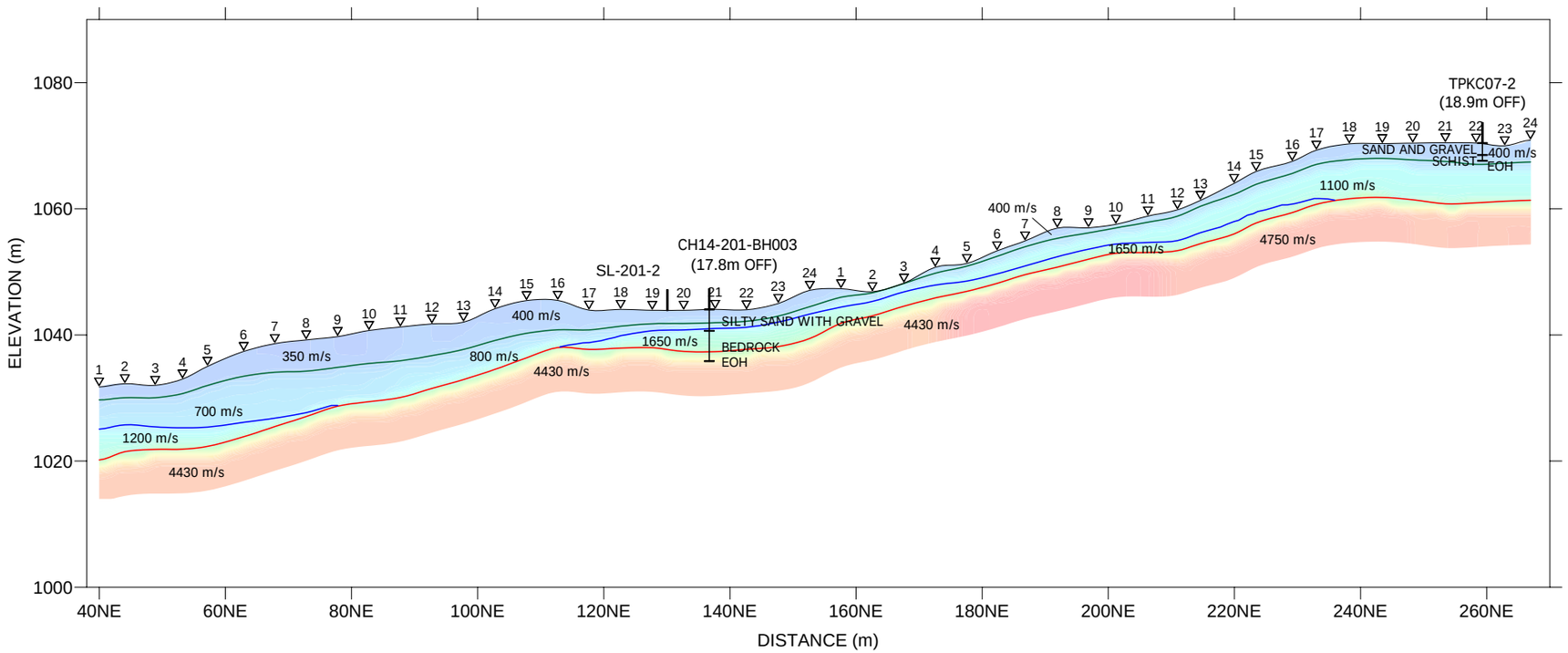
SEISMIC REFRACTION SURVEY

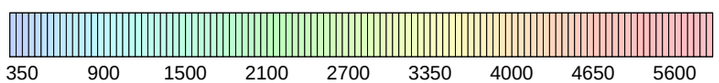
INTERPRETED DEPTH PROFILE
SL-201-6

FRONTIER GEOSCIENCES INC.

DATE: OCT. 2015	SCALE 1:1,000	FIG. 16

SL-201-7 SEISMIC REFRACTION PROFILE





P-WAVE VELOCITY (m/s)

FIRST SEISMIC VELOCITY LAYER

SECOND SEISMIC VELOCITY LAYER

SEISMIC BASAL VELOCITY LAYER



METRES

NOTE: THIS DRAWING MUST BE READ WITH REFERENCE TO PROJECT REPORT FGI-1415-FC
ELEVATIONS SURVEYED MAY 2016

CH2MHILL

ID SPILLWAY, FARO MINE REMEDIATION PROJECT

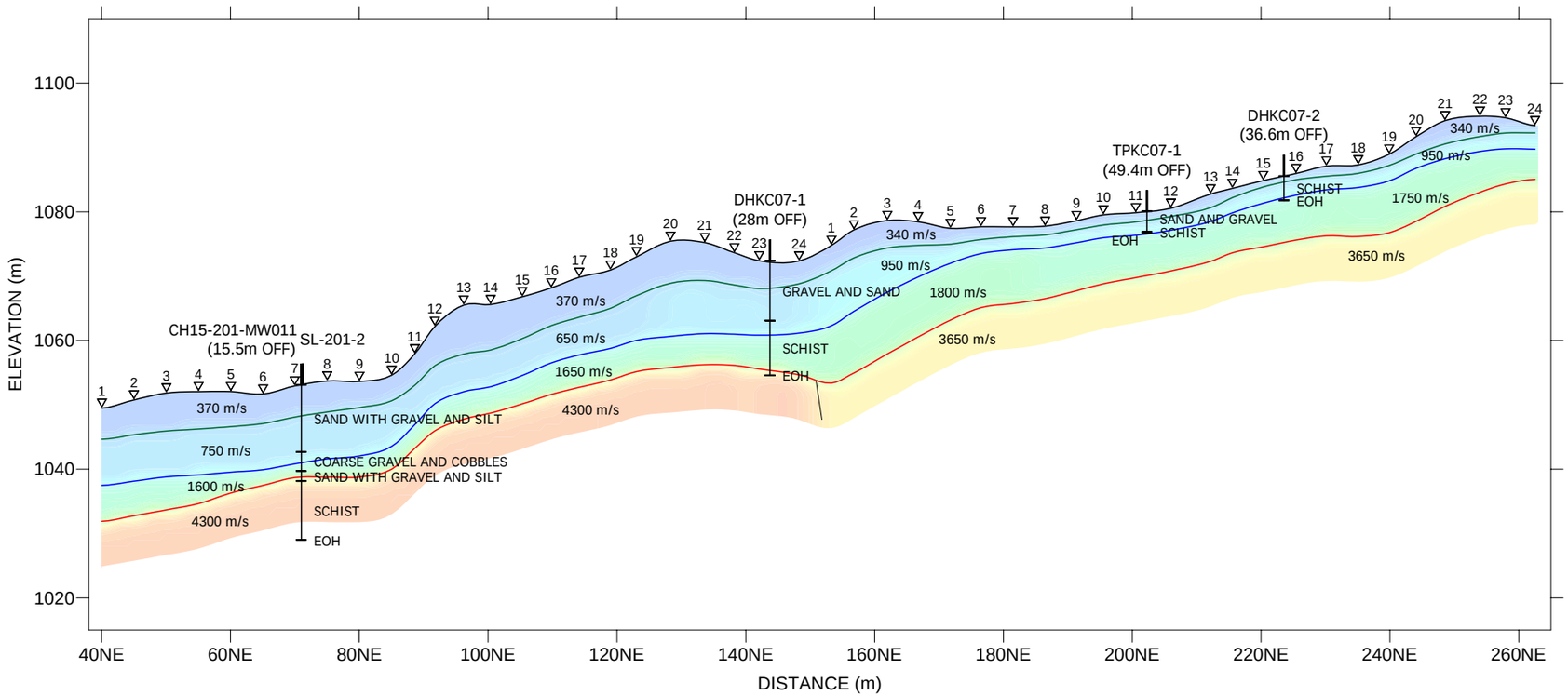
SEISMIC REFRACTION SURVEY

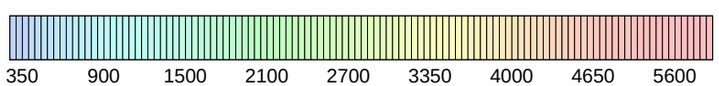
INTERPRETED DEPTH PROFILE
SL-201-7

FRONTIER GEOSCIENCES INC.

DATE: OCT. 2015	SCALE 1:1,000	FIG. 17

SL-201-8 SEISMIC REFRACTION PROFILE



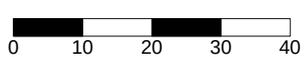


P-WAVE VELOCITY (m/s)

FIRST SEISMIC VELOCITY LAYER

SECOND SEISMIC VELOCITY LAYER

SEISMIC BASAL VELOCITY LAYER



METRES

NOTE: THIS DRAWING MUST BE READ WITH REFERENCE TO PROJECT REPORT FGI-1415-FC
ELEVATIONS SURVEYED MAY 2016

CH2MHILL

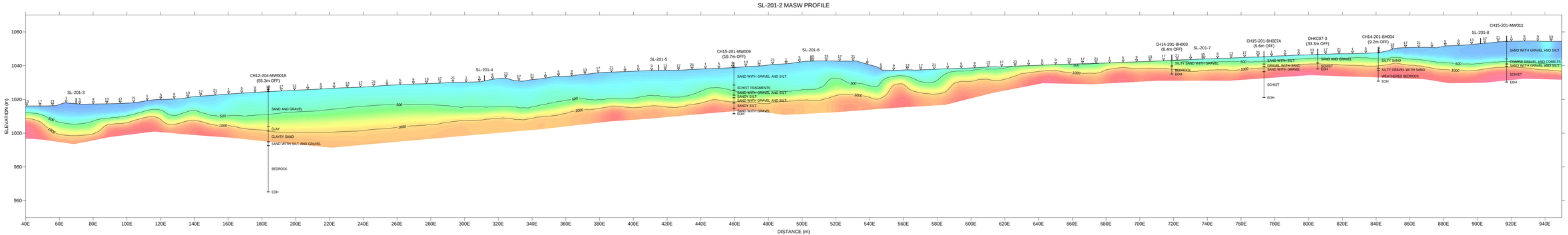
ID SPILLWAY, FARO MINE REMEDIATION PROJECT

SEISMIC REFRACTION SURVEY

INTERPRETED DEPTH PROFILE
SL-201-8

FRONTIER GEOSCIENCES INC.

DATE: OCT. 2015	SCALE 1:1,000	FIG. 18



NOTE: THIS DRAWING MUST BE READ WITH REFERENCE TO PROJECT REPORT FGI-1415-FC
ELEVATIONS SURVEYED MAY 2016

CH2MHILL
ID SPILLWAY, FARO MINE REMEDIATION PROJECT

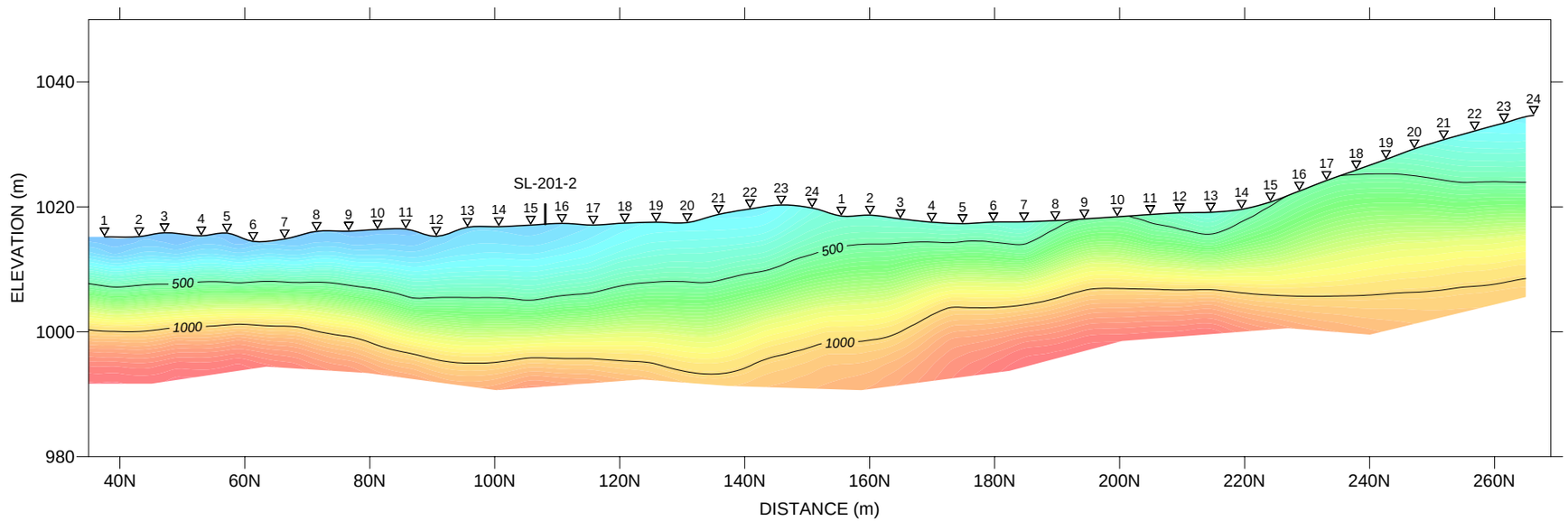
MASW SURVEY

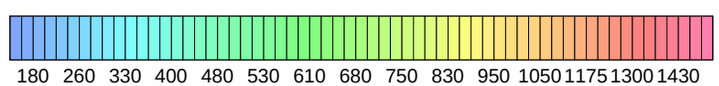
INVERTED MASW PROFILE
SL-201-2

FRONTIER GEOSCIENCES INC.

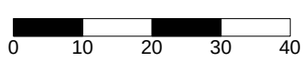
DATE: OCT. 2015	SCALE: 1:1,000	FIG. 19

SL-201-3 MASW PROFILE





S-WAVE VELOCITY (m/s)



METRES

NOTE: THIS DRAWING MUST BE READ WITH REFERENCE TO PROJECT REPORT FGI-1415-FC
ELEVATIONS SURVEYED MAY 2016

CH2MHILL

ID SPILLWAY, FARO MINE REMEDIATION PROJECT

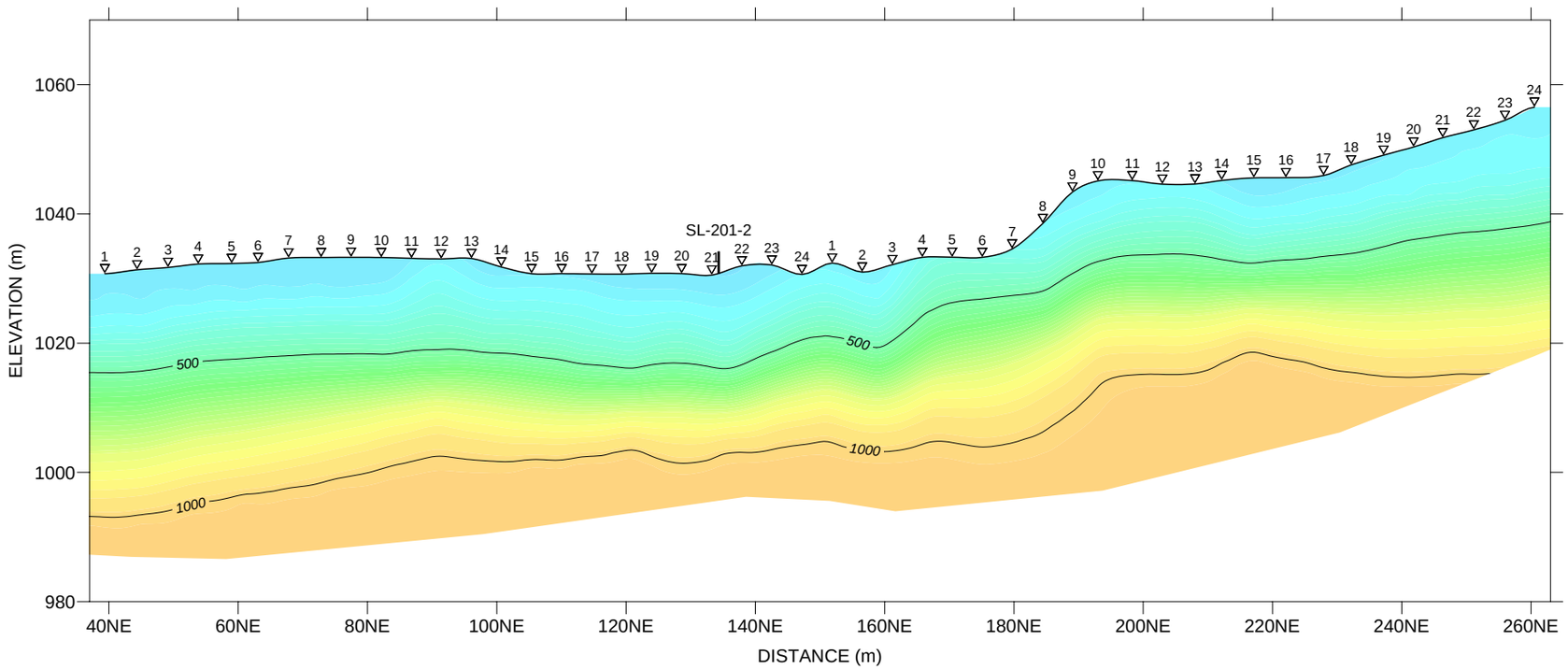
MASW SURVEY

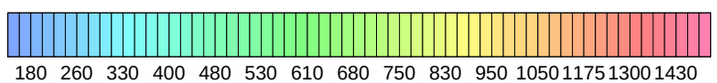
INVERTED MASW PROFILE
SL-201-3

FRONTIER GEOSCIENCES INC.

DATE: OCT. 2015	SCALE 1:1,000	FIG. 20

SL-201-4 MASW PROFILE





S-WAVE VELOCITY (m/s)



METRES

NOTE: THIS DRAWING MUST BE READ WITH REFERENCE TO PROJECT REPORT FGI-1415-FC
ELEVATIONS SURVEYED MAY 2016

CH2MHILL

ID SPILLWAY, FARO MINE REMEDIATION PROJECT

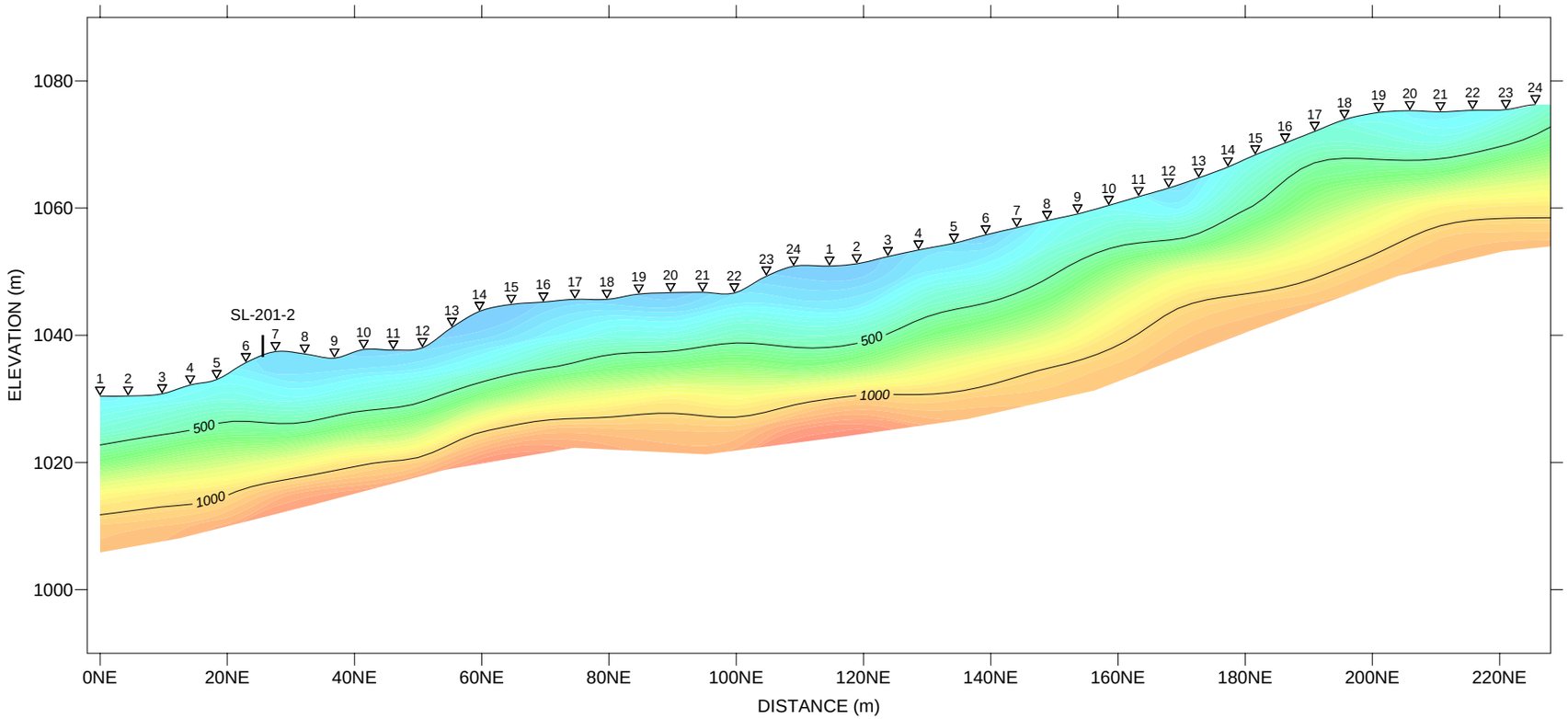
MASW SURVEY

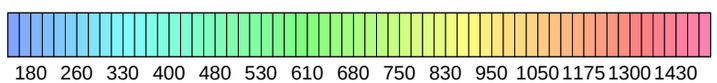
INVERTED MASW PROFILE
SL-201-4

FRONTIER GEOSCIENCES INC.

DATE: OCT. 2015	SCALE 1:1,000	FIG. 21

SL-201-5 MASW PROFILE





S-WAVE VELOCITY (m/s)



METRES

NOTE: THIS DRAWING MUST BE READ WITH REFERENCE TO PROJECT REPORT FGI-1415-FC
ELEVATIONS SURVEYED MAY 2016

CH2MHILL

ID SPILLWAY, FARO MINE REMEDIATION PROJECT

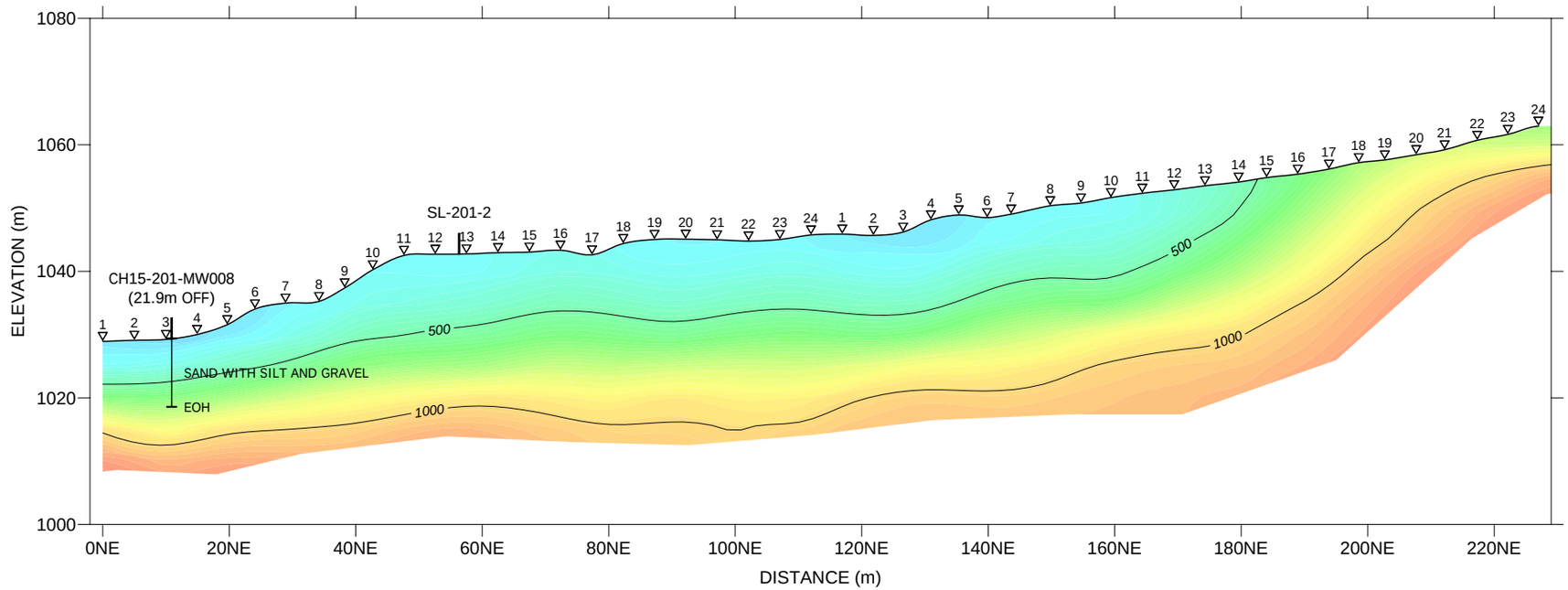
MASW SURVEY

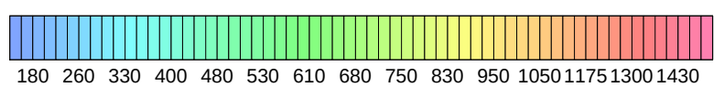
INVERTED MASW PROFILE
SL-201-5

FRONTIER GEOSCIENCES INC.

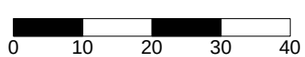
DATE: OCT. 2015	SCALE 1:1,000	FIG. 22

SL-201-6 MASW PROFILE





S-WAVE VELOCITY (m/s)



METRES

NOTE: THIS DRAWING MUST BE READ WITH REFERENCE TO PROJECT REPORT FGI-1415-FC
ELEVATIONS SURVEYED MAY 2016

CH2MHILL

ID SPILLWAY, FARO MINE REMEDIATION PROJECT

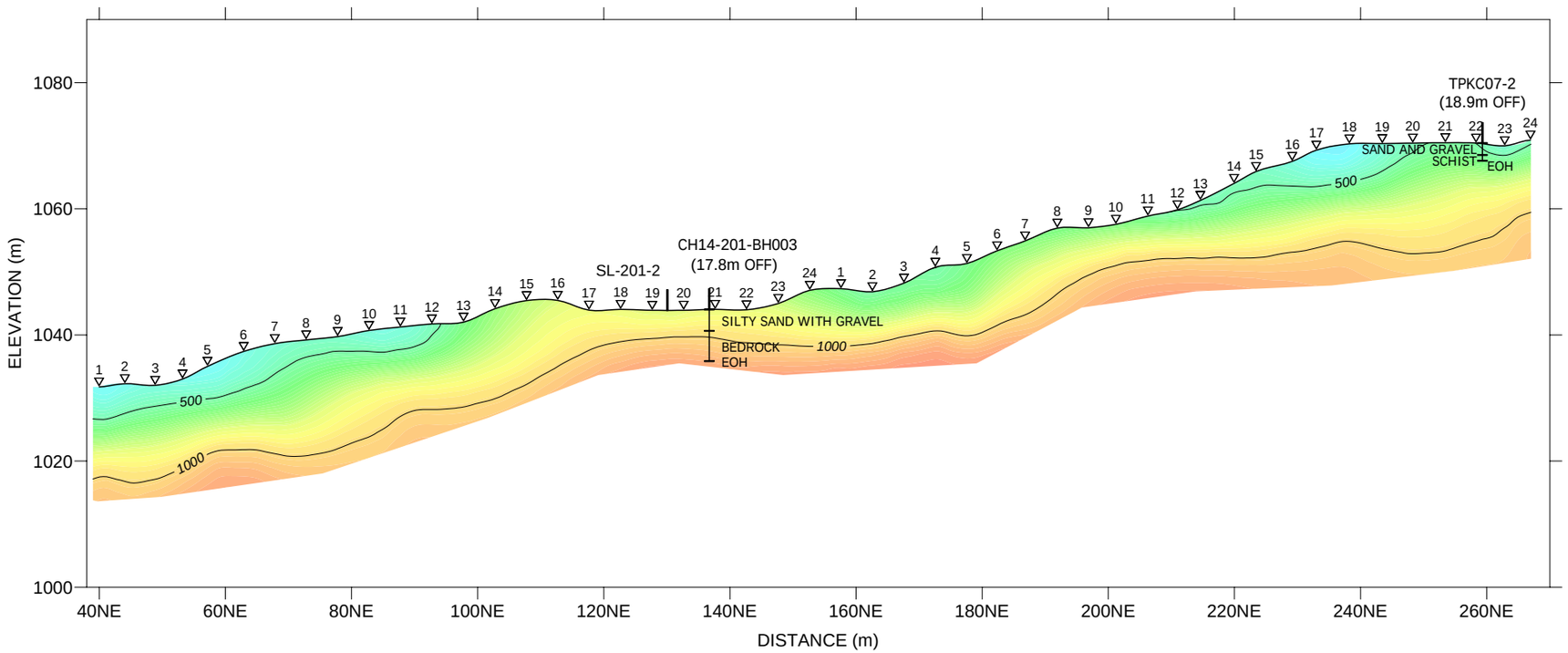
MASW SURVEY

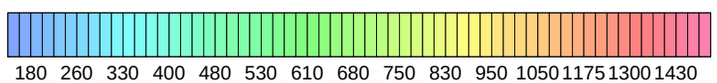
INVERTED MASW PROFILE
SL-201-6

FRONTIER GEOSCIENCES INC.

DATE: OCT. 2015	SCALE 1:1,000	FIG. 23

SL-201-7 MASW PROFILE





S-WAVE VELOCITY (m/s)



METRES

NOTE: THIS DRAWING MUST BE READ WITH REFERENCE TO PROJECT REPORT FGI-1415-FC
ELEVATIONS SURVEYED MAY 2016

CH2MHILL

ID SPILLWAY, FARO MINE REMEDIATION PROJECT

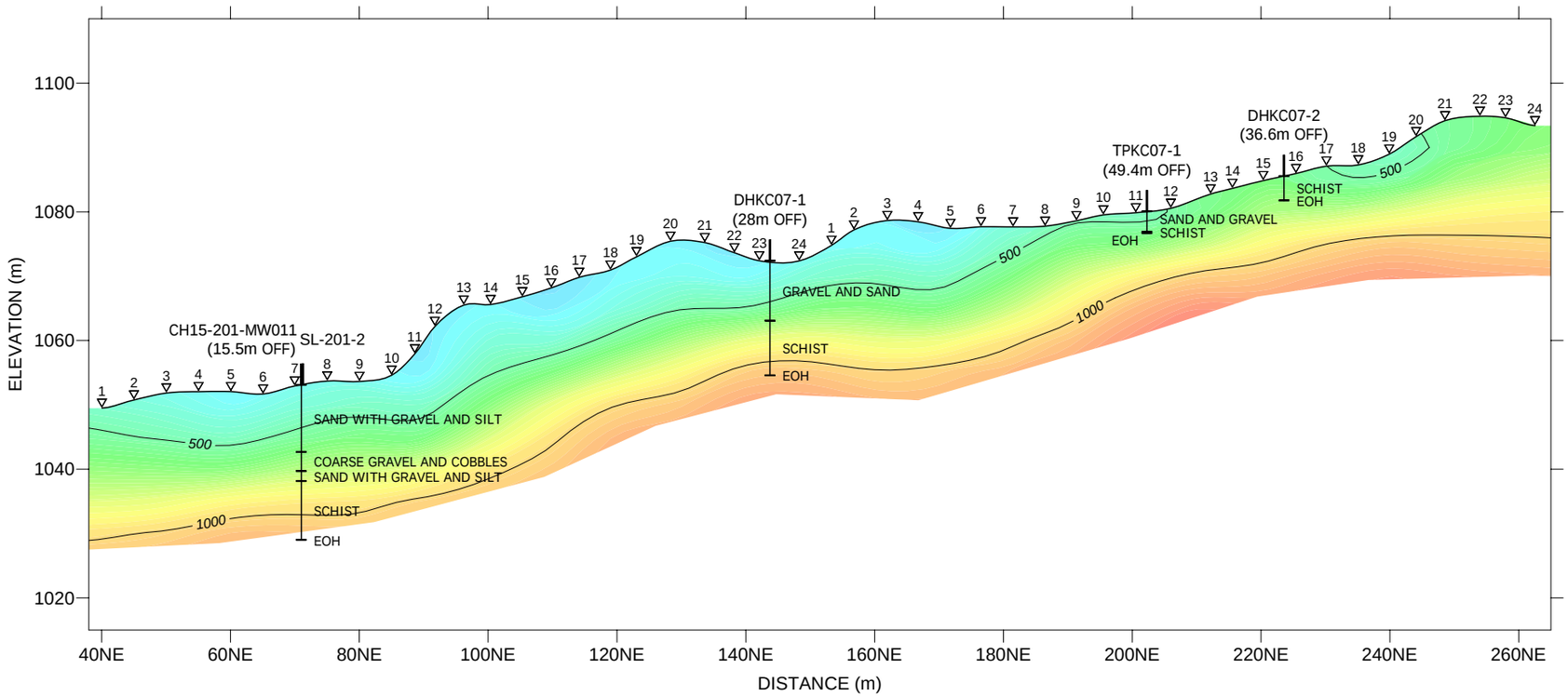
MASW SURVEY

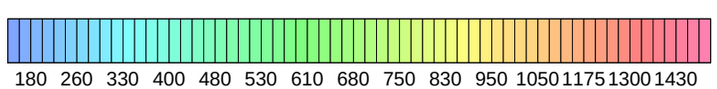
INVERTED MASW PROFILE
SL-201-7

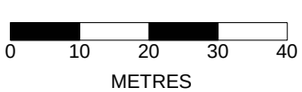
FRONTIER GEOSCIENCES INC.

DATE: OCT. 2015	SCALE 1:1,000	FIG. 24

SL-201-8 MASW PROFILE







NOTE: THIS DRAWING MUST BE READ WITH REFERENCE TO PROJECT REPORT FGI-1415-FC
ELEVATIONS SURVEYED MAY 2016

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MASW SURVEY

INVERTED MASW PROFILE
SL-201-8

FRONTIER GEOSCIENCES INC.

DATE: OCT. 2015	SCALE 1:1,000	FIG. 25

Attachment 2
CPT and Sonic Borings Data from ConeTec

PRESENTATION OF SITE INVESTIGATION RESULTS

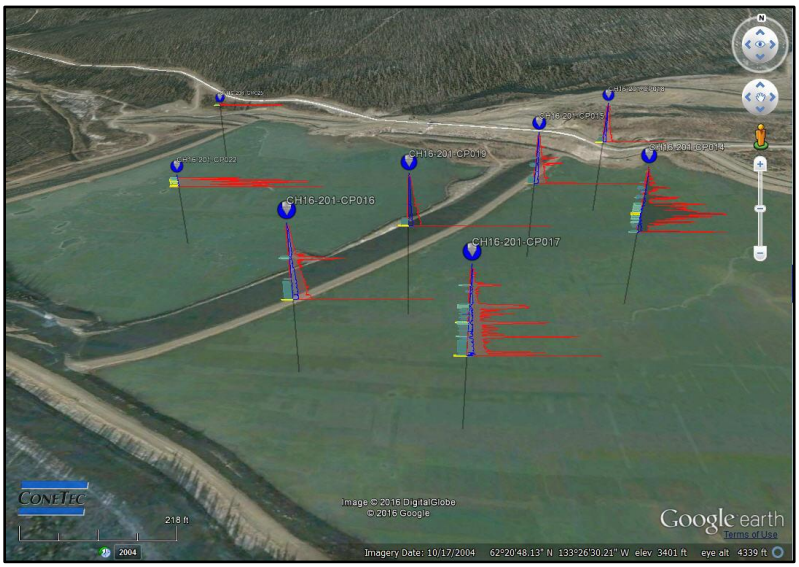
Faro Mine Complex, YT

Prepared for:

CH2M Hill Canada Ltd.

ConeTec Job No: 16-02014

Project Start Date: 06-March-2016
Project End Date: 17-March-2016
Report Date: 29-April-2016



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Introduction

The enclosed report presents the results of the site investigation program conducted by ConeTec Investigations Ltd. for CH2M Hill Canada Ltd. at Faro Mine Complex in Yukon Territory. The program consisted of eight gamma seismic cone penetration tests (GSCPT), three gamma flow (ball) penetration tests (BGCPT) and eight sample locations.

Project Information

Project	
Client	CH2M Hill Canada Ltd.
Project	Faro Mine Complex
ConeTec project number	16-02014

A map from Google earth including the GSCPT and BGCPT test locations is presented below.



Rig Description	Deployment System	Test Type
Portable ramset	14 ton hydraulic ramset	GSCPT, BGCPT
Fraste ML	Drill head	Sampling

Coordinates		
Test Type	Collection Method	EPSG Number
GSCPT, BGCPT, sampling	Trimble RTK Survey	32608

Cone Penetration Test (CPT)	
Depth reference	Existing ice surface at the time of testing.
Tip and sleeve data offset	0.1 meter. This has been accounted for in the CPT data files.
Additional information	Passive gamma and advanced CPT plots with $Su(N_{kt})$ are provided in the data release folder.

Cone Description	Cone Number	Cross Sectional Area (cm^2)	Sleeve Area (cm^2)	Tip Capacity (bar)	Sleeve Capacity (bar)	Pore Pressure Capacity (psi)
317:T375F10U200	317	15	225	375	10	200
Cone 317 was used for all GSCPT and BGCPT soundings.						

Changes to SBT Chart					
Original SBT Settings			Revised SBT Settings		
Zone	Unit Weight (kN/m^3)	Zone Text	Zone	Unit Weight (kN/m^3)	Zone Text
0	18.64	Undefined	0	17.50	Undefined
1	17.50	Sensitive Fines	1	17.50	Fines
2	12.50	Organic Soil	2	17.50	Fines
Additional information		Undrained parameters have been calculated for materials that classify as undefined (Zone 0).			

Interpretation Tables	
Additional information	The Soil Behaviour Type (SBT) classification chart (Robertson et al., 1986) was used to classify the soil for this project. A detailed set of CPT interpretations were generated and are provided in Excel format files in the release folder. The CPT interpretations are based on values of corrected tip (q_t), sleeve friction (f_s) and pore pressure averaged over a user specified interval of 20 cm. Pore pressure equilibrium profiles was used for the interpretation tables except for CPT soundings CH16-201-CP022 and CH16-201-CP025 where hydrostatic conditions were assumed.

Sampling	
Depth reference	Existing ice surface at the time of sampling.
Sampling method	Sonic
Additional information	Sample photos for each location are provided in the release folder. Sample photos for location CH16-201-BH012 is not available.

Limitations

This report has been prepared for the exclusive use of CH2M Hill Canada Ltd. (Client) for the project titled “Faro Mine Complex”. The report’s contents may not be relied upon by any other party without the express written permission of ConeTec Investigations Ltd. (ConeTec). ConeTec has provided site investigation services, prepared the factual data reporting, and provided geotechnical parameter calculations consistent with current best practices. No other warranty, expressed or implied, is made.

The information presented in the report document and the accompanying data set pertain to the specific project, site conditions and objectives described to ConeTec by the Client. In order to properly understand the factual data, assumptions and calculations, reference must be made to the documents provided and their accompanying data sets, in their entirety.

The cone penetration tests (CPTu) are conducted using an integrated electronic piezocone penetrometer and data acquisition system manufactured by Adara Systems Ltd. of Richmond, British Columbia, Canada.

ConeTec's piezocone penetrometers are compression type designs in which the tip and friction sleeve load cells are independent and have separate load capacities. The piezocones use strain gauged load cells for tip and sleeve friction and a strain gauged diaphragm type transducer for recording pore pressure. The piezocones also have a platinum resistive temperature device (RTD) for monitoring the temperature of the sensors, an accelerometer type dual axis inclinometer and a geophone sensor for recording seismic signals. All signals are amplified down hole within the cone body and the analog signals are sent to the surface through a shielded cable.

ConeTec penetrometers are manufactured with various tip, friction and pore pressure capacities in both 10 cm^2 and 15 cm^2 tip base area configurations in order to maximize signal resolution for various soil conditions. The specific piezocone used for each test is described in the CPT summary table presented in the first Appendix. The 15 cm^2 penetrometers do not require friction reducers as they have a diameter larger than the deployment rods. The 10 cm^2 piezocones use a friction reducer consisting of a rod adapter extension behind the main cone body with an enlarged cross sectional area (typically 44 mm diameter over a length of 32 mm with tapered leading and trailing edges) located at a distance of 585 mm above the cone tip.

The penetrometers are designed with equal end area friction sleeves, a net end area ratio of 0.8 and cone tips with a 60 degree apex angle.

All ConeTec piezocones can record pore pressure at various locations. Unless otherwise noted, the pore pressure filter is located directly behind the cone tip in the "u_2" position (ASTM Type 2). The filter is 6 mm thick, made of porous plastic (polyethylene) having an average pore size of 125 microns (90-160 microns). The function of the filter is to allow rapid movements of extremely small volumes of water needed to activate the pressure transducer while preventing soil ingress or blockage.

The piezocone penetrometers are manufactured with dimensions, tolerances and sensor characteristics that are in general accordance with the current ASTM D5778 standard. ConeTec's calibration criteria also meets or exceeds those of the current ASTM D5778 standard. An illustration of the piezocone penetrometer is presented in Figure CPTu.

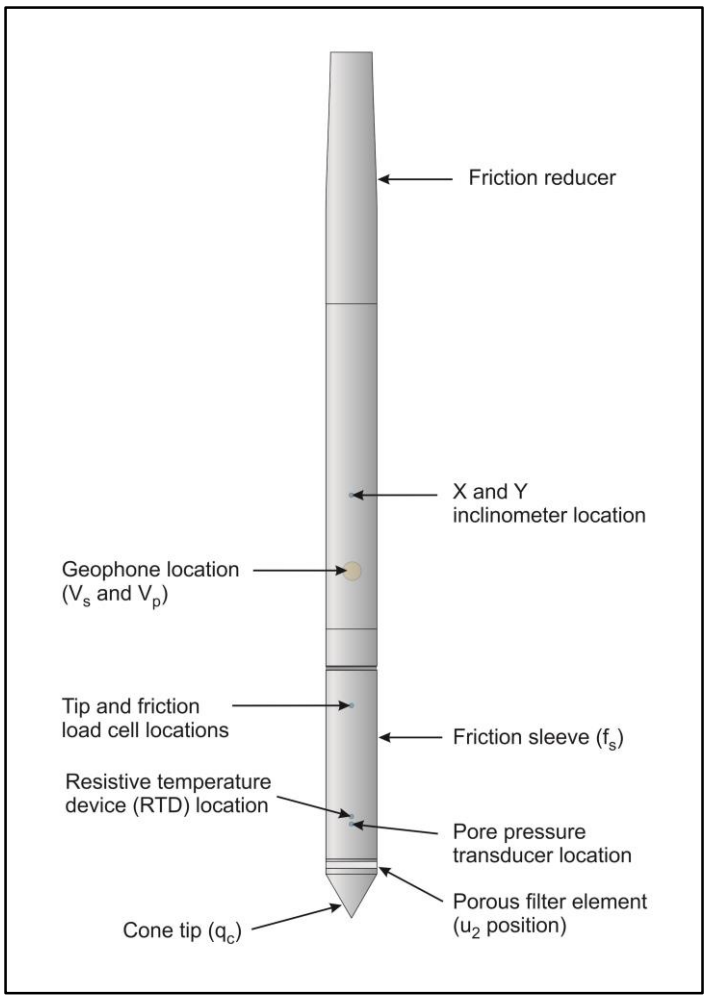


Figure CPTu. Piezocone Penetrometer (15 cm^2)

The ConeTec data acquisition systems consist of a Windows based computer and a signal conditioner and power supply interface box with a 16 bit (or greater) analog to digital (A/D) converter. The data is recorded at fixed depth increments using a depth wheel attached to the push cylinders or by using a spring loaded rubber depth wheel that is held against the cone rods. The typical recording intervals are either 2.5 cm or 5.0 cm depending on project requirements; custom recording intervals are possible. The system displays the CPTu data in real time and records the following parameters to a storage media during penetration:

- Depth
- Uncorrected tip resistance (q_c)
- Sleeve friction (f_s)
- Dynamic pore pressure (u)
- Additional sensors such as resistivity, passive gamma, ultra violet induced fluorescence, if applicable

All testing is performed in accordance to ConeTec's CPT operating procedures which are in general accordance with the current ASTM D5778 standard.

Prior to the start of a CPTu sounding a suitable cone is selected, the cone and data acquisition system are powered on, the pore pressure system is saturated with either glycerine or silicone oil and the baseline readings are recorded with the cone hanging freely in a vertical position.

The CPTu is conducted at a steady rate of 2 cm/s, within acceptable tolerances. Typically one meter length rods with an outer diameter of 1.5 inches are added to advance the cone to the sounding termination depth. After cone retraction final baselines are recorded.

Additional information pertaining to ConeTec's cone penetration testing procedures:

- Each filter is saturated in silicone oil or glycerine under vacuum pressure prior to use
- Recorded baselines are checked with an independent multi-meter
- Baseline readings are compared to previous readings
- Soundings are terminated at the client's target depth or at a depth where an obstruction is encountered, excessive rod flex occurs, excessive inclination occurs, equipment damage is likely to take place, or a dangerous working environment arises
- Differences between initial and final baselines are calculated to ensure zero load offsets have not occurred and to ensure compliance with ASTM standards

The interpretation of piezocone data for this report is based on the corrected tip resistance (q_t), sleeve friction (f_s) and pore water pressure (u). The interpretation of soil type is based on the correlations developed by Robertson (1990) and Robertson (2009). It should be noted that it is not always possible to accurately identify a soil type based on these parameters. In these situations, experience, judgment and an assessment of other parameters may be used to infer soil behaviour type.

The recorded tip resistance (q_c) is the total force acting on the piezocone tip divided by its base area. The tip resistance is corrected for pore pressure effects and termed corrected tip resistance (q_t) according to the following expression presented in Robertson et al, 1986:

$$q_t = q_c + (1\text{-}a) \bullet u_2$$

where: q_t is the corrected tip resistance
q_c is the recorded tip resistance
u_2 is the recorded dynamic pore pressure behind the tip (u_2 position)
a is the Net Area Ratio for the piezocone (0.8 for ConeTec probes)

The sleeve friction (f_s) is the frictional force on the sleeve divided by its surface area. As all ConeTec piezocones have equal end area friction sleeves, pore pressure corrections to the sleeve data are not required.

The dynamic pore pressure (u) is a measure of the pore pressures generated during cone penetration. To record equilibrium pore pressure, the penetration must be stopped to allow the dynamic pore pressures to stabilize. The rate at which this occurs is predominantly a function of the permeability of the soil and the diameter of the cone.

The friction ratio (Rf) is a calculated parameter. It is defined as the ratio of sleeve friction to the tip resistance expressed as a percentage. Generally, saturated cohesive soils have low tip resistance, high friction ratios and generate large excess pore water pressures. Cohesionless soils have higher tip resistances, lower friction ratios and do not generate significant excess pore water pressure.

A summary of the CPTu soundings along with test details and individual plots are provided in the appendices. A set of interpretation files were generated for each sounding based on published correlations and are provided in Excel format in the data release folder. Information regarding the interpretation methods used is also included in the data release folder.

For additional information on CPTu interpretations, refer to Robertson et al. (1986), Lunne et al. (1997), Robertson (2009), Mayne (2013, 2014) and Mayne and Peuchen (2012).

References

ASTM D5778-12, 2012, "Standard Test Method for Performing Electronic Friction Cone and Piezocone Penetration Testing of Soils", ASTM, West Conshohocken, US.

Lunne, T., Robertson, P.K. and Powell, J. J. M., 1997, “Cone Penetration Testing in Geotechnical Practice”, Blackie Academic and Professional.

Mayne, P.W., 2013, “Evaluating yield stress of soils from laboratory consolidation and in-situ cone penetration tests”, Sound Geotechnical Research to Practice (Holtz Volume) GSP 230, ASCE, Reston/VA: 406-420.

Mayne, P.W. and Peuchen, J., 2012, “Unit weight trends with cone resistance in soft to firm clays”, Geotechnical and Geophysical Site Characterization *4,* Vol. 1 (Proc. ISC-4, Pernambuco), CRC Press, London: 903-910.

Mayne, P.W., 2014, “Interpretation of geotechnical parameters from seismic piezocone tests”, CPT’14 Keynote Address, Las Vegas, NV, May 2014.

Robertson, P.K., Campanella, R.G., Gillespie, D. and Greig, J., 1986, “Use of Piezometer Cone Data”, Proceedings of InSitu 86, ASCE Specialty Conference, Blacksburg, Virginia.

Robertson, P.K., 1990, “Soil Classification Using the Cone Penetration Test”, Canadian Geotechnical Journal, Volume 27: 151-158.

Robertson, P.K., 2009, “Interpretation of cone penetration tests – a unified approach”, Canadian Geotechnical Journal, Volume 46: 1337-1355.

Passive gamma testing is performed in conjunction with piezocone penetration testing (GCPTu) by the addition of a gamma module and gamma data acquisition system.

The gamma module detects naturally occurring gamma radiation from radioactive elements within a soil deposit.

Small amounts of gamma radiation are emitted by radioactive elements such as thorium, potassium and uranium. Generally, clayey soils emit greater amounts of natural gamma radiation due to the presence of potassium-40 (^{40}K). Thus, gamma logging can be used to indicate variations in clay content.

The gamma module is manufactured by ConeTec Investigations Ltd. of Richmond, BC, Canada. An illustration of the piezocone penetrometer and gamma module is presented in Figure GCPTu.

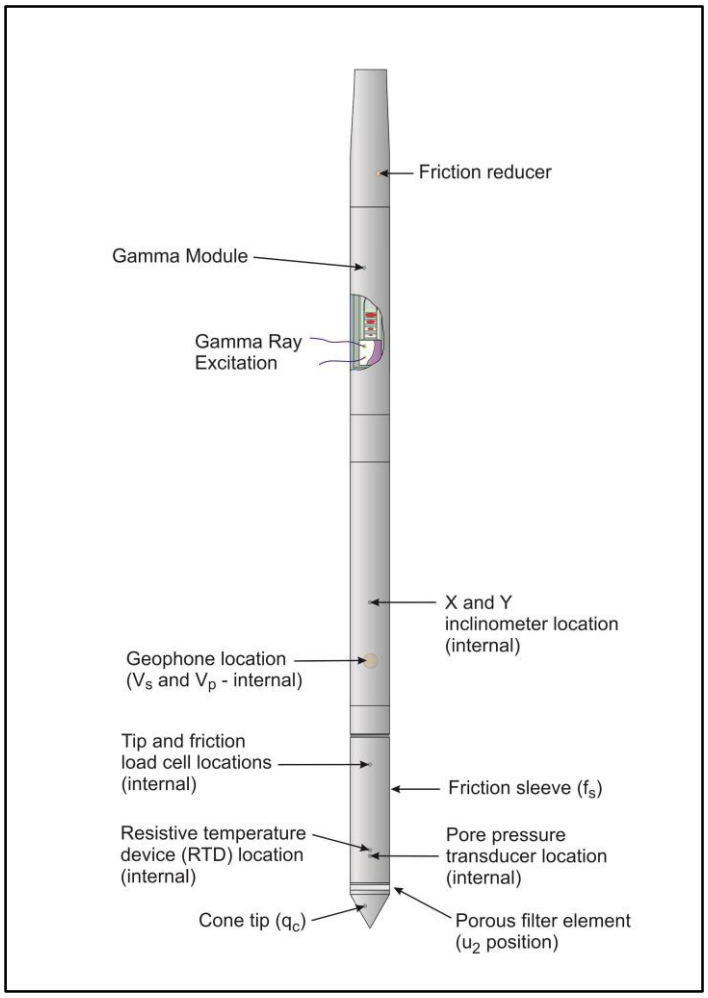


Figure GCPTu. Typical gamma module and piezocone penetrometer

Prior to the start of a GCPTu sounding, the procedures described in the cone penetration test section are followed, the gamma data acquisition system is initialized and the sounding parameters are entered. The gamma module is checked against calibration tubes to verify that the module is operating properly.
CPTu data is typically collected at 2.5 cm or 5.0 cm depth increments whereas the passive gamma data is collected every 10 cm in order to allow enough time to collect a representative number of counts. In

order to present the gamma data with the other CPT parameters, the gamma data is duplicated over the relevant depth increments in the data files.

Due to the vertical offset between the cone tip and the sensor location, gamma data is not available for the last 75 cm of each profile.

GCPTu plots are presented in the relevant appendix.

Shear wave velocity testing is performed in conjunction with the piezocone penetration test (SCPTu) in order to collect interval velocities. For some projects seismic compression wave (Vp) velocity is also determined.

ConeTec's piezocone penetrometers are manufactured with a horizontally active geophone (28 hertz) that is rigidly mounted in the body of the cone penetrometer, 0.2 meters behind the cone tip.

Shear waves are typically generated by using an impact hammer horizontally striking a beam that is held in place by a normal load. In some instances an auger source or an imbedded impulsive source maybe used for both shear waves and compression waves. The hammer and beam act as a contact trigger that triggers the recording of the seismic wave traces. For impulsive devices an accelerometer trigger may be used. The traces are recorded using an up-hole integrated digital oscilloscope which is part of the SCPTu data acquisition system. An illustration of the shear wave testing configuration is presented in Figure SCPTu-1.

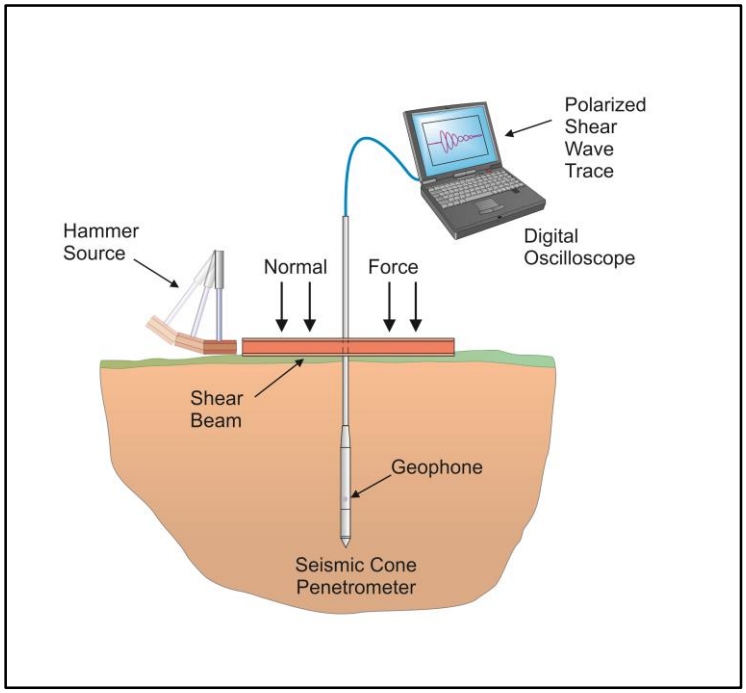


Figure SCPTu-1. Illustration of the SCPTu system

All testing is performed in accordance to ConeTec's SCPTu operating procedures.

Prior to the start of a SCPTu sounding, the procedures described in the Cone Penetration Test section are followed. In addition, the active axis of the geophone is aligned parallel to the beam (or source) and the horizontal offset between the cone and the source is measured and recorded.

Prior to recording seismic waves at each test depth, cone penetration is stopped and the rods are decoupled from the rig to avoid transmission of rig energy down the rods. Multiple wave traces are recorded for quality control purposes. After reviewing wave traces for consistency the cone is pushed to the next test depth (typically one meter intervals or as requested by the client). Figure SCPTu-2 presents an illustration of a SCPTu test.

For additional information on seismic cone penetration testing refer to Robertson et.al. (1986).

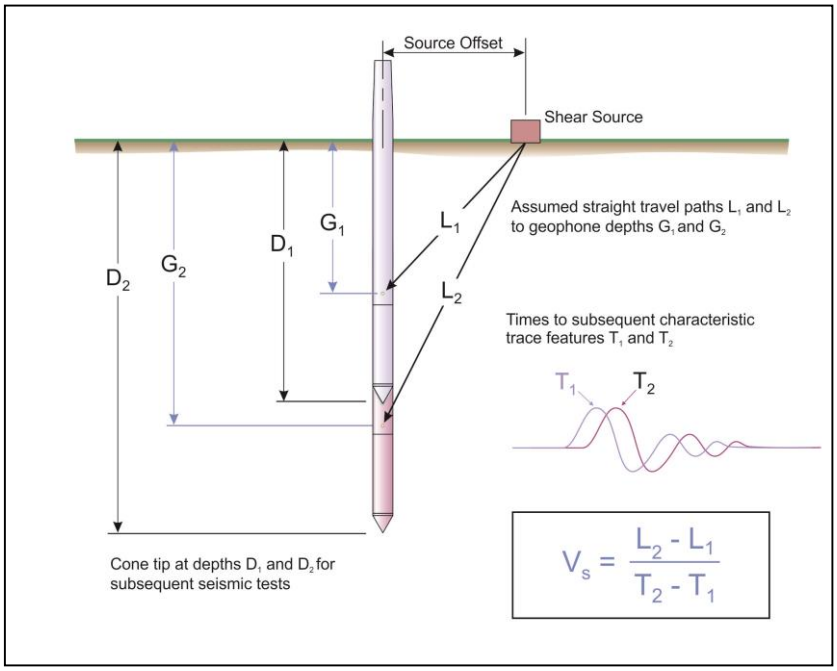


Figure SCPTu-2. Illustration of a seismic cone penetration test

Calculation of the interval velocities are performed by visually picking a common feature (e.g. the first characteristic peak, trough, or crossover) on all of the recorded wave sets and taking the difference in ray path divided by the time difference between subsequent features. Ray path is defined as the straight line distance from the seismic source to the geophone, accounting for beam offset, source depth and geophone offset from the cone tip.

The average shear wave velocity to a depth of 30 meters (V_{s30}) has been calculated and provided for all applicable soundings using an equation presented in Crow et al., 2012.

$$V_{s30} = \frac{total\ thickness\ of\ all\ layers\ (30m)}{\sum(layer\ traveltimes)}$$

The layer travel times refers to the travel times propagating in the vertical direction, not the measured travel times from an offset source.

Tabular results and SCPTu plots are presented in the relevant appendix.

References

Crow, H.L., Hunter, J.A., Bobrowsky, P.T., 2012, "National shear wave measurement guidelines for Canadian seismic site assessment", GeoManitoba 2012, Sept 30 to Oct 2, Winnipeg, Manitoba.

Robertson, P.K., Campanella, R.G., Gillespie D and Rice, A., 1986, "Seismic CPT to Measure In-Situ Shear Wave Velocity", Journal of Geotechnical Engineering ASCE, Vol. 112, No. 8: 791-803.

Full flow penetration testing (BCPTu) is performed in conjunction with a piezocone penetration test using an integrated electronic piezocone with a spherical attachment and a data acquisition system manufactured by Adara Systems Ltd. of Richmond, British Columbia, Canada.

ConeTec's piezocone penetrometers are compression type designs in which the tip and friction sleeve load cells are independent and have separate load capacities. The piezocones use strain gauged load cells for tip and sleeve friction and a strain gauged diaphragm type transducer for recording pore pressure. The piezocones also have a platinum resistive temperature device (RTD) for monitoring the temperature of the sensors, an accelerometer type dual axis inclinometer and a geophone sensor for recording seismic signals. All signals are amplified down hole within the cone body and the analog signals are sent to the surface through a shielded cable.

ConeTec penetrometers are manufactured with various tip, friction and pore pressure capacities in 5 cm^2, 10 cm^2 and 15 cm^2 tip base area configurations in order to maximize signal resolution for various soil conditions. The 15 cm^2 penetrometers do not require friction reducers as they have a diameter larger than the deployment rods. The 5 cm^2 and 10 cm^2 piezocones use a friction reducer consisting of a rod adapter extension behind the main cone body with an enlarged cross sectional area (typically 44 mm diameter over a length of 32 mm with tapered leading and trailing edges) located at a distance of 585 mm above the cone tip.

The penetrometers are designed with equal end area friction sleeves, a net end area ratio of 0.8 and cone tips with a 60 degree apex angle.

The piezocone penetrometers are manufactured with dimensions, tolerances and sensor characteristics that are in general accordance with the current ASTM D5778 standard. ConeTec's calibration criteria also meet or exceed those of the current ASTM D5778 standard.

For ball full flow penetration tests, the cone tip is replaced with a spherical attachment that can have projected plan areas of 40 cm^2, 60 cm^2, 100 cm^2 or 150 cm^2. The selection of the size is based on soil strength and deployment limitations. An illustration of the piezocone with a spherical attachment is presented in Figure BCPTu.

The specific piezocone and ball area used for each test is described in the ball full flow penetration test summary presented in the relevant appendix.

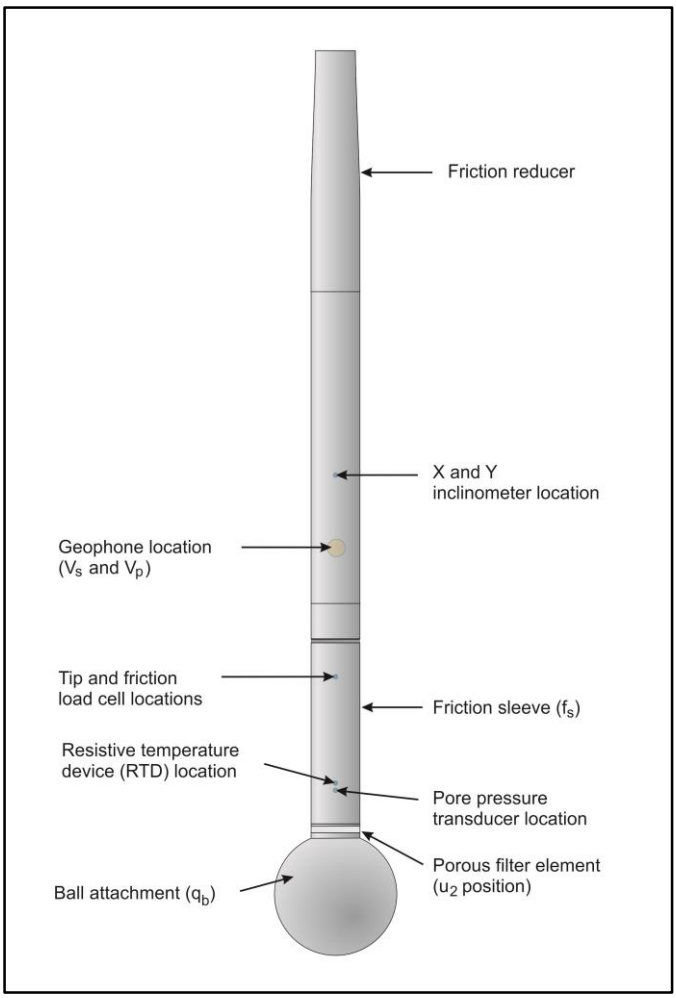


Figure BCPTu. Piezocone penetrometer with a spherical attachment

The ConeTec data acquisition systems consist of a Windows based computer and a signal conditioner and power supply interface box with a 16 bit (or greater) analog to digital (A/D) converter. The data is recorded in fixed depth increments using a depth wheel attached to the push cylinders or by using a spring loaded rubber depth wheel that is held against the cone rods. The typical recording intervals are either 2.5 cm or 5.0 cm depending on project requirements; custom recording intervals are possible.

The system displays the data in real time and records the following parameters to a storage media during penetration:

- Depth
- Uncorrected ball tip resistance (q_b)
- Sleeve friction (f_s)
- Dynamic pore pressure (u) at the shoulder (u_2) or at the equator of the ball
- Additional sensors such as resistivity, passive gamma, ultra violet induced fluorescence, if applicable

Prior to the start of a BCPTu sounding a suitable cone and spherical attachment are selected, the cone and data acquisition system are powered on, the pore pressure system is saturated with either glycerine or silicone oil and the baseline readings are recorded with the ball hanging freely in a vertical position.

The BCPTu is conducted at a steady rate of 2 cm/s, within acceptable tolerances. Typically one meter length rods with an outer diameter of 1.5 inches are added to advance the ball to the sounding termination depth. The test may be interrupted at selected depths to cycle the probe up and down in order to achieve a completely remolded soil state. Cycling is typically conducted during retraction of the ball and the number of conducted cycles is dependent on reaching a consistent tip value. After ball retraction the final baselines are recorded.

The full flow penetration test can be halted at specific depths to carry out pore pressure dissipation (PPD) tests. For each dissipation test the data acquisition system measures and records the variation of the pore pressure (u) with time (t). Pore pressure dissipation data can be interpreted to provide estimates of equilibrium pore pressures (u_{eq}).

Additional information pertaining to ConeTec's full flow penetration testing procedures:

- Each filter is saturated in silicone oil or glycerine under vacuum pressure prior to use
- Recorded baselines are checked with an independent multi-meter
- Baseline readings are compared to previous readings verifying compliance with ASTM standards
- Soundings are terminated at the client's target depth or at a depth where an obstruction is encountered, excessive rod flex occurs or excessive inclination occurs, equipment damage is likely to take place or a dangerous working environment arises
- Differences between initial and final baselines are calculated to ensure zero load offsets have not occurred and to ensure compliance with ASTM standards

Full flow penetration tests are conducted to assess the undrained shear strength (Su) of low to medium strength soils. During penetration, the soil flows around the penetrometer significantly reducing the influence of overburden stress as compared to the cone penetration test (CPTu). For the test to be valid, the soil must flow around the penetrometer. Cycling is conducted in order to achieve a completely remolded soil state to provide an indication of sensitivity in soft soils.

The recorded ball tip resistance (q_b) is the total force acting on the piezocone spherical attachment divided by its base area. The ball tip resistance is corrected for pore pressure effects and termed corrected ball tip resistance (q_{bt}) according to the following expression:

$$q_{bt} = q_b + [(1 - a)u_2]\frac{A_s}{A_p}$$

where: q_{bt} is the corrected ball tip resistance
q_b is the recorded ball tip resistance
u_2 is the recorded dynamic pore pressure behind the tip (u_2 position)
a is the Net Area Ratio for the piezocone (0.8 for ConeTec probes)
A_s is the shaft area
A_p is the ball plan area

The undrained shear strength (Su) derived from the full flow penetration test is related to the net penetration resistance (q_{net}) using the following relationship:

$$Su = \frac{q_{net}}{N_{ball}}$$

Due to different geometry and the subdued sleeve and pore pressure response, full flow penetration test results are not used for the interpretation of other geotechnical parameters or for soil classification.

A summary of the BCPTu soundings along with test details and individual plots are provided in the appendices. Tabular results generated for each sounding are provided in Excel format in the data release folder. Information regarding the interpretation methods is also included in the data release folder.

For additional information on full flow penetrometer testing, refer to Weemees et al. (2006).

References

ASTM D5778-12, 2012, "Standard Test Method for Performing Electronic Friction Cone and Piezocone Penetration Testing of Soils", ASTM, West Conshohocken, US.

Weemees, I., Howie, J., Woeller, D.J., Sharp, J.T., Cargill, E., Greig, J., 2006, “Improved Techniques for the In-Situ Determination of Undrained Shear Strength in Soft Clays,” Sea to Sky Geotechnics, Proceedings of the 59th Canadian Geotechnical Conference, Vancouver, B.C., 1–4 October. BiTech Publishers Ltd., Richmond, B.C. pp. 89–95.

The cone penetration test is halted at specific depths to carry out pore pressure dissipation (PPD) tests, shown in Figure PPD-1. For each dissipation test the cone and rods are decoupled from the rig and the data acquisition system measures and records the variation of the pore pressure (u) with time (t).

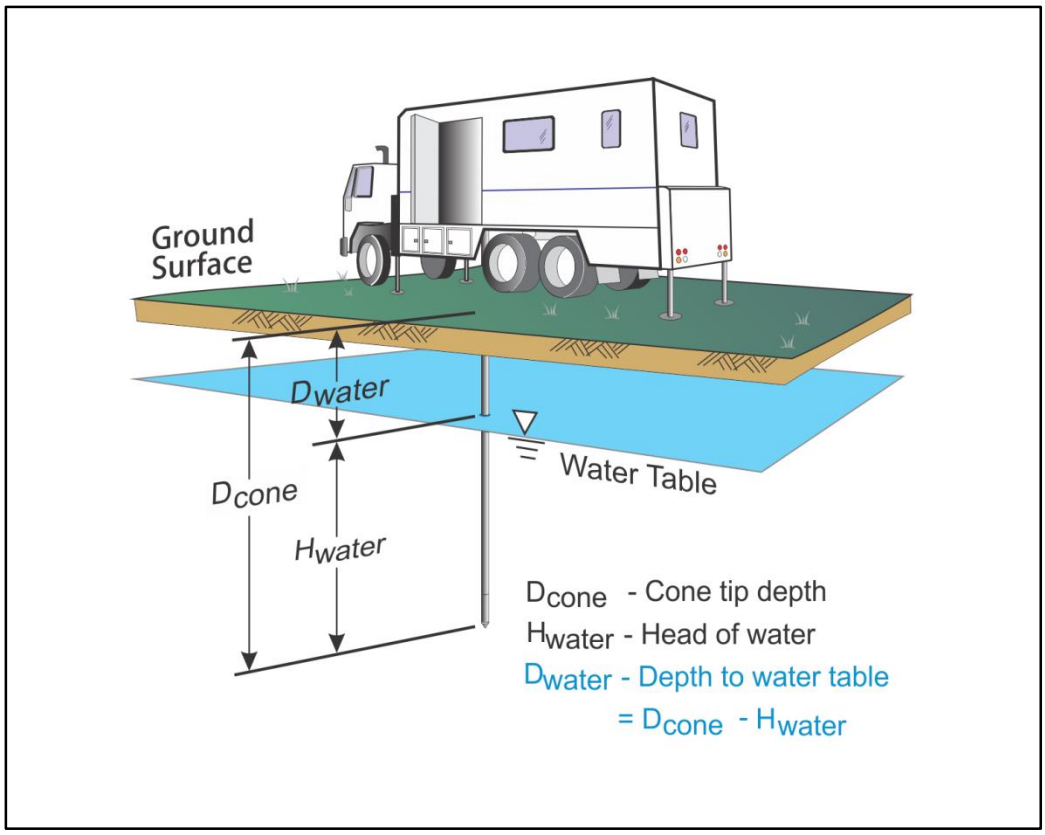


Figure PPD-1. Pore pressure dissipation test setup

Pore pressure dissipation data can be interpreted to provide estimates of ground water conditions, permeability, consolidation characteristics and soil behaviour.

The typical shapes of dissipation curves shown in Figure PPD-2 are very useful in assessing soil type, drainage, in situ pore pressure and soil properties. A flat curve that stabilizes quickly is typical of a freely draining sand. Undrained soils such as clays will typically show positive excess pore pressure and have long dissipation times. Dilative soils will often exhibit dynamic pore pressures below equilibrium that then rise over time. Overconsolidated fine-grained soils will often exhibit an initial dilatory response where there is an initial rise in pore pressure before reaching a peak and dissipating.

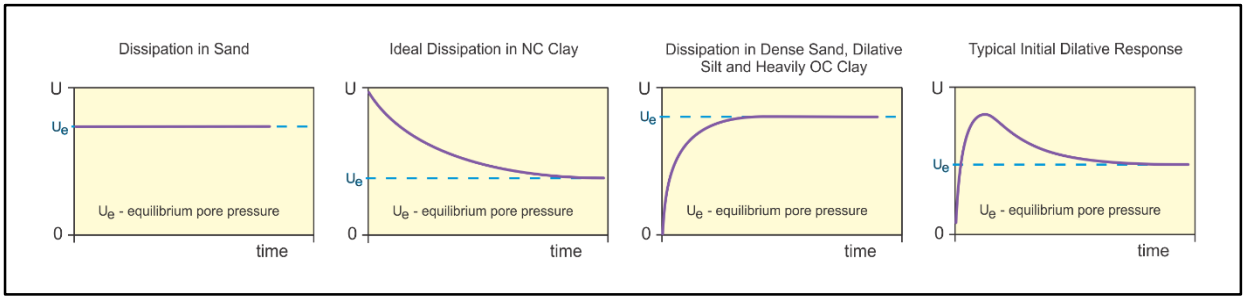


Figure PPD-2. Pore pressure dissipation curve examples

In order to interpret the equilibrium pore pressure (u_{eq}) and the apparent phreatic surface, the pore pressure should be monitored until such time as there is no variation in pore pressure with time as shown for each curve of Figure PPD-2.

In fine grained deposits the point at which 100% of the excess pore pressure has dissipated is known as t_{100}. In some cases this can take an excessive amount of time and it may be impractical to take the dissipation to t_{100}. A theoretical analysis of pore pressure dissipations by Teh and Houlsby (1991) showed that a single curve relating degree of dissipation versus theoretical time factor (T*) may be used to calculate the coefficient of consolidation (c_h) at various degrees of dissipation resulting in the expression for c_h shown below.

$$c_h = \frac{T^* \cdot a^2 \cdot \sqrt{I_r}}{t}$$

Where:

T* is the dimensionless time factor (Table Time Factor)
a is the radius of the cone
I_r is the rigidity index
t is the time at the degree of consolidation

Table Time Factor. T* versus degree of dissipation (Teh and Houlsby, 1991)

Degree of Dissipation (%)	20	30	40	50	60	70	80
T* (u_2)	0.038	0.078	0.142	0.245	0.439	0.804	1.60

The coefficient of consolidation is typically analyzed using the time (t_{50}) corresponding to a degree of dissipation of 50% (u_{50}). In order to determine t_{50}, dissipation tests must be taken to a pressure less than u_{50}. The u_{50} value is half way between the initial maximum pore pressure and the equilibrium pore pressure value, known as u_{100}. To estimate u_{50}, both the initial maximum pore pressure and u_{100} must be known or estimated. Other degrees of dissipations may be considered, particularly for extremely long dissipations.

At any specific degree of dissipation the equilibrium pore pressure (u at t_{100}) must be estimated at the depth of interest. The equilibrium value may be determined from one or more sources such as measuring the value directly (u_{100}), estimating it from other dissipations in the same profile, estimating the phreatic surface and assuming hydrostatic conditions, from nearby soundings, from client provided information, from site observations and/or past experience, or from other site instrumentation.

For calculations of c_h (Teh and Houlsby, 1991), t_{50} values are estimated from the corresponding pore pressure dissipation curve and a rigidity index (I_r) is assumed. For curves having an initial dilatory response in which an initial rise in pore pressure occurs before reaching a peak, the relative time from the peak value is used in determining t_{50}. In cases where the time to peak is excessive, t_{50} values are not calculated.

Due to possible inherent uncertainties in estimating I_r, the equilibrium pore pressure and the effect of an initial dilatory response on calculating t_{50}, other methods should be applied to confirm the results for c_h.

Additional published methods for estimating the coefficient of consolidation from a piezocone test are described in Burns and Mayne (1998, 2002), Jones and Van Zyl (1981), Robertson et al. (1992) and Sully et al. (1999).

A summary of the pore pressure dissipation tests and dissipation plots are presented in the relevant appendix.

References

Burns, S.E. and Mayne, P.W., 1998, "Monotonic and dilatory pore pressure decay during piezocone tests", Canadian Geotechnical Journal 26 (4): 1063-1073.

Burns, S.E. and Mayne, P.W., 2002, "Analytical cavity expansion-critical state model cone dissipation in fine-grained soils", Soils & Foundations, Vol. 42(2): 131-137.

Jones, G.A. and Van Zyl, D.J.A., 1981, "The piezometer probe: a useful investigation tool", Proceedings, 10th International Conference on Soil Mechanics and Foundation Engineering, Vol. 3, Stockholm: 489-495.

Robertson, P.K., Sully, J.P., Woeller, D.J., Lunne, T., Powell, J.J.M. and Gillespie, D.G., 1992, "Estimating coefficient of consolidation from piezocone tests", Canadian Geotechnical Journal, 29(4): 551-557.

Sully, J.P., Robertson, P.K., Campanella, R.G. and Woeller, D.J., 1999, "An approach to evaluation of field CPTU dissipation data in overconsolidated fine-grained soils", Canadian Geotechnical Journal, 36(2): 369-381.

Teh, C.I., and Houlsby, G.T., 1991, "An analytical study of the cone penetration test in clay", Geotechnique, 41(1): 17-34.

Sonic sampling is conducted using a sonic piston sampler and a drill rig that has been fitted with a sonic drill head.

The stainless steel sampler is designed to collect a 50 mm diameter sample in one or two meter lengths. The sampler has a free piston that moves up and down the barrel, which is kept in place by a column of water.

The sonic drill head uses mechanically induced vibration that is transferred directly to the drill rods and sampler. The vibrations induce a layer of liquefaction surrounding the rods which reduces both rod friction and tip resistance.

Prior to deployment, the chamber in the barrel is filled with water moving the piston through the barrel to the leading edge of the sampler. The water valve is locked, ensuring that the piston remains at the leading edge and no soil is collected prematurely.

The sonic drill head is used to advance the sampler into the ground from the surface or through a cased hole, using two meter length drill rods. Once the desired depth is reached, the valve holding the water in the barrel is unlocked and the drill string is vibrated down to the final depth, collecting a sample as the water behind the piston flows into the inner rods. The sonic head is disconnected and the water valve is closed, causing passive suction to hold the sample in the barrel.

The drill string and sampler are pulled out of the ground and the sample is extracted. The sampler is then prepared and redeployed into the ground to the next desired sample depth and the procedures are repeated.

A representative photograph is taken of each sample, including a label with the location name, sample depth range, date and sample number. The samples are placed or sectioned into sample pails or bottles following the project's specific sampling requirements and logged in an Excel spreadsheet. The sample log provides information pertaining to the sample location, as well as each sample that was collected.

The sample logs are presented in the relevant appendix and the sample photos are provided in the data release folder.

The appendices listed below are included in the report:

- Cone Penetration Test Summary and Standard Plots
- Passive Gamma Cone Penetration Test Plots
- Advanced Cone Penetration Test Plots with S_u (N_{kt})
- Seismic Cone Penetration Test Plots
- Seismic Cone Penetration Test Results
- Pore Pressure Dissipation (CPTu) Summary and Pore Pressure Dissipation Plots
- Ball Full Flow Penetration Test Summary and Undrained Strength with Gamma Plots
- Pore Pressure Dissipation (BCPTu) Summary and Pore Pressure Dissipation Plots
- Sample Summary and Sample Logs

Cone Penetration Test Summary and Standard Plots

CONETEC

Job No: 16-02014
Client: CH2M Hill Canada Ltd.
Project: Faro Mine Complex
Start Date: 06-Mar-2016
End Date: 16-Mar-2016

CONE PENETRATION TEST SUMMARY

Sounding ID	File Name	Date	Cone	Assumed Phreatic Surface[1] (m)	Depth to Mudline (m)	Final Depth[2] (m)	Northing[3] (m)	Easting (m)	Elevation (m)[4]	Refer to Notation Number
CH16-201-CP014	16-02014_GS014	15-Mar-16	317:T375F10U200	-3.2	3.20	18.950	6914053.79	580670.30	1046.63	
CH16-201-CP015	16-02014_GS015	16-Mar-16	317:T375F10U200	-6.7	6.70	16.400	6914144.44	580594.24	1046.61	
CH16-201-CP016	16-02014_GS016	15-Mar-16	317:T375F10U200	-7.9	7.85	18.950	6913921.32	580410.85	1046.62	
CH16-201-CP017	16-02014_GS017	14-Mar-16	317:T375F10U200	-5.3	5.25	20.675	6913870.65	580528.32	1046.64	
CH16-201-CP018	16-02014_GS018	13-Mar-16	317:T375F10U200	-5.1	5.10	14.075	6914262.66	580678.76	1046.59	
CH16-201-CP019	16-02014_GS019	16-Mar-16	317:T375F10U200	-7.8	7.80	14.625	6914022.78	580483.02	1046.61	
CH16-201-CP022	16-02014_GS022	07-Mar-16	317:T375F10U200	-6.2	6.20	4.025	6914145.57	580247.33	1029.95	5
CH16-201-CP025	16-02014_GS025	06-Mar-16	317:T375F10U200	-12.1	12.10	0.750	6914430.77	580201.00	1030.02	5

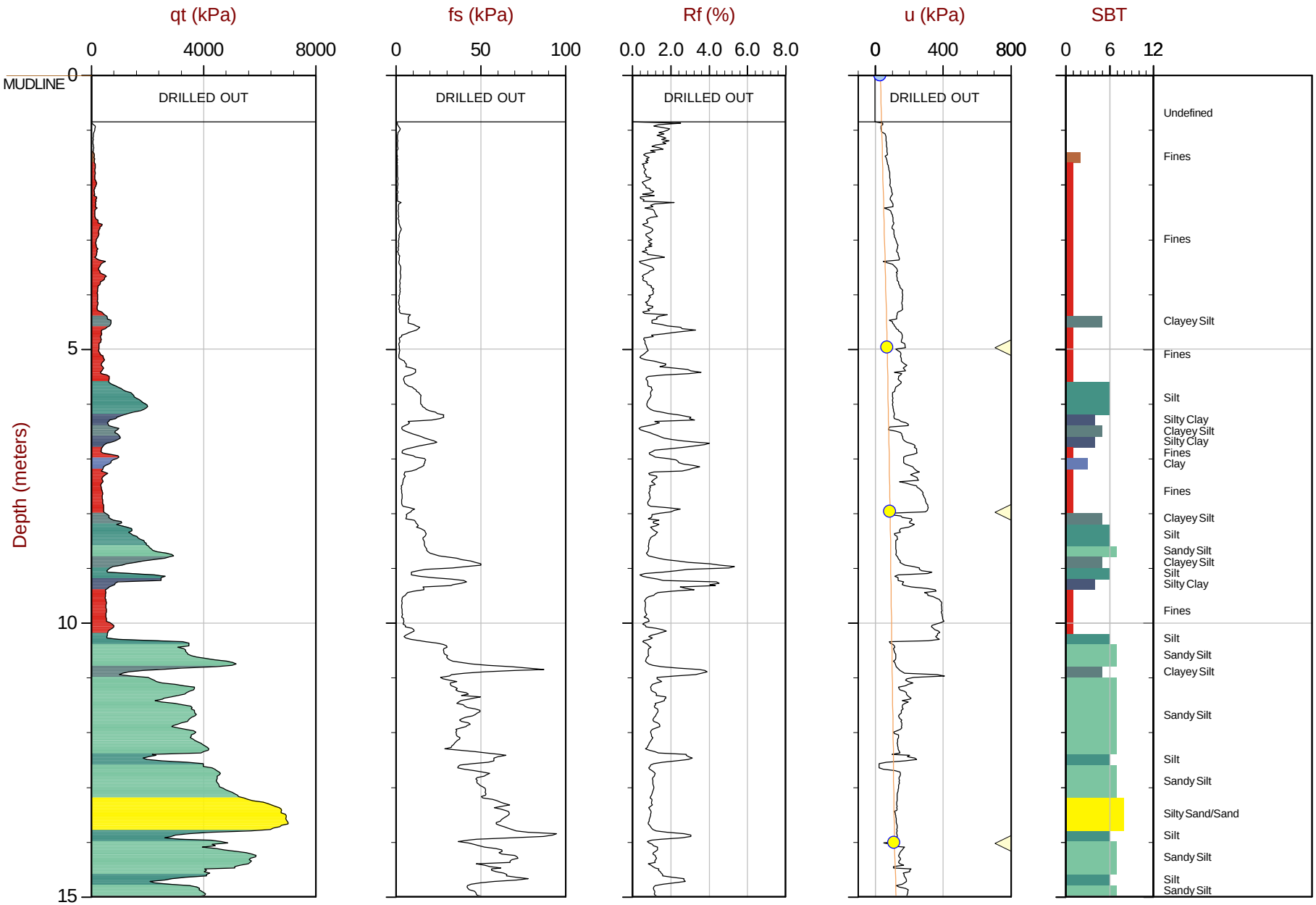
1. The assumed phreatic surface is based on the water depth above the mudline. Equilibrium pore pressure profiles were used for the interpretation tables unless otherwise noted.
2. Depths were referenced to the existing mudline at the time of testing.
3. Coordinates and elevations were surveyed using Trimble RTK system with datum: WGS84/UTM Zone 8 North.
4. Elevations are referenced to the exisiting ice surface at the time of testing.
5. Hydrostatic conditions were assumed for the interpretation tables.

CONETEC

CH2M

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Site: Faro IP

Sounding: CH16-201-CP014
Cone: 317:T375F10U200



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Avg Int: 0.200 m
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Unit Wt: SBT Zones

SBT: Robertson and Campanella, 1986
Coords: UTM Zone 8 N: 6914053.79m E: 580670.30m Elev: 1046.63m
Page No: 1 of 2

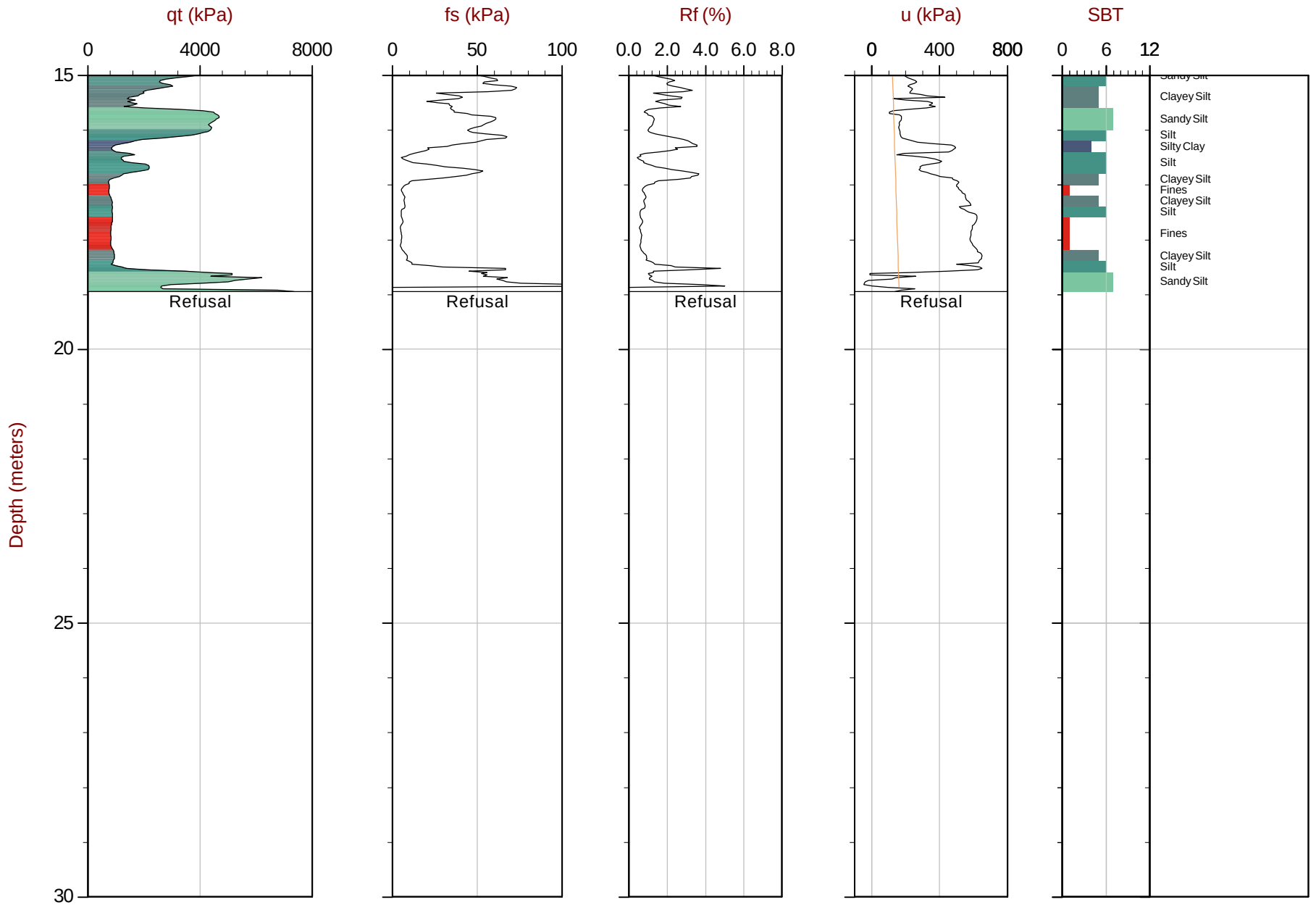
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Dissipation, equilibrium not achieved
Equilibrium Pore Pressure Line

CONETEC

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Site: Faro IP

Sounding: CH16-201-CP014
Cone: 317:T375F10U200



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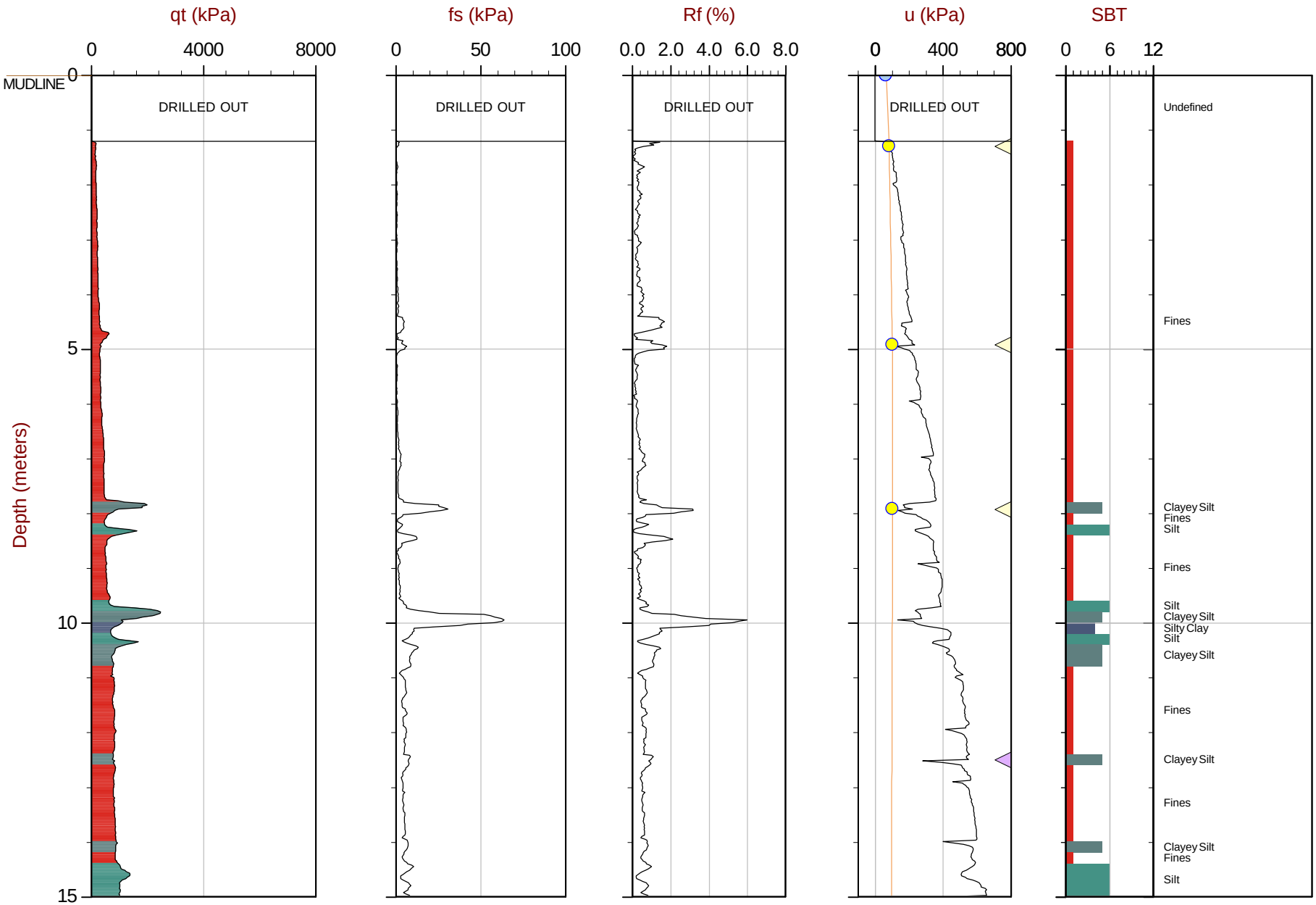
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Ueq
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Dissipation, equilibrium not achieved
Equilibrium Pore Pressure Line

CONETEC

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Site: Faro IP

Sounding: CH16-201-CP015
Cone: 317:T375F10U200



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SBT: Robertson and Campanella, 1986
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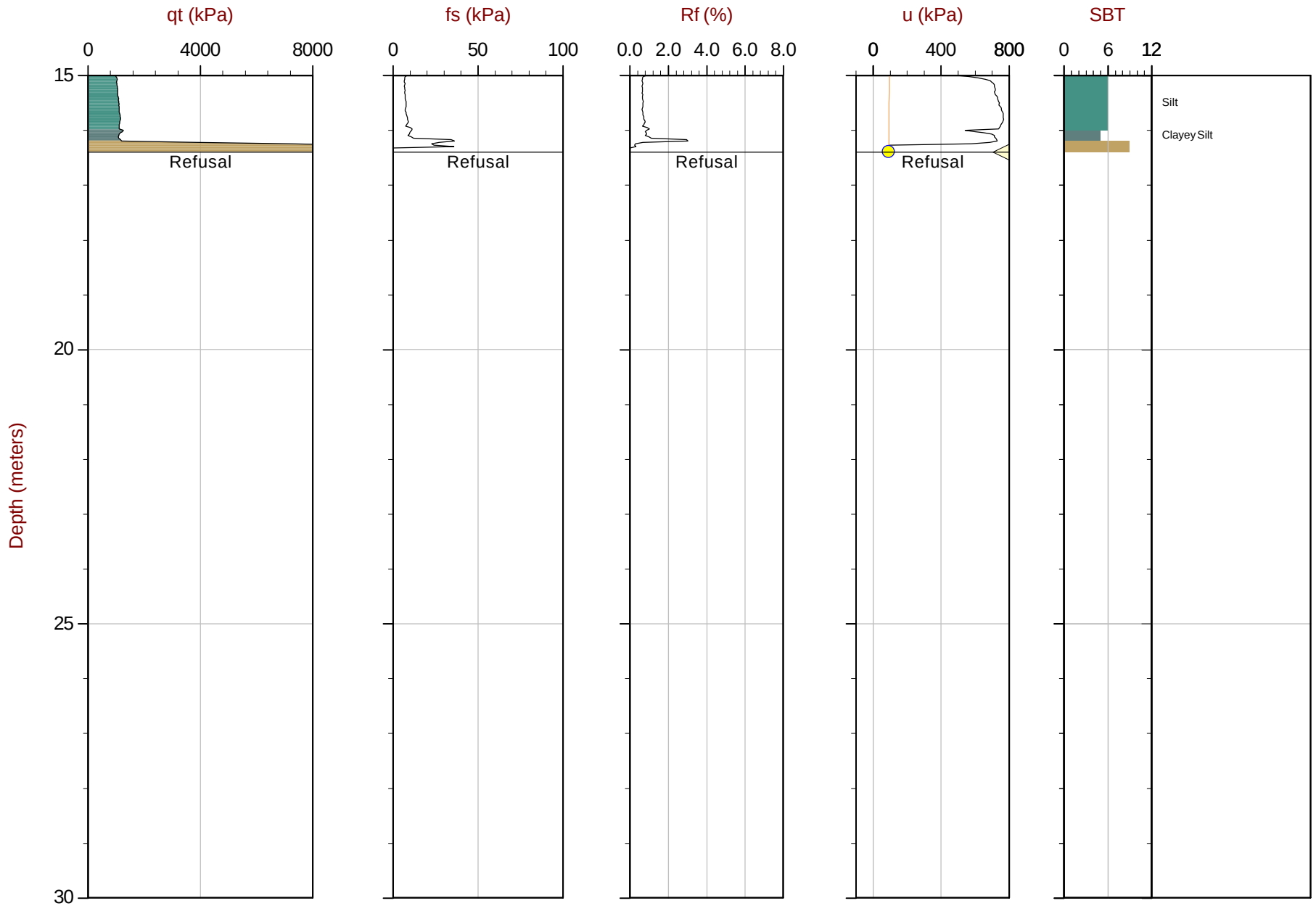
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Dissipation, equilibrium not achieved
Equilibrium Pore Pressure Line

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Site: Faro IP

Sounding: CH16-201-CP015
Cone: 317:T375F10U200



Max Depth: 16.400 m / 53.81 ft
Depth Inc: 0.025 m / 0.082 ft
Avg Int: 0.200 m
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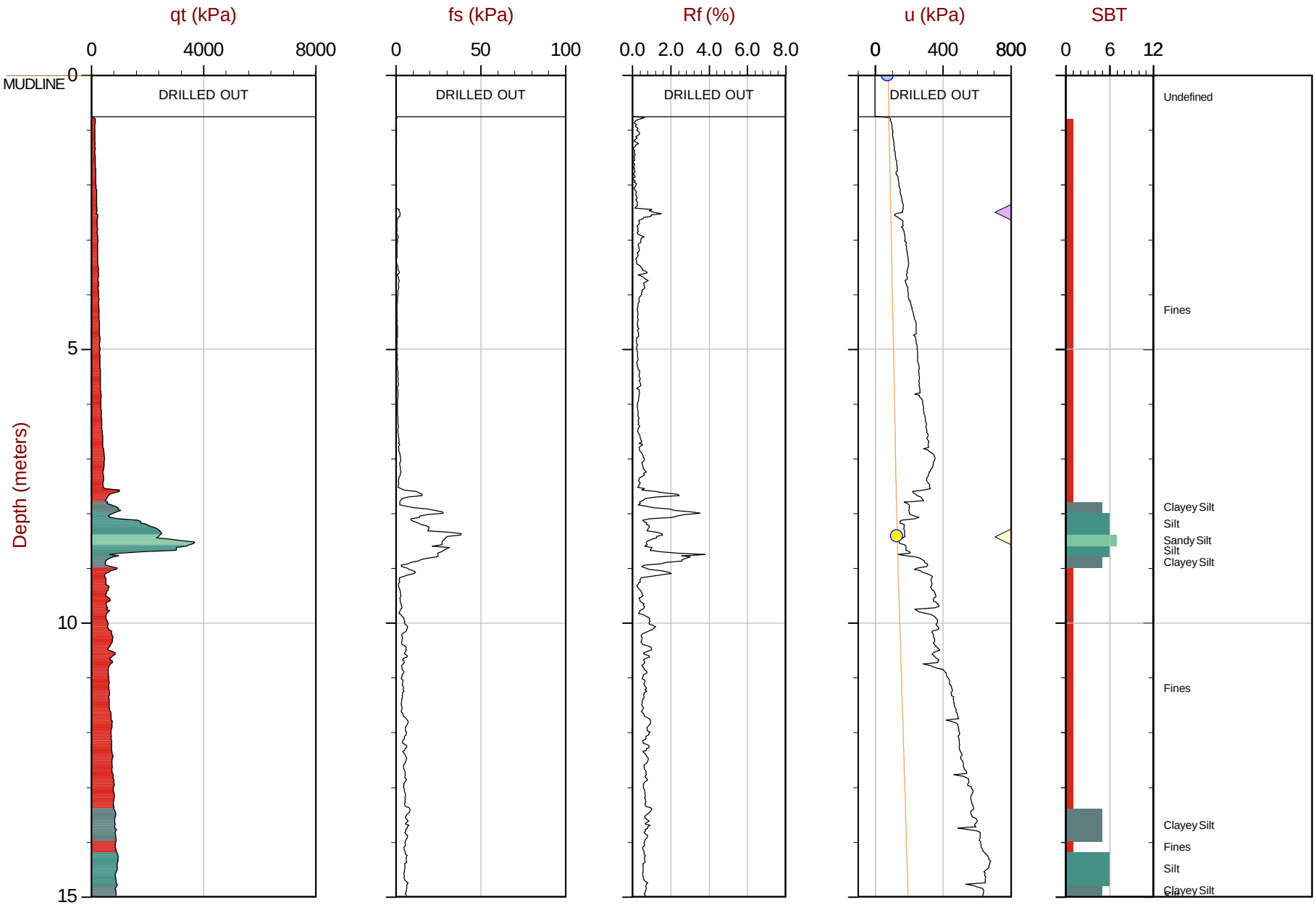
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Sounding: CH16-201-CP016
Cone: 317:T375F10U200



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SBT: Robertson and Campanella, 1986
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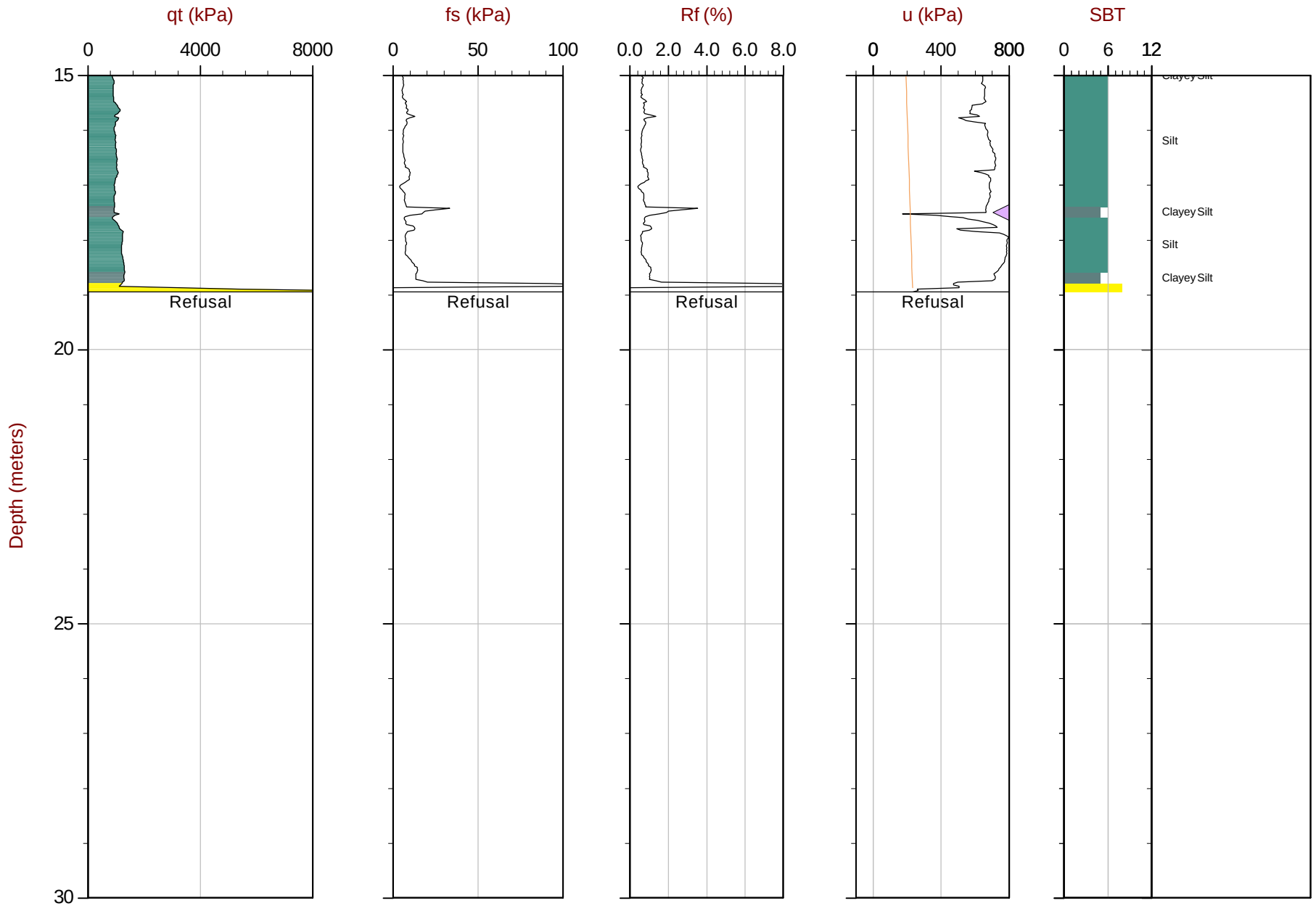
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Dissipation, equilibrium not achieved
Equilibrium Pore Pressure Line

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Site: Faro IP

Sounding: CH16-201-CP016
Cone: 317:T375F10U200



Max Depth: 18.950 m / 62.17 ft
Depth Inc: 0.025 m / 0.082 ft
Avg Int: 0.200 m
Overplot Item:

File: 16-02014_GS016.COR
Unit Wt: SBT Zones

SBT: Robertson and Campanella, 1986
Coords: UTM Zone 8 N: 6913921.32m E: 580410.84m Elev: 1046.62m
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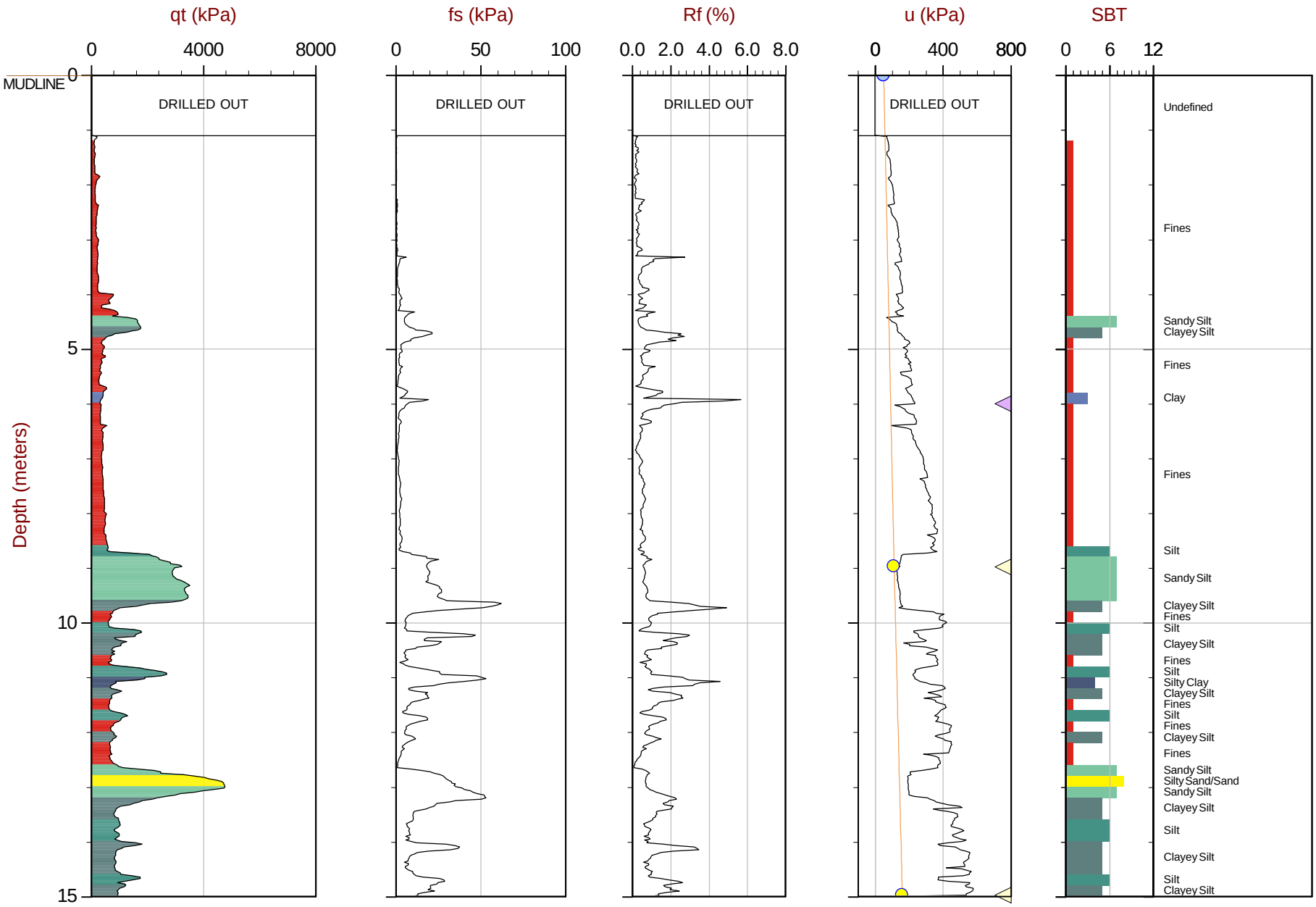
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Dissipation, equilibrium not achieved
Equilibrium Pore Pressure Line

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Job No: 16-02014
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Site: Faro IP

Sounding: CH16-201-CP017
Cone: 317:T375F10U200



Max Depth: 20.675 m / 67.83 ft
Depth Inc: 0.025 m / 0.082 ft
Avg Int: 0.200 m
Overplot Item:

File: 16-02014_GS017.COR
Unit Wt: SBT Zones

SBT: Robertson and Campanella, 1986
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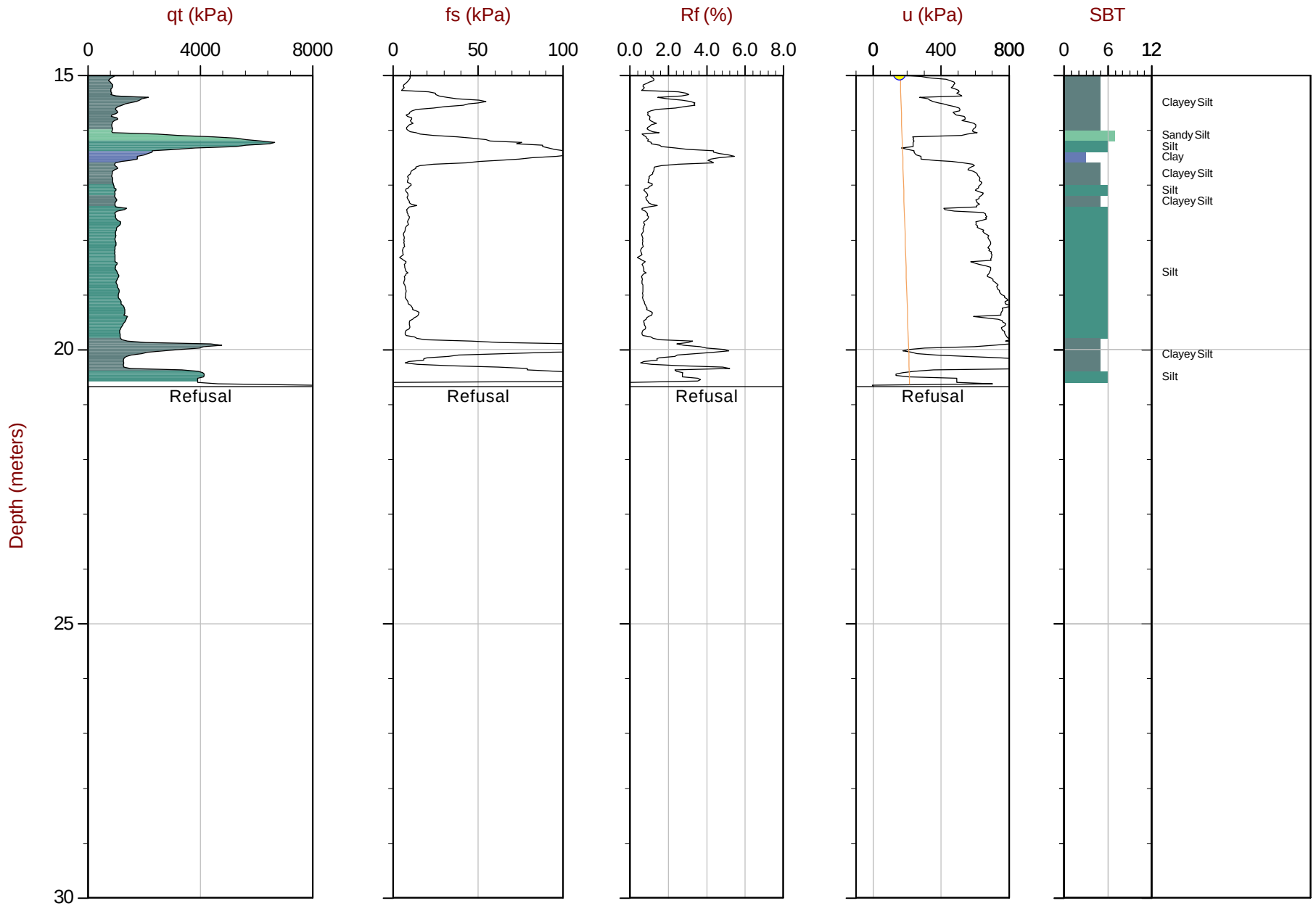
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Equilibrium Pore Pressure Line

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Site: Faro IP

Sounding: CH16-201-CP017
Cone: 317:T375F10U200



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Depth Inc: 0.025 m / 0.082 ft
Avg Int: 0.200 m
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Unit Wt: SBT Zones

SBT: Robertson and Campanella, 1986
Coords: UTM Zone 8 N: 6913870.65m E: 580528.32m Elev: 1046.64m
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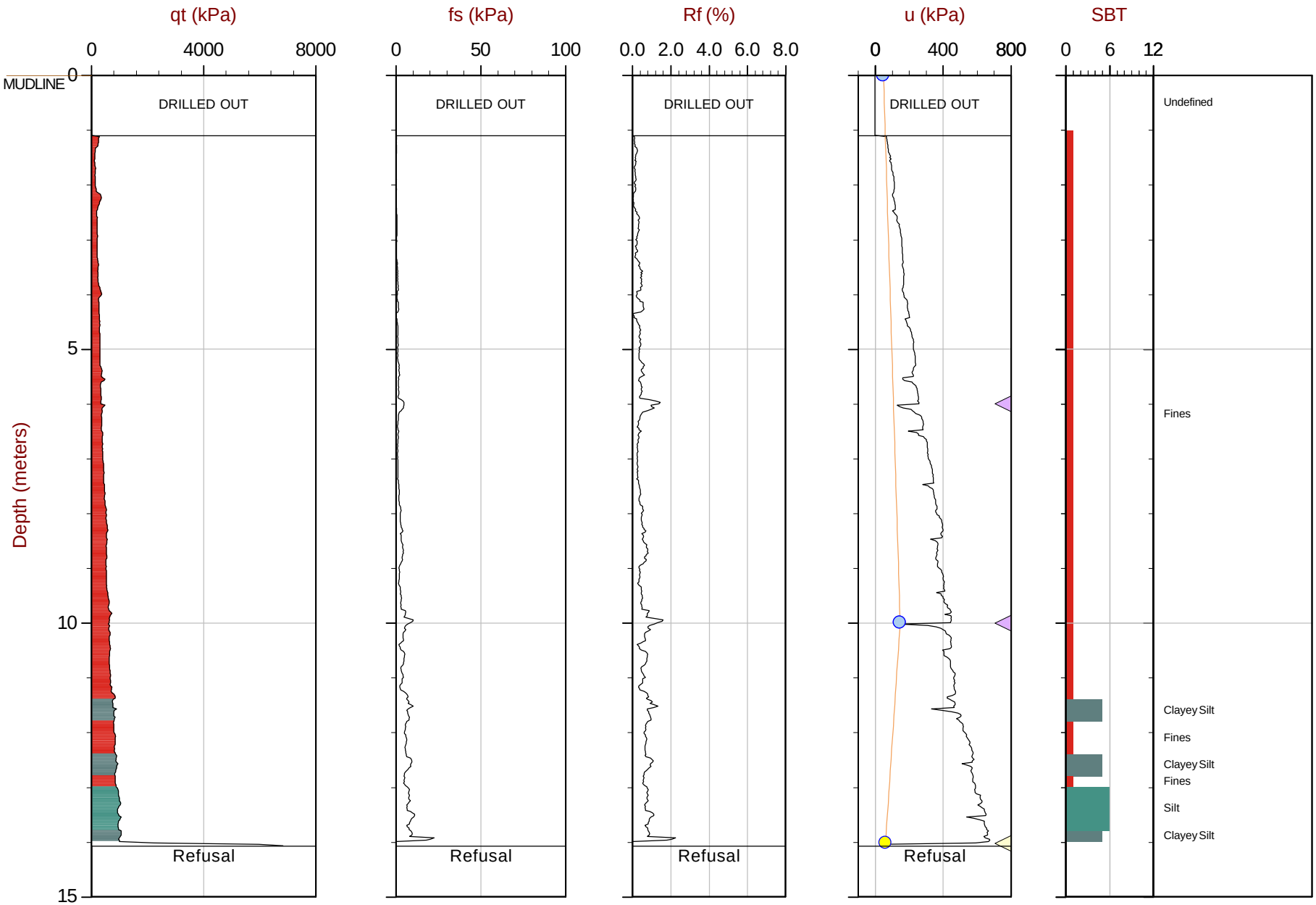
Assumed Ueq
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Dissipation, equilibrium not achieved
Equilibrium Pore Pressure Line

CONETEC

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Job No: 16-02014
Date: 03:13:16 13:10
Site: Faro IP

Sounding: CH16-201-CP018
Cone: 317:T375F10U200



Max Depth: 14.075 m / 46.18 ft
Depth Inc: 0.025 m / 0.082 ft
Avg Int: 0.200 m
Overplot Item:

File: 16-02014_GS018.COR
Unit Wt: SBT Zones

SBT: Robertson and Campanella, 1986
Coords: UTM Zone 8 N: 6914262.66m E: 580678.76m Elev: 1046.59m
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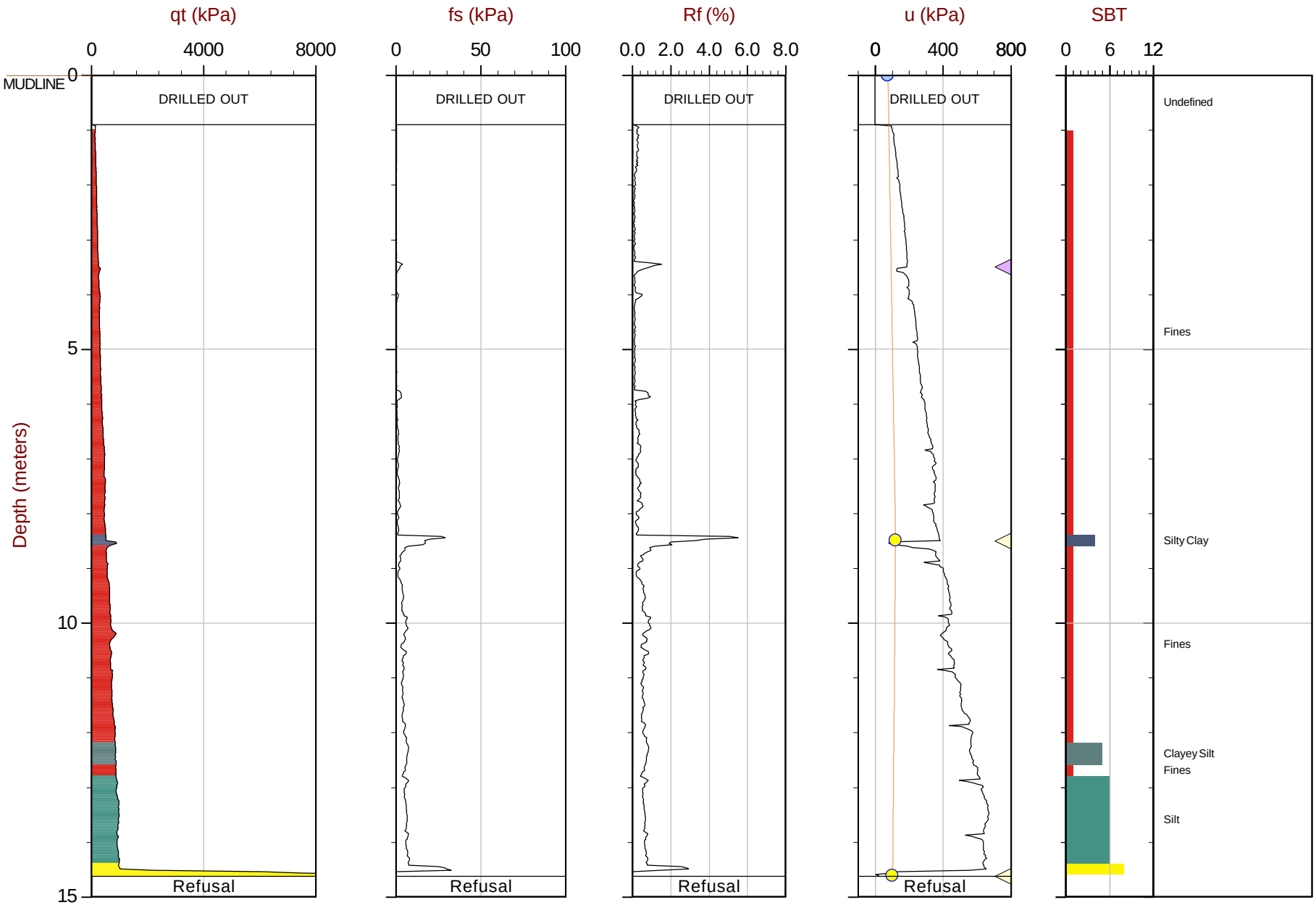
Assumed Ueq
Ueq
Dissipation, equilibrium achieved
Dissipation, equilibrium not achieved
Equilibrium Pore Pressure Line

CONETEC

CH2M

Job No: 16-02014
Date: 03:16:16 10:17
Site: Faro IP

Sounding: CH16-201-CP019
Cone: 317:T375F10U200



Max Depth: 14.625 m / 47.98 ft
Depth Inc: 0.025 m / 0.082 ft
Avg Int: 0.200 m
Overplot Item:

File: 16-02014_GS019.COR
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Page No: 1 of 1

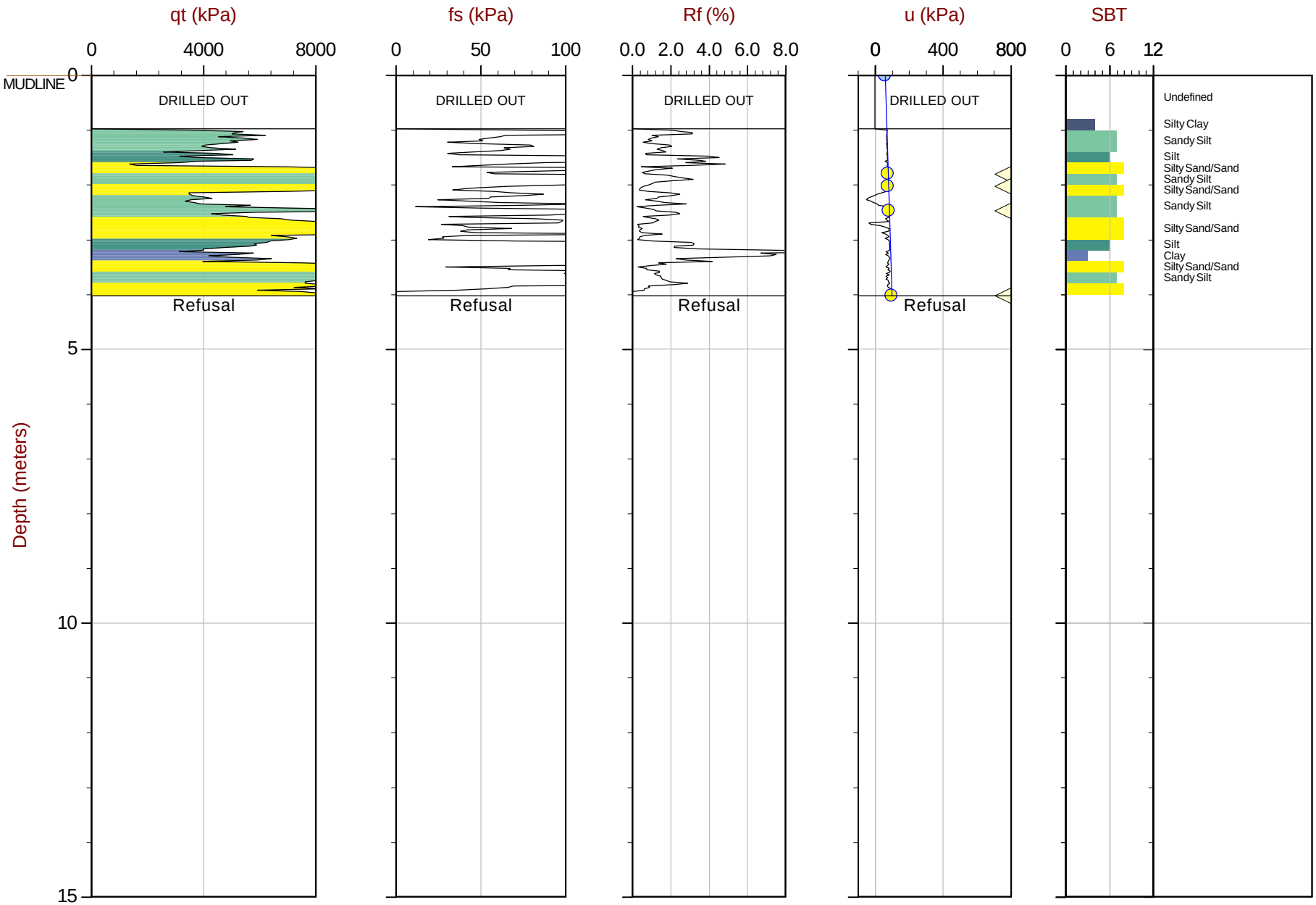
Assumed Ueq
Ueq
Dissipation, equilibrium achieved
Dissipation, equilibrium not achieved
Equilibrium Pore Pressure Line

CONETEC

CH2M

Job No: 16-02014
Date: 03:07:16 16:23
Site: Faro CVP

Sounding: CH16-201-CP022
Cone: 317:T375F10U200



Max Depth: 4.025 m / 13.21 ft
Depth Inc: 0.025 m / 0.082 ft
Avg Int: 0.200 m
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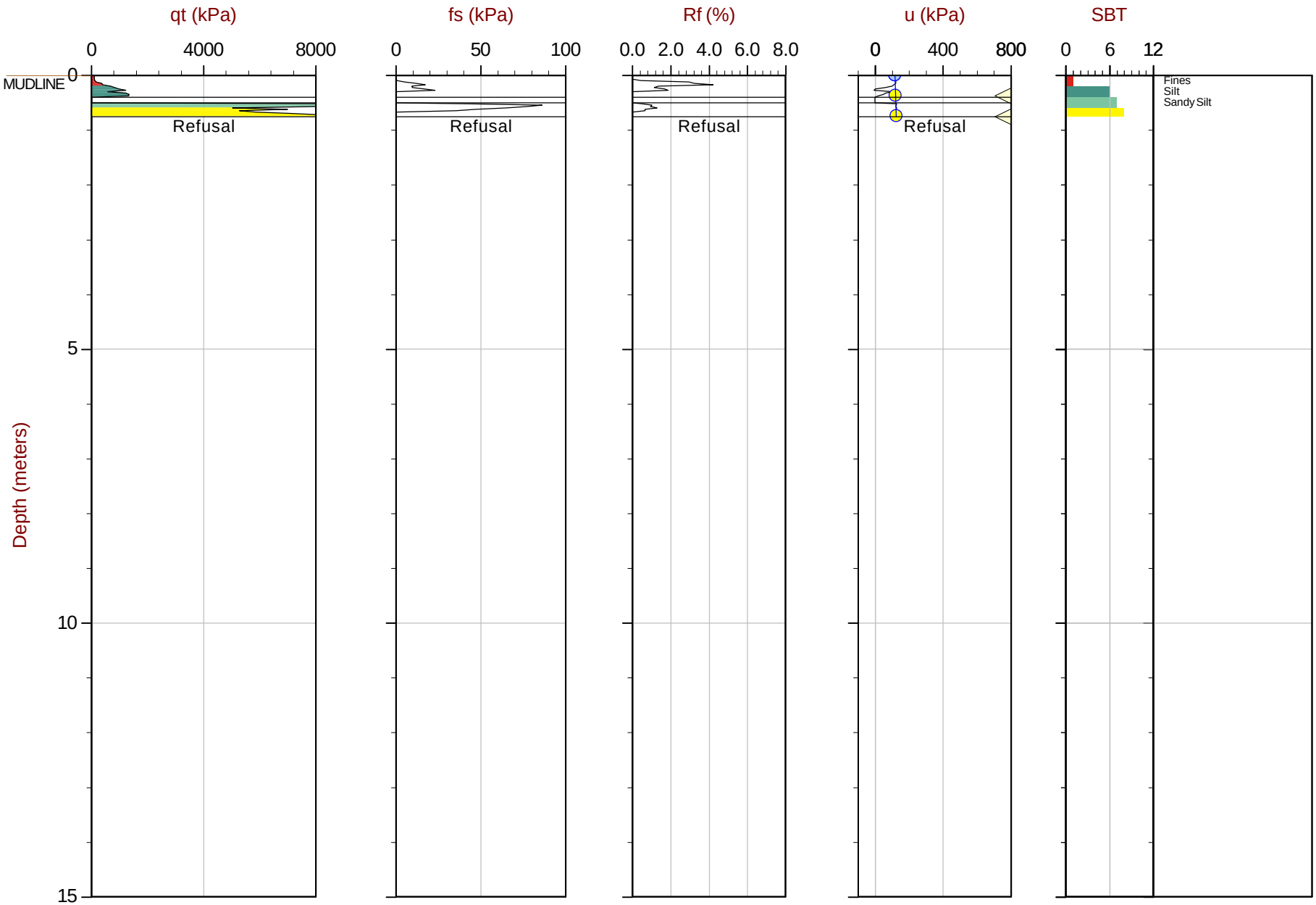
Assumed Ueq
Ueq
Dissipation, equilibrium achieved
Dissipation, equilibrium not achieved
Hydrostatic Line

CONETEC

CH2M

Job No: 16-02014
Date: 03:06:16 16:43
Site: Faro CVP

Sounding: CH16-201-CP025
Cone: 317:T375F10U200



Max Depth: 0.750 m / 2.46 ft
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Avg Int: 0.200 m
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File: 16-02014_GS025.COR
Unit Wt: SBT Zones

SBT: Robertson and Campanella, 1986
Coords: UTM Zone 8 N: 6914430.77m E: 580201.00m Elev: 1030.02m
Page No: 1 of 1

Assumed Ueq
Ueq
Dissipation, equilibrium achieved
Dissipation, equilibrium not achieved
Hydrostatic Line

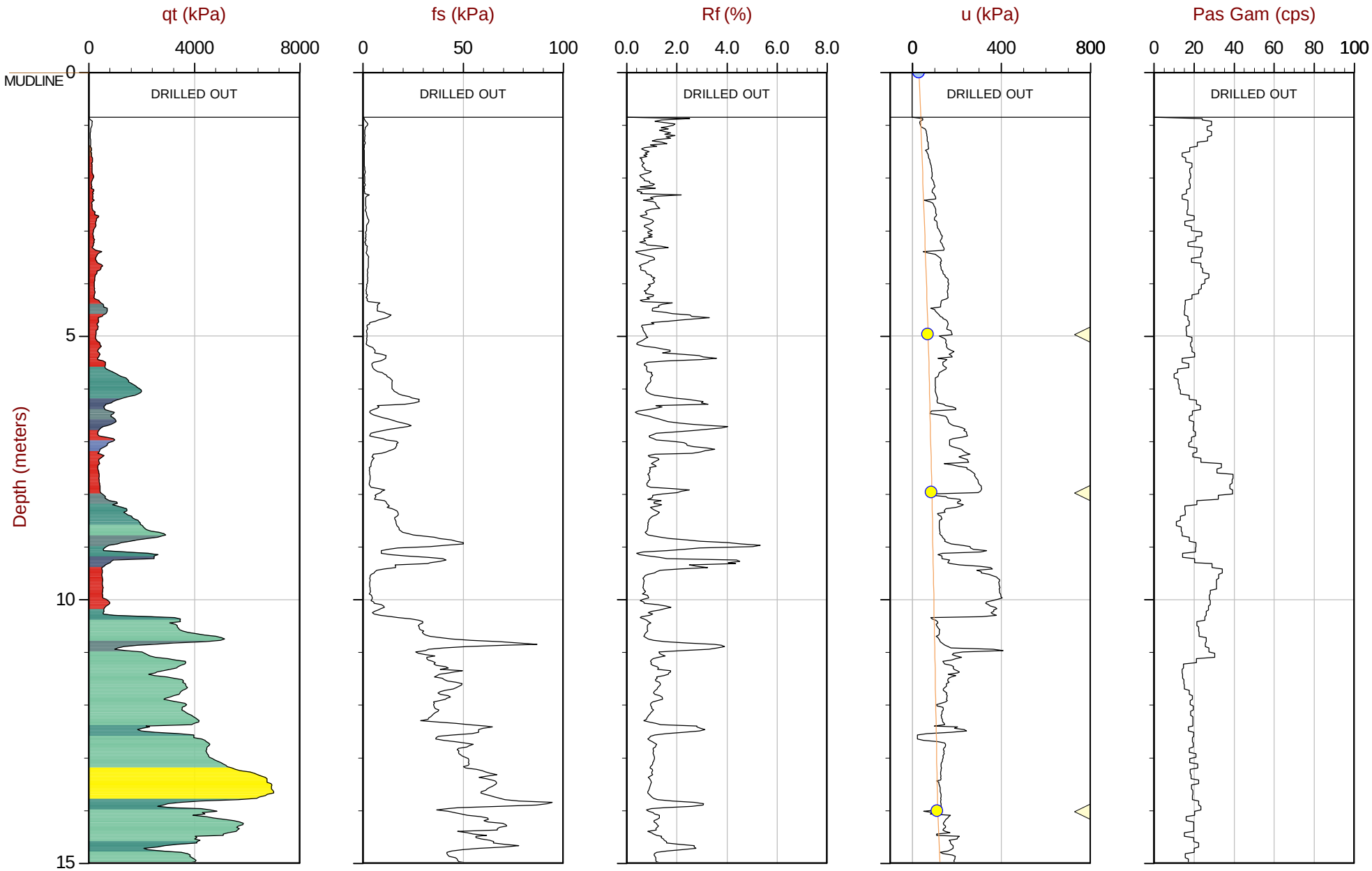
Passive Gamma Cone Penetration Test Plots

CONETEC

CH2M

Job No: 16-02014
Date: 03:15:16 10:14
Site: Faro IP

Sounding: CH16-201-CP014
Cone: 317:T375F10U200



Max Depth: 18.950 m / 62.17 ft
Depth Inc: 0.025 m / 0.082 ft
Avg Int: 0.200 m
Overplot Item:

File: 16-02014_GS014.COR
Unit Wt: SBT Zones

SBT: Robertson and Campanella, 1986
Coords: UTM Zone 8 N: 6914053.79m E: 580670.30m Elev: 1046.63m
Page No: 1 of 2

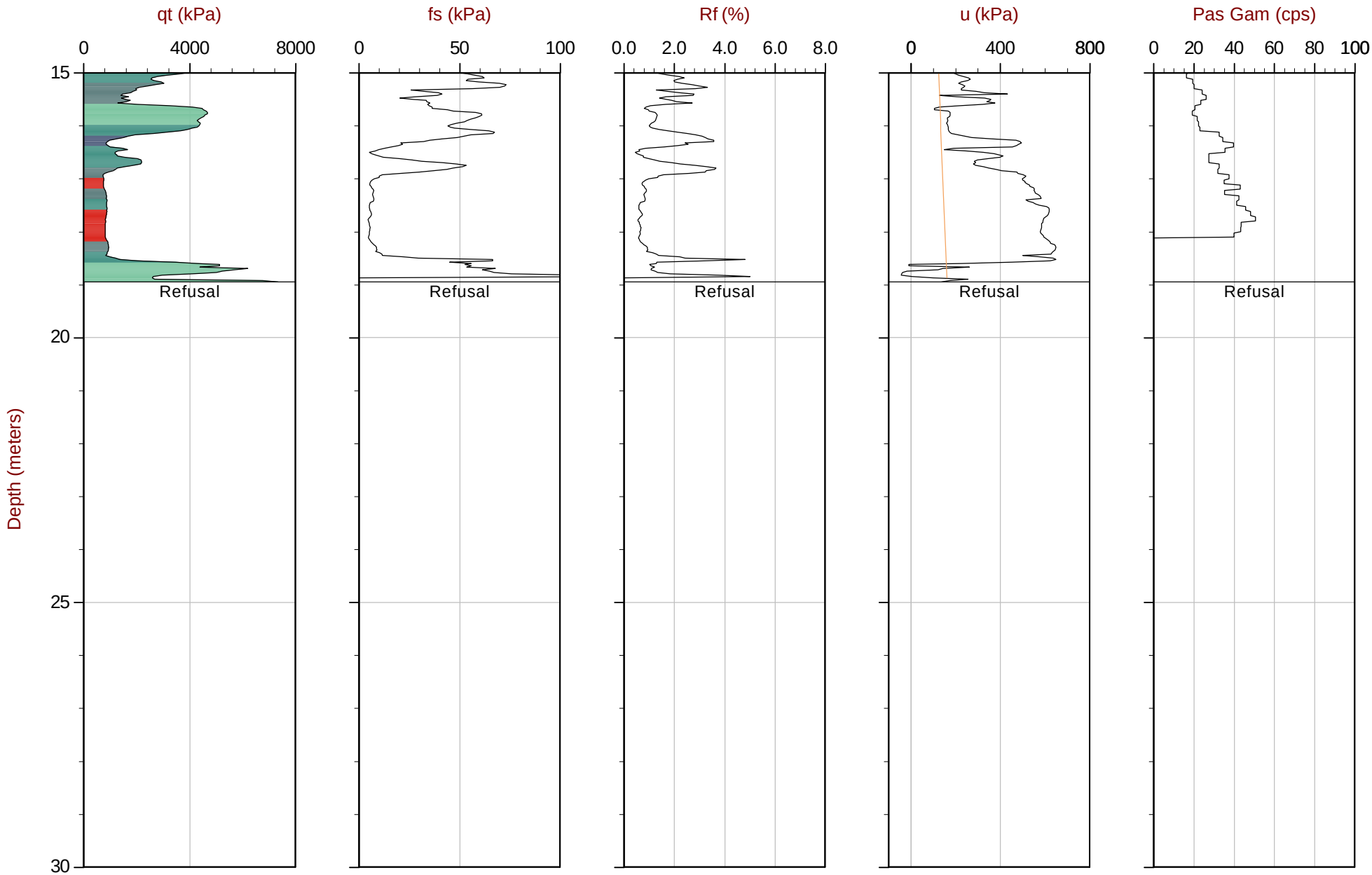
Assumed Ueq
Ueq
Dissipation, equilibrium achieved
Dissipation, equilibrium not achieved
Equilibrium Pore Pressure Line

CONETEC

CH2M

Job No: 16-02014
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Site: Faro IP

Sounding: CH16-201-CP014
Cone: 317:T375F10U200



Max Depth: 18.950 m / 62.17 ft
Depth Inc: 0.025 m / 0.082 ft
Avg Int: 0.200 m
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Coords: UTM Zone 8 N: 6914053.79m E: 580670.30m Elev: 1046.63m
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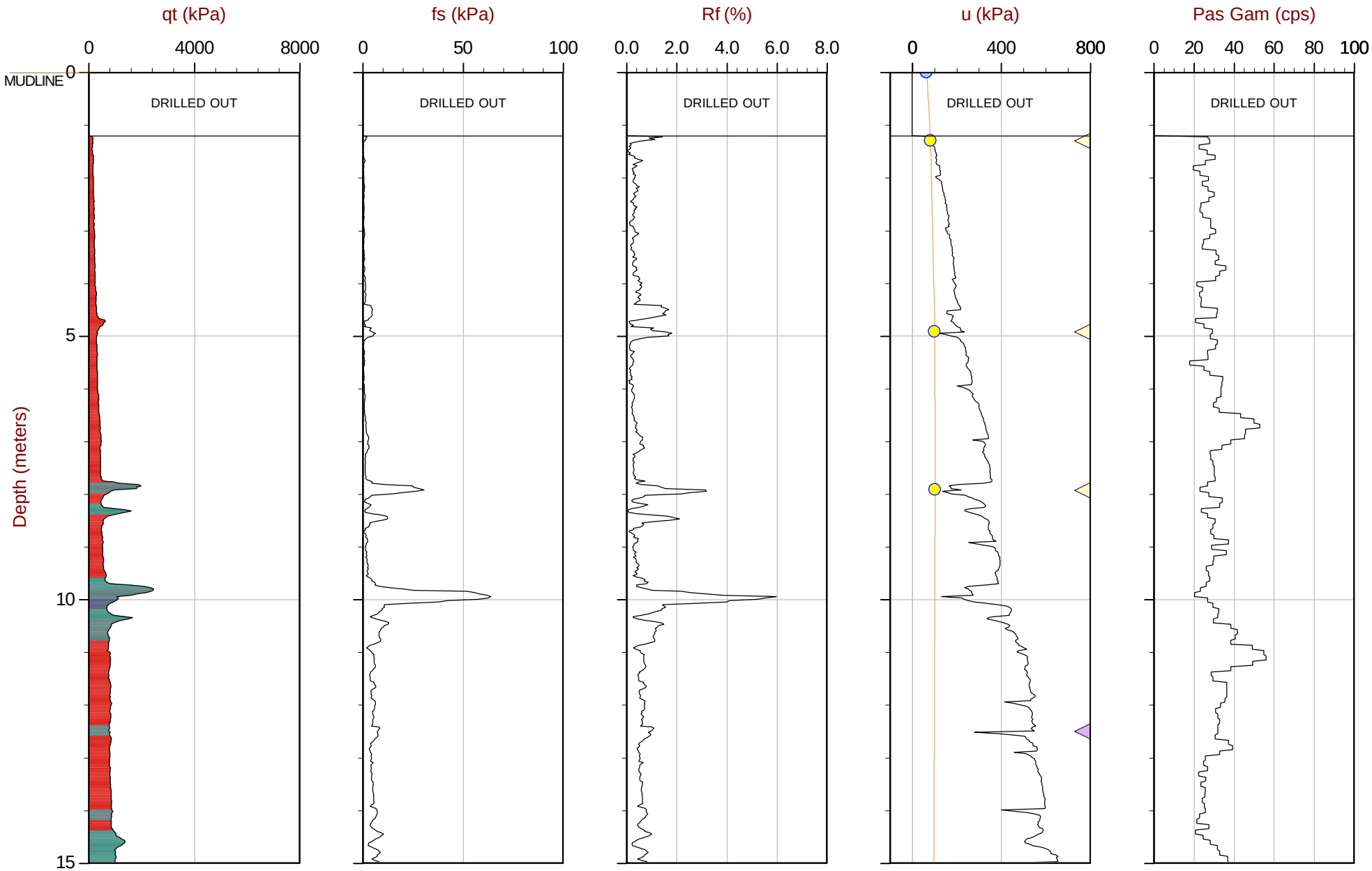
Assumed Ueq
Ueq
Dissipation, equilibrium achieved
Dissipation, equilibrium not achieved
Equilibrium Pore Pressure Line

CONETEC

CH2M

Job No: 16-02014
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Site: Faro IP

Sounding: CH16-201-CP015
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Max Depth: 16.400 m / 53.81 ft
Depth Inc: 0.025 m / 0.082 ft
Avg Int: 0.200 m
Overplot Item:

File: 16-02014_GS015.COR
Unit Wt: SBT Zones

SBT: Robertson and Campanella, 1986
Coords: UTM Zone 8 N: 6914144.44m E: 580594.24m Elev: 1046.61m
Page No: 1 of 2

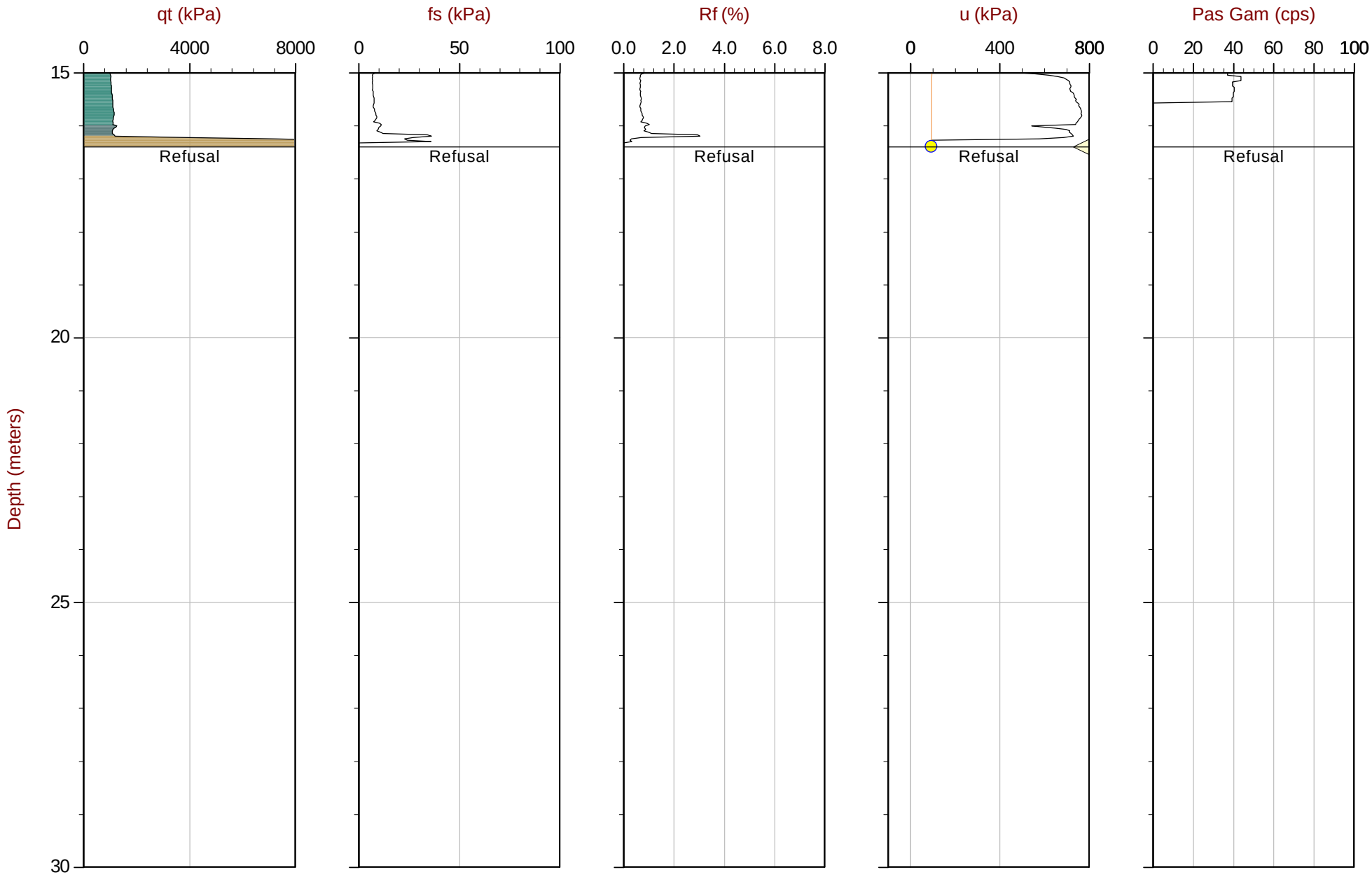
Assumed Ueq
Ueq
Dissipation, equilibrium achieved
Dissipation, equilibrium not achieved
Equilibrium Pore Pressure Line

CONETEC

CH2M

Job No: 16-02014
Date: 03:16:16 14:30
Site: Faro IP

Sounding: CH16-201-CP015
Cone: 317:T375F10U200



Max Depth: 16.400 m / 53.81 ft
Depth Inc: 0.025 m / 0.082 ft
Avg Int: 0.200 m
Overplot Item:

File: 16-02014_GS015.COR
Unit Wt: SBT Zones

SBT: Robertson and Campanella, 1986
Coords: UTM Zone 8 N: 6914144.44m E: 580594.24m Elev: 1046.61m
Page No: 2 of 2

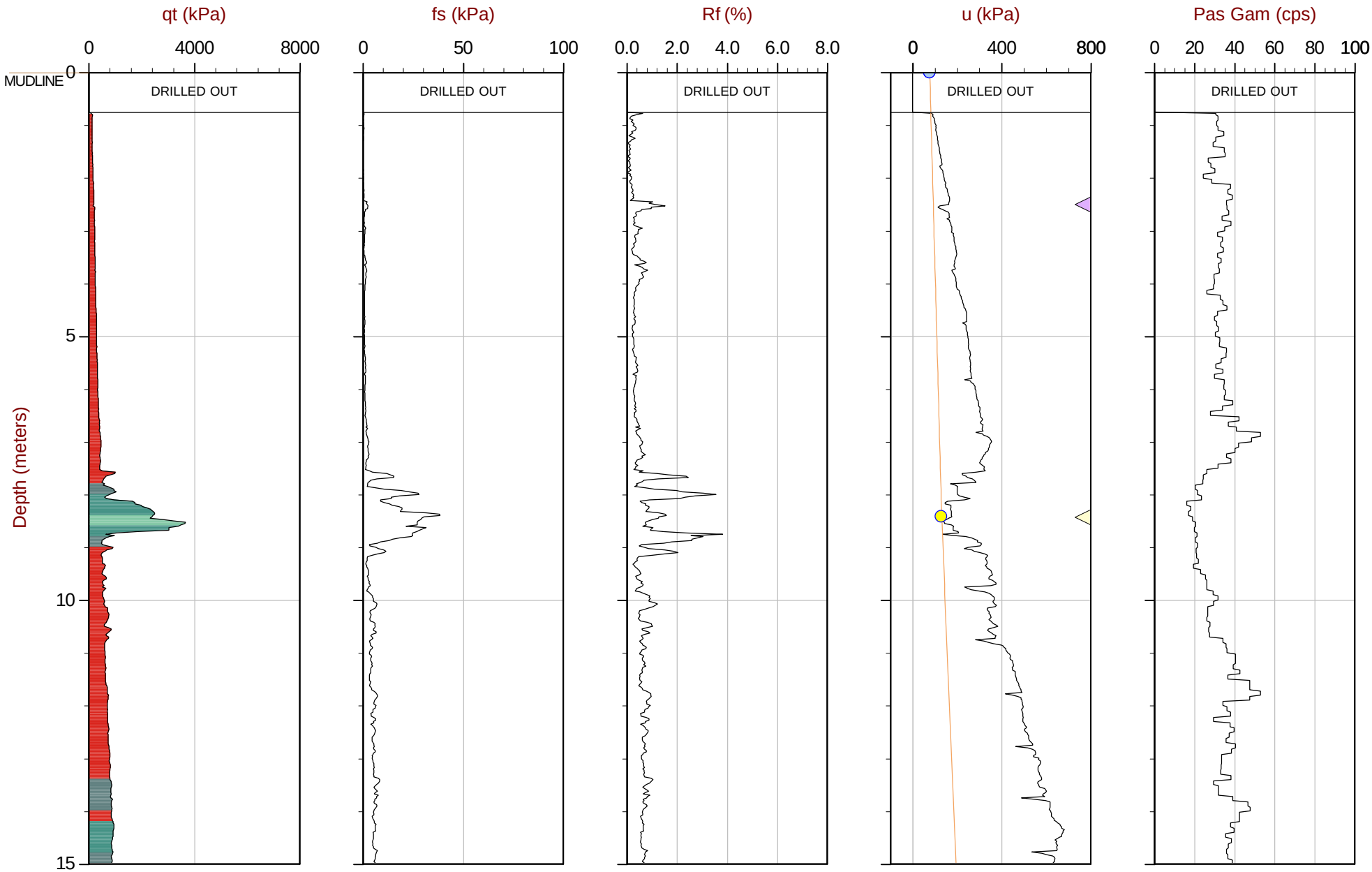
Assumed Ueq
Ueq
Dissipation, equilibrium achieved
Dissipation, equilibrium not achieved
Equilibrium Pore Pressure Line

CONETEC

CH2M

Job No: 16-02014
Date: 03:15:16 13:40
Site: Faro IP

Sounding: CH16-201-CP016
Cone: 317:T375F10U200



Max Depth: 18.950 m / 62.17 ft
Depth Inc: 0.025 m / 0.082 ft
Avg Int: 0.200 m
Overplot Item:

File: 16-02014_GS016.COR
Unit Wt: SBT Zones

SBT: Robertson and Campanella, 1986
Coords: UTM Zone 8 N: 6913921.32m E: 580410.84m Elev: 1046.62m
Page No: 1 of 2

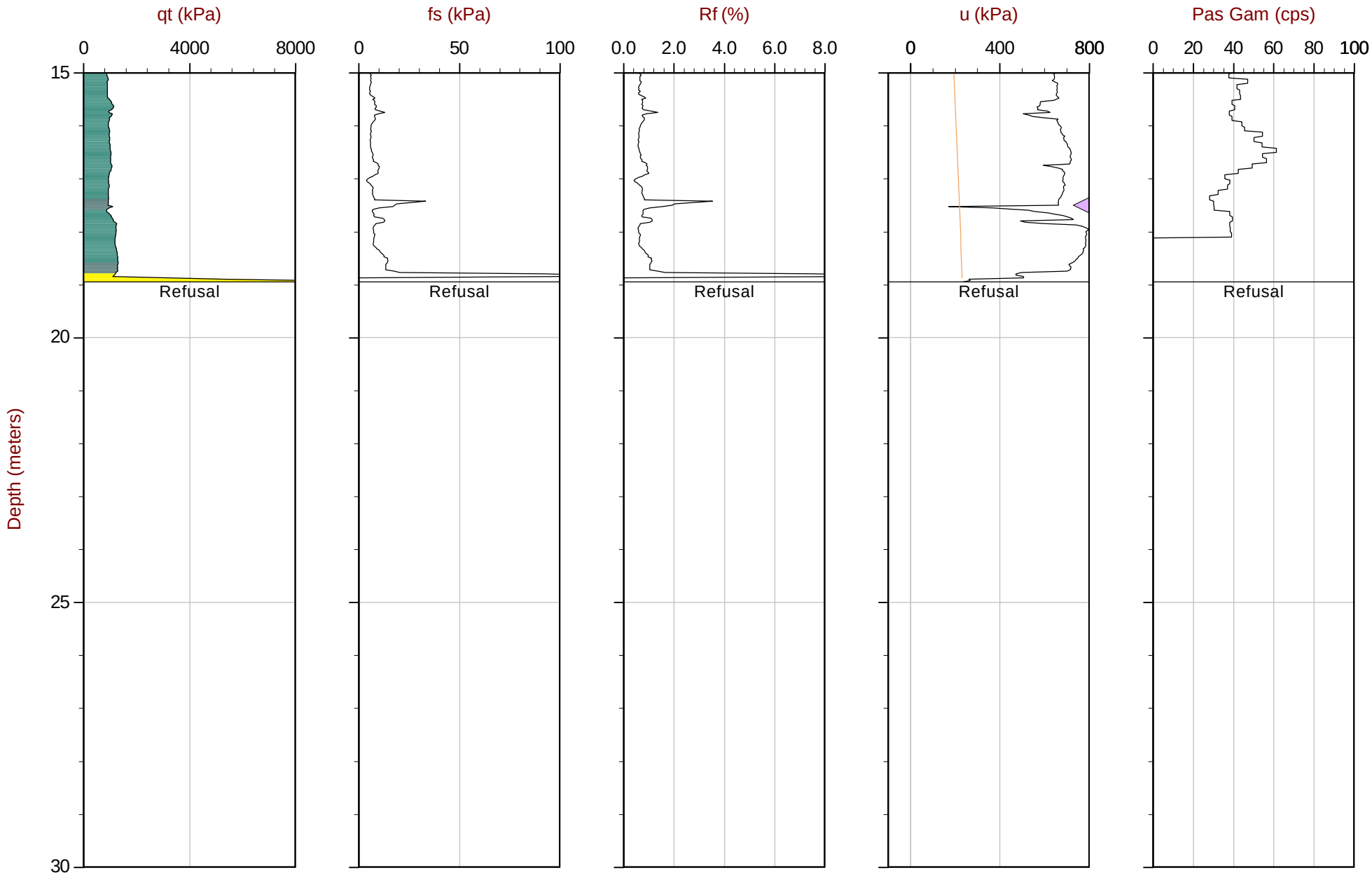
Assumed Ueq
Ueq
Dissipation, equilibrium achieved
Dissipation, equilibrium not achieved
Equilibrium Pore Pressure Line

CONETEC

CH2M

Job No: 16-02014
Date: 03:15:16 13:40
Site: Faro IP

Sounding: CH16-201-CP016
Cone: 317:T375F10U200



Max Depth: 18.950 m / 62.17 ft
Depth Inc: 0.025 m / 0.082 ft
Avg Int: 0.200 m
Overplot Item:

File: 16-02014_GS016.COR
Unit Wt: SBT Zones

SBT: Robertson and Campanella, 1986
Coords: UTM Zone 8 N: 6913921.32m E: 580410.84m Elev: 1046.62m
Page No: 2 of 2

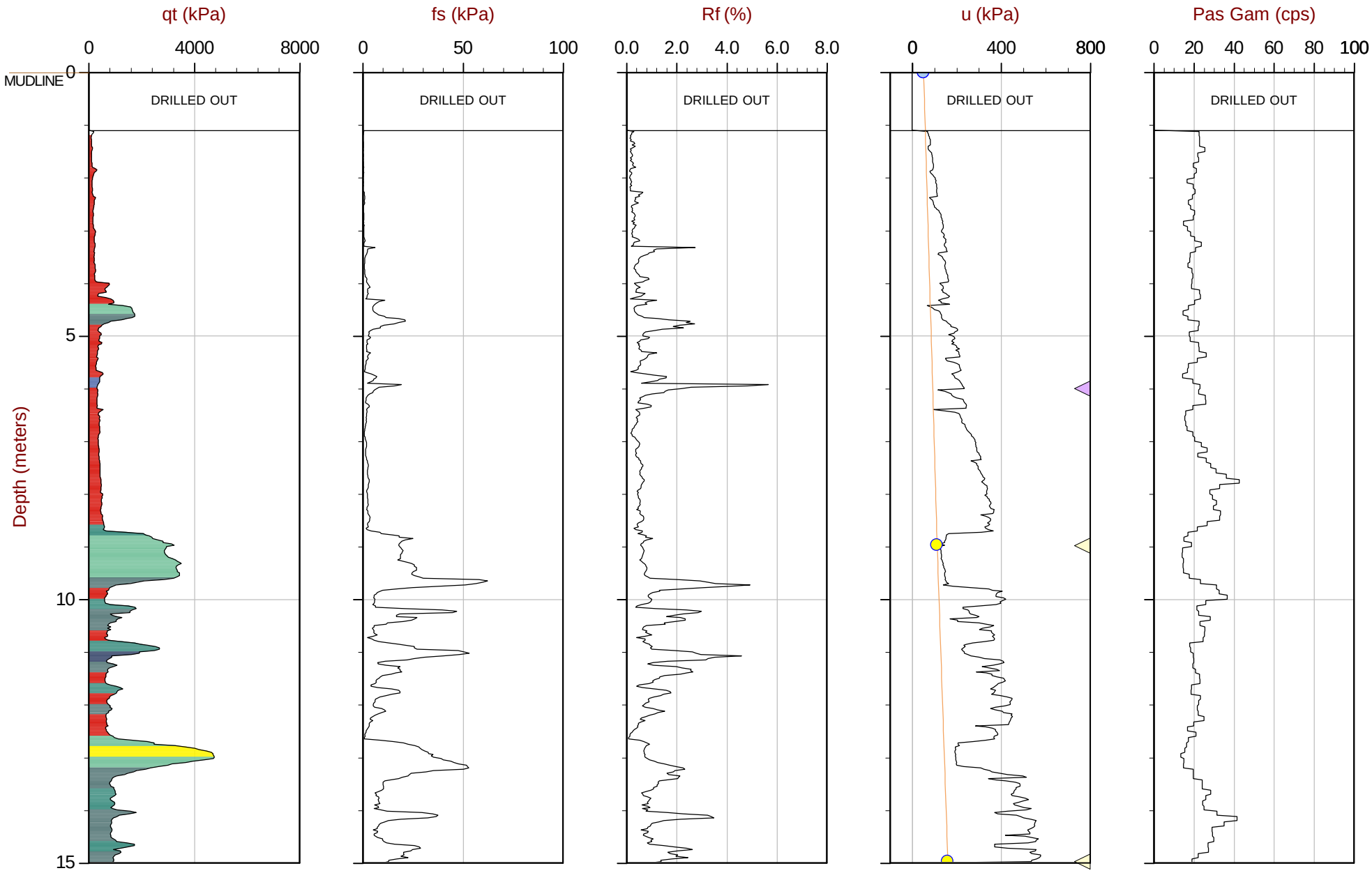
Assumed Ueq
Ueq
Dissipation, equilibrium achieved
Dissipation, equilibrium not achieved
Equilibrium Pore Pressure Line

CONETEC

CH2M

Job No: 16-02014
Date: 03:14:16 09:45
Site: Faro IP

Sounding: CH16-201-CP017
Cone: 317:T375F10U200



Max Depth: 20.675 m / 67.83 ft
Depth Inc: 0.025 m / 0.082 ft
Avg Int: 0.200 m
Overplot Item:

File: 16-02014_GS017.COR
Unit Wt: SBT Zones

SBT: Robertson and Campanella, 1986
Coords: UTM Zone 8 N: 6913870.65m E: 580528.32m Elev: 1046.64m
Page No: 1 of 2

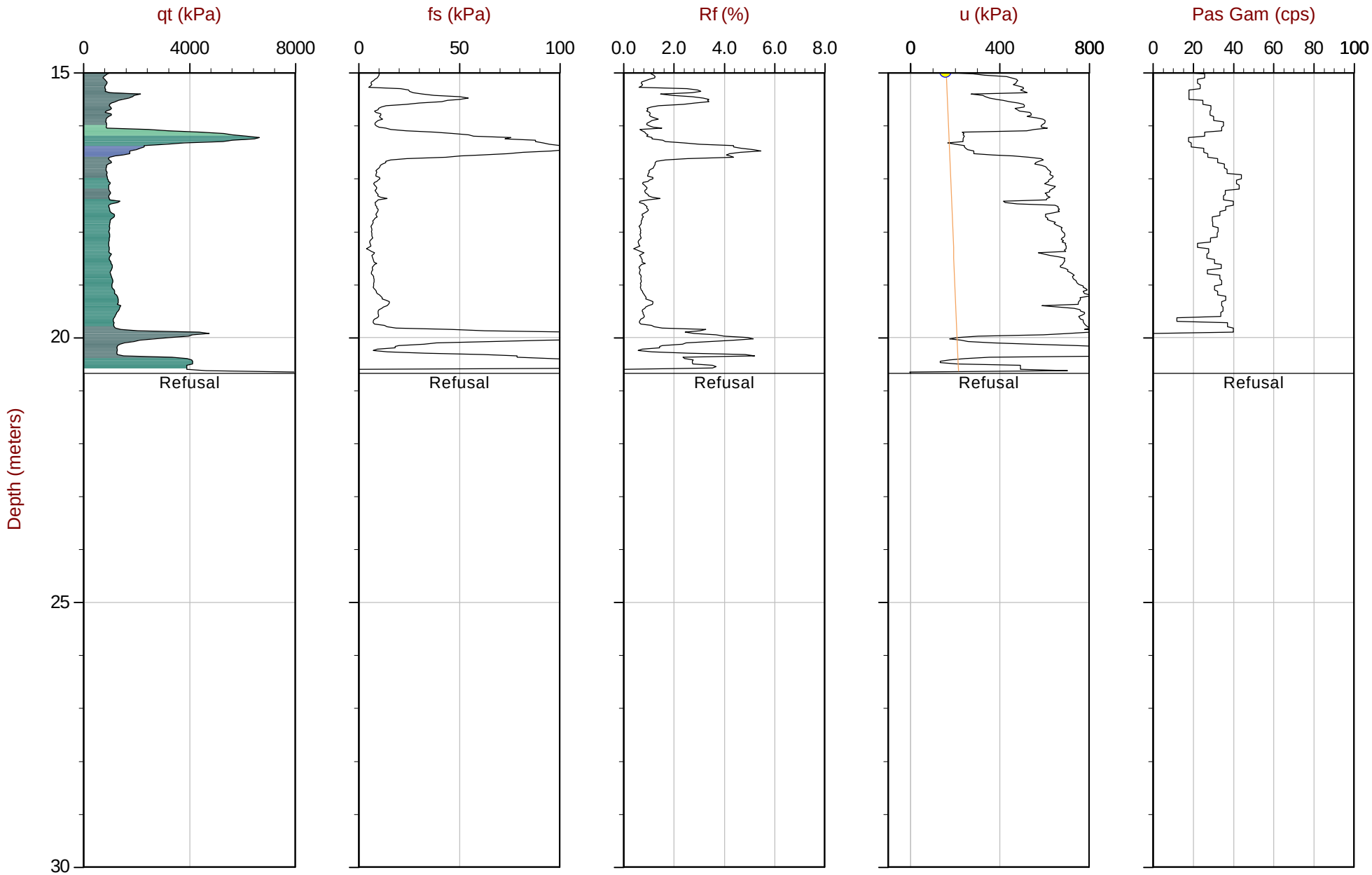
Assumed Ueq
Ueq
Dissipation, equilibrium achieved
Dissipation, equilibrium not achieved
Equilibrium Pore Pressure Line

CONETEC

CH2M

Job No: 16-02014
Date: 03:14:16 09:45
Site: Faro IP

Sounding: CH16-201-CP017
Cone: 317:T375F10U200



Max Depth: 20.675 m / 67.83 ft
Depth Inc: 0.025 m / 0.082 ft
Avg Int: 0.200 m
Overplot Item:

File: 16-02014_GS017.COR
Unit Wt: SBT Zones

SBT: Robertson and Campanella, 1986
Coords: UTM Zone 8 N: 6913870.65m E: 580528.32m Elev: 1046.64m
Page No: 2 of 2

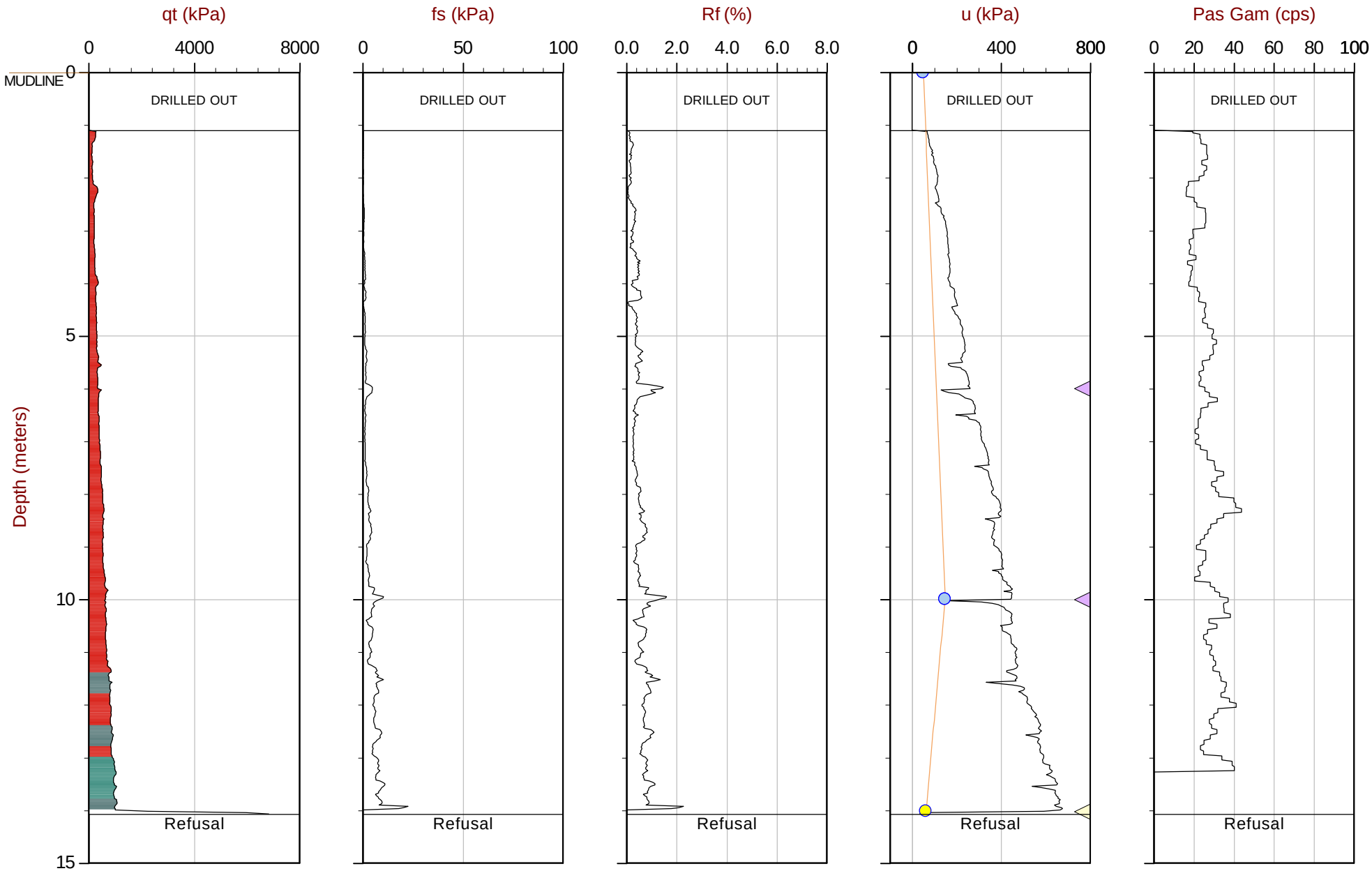
Assumed Ueq
Ueq
Dissipation, equilibrium achieved
Dissipation, equilibrium not achieved
Equilibrium Pore Pressure Line

CONETEC

CH2M

Job No: 16-02014
Date: 03:13:16 13:10
Site: Faro IP

Sounding: CH16-201-CP018
Cone: 317:T375F10U200



Max Depth: 14.075 m / 46.18 ft
Depth Inc: 0.025 m / 0.082 ft
Avg Int: 0.200 m
Overplot Item:

File: 16-02014_GS018.COR
Unit Wt: SBT Zones

SBT: Robertson and Campanella, 1986
Coords: UTM Zone 8 N: 6914262.66m E: 580678.76m Elev: 1046.59m
Page No: 1 of 1

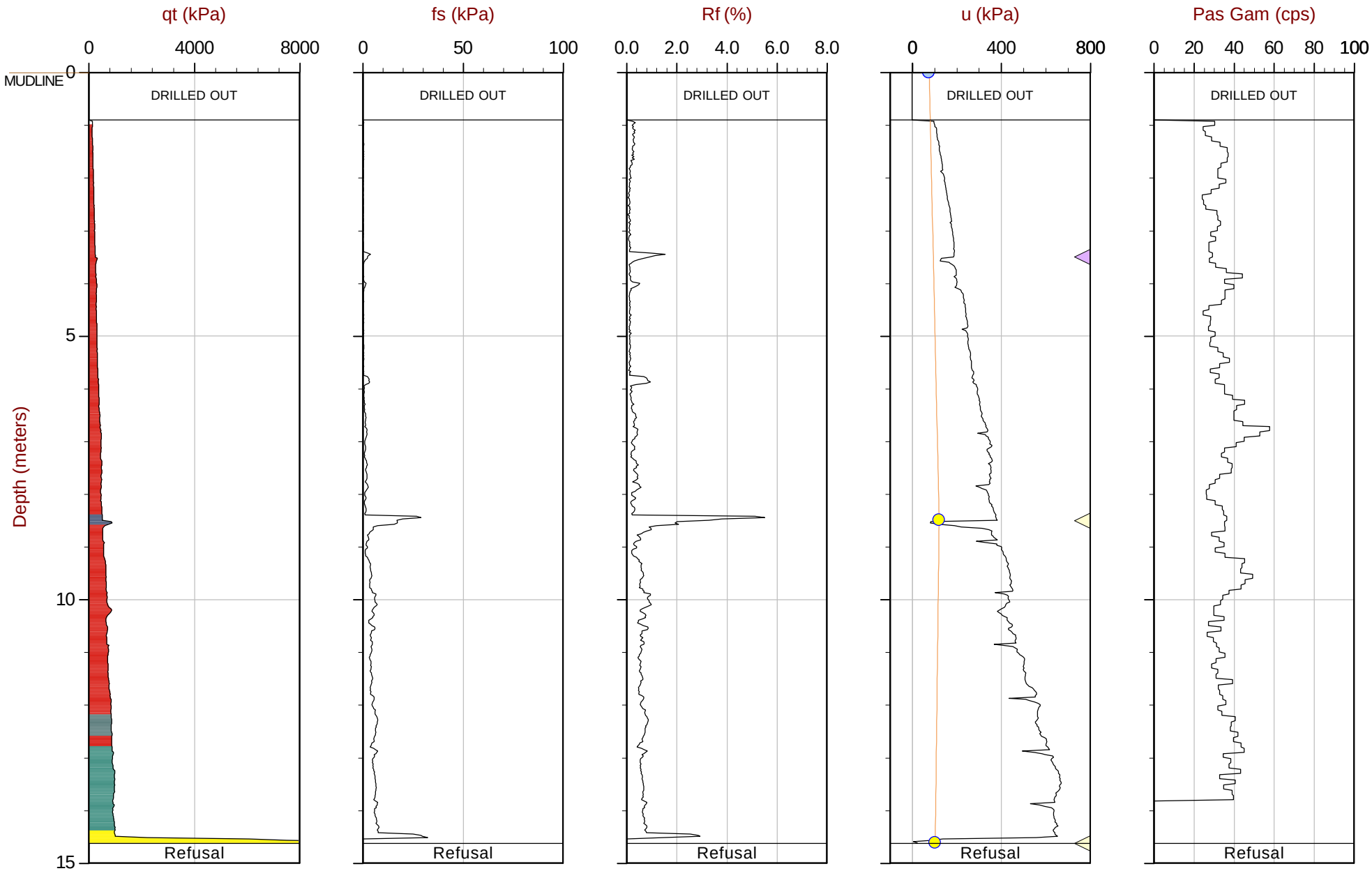
Assumed Ueq
Ueq
Dissipation, equilibrium achieved
Dissipation, equilibrium not achieved
Equilibrium Pore Pressure Line

CONETEC

CH2M

Job No: 16-02014
Date: 03:16:16 10:17
Site: Faro IP

Sounding: CH16-201-CP019
Cone: 317:T375F10U200



Max Depth: 14.625 m / 47.98 ft
Depth Inc: 0.025 m / 0.082 ft
Avg Int: 0.200 m
Overplot Item:

File: 16-02014_GS019.COR
Unit Wt: SBT Zones

SBT: Robertson and Campanella, 1986
Coords: UTM Zone 8 N: 6914022.78m E: 580483.02m Elev: 1046.61m
Page No: 1 of 1

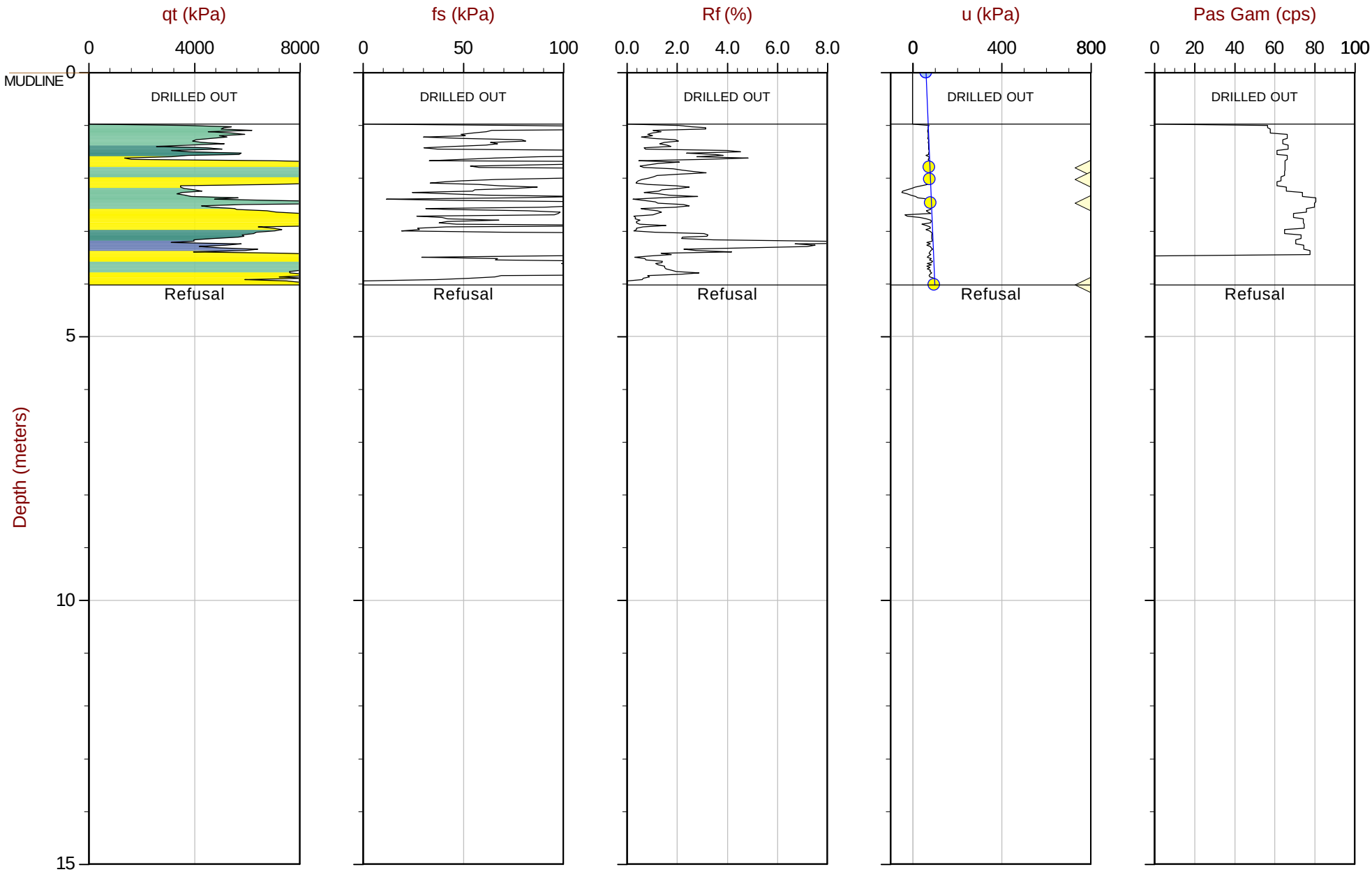
Assumed Ueq
Ueq
Dissipation, equilibrium achieved
Dissipation, equilibrium not achieved
Equilibrium Pore Pressure Line

CONETEC

CH2M

Job No: 16-02014
Date: 03:07:16 16:23
Site: Faro CVP

Sounding: CH16-201-CP022
Cone: 317:T375F10U200



Max Depth: 4.025 m / 13.21 ft
Depth Inc: 0.025 m / 0.082 ft
Avg Int: 0.200 m
Overplot Item:

File: 16-02014_GS022.COR
Unit Wt: SBT Zones

SBT: Robertson and Campanella, 1986
Coords: UTM Zone 8 N: 6914145.57m E: 580247.33m Elev: 1029.95m
Page No: 1 of 1

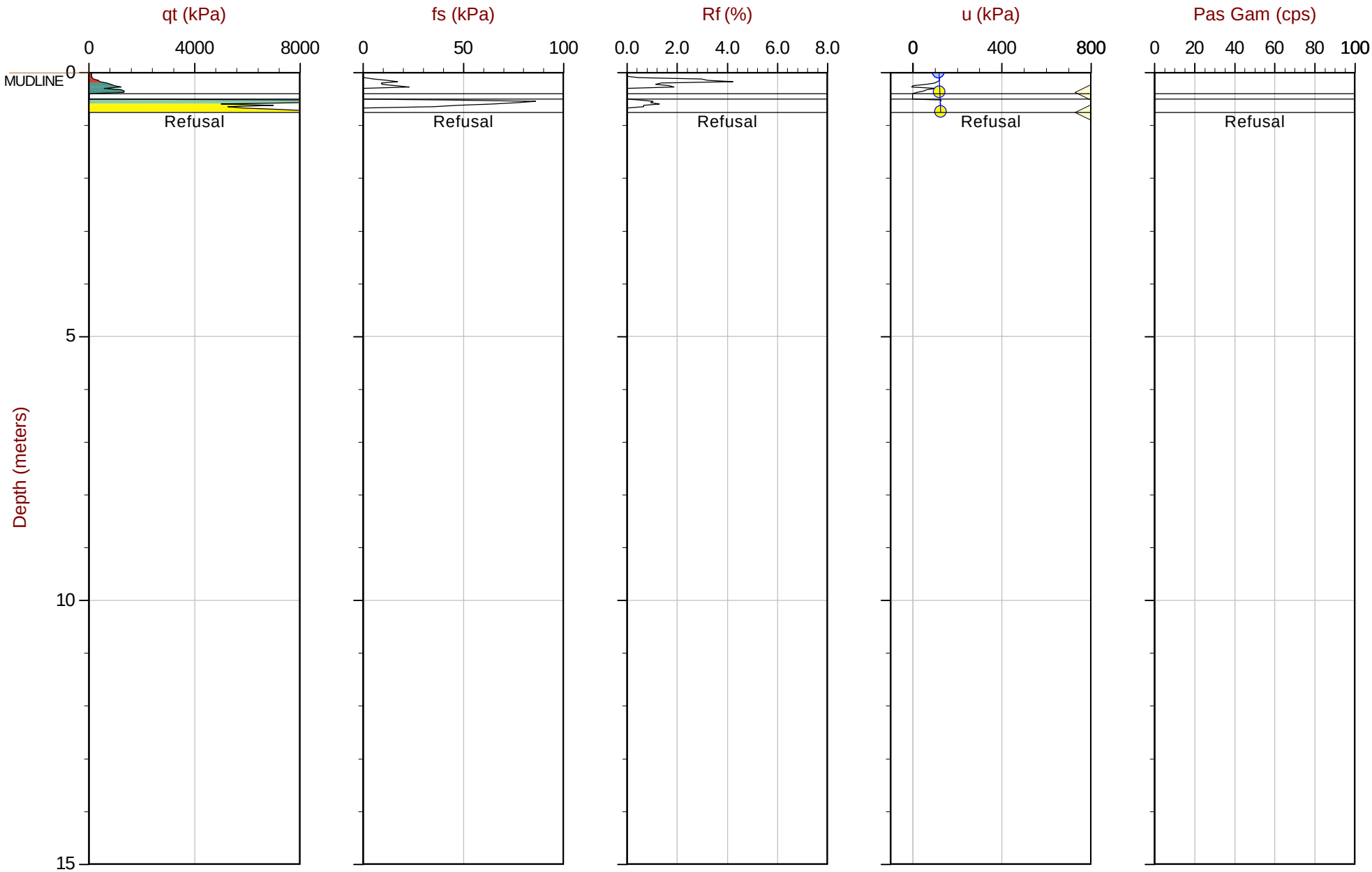
Assumed Ueq
Ueq
Dissipation, equilibrium achieved
Dissipation, equilibrium not achieved
Hydrostatic Line

CONETEC

CH2M

Job No: 16-02014
Date: 03:06:16 16:43
Site: Faro CVP

Sounding: CH16-201-CP025
Cone: 317:T375F10U200



Max Depth: 0.750 m / 2.46 ft
Depth Inc: 0.025 m / 0.082 ft
Avg Int: 0.200 m
Overplot Item:

File: 16-02014_GS025.COR
Unit Wt: SBT Zones

SBT: Robertson and Campanella, 1986
Coords: UTM Zone 8 N: 6914430.77m E: 580201.00m Elev: 1030.02m
Page No: 1 of 1

Assumed Ueq
Ueq
Dissipation, equilibrium achieved
Dissipation, equilibrium not achieved
Hydrostatic Line

Advanced Cone Penetration Test Plots with Su(Nkt)

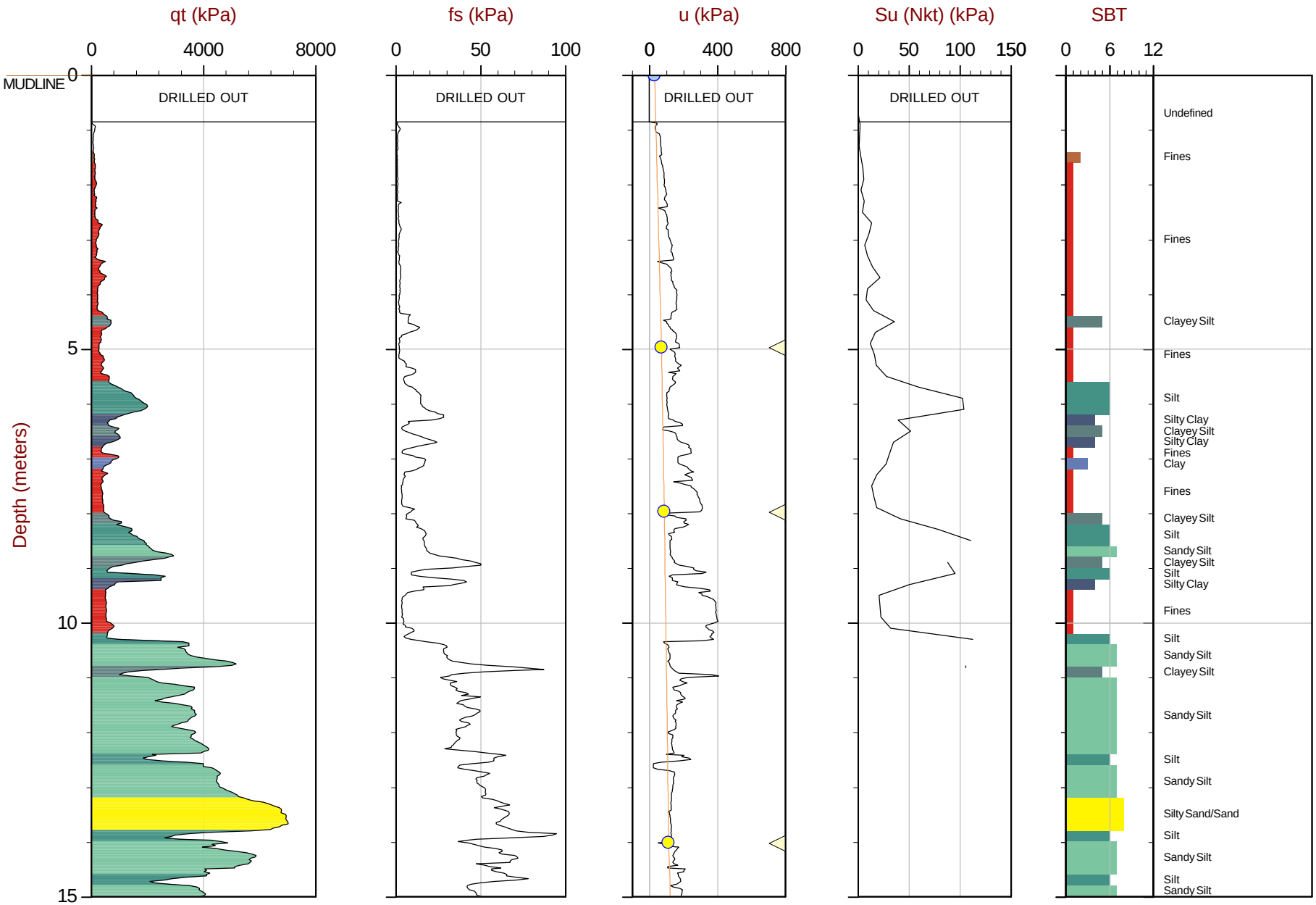


CONETEC

CH2M

Job No: 16-02014
Date: 03:15:16 10:14
Site: Faro IP

Sounding: CH16-201-CP014
Cone: 317:T375F10U200



Max Depth: 18.950 m / 62.17 ft
Depth Inc: 0.025 m / 0.082 ft
Avg Int: 0.200 m
Overplot Item:
Assumed Ueq
Ueq

File: 16-02014_GS014.COR
Unit Wt: SBT Zones
Su Nkt: 15.0
Dissipation, equilibrium achieved
Dissipation, equilibrium not achieved
Equilibrium Pore Pressure Line

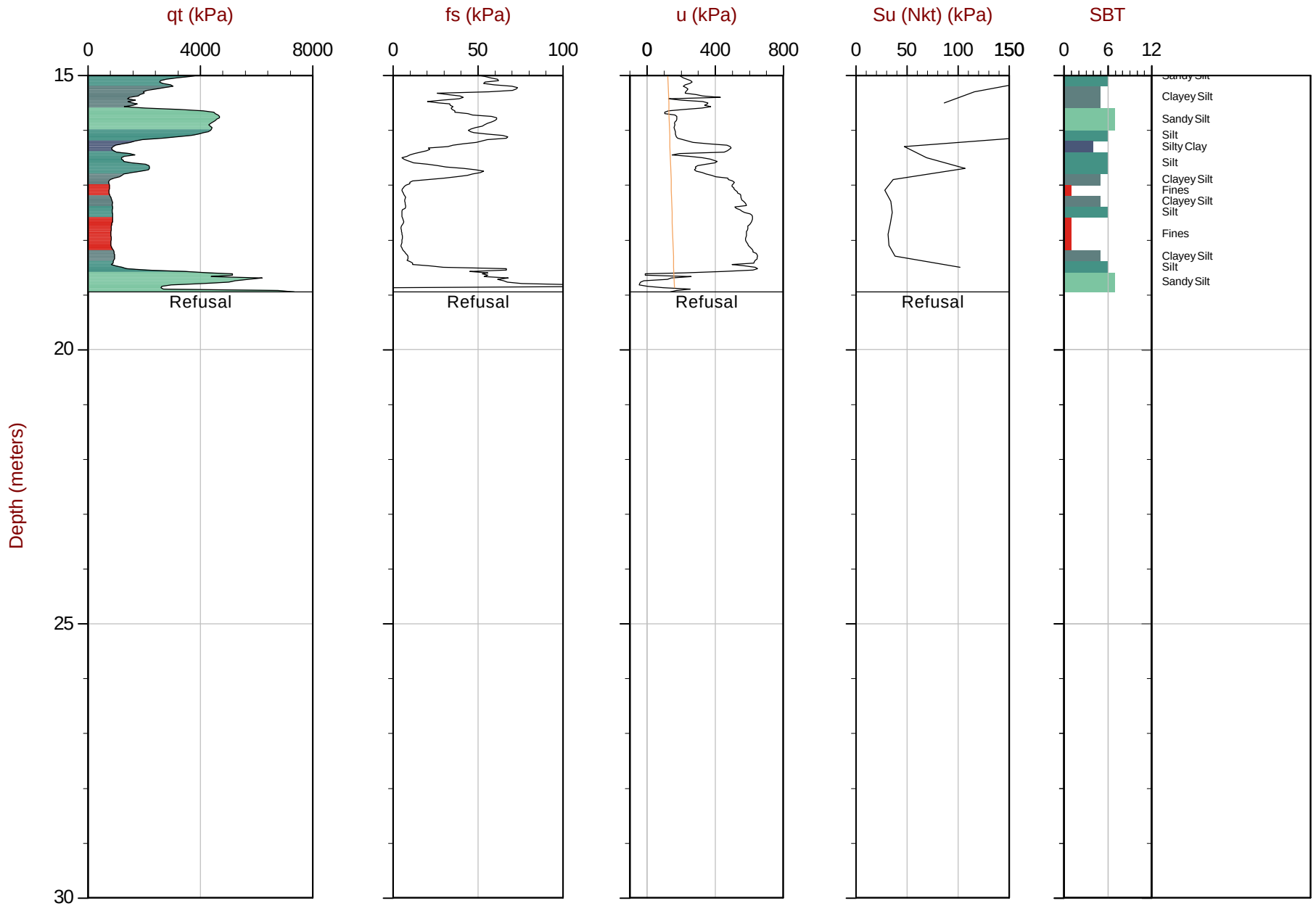
SBT: Robertson and Campanella, 1986
Coords: UTM Zone 8 N: 6914053.79m E: 580670.30m Elev: 1046.63m
Page No: 1 of 2

CONETEC

CH2M

Job No: 16-02014
Date: 03:15:16 10:14
Site: Faro IP

Sounding: CH16-201-CP014
Cone: 317:T375F10U200



Max Depth: 18.950 m / 62.17 ft
Depth Inc: 0.025 m / 0.082 ft
Avg Int: 0.200 m
Overplot Item:
Assumed Ueq
Ueq

File: 16-02014_GS014.COR
Unit Wt: SBT Zones
Su Nkt: 15.0
Dissipation, equilibrium achieved
Dissipation, equilibrium not achieved
Equilibrium Pore Pressure Line

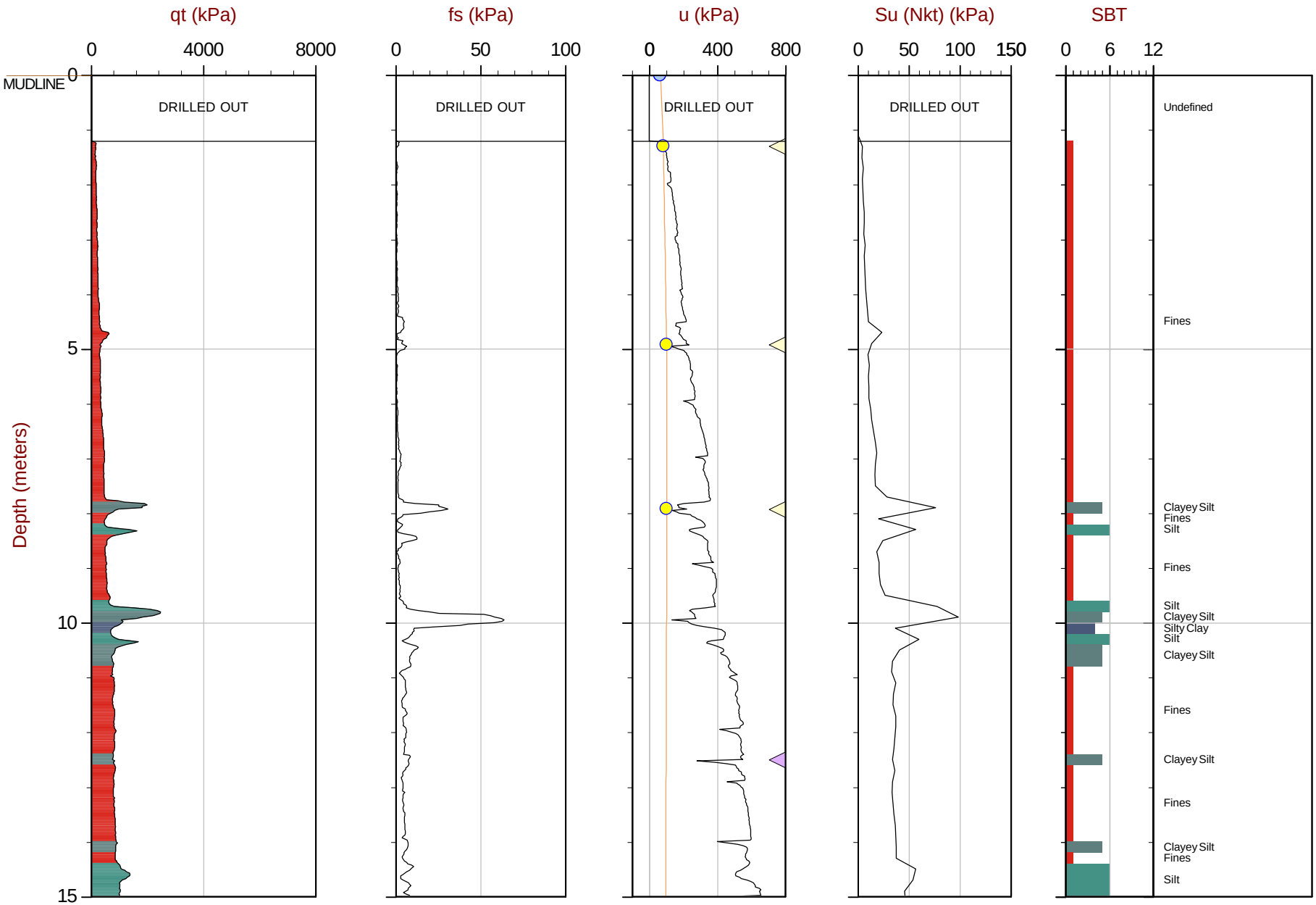
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Coords: UTM Zone 8 N: 6914053.79m E: 580670.30m Elev: 1046.63m
Page No: 2 of 2

CONETEC

CH2M

Job No: 16-02014
Date: 03:16:16 14:30
Site: Faro IP

Sounding: CH16-201-CP015
Cone: 317:T375F10U200



Max Depth: 16.400 m / 53.81 ft
Depth Inc: 0.025 m / 0.082 ft
Avg Int: 0.200 m
Overplot Item:

File: 16-02014_GS015.COR
Unit Wt: SBT Zones
Su Nkt: 15.0

SBT: Robertson and Campanella, 1986
Coords: UTM Zone 8 N: 6914144.44m E: 580594.24m Elev: 1046.61m
Page No: 1 of 2

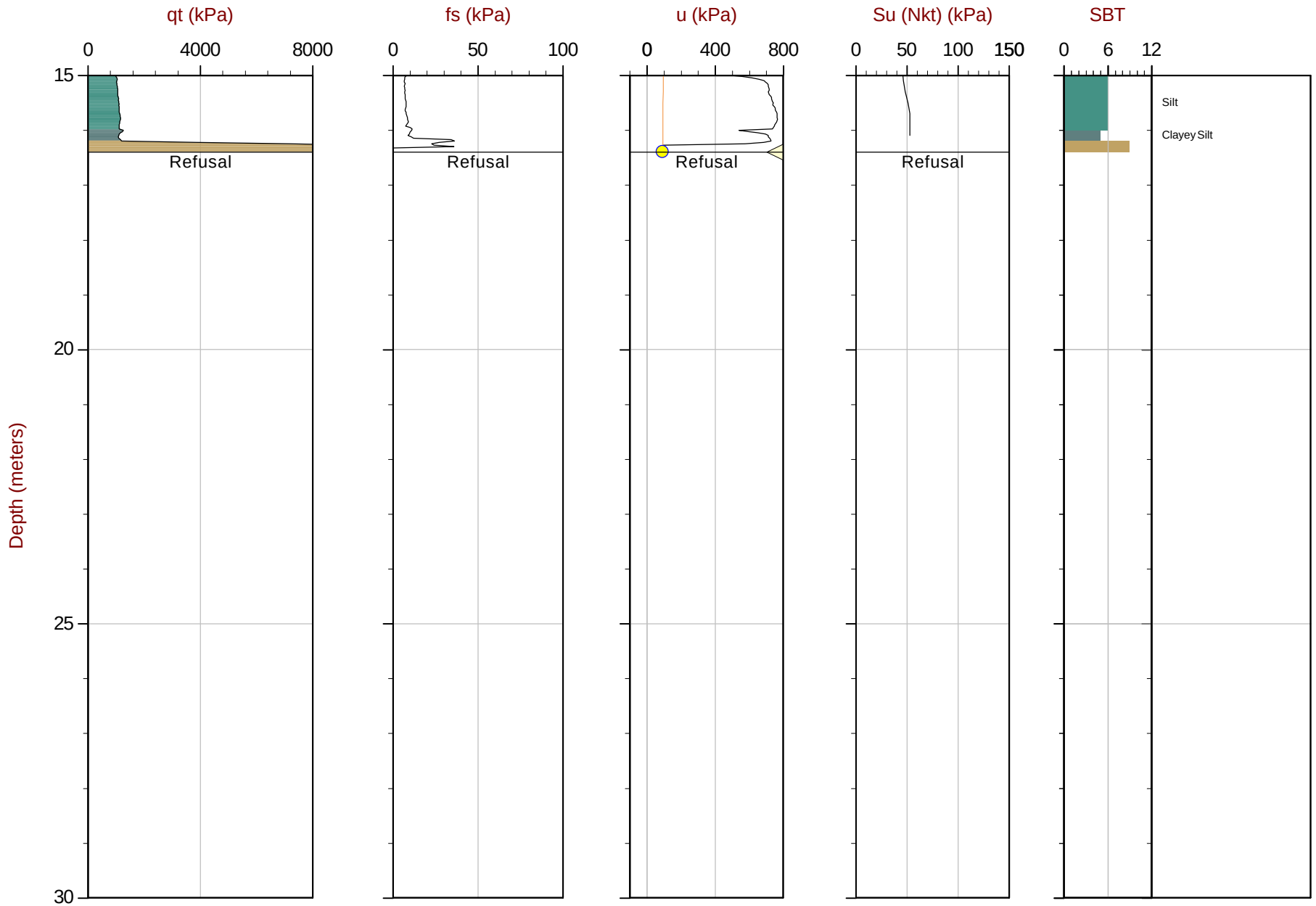
Assumed Ueq
Ueq
Dissipation, equilibrium achieved
Dissipation, equilibrium not achieved
Equilibrium Pore Pressure Line

CONETEC

CH2M

Job No: 16-02014
Date: 03:16:16 14:30
Site: Faro IP

Sounding: CH16-201-CP015
Cone: 317:T375F10U200



Max Depth: 16.400 m / 53.81 ft
Depth Inc: 0.025 m / 0.082 ft
Avg Int: 0.200 m
Overplot Item:
Assumed Ueq
Ueq

File: 16-02014_GS015.COR
Unit Wt: SBT Zones
Su Nkt: 15.0
Dissipation, equilibrium achieved
Dissipation, equilibrium not achieved
Equilibrium Pore Pressure Line

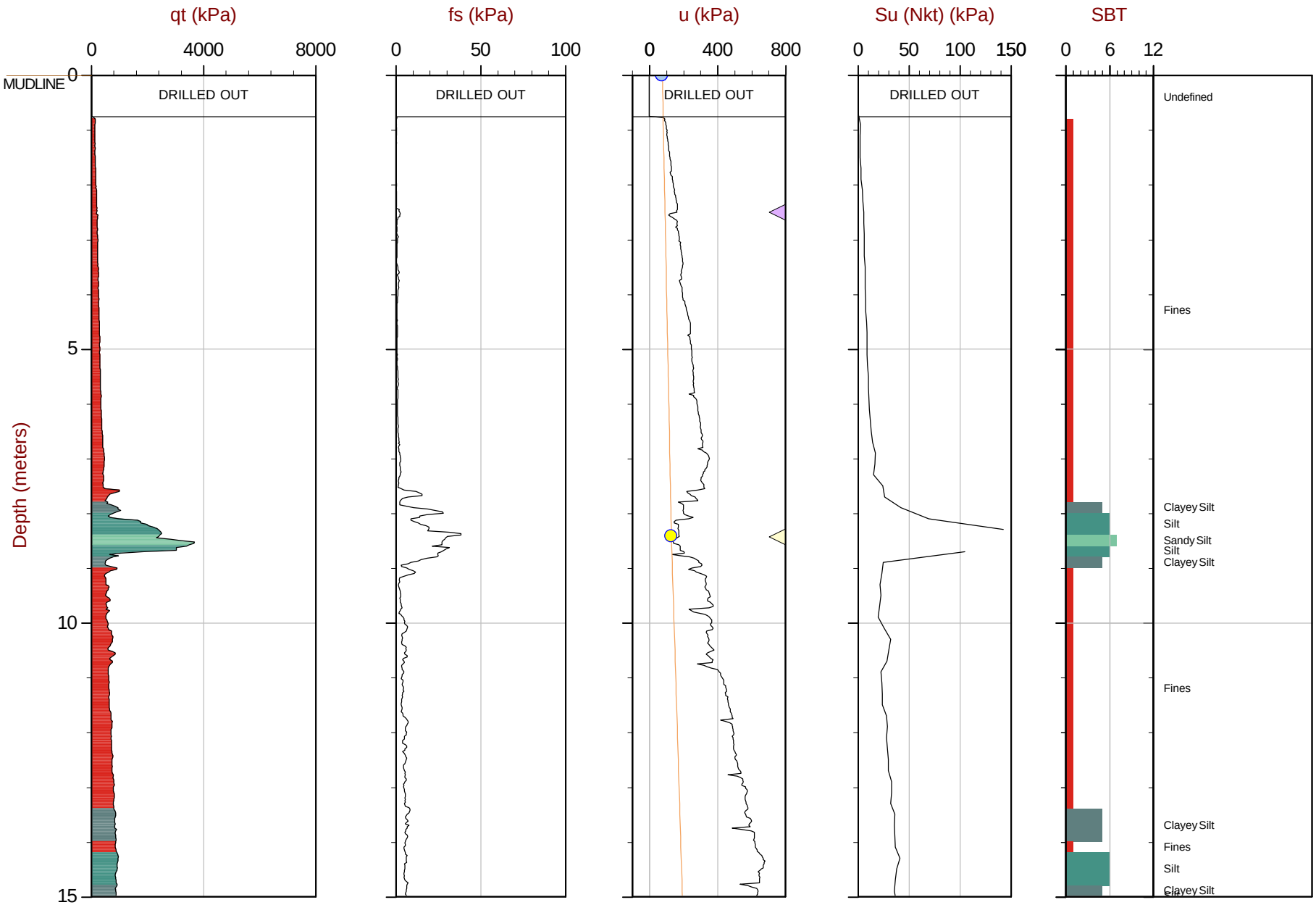
SBT: Robertson and Campanella, 1986
Coords: UTM Zone 8 N: 6914144.44m E: 580594.24m Elev: 1046.61m

CONETEC

CH2M

Job No: 16-02014
Date: 03:15:16 13:40
Site: Faro IP

Sounding: CH16-201-CP016
Cone: 317:T375F10U200



Max Depth: 18.950 m / 62.17 ft
Depth Inc: 0.025 m / 0.082 ft
Avg Int: 0.200 m
Overplot Item:
Assumed Ueq
Ueq

File: 16-02014_GS016.COR
Unit Wt: SBT Zones
Su Nkt: 15.0
Dissipation, equilibrium achieved
Dissipation, equilibrium not achieved
Equilibrium Pore Pressure Line

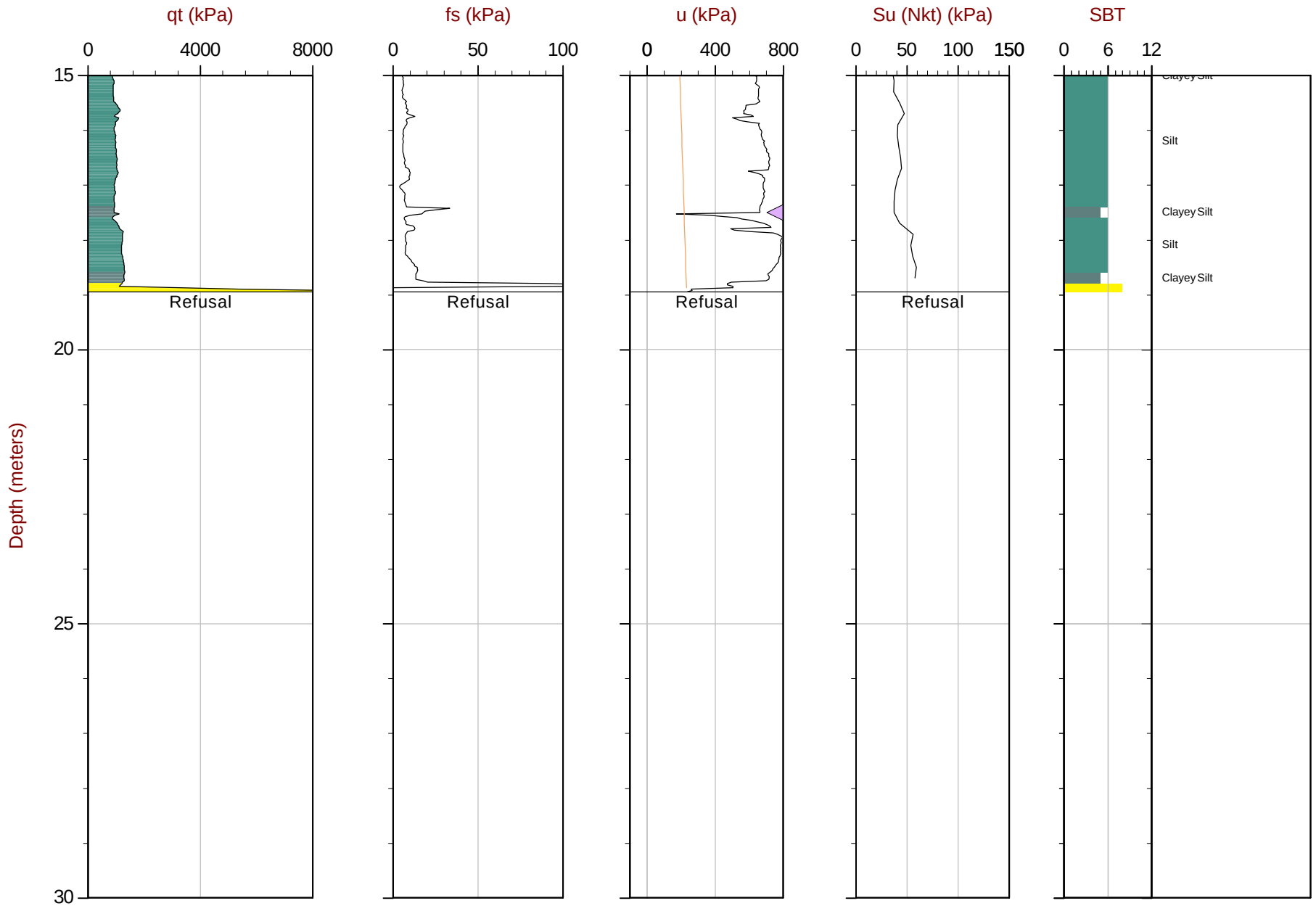
SBT: Robertson and Campanella, 1986
Coords: UTM Zone 8 N: 6913921.32m E: 580410.84m Elev: 1046.62m
Page No: 1 of 2

CONETEC

CH2M

Job No: 16-02014
Date: 03:15:16 13:40
Site: Faro IP

Sounding: CH16-201-CP016
Cone: 317:T375F10U200



Max Depth: 18.950 m / 62.17 ft
Depth Inc: 0.025 m / 0.082 ft
Avg Int: 0.200 m
Overplot Item:
Assumed Ueq
Ueq

File: 16-02014_GS016.COR
Unit Wt: SBT Zones
Su Nkt: 15.0
Dissipation, equilibrium achieved
Dissipation, equilibrium not achieved
Equilibrium Pore Pressure Line

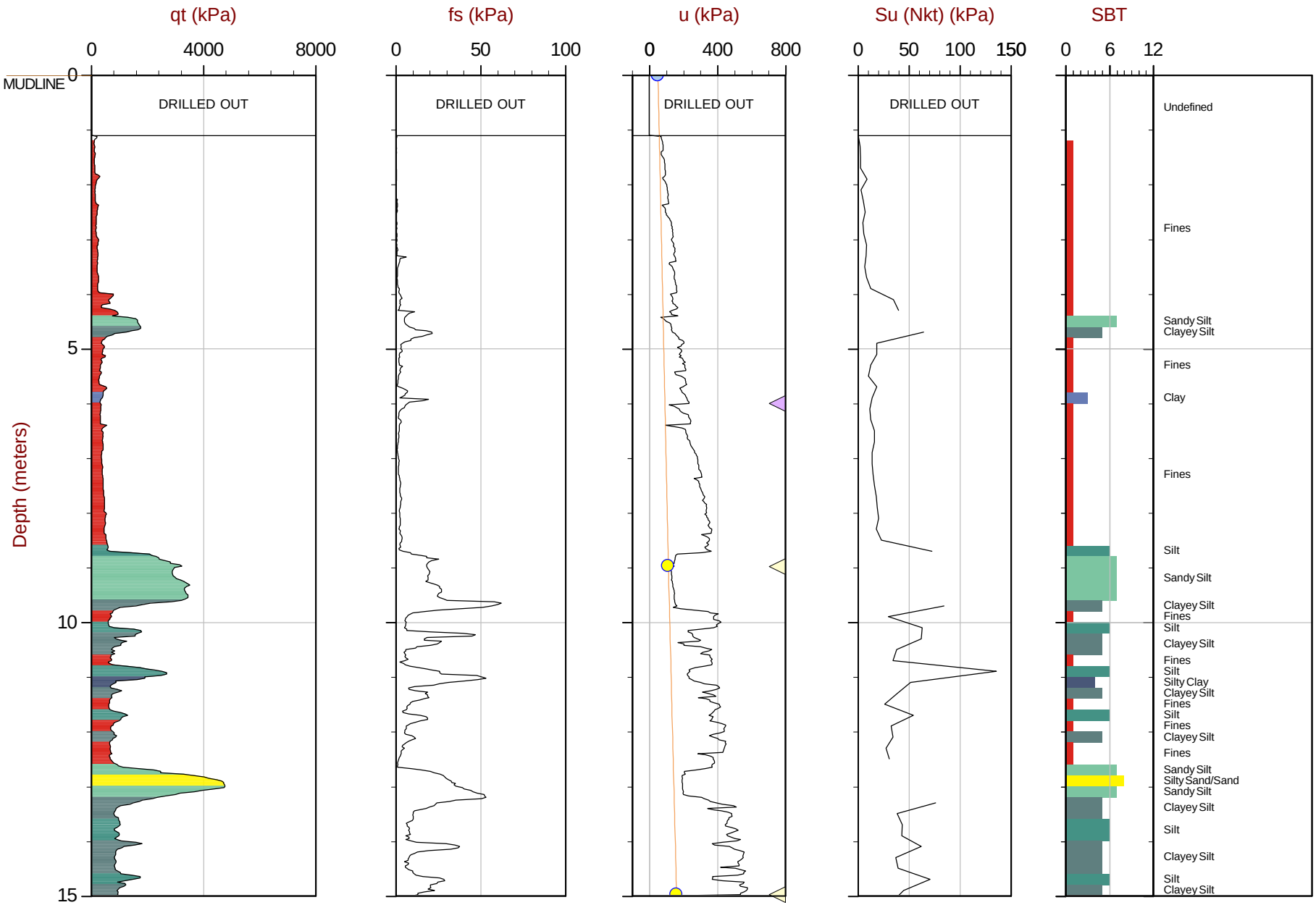
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Coords: UTM Zone 8 N: 6913921.32m E: 580410.84m Elev: 1046.62m
Page No: 2 of 2

CONETEC

CH2M

Job No: 16-02014
Date: 03:14:16 09:45
Site: Faro IP

Sounding: CH16-201-CP017
Cone: 317:T375F10U200



Max Depth: 20.675 m / 67.83 ft
Depth Inc: 0.025 m / 0.082 ft
Avg Int: 0.200 m
Overplot Item:
Assumed Ueq
Ueq

File: 16-02014_GS017.COR
Unit Wt: SBT Zones
Su Nkt: 15.0
Dissipation, equilibrium achieved
Dissipation, equilibrium not achieved
Equilibrium Pore Pressure Line

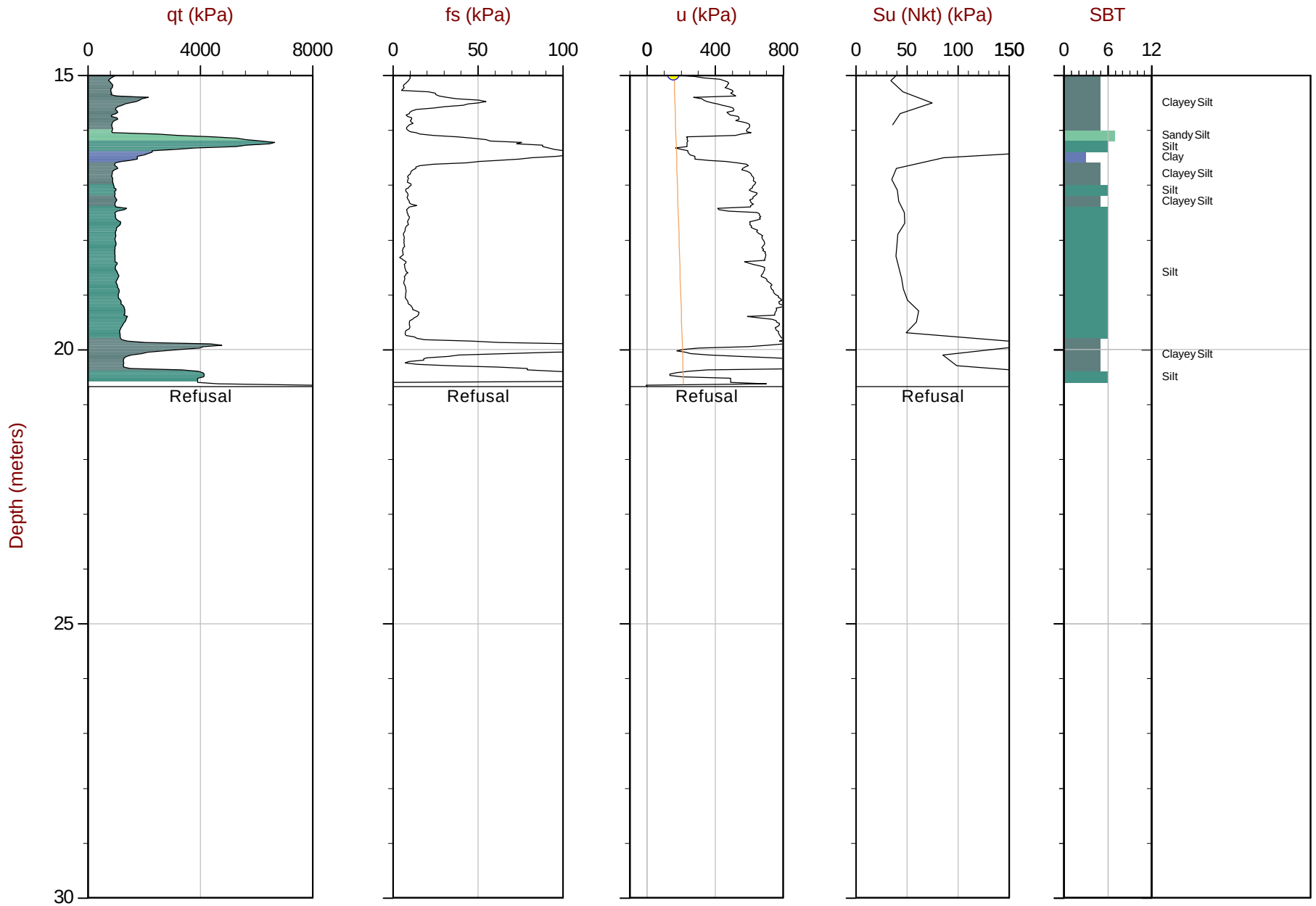
SBT: Robertson and Campanella, 1986
Coords: UTM Zone 8 N: 6913870.65m E: 580528.32m Elev: 1046.64m
Page No: 1 of 2

CONETEC

CH2M

Job No: 16-02014
Date: 03:14:16 09:45
Site: Faro IP

Sounding: CH16-201-CP017
Cone: 317:T375F10U200



Max Depth: 20.675 m / 67.83 ft
Depth Inc: 0.025 m / 0.082 ft
Avg Int: 0.200 m
Overplot Item:
Assumed Ueq
Ueq

File: 16-02014_GS017.COR
Unit Wt: SBT Zones
Su Nkt: 15.0
Dissipation, equilibrium achieved
Dissipation, equilibrium not achieved
Equilibrium Pore Pressure Line

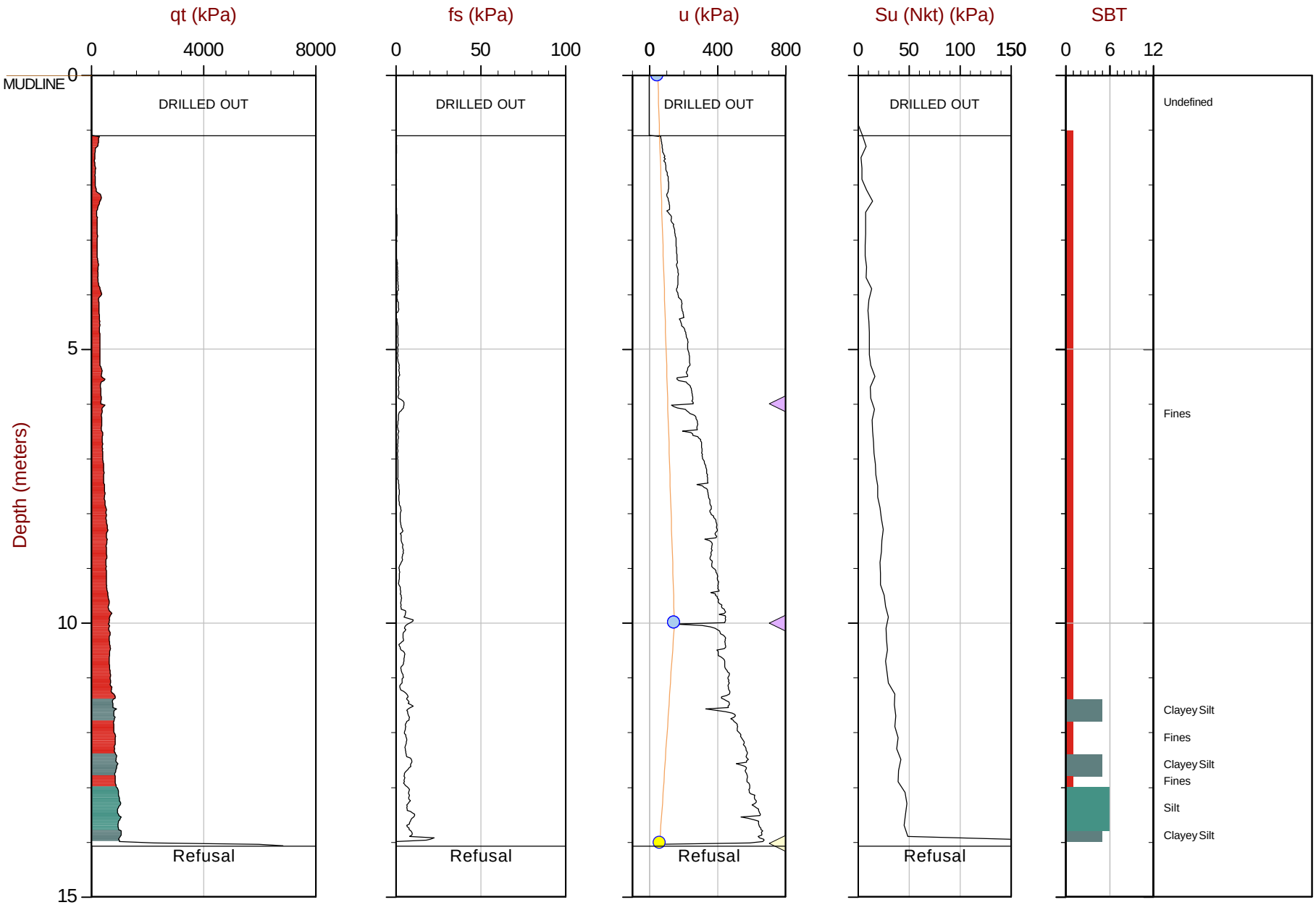
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Coords: UTM Zone 8 N: 6913870.65m E: 580528.32m Elev: 1046.64m
Page No: 2 of 2

CONETEC

CH2M

Job No: 16-02014
Date: 03:13:16 13:10
Site: Faro IP

Sounding: CH16-201-CP018
Cone: 317:T375F10U200



Max Depth: 14.075 m / 46.18 ft
Depth Inc: 0.025 m / 0.082 ft
Avg Int: 0.200 m
Overplot Item:
Assumed Ueq
Ueq

File: 16-02014_GS018.COR
Unit Wt: SBT Zones
Su Nkt: 15.0
Dissipation, equilibrium achieved
Dissipation, equilibrium not achieved
Equilibrium Pore Pressure Line

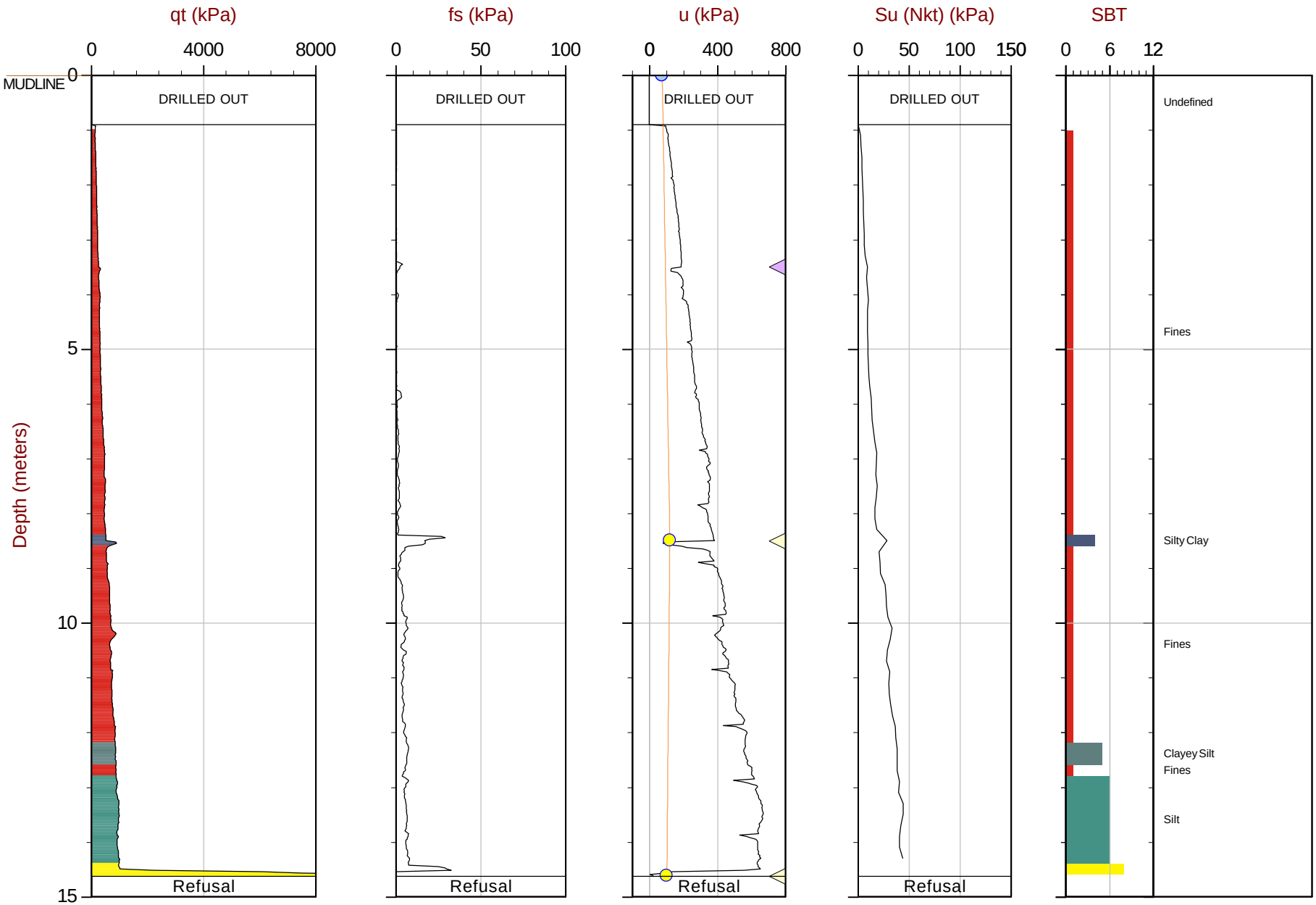
SBT: Robertson and Campanella, 1986
Coords: UTM Zone 8 N: 6914262.66m E: 580678.76m Elev: 1046.59m
Page No: 1 of 1

CONETEC

CH2M

Job No: 16-02014
Date: 03:16:16 10:17
Site: Faro IP

Sounding: CH16-201-CP019
Cone: 317:T375F10U200



Max Depth: 14.625 m / 47.98 ft
Depth Inc: 0.025 m / 0.082 ft
Avg Int: 0.200 m
Overplot Item:
Assumed Ueq
Ueq

File: 16-02014_GS019.COR
Unit Wt: SBT Zones
Su Nkt: 15.0
Dissipation, equilibrium achieved
Dissipation, equilibrium not achieved
Equilibrium Pore Pressure Line

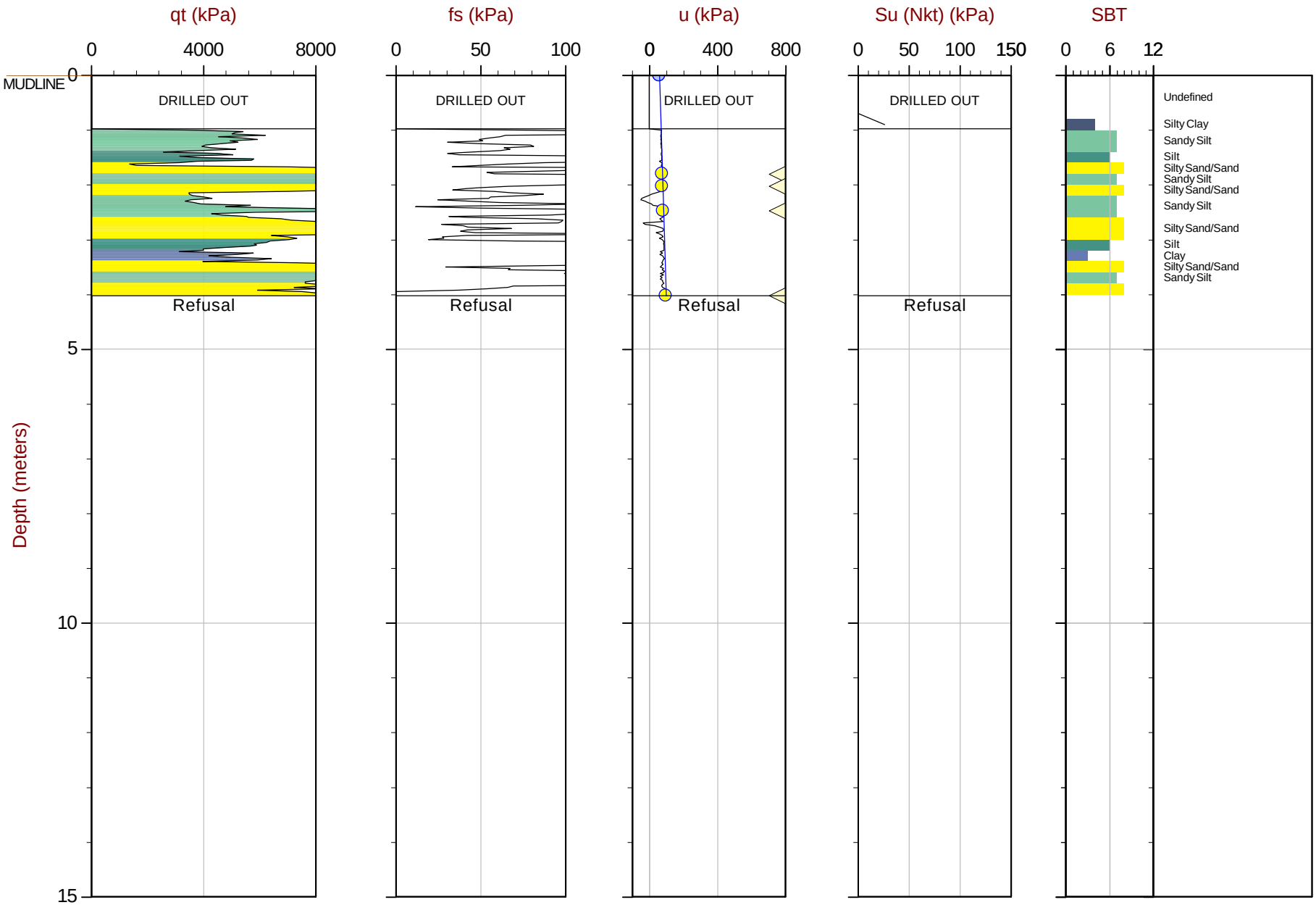
SBT: Robertson and Campanella, 1986
Coords: UTM Zone 8 N: 6914022.78m E: 580483.02m Elev: 1046.61m
Page No: 1 of 1

CONETEC

CH2M

Job No: 16-02014
Date: 03:07:16 16:23
Site: Faro CVP

Sounding: CH16-201-CP022
Cone: 317:T375F10U200



Max Depth: 4.025 m / 13.21 ft
Depth Inc: 0.025 m / 0.082 ft
Avg Int: 0.200 m
Overplot Item:
Assumed Ueq
Ueq

File: 16-02014_GS022.COR
Unit Wt: SBT Zones
Su Nkt: 15.0
Dissipation, equilibrium achieved
Dissipation, equilibrium not achieved
Hydrostatic Line

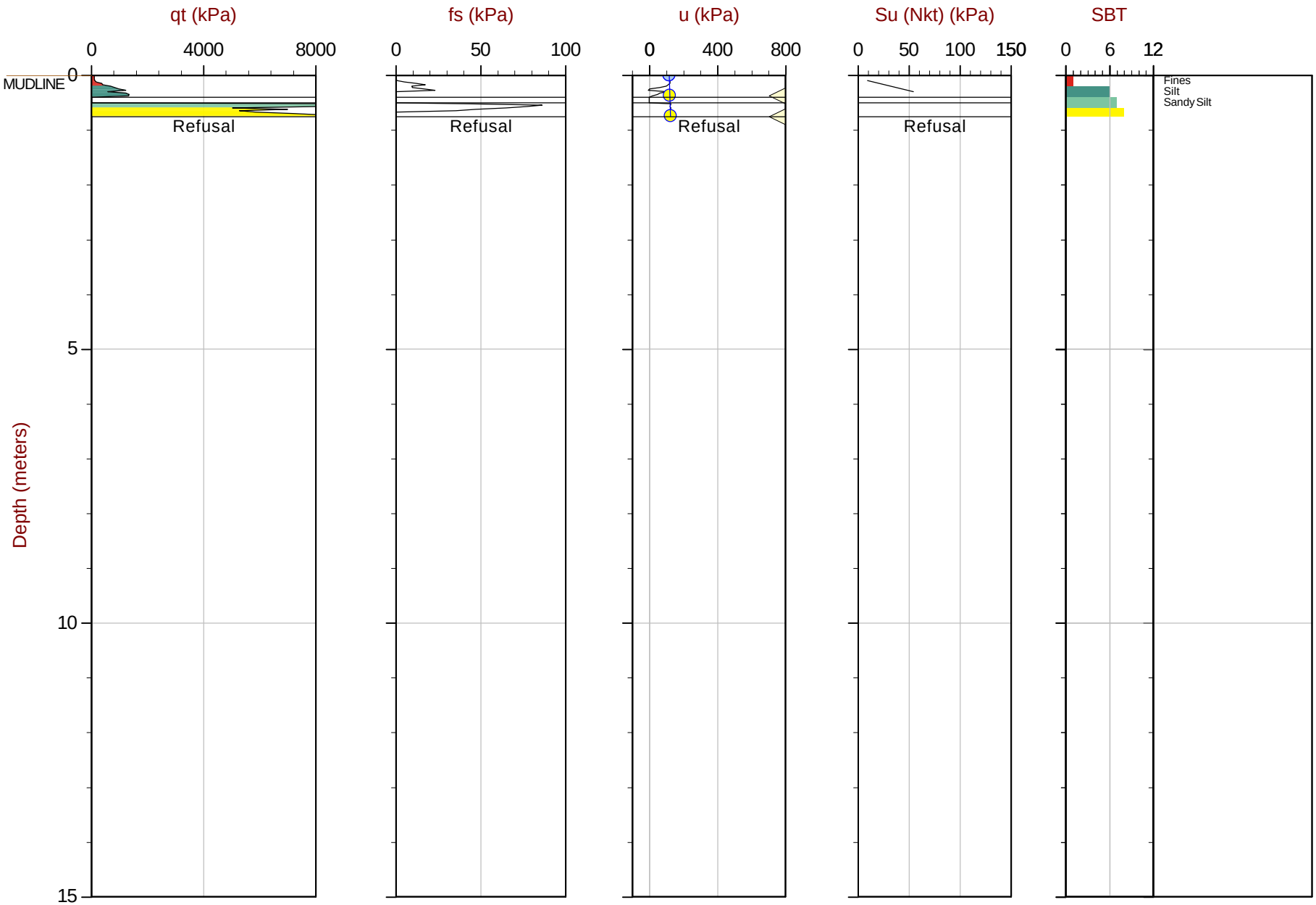
SBT: Robertson and Campanella, 1986
Coords: UTM Zone 8 N: 6914145.57m E: 580247.33m Elev: 1029.95m
Page No: 1 of 1

CONETEC

CH2M

Job No: 16-02014
Date: 03:06:16 16:43
Site: Faro CVP

Sounding: CH16-201-CP025
Cone: 317:T375F10U200



Max Depth: 0.750 m / 2.46 ft
Depth Inc: 0.025 m / 0.082 ft
Avg Int: 0.200 m
Overplot Item:
Assumed Ueq
Ueq

File: 16-02014_GS025.COR
Unit Wt: SBT Zones
Su Nkt: 15.0
Dissipation, equilibrium achieved
Dissipation, equilibrium not achieved
Hydrostatic Line

SBT: Robertson and Campanella, 1986
Coords: UTM Zone 8 N: 6914430.77m E: 580201.00m Elev: 1030.02m
Page No: 1 of 1

Seismic Cone Penetration Test Vs Plots

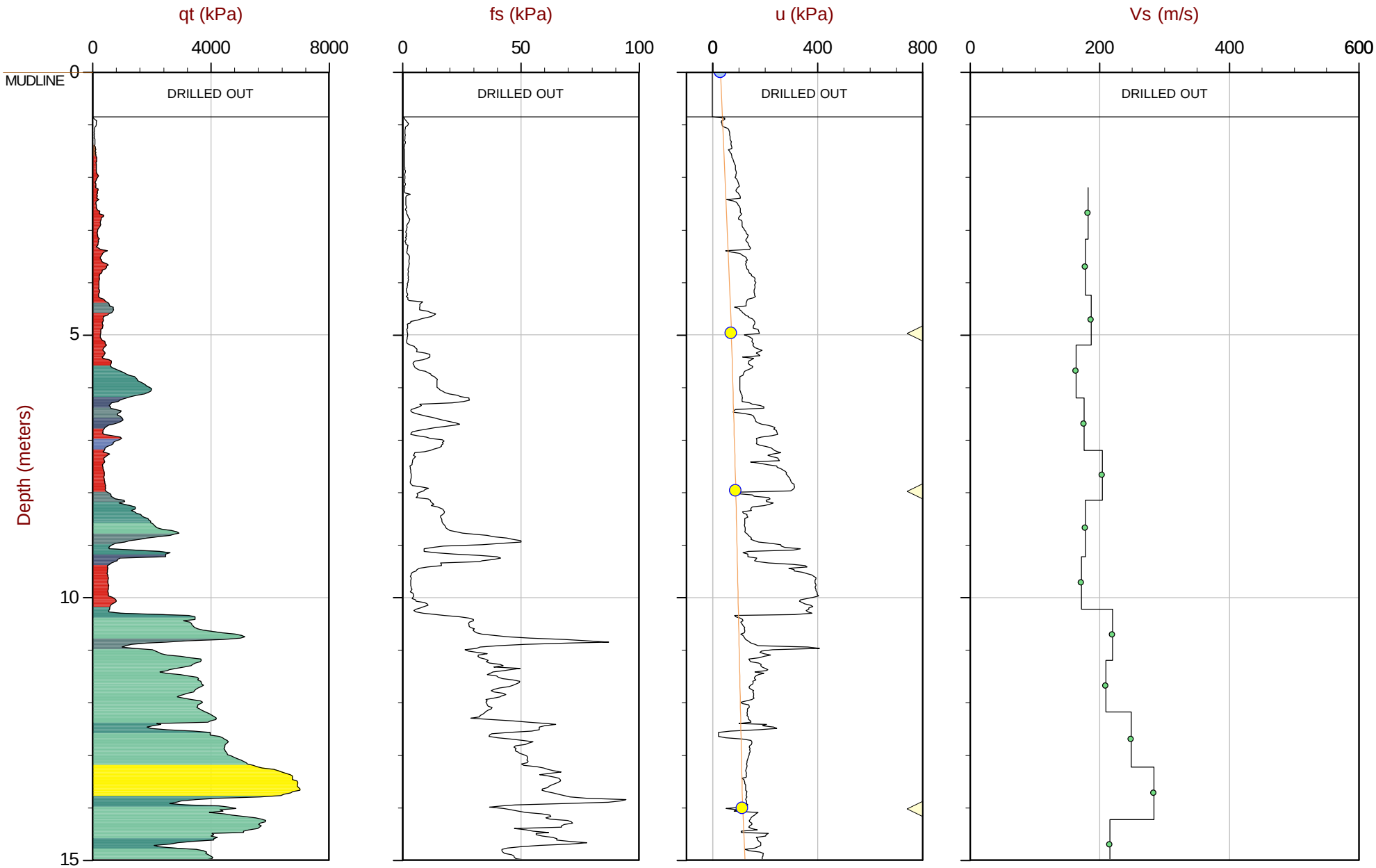
CONETEC

CONETEC

CH2M

Job No: 16-02014
Date: 03:15:16 10:14
Site: Faro IP

Sounding: CH16-201-CP014
Cone: 317:T375F10U200



Max Depth: 18.950 m / 62.17 ft
Depth Inc: 0.025 m / 0.082 ft
Avg Int: 0.200 m
Overplot Item:

File: 16-02014_GS014.COR
Unit Wt: SBT Zones

SBT: Robertson and Campanella, 1986
Coords: UTM Zone 8 N: 6914053.79m E: 580670.30m Elev: 1046.63m
Page No: 1 of 2

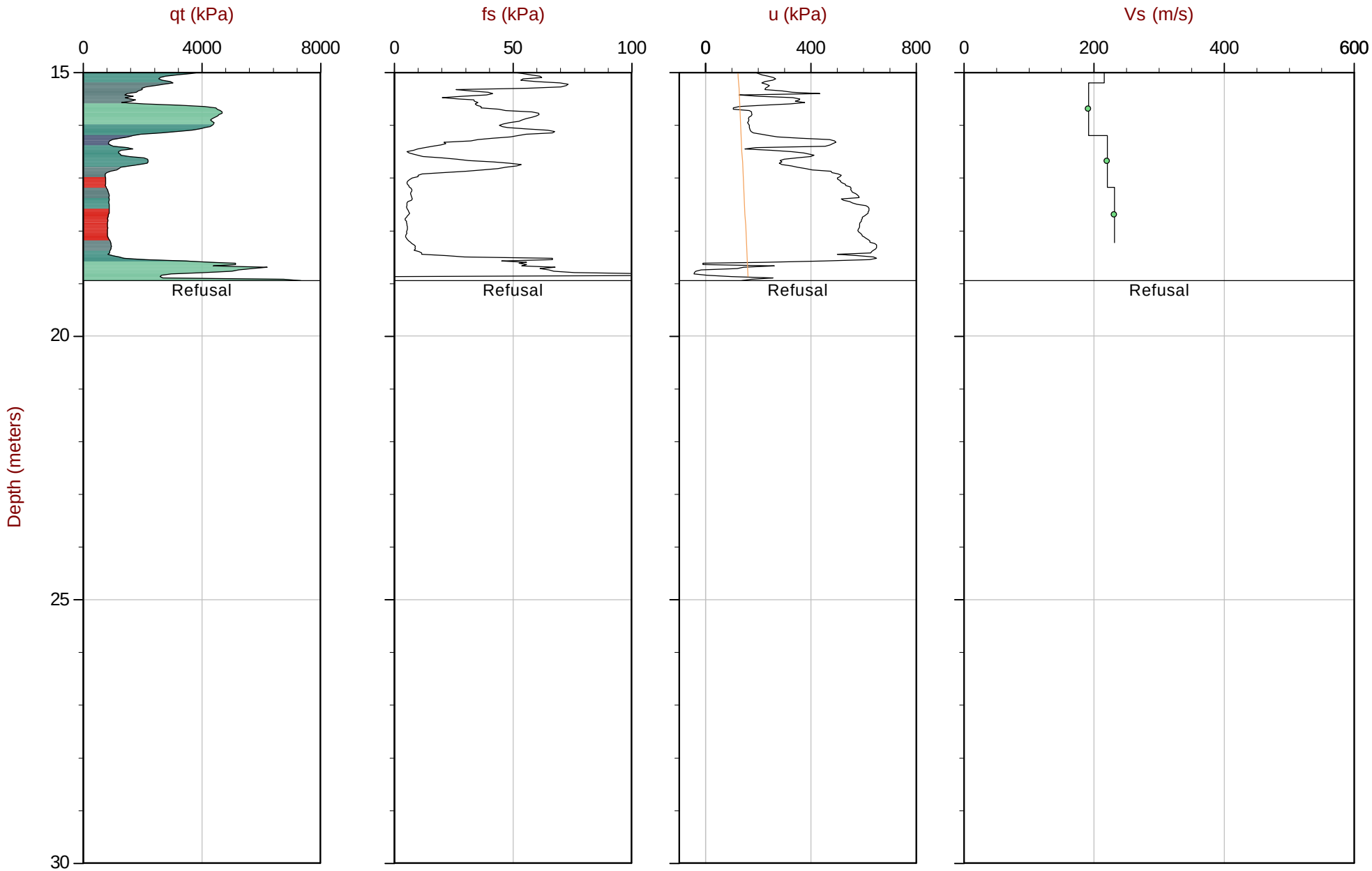
Assumed Ueq
Ueq
Dissipation, equilibrium achieved
Dissipation, equilibrium not achieved
Equilibrium Pore Pressure Line

CONETEC

CH2M

Job No: 16-02014
Date: 03:15:16 10:14
Site: Faro IP

Sounding: CH16-201-CP014
Cone: 317:T375F10U200



Max Depth: 18.950 m / 62.17 ft
Depth Inc: 0.025 m / 0.082 ft
Avg Int: 0.200 m
Overplot Item:

File: 16-02014_GS014.COR
Unit Wt: SBT Zones

SBT: Robertson and Campanella, 1986
Coords: UTM Zone 8 N: 6914053.79m E: 580670.30m Elev: 1046.63m
Page No: 2 of 2

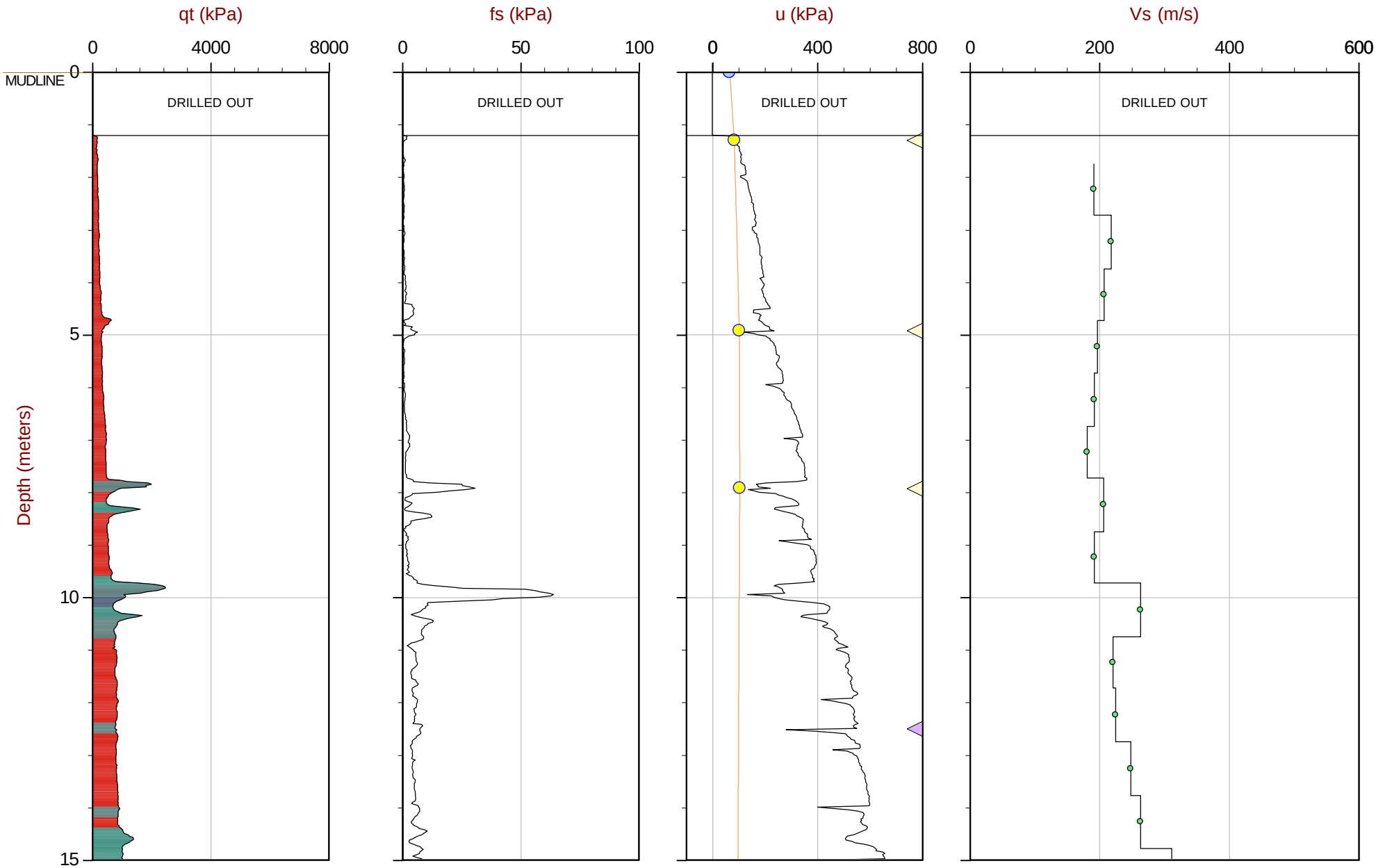
Assumed Ueq
Ueq
Dissipation, equilibrium achieved
Dissipation, equilibrium not achieved
Equilibrium Pore Pressure Line

CONETEC

CH2M

Job No: 16-02014
Date: 03:16:16 14:30
Site: Faro IP

Sounding: CH16-201-CP015
Cone: 317:T375F10U200



Max Depth: 16.400 m / 53.81 ft
Depth Inc: 0.025 m / 0.082 ft
Avg Int: 0.200 m
Overplot Item:

File: 16-02014_GS015.COR
Unit Wt: SBT Zones

SBT: Robertson and Campanella, 1986
Coords: UTM Zone 8 N: 6914144.44m E: 580594.24m Elev: 1046.61m
Page No: 1 of 2

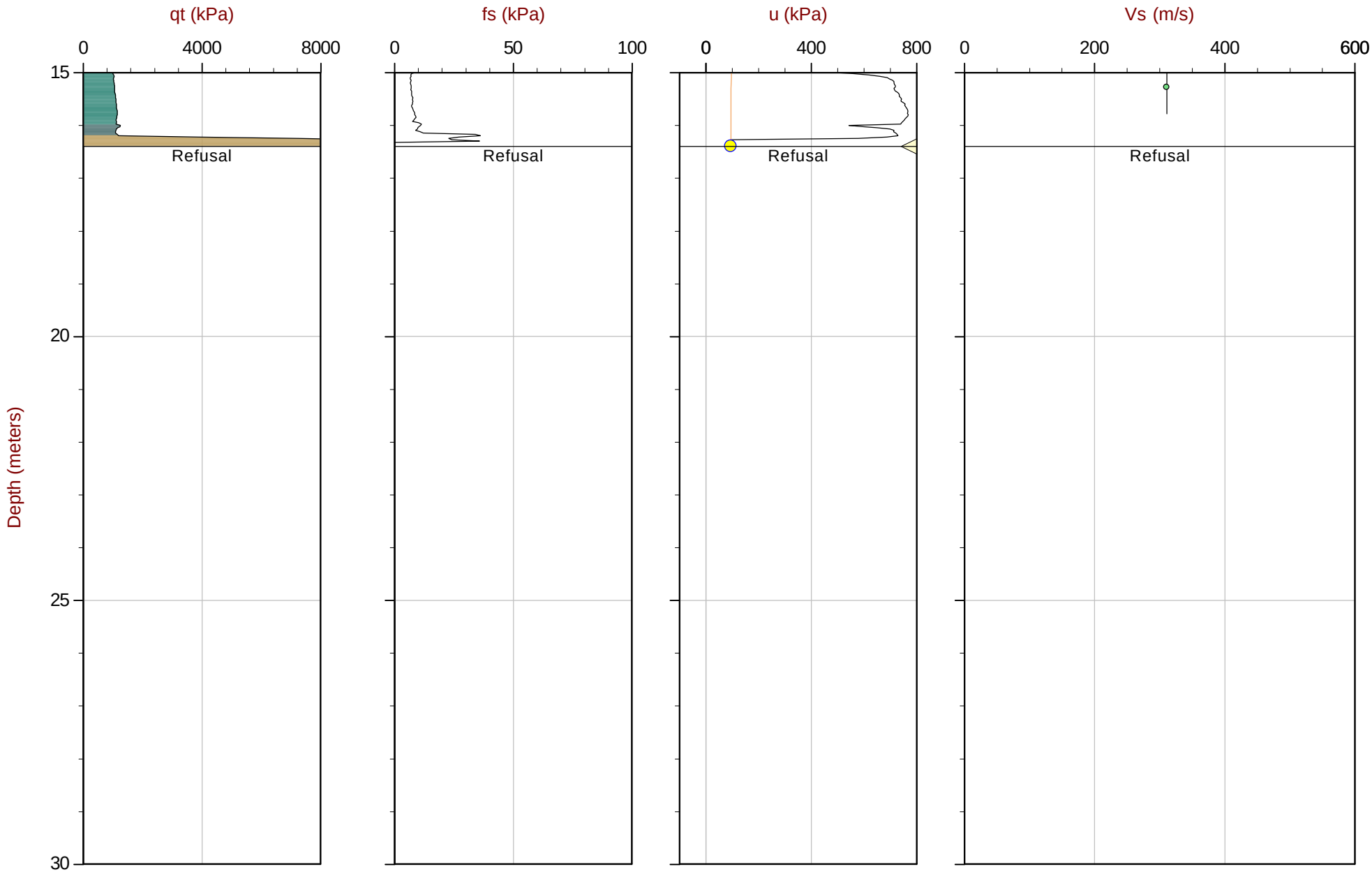
Assumed Ueq
Ueq
Dissipation, equilibrium achieved
Dissipation, equilibrium not achieved
Equilibrium Pore Pressure Line

CONETEC

CH2M

Job No: 16-02014
Date: 03:16:16 14:30
Site: Faro IP

Sounding: CH16-201-CP015
Cone: 317:T375F10U200



Max Depth: 16.400 m / 53.81 ft
Depth Inc: 0.025 m / 0.082 ft
Avg Int: 0.200 m
Overplot Item:

File: 16-02014_GS015.COR
Unit Wt: SBT Zones

SBT: Robertson and Campanella, 1986
Coords: UTM Zone 8 N: 6914144.44m E: 580594.24m Elev: 1046.61m
Page No: 2 of 2

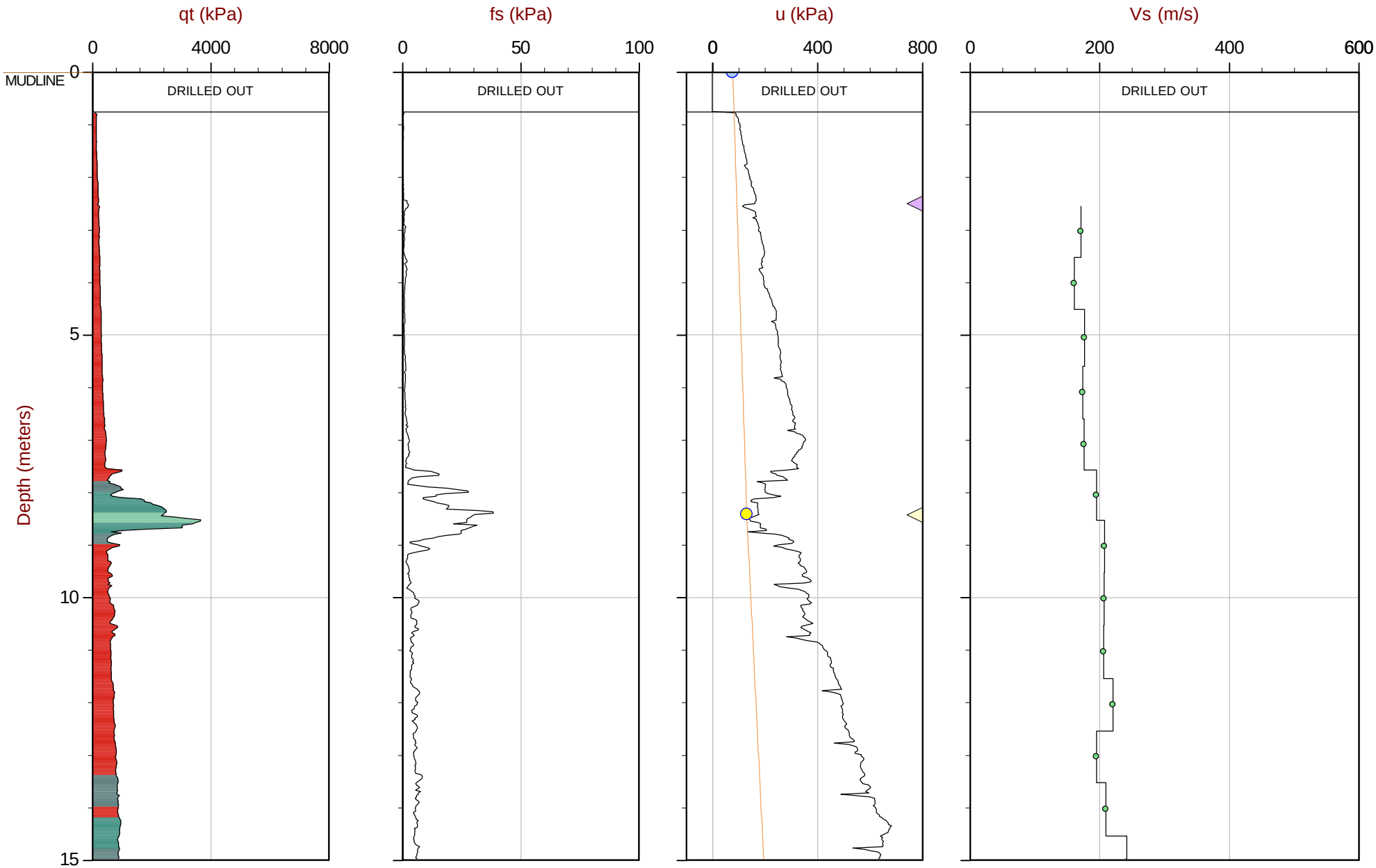
Assumed Ueq
Ueq
Dissipation, equilibrium achieved
Dissipation, equilibrium not achieved
Equilibrium Pore Pressure Line

CONETEC

CH2M

Job No: 16-02014
Date: 03:15:16 13:40
Site: Faro IP

Sounding: CH16-201-CP016
Cone: 317:T375F10U200



Max Depth: 18.950 m / 62.17 ft
Depth Inc: 0.025 m / 0.082 ft
Avg Int: 0.200 m
Overplot Item:

File: 16-02014_GS016.COR
Unit Wt: SBT Zones

SBT: Robertson and Campanella, 1986
Coords: UTM Zone 8 N: 6913921.32m E: 580410.84m Elev: 1046.62m
Page No: 1 of 2

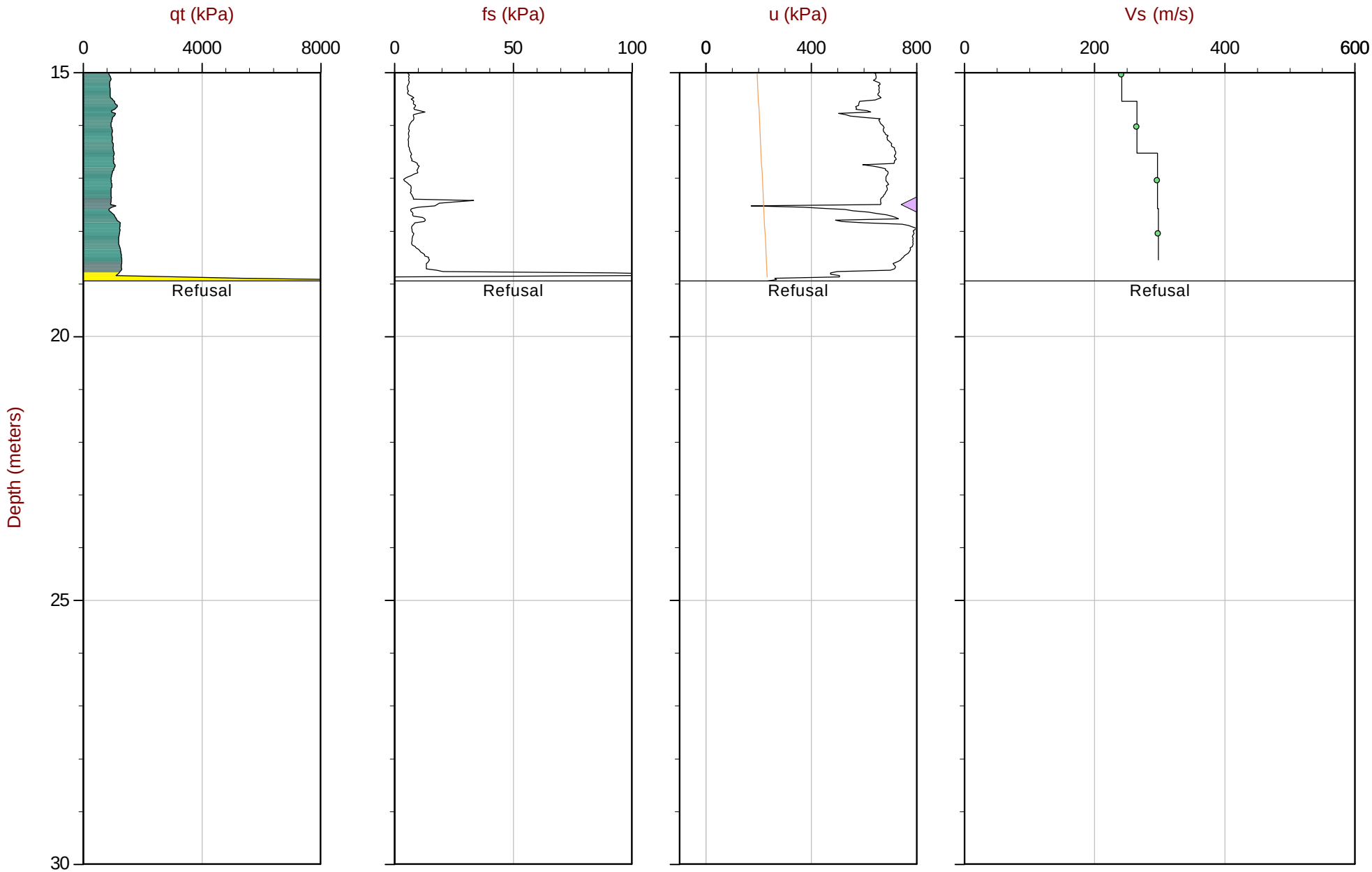
Assumed Ueq
Ueq
Dissipation, equilibrium achieved
Dissipation, equilibrium not achieved
Equilibrium Pore Pressure Line

CONETEC

CH2M

Job No: 16-02014
Date: 03:15:16 13:40
Site: Faro IP

Sounding: CH16-201-CP016
Cone: 317:T375F10U200



Max Depth: 18.950 m / 62.17 ft
Depth Inc: 0.025 m / 0.082 ft
Avg Int: 0.200 m
Overplot Item:

File: 16-02014_GS016.COR
Unit Wt: SBT Zones

SBT: Robertson and Campanella, 1986
Coords: UTM Zone 8 N: 6913921.32m E: 580410.84m Elev: 1046.62m
Page No: 2 of 2

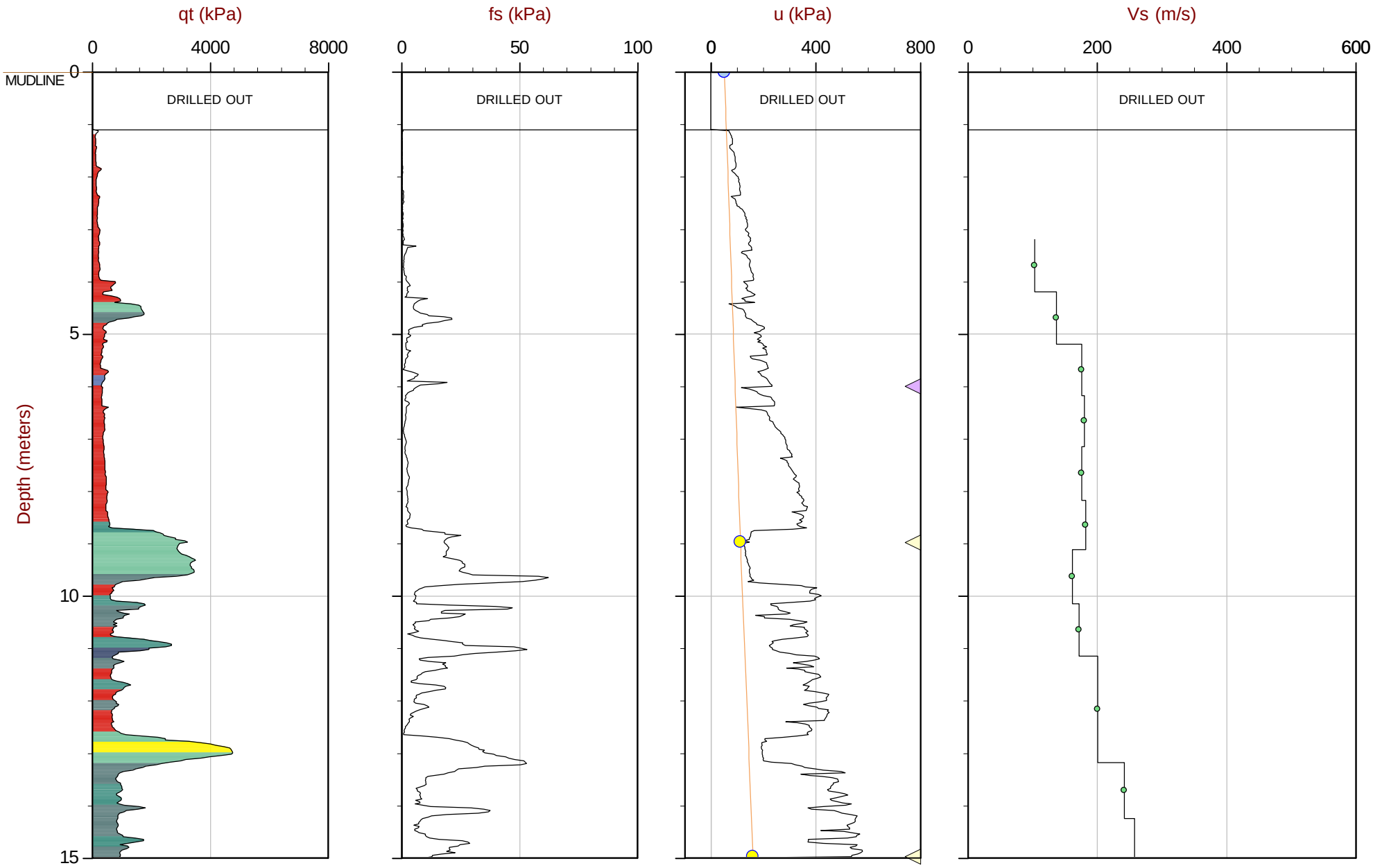
Assumed Ueq
Ueq
Dissipation, equilibrium achieved
Dissipation, equilibrium not achieved
Equilibrium Pore Pressure Line

CONETEC

CH2M

Job No: 16-02014
Date: 03:14:16 09:45
Site: Faro IP

Sounding: CH16-201-CP017
Cone: 317:T375F10U200



Max Depth: 20.675 m / 67.83 ft
Depth Inc: 0.025 m / 0.082 ft
Avg Int: 0.200 m
Overplot Item:

File: 16-02014_GS017.COR
Unit Wt: SBT Zones

SBT: Robertson and Campanella, 1986
Coords: UTM Zone 8 N: 6913870.65m E: 580528.32m Elev: 1046.64m
Page No: 1 of 2

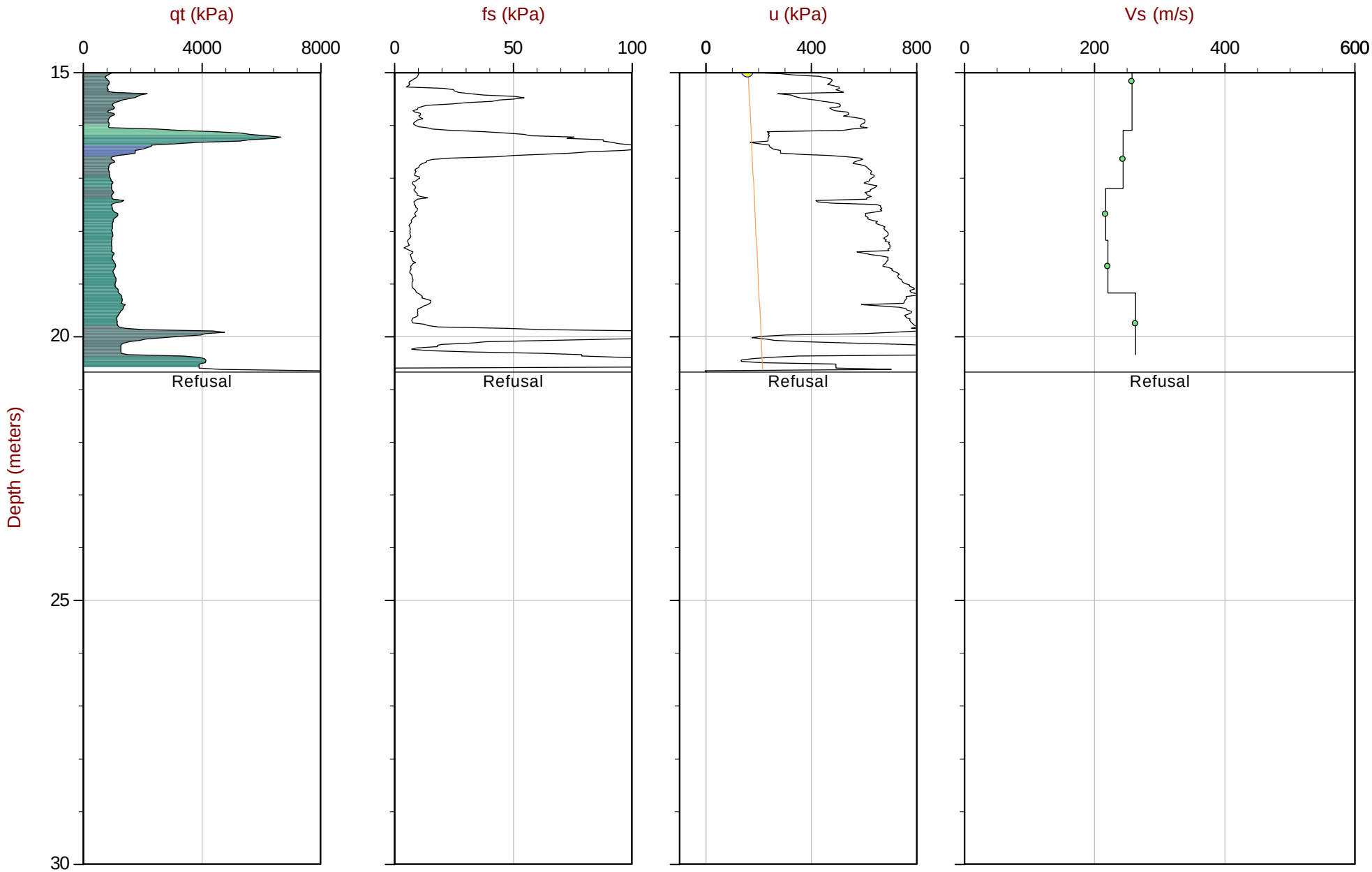
Assumed Ueq
Ueq
Dissipation, equilibrium achieved
Dissipation, equilibrium not achieved
Equilibrium Pore Pressure Line

CONETEC

CH2M

Job No: 16-02014
Date: 03:14:16 09:45
Site: Faro IP

Sounding: CH16-201-CP017
Cone: 317:T375F10U200



Max Depth: 20.675 m / 67.83 ft
Depth Inc: 0.025 m / 0.082 ft
Avg Int: 0.200 m
Overplot Item:

File: 16-02014_GS017.COR
Unit Wt: SBT Zones

SBT: Robertson and Campanella, 1986
Coords: UTM Zone 8 N: 6913870.65m E: 580528.32m Elev: 1046.64m
Page No: 2 of 2

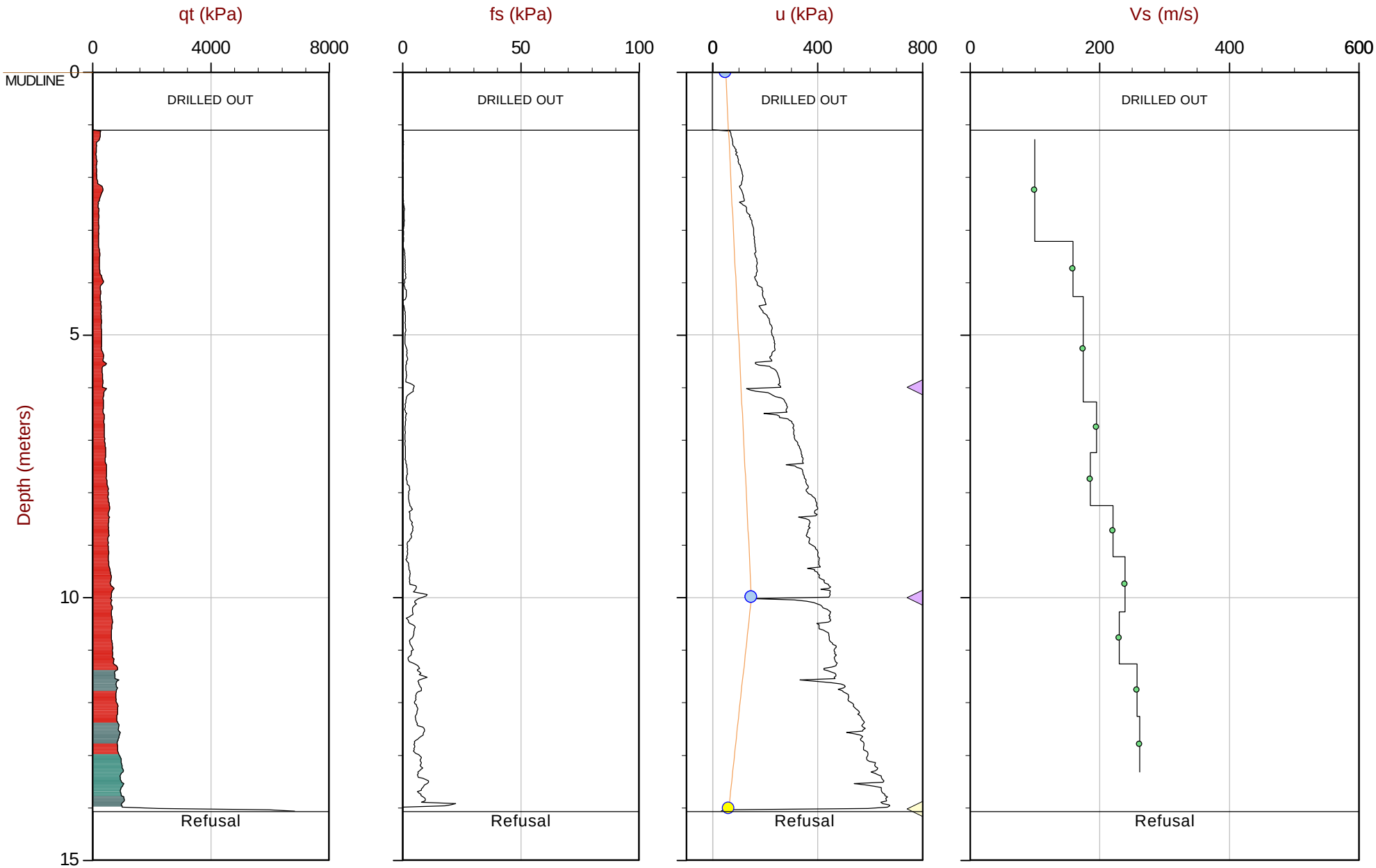
Assumed Ueq
Ueq
Dissipation, equilibrium achieved
Dissipation, equilibrium not achieved
Equilibrium Pore Pressure Line

CONETEC

CH2M

Job No: 16-02014
Date: 03:13:16 13:10
Site: Faro IP

Sounding: CH16-201-CP018
Cone: 317:T375F10U200



Max Depth: 14.075 m / 46.18 ft
Depth Inc: 0.025 m / 0.082 ft
Avg Int: 0.200 m
Overplot Item:

File: 16-02014_GS018.COR
Unit Wt: SBT Zones

SBT: Robertson and Campanella, 1986
Coords: UTM Zone 8 N: 6914262.66m E: 580678.76m Elev: 1046.59m
Page No: 1 of 1

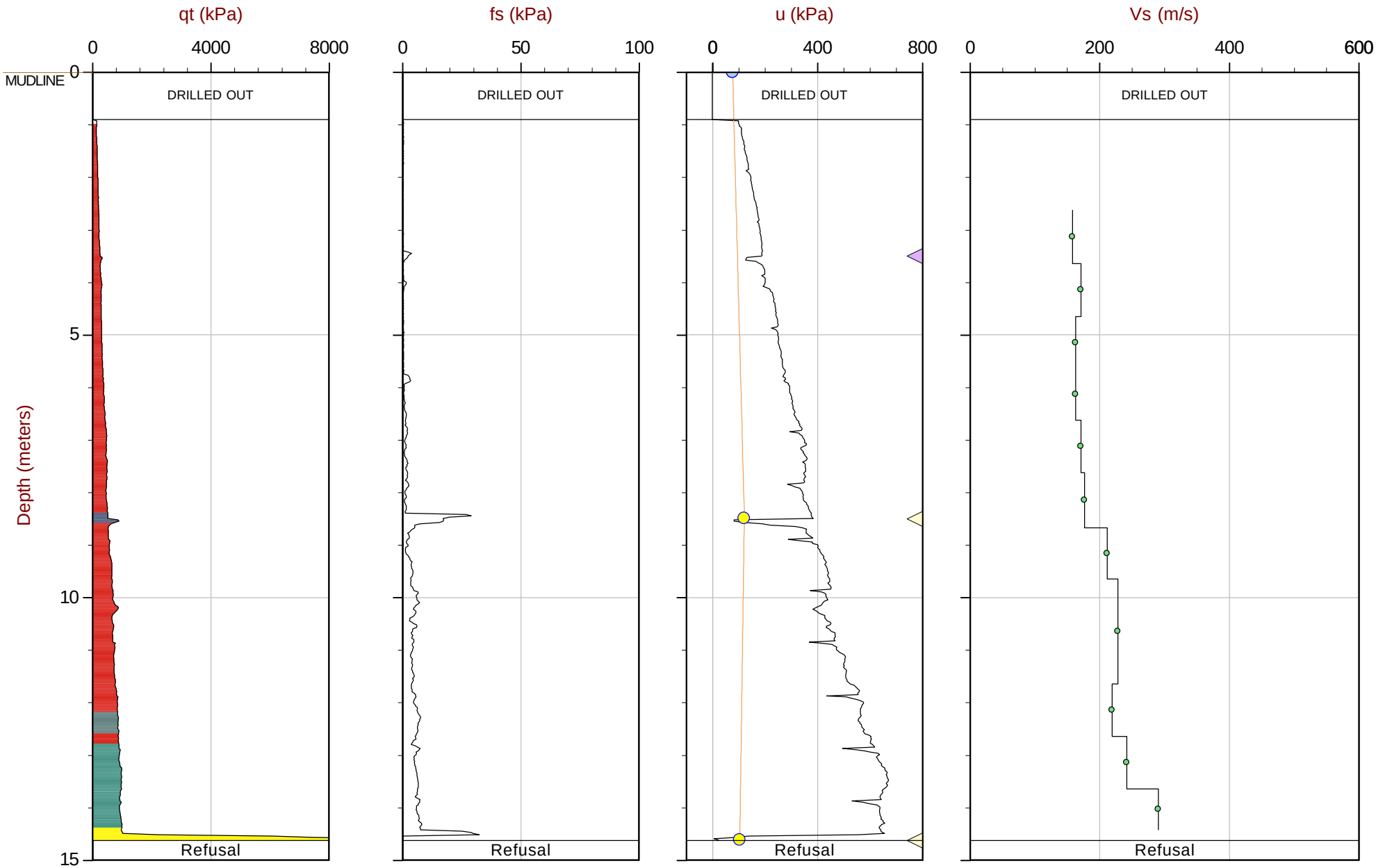
Assumed Ueq
Ueq
Dissipation, equilibrium achieved
Dissipation, equilibrium not achieved
Equilibrium Pore Pressure Line

CONETEC

CH2M

Job No: 16-02014
Date: 03:16:16 10:17
Site: Faro IP

Sounding: CH16-201-CP019
Cone: 317:T375F10U200



Max Depth: 14.625 m / 47.98 ft
Depth Inc: 0.025 m / 0.082 ft
Avg Int: 0.200 m
Overplot Item:

File: 16-02014_GS019.COR
Unit Wt: SBT Zones

SBT: Robertson and Campanella, 1986
Coords: UTM Zone 8 N: 6914022.78m E: 580483.02m Elev: 1046.61m
Page No: 1 of 1

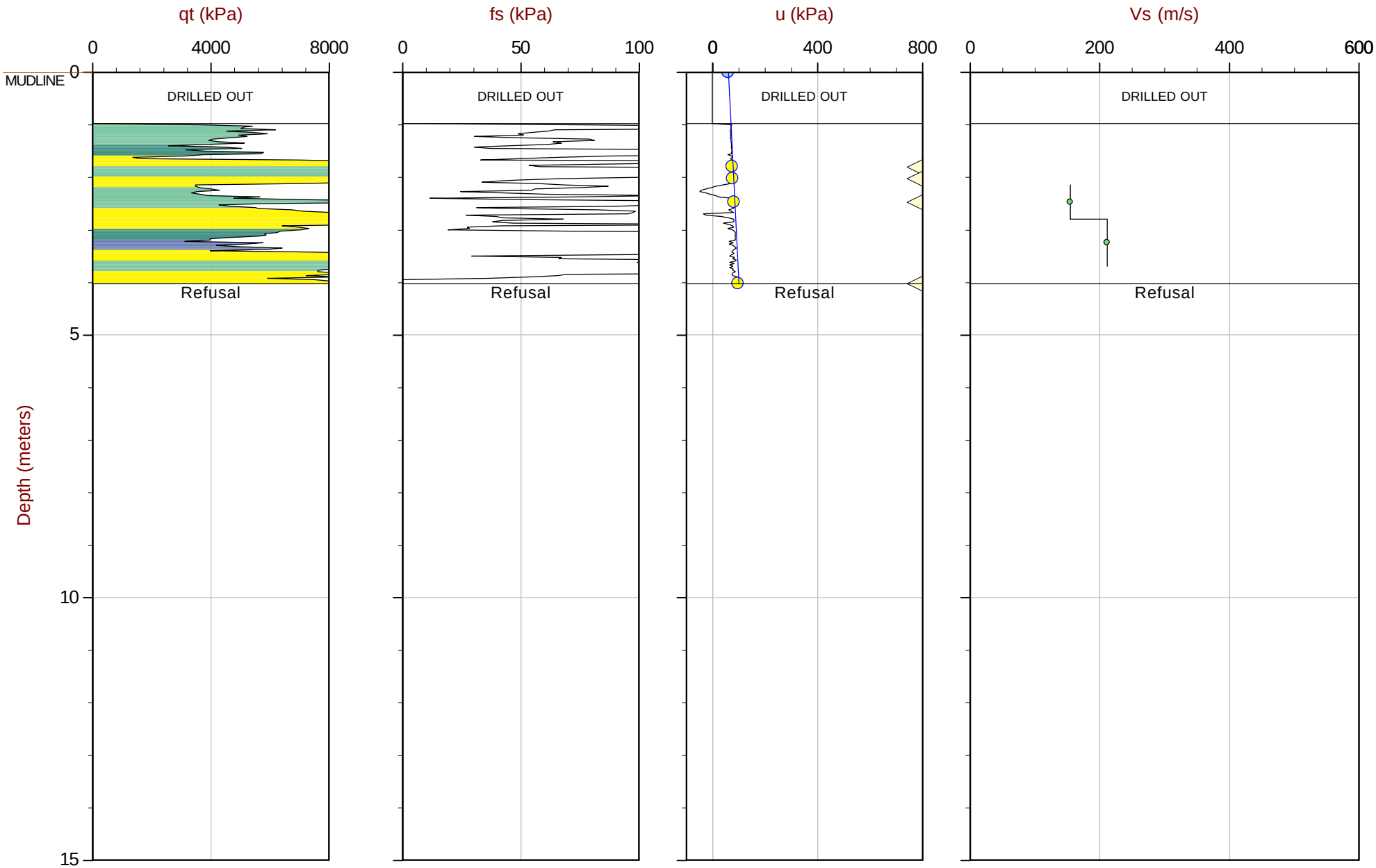
Assumed Ueq
Ueq
Dissipation, equilibrium achieved
Dissipation, equilibrium not achieved
Equilibrium Pore Pressure Line

CONETEC

CH2M

Job No: 16-02014
Date: 03:07:16 16:23
Site: Faro CVP

Sounding: CH16-201-CP022
Cone: 317:T375F10U200



Max Depth: 4.025 m / 13.21 ft
Depth Inc: 0.025 m / 0.082 ft
Avg Int: 0.200 m
Overplot Item:

File: 16-02014_GS022.COR
Unit Wt: SBT Zones

SBT: Robertson and Campanella, 1986
Coords: UTM Zone 8 N: 6914145.57m E: 580247.33m Elev: 1029.95m
Page No: 1 of 1

Assumed Ueq
Ueq
Dissipation, equilibrium achieved
Dissipation, equilibrium not achieved
Hydrostatic Line

Seismic Cone Penetration Test Vs Results



Job No:	16-02014
Client:	CH2M Hill Canada Ltd.
Project:	Faro Mine Complex
Sounding ID:	CH16-201-CP014
Date:	15-Mar-2016

Seismic Source:	Auto-seis hammer
Source Offset (m):	2.80
Source Depth (m):	0.00
Geophone Offset (m):	0.20

SCPTu SHEAR WAVE VELOCITY TEST RESULTS - Vs

Tip Depth (m)	Geophone Depth (m)	Ray Path (m)	Ray Path Difference (m)	Travel Time Interval (ms)	Interval Velocity (m/s)
2.40	2.20	3.56			
3.38	3.18	4.24	0.68	3.71	182
4.45	4.25	5.09	0.85	4.78	178
5.40	5.20	5.91	0.82	4.37	187
6.40	6.20	6.80	0.90	5.48	164
7.40	7.20	7.73	0.92	5.25	176
8.35	8.15	8.62	0.89	4.37	204
9.43	9.23	9.65	1.03	5.78	178
10.43	10.23	10.61	0.96	5.57	172
11.40	11.20	11.54	0.94	4.26	220
12.38	12.18	12.50	0.95	4.54	210
13.43	13.23	13.52	1.03	4.11	249
14.43	14.23	14.50	0.98	3.45	284
15.40	15.20	15.46	0.95	4.40	216
16.40	16.20	16.44	0.98	5.14	192
17.38	17.18	17.41	0.97	4.37	221
18.43	18.23	18.44	1.04	4.48	232

Job No:	16-02014
Client:	CH2M Hill Canada Ltd.
Project:	Faro Mine Complex
Sounding ID:	CH16-201-CP015
Date:	16-Mar-2016

Seismic Source:	Auto-seis hammer
Source Offset (m):	3.10
Source Depth (m):	0.15
Geophone Offset (m):	0.20

SCPTu SHEAR WAVE VELOCITY TEST RESULTS - Vs

Tip Depth (m)	Geophone Depth (m)	Ray Path (m)	Ray Path Difference (m)	Travel Time Interval (ms)	Interval Velocity (m/s)
3.95	3.75	4.75			
4.93	4.73	5.53	0.78	3.77	207
5.93	5.73	6.38	0.85	4.33	197
6.95	6.75	7.29	0.91	4.72	192
7.93	7.73	8.19	0.90	4.95	181
8.95	8.75	9.14	0.95	4.61	206
9.93	9.73	10.07	0.93	4.84	192
10.95	10.75	11.04	0.97	3.71	263
11.93	11.73	11.99	0.94	4.27	221
12.95	12.75	12.98	0.99	4.39	225
13.98	13.78	13.98	1.00	4.05	248
14.98	14.78	14.95	0.98	3.71	263
15.98	15.78	15.93	0.98	3.15	311

Job No:	16-02014
Client:	CH2M Hill Canada Ltd.
Project:	Faro Mine Complex
Sounding ID:	CH16-201-CP016
Date:	15-Mar-2016

Seismic Source:	Auto-seis hammer
Source Offset (m):	3.00
Source Depth (m):	0.30
Geophone Offset (m):	0.20

SCPTu SHEAR WAVE VELOCITY TEST RESULTS - Vs

Tip Depth (m)	Geophone Depth (m)	Ray Path (m)	Ray Path Difference (m)	Travel Time Interval (ms)	Interval Velocity (m/s)
3.73	3.53	4.41			
4.72	4.52	5.18	0.77	4.78	161
5.80	5.60	6.09	0.91	5.17	177
6.80	6.60	6.98	0.89	5.09	174
7.78	7.58	7.87	0.90	5.09	176
8.73	8.53	8.76	0.89	4.54	195
9.73	9.53	9.71	0.95	4.54	208
10.73	10.53	10.66	0.96	4.62	207
11.75	11.55	11.64	0.98	4.78	206
12.75	12.55	12.61	0.97	4.38	221
13.73	13.53	13.57	0.95	4.89	195
14.75	14.55	14.56	1.00	4.74	210
15.75	15.55	15.54	0.98	4.04	242
16.73	16.53	16.50	0.96	3.63	265
17.78	17.58	17.54	1.03	3.48	297
18.75	18.55	18.49	0.96	3.21	298

Job No:	16-02014
Client:	CH2M Hill Canada Ltd.
Project:	Faro Mine Complex
Sounding ID:	CH16-201-CP017
Date:	14-Mar-2016

Seismic Source:	Auto-seis hammer
Source Offset (m):	3.05
Source Depth (m):	0.25
Geophone Offset (m):	0.20

SCPTu SHEAR WAVE VELOCITY TEST RESULTS - Vs

Tip Depth (m)	Geophone Depth (m)	Ray Path (m)	Ray Path Difference (m)	Travel Time Interval (ms)	Interval Velocity (m/s)
3.40	3.20	4.24			
4.40	4.20	4.99	0.75	7.27	103
5.40	5.20	5.81	0.82	6.02	137
6.38	6.18	6.67	0.85	4.86	176
7.35	7.15	7.54	0.88	4.86	180
8.38	8.18	8.50	0.95	5.41	176
9.32	9.12	9.38	0.88	4.86	182
10.35	10.15	10.36	0.98	6.03	162
11.35	11.15	11.32	0.96	5.56	172
13.38	13.18	13.28	1.97	9.80	201
14.45	14.25	14.33	1.04	4.31	242
16.30	16.10	16.14	1.81	7.02	258
17.40	17.20	17.22	1.08	4.44	244
18.38	18.18	18.19	0.97	4.45	217
19.38	19.18	19.17	0.99	4.47	221
20.55	20.35	20.33	1.16	4.39	263

Job No:	16-02014
Client:	CH2M Hill Canada Ltd.
Project:	Faro Mine Complex
Sounding ID:	CH16-201-CP018
Date:	13-Mar-2016

Seismic Source:	Auto-seis hammer
Source Offset (m):	3.30
Source Depth (m):	0.00
Geophone Offset (m):	0.20

SCPTu SHEAR WAVE VELOCITY TEST RESULTS - Vs

Tip Depth (m)	Geophone Depth (m)	Ray Path (m)	Ray Path Difference (m)	Travel Time Interval (ms)	Interval Velocity (m/s)
1.48	1.28	3.54			
3.42	3.22	4.61	1.07	10.67	100
4.47	4.27	5.40	0.79	4.94	159
6.48	6.28	7.09	1.70	9.70	175
7.45	7.25	7.97	0.87	4.48	195
8.45	8.25	8.89	0.92	4.94	186
9.43	9.23	9.80	0.92	4.14	221
10.48	10.28	10.80	0.99	4.17	239
11.47	11.27	11.74	0.95	4.11	230
12.47	12.27	12.71	0.96	3.73	258
13.53	13.33	13.73	1.03	3.92	262

Job No:	16-02014
Client:	CH2M Hill Canada Ltd.
Project:	Faro Mine Complex
Sounding ID:	CH16-201-CP019
Date:	16-Mar-2016

Seismic Source:	Auto-seis hammer
Source Offset (m):	2.85
Source Depth (m):	0.20
Geophone Offset (m):	0.20

SCPTu SHEAR WAVE VELOCITY TEST RESULTS - Vs

Tip Depth (m)	Geophone Depth (m)	Ray Path (m)	Ray Path Difference (m)	Travel Time Interval (ms)	Interval Velocity (m/s)
2.83	2.63	3.75			
3.85	3.65	4.47	0.73	4.62	158
4.85	4.65	5.28	0.81	4.73	171
5.85	5.65	6.15	0.87	5.30	163
6.83	6.63	7.03	0.88	5.41	163
7.83	7.63	7.96	0.92	5.41	171
8.88	8.68	8.95	0.99	5.57	177
9.85	9.65	9.87	0.92	4.36	212
11.85	11.65	11.80	1.93	8.47	228
12.85	12.65	12.77	0.97	4.44	219
13.85	13.65	13.75	0.98	4.03	242
14.63	14.43	14.51	0.76	2.62	291

Job No:	16-02014
Client:	CH2M Hill Canada Ltd.
Project:	Faro Mine Complex
Sounding ID:	CH16-201-CP022
Date:	07-Mar-2016

Seismic Source:	Auto-seis hammer
Source Offset (m):	3.00
Source Depth (m):	0.00
Geophone Offset (m):	0.20

SCPTu SHEAR WAVE VELOCITY TEST RESULTS - Vs

Tip Depth (m)	Geophone Depth (m)	Ray Path (m)	Ray Path Difference (m)	Travel Time Interval (ms)	Interval Velocity (m/s)
2.35	2.15	3.69			
3.00	2.80	4.10	0.41	2.66	155
3.90	3.70	4.76	0.66	3.11	212

Pore Pressure Dissipation (CPTu) Summary and Pore Pressure Dissipaton Plots

Job No:	16-02014
Client:	CH2M Hill Canada Ltd.
Project:	Faro Mine Complex
Start Date:	06-Mar-2016
End Date:	16-Mar-2016

CPTu PORE PRESSURE DISSIPATION SUMMARY

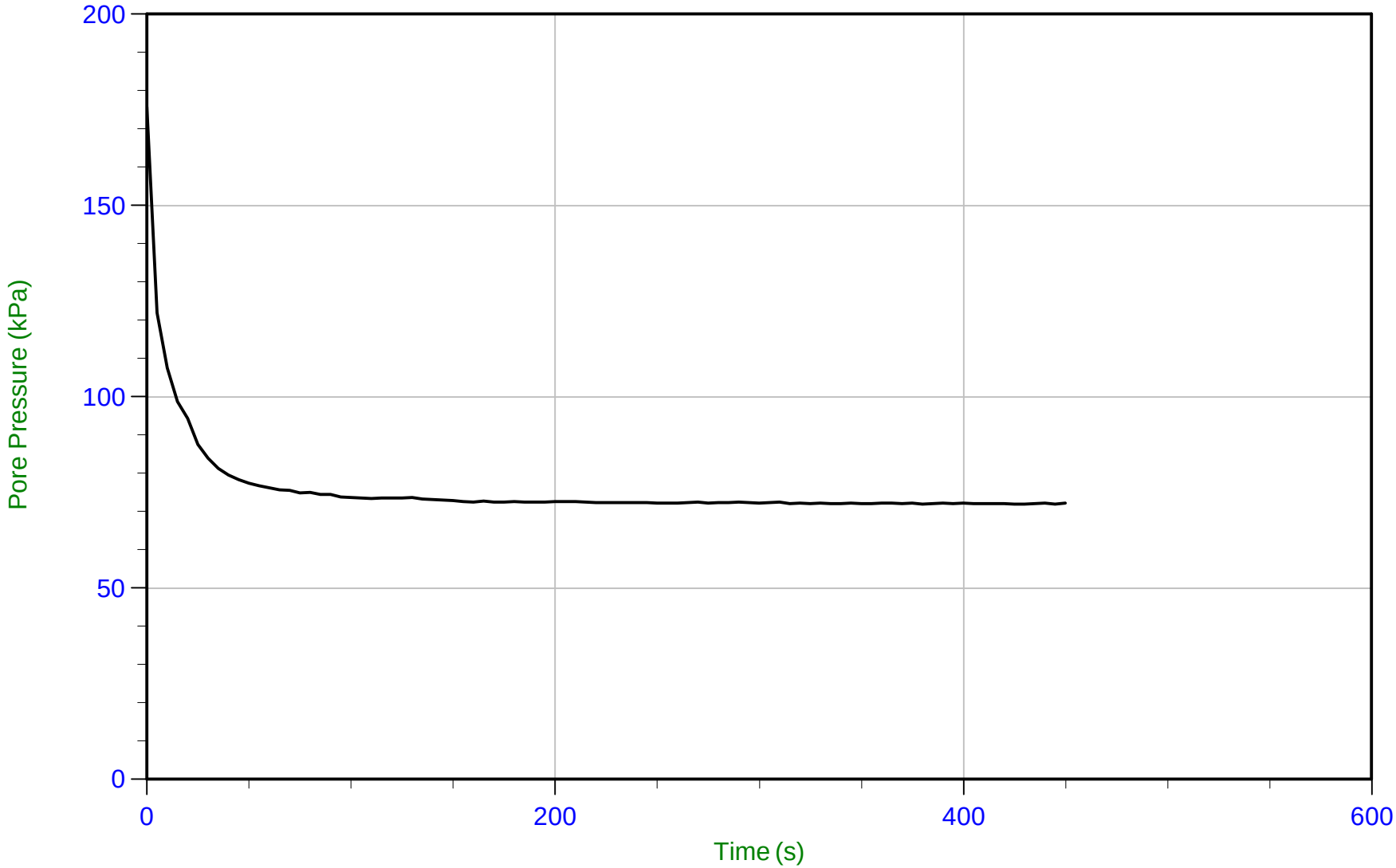
Sounding ID	File Name	Cone Area (cm^2)	Duration (s)	Test Depth (m)	Estimated Equilibrium Pore Pressure U_{eq} (m)	Calculated Phreatic Surface (m)
CH16-201-CP014	16-02014_GS014	15	450	4.975	7.3	-2.4
CH16-201-CP014	16-02014_GS014	15	1200	7.975	9.0	-1.1
CH16-201-CP014	16-02014_GS014	15	450	14.025	11.7	2.3
CH16-201-CP015	16-02014_GS015	15	790	1.300	8.5	-7.2
CH16-201-CP015	16-02014_GS015	15	3600	4.925	10.4	-5.5
CH16-201-CP015	16-02014_GS015	15	400	7.925	10.6	-2.7
CH16-201-CP015	16-02014_GS015	15	450	12.500	Not Achieved	
CH16-201-CP015	16-02014_GS015	15	600	16.400	9.7	6.7
CH16-201-CP016	16-02014_GS016	15	1260	2.500	Not Achieved	
CH16-201-CP016	16-02014_GS016	15	600	8.425	13.3	-4.9
CH16-201-CP016	16-02014_GS016	15	5400	17.500	Not Achieved	
CH16-201-CP017	16-02014_GS017	15	950	6.000	Not Achieved	
CH16-201-CP017	16-02014_GS017	15	400	8.975	11.5	-2.5
CH16-201-CP017	16-02014_GS017	15	1800	14.975	16.4	-1.4
CH16-201-CP018	16-02014_GS018	15	775	6.000	Not Achieved	
CH16-201-CP018	16-02014_GS018	15	750	10.000	Not Achieved	
CH16-201-CP018	16-02014_GS018	15	5400	14.025	6.3	7.7
CH16-201-CP019	16-02014_GS019	15	1350	3.500	Not Achieved	
CH16-201-CP019	16-02014_GS019	15	3400	8.500	12.4	-3.9
CH16-201-CP019	16-02014_GS019	15	1500	14.625	10.6	4.0
CH16-201-CP022	16-02014_GS022	15	3110	1.800	7.7	-5.9
CH16-201-CP022	16-02014_GS022	15	520	2.025	7.8	-5.8
CH16-201-CP022	16-02014_GS022	15	550	2.475	8.3	-5.8
CH16-201-CP022	16-02014_GS022	15	205	4.025	9.9	-5.9
CH16-201-CP025	16-02014_GS025	15	360	0.375	12.4	-12.0
CH16-201-CP025	16-02014_GS025	15	560	0.750	13.0	-12.3

CONETEC

CH2M

Job No: 16-02014
Date: 03/15/2016 10:14
Site: Faro IP

Sounding: CH16-201-CP014
Cone: 317:T375F10U200
Cone Area: 15 sq cm



Trace Summary:

Filename: 16-02014_GS014.PPF
Depth: 4.975 m / 16.322 ft
Duration: 450.0 s

U Min: 71.9 kPa
U Max: 175.8 kPa

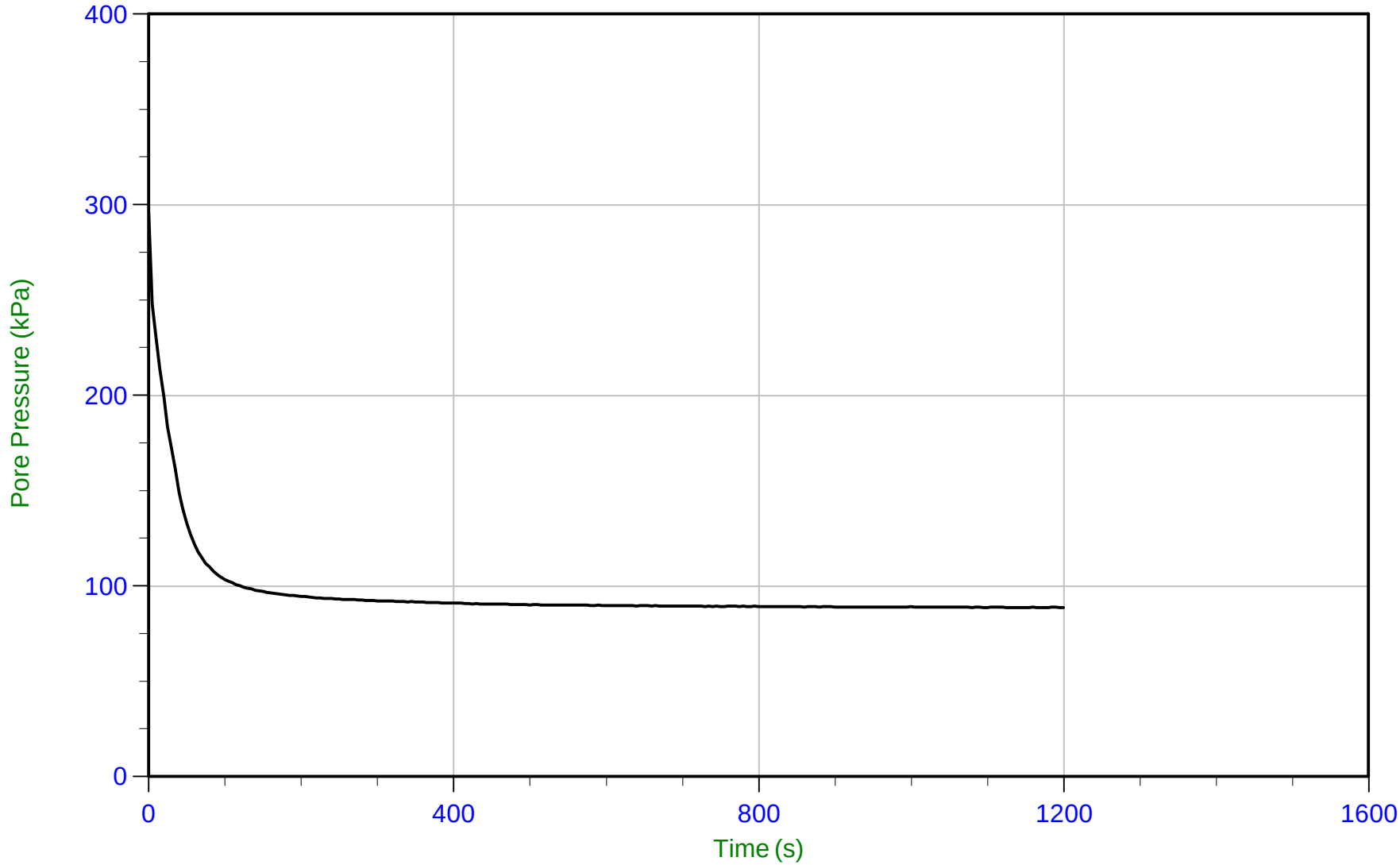
WT: -2.366 m / -7.762 ft
Ueq: 72.0 kPa

CONETEC

CH2M

Job No: 16-02014
Date: 03/15/2016 10:14
Site: Faro IP

Sounding: CH16-201-CP014
Cone: 317:T375F10U200
Cone Area: 15 sq cm



Trace Summary:

Filename: 16-02014_GS014.PPF
Depth: 7.975 m / 26.164 ft
Duration: 1200.0 s

U Min: 88.6 kPa
U Max: 296.3 kPa

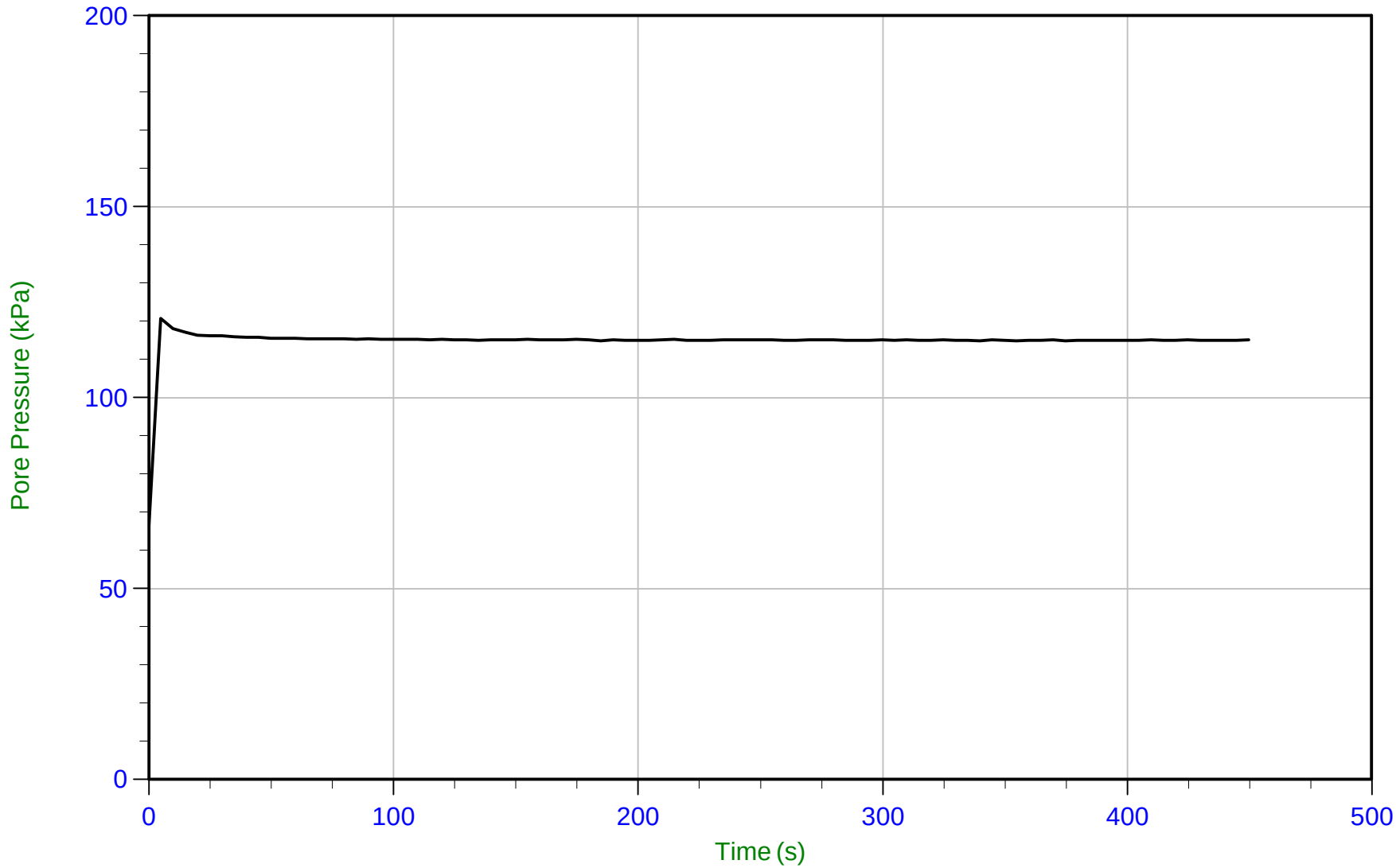
WT: -1.073 m / -3.520 ft
Ueq: 88.7 kPa

CONETEC

CH2M

Job No: 16-02014
Date: 03/15/2016 10:14
Site: Faro IP

Sounding: CH16-201-CP014
Cone: 317:T375F10U200
Cone Area: 15 sq cm



Trace Summary:

Filename: 16-02014_GS014.PPF
Depth: 14.025 m / 46.013 ft
Duration: 450.0 s

U Min: 66.7 kPa
U Max: 120.7 kPa

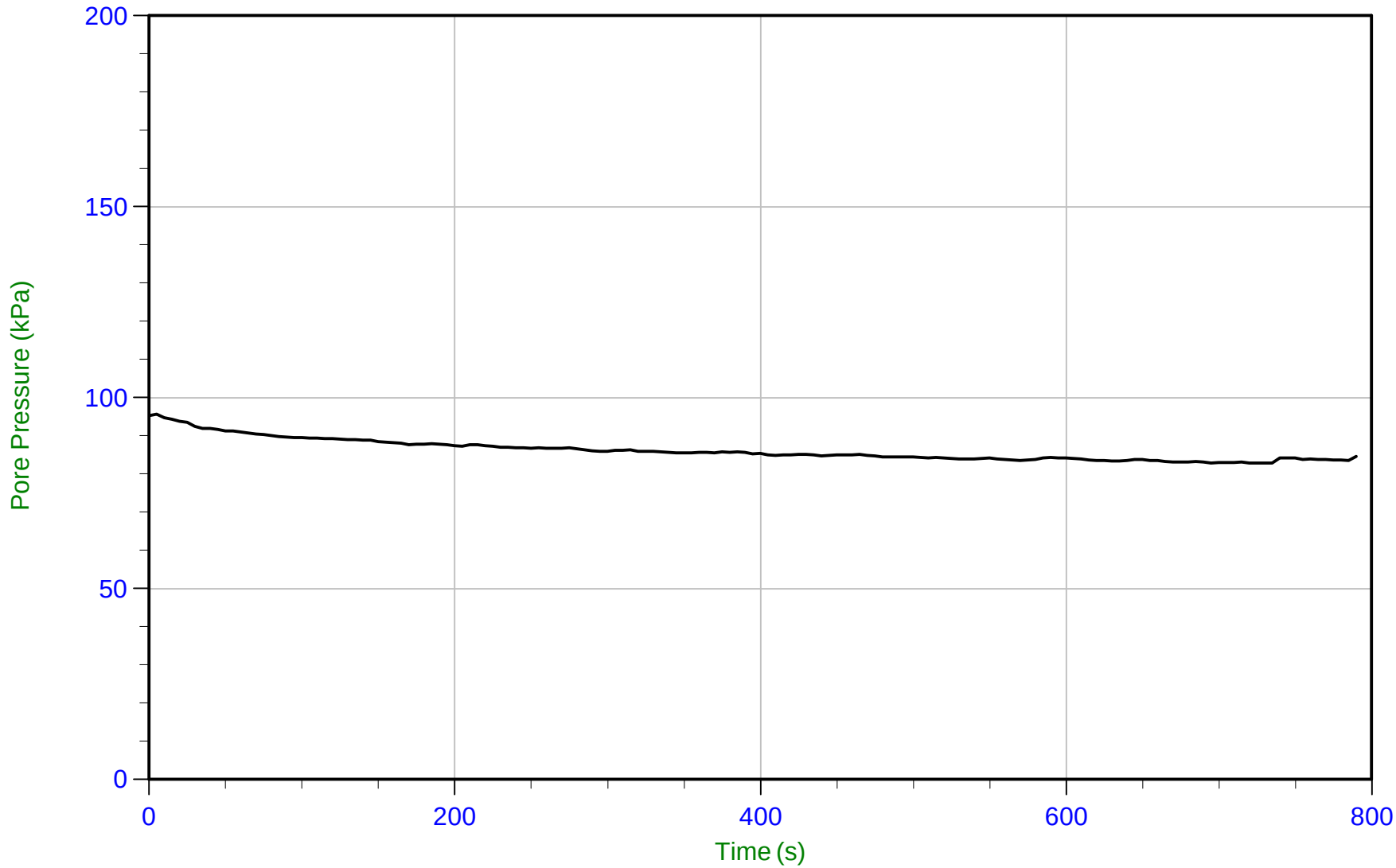
WT: 2.331 m / 7.648 ft
Ueq: 114.6 kPa

CONETEC

CH2M

Job No: 16-02014
Date: 03/16/2016 14:30
Site: Faro IP

Sounding: CH16-201-CP015
Cone: 317:T375F10U200
Cone Area: 15 sq cm



Trace Summary:

Filename: 16-02014_GS015.PPF
Depth: 1.300 m / 4.265 ft
Duration: 790.0 s

U Min: 82.8 kPa
U Max: 95.7 kPa

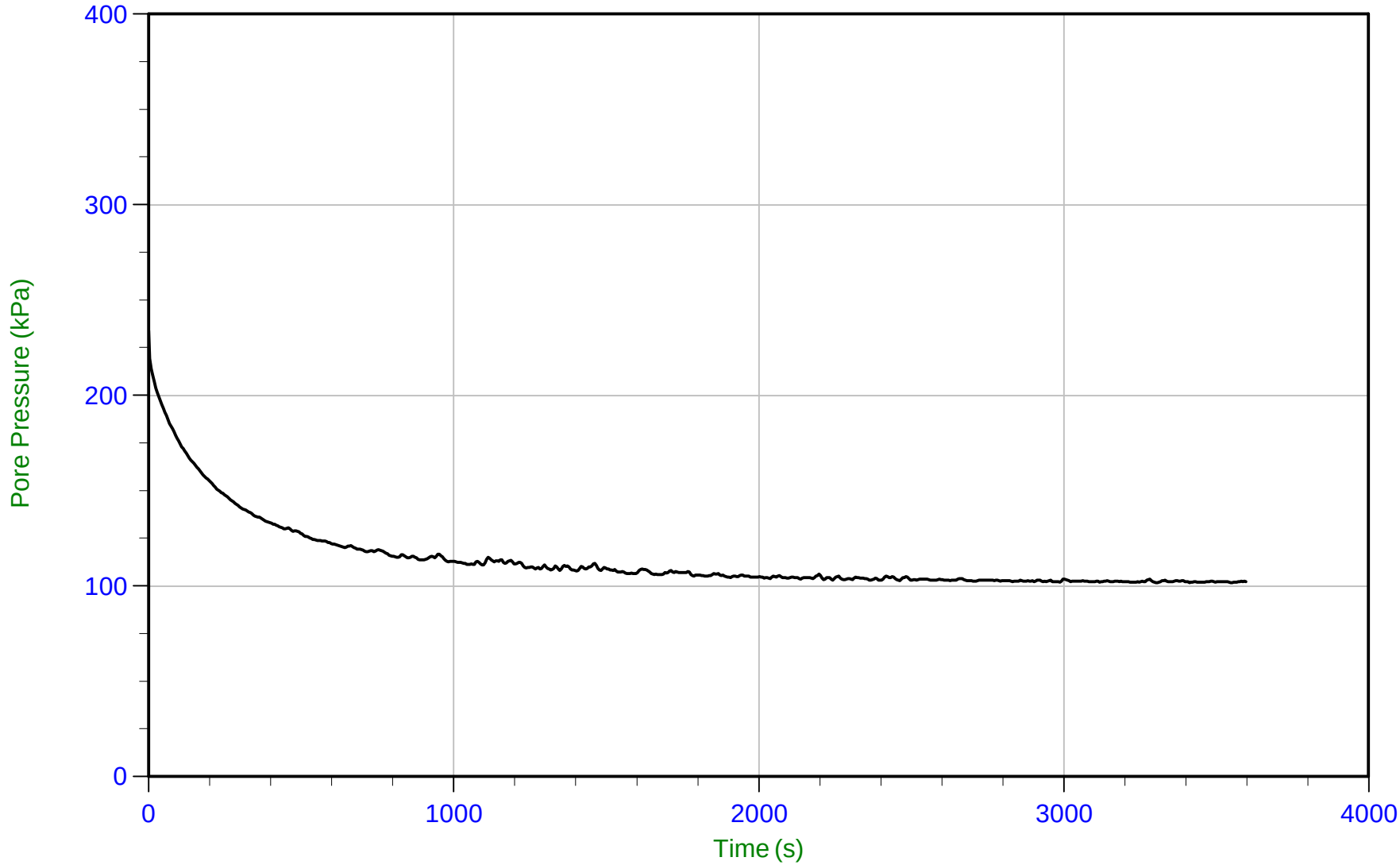
WT: -7.193 m / -23.599 ft
Ueq: 83.3 kPa

CONETEC

CH2M

Job No: 16-02014
Date: 03/16/2016 14:30
Site: Faro IP

Sounding: CH16-201-CP015
Cone: 317:T375F10U200
Cone Area: 15 sq cm



Trace Summary:

Filename: 16-02014_GS015.PPF
Depth: 4.925 m / 16.158 ft
Duration: 3600.0 s

U Min: 101.8 kPa
U Max: 234.1 kPa

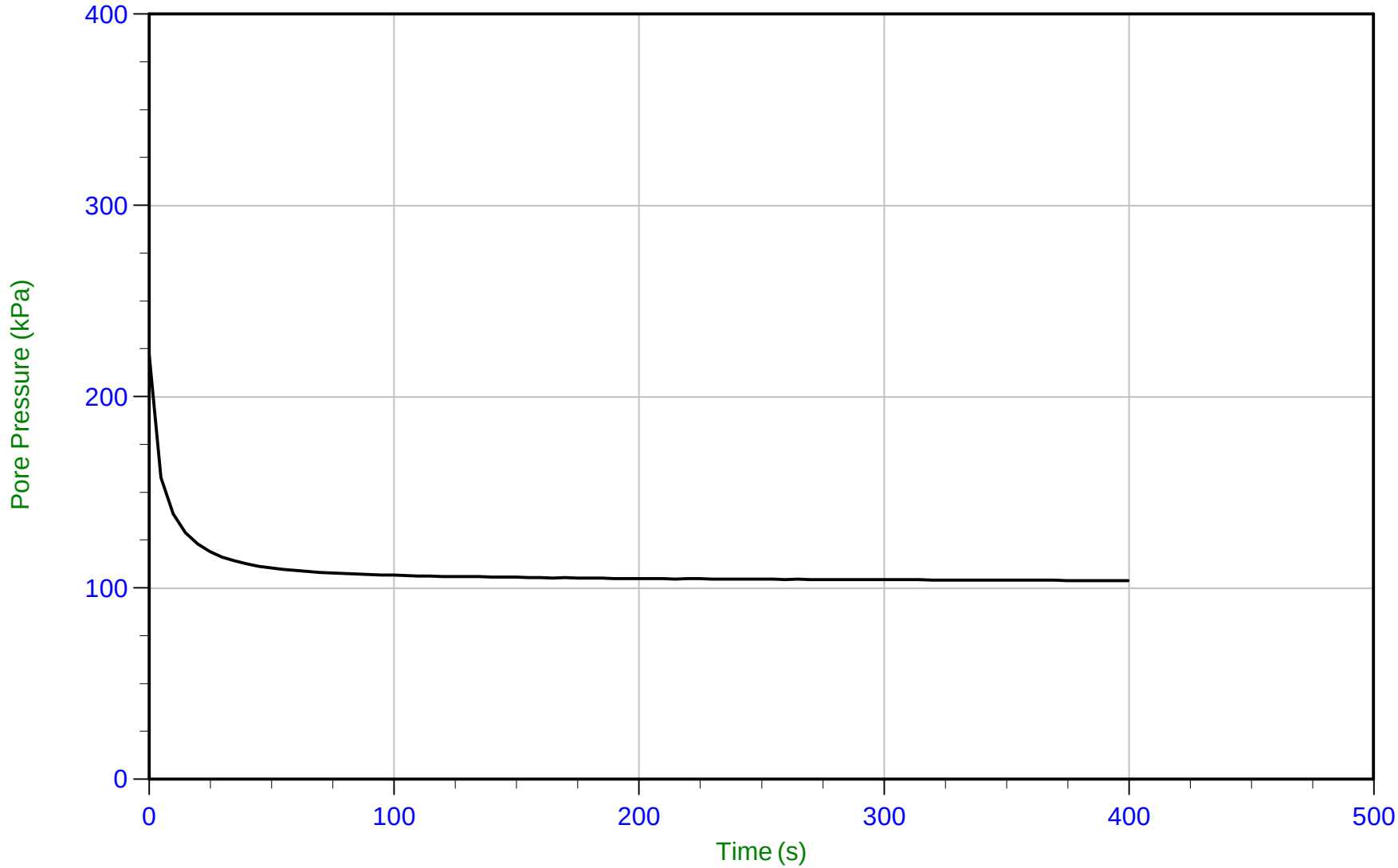
WT: -5.488 m / -18.005 ft
Ueq: 102.1 kPa

CONETEC

CH2M

Job No: 16-02014
Date: 03/16/2016 14:30
Site: Faro IP

Sounding: CH16-201-CP015
Cone: 317:T375F10U200
Cone Area: 15 sq cm



Trace Summary:

Filename: 16-02014_GS015.PPF
Depth: 7.925 m / 26.000 ft
Duration: 400.0 s

U Min: 103.8 kPa
U Max: 222.0 kPa

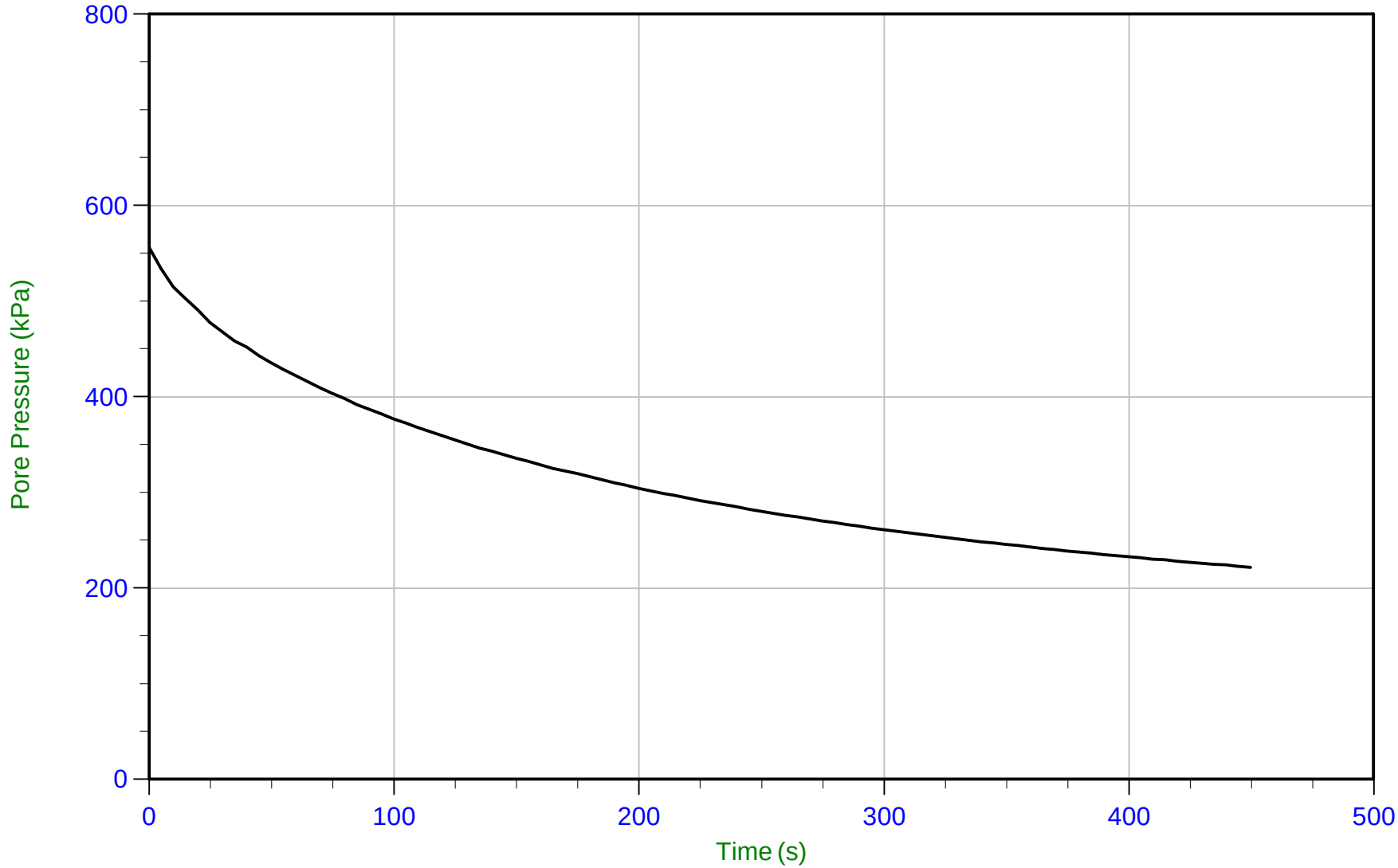
WT: -2.659 m / -8.724 ft
Ueq: 103.8 kPa

CONETEC

CH2M

Job No: 16-02014
Date: 03/16/2016 14:30
Site: Faro IP

Sounding: CH16-201-CP015
Cone: 317:T375F10U200
Cone Area: 15 sq cm



Trace Summary:

Filename: 16-02014_GS015.PPF
Depth: 12.500 m / 41.010 ft
Duration: 450.0 s

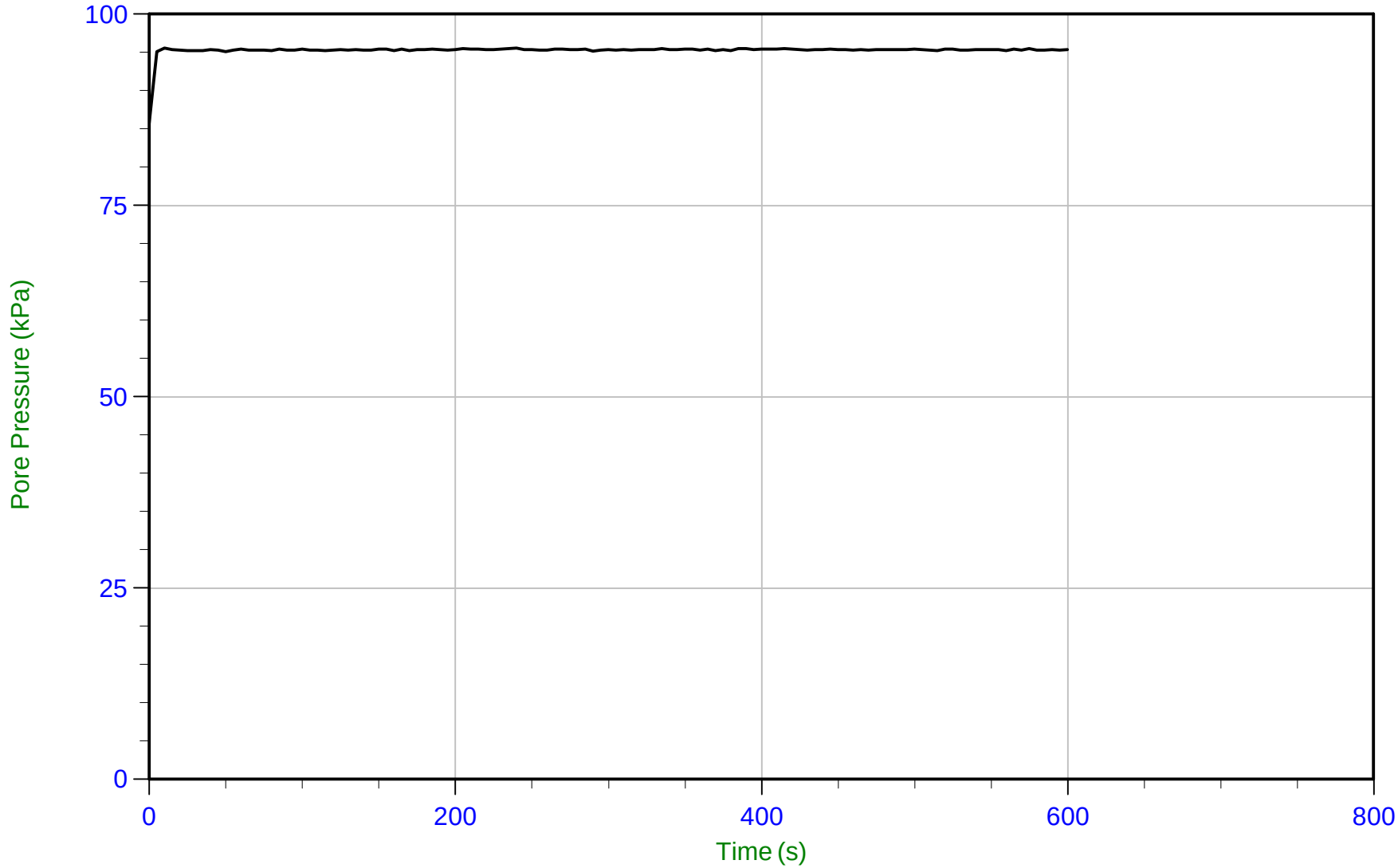
U Min: 221.6 kPa
U Max: 556.2 kPa

CONETEC

CH2M

Job No: 16-02014
Date: 03/16/2016 14:30
Site: Faro IP

Sounding: CH16-201-CP015
Cone: 317:T375F10U200
Cone Area: 15 sq cm



Trace Summary:

Filename: 16-02014_GS015.PPF
Depth: 16.400 m / 53.805 ft
Duration: 600.0 s

U Min: 85.8 kPa
U Max: 95.6 kPa

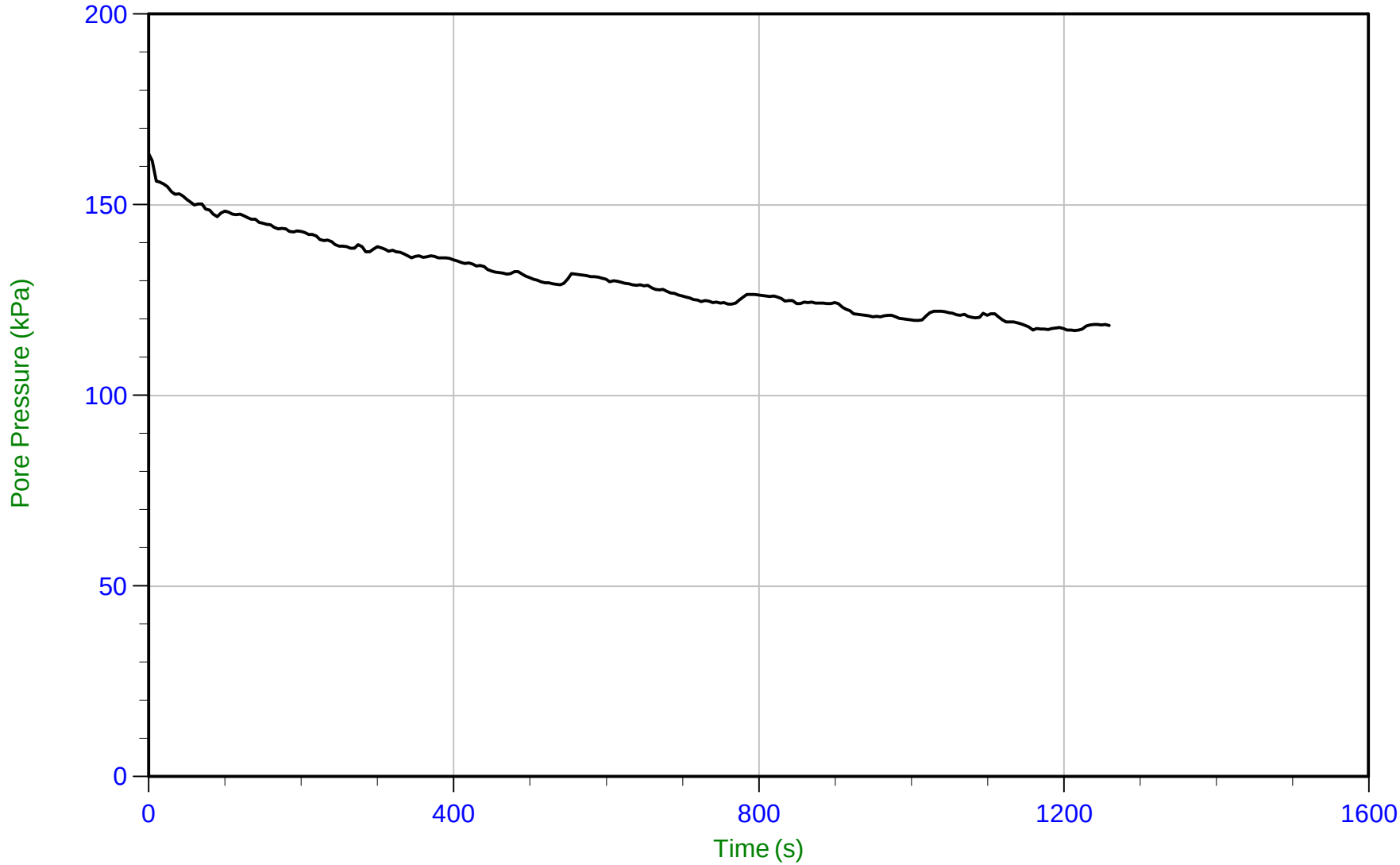
WT: 6.669 m / 21.880 ft
Ueq: 95.4 kPa

CONETEC

CH2M

Job No: 16-02014
Date: 03/15/2016 13:40
Site: Faro IP

Sounding: CH16-201-CP016
Cone: 317:T375F10U200
Cone Area: 15 sq cm



Trace Summary:

Filename: 16-02014_GS016.PPF
Depth: 2.500 m / 8.202 ft
Duration: 1260.0 s

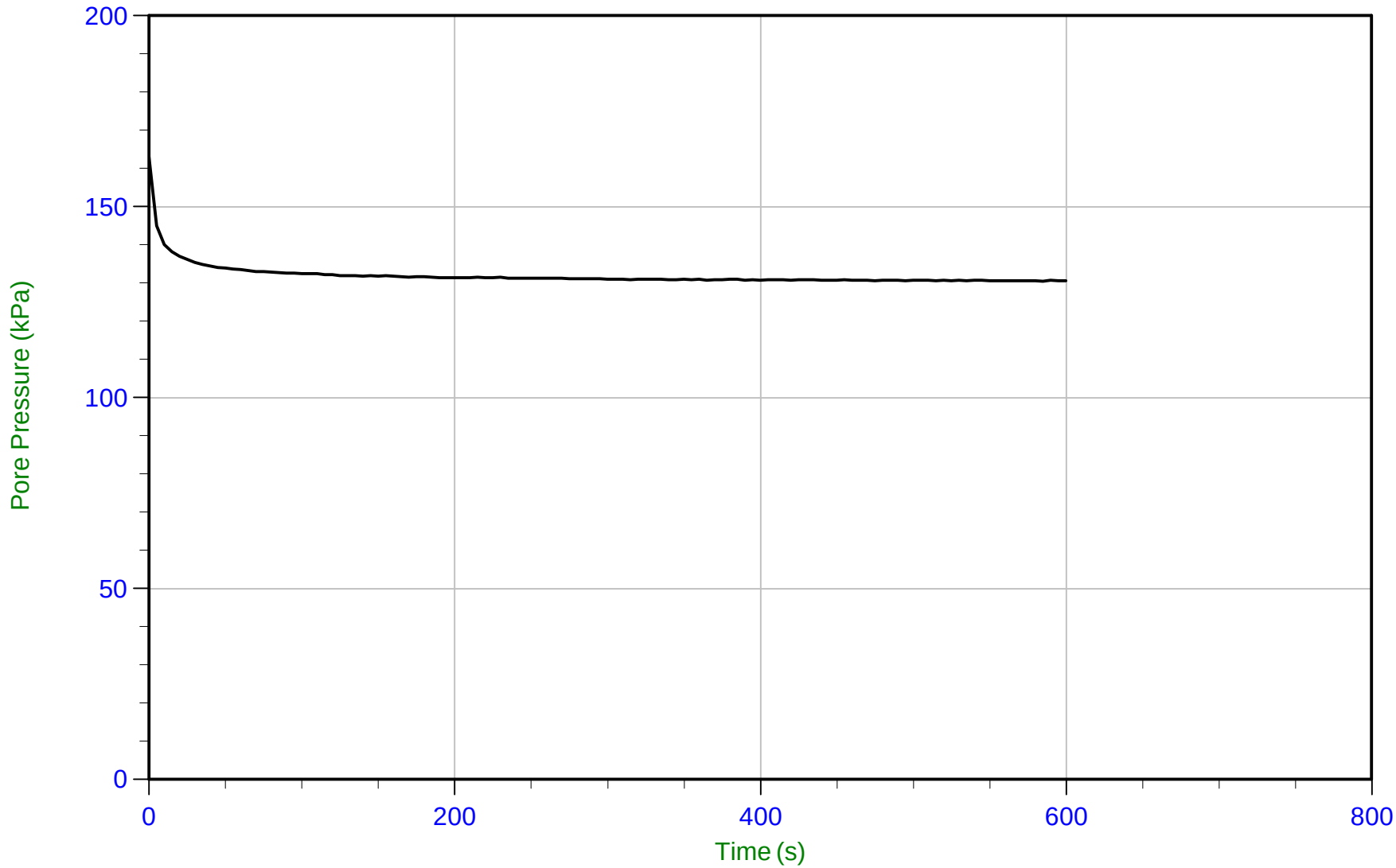
U Min: 117.0 kPa
U Max: 163.4 kPa

CONETEC

CH2M

Job No: 16-02014
Date: 03/15/2016 13:40
Site: Faro IP

Sounding: CH16-201-CP016
Cone: 317:T375F10U200
Cone Area: 15 sq cm



Trace Summary:

Filename: 16-02014_GS016.PPF
Depth: 8.425 m / 27.641 ft
Duration: 600.0 s

U Min: 130.5 kPa
U Max: 163.1 kPa

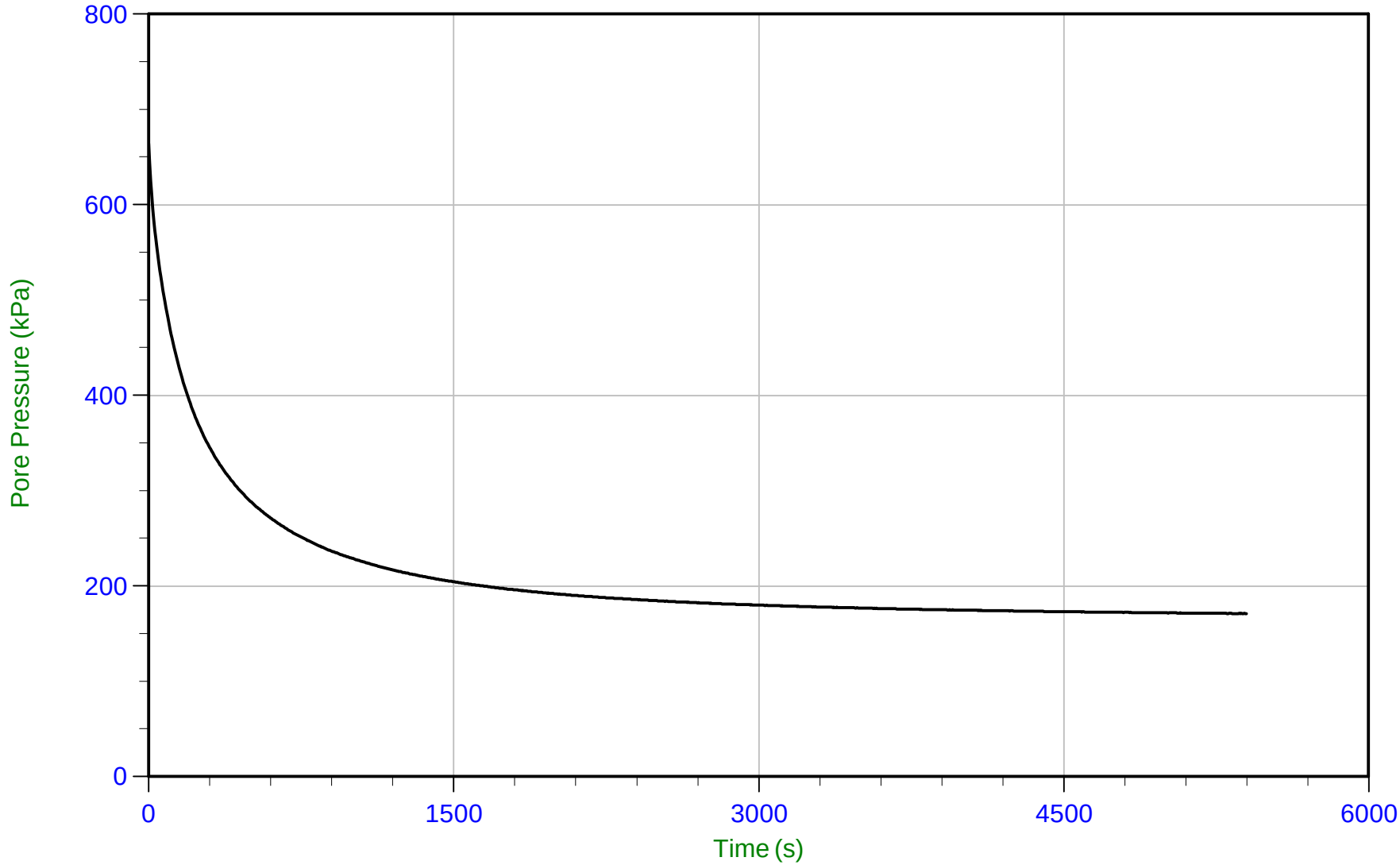
WT: -4.890 m / -16.043 ft
Ueq: 130.5 kPa

CONETEC

CH2M

Job No: 16-02014
Date: 03/15/2016 13:40
Site: Faro IP

Sounding: CH16-201-CP016
Cone: 317:T375F10U200
Cone Area: 15 sq cm



Trace Summary:

Filename: 16-02014_GS016.PPF
Depth: 17.500 m / 57.414 ft
Duration: 5400.0 s

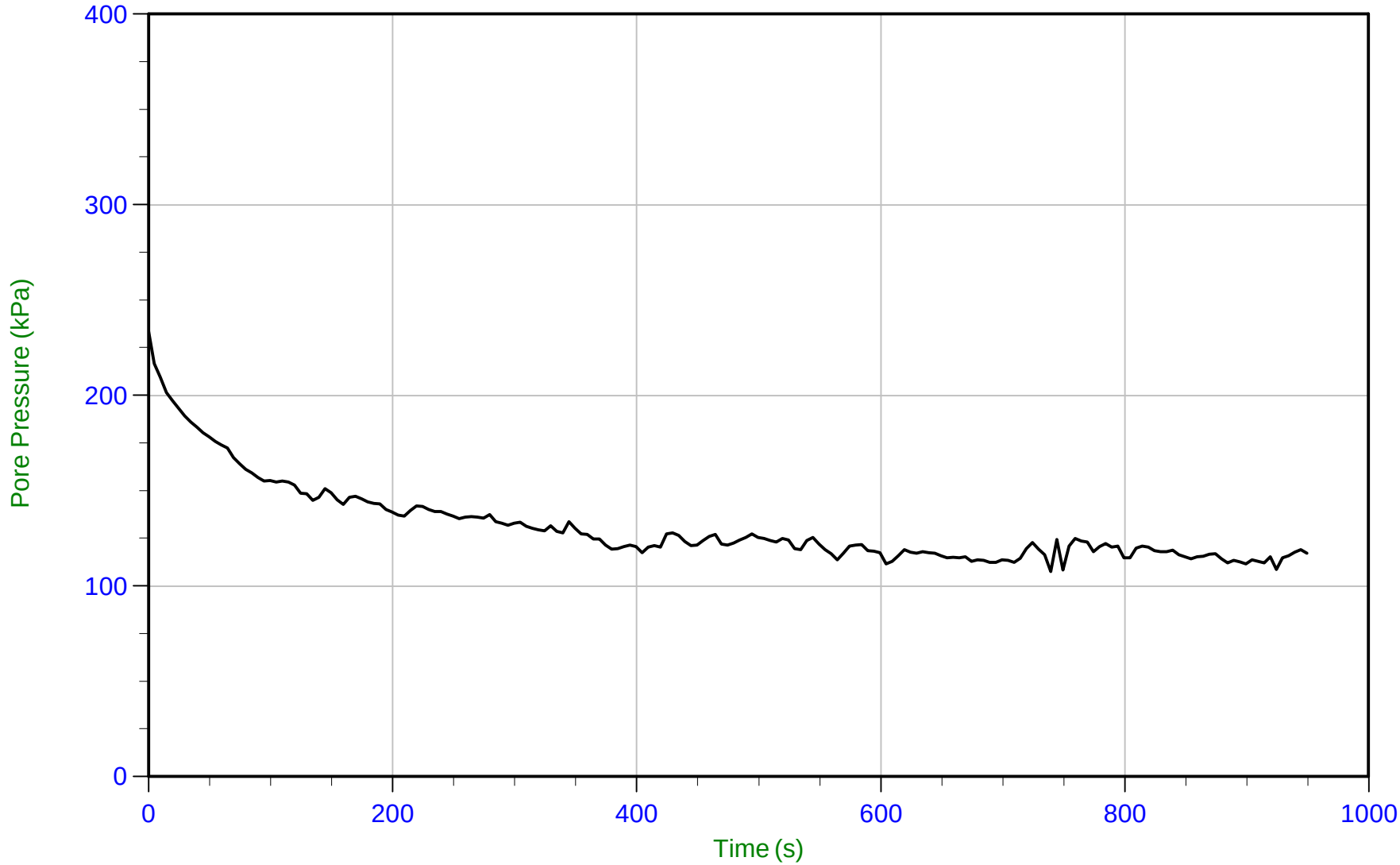
U Min: 171.0 kPa
U Max: 664.3 kPa

CONETEC

CH2M

Job No: 16-02014
Date: 03/14/2016 09:45
Site: Faro IP

Sounding: CH16-201-CP017
Cone: 317:T375F10U200
Cone Area: 15 sq cm



Trace Summary:

Filename: 16-02014_GS017.PPF
Depth: 6.000 m / 19.685 ft
Duration: 950.0 s

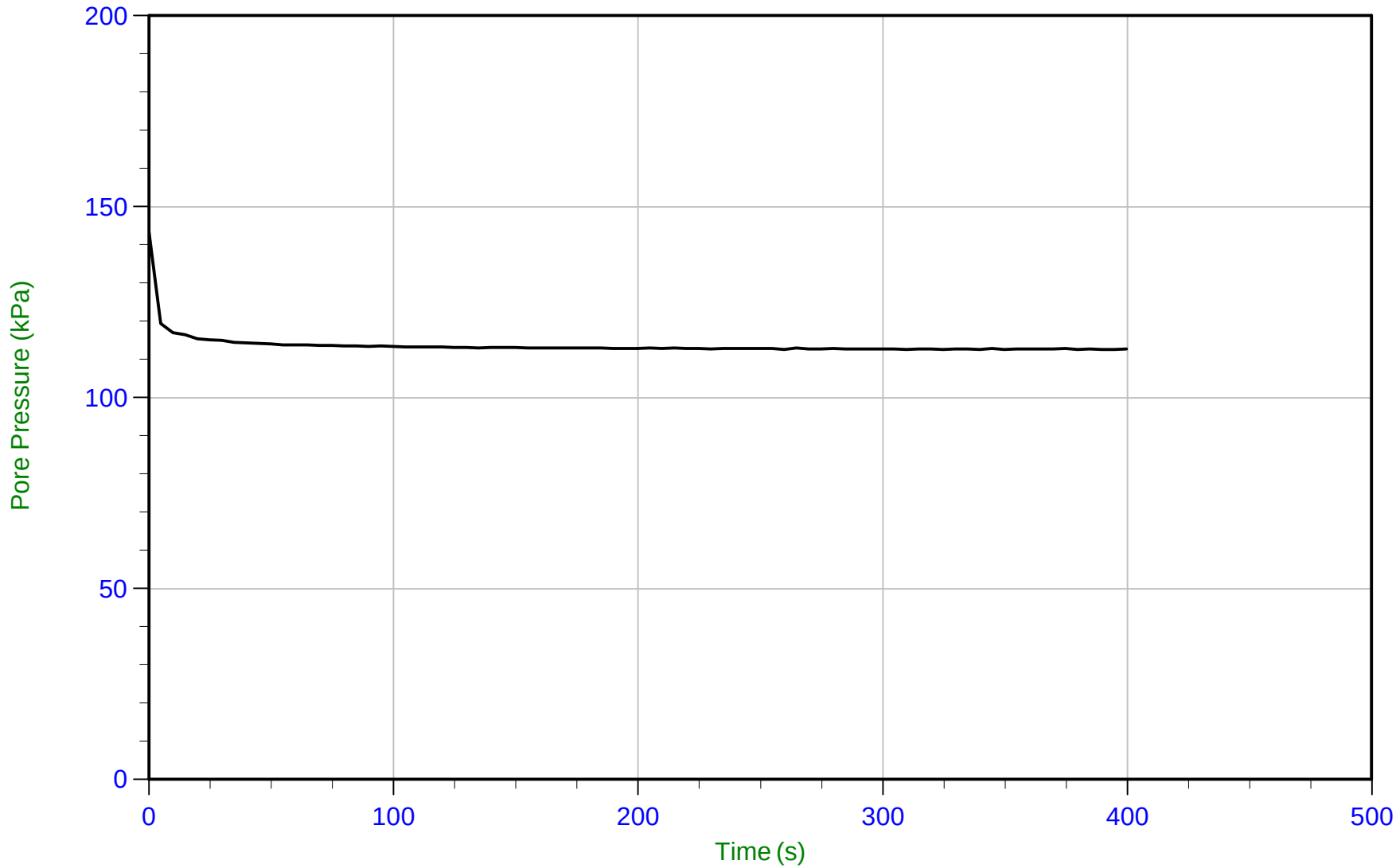
U Min: 107.5 kPa
U Max: 233.5 kPa

CONETEC

CH2M

Job No: 16-02014
Date: 03/14/2016 09:45
Site: Faro IP

Sounding: CH16-201-CP017
Cone: 317:T375F10U200
Cone Area: 15 sq cm



Trace Summary:

Filename: 16-02014_GS017.PPF
Depth: 8.975 m / 29.445 ft
Duration: 400.0 s

U Min: 112.6 kPa
U Max: 143.4 kPa

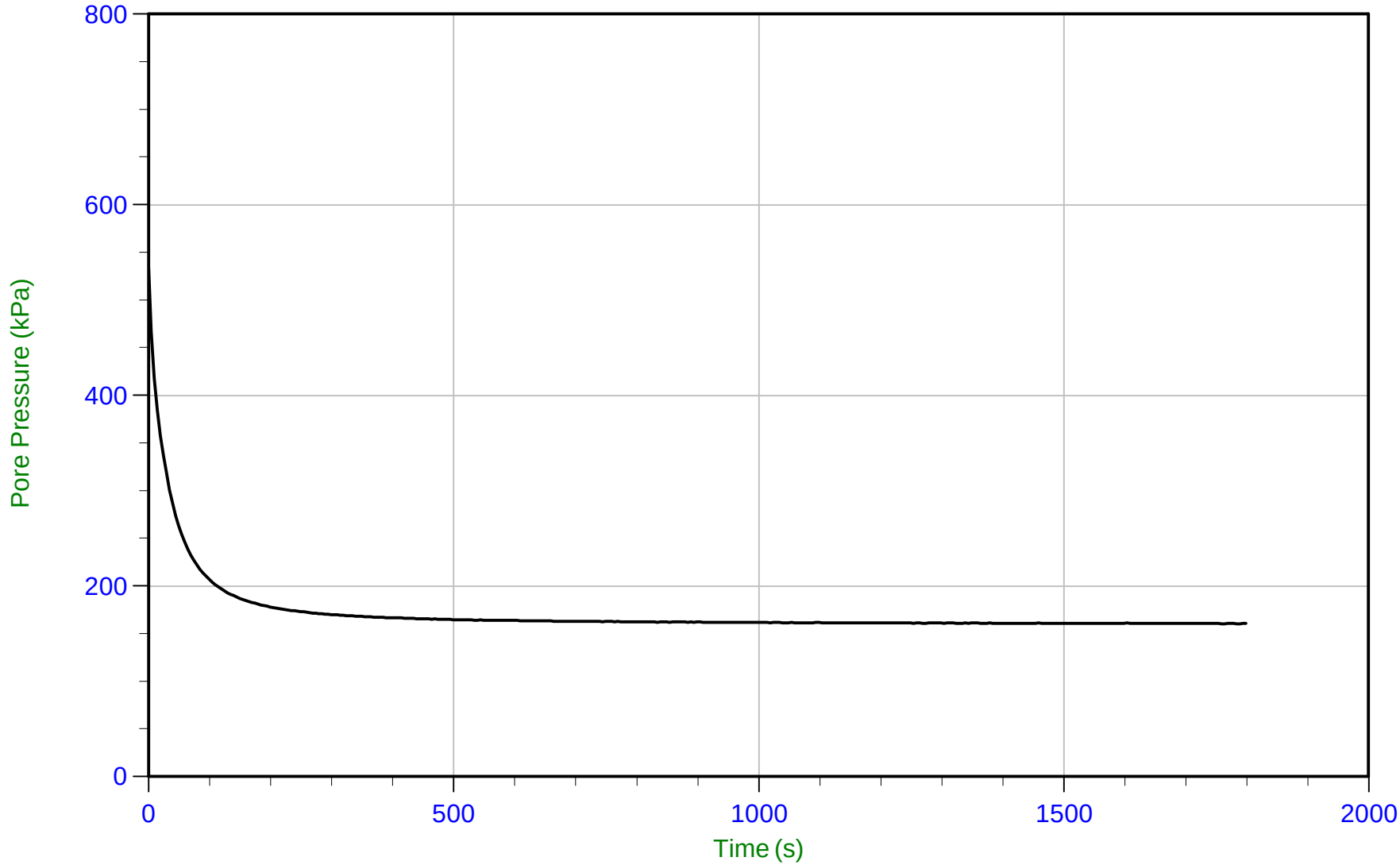
WT: -2.505 m / -8.218 ft
Ueq: 112.5 kPa

CONETEC

CH2M

Job No: 16-02014
Date: 03/14/2016 09:45
Site: Faro IP

Sounding: CH16-201-CP017
Cone: 317:T375F10U200
Cone Area: 15 sq cm



Trace Summary:

Filename: 16-02014_GS017.PPF
Depth: 14.975 m / 49.130 ft
Duration: 1800.0 s

U Min: 160.5 kPa
U Max: 533.4 kPa

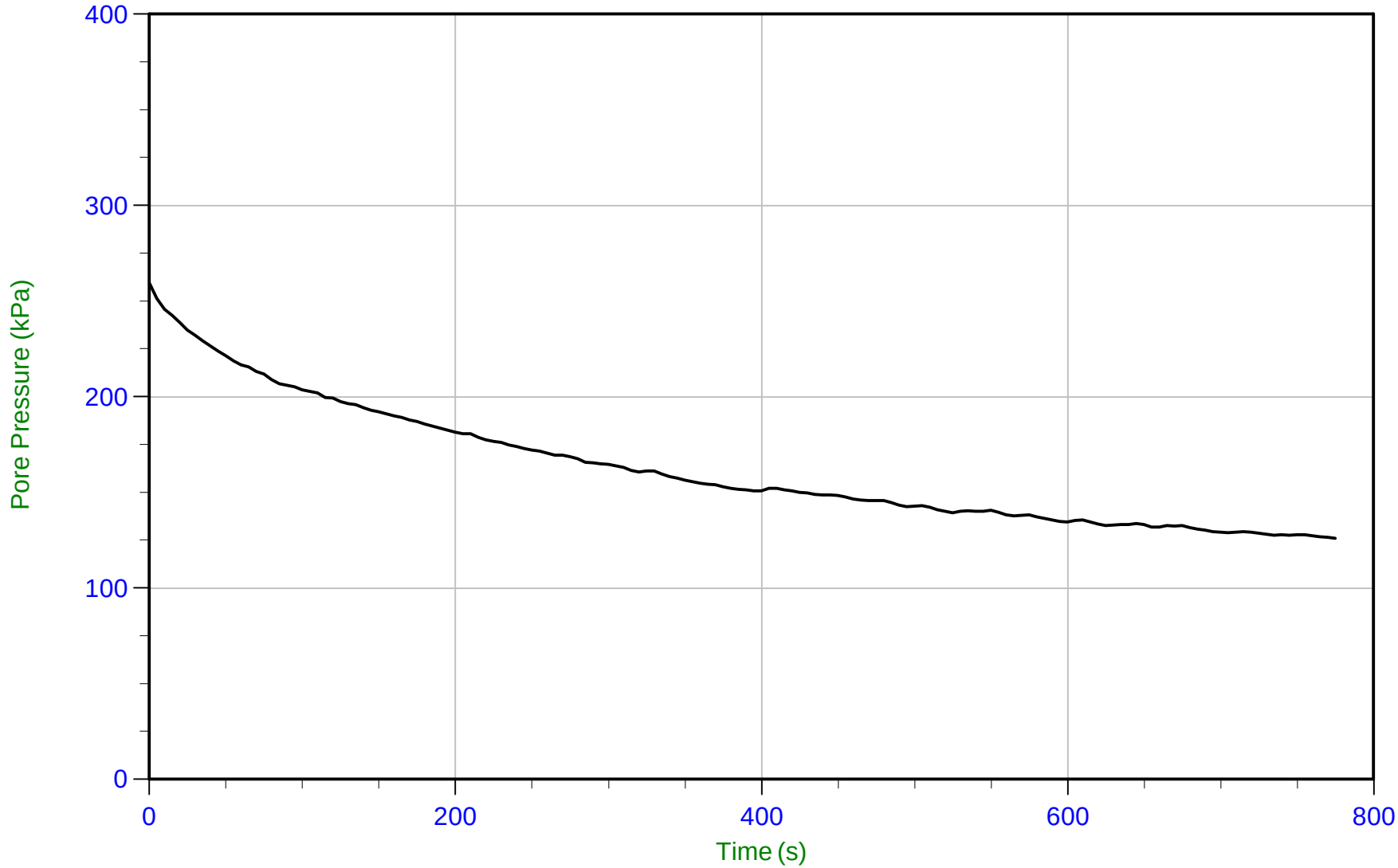
WT: -1.413 m / -4.636 ft
Ueq: 160.7 kPa

CONETEC

CH2M

Job No: 16-02014
Date: 03/13/2016 13:10
Site: Faro IP

Sounding: CH16-201-CP018
Cone: 317:T375F10U200
Cone Area: 15 sq cm



Trace Summary:

Filename: 16-02014_GS018.PPF
Depth: 6.000 m / 19.685 ft
Duration: 775.0 s

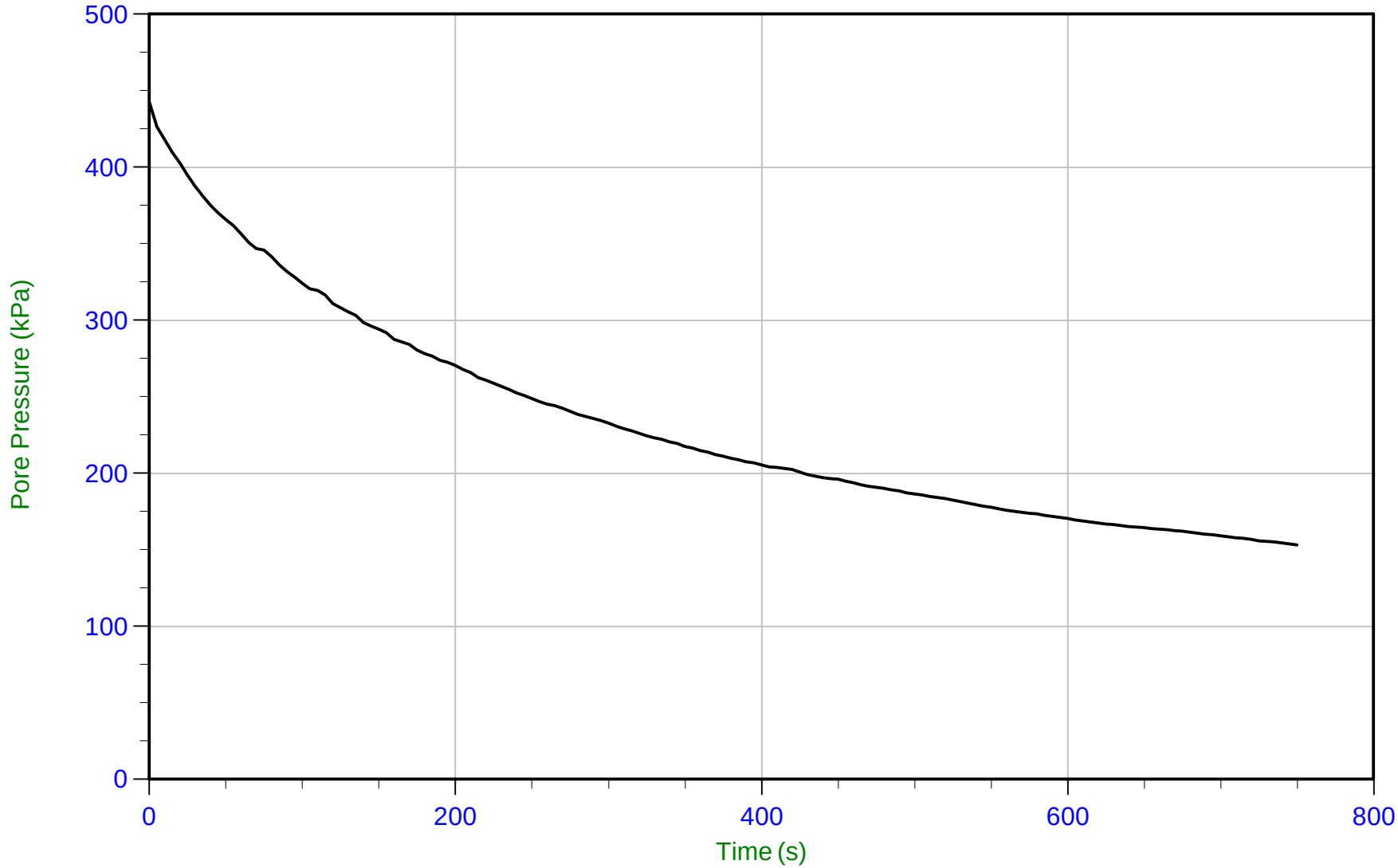
U Min: 125.9 kPa
U Max: 259.6 kPa

CONETEC

CH2M

Job No: 16-02014
Date: 03/13/2016 13:10
Site: Faro IP

Sounding: CH16-201-CP018
Cone: 317:T375F10U200
Cone Area: 15 sq cm



Trace Summary:

Filename: 16-02014_GS018.PPF
Depth: 10.000 m / 32.808 ft
Duration: 750.0 s

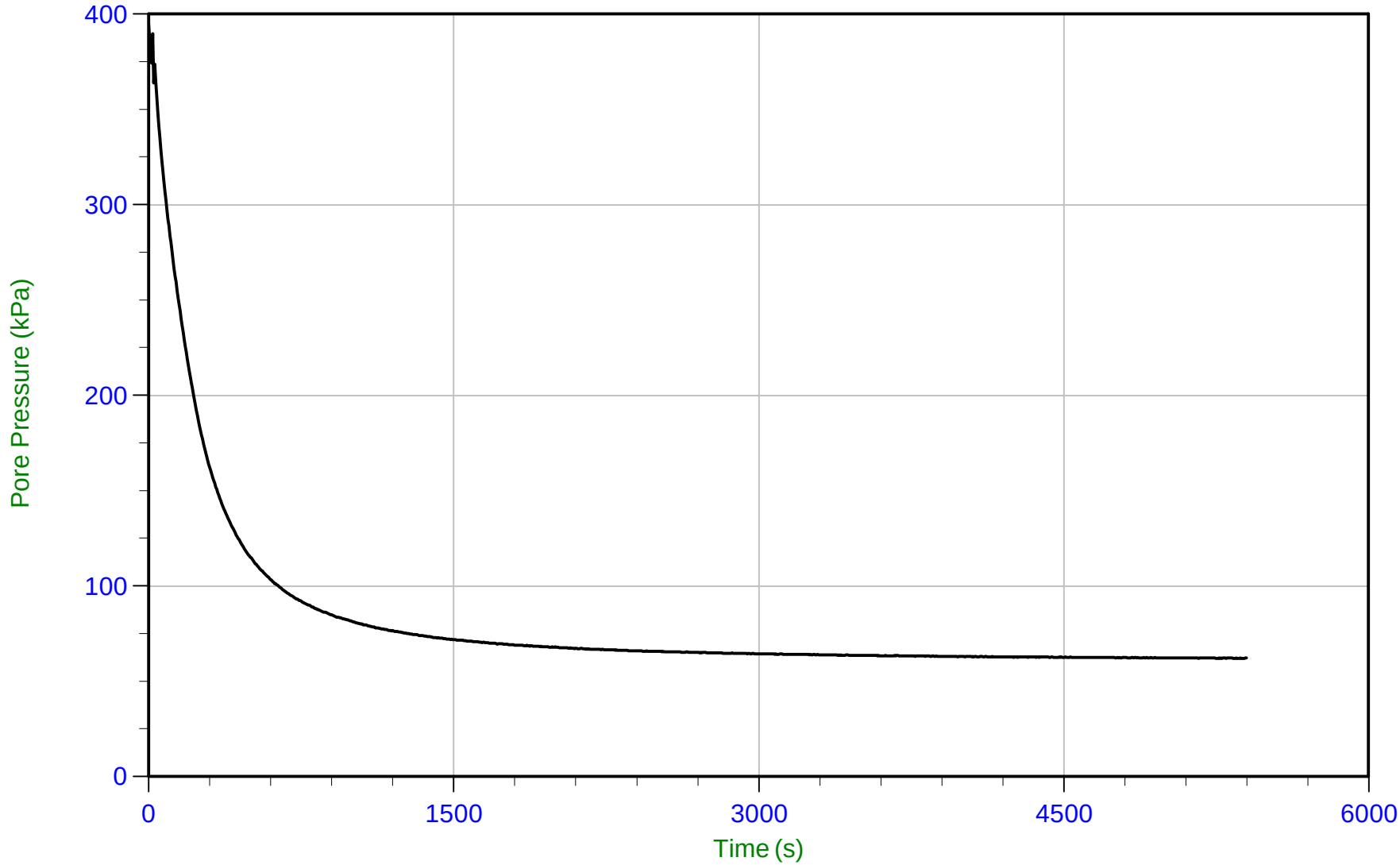
U Min: 153.3 kPa
U Max: 442.8 kPa

CONETEC

CH2M

Job No: 16-02014
Date: 03/13/2016 13:10
Site: Faro IP

Sounding: CH16-201-CP018
Cone: 317:T375F10U200
Cone Area: 15 sq cm



Trace Summary:

Filename: 16-02014_GS018.PPF
Depth: 14.025 m / 46.013 ft
Duration: 5400.0 s

U Min: 62.0 kPa
U Max: 394.9 kPa

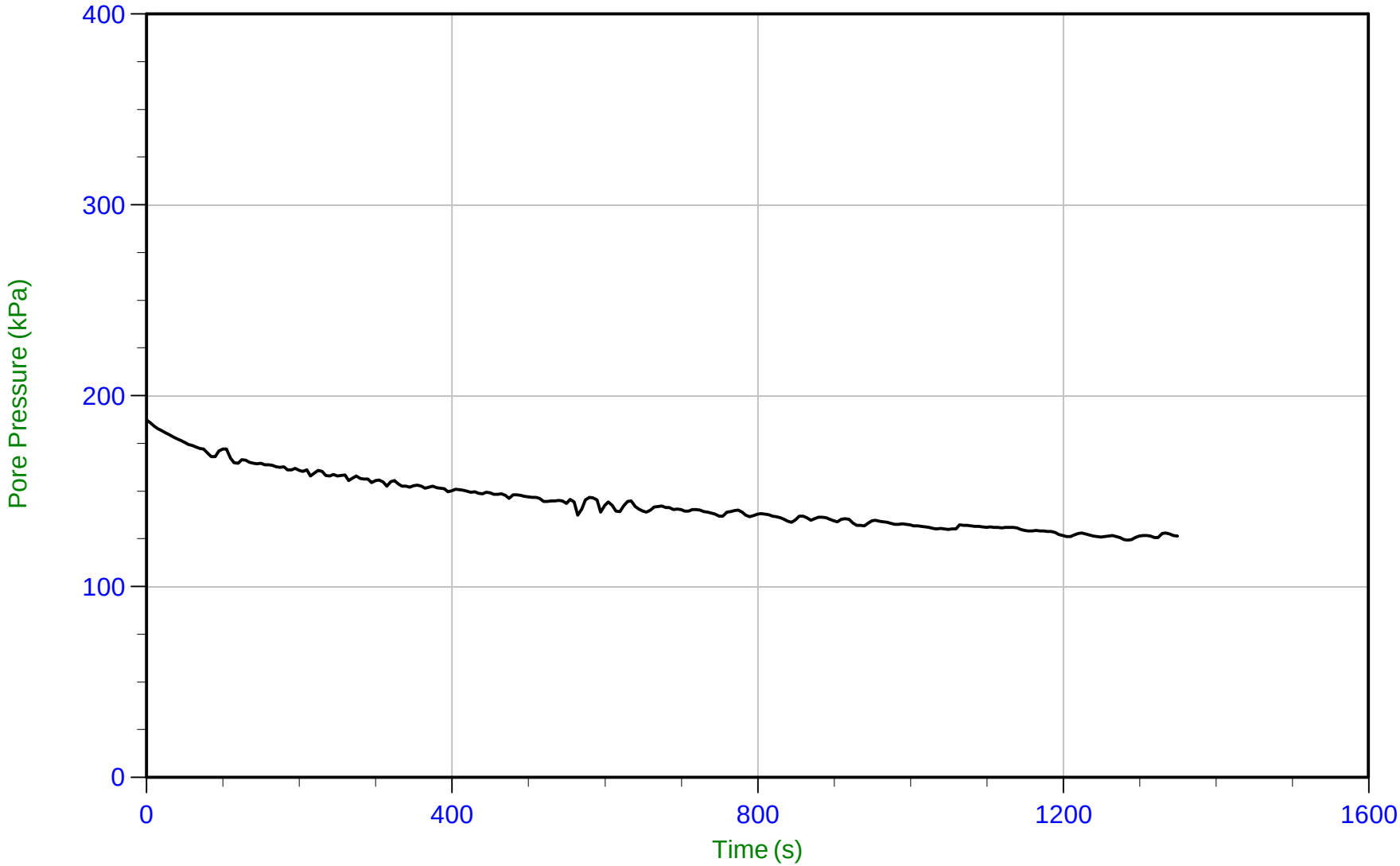
WT: 7.691 m / 25.233 ft
Ueq: 62.1 kPa

CONETEC

CH2M

Job No: 16-02014
Date: 03/16/2016 10:17
Site: Faro IP

Sounding: CH16-201-CP019
Cone: 317:T375F10U200
Cone Area: 15 sq cm



Trace Summary:

Filename: 16-02014_GS019.PPF
Depth: 3.500 m / 11.483 ft
Duration: 1350.0 s

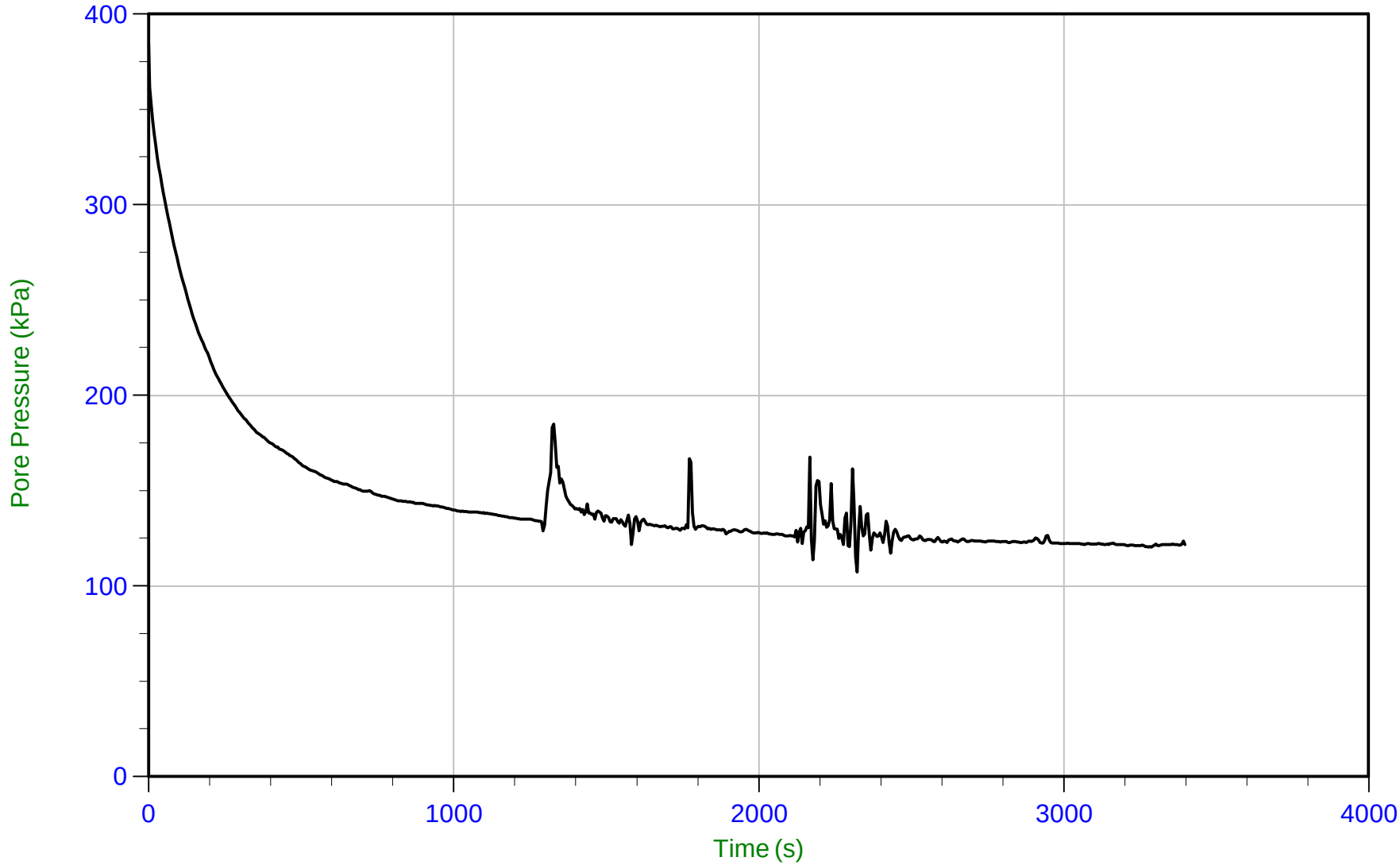
U Min: 124.5 kPa
U Max: 187.5 kPa

CONETEC

CH2M

Job No: 16-02014
Date: 03/16/2016 10:17
Site: Faro IP

Sounding: CH16-201-CP019
Cone: 317:T375F10U200
Cone Area: 15 sq cm



Trace Summary:

Filename: 16-02014_GS019.PPF
Depth: 8.500 m / 27.887 ft
Duration: 3400.0 s

U Min: 107.3 kPa
U Max: 384.4 kPa

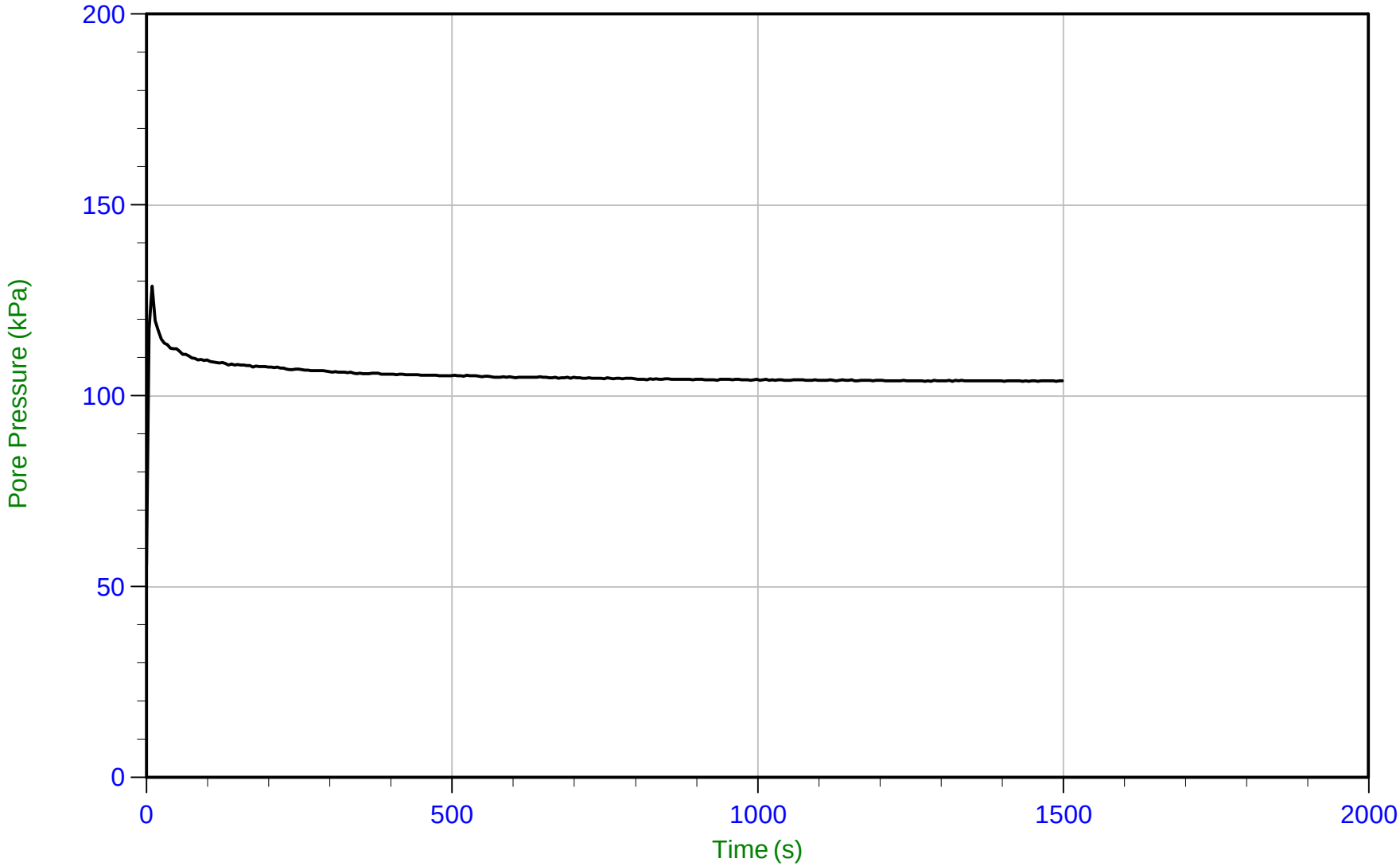
WT: -3.877 m / -12.720 ft
Ueq: 121.3 kPa

CONETEC

CH2M

Job No: 16-02014
Date: 03/16/2016 10:17
Site: Faro IP

Sounding: CH16-201-CP019
Cone: 317:T375F10U200
Cone Area: 15 sq cm



Trace Summary:

Filename: 16-02014_GS019.PPF
Depth: 14.625 m / 47.982 ft
Duration: 1500.0 s

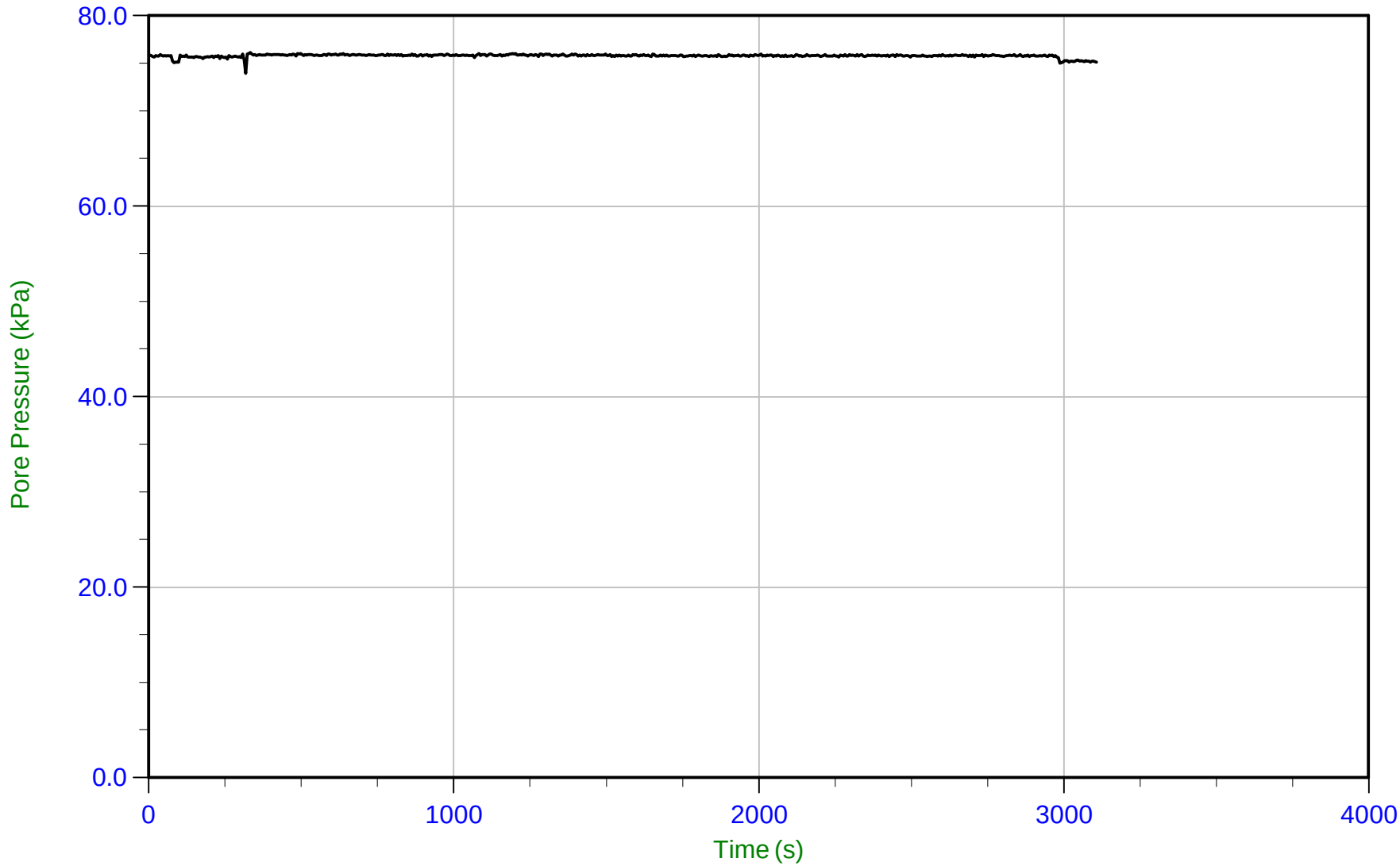
U Min: 55.7 kPa
U Max: 128.7 kPa

CONETEC

CH2M

Job No: 16-02014
Date: 03/07/2016 16:23
Site: Faro CVP

Sounding: CH16-201-CP022
Cone: 317:T375F10U200
Cone Area: 15 sq cm



Trace Summary:

Filename: 16-02014_GS022.PPF
Depth: 1.800 m / 5.905 ft
Duration: 3110.0 s

U Min: 73.9 kPa
U Max: 76.1 kPa

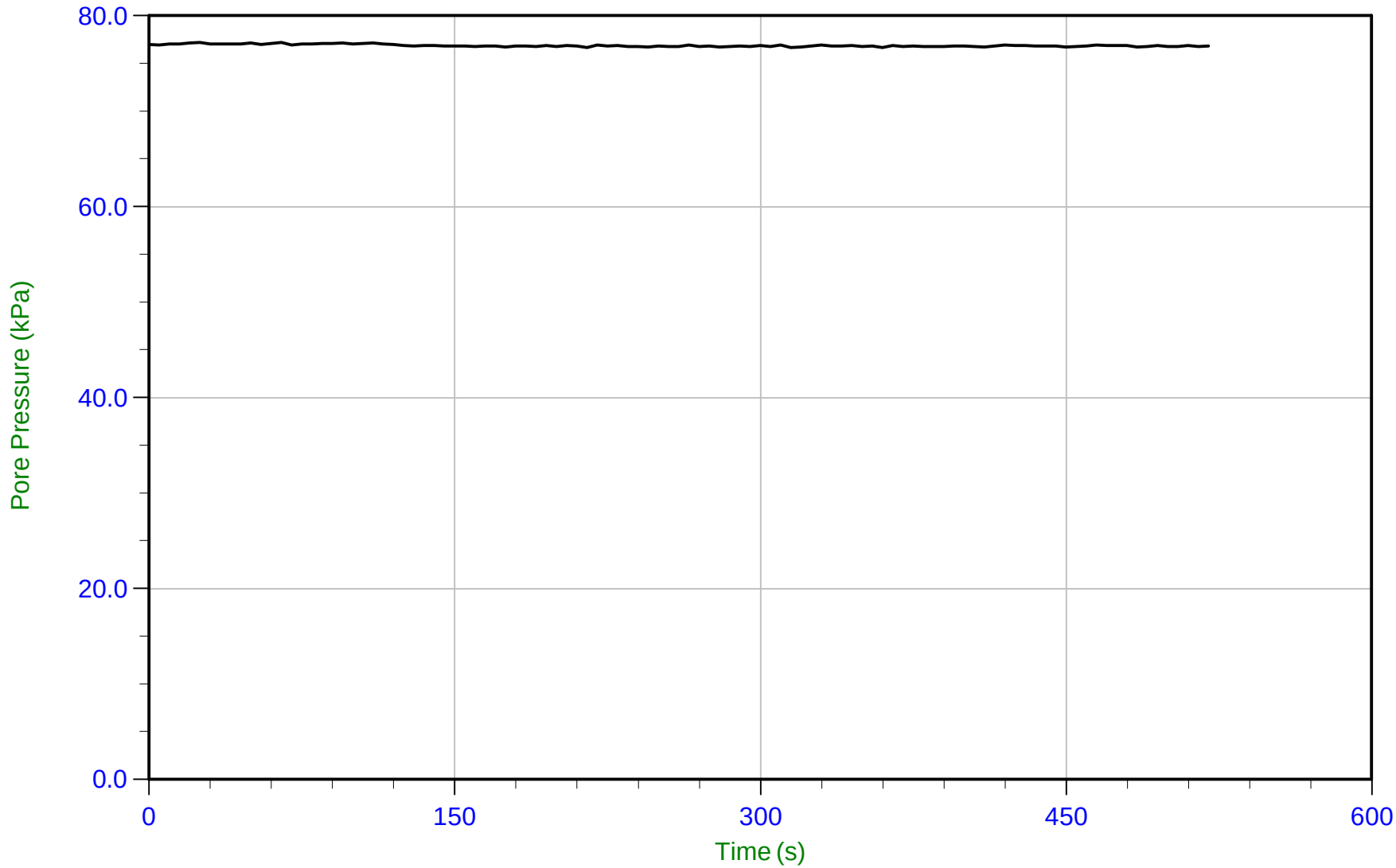
WT: -5.916 m / -19.409 ft
Ueq: 75.6 kPa

CONETEC

CH2M

Job No: 16-02014
Date: 03/07/2016 16:23
Site: Faro CVP

Sounding: CH16-201-CP022
Cone: 317:T375F10U200
Cone Area: 15 sq cm



Trace Summary:

Filename: 16-02014_GS022.PPF
Depth: 2.025 m / 6.644 ft
Duration: 520.0 s

U Min: 76.6 kPa
U Max: 77.2 kPa

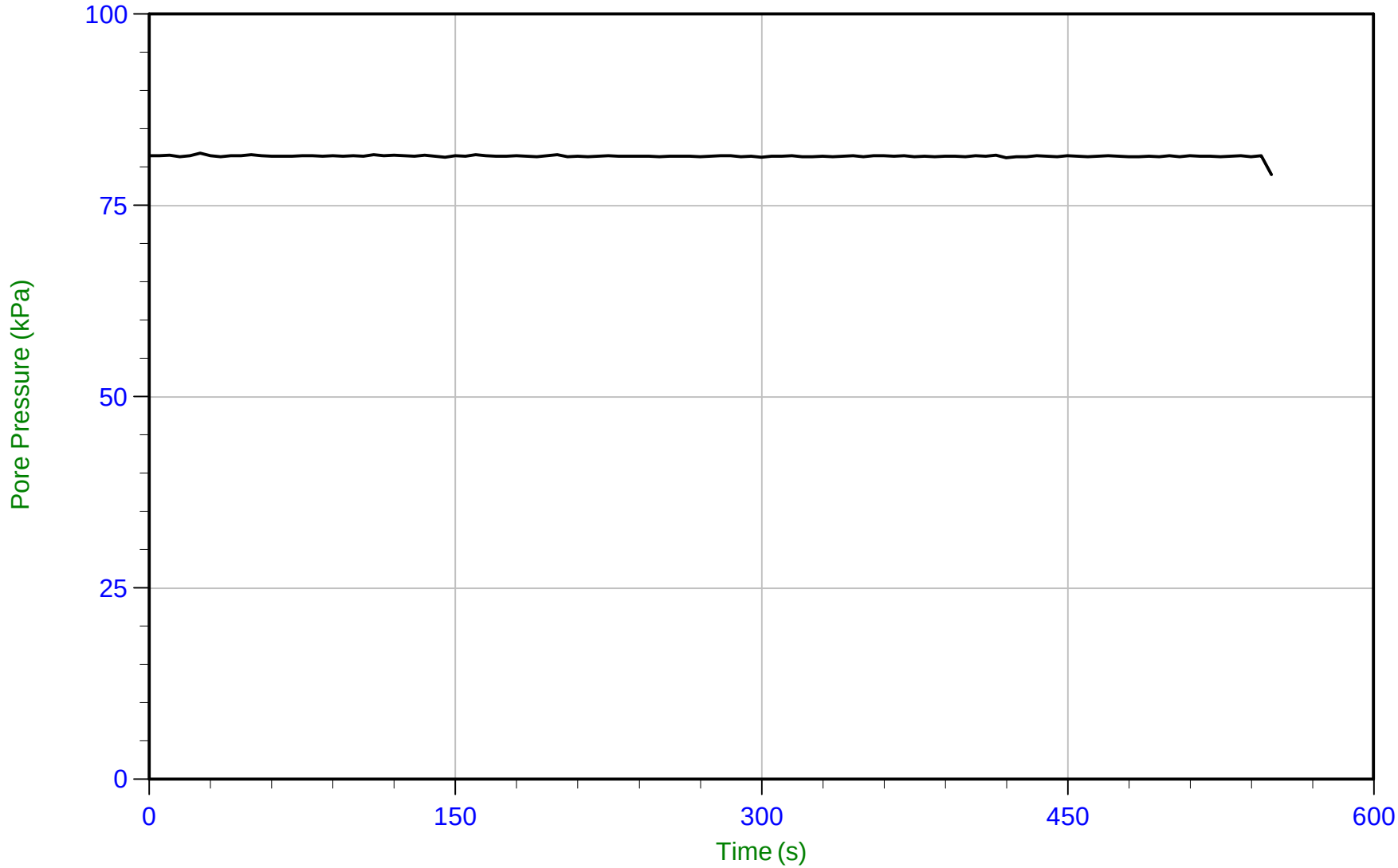
WT: -5.811 m / -19.065 ft
Ueq: 76.8 kPa

CONETEC

CH2M

Job No: 16-02014
Date: 03/07/2016 16:23
Site: Faro CVP

Sounding: CH16-201-CP022
Cone: 317:T375F10U200
Cone Area: 15 sq cm



Trace Summary:

Filename: 16-02014_GS022.PPF
Depth: 2.475 m / 8.120 ft
Duration: 550.0 s

U Min: 79.0 kPa
U Max: 81.8 kPa

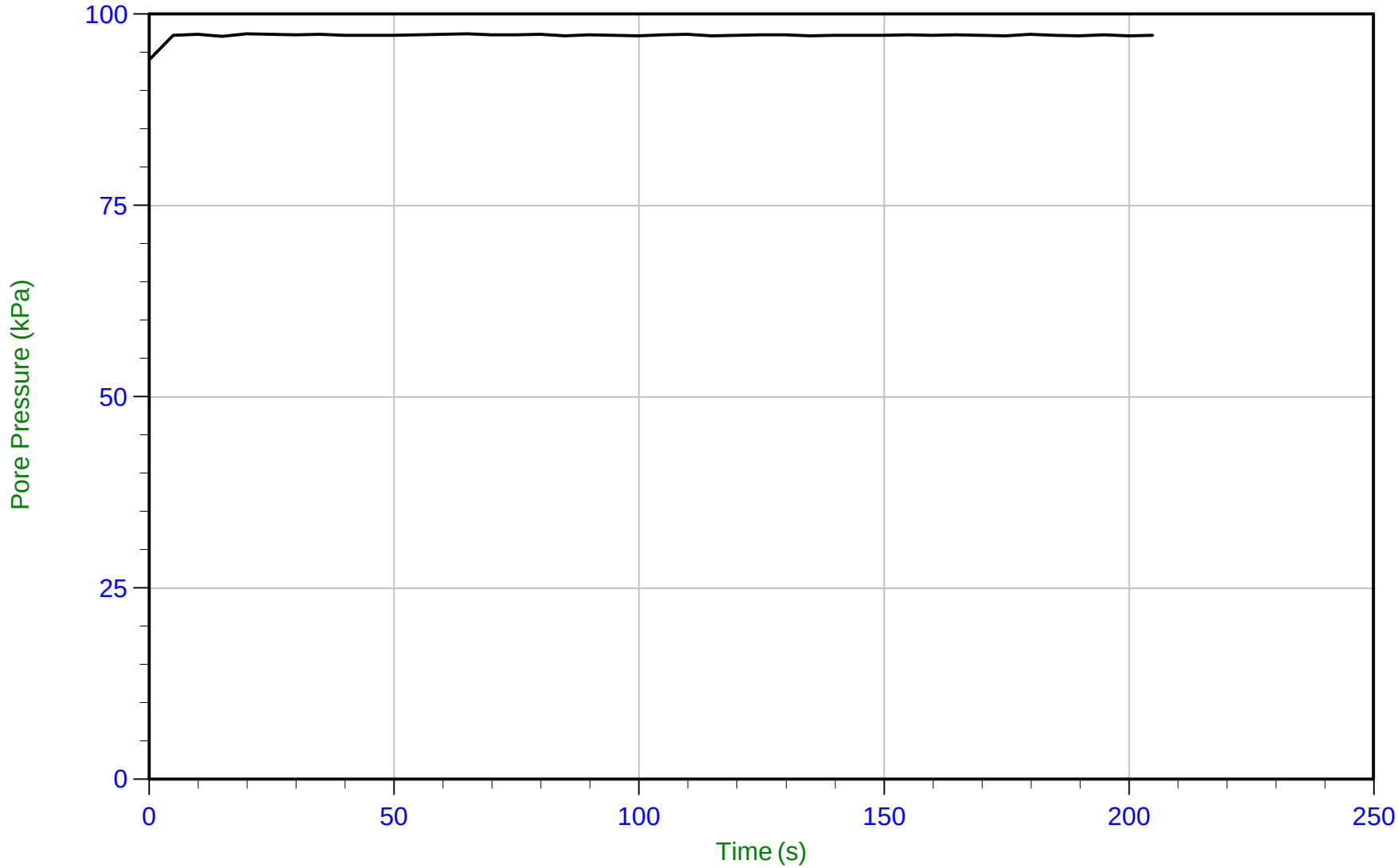
WT: -5.826 m / -19.114 ft
Ueq: 81.4 kPa

CONETEC

CH2M

Job No: 16-02014
Date: 03/07/2016 16:23
Site: Faro CVP

Sounding: CH16-201-CP022
Cone: 317:T375F10U200
Cone Area: 15 sq cm



Trace Summary:

Filename: 16-02014_GS022.PPF
Depth: 4.025 m / 13.205 ft
Duration: 205.0 s

U Min: 94.0 kPa
U Max: 97.5 kPa

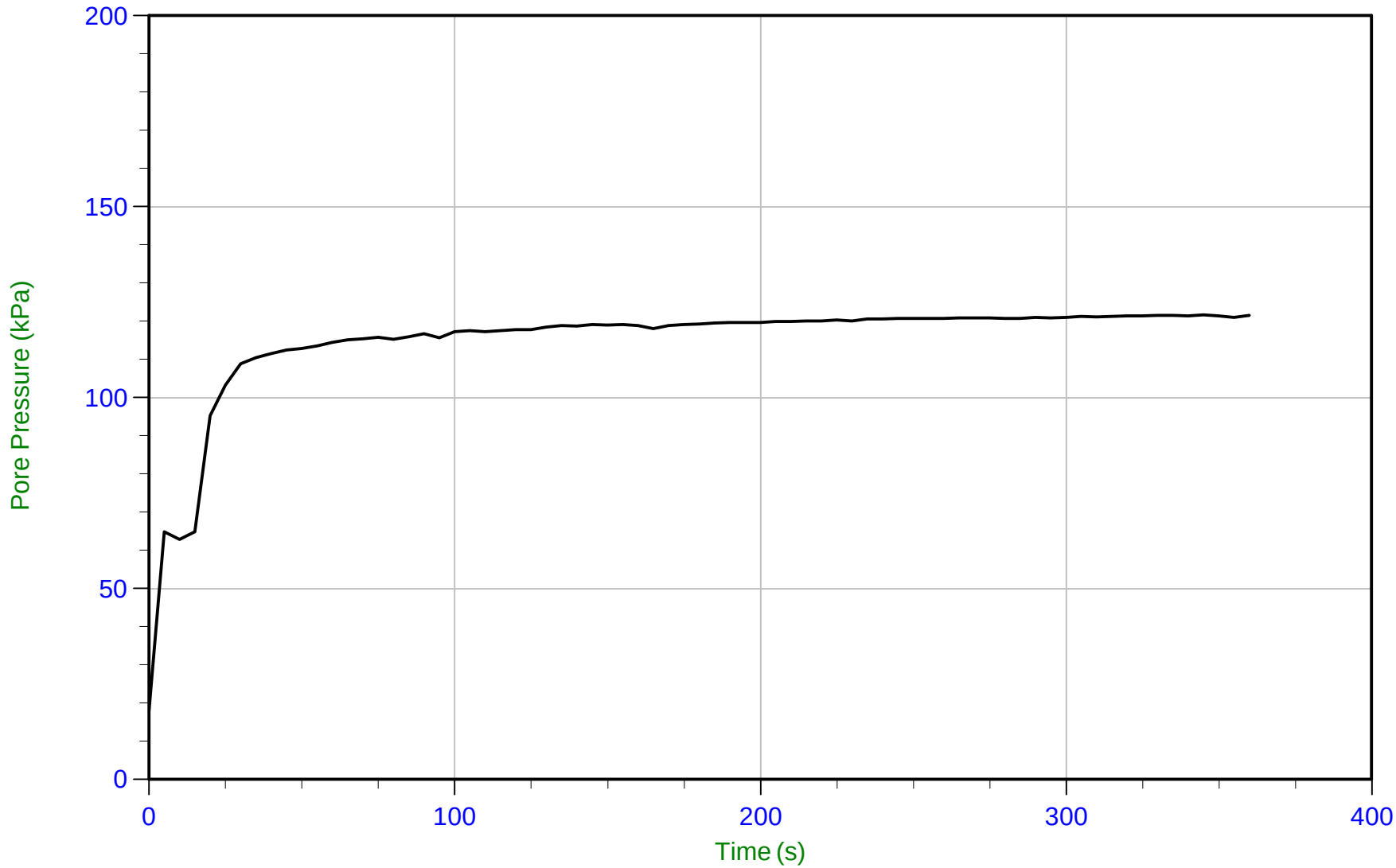
WT: -5.876 m / -19.278 ft
Ueq: 97.1 kPa

CONETEC

CH2M

Job No: 16-02014
Date: 03/06/2016 16:43
Site: Faro CVP

Sounding: CH16-201-CP025
Cone: 317:T375F10U200
Cone Area: 15 sq cm



Trace Summary:

Filename: 16-02014_GS025.PPF
Depth: 0.375 m / 1.230 ft
Duration: 360.0 s

U Min: 17.9 kPa
U Max: 121.6 kPa

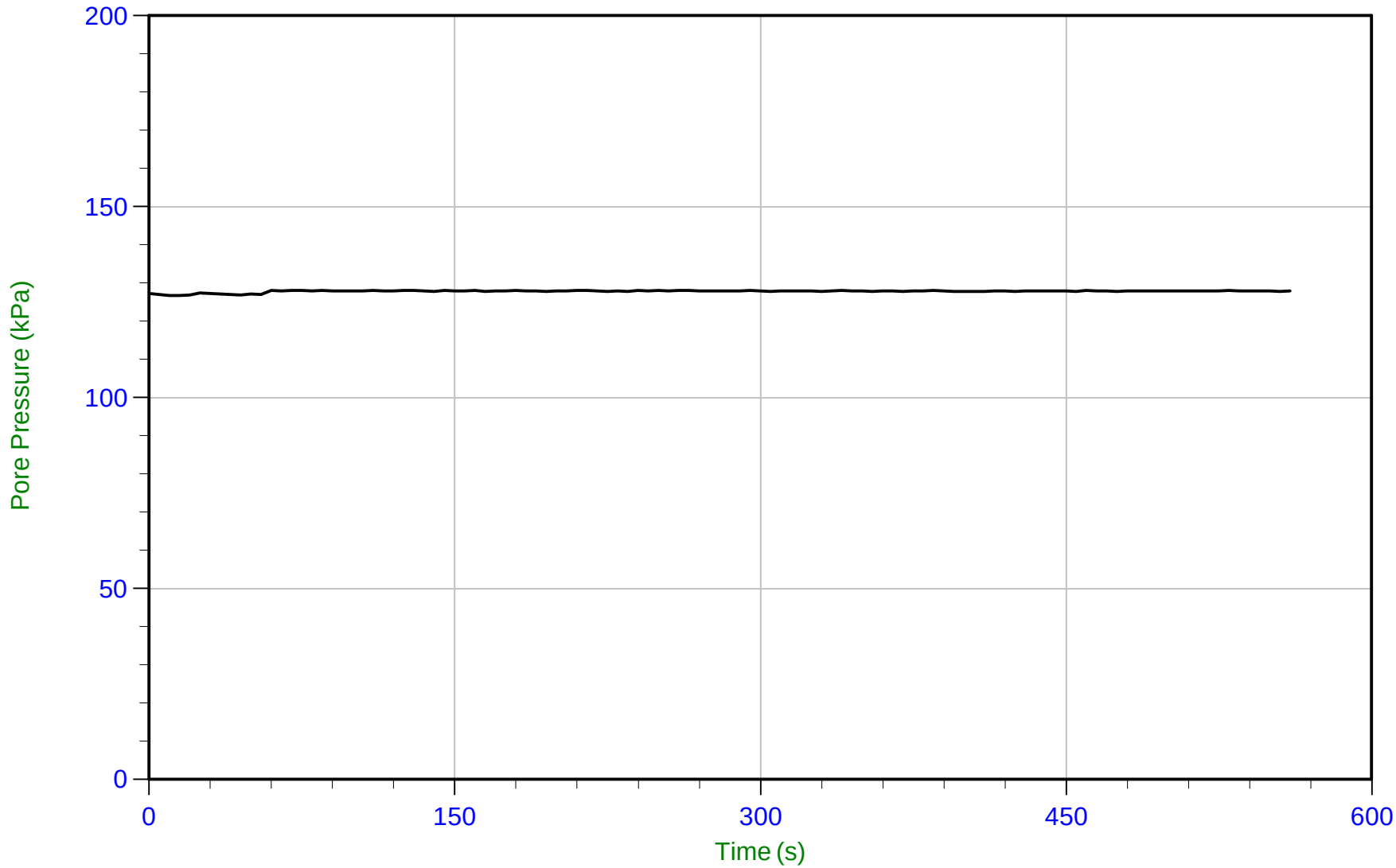
WT: -12.002 m / -39.376 ft
Ueq: 121.3 kPa

CONETEC

CH2M

Job No: 16-02014
Date: 03/06/2016 16:43
Site: Faro CVP

Sounding: CH16-201-CP025
Cone: 317:T375F10U200
Cone Area: 15 sq cm



Trace Summary:

Filename: 16-02014_GS025.PPF
Depth: 0.750 m / 2.461 ft
Duration: 560.0 s

U Min: 126.7 kPa
U Max: 128.1 kPa

WT: -12.267 m / -40.246 ft
Ueq: 127.6 kPa

Ball Full Flow Penetration Test Summary and Undrained Shear Strenght with Gamma Plots

CONETEC

Job No:	16-02014
Client:	CH2M Hill Canada Ltd.
Project:	Faro Mine Complex
Start Date:	12-Mar-2016
End Date:	17-Mar-2016

BALL FULL FLOW PENETRATION TEST SUMMARY

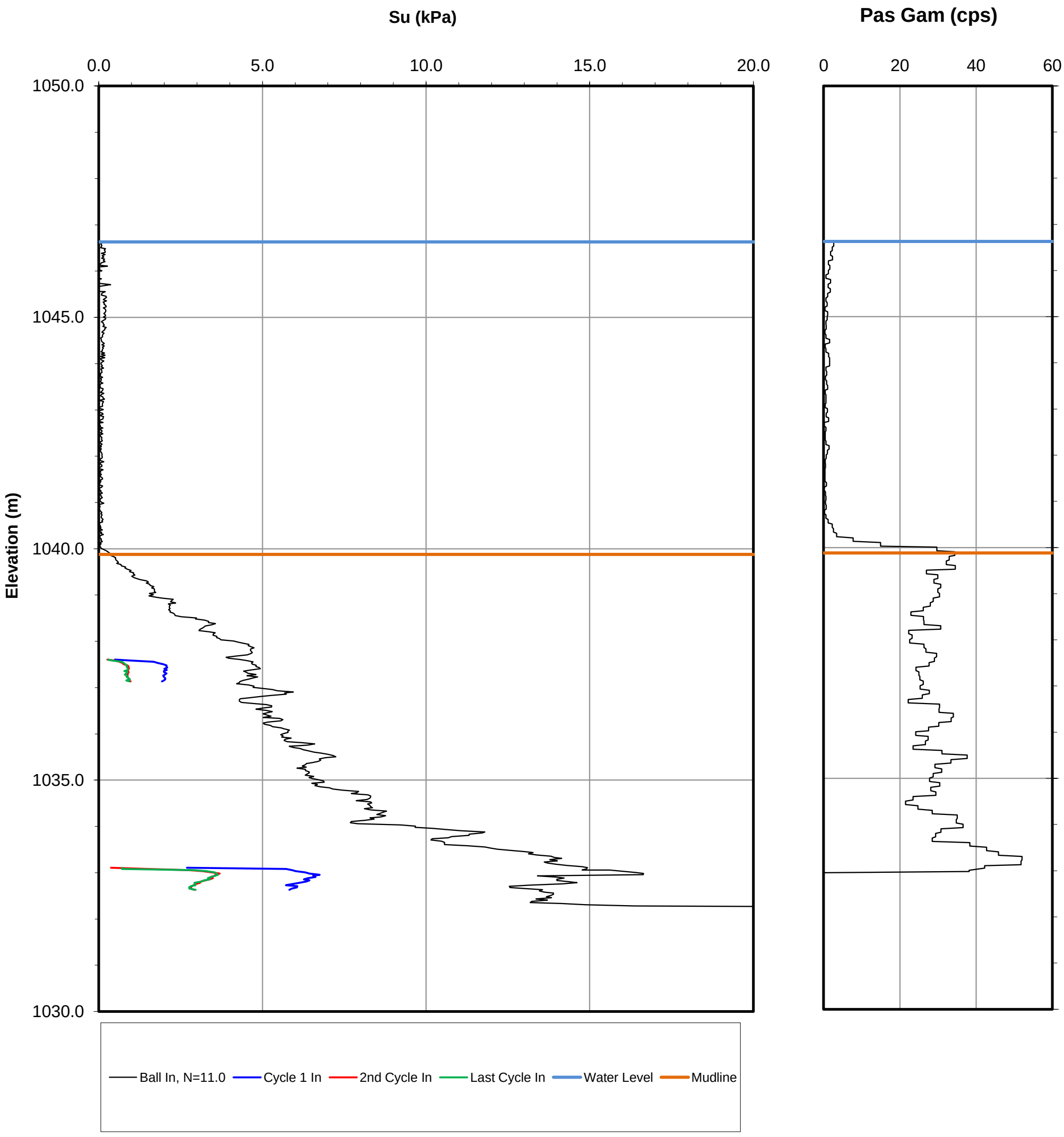
Sounding ID	File Name	Date	Cone	Cone Area (cm^2)	Ball Area (cm^2)	Final Depth (m)	Cycling Conducted	Northing[1] (m)	Easting (m)	Elevation[2] (m)	Refer to Notation Number
CH16-201-CP015A	16-02014_GB015A	17-Mar-16	317:T375F10U200	15	150	14.425	Yes	6914142.55	580594.03	1046.63	
CH16-201-CP017A	16-02014_GB017A	14-Mar-16	317:T375F10U200	15	150	14.000	Yes	6913869.52	580529.26	1046.64	
CH16-201-CP026	16-02014_GB026	12-Mar-16	317:T375F10U200	15	150	8.900	No	6914405.12	580344.68	1029.91	

1. Coordinate and elevations were surveyed using Trimble system with datum: WGS84/UTM Zone 8 North.
2. Elevations are referenced to the exisiting ice surface at the time of testing.

Project: 16-02014
Client: CH2M Hill Canada Ltd.
Project: Faro Mine Complex
Sounding: CH16-201-CP015A
Sounding Date: March 17th, 2016

Coordinate System: WGS84/UTM Zone 8N
Northing (m): 6914142.55
Easting (m): 580594.03
Elevation (m): 1046.632

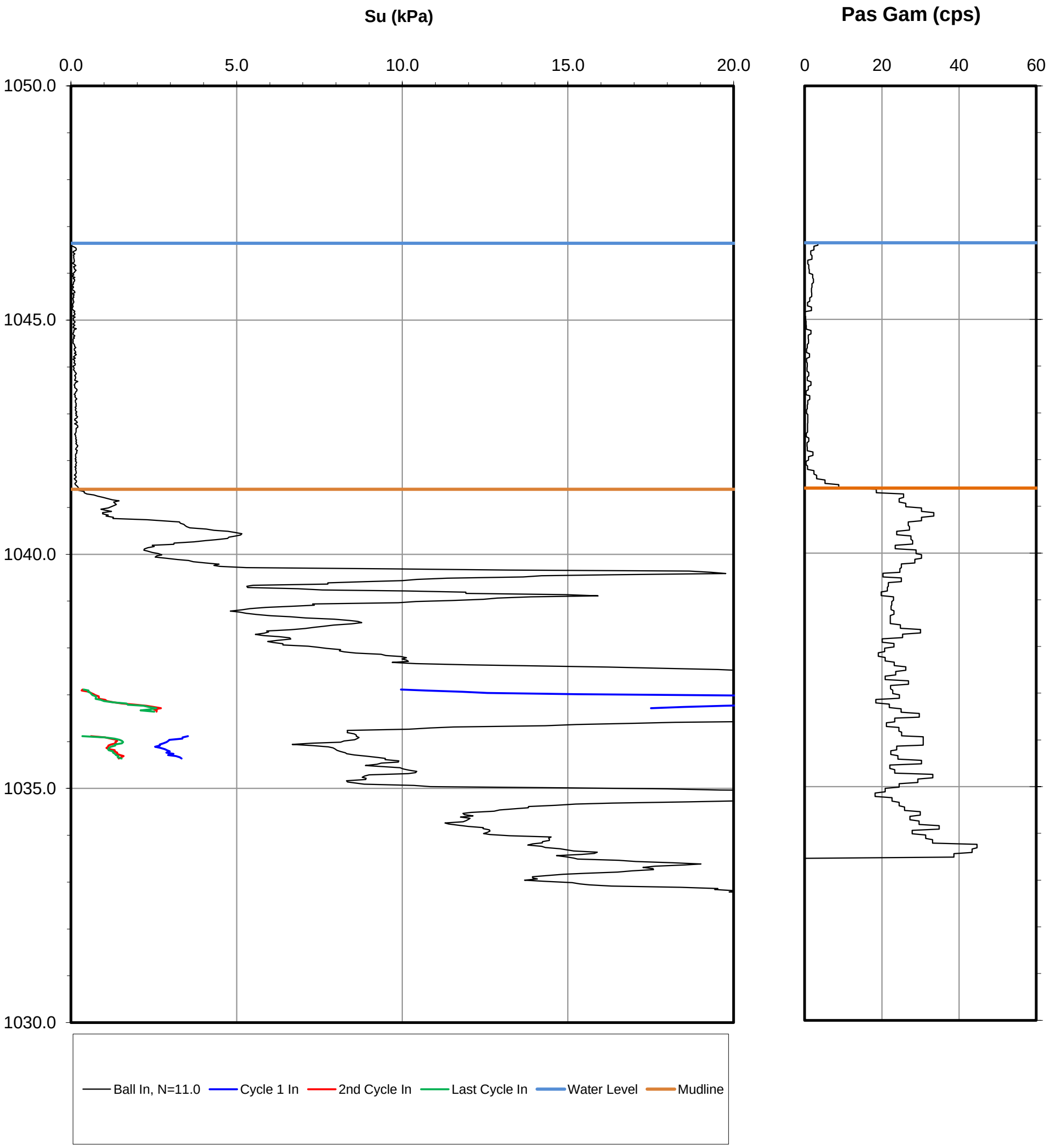
Flow Penetrometer Undrained Strength



Project: 16-02014
Client: CH2M Hill Canada Ltd.
Project: Faro Mine Complex
Sounding: CH16-201-CP017A
Sounding Date: March 14th, 2016

Coordinate System: WGS84/UTM Zone 8N
Northing (m): 6913869.52
Easting (m): 580529.26
Elevation (m): 1046.64

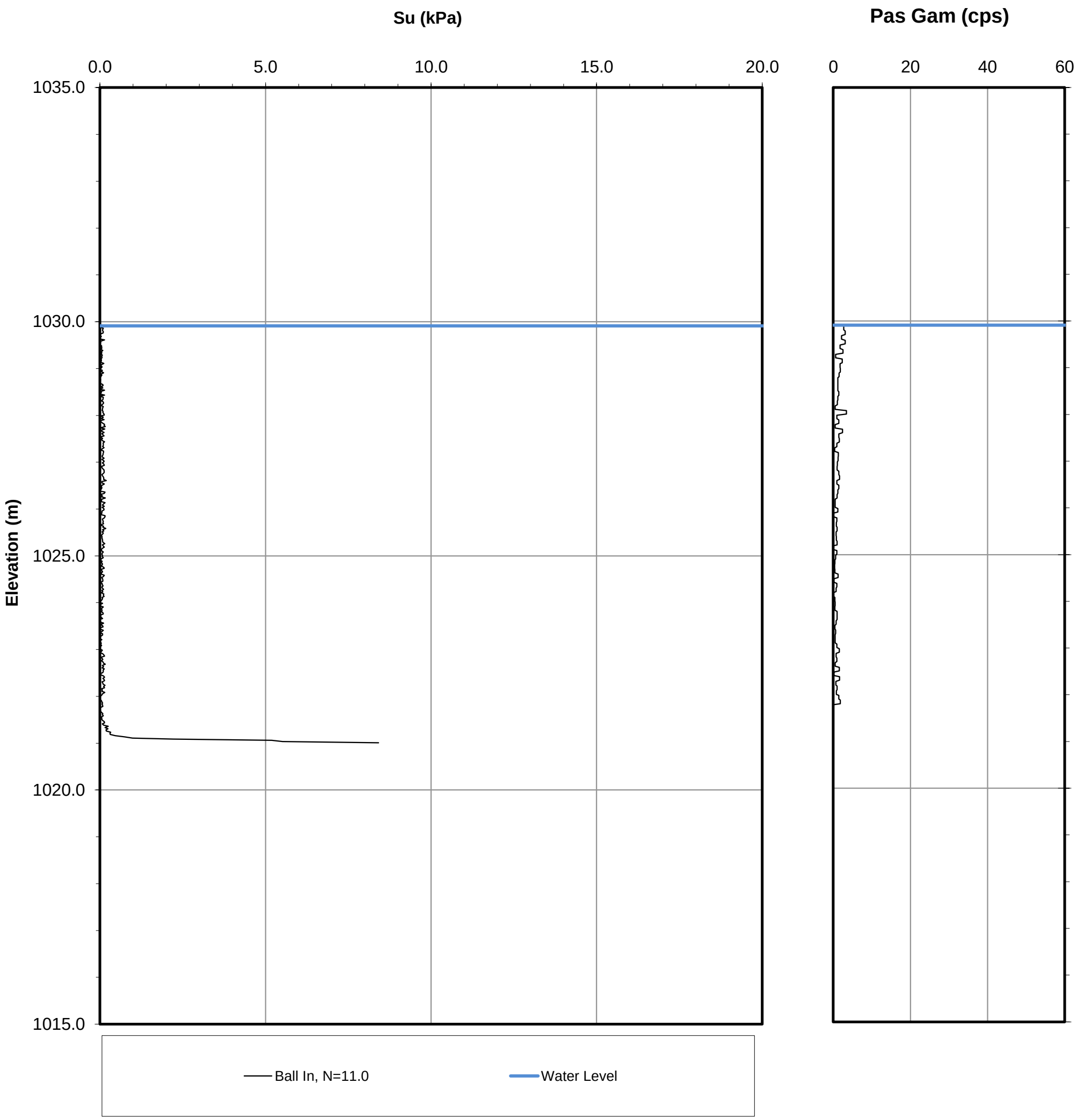
Flow Penetrometer Undrained Strength



Project: 16-02014
Client: CH2M Hill Canada Ltd.
Project: Faro Mine Complex
Sounding: CH16-201-CP026
Sounding Date: March 12th, 2016

Coordinate System: WGS84/UTM Zone 8N
Northing (m): 6914405.12
Easting (m): 580344.68
Elevation (m): 1029.91

Flow Penetrometer Undrained Strength



Pore Pressure Dissipation (BGCPTu) Summary and PPD Plots

Job No:	16-02014
Client:	CH2M Hill Canada Ltd.
Project:	Faro Mine Complex
Start Date:	12-Mar-2016
End Date:	17-Mar-2016

BCPTu PORE PRESSURE DISSIPATION SUMMARY

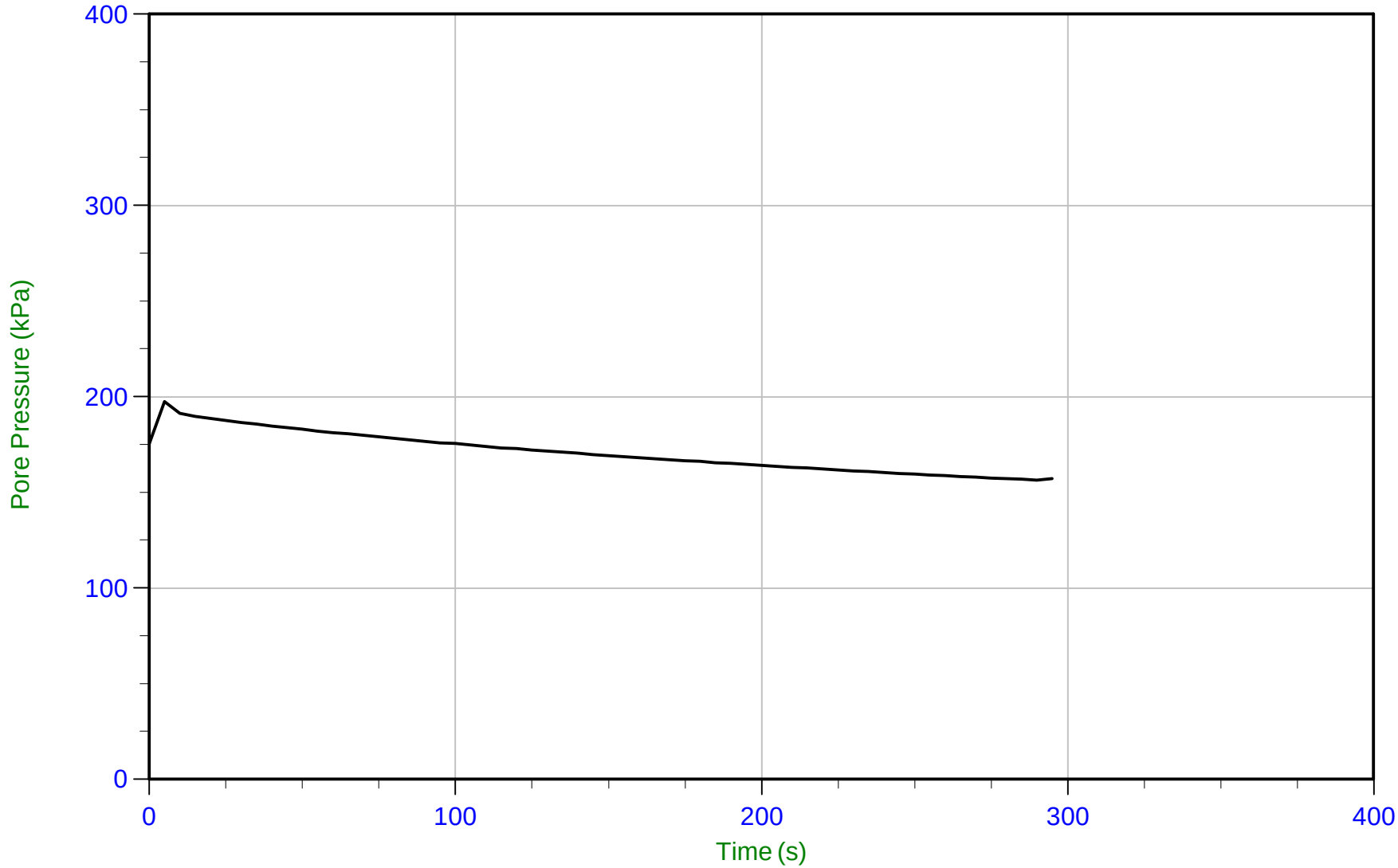
Sounding ID	File Name	Cone Area (cm^2)	Pore Pressure Filter Location	Duration (s)	Test Depth (m)	Estimated Equilibrium Pore Pressure U_{eq} (kPa)
CH16-201-CP015A	16-02014_GB015A	15	u_2	295	14.425	Not Achieved
CH16-201-CP026	16-02014_GB026	15	u_2	315	8.900	87.9

CONETEC

CH2M

Job No: 16-02014
Date: 03/17/2016 10:35
Site: Faro IP

Sounding: CH16-201-CP015A
Cone: 317:T375F10U200
Cone Area: 15 sq cm



Trace Summary:

Filename: 16-02014_GB015A.PPF
Depth: 14.425 m / 47.326 ft
Duration: 295.0 s

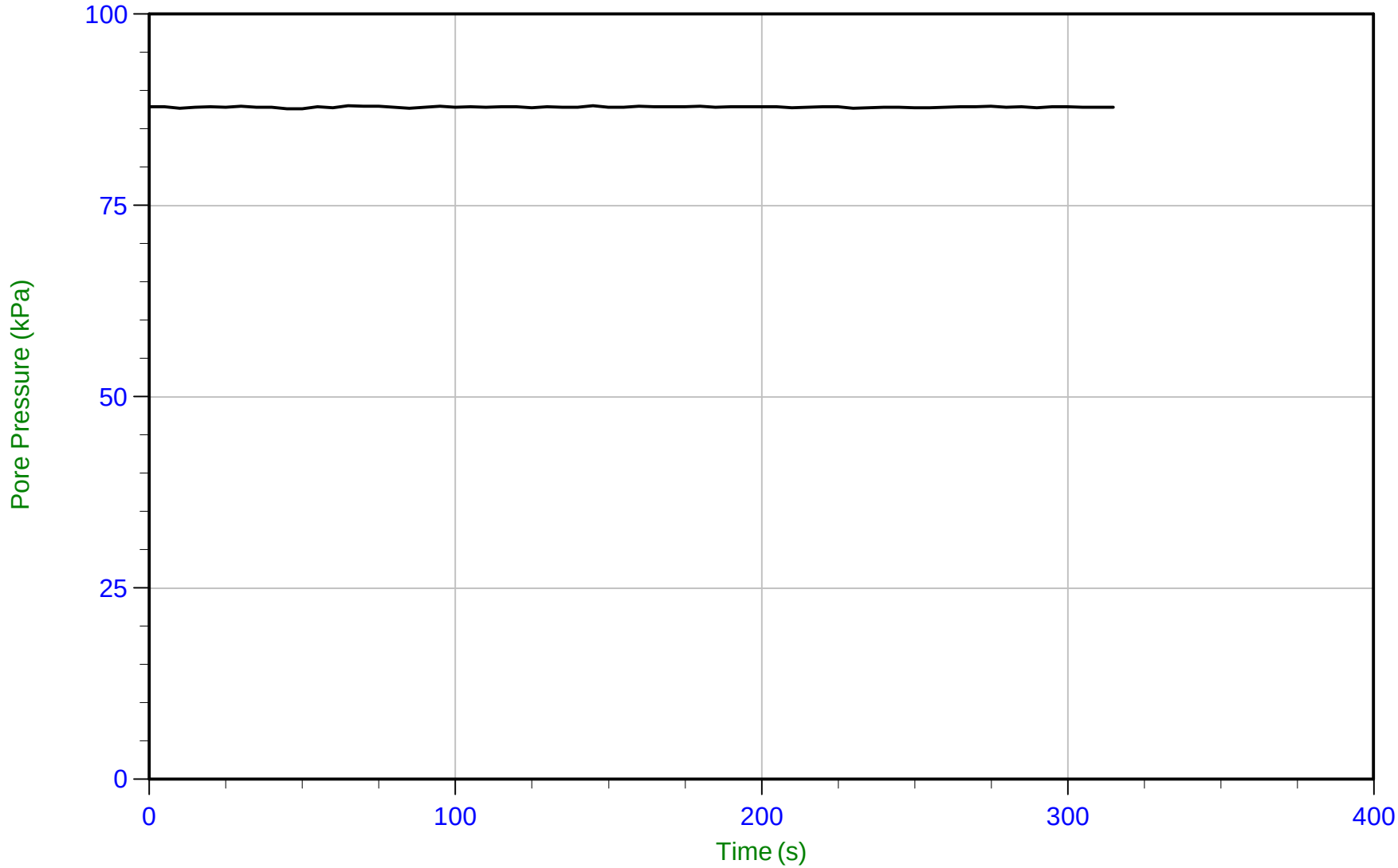
U Min: 156.3 kPa
U Max: 197.5 kPa

CONETEC

CH2M

Job No: 16-02014
Date: 03/12/2016 16:05
Site: Faro CVP

Sounding: CH16-201-CP026
Cone: 317:T375F10U200
Cone Area: 15 sq cm



Trace Summary:

Filename: 16-02014_GB026.PPF
Depth: 8.900 m / 29.199 ft
Duration: 315.0 s

U Min: 87.6 kPa
U Max: 88.0 kPa

WT: -0.062 m / -0.203 ft
Ueq: 87.9 kPa

Sample Summary and Sample Logs

CONETEC

Job No: 16-02014
Client: CH2M Hill Canada Ltd-Calgary, AB
Project: Faro Mine Complex
Start Date: 08-Mar-2016
End Date: 12-Mar-2016

SAMPLE SUMMARY

Location ID	Date From	Date To	Depth From (m)	Depth To (m)	Depth From (ft)	Depth To (ft)	Sample Methods	Sample # From	Sample # To	Northing[1] (m)	Easting (m)	Elevation[2] (m)	Elevation Collection Method	Refer to Notation Number
CH16-201-BH005	11-Mar-2016	11-Mar-2016	9.35	9.85	30.68	32.32	S	1	1	6914249.55	580349.28	1029.95	Trimble	
CH16-201-BH005A	11-Mar-2016	11-Mar-2016	9.40	11.40	30.84	37.40	S	1	1	6914248.55	580349.31	1029.95	Trimble	
CH16-201-BH005B	12-Mar-2016	12-Mar-2016	9.45	11.45	31.00	37.57	S	1	1	6914247.60	580349.33	1029.92	Trimble	
CH16-201-BH006	10-Mar-2016	10-Mar-2016	13.40	15.40	43.96	50.52	S	1	1	6914347.55	580167.99	1029.95	Trimble	
CH16-201-BH006A	10-Mar-2016	10-Mar-2016	13.40	17.40	43.96	57.09	S	1	2	6914346.09	580167.45	1029.94	Trimble	
CH16-201-BH007	08-Mar-2016	08-Mar-2016	6.05	23.80	19.85	78.08	S	1	10	6914140.78	580284.42	1030.04	Trimble	
CH16-201-BH008	10-Mar-2016	10-Mar-2016	15.30	19.30	50.20	63.32	S	1	2	6914402.21	580198.07	1029.94	Trimble	
CH16-201-BH009	09-Mar-2016	09-Mar-2016	8.30	13.40	27.23	43.96	S	1	4	6914353.08	580392.41	1029.96	Trimble	
CH16-201-BH010	09-Mar-2016	09-Mar-2016	14.70	17.80	48.23	58.40	S	1	5	6914421.36	580213.61	1029.98	Trimble	
CH16-201-BH010A	10-Mar-2016	10-Mar-2016	15.80	19.80	51.84	64.96	S	1	3	6914420.14	580212.81	1029.97	Trimble	
CH16-201-BH011	11-Mar-2016	11-Mar-2016	8.55	9.55	28.05	31.33	S	1	1	6914403.53	580346.27	1029.93	Trimble	
CH16-201-BH011A	12-Mar-2016	12-Mar-2016	7.50	8.00	24.61	26.25	S	1	2	6914404.38	580345.48	1029.99	Trimble	
CH16-201-BH012	11-Mar-2016	11-Mar-2016	14.63	15.63	48.00	51.28	S	1	2	6914322.36	580372.08	1030.04	Trimble	
CH16-201-BH012A	12-Mar-2016	12-Mar-2016	13.60	15.60	44.62	51.18	S	1	1	6914327.27	580366.12	1029.90	Trimble	

1. Coordinate and elevatios were surveyed using a Trimble system with datum: WGS84/UTM Zone 8 North.
2. Elevations are referenced to the existing ice surface at the time of sampling.

Sample Methods	
Code	**Description**
S	Sonic

SAMPLE LOG

LOCATION ID: CH16-201-BH005

Client: CH2M Hill Canada Ltd-Calgary, A
ConeTec Job #: 16-02014
Rig: FrasteC05-010

Staff: SDAV JWOO RDOY
Weather Conditions: Clear, sunny
Additional Comments:

Coordinate Reference System: WGS84/UTM Zone 8 North
Coordinate Collection Method: Trimble
Northing (m): 6914249.55
Easting (m): 580349.28

Elevation Collection Method: Trimble
Reference Elevation (m): 1029.95

Mudline Depth (m): 9.2
Mudline Collection Method:

Sample # Sequential	Date Time	Depth From (m)	Depth To (m)	Sample Method	Recovered Sample Length (m)	Recovery Percentage (0 - 100 %)	pH	Redox [Oxidation-reduction-ORP] (mV)	Specific Conductance (µS/cm)	Temp. (°C)	Comments
1	11-Mar-2016 17:00	9.35	9.85	S							no recovery

Sample Methods	
Code	Description
S	Sonic

SAMPLE LOG

LOCATION ID: CH16-201-BH005A

Client: CH2M Hill Canada Ltd-Calgary, A
ConeTec Job #: 16-02014
Rig: FrasteC05-010

Staff: SDAV JWOO RDOY
Weather Conditions: Clear, sunny
Additional Comments:

Coordinate Reference System: WGS84/UTM Zone 8 North
Coordinate Collection Method: Trimble
Northing (m): 6914248.55
Easting (m): 580349.31

Elevation Collection Method: Trimble
Reference Elevation (m): 1029.95

Mudline Depth (m): 9.3
Mudline Collection Method:

Sample # Sequential	Date Time	Depth From (m)	Depth To (m)	Sample Method	Recovered Sample Length (m)	Recovery Percentage (0 - 100 %)	pH	Redox [Oxidation-reduction-ORP] (mV)	Specific Conductance (µS/cm)	Temp. (°C)	Comments
1	11-Mar-2016 17:00	9.40	11.40	S	0.6	30					sampler mostly full of water

Sample Methods	
Code	**Description**
S	Sonic

SAMPLE LOG

LOCATION ID: CH16-201-BH005B

Client: CH2M Hill Canada Ltd-Calgary, A
ConeTec Job #: 16-02014
Rig: FrasteC05-010

Staff: SDAV JWOO RDOY
Weather Conditions: Clear, sunny
Additional Comments:

Coordinate Reference System: WGS84/UTM Zone 8 North
Coordinate Collection Method: Trimble
Northing (m): 6914247.60
Easting (m): 580349.33

Elevation Collection Method: Trimble
Reference Elevation (m): 1029.92

Mudline Depth (m): 9.4
Mudline Collection Method:

Sample # Sequential	Date Time	Depth From (m)	Depth To (m)	Sample Method	Recovered Sample Length (m)	Recovery Percentage (0 - 100 %)	pH	Redox [Oxidation-reduction-ORP] (mV)	Specific Conductance (µS/cm)	Temp. (°C)	Comments
1	12-Mar-2016 12:05	9.45	11.45	S	0.9	45					sand and gravel

Sample Methods	
Code	Description
S	Sonic

SAMPLE LOG

LOCATION ID:	**CH16-201-BH006**
Client:	CH2M Hill Canada Ltd-Calgary, A
ConeTec Job #:	16-02014
Rig:	FrasteC05-010
Staff:	SDAV JWOO RDOY
Weather Conditions:	Clear, sunny
Additional Comments:	

Coordinate Reference System:	WGS84/UTM Zone 8 North
Coordinate Collection Method:	Trimble
Northing (m):	6914347.55
Easting (m):	580167.99
Elevation Collection Method:	Trimble
Reference Elevation (m):	1029.95
Mudline Depth (m):	13.4
Mudline Collection Method:	

Sample # Sequential	Date Time	Depth From (m)	Depth To (m)	Sample Method	Recovered Sample Length (m)	Recovery Percentage (0 - 100 %)	pH	Redox [Oxidation-reduction-ORP] (mV)	Specific Conductance (µS/cm)	Temp. (°C)	Comments
1	10-Mar-2016 13:15	13.40	15.40	S	0.0	2					shoe plugged with gravel

Sample Methods	
Code	**Description**
S	Sonic

SAMPLE LOG

LOCATION ID:	**CH16-201-BH006A**
Client:	CH2M Hill Canada Ltd-Calgary, A
ConeTec Job #:	16-02014
Rig:	FrasteC05-010
Staff:	SDAV JWOO RDOY
Weather Conditions:	clear, sunny
Additional Comments:	

Coordinate Reference System:	WGS84/UTM Zone 8 North
Coordinate Collection Method:	Trimble
Northing (m):	6914346.09
Easting (m):	580167.45
Elevation Collection Method:	Trimble
Reference Elevation (m):	1029.94
Mudline Depth (m):	
Mudline Collection Method:	

Sample # Sequential	Date Time	Depth From (m)	Depth To (m)	Sample Method	Recovered Sample Length (m)	Recovery Percentage (0 - 100 %)	pH	Redox [Oxidation-reduction-ORP] (mV)	Specific Conductance (µS/cm)	Temp. (°C)	Comments
1	10-Mar-2016 14:00	13.40	15.40	S	1.2	60					silt and gravel with organics
2	10-Mar-2016 14:25	15.40	17.40	S	1.7	85					silt and gravel with organics

Sample Methods	
Code	**Description**
S	Sonic

SAMPLE LOG

LOCATION ID: CH16-201-BH007

Client: CH2M Hill Canada Ltd-Calgary, A
ConeTec Job #: 16-02014
Rig: FrasteC05-010

Staff: SDAV JWOO RDOY
Weather Conditions: Clear, sunny
Additional Comments:

Coordinate Reference System: WGS84/UTM Zone 8 North
Coordinate Collection Method: Trimble
Northing (m): 6914140.78
Easting (m): 580284.42

Elevation Collection Method: Trimble
Reference Elevation (m): 1030.04

Mudline Depth (m): 7.1
Mudline Collection Method:

Sample # Sequential	Date Time	Depth From (m)	Depth To (m)	Sample Method	Recovered Sample Length (m)	Recovery Percentage (0 - 100 %)	pH	Redox [Oxidation-reduction-ORP] (mV)	Specific Conductance (µS/cm)	Temp. (°C)	Comments
1	08-Mar-2016 13:05	6.05	6.05	S							water
2	08-Mar-2016 13:20	7.05	7.80	S	0.5	67					sand and gravel
3	08-Mar-2016 13:50	7.80	9.80	S	1.4	70					sand and gravel
4	08-Mar-2016 14:15	9.80	11.80	S	2.0	100					sand and gravel
5	08-Mar-2016 14:45	11.80	13.80	S	2.0	100					sand and gravel
6	08-Mar-2016 15:00	13.80	15.80	S	2.0	100					sand and gravel
7	08-Mar-2016 15:25	15.80	17.80	S	2.0	100					sand and gravel
8	08-Mar-2016 15:45	17.80	19.80	S	2.0	100					sand and gravel
9	08-Mar-2016 16:05	19.80	21.80	S	2.0	100					sand
10	08-Mar-2016 16:25	21.80	23.80	S	2.0	100					sand

Sample Methods

Code	Description
S	Sonic

SAMPLE LOG

LOCATION ID: CH16-201-BH008

Client: CH2M Hill Canada Ltd-Calgary, A
ConeTec Job #: 16-02014
Rig: FrasteC05-10

Staff: SDAV JWOO RDOY
Weather Conditions: Clear, sunny
Additional Comments:

Coordinate Reference System: WGS84/UTM Zone 8 North
Coordinate Collection Method: Trimble
Northing (m): 6914402.21
Easting (m): 580198.07

Elevation Collection Method: Trimble
Reference Elevation (m): 1029.94

Mudline Depth (m): 15.2
Mudline Collection Method:

Sample # Sequential	Date Time	Depth From (m)	Depth To (m)	Sample Method	Recovered Sample Length (m)	Recovery Percentage (0 - 100 %)	pH	Redox [Oxidation-reduction-ORP] (mV)	Specific Conductance (µS/cm)	Temp. (°C)	Comments
1	10-Mar-2016 15:45	15.30	17.30	S	1.8	90					sludge, silt with gravel and organics
2	10-Mar-2016 16:15	17.30	19.30	S	1.5	73					sand and gravel

Sample Methods

Code	Description
S	Sonic

SAMPLE LOG

LOCATION ID: CH16-201-BH009

Client: CH2M Hill Canada Ltd-Calgary, A
ConeTec Job #: 16-02014
Rig: FrasteC05-010

Staff: SDAV JWOO RDOY
Weather Conditions: Clear, sunny
Additional Comments:

Coordinate Reference System: WGS84/UTM Zone 8 North
Coordinate Collection Method: Trimble
Northing (m): 6914353.08
Easting (m): 580392.41

Elevation Collection Method: Trimble
Reference Elevation (m): 1029.96

Mudline Depth (m): 9.7
Mudline Collection Method:

Sample # Sequential	Date Time	Depth From (m)	Depth To (m)	Sample Method	Recovered Sample Length (m)	Recovery Percentage (0 - 100 %)	pH	Redox [Oxidation-reduction-ORP] (mV)	Specific Conductance (µS/cm)	Temp. (°C)	Comments
1	09-Mar-2016 10:25	8.30	8.30	S							water
2	09-Mar-2016 10:45	9.50	9.50	S							water
3	09-Mar-2016 11:00	9.65	11.40	S	0.8	43					sand and gravel
4	09-Mar-2016 11:40	11.40	13.40	S	1.3	65					sand gravel and organics

Sample Methods

Code	Description
S	Sonic

SAMPLE LOG

LOCATION ID: CH16-201-BH010

Client: CH2M Hill Canada Ltd-Calgary, A
ConeTec Job #: 16-02014
Rig: FrasteC05-010

Staff: SDAV JWOO RDOY
Weather Conditions: Clear, sunny
Additional Comments:

Coordinate Reference System: WGS84/UTM Zone 8 North
Coordinate Collection Method: Trimble
Northing (m): 6914421.36
Easting (m): 580213.61

Elevation Collection Method: Trimble
Reference Elevation (m): 1029.98

Mudline Depth (m): 15.5
Mudline Collection Method:

Sample # Sequential	Date Time	Depth From (m)	Depth To (m)	Sample Method	Recovered Sample Length (m)	Recovery Percentage (0 - 100 %)	pH	Redox [Oxidation-reduction-ORP] (mV)	Specific Conductance (µS/cm)	Temp. (°C)	Comments
1	09-Mar-2016 14:00	14.70	14.70	S							water
2	09-Mar-2016 14:20	15.50	15.50	S							fine sand and silt
3	09-Mar-2016 14:45	15.50	15.90	S							rust coloured water only
4	09-Mar-2016 15:10	15.50	16.50	S							sampler filled with water
5	09-Mar-2016 15:40	16.70	17.80	S	1.5	136					sand and gravel

Sample Methods

Code	Description
S	Sonic

SAMPLE LOG

LOCATION ID: CH16-201-BH010A

Client: CH2M Hill Canada Ltd-Calgary, A
ConeTec Job #: 16-02014
Rig: FrasteC05-010

Staff: SDAV JWOO RDOY
Weather Conditions: Clear, sunny
Additional Comments:

Coordinate Reference System: WGS84/UTM Zone 8 North
Coordinate Collection Method: Trimble
Northing (m): 6914420.14
Easting (m): 580212.81

Elevation Collection Method: Trimble
Reference Elevation (m): 1029.97

Mudline Depth (m): 15.7
Mudline Collection Method:

Sample # Sequential	Date Time	Depth From (m)	Depth To (m)	Sample Method	Recovered Sample Length (m)	Recovery Percentage (0 - 100 %)	pH	Redox [Oxidation-reduction-ORP] (mV)	Specific Conductance (µS/cm)	Temp. (°C)	Comments
1	10-Mar-2016 10:15	15.80	17.80	S	2.0	100					fine sand and silt
2	10-Mar-2016 10:30	17.80	19.30	S	1.7	113					fine sand and silt with organics
3	10-Mar-2016 11:15	19.30	19.80	S							sampler damaged, no recovery

Sample Methods

Code	Description
S	Sonic

SAMPLE LOG

LOCATION ID:	**CH16-201-BH011**
Client:	CH2M Hill Canada Ltd-Calgary, A
ConeTec Job #:	16-02014
Rig:	FrasteC05-010
Staff:	SDAV JWOO RDOY
Weather Conditions:	Clear, sunny
Additional Comments:	

Coordinate Reference System:	WGS84/UTM Zone 8 North
Coordinate Collection Method:	Trimble
Northing (m):	6914403.53
Easting (m):	580346.27
Elevation Collection Method:	Trimble
Reference Elevation (m):	1029.93
Mudline Depth (m):	8.4
Mudline Collection Method:	

Sample # Sequential	Date Time	Depth From (m)	Depth To (m)	Sample Method	Recovered Sample Length (m)	Recovery Percentage (0 - 100 %)	pH	Redox [Oxidation-reduction-ORP] (mV)	Specific Conductance (µS/cm)	Temp. (°C)	Comments
1	11-Mar-2016 13:00	8.55	9.55	S	0.4	35					sludge, silt and gravel

Sample Methods	
Code	**Description**
S	Sonic

SAMPLE LOG

LOCATION ID: CH16-201-BH011A

Client: CH2M Hill Canada Ltd-Calgary, A
ConeTec Job #: 16-02014
Rig: FrasteC05-010

Staff: SDAV JWOO RDOY
Weather Conditions: Clear, sunny
Additional Comments:

Coordinate Reference System: WGS84/UTM Zone 8 North
Coordinate Collection Method: Trimble
Northing (m): 6914404.38
Easting (m): 580345.48

Elevation Collection Method: Trimble
Reference Elevation (m): 1029.99

Mudline Depth (m): 7.0
Mudline Collection Method:

Sample # Sequential	Date Time	Depth From (m)	Depth To (m)	Sample Method	Recovered Sample Length (m)	Recovery Percentage (0 - 100 %)	pH	Redox [Oxidation-reduction-ORP] (mV)	Specific Conductance (µS/cm)	Temp. (°C)	Comments
1	12-Mar-2016 17:30	7.50	7.50	S	0.8						sludge
2	12-Mar-2016 18:00	8.00	8.00	S	0.3						sludge

Sample Methods

Code	Description
S	Sonic

SAMPLE LOG

LOCATION ID: CH16-201-BH012

Client: CH2M Hill Canada Ltd-Calgary, A
ConeTec Job #: 16-02014
Rig: FrasteC05-010

Staff: SDAV JWOO RDOY
Weather Conditions: Clear, sunny
Additional Comments:

Coordinate Reference System: WGS84/UTM Zone 8 North
Coordinate Collection Method: Trimble
Northing (m): 6914322.36
Easting (m): 580372.08

Elevation Collection Method: Trimble
Reference Elevation (m): 1030.04

Mudline Depth (m): 14.5
Mudline Collection Method:

Sample # Sequential	Date Time	Depth From (m)	Depth To (m)	Sample Method	Recovered Sample Length (m)	Recovery Percentage (0 - 100 %)	pH	Redox [Oxidation-reduction-ORP] (mV)	Specific Conductance (µS/cm)	Temp. (°C)	Comments
1	11-Mar-2016 15:30	14.63	15.13	S							
2	11-Mar-2016 16:00	15.13	15.63	S	0.3	50					silt gravel and organics

Sample Methods

Code	Description
S	Sonic

SAMPLE LOG

LOCATION ID:	**CH16-201-BH012A**
Client:	CH2M Hill Canada Ltd-Calgary, A
ConeTec Job #:	16-02014
Rig:	FrasteC05-010
Staff:	SDAV JWOO RDOY
Weather Conditions:	Clear, sunny
Additional Comments:	

Coordinate Reference System:	WGS84/UTM Zone 8 North
Coordinate Collection Method:	Trimble
Northing (m):	6914327.27
Easting (m):	580366.12
Elevation Collection Method:	Trimble
Reference Elevation (m):	1029.90
Mudline Depth (m):	13.5
Mudline Collection Method:	

Sample # Sequential	Date Time	Depth From (m)	Depth To (m)	Sample Method	Recovered Sample Length (m)	Recovery Percentage (0 - 100 %)	pH	Redox [Oxidation-reduction-ORP] (mV)	Specific Conductance (µS/cm)	Temp. (°C)	Comments
1	12-Mar-2016 13:25	13.60	15.60	S	2.0	100					loose watery fine sand, silt and gravel

Sample Methods	
Code	**Description**
S	Sonic

Attachment 3
CH2M Borehole Logs

KEY TO SOIL BORING LOGS

SAMPLE TYPES AND ABBREVIATIONS

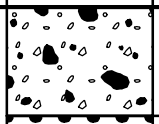
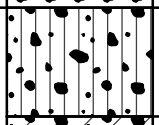
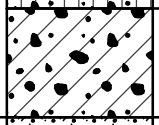
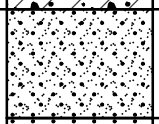
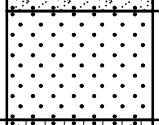
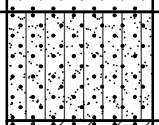
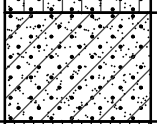
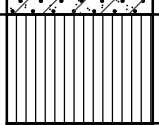
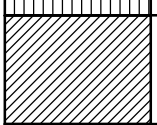
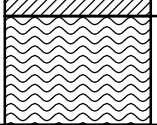
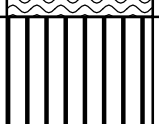
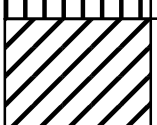
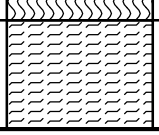
TERM	EXPLANATION
BU	Bulk Sample
AL	AQUALOCK SAMPLE
USCS	UNIFIED SOIL CLASSIFICATION SYSTEM (ASTM D2487)
LL	LIQUID LIMIT (ASTM D4318)
PI	PLASTICITY INDEX (ASTM D4318)
Cu	Uniformity Coefficient
Cc	Coefficient of Gradation
w_c	WATER CONTENT (%)

GENERAL NOTES

1) THE BORING LOGS AND RELATED INFORMATION DEPICT SUBSURFACE CONDITIONS AND WATER LEVELS ONLY AT THE SPECIFIC LOCATIONS AND DATES INDICATED. SOIL CONDITIONS AND WATER LEVELS OCCURRING AT OTHER LOCATIONS MAY DIFFER FROM THE CONDITIONS OCCURRING AT THESE BORING LOCATIONS. THE PASSAGE OF TIME MAY RESULT IN A CHANGE IN THE CONDITIONS AT THESE LOCATIONS.

2) DRILLING OF SOIL BORINGS WAS DIRECTED BY CH2M HILL GEOTECHNICAL PERSONNEL. THE SUBSURFACE MATERIALS FROM THE BORINGS WERE CLASSIFIED IN APPROXIMATE ACCORDANCE WITH ASTM D4288 (VISUAL-MANUAL PROCEDURE FOR DESCRIPTION OF SOILS, AND ADJUSTED BASED ON LABORATORY TEST RESULTS WHERE NECESSARY.

SOIL CLASSIFICATION CHART

MAJOR DIVISIONS			SYMBOLS		TYPICAL DESCRIPTIONS
			GRAPH	LETTER	
COARSE GRAINED SOILS MORE THAN 50% OF MATERIAL IS LARGER THAN NO. 200 SIEVE SIZE	GRAVEL AND GRAVELLY SOILS MORE THAN 50% OF COARSE FRACTION RETAINED ON NO. 4 SIEVE	CLEAN GRAVELS (LITTLE OR NO FINES)		GW	WELL-GRADED GRAVELS, GRAVEL - SAND MIXTURES, LITTLE OR NO FINES
				GP	POORLY-GRADED GRAVELS, GRAVEL - SAND MIXTURES, LITTLE OR NO FINES
		GRAVELS WITH FINES (APPRECIABLE AMOUNT OF FINES)		GM	SILTY GRAVELS, GRAVEL - SAND - SILT MIXTURES
				GC	CLAYEY GRAVELS, GRAVEL - SAND - CLAY MIXTURES
	SAND AND SANDY SOILS MORE THAN 50% OF COARSE FRACTION PASSING ON NO. 4 SIEVE	CLEAN SANDS (LITTLE OR NO FINES)		SW	WELL-GRADED SANDS, GRAVELLY SANDS, LITTLE OR NO FINES
				SP	POORLY-GRADED SANDS, GRAVELLY SAND, LITTLE OR NO FINES
		SANDS WITH FINES (APPRECIABLE AMOUNT OF FINES)		SM	SILTY SANDS, SAND - SILT MIXTURES
				SC	CLAYEY SANDS, SAND - CLAY MIXTURES
FINE GRAINED SOILS MORE THAN 50% OF MATERIAL IS SMALLER THAN NO. 200 SIEVE SIZE	SILTS AND CLAYS	LIQUID LIMIT LESS THAN 50		ML	INORGANIC SILTS AND VERY FINE SANDS, ROCK FLOUR, SILTY OR CLAYEY FINE SANDS OR CLAYEY SILTS WITH SLIGHT PLASTICITY
				CL	INORGANIC CLAYS OF LOW TO MEDIUM PLASTICITY, GRAVELLY CLAYS, SANDY CLAYS, SILTY CLAYS, LEAN CLAYS
				OL	ORGANIC SILTS AND ORGANIC SILTY CLAYS OF LOW PLASTICITY
	SILTS AND CLAYS	LIQUID LIMIT GREATER THAN 50		MH	INORGANIC SILTS, MICACEOUS OR DIATOMACEOUS FINE SAND OR SILTY SOILS
				CH	INORGANIC CLAYS OF HIGH PLASTICITY
				OH	ORGANIC CLAYS OF MEDIUM TO HIGH PLASTICITY, ORGANIC SILTS
HIGHLY ORGANIC SOILS				PT	PEAT, HUMUS, SWAMP SOILS WITH HIGH ORGANIC CONTENTS

NOTE: DUAL SYMBOLS ARE USED TO INDICATE BORDERLINE SOIL CLASSIFICATIONS

PROJECT NUMBER:	BORING NUMBER:
673709	CH16-201-BH005

SOIL BORING LOG

PROJECT : Faro Mine Remediation Project, CVD and ID Pond LOCATION : CVD Pond (6914249.55 N, 580349.28 E)

ICE WORK PAD SURFACE ELEVATION : 1029.95 m DRILLING CONTRACTOR : ConeTec

DRILLING METHOD AND EQUIPMENT : Track-mounted, sonic drill rig and Aqualock (AL) piston sample barrel; 50mm or 70 mm-inside diameter, with lengths of 1m or 2m.

MUDLINE DEPTH BELOW ICE WORK PAD SURFACE : 9.23 m START : 3/11/16 16:45 END : 3/11/16 17:15 LOGGER : T. Munson

DEPTH BELOW ICE PAD SURFACE (m) AND ELEVATION	INTERVAL (m)	RECOVERY (m)	TYPE/#	GRAPHIC LOG	SOIL DESCRIPTION SOIL NAME, USCS GROUP SYMBOL, COLOR, MOISTURE CONTENT, RELATIVE DENSITY OR CONSISTENCY, SOIL STRUCTURE, MINERALOGY	COMMENTS DRILLING OBSERVATIONS, SOUNDING INFORMATION, SAMPLING METHODS, LABORATORY TEST RESULTS
8 1022.0						Mudline sounding data Weighted tape: 9.23 m Lowrance HDS-7 Gen2 fish finder: 0.9 m (keel) + 8.4 m reading = 9.3 m depth below water surface.
9 1021.0						
	9.35				Mudline	
	9.85	0.00	AL		No Recovery	1-m-long barrel; no catcher was used
10 1020.0					Bottom of Hole at 9.85 m below water surface 3/11/16 17:15	
11 1019.0						
12 1018.0						
13 1017.0						
14 1016.0						
15 1015.0						
16 1014.0						
17 1013.0						

PROJECT NUMBER:	BORING NUMBER:
673709	CH16-201-BH005A

SOIL BORING LOG

PROJECT : Faro Mine Remediation Project, CVD and ID Pond LOCATION : CVD Pond (6914248.55 N, 580349.31 E)

ICE WORK PAD SURFACE ELEVATION : 1029.95 m DRILLING CONTRACTOR : ConeTec

DRILLING METHOD AND EQUIPMENT : Track-mounted, sonic drill rig and Aqualock (AL) piston sample barrel; 50mm or 70 mm-inside diameter, with lengths of 1m or 2m.

MUDLINE DEPTH BELOW ICE WORK PAD SURFACE : 9.3 m START : 3/11/16 17:15 END : 3/11/16 18:00 LOGGER : T. Munson

DEPTH BELOW ICE PAD SURFACE (m) AND ELEVATION	INTERVAL (m)	RECOVERY (m)	TYPE/#	GRAPHIC LOG	SOIL DESCRIPTION SOIL NAME, USCS GROUP SYMBOL, COLOR, MOISTURE CONTENT, RELATIVE DENSITY OR CONSISTENCY, SOIL STRUCTURE, MINERALOGY	COMMENTS DRILLING OBSERVATIONS, SOUNDING INFORMATION, SAMPLING METHODS, LABORATORY TEST RESULTS
8 1022.0						Mudline sounding data Weighted tape: 9.30 m Lowrance HDS-7 Gen2 fish finder: 0.9 m (keel) + 8.4 m reading = 9.3 m depth below water surface.
9 1021.0						
	9.40				Mudline	
					WELL-GRADED SAND WITH GRAVEL (SW); dark grey, wet, fine to coarse sand, fine to coarse, subrounded to rounded gravel	sampler mostly full of water no catcher was used
10 1020.0		0.47	AL-SOa			
11 1019.0	11.40					
					Bottom of Hole at 11.40 m below water surface 3/11/16 18:00	
12 1018.0						
13 1017.0						
14 1016.0						
15 1015.0						
16 1014.0						
17 1013.0						

PROJECT NUMBER:	BORING NUMBER:
673709	CH16-201-BH005B

SOIL BORING LOG

PROJECT : Faro Mine Remediation Project, CVD and ID Pond LOCATION : CVD Pond (6914247.60 N, 580349.33 E)

ICE WORK PAD SURFACE ELEVATION : 1029.92 m DRILLING CONTRACTOR : ConeTec

DRILLING METHOD AND EQUIPMENT : Track-mounted, sonic drill rig and Aqualock (AL) piston sample barrel; 50mm or 70 mm-inside diameter, with lengths of 1m or 2m.

MUDLINE DEPTH BELOW ICE WORK PAD SURFACE : 9.35 m START : 3/12/16 11:30 END : 3/12/16 12:30 LOGGER : T. Munson

DEPTH BELOW ICE PAD SURFACE (m) AND ELEVATION	INTERVAL (m)	RECOVERY (m)	TYPE/#	GRAPHIC LOG	SOIL DESCRIPTION SOIL NAME, USCS GROUP SYMBOL, COLOR, MOISTURE CONTENT, RELATIVE DENSITY OR CONSISTENCY, SOIL STRUCTURE, MINERALOGY	COMMENTS DRILLING OBSERVATIONS, SOUNDING INFORMATION, SAMPLING METHODS, LABORATORY TEST RESULTS
8 1021.9						Mudline sounding data Weighted tape: 9.35 m (appeared firm) Lowrance HDS-7 Gen2 fish finder: 0.9 m (keel) + 8.5 m reading = 9.4 m depth below water surface. Driller indicated soils at mudline supported weight of drill string with less than 2cm penetration; therefore, relatively dense.
9 1020.9						
	9.45				Mudline	
					WELL-GRADED SAND (SW); dark grey, wet, fine to medium sand becoming fine to coarse sand below 9.75m	Observed less than 5 cm possible sludge at top of recovered soil sample. Sample SOA1 (9.45m to 9.9m): See Laboratory Data for Geochemical Tests
10 1019.9					**WELL-GRADED GRAVEL WITH SAND (GW)**; dark grey, wet, fine, subrounded to rounded gravel, medium to coarse grained sand, becoming fine to coarse gravel below 10.1m	
		0.90	AL-SOa			
11 1018.9						
	11.45					
					Bottom of Hole at 11.45 m below water surface 3/12/16 12:30	
12 1017.9						
13 1016.9						
14 1015.9						
15 1014.9						
16 1013.9						
17 1012.9						

PROJECT NUMBER:	BORING NUMBER:
673709	CH16-201-BH006

SOIL BORING LOG

PROJECT : Faro Mine Remediation Project, CVD and ID Pond LOCATION : CVD Pond (6914347.55 N, 580167.99 E)

ICE WORK PAD SURFACE ELEVATION : 1029.95 m DRILLING CONTRACTOR : ConeTec

DRILLING METHOD AND EQUIPMENT : Track-mounted, sonic drill rig and Aqualock (AL) piston sample barrel; 50mm or 70 mm-inside diameter, with lengths of 1m or 2m.

MUDLINE DEPTH BELOW ICE WORK PAD SURFACE : 13.35 m START : 3/10/16 13:00 END : 3/10/16 13:30 LOGGER : T. Munson

DEPTH BELOW ICE PAD SURFACE (m) AND ELEVATION	INTERVAL (m)	RECOVERY (m)	TYPE/#	GRAPHIC LOG	SOIL DESCRIPTION SOIL NAME, USCS GROUP SYMBOL, COLOR, MOISTURE CONTENT, RELATIVE DENSITY OR CONSISTENCY, SOIL STRUCTURE, MINERALOGY	COMMENTS DRILLING OBSERVATIONS, SOUNDING INFORMATION, SAMPLING METHODS, LABORATORY TEST RESULTS
12 1018.0						Mudline sounding data Weighted tape: 13.35 m (appeared firm)
13 1017.0						
	13.40				Mudline	
14 1016.0		0.04	AL-SOa		**POORLY-GRADED GRAVEL WITH SILT AND SAND (GP-GM)**; dark grey, wet, estimated very dense, fine to coarse, subrounded to rounded gravel, fine to medium grained sand	Driller indicated relatively high drilling resistance, and he assumed the sampler shoe was plugged with gravel just below the mudline.
15 1015.0						
	15.40				Bottom of Hole at 15.40 m below water surface 3/10/16 13:30	
16 1014.0						
17 1013.0						
18 1012.0						
19 1011.0						
20 1010.0						
21 1009.0						

PROJECT NUMBER:	BORING NUMBER:
673709	CH16-201-BH006A

SOIL BORING LOG

PROJECT : Faro Mine Remediation Project, CVD and ID Pond LOCATION : CVD Pond (6914346.09 N, 580167.45 E)

ICE WORK PAD SURFACE ELEVATION : 1029.94 m DRILLING CONTRACTOR : ConeTec

DRILLING METHOD AND EQUIPMENT : Track-mounted, sonic drill rig and Aqualock (AL) piston sample barrel; 50mm or 70 mm-inside diameter, with lengths of 1m or 2m.

MUDLINE DEPTH BELOW ICE WORK PAD SURFACE : 13.33 m START : 3/10/16 13:45 END : 3/10/16 14:50 LOGGER : T. Munson

DEPTH BELOW ICE PAD SURFACE (m) AND ELEVATION	INTERVAL (m)	RECOVERY (m)	TYPE/#	GRAPHIC LOG	SOIL DESCRIPTION SOIL NAME, USCS GROUP SYMBOL, COLOR, MOISTURE CONTENT, RELATIVE DENSITY OR CONSISTENCY, SOIL STRUCTURE, MINERALOGY	COMMENTS DRILLING OBSERVATIONS, SOUNDING INFORMATION, SAMPLING METHODS, LABORATORY TEST RESULTS
12 1017.9						Mudline sounding data Weighted tape: 13.33 m (appeared firm)
13 1016.9	13.40				Mudline	
14 1015.9		1.20	AL-SOa		**POORLY-GRADED SAND WITH SILT (SP-SM)**; dark grey and black, wet, very fine to fine sand, non-plastic silt, dilatant, frequent orgranics, gravelly and abundant organics in upper 5cm, sample appeared very disturbed. **POORLY-GRADED SAND (SP)**; grey, wet, very fine to fine sand **ORGANIC SANDY SILT (OH)**; black, wet, abundant organics with roots up to 5cm diameter **POORLY-GRADED SAND WITH SILT (SP-SM)**; dark grey and black, wet, very fine to fine sand, non-plastic silt, dilatant, frequent organics, gravelly and abundant organics in upper 5cm, sample appeared very disturbed.	Sample SOa1 (13.4m to 13.88m): See Laboratory Data for Geochemical Tests Sample SOa3 (13.98m to 14.04 m): See Laboratory Data for Geochemical Tests
15 1014.9	15.40					
16 1013.9		1.70	AL-SOb		**GRAVELLY CLAY (CL)**; grey, wet, low to medium plasticity clay, fine subrounded to rounded gravel, sample appeared disturbed **GRAVELLY SILT WITH SAND (ML) TO SILTY GRAVEL WITH SAND (GM)**; dark grey, wet, low plasticity silt, fine to medium grained sand, fine to coarse subrounded to rounded gravel, sample appeared disturbed	
17 1012.9	17.40					
18 1011.9					Bottom of Hole at 17.40 m below water surface 3/10/16 14:50	
19 1010.9						
20 1009.9						
21 1008.9						

PROJECT NUMBER:	BORING NUMBER:
673709	CH16-201-BH007

SOIL BORING LOG

PROJECT : Faro Mine Remediation Project, CVD and ID Pond LOCATION : CVD Pond (6914140.78 N, 580284.42 E)

ICE WORK PAD SURFACE ELEVATION : 1030.04 m DRILLING CONTRACTOR : ConeTec

DRILLING METHOD AND EQUIPMENT : Track-mounted, sonic drill rig and Aqualock (AL) piston sample barrel; 50mm or 70 mm-inside diameter, with lengths of 1m or 2m.

MUDLINE DEPTH BELOW ICE WORK PAD SURFACE : 7.1 m START : 3/8/16 13:00 END : 3/8/16 16:30 LOGGER : T. Munson

DEPTH BELOW ICE PAD SURFACE (m) AND ELEVATION	INTERVAL (m)	RECOVERY (m)	TYPE/#	GRAPHIC LOG	SOIL DESCRIPTION SOIL NAME, USCS GROUP SYMBOL, COLOR, MOISTURE CONTENT, RELATIVE DENSITY OR CONSISTENCY, SOIL STRUCTURE, MINERALOGY	COMMENTS DRILLING OBSERVATIONS, SOUNDING INFORMATION, SAMPLING METHODS, LABORATORY TEST RESULTS
6 1024.0	6.05					
		0.00	AL		point sample that recovered water with very slight turbidity	
7 1023.0	7.05					
		0.75	AL-SOa		**WELL-GRADED SAND (SW)**; grayish brown, wet, medium to coarse grained sand	Sample SOa1 (7.05m to 7.75m): particle size analysis - Gravel 4%; Sand 88%; Fines 8%; Cu=8.7; Cc=2.5; See Laboratory Data for Geochemical Tests
	7.80					
8 1022.0					**POORLY-GRADED GRAVEL (GP)**; grayish brown, wet, fine to coarse, subrounded to rounded gravel **WELL-GRADED SAND (SW)**; dark brown, wet, fine to coarse grained sand, below 8.8m becomes medium to coarse grained sand with fine gravel, subrounded to rounded	
9 1021.0		1.39	AL-SOb			
	9.80					
10 1020.0					**WELL-GRADED SAND WITH SILT AND GRAVEL (SW-SM)**; dark brown, wet, fine to coarse grained sand	For samples below 9.8 m, the recovery was estimated between 80 and 100% based on estimated sample volume. Sample SOc (9.8m to 11.8m): particle size analysis - Gravel 18%; Sand 71%; Fines 11%; Cu=22; Cc=2.4;
11 1019.0		2.00	AL-SOc			
	11.80					
12 1018.0					**WELL-GRADED SAND WITH SILT AND GRAVEL (SW-SM)**; dark brown, wet, fine to coarse grained sand	
13 1017.0		2.00	AL-SOd			
	13.80					
14 1016.0					**WELL-GRADED SAND WITH SILT (SW-SM)**; dark brown, wet, fine to coarse grained sand	Sample SOe1 (13.8m to 14.8m): particle size analysis - Gravel 4%; Sand 87%; Fines 9%; Cu=8.0; Cc=2.3
15 1015.0		2.00	AL-SOe			

PROJECT NUMBER:	BORING NUMBER:
673709	CH16-201-BH007

SOIL BORING LOG

PROJECT : Faro Mine Remediation Project, CVD and ID Pond LOCATION : CVD Pond (6914140.78 N, 580284.42 E)

ICE WORK PAD SURFACE ELEVATION : 1030.04 m DRILLING CONTRACTOR : ConeTec

DRILLING METHOD AND EQUIPMENT : Track-mounted, sonic drill rig and Aqualock (AL) piston sample barrel; 50mm or 70 mm-inside diameter, with lengths of 1m or 2m.

MUDLINE DEPTH BELOW ICE WORK PAD SURFACE : 7.1 m START : 3/8/16 13:00 END : 3/8/16 16:30 LOGGER : T. Munson

DEPTH BELOW ICE PAD SURFACE (m) AND ELEVATION	INTERVAL (m)	RECOVERY (m)	TYPE/#	GRAPHIC LOG	SOIL DESCRIPTION SOIL NAME, USCS GROUP SYMBOL, COLOR, MOISTURE CONTENT, RELATIVE DENSITY OR CONSISTENCY, SOIL STRUCTURE, MINERALOGY	COMMENTS DRILLING OBSERVATIONS, SOUNDING INFORMATION, SAMPLING METHODS, LABORATORY TEST RESULTS
15.80					**WELL-GRADED SAND WITH GRAVEL (SW)**; varicolored, wet, coarse to fine grained sand, fine to coarse, subrounded to rounded gravel, slight iron appearance to water in sample below 15.3m	Sample SOe2 (14.8m to 15.8m): See Laboratory Data for Geochemical Tests
16 1014.0					**POORLY-GRADED SAND (SP)**; brown, fine to medium grained sand, slight iron appearance to water	
17 1013.0	2.00	2.00	AL-SOf		**WELL-GRADED SAND WITH GRAVEL (SW)**; brown, wet, fine to coarse grained sand, fine gravel, angular to rounded, slight iron appearance to water	
17.80						
18 1012.0					**POORLY-GRADED SAND (SP)**; brown, wet, fine to medium grained sand	
19 1011.0	2.00	2.00	AL-SOg		**POORLY-GRADED SAND (SP)**; brown, wet, fine to coarse grained sand, trace gravel	
19.80						
20 1010.0					**SILTY SAND (SM)**; brown, wet, very fine grained sand, low plasticity silt	
21 1009.0	2.00	2.00	AL-SOh		**WELL-GRADED SAND (SW)**; grayish brown, wet, coarse to fine grained sand	
21.80						
22 1008.0					**WELL-GRADED SAND (SW)**; grayish brown, wet, coarse to fine grained sand	
23 1007.0	2.00	2.00	AL-SOi			
23.80						
24 1006.0					Bottom of Hole at 23.80 m below water surface 3/8/16 16:30	
25 1005.0						

PROJECT NUMBER:	BORING NUMBER:
673709	CH16-201-BH008

SOIL BORING LOG

PROJECT : Faro Mine Remediation Project, CVD and ID Pond LOCATION : CVD Pond (6914402.21 N, 580198.07 E)

ICE WORK PAD SURFACE ELEVATION : 1029.94 m DRILLING CONTRACTOR : ConeTec

DRILLING METHOD AND EQUIPMENT : Track-mounted, sonic drill rig and Aqualock (AL) piston sample barrel; 50mm or 70 mm-inside diameter, with lengths of 1m or 2m.

MUDLINE DEPTH BELOW ICE WORK PAD SURFACE : 15.21 m START : 3/10/16 15:40 END : 3/10/16 16:30 LOGGER : T. Munson

DEPTH BELOW ICE PAD SURFACE (m) AND ELEVATION	INTERVAL (m)	RECOVERY (m)	TYPE/#	GRAPHIC LOG	SOIL DESCRIPTION SOIL NAME, USCS GROUP SYMBOL, COLOR, MOISTURE CONTENT, RELATIVE DENSITY OR CONSISTENCY, SOIL STRUCTURE, MINERALOGY	COMMENTS DRILLING OBSERVATIONS, SOUNDING INFORMATION, SAMPLING METHODS, LABORATORY TEST RESULTS
14 1015.9						Mudline sounding data Weighted tape: 15.21 m Lowrance HDS-7 Gen2 fish finder: 0.9 m (keel) + 14.4 m reading = 15.3 m depth below water surface.
15 1014.9	15.30				Mudline	
16 1013.9		1.82	AL-SOa		**ELASTIC SILT (MH)**; dark grey, wet, very soft with no structure, low plasticity (possible sludge)	Sample SOa1 (15.3m to 15.92m): particle size analysis - Gravel 0%; Sand 3%; Fines 97% Atterberg Limits - LL=53%; PI=18%; See Laboratory Data for Geochemical Tests
17 1012.9	17.30				**SILTY SAND (SM)**; dark grey, wet, fine gravel, sample appeared disturbed but had soil structure **ORGANIC SILT WITH SAND (OL)**; dark grey and dark brown, moist, fine sand, sample appears to have soil structure **SANDY SILT (SM)**; dark grey, moist, fine to medium grained sand, low plasticity silt	Sample SOa2 (15.92 to 16.64m): particle size analysis - Gravel 1%; Sand 59%; Fines 40% Atterberg Limits - LL=43%; PI=11%; See Laboratory Data for Geochemical Tests Sample SOa3 (16.64m to 17.01m): See Laboratory Data for Geochemical Tests
18 1011.9		1.46	AL-SOb		**POORLY-GRADED SAND WITH SILT (SP-SM)**; dark grey, wet, fine to coarse sand	Sample SOb1 (17.3m to 18.26m): particle size analysis - Gravel 4%; Sand 86%; Fines 10%; Cu=18; Cc=4.5; See Laboratory Data for Geochemical Tests
19 1010.9	19.30				**WELL-GRADED GRAVEL (GW)**; dark grey, wet, fine to coarse, subrounded to rounded	
20 1009.9					Bottom of Hole at 19.30 m below water surface 3/10/16 16:30	
21 1008.9						
22 1007.9						
23 1006.9						

PROJECT NUMBER:	BORING NUMBER:
673709	CH16-201-BH009

SOIL BORING LOG

PROJECT : Faro Mine Remediation Project, CVD and ID Pond LOCATION : CVD Pond (6914353.08 N, 580392.41 E)

ICE WORK PAD SURFACE ELEVATION : 1029.96 m DRILLING CONTRACTOR : ConeTec

DRILLING METHOD AND EQUIPMENT : Track-mounted, sonic drill rig and Aqualock (AL) piston sample barrel; 50mm or 70 mm-inside diameter, with lengths of 1m or 2m.

MUDLINE DEPTH BELOW ICE WORK PAD SURFACE : 9.67 m START : 3/9/16 10:15 END : 3/9/16 12:00 LOGGER : T. Munson

DEPTH BELOW ICE PAD SURFACE (m) AND ELEVATION	INTERVAL (m)	RECOVERY (m)	TYPE/#	GRAPHIC LOG	SOIL DESCRIPTION: SOIL NAME, USCS GROUP SYMBOL, COLOR, MOISTURE CONTENT, RELATIVE DENSITY OR CONSISTENCY, SOIL STRUCTURE, MINERALOGY	COMMENTS: DRILLING OBSERVATIONS, SOUNDING INFORMATION, SAMPLING METHODS, LABORATORY TEST RESULTS
8 1022.0						Mudline sounding data Weighted tape: 9.67 m
	8.30					
		0.00	AL		point sample recovered water with negligible turbidity	
9 1021.0						
	9.50					
	9.65	0.00	AL		point sample recovered dirty water with minor turbidity, sample did not appear to be sludge	
10 1020.0					**SILTY SAND (SM)**; dark grey, wet, fine to coarse grained sand, trace fine to coarse, subrounded to rounded gravel	Sample SOa1 (9.65m to 10.0m): particle size analysis - Gravel 12%; Sand 72%; Fines 16%; See Laboratory Data for Geochemical Tests
		0.75	AL-SOa			Sample SOa2 (10.0m to 10.4m): See Laboratory Data for Geochemical Tests
11 1019.0						
	11.40					
					SILTY SAND (SM); dark grey, wet, fine to coarse grained sand, trace fine to coarse, subrounded to rounded gravel	Initial attempt to advance sample SOb encountered practical refusal at mudline and bent drill rod.
12 1018.0					**SILTY SAND (SM)**; dark grey, wet, fine to coarse grained sand, with abundant wood debris, shoe contained organic silty sand with abundant fine roots and black, decaying organics	Sample SOb2 (11.90m to 12.30m): particle size analysis - Gravel 23%; Sand 59%; Fines 18%; Atterberg Limits - LL=23%; PI=2%; Organic content < 1%; Loss on ignition < 1%; See Laboratory Data for Geochemical Tests
		1.30	AL-SOb			
13 1017.0						
	13.40					
14 1016.0					Bottom of Hole at 13.40 m below water surface 3/9/16 12:00	
15 1015.0						
16 1014.0						
17 1013.0						

PROJECT NUMBER:	BORING NUMBER:
673709	CH16-201-BH010

SOIL BORING LOG

PROJECT : Faro Mine Remediation Project, CVD and ID Pond LOCATION : CVD Pond (6914421.36 N, 580213.61 E)

ICE WORK PAD SURFACE ELEVATION : 1029.98 m DRILLING CONTRACTOR : ConeTec

DRILLING METHOD AND EQUIPMENT : Track-mounted, sonic drill rig and Aqualock (AL) piston sample barrel; 50mm or 70 mm-inside diameter, with lengths of 1m or 2m.

MUDLINE DEPTH BELOW ICE WORK PAD SURFACE : 15.5 m START : 3/9/16 14:00 END : 3/9/16 15:45 LOGGER : T. Munson

DEPTH BELOW ICE PAD SURFACE (m) AND ELEVATION	INTERVAL (m)	RECOVERY (m)	TYPE/#	GRAPHIC LOG	SOIL DESCRIPTION SOIL NAME, USCS GROUP SYMBOL, COLOR, MOISTURE CONTENT, RELATIVE DENSITY OR CONSISTENCY, SOIL STRUCTURE, MINERALOGY	COMMENTS DRILLING OBSERVATIONS, SOUNDING INFORMATION, SAMPLING METHODS, LABORATORY TEST RESULTS
14 1016.0						Mudline sounding data Weighted tape: 15.54 m (appeared firm) prior to drilling; however, Sample AL-SOa appeared to encounter mudline at 15.50m.
	14.70					
		0.00	AL		point sample recovered water with negligible turbidity	
15 1015.0	15.50					
	15.54	0.04	AL-SOa		point sample at mudline recovered **SILT (ML)**; dark to light grey, wet, scattered organics, coloring varied in 2 to 5mm partings	
	15.90	0.00	AL			
16 1014.0		0.00	AL		no recovery from 15.54 to 15.9 m; water in sampler had rust coloring	
	16.50				no recovery from 15.9 to 16.5 m	
	16.70					
17 1013.0		1.30	AL-SOb		**SILT (ML)**; dark grey, wet	
	17.80					
18 1012.0					Bottom of Hole at 17.80 m below water surface 3/9/16 15:45	
19 1011.0						
20 1010.0						
21 1009.0						
22 1008.0						
23 1007.0						

PROJECT NUMBER:	BORING NUMBER:
673709	CH16-201-BH010A

SOIL BORING LOG

PROJECT : Faro Mine Remediation Project, CVD and ID Pond
LOCATION : CVD Pond (6914420.14 N, 580212.81 E)

ICE WORK PAD SURFACE ELEVATION : 1029.97 m
DRILLING CONTRACTOR : ConeTec

DRILLING METHOD AND EQUIPMENT : Track-mounted, sonic drill rig and Aqualock (AL) piston sample barrel; 50mm or 70 mm-inside diameter, with lengths of 1m or 2m.

MUDLINE DEPTH BELOW ICE WORK PAD SURFACE : 15.72 m START : 3/10/16 09:45 END : 3/10/16 11:00 LOGGER : T. Munson

DEPTH BELOW ICE PAD SURFACE (m) AND ELEVATION	INTERVAL (m)	RECOVERY (m)	TYPE/#	GRAPHIC LOG	SOIL DESCRIPTION: SOIL NAME, USCS GROUP SYMBOL, COLOR, MOISTURE CONTENT, RELATIVE DENSITY OR CONSISTENCY, SOIL STRUCTURE, MINERALOGY	COMMENTS: DRILLING OBSERVATIONS, SOUNDING INFORMATION, SAMPLING METHODS, LABORATORY TEST RESULTS
14 1016.0						Mudline sounding data Weighted tape: 15.72 m (appeared firm)
15 1015.0						
	15.80				Mudline	
16 1014.0					**ELASTIC SILT WITH SAND (MH)**; dark grey, moist, scattered fine roots, sample appeared to have native soil structure	Sample SOa1 (15.8m to 16.7m) : particle size analysis - Gravel <1%; Sand 23%; Fines 76% Atterberg Limits - LL=62%; PI=11%; Organic content = 9.2%; Loss on ignition = 11.4%; See Laboratory Data for Geochemical Tests Sample SOa2 (16.7m to 17.8m) : See Laboratory Data for Geochemical Tests
17 1013.0	2.00		AL-SOa		**SILT WITH GRAVEL AND SAND (ML)**; dark grey, moist, fine gravel, fine grained sand	
	17.80					
18 1012.0					**GRAVELLY SILT WITH SAND (ML)**; dark grey, moist, fine, subrounded to rounded gravel, fine grained sand **GRAVELLY SILT WITH SAND (ML)**; dark grey, moist, fine, subrounded to rounded gravel, fine grained sand **SILT (ML)**; dark grey, moist, low plasticity, scattered organics **SILT (ML)**; light grey, moist, low plasticity, scattered organics	Sample SOb2 (17.93m to 18.16m): See Laboratory Data for Geochemical Tests Sample SOb4 (18.24m to 19.15m): particle size analysis - Gravel 0%; Sand 24%; Fines 76% Atterberg Limits - LL=48%; PI=10%; Organic content = 2.4%; Loss on ignition = 2.7%
19 1011.0	1.70		AL-SOb		**SILT WITH SAND (ML)**; dark grey, moist, low plasticity, scattered organics	
	19.30				**PEAT**	
		0.00	AL		**SILT (ML)**; dark grey, moist, low plasticity, frequent organics	
	19.80				no recovery; sampler shoe damaged	
20 1010.0					Bottom of Hole at 19.80 m below water surface 3/10/16 11:00	
21 1009.0						
22 1008.0						
23 1007.0						

PROJECT NUMBER:	BORING NUMBER:
673709	CH16-201-BH011

SOIL BORING LOG

PROJECT : Faro Mine Remediation Project, CVD and ID Pond
LOCATION : CVD Pond (6914403.53 N, 580346.27 E)

ICE WORK PAD SURFACE ELEVATION : 1029.93 m
DRILLING CONTRACTOR : ConeTec

DRILLING METHOD AND EQUIPMENT : Track-mounted, sonic drill rig and Aqualock (AL) piston sample barrel; 50mm or 70 mm-inside diameter, with lengths of 1m or 2m.

MUDLINE DEPTH BELOW ICE WORK PAD SURFACE : 7.2 m
START : 3/11/16 13:07
END : 3/11/16 13:25
LOGGER : T. Munson

DEPTH BELOW ICE PAD SURFACE (m) AND ELEVATION	INTERVAL (m)	RECOVERY (m)	TYPE/#	GRAPHIC LOG	SOIL DESCRIPTION SOIL NAME, USCS GROUP SYMBOL, COLOR, MOISTURE CONTENT, RELATIVE DENSITY OR CONSISTENCY, SOIL STRUCTURE, MINERALOGY	COMMENTS DRILLING OBSERVATIONS, SOUNDING INFORMATION, SAMPLING METHODS, LABORATORY TEST RESULTS
6 1023.9						Mudline sounding data Weighted tape prior to drilling: 8.43 m (appeared soft) Following drilling, filled approximately 15-cm-diameter can (coffee can) with gravels for ballast and sounded mudline 10 cm north of borehole at 7.2 m. Lowrance HDS-7 Gen2 fish finder: 0.9 m (keel) + 6.1 m reading = 7.0 m depth below water surface. Therefore, appeared that sludge extended from approximately 7.2 m to 8.7 m.
7 1022.9					Mudline	
8 1021.9						
8.55						
9 1020.9		0.35	AL-SOa		**LEAN CLAY (CL)**; grey, wet, extremely soft, appears to be sludge **SILTY GRAVEL WITH SAND (GM)**; grey-brown, moist, estimated very dense, fine, subrounded to rounded gravel, fine to coarse grained sand, low to medium plasticity silt, dense gravel observed in shoe of sampler	Drilled indicated relatively high resistance was encountered a short distance below the start of sample SOa. Sample SOa1 (8.55m to 8.7m): See Laboratory Data for Geochemical Tests Sample SOa2 (8.7 to 8.9m): See Laboratory Data for Geochemical Tests
9.40						
10 1019.9					Bottom of Hole at 9.40 m below water surface 3/11/16 13:25	
11 1018.9						
12 1017.9						
13 1016.9						
14 1015.9						
15 1014.9						

PROJECT NUMBER:	BORING NUMBER:
673709	CH16-201-BH011A

SOIL BORING LOG

PROJECT : Faro Mine Remediation Project, CVD and ID Pond LOCATION : CVD Pond (6914404.38 N, 580345.48 E)

ICE WORK PAD SURFACE ELEVATION : 1029.99 m DRILLING CONTRACTOR : ConeTec

DRILLING METHOD AND EQUIPMENT : Track-mounted, sonic drill rig and Aqualock (AL) piston sample barrel; 50mm or 70 mm-inside diameter, with lengths of 1m or 2m.

MUDLINE DEPTH BELOW ICE WORK PAD SURFACE : 6.9 m START : 3/12/2016 END : 3/12/2016 LOGGER : T. Munson

DEPTH BELOW ICE PAD SURFACE (m) AND ELEVATION	INTERVAL (m)	RECOVERY (m)	TYPE/#	GRAPHIC LOG	SOIL DESCRIPTION SOIL NAME, USCS GROUP SYMBOL, COLOR, MOISTURE CONTENT, RELATIVE DENSITY OR CONSISTENCY, SOIL STRUCTURE, MINERALOGY	COMMENTS DRILLING OBSERVATIONS, SOUNDING INFORMATION, SAMPLING METHODS, LABORATORY TEST RESULTS
5 1025.0						Mudline sounding data Lowrance HDS-7 Gen2 fish finder: 0.9 m (keel) + fluctuating reading between 6.0 m and 7.5 m = 6.9 to 8.4 m depth below water surface. It was assumed the unstable readings were because the device could not interpret the properties of probable sludge. Based on this information and sounding at BH-011, the mudline was assumed to be at approximately 6.9 m below the water surface.
6 1024.0						
7 1023.0					Mudline	
	7.50	0.80	AL-SOa		point sample recovered rust-colored viscous fluid with clay-sized solids, sample appeared to be sludge	Sample SOA (point sample at 7.5m): See Laboratory Data for Geochemical Tests
8 1022.0	8.00	0.37	AL-SOb		point sample recovered rust-colored viscous fluid with clay-sized solids, sample appeared to be sludge Bottom of Hole at 8.00 m below water surface 3/12/2016	Sample SOB (point sample at 8m): See Laboratory Data for Geochemical Tests
9 1021.0						
10 1020.0						
11 1019.0						
12 1018.0						
13 1017.0						
14 1016.0						

PROJECT NUMBER:	BORING NUMBER:
673709	CH16-201-BH012

SOIL BORING LOG

PROJECT : Faro Mine Remediation Project, CVD and ID Pond LOCATION : CVD Pond (6914322.36 N, 580372.08 E)

ICE WORK PAD SURFACE ELEVATION : 1030.04 m DRILLING CONTRACTOR : ConeTec

DRILLING METHOD AND EQUIPMENT : Track-mounted, sonic drill rig and Aqualock (AL) piston sample barrel; 50mm or 70 mm-inside diameter, with lengths of 1m or 2m.

MUDLINE DEPTH BELOW ICE WORK PAD SURFACE : 14.51 m START : 3/11/16 15:10 END : 3/11/16 16:10 LOGGER : T. Munson

DEPTH BELOW ICE PAD SURFACE (m) AND ELEVATION	INTERVAL (m)	RECOVERY (m)	TYPE/#	GRAPHIC LOG	SOIL DESCRIPTION: SOIL NAME, USCS GROUP SYMBOL, COLOR, MOISTURE CONTENT, RELATIVE DENSITY OR CONSISTENCY, SOIL STRUCTURE, MINERALOGY	COMMENTS: DRILLING OBSERVATIONS, SOUNDING INFORMATION, SAMPLING METHODS, LABORATORY TEST RESULTS
13 1017.0						Mudline sounding data Weighted tape: 14.51 m Lowrance HDS-7 Gen2 fish finder: 0.9 m (keel) + 13.6 m reading = 14.5 m depth below water surface.
14 1016.0						
	14.63				Mudline	
		0.00	AL-SOa		no recovery	
15 1015.0	15.13					
		0.25	AL-SOb		**ORGANIC SILT WITH SAND (OH)**; dark grey to black, moist to wet, abundant organics, sample appeared to have native soil structure, sampler shoe contained organic debris.	Sample SOb (15.13m to 15.38m): Passing No. 200 Sieve = 33.6%; Atterberg Limits - LL=92%; PI=13%; Organic content = 12%; Loss on ignition = 15%; See Laboratory Data for Geochemical Tests
	15.63				Bottom of Hole at 15.63 m below water surface 3/11/16 16:10	
16 1014.0						
17 1013.0						
18 1012.0						
19 1011.0						
20 1010.0						
21 1009.0						
22 1008.0						

PROJECT NUMBER:	BORING NUMBER:
673709	CH16-201-BH012A

SOIL BORING LOG

PROJECT : Faro Mine Remediation Project, CVD and ID Pond LOCATION : CVD Pond (6914327.27 N, 580366.12 E)

ICE WORK PAD SURFACE ELEVATION : 1029.90 m DRILLING CONTRACTOR : ConeTec

DRILLING METHOD AND EQUIPMENT : Track-mounted, sonic drill rig and Aqualock (AL) piston sample barrel; 50mm or 70 mm-inside diameter, with lengths of 1m or 2m.

MUDLINE DEPTH BELOW ICE WORK PAD SURFACE : 13.45 m START : 3/12/16 13:00 END : 3/12/16 14:30 LOGGER : T. Munson

DEPTH BELOW ICE PAD SURFACE (m) AND ELEVATION	INTERVAL (m)	RECOVERY (m)	TYPE/#	GRAPHIC LOG	SOIL DESCRIPTION: SOIL NAME, USCS GROUP SYMBOL, COLOR, MOISTURE CONTENT, RELATIVE DENSITY OR CONSISTENCY, SOIL STRUCTURE, MINERALOGY	COMMENTS: DRILLING OBSERVATIONS, SOUNDING INFORMATION, SAMPLING METHODS, LABORATORY TEST RESULTS
12 1017.9						Mudline sounding data Weighted tape: 13.45 m Lowrance HDS-7 Gen2 fish finder: 0.9 m (keel) + 12.5 m reading = 13.4 m depth below water surface.
13 1016.9						
	13.60				Mudline	
					no recovery assumed in this depth range	Sample SOa1 (14.0m to 14.17m): particle size analysis - Gravel 2%; Sand 73%; Fines 25%; Organic content = 1.7%; Loss on ignition = 1.8%; See Laboratory Data for Geochemical Tests
14 1015.9					**SILTY SAND (SM)**; dark grey, wet, fine to coarse sand	
		1.40	AL-SOa		**WELL-GRADED SAND WITH SILT AND GRAVEL (SW-SM)**; dark grey, wet, fine to coarse grained sand, fine gravel	Sample SOa2 (14.17m to 14.34m): particle size analysis - Gravel 2%; Sand 81%; Fines 17%; Atterberg Limits - LL=19%; PI=<1%; Organic content = <1%; Loss on ignition = <1%; See Laboratory Data for Geochemical Tests
15 1014.9					**WELL-GRADED GRAVEL WITH SAND (GW)**; dark grey, wet, fine to coarse, subrounded to rounded gravel, fine to coarse grained sand	Sample SOa4 (14.5m to 15.1m): particle size analysis - Gravel 34%; Sand 57%; Fines 9%; Cu=37; Cc=1.3
	15.60					
16 1013.9					Bottom of Hole at 15.60 m below water surface 3/12/16 14:30	
17 1012.9						
18 1011.9						
19 1010.9						
20 1009.9						
21 1008.9						

Attachment 4
Field Investigation Photographs

CH16-201-BH005B

2016-03-12 11:17:59

Field Team Travis Munson

Coordinates (UTM NAD83 Zone 8N)		Accuracy (m +/-
580352.0	6914242.0	8.0

Center rods for larger diameter sonic drill system.

https://deliver.ch2m.com/sites/TM1/Photos_2016_0103/CH16-201-BH005B_2016-03-12_111759.jpg



CH16-201-BH005B

2016-03-12 11:20:06

Field Team Travis Munson

Coordinates (UTM NAD83 Zone 8N)		Accuracy (m +/-
580352.0	6914242.0	8.0

90mm outside diameter casing for larger diameter sonic drill system.

https://deliver.ch2m.com/sites/TM1/Photos_2016_0103/CH16-201-BH005B_2016-03-12_112006.jpg



CH16-201-BH005B

2016-03-12 11:22:42

Field Team Travis Munson

Coordinates (UTM NAD83 Zone 8N)		Accuracy (m +/-
580352.0	6914242.0	8.0

70mm inside diameter barrel for larger diameter sonic drill system.

https://deliver.ch2m.com/sites/TM1/Photos_2016_0103/CH16-201-BH005B_2016-03-12_112242.jpg



CH16-201-BH005B

2016-03-12 11:31:00

Field Team Travis Munson

Coordinates (UTM NAD83 Zone 8N)		Accuracy (m +/-
580344.0	6914244.0	8.0

Sonic plug and catcher for 70mm system.

https://deliver.ch2m.com/sites/TM1/Photos_2016_0103/CH16-201-BH005B_2016-03-12_113100.jpg



CH16-201-BH005B

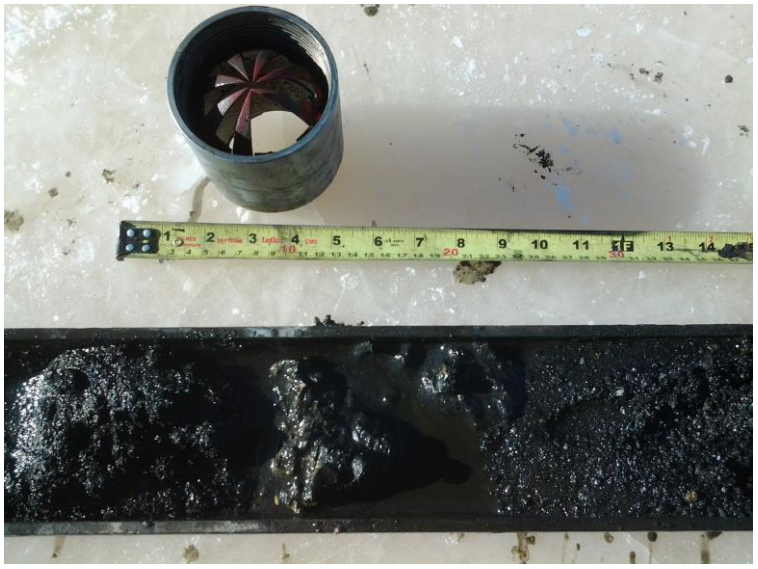
2016-03-12 12:07:27

Field Team Travis Munson

Coordinates (UTM NAD83 Zone 8N)		Accuracy (m +/-
580351.0	6914250.0	6.0

Sample SOa

https://deliver.ch2m.com/sites/TM1/Photos_2016_0103/CH16-201-BH005B_2016-03-12_120728.jpg



CH16-201-BH005B

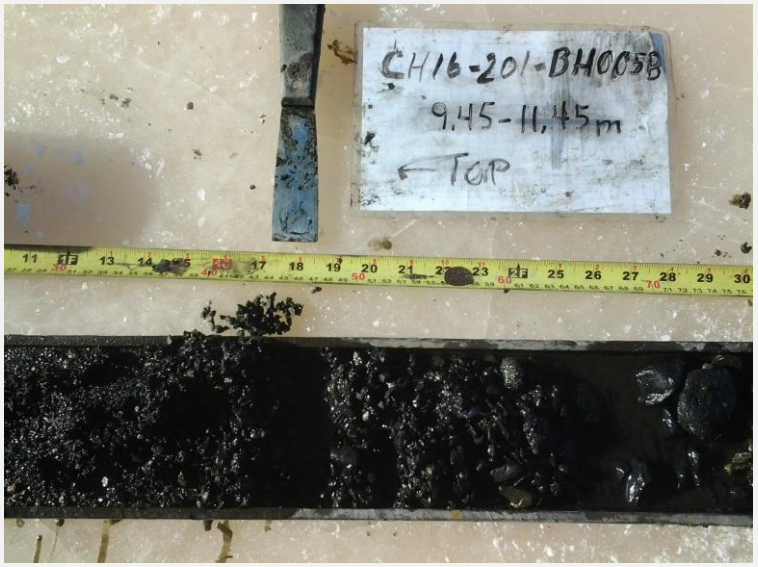
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Field Team Travis Munson

Coordinates (UTM NAD83 Zone 8N)		Accuracy (m +/-
580351.0	6914250.0	6.0

Sample SOa

https://deliver.ch2m.com/sites/TM1/Photos_2016_0103/CH16-201-BH005B_2016-03-12_120907.jpg



CH16-201-BH005B

2016-03-12 12:09:27

Field Team Travis Munson

Coordinates (UTM NAD83 Zone 8N)		Accuracy (m +/-
580351.0	6914250.0	6.0

Sample SOa

https://deliver.ch2m.com/sites/TM1/Photos_2016_0103/CH16-201-BH005B_2016-03-12_120927.jpg



CH16-201-BH006

2016-03-10 13:29:50

Field Team Travis Munson

Coordinates (UTM NAD83 Zone 8N)		Accuracy (m +/-
580164.0	6914340.0	6.0

Sample SOa

https://deliver.ch2m.com/sites/TM1/Photos_2016_0103/CH16-201-BH006_2016-03-10_132950.jpg



CH16-201-BH006A

2016-03-10 14:38:47

Field Team Travis Munson

Coordinates (UTM NAD83 Zone 8N)		Accuracy (m +/-
580167.0	6914344.0	6.0

Sample SOa

https://deliver.ch2m.com/sites/TM1/Photos_2016_0103/CH16-201-BH006A_2016-03-10_143848.jpg



CH16-201-BH006A

2016-03-10 14:41:23

Field Team Travis Munson

Coordinates (UTM NAD83 Zone 8N)		Accuracy (m +/-
580167.0	6914344.0	6.0

Sample SOa

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CH16-201-BH006A

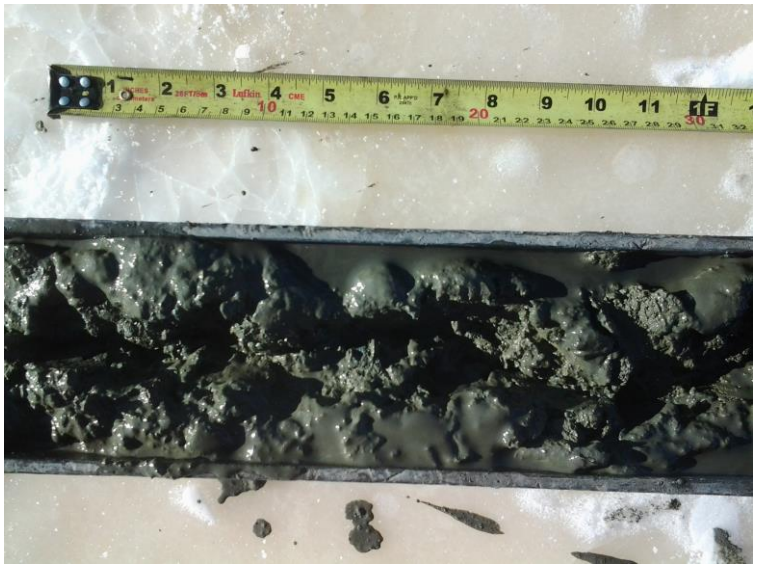
2016-03-10 14:51:09

Field Team Travis Munson

Coordinates (UTM NAD83 Zone 8N)		Accuracy (m +/-
580162.0	6914337.0	6.0

Sample SOb

https://deliver.ch2m.com/sites/TM1/Photos_2016_0103/CH16-201-BH006A_2016-03-10_145109.jpg



CH16-201-BH006A

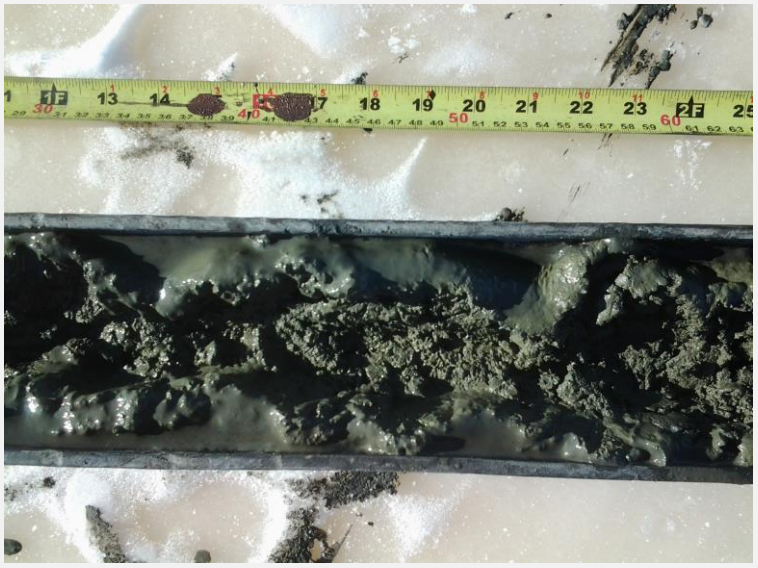
2016-03-10 14:52:21

Field Team Travis Munson

Coordinates (UTM NAD83 Zone 8N)		Accuracy (m +/-
580162.0	6914337.0	6.0

Sample SOb

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CH16-201-BH006A

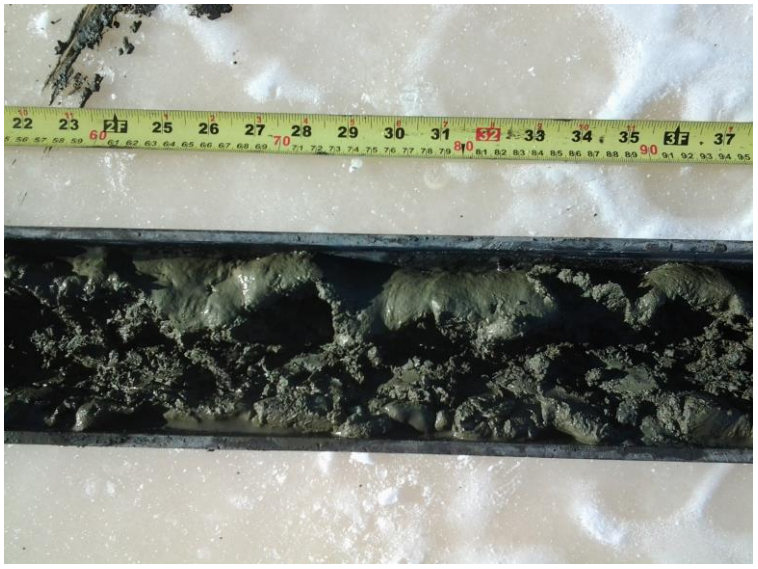
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Field Team Travis Munson

Coordinates (UTM NAD83 Zone 8N)		Accuracy (m +/-
580162.0	6914337.0	6.0

Sample SOb

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CH16-201-BH006A

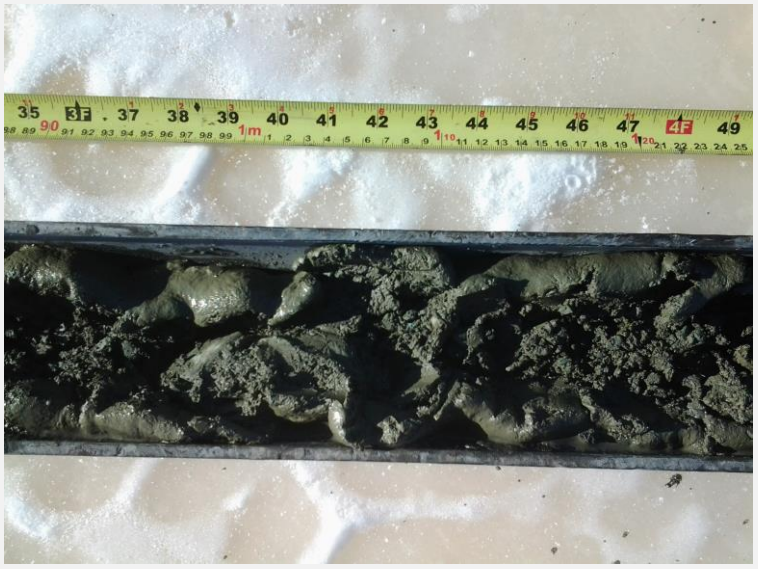
2016-03-10 14:53:07

Field Team Travis Munson

Coordinates (UTM NAD83 Zone 8N)		Accuracy (m +/-
580162.0	6914337.0	6.0

Sample SOb

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CH16-201-BH006A

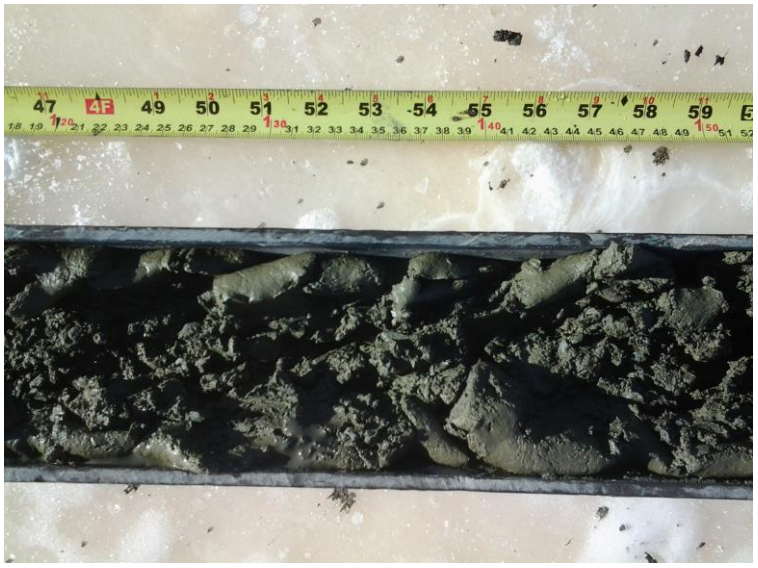
2016-03-10 14:53:18

Field Team Travis Munson

Coordinates (UTM NAD83 Zone 8N)		Accuracy (m +/-
580162.0	6914337.0	6.0

Sample SOb

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CH16-201-BH006A

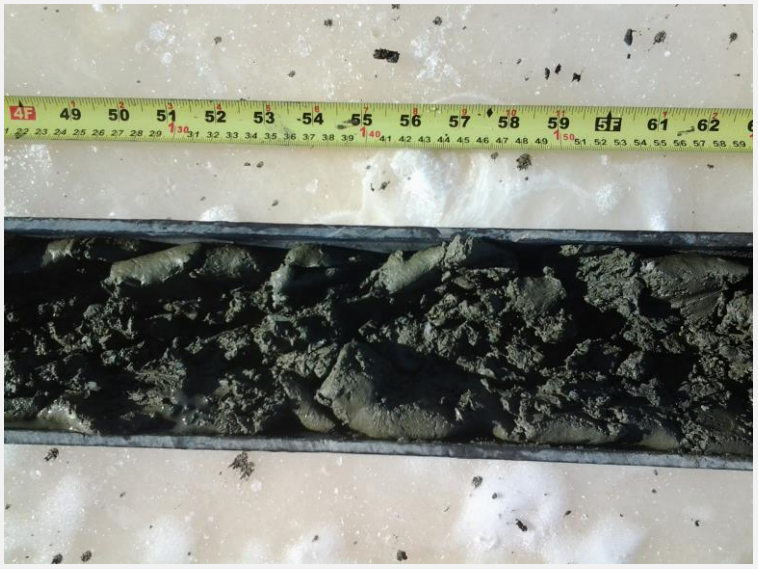
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Field Team Travis Munson

Coordinates (UTM NAD83 Zone 8N)		Accuracy (m +/-
580162.0	6914337.0	6.0

Sample SOb

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CH16-201-BH006A

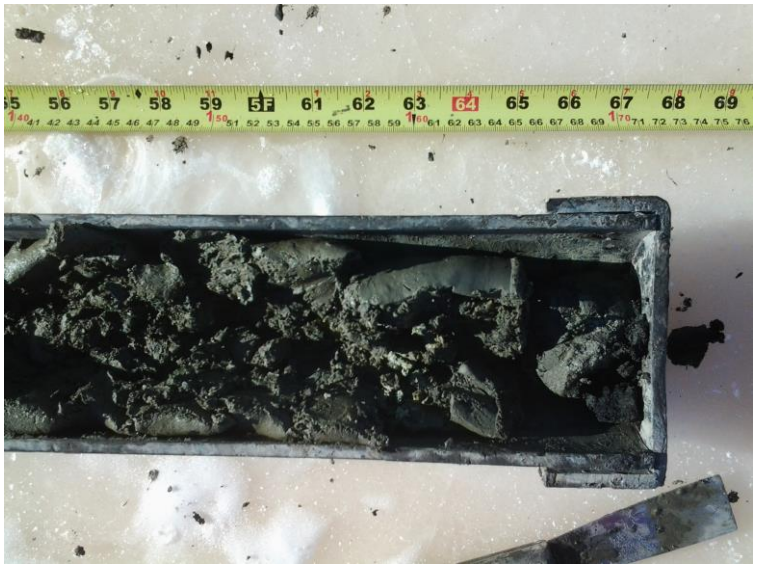
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Field Team Travis Munson

Coordinates (UTM NAD83 Zone 8N)		Accuracy (m +/-
580162.0	6914337.0	6.0

Sample SOb

https://deliver.ch2m.com/sites/TM1/Photos_2016_0103/CH16-201-BH006A_2016-03-10_145350.jpg



CH16-201-BH008

2016-03-10 16:02:42

Field Team Travis Munson

Coordinates (UTM NAD83 Zone 8N)		Accuracy (m +/-
580195.0	6914392.0	8.0

Sample SOa

https://deliver.ch2m.com/sites/TM1/Photos_2016_0103/CH16-201-BH008_2016-03-10_160242.jpg



CH16-201-BH008

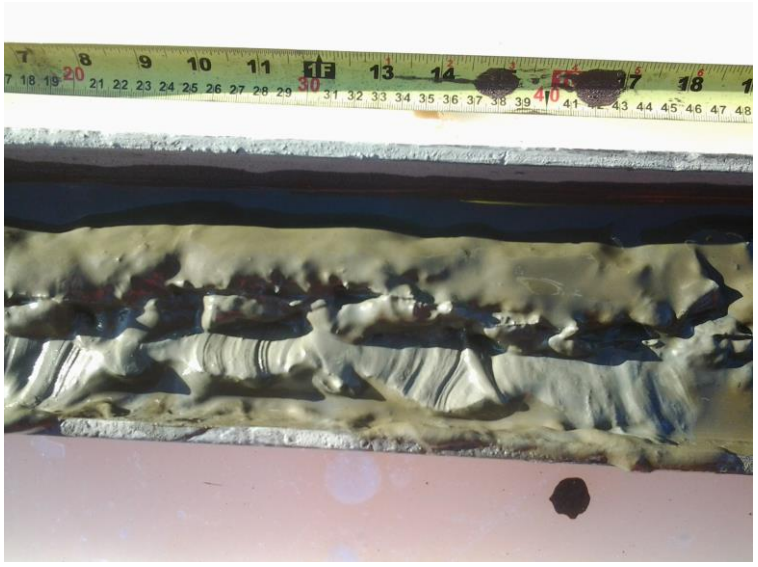
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Field Team Travis Munson

Coordinates (UTM NAD83 Zone 8N)		Accuracy (m +/-
580195.0	6914392.0	8.0

Sample SOa

https://deliver.ch2m.com/sites/TM1/Photos_2016_0103/CH16-201-BH008_2016-03-10_160406.jpg



CH16-201-BH008

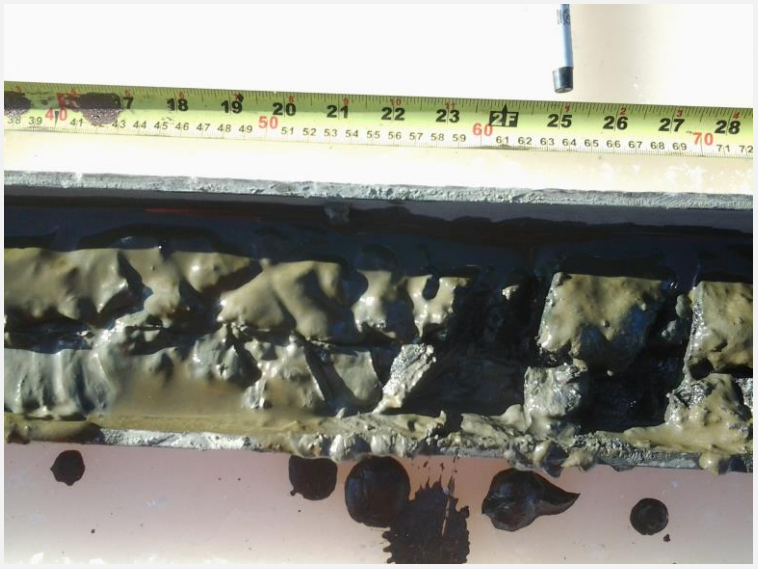
2016-03-10 16:04:27

Field Team Travis Munson

Coordinates (UTM NAD83 Zone 8N)		Accuracy (m +/-
580195.0	6914392.0	8.0

Sample SOa

https://deliver.ch2m.com/sites/TM1/Photos_2016_0103/CH16-201-BH008_2016-03-10_160427.jpg



CH16-201-BH008

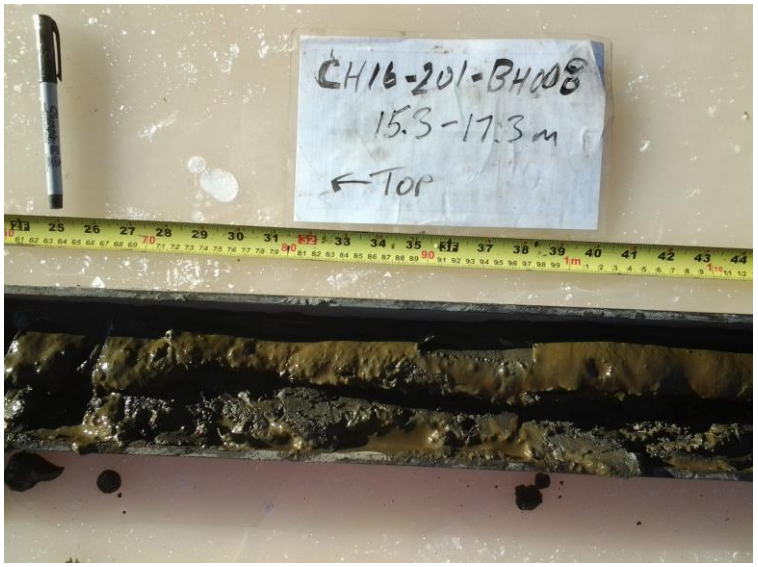
2016-03-10 16:04:44

Field Team Travis Munson

Coordinates (UTM NAD83 Zone 8N)		Accuracy (m +/-
580195.0	6914392.0	8.0

Sample SOa

https://deliver.ch2m.com/sites/TM1/Photos_2016_0103/CH16-201-BH008_2016-03-10_160444.jpg



CH16-201-BH008

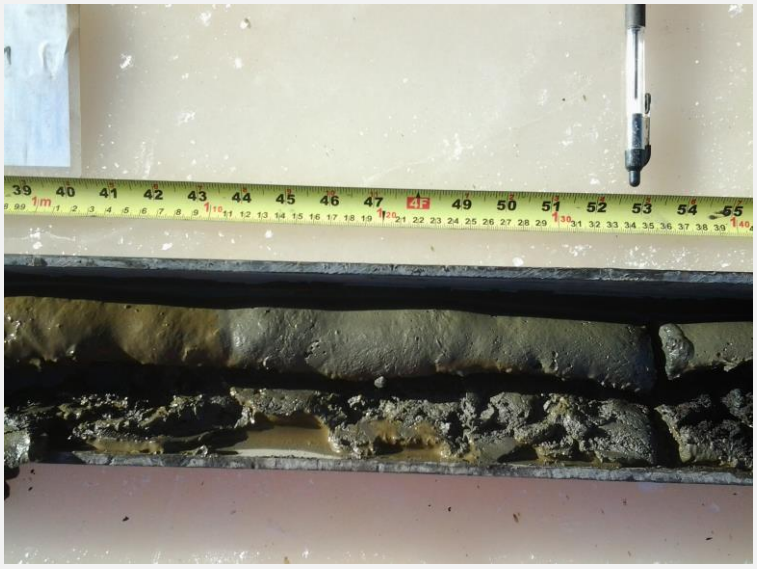
2016-03-10 16:05:13

Field Team Travis Munson

Coordinates (UTM NAD83 Zone 8N)		Accuracy (m +/-
580195.0	6914392.0	8.0

Sample SOa

https://deliver.ch2m.com/sites/TM1/Photos_2016_0103/CH16-201-BH008_2016-03-10_160513.jpg



CH16-201-BH008

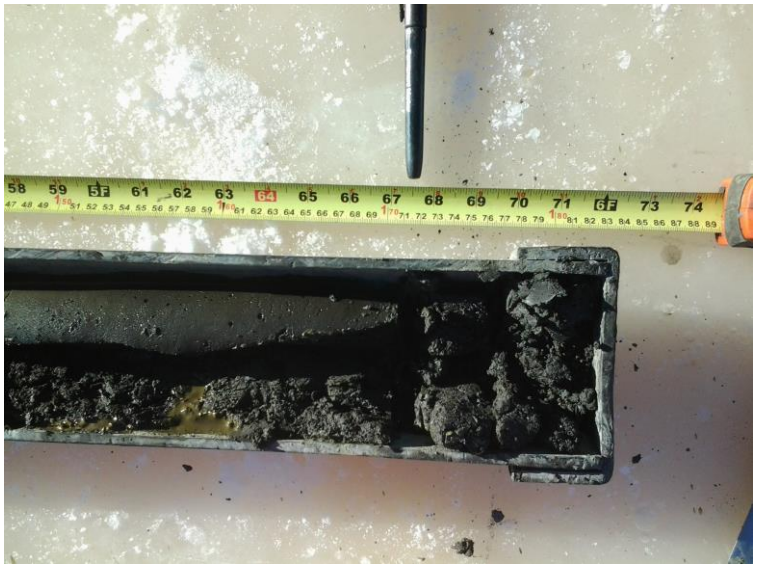
2016-03-10 16:05:30

Field Team Travis Munson

Coordinates (UTM NAD83 Zone 8N)		Accuracy (m +/-
580195.0	6914392.0	8.0

Sample SOa

https://deliver.ch2m.com/sites/TM1/Photos_2016_0103/CH16-201-BH008_2016-03-10_160530.jpg



CH16-201-BH008

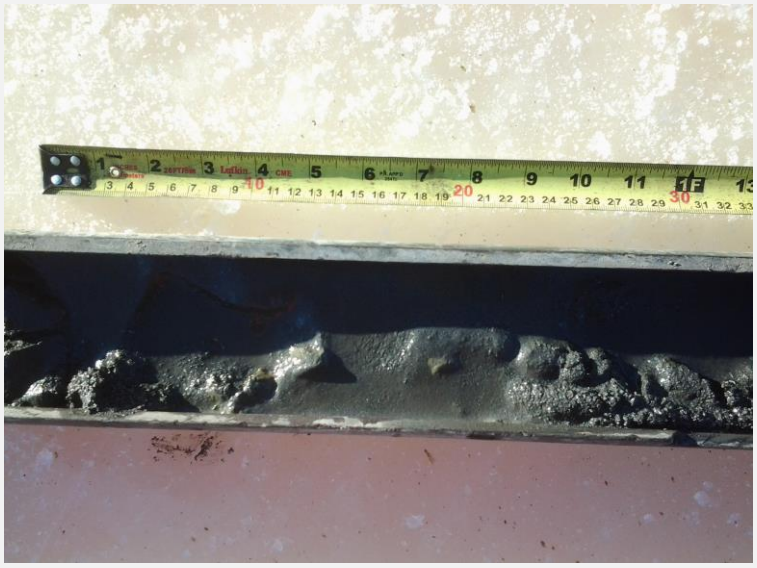
2016-03-10 16:30:48

Field Team Travis Munson

Coordinates (UTM NAD83 Zone 8N)		Accuracy (m +/-
580188.0	6914404.0	8.0

Sample SOb

https://deliver.ch2m.com/sites/TM1/Photos_2016_0103/CH16-201-BH008_2016-03-10_163048.jpg



CH16-201-BH008

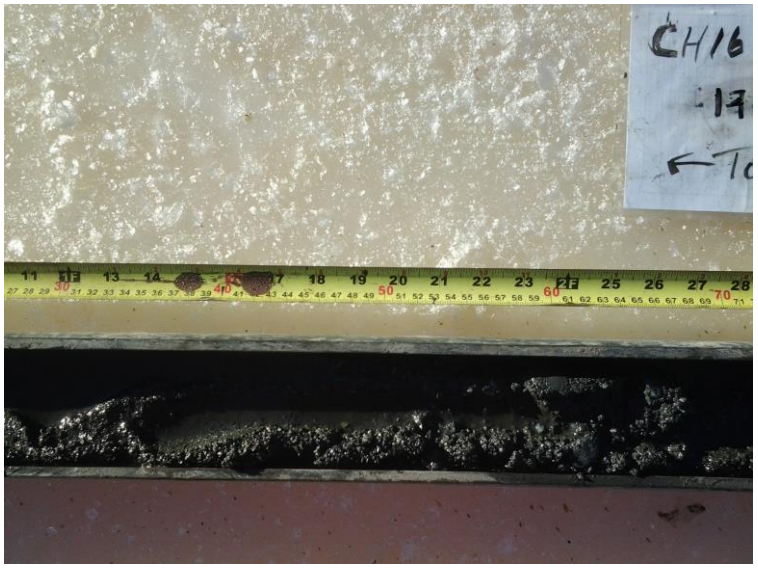
2016-03-10 16:31:47

Field Team Travis Munson

Coordinates (UTM NAD83 Zone 8N)		Accuracy (m +/-
580188.0	6914404.0	8.0

Sample SOb

https://deliver.ch2m.com/sites/TM1/Photos_2016_0103/CH16-201-BH008_2016-03-10_163148.jpg



CH16-201-BH008

2016-03-10 16:32:23

Field Team Travis Munson

Coordinates (UTM NAD83 Zone 8N)		Accuracy (m +/-
580188.0	6914404.0	8.0

Sample SOb

https://deliver.ch2m.com/sites/TM1/Photos_2016_0103/CH16-201-BH008_2016-03-10_163223.jpg



CH16-201-BH008

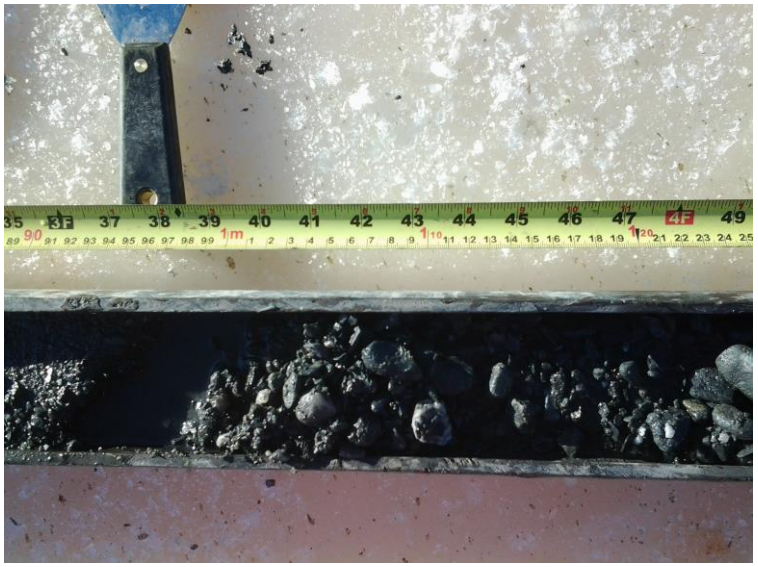
2016-03-10 16:32:40

Field Team Travis Munson

Coordinates (UTM NAD83 Zone 8N)		Accuracy (m +/-
580188.0	6914404.0	8.0

Sample SOb

https://deliver.ch2m.com/sites/TM1/Photos_2016_0103/CH16-201-BH008_2016-03-10_163241.jpg



CH16-201-BH008

2016-03-10 16:32:58

Field Team Travis Munson

Coordinates (UTM NAD83 Zone 8N)		Accuracy (m +/-
580188.0	6914404.0	8.0

Sample SOb

https://deliver.ch2m.com/sites/TM1/Photos_2016_0103/CH16-201-BH008_2016-03-10_163258.jpg



CH16-201-BH009

2016-03-09 10:45:24

Field Team Travis Munson

Coordinates (UTM NAD83 Zone 8N)		Accuracy (m +/-
580388.0	6914346.0	8.0

Sample AL-2; dirty water with minor turbidity, not sludge.

https://deliver.ch2m.com/sites/TM1/Photos_2016_0103/CH16-201-BH005_2016-03-09_104524.jpg



CH16-201-BH009

2016-03-09 11:28:27

Field Team Travis Munson

Coordinates (UTM NAD83 Zone 8N)		Accuracy (m +/-
580386.0	6914346.0	8.0

Sample SOa 1,2

https://deliver.ch2m.com/sites/TM1/Photos_2016_0103/CH16-201-BH005_2016-03-09_112827.jpg



CH16-201-BH009

2016-03-09 11:35:32

Field Team Travis Munson

Coordinates (UTM NAD83 Zone 8N)		Accuracy (m +/-
580383.0	6914346.0	6.0

Bent drill rod pushing on dense soil at mudline (while attempting to enter borehole for SOb at 11.4m.



https://deliver.ch2m.com/sites/TM1/Photos_2016_0103/CH16-201-BH005_2016-03-09_113532.jpg

CH16-201-BH009

2016-03-09 12:01:02

Field Team Travis Munson

Coordinates (UTM NAD83 Zone 8N)		Accuracy (m +/-
580391.0	6914344.0	6.0

Sample SOb 1,2,3



https://deliver.ch2m.com/sites/TM1/Photos_2016_0103/CH16-201-BH005_2016-03-09_120102.jpg

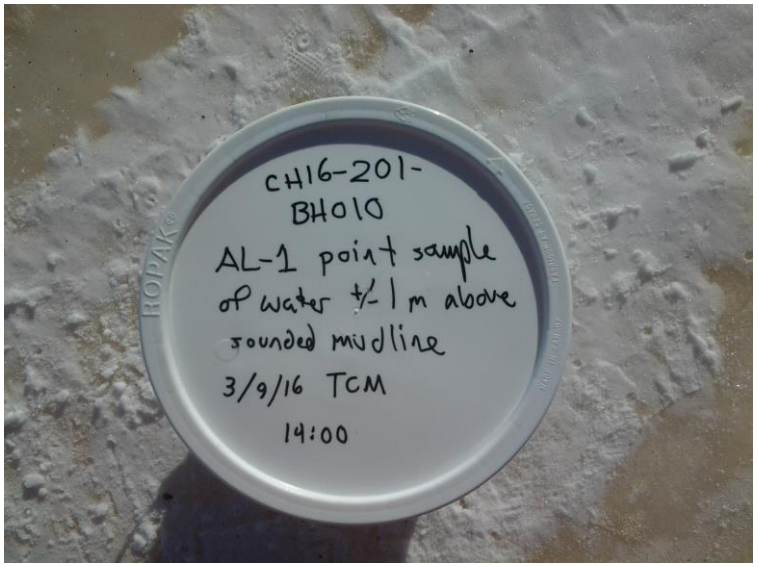
CH16-201-BH010

2016-03-09 14:11:48

Field Team Travis Munson

Coordinates (UTM NAD83 Zone 8N)		Accuracy (m +/-
580209.0	6914431.0	8.0

Sample AL-1



https://deliver.ch2m.com/sites/TM1/Photos_2016_0103/CH16-201-BH010_2016-03-09_141148.jpg

CH16-201-BH010

2016-03-09 14:33:19

Field Team Travis Munson

Coordinates (UTM NAD83 Zone 8N)		Accuracy (m +/-
580214.0	6914416.0	6.0

Sample SOa

https://deliver.ch2m.com/sites/TM1/Photos_2016_0103/CH16-201-BH010_2016-03-09_143319.jpg



CH16-201-BH010

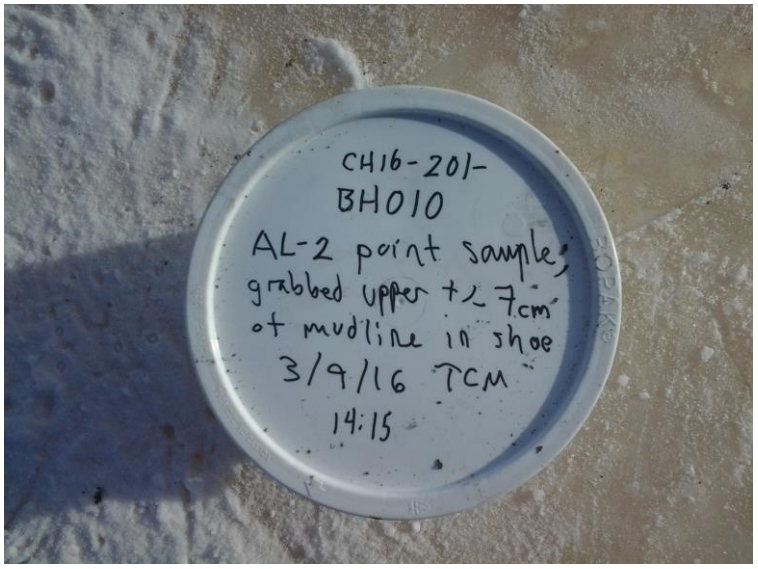
2016-03-09 14:39:26

Field Team Travis Munson

Coordinates (UTM NAD83 Zone 8N)		Accuracy (m +/-
580208.0	6914420.0	8.0

Sample SOa

https://deliver.ch2m.com/sites/TM1/Photos_2016_0103/CH16-201-BH010_2016-03-09_143927.jpg



CH16-201-BH010A

2016-03-10 10:07:06

Field Team Travis Munson

Coordinates (UTM NAD83 Zone 8N)		Accuracy (m +/-
580201.0	6914417.0	8.0

Sample SOa

https://deliver.ch2m.com/sites/TM1/Photos_2016_0103/CH16-201-BH010A_2016-03-10_100706.jpg



CH16-201-BH010A

2016-03-10 10:11:05

Field Team Travis Munson

Coordinates (UTM NAD83 Zone 8N)		Accuracy (m +/-
580201.0	6914417.0	8.0

Sample SOa

https://deliver.ch2m.com/sites/TM1/Photos_2016_0103/CH16-201-BH010A_2016-03-10_101105.jpg



CH16-201-BH010A

2016-03-10 10:11:50

Field Team Travis Munson

Coordinates (UTM NAD83 Zone 8N)		Accuracy (m +/-
580201.0	6914417.0	8.0

Sample SOa

https://deliver.ch2m.com/sites/TM1/Photos_2016_0103/CH16-201-BH010A_2016-03-10_101150.jpg



CH16-201-BH010A

2016-03-10 10:12:56

Field Team Travis Munson

Coordinates (UTM NAD83 Zone 8N)		Accuracy (m +/-
580201.0	6914417.0	8.0

Sample SOa

https://deliver.ch2m.com/sites/TM1/Photos_2016_0103/CH16-201-BH010A_2016-03-10_101257.jpg



CH16-201-BH010A

2016-03-10 10:13:53

Field Team Travis Munson

Coordinates (UTM NAD83 Zone 8N)		Accuracy (m +/-
580201.0	6914417.0	8.0

Sample SOa

https://deliver.ch2m.com/sites/TM1/Photos_2016_0103/CH16-201-BH010A_2016-03-10_101354.jpg



CH16-201-BH010A

2016-03-10 10:14:28

Field Team Travis Munson

Coordinates (UTM NAD83 Zone 8N)		Accuracy (m +/-
580201.0	6914417.0	8.0

Sample SOa

https://deliver.ch2m.com/sites/TM1/Photos_2016_0103/CH16-201-BH010A_2016-03-10_101428.jpg



CH16-201-BH010A

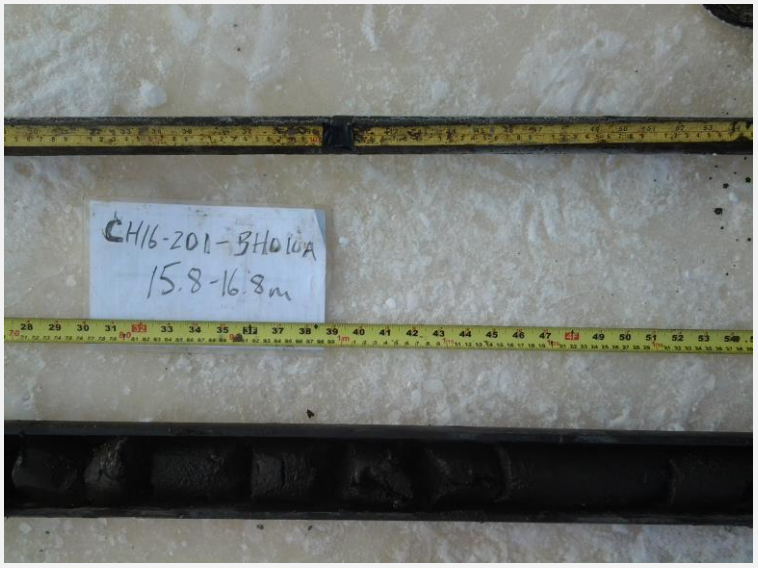
2016-03-10 10:14:44

Field Team Travis Munson

Coordinates (UTM NAD83 Zone 8N)		Accuracy (m +/-
580201.0	6914417.0	8.0

Sample SOa

https://deliver.ch2m.com/sites/TM1/Photos_2016_0103/CH16-201-BH010A_2016-03-10_101444.jpg



CH16-201-BH010A

2016-03-10 10:15:03

Field Team Travis Munson

Coordinates (UTM NAD83 Zone 8N)		Accuracy (m +/-
580201.0	6914417.0	8.0

Sample SOa

https://deliver.ch2m.com/sites/TM1/Photos_2016_0103/CH16-201-BH010A_2016-03-10_101504.jpg



CH16-201-BH010A

2016-03-10 10:35:44

Field Team Travis Munson

Coordinates (UTM NAD83 Zone 8N)		Accuracy (m +/-
580201.0	6914417.0	8.0

Sample SOa

https://deliver.ch2m.com/sites/TM1/Photos_2016_0103/CH16-201-BH010A_2016-03-10_103544.jpg



CH16-201-BH010A

2016-03-10 10:36:00

Field Team Travis Munson

Coordinates (UTM NAD83 Zone 8N)		Accuracy (m +/-
580201.0	6914417.0	8.0

Sample SOa

https://deliver.ch2m.com/sites/TM1/Photos_2016_0103/CH16-201-BH010A_2016-03-10_103600.jpg



CH16-201-BH010A

2016-03-10 10:36:16

Field Team Travis Munson

Coordinates (UTM NAD83 Zone 8N)		Accuracy (m +/-
580201.0	6914417.0	8.0

Sample SOa

https://deliver.ch2m.com/sites/TM1/Photos_2016_0103/CH16-201-BH010A_2016-03-10_103616.jpg



CH16-201-BH010A

2016-03-10 10:36:33

Field Team Travis Munson

Coordinates (UTM NAD83 Zone 8N)		Accuracy (m +/-
580201.0	6914417.0	8.0

Sample SOa

https://deliver.ch2m.com/sites/TM1/Photos_2016_0103/CH16-201-BH010A_2016-03-10_103633.jpg



CH16-201-BH010A

2016-03-10 10:36:51

Field Team Travis Munson

Coordinates (UTM NAD83 Zone 8N)		Accuracy (m +/-
580201.0	6914417.0	8.0

Sample SOa

https://deliver.ch2m.com/sites/TM1/Photos_2016_0103/CH16-201-BH010A_2016-03-10_103651.jpg



CH16-201-BH010A

2016-03-10 10:37:06

Field Team Travis Munson

Coordinates (UTM NAD83 Zone 8N)		Accuracy (m +/-
580201.0	6914417.0	8.0

Sample SOa

https://deliver.ch2m.com/sites/TM1/Photos_2016_0103/CH16-201-BH010A_2016-03-10_103707.jpg



CH16-201-BH010A

2016-03-10 10:37:53

Field Team Travis Munson

Coordinates (UTM NAD83 Zone 8N)		Accuracy (m +/-
580201.0	6914417.0	8.0

Sample SOa

https://deliver.ch2m.com/sites/TM1/Photos_2016_0103/CH16-201-BH010A_2016-03-10_103753.jpg



CH16-201-BH010A

2016-03-10 10:38:21

Field Team Travis Munson

Coordinates (UTM NAD83 Zone 8N)		Accuracy (m +/-
580201.0	6914417.0	8.0

Sample SOa

https://deliver.ch2m.com/sites/TM1/Photos_2016_0103/CH16-201-BH010A_2016-03-10_103821.jpg



CH16-201-BH010A

2016-03-10 10:44:43

Field Team Travis Munson

Coordinates (UTM NAD83 Zone 8N) Accuracy (m +/-

580201.0 6914417.0 8.0

Sample SOa

https://deliver.ch2m.com/sites/TM1/Photos_2016_0103/CH16-201-BH010A_2016-03-10_104443.jpg



CH16-201-BH010A

2016-03-10 11:04:02

Field Team Travis Munson

Coordinates (UTM NAD83 Zone 8N) Accuracy (m +/-

580209.0 6914410.0 6.0

Sample SOb

https://deliver.ch2m.com/sites/TM1/Photos_2016_0103/CH16-201-BH010A_2016-03-10_110402.jpg



CH16-201-BH010A

2016-03-10 11:05:28

Field Team Travis Munson

Coordinates (UTM NAD83 Zone 8N) Accuracy (m +/-

580209.0 6914410.0 6.0

Sample SOb

https://deliver.ch2m.com/sites/TM1/Photos_2016_0103/CH16-201-BH010A_2016-03-10_110528.jpg



CH16-201-BH010A

2016-03-10 11:05:54

Field Team Travis Munson

Coordinates (UTM NAD83 Zone 8N)		Accuracy (m +/-
580209.0	6914410.0	6.0

Sample SOb

https://deliver.ch2m.com/sites/TM1/Photos_2016_0103/CH16-201-BH010A_2016-03-10_110555.jpg



CH16-201-BH010A

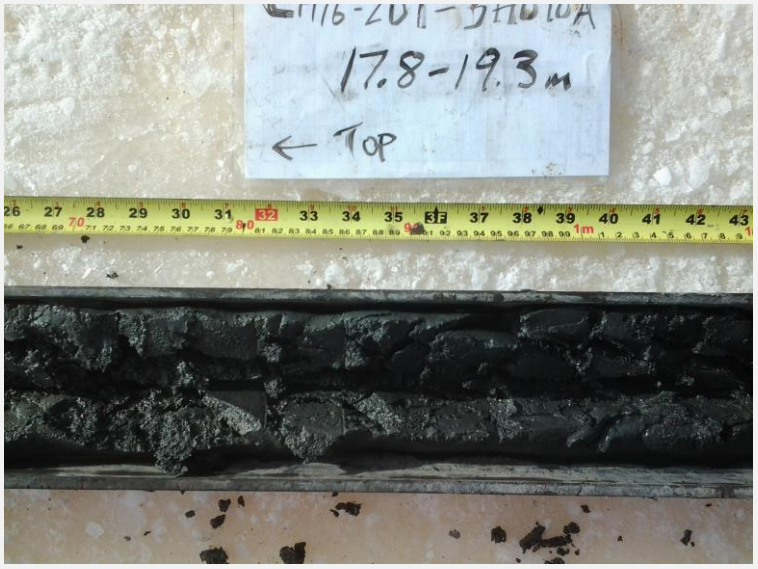
2016-03-10 11:06:12

Field Team Travis Munson

Coordinates (UTM NAD83 Zone 8N)		Accuracy (m +/-
580209.0	6914410.0	6.0

Sample SOb

https://deliver.ch2m.com/sites/TM1/Photos_2016_0103/CH16-201-BH010A_2016-03-10_110612.jpg



CH16-201-BH010A

2016-03-10 11:06:35

Field Team Travis Munson

Coordinates (UTM NAD83 Zone 8N)		Accuracy (m +/-
580209.0	6914410.0	6.0

Sample SOb

https://deliver.ch2m.com/sites/TM1/Photos_2016_0103/CH16-201-BH010A_2016-03-10_110635.jpg



CH16-201-BH010A

2016-03-10 11:06:54

Field Team Travis Munson

Coordinates (UTM NAD83 Zone 8N)		Accuracy (m +/-
580209.0	6914410.0	6.0

Sample SOb

https://deliver.ch2m.com/sites/TM1/Photos_2016_0103/CH16-201-BH010A_2016-03-10_110655.jpg



CH16-201-BH010A

2016-03-10 11:16:26

Field Team Travis Munson

Coordinates (UTM NAD83 Zone 8N)		Accuracy (m +/-
580211.0	6914416.0	8.0

Damaged bit after Sample SOc (AL-3)

https://deliver.ch2m.com/sites/TM1/Photos_2016_0103/CH16-201-BH010A_2016-03-10_111626.jpg



CH16-201-BH011A

2016-03-12 17:46:01

Field Team Travis Munson

Coordinates (UTM NAD83 Zone 8N)		Accuracy (m +/-
580337.0	6914402.0	6.0

Sample SOa (sludge taken in a point sample at a depth of 7.5 feet below water surface)

https://deliver.ch2m.com/sites/TM1/Photos_2016_0103/CH16-201-BH011A_2016-03-12_174601.jpg



CH16-201-BH011A

2016-03-12 18:07:16

Field Team Travis Munson

Coordinates (UTM NAD83 Zone 8N)		Accuracy (m +/-
580341.0	6914399.0	8.0

Sample SOb (point sample of sludge at 8.0 m below water level)



https://deliver.ch2m.com/sites/TM1/Photos_2016_0103/CH16-201-BH011A_2016-03-12_180717.jpg

CH16-201-BH012A

2016-03-12 13:27:45

Field Team Travis Munson

Coordinates (UTM NAD83 Zone 8N)		Accuracy (m +/-
580354.0	6914310.0	6.0

Sample SOa



https://deliver.ch2m.com/sites/TM1/Photos_2016_0103/CH16-201-BH012A_2016-03-12_132745.jpg

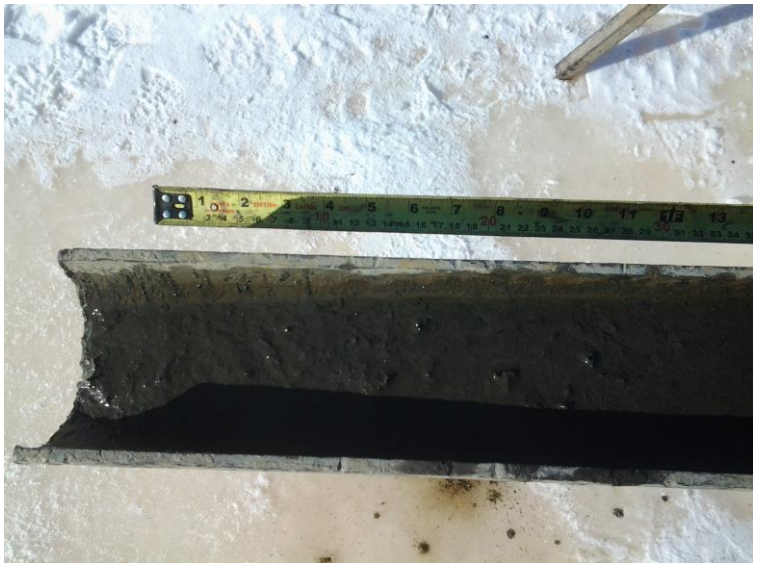
CH16-201-BH012A

2016-03-12 13:31:01

Field Team Travis Munson

Coordinates (UTM NAD83 Zone 8N)		Accuracy (m +/-
580354.0	6914310.0	6.0

Sample SOa



https://deliver.ch2m.com/sites/TM1/Photos_2016_0103/CH16-201-BH012A_2016-03-12_133101.jpg

CH16-201-BH012A

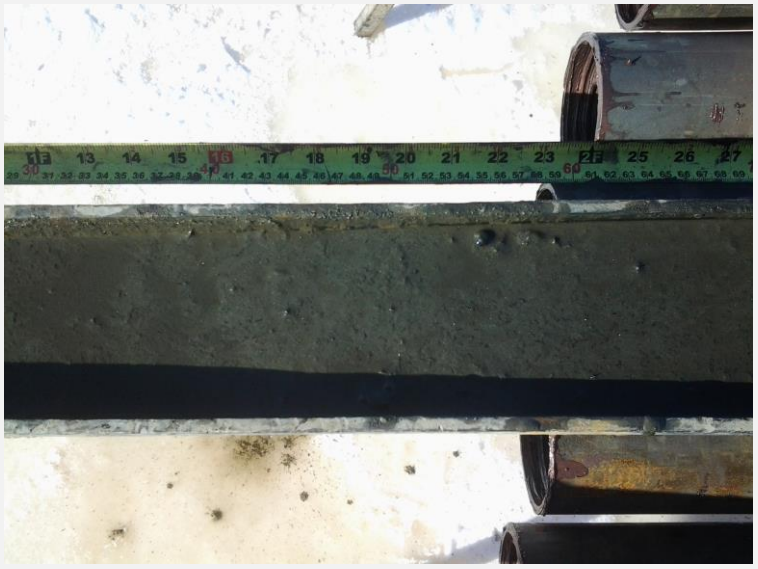
2016-03-12 13:31:57

Field Team Travis Munson

Coordinates (UTM NAD83 Zone 8N)		Accuracy (m +/-
580354.0	6914310.0	6.0

Sample SOa

https://deliver.ch2m.com/sites/TM1/Photos_2016_0103/CH16-201-BH012A_2016-03-12_133157.jpg



CH16-201-BH012A

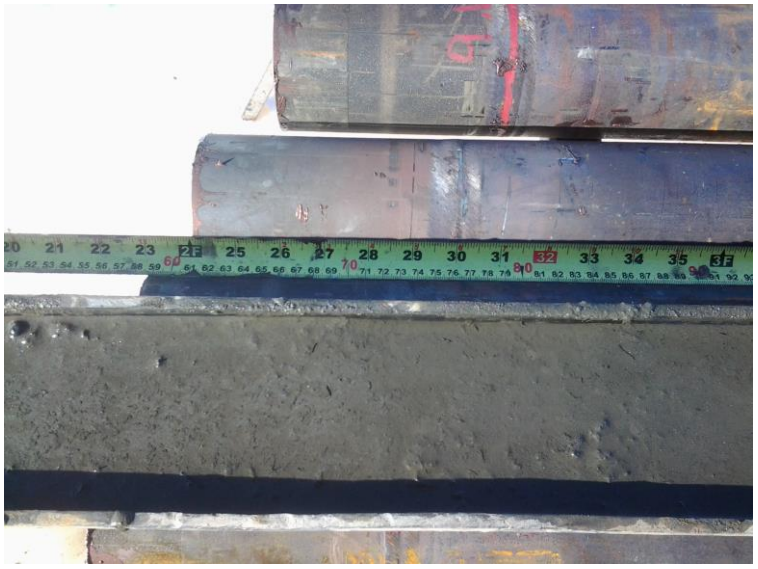
2016-03-12 13:32:13

Field Team Travis Munson

Coordinates (UTM NAD83 Zone 8N)		Accuracy (m +/-
580354.0	6914310.0	6.0

Sample SOa

https://deliver.ch2m.com/sites/TM1/Photos_2016_0103/CH16-201-BH012A_2016-03-12_133214.jpg



CH16-201-BH012A

2016-03-12 13:32:34

Field Team Travis Munson

Coordinates (UTM NAD83 Zone 8N)		Accuracy (m +/-
580354.0	6914310.0	6.0

Sample SOa

https://deliver.ch2m.com/sites/TM1/Photos_2016_0103/CH16-201-BH012A_2016-03-12_133234.jpg



CH16-201-BH012A

2016-03-12 13:32:59

Field Team Travis Munson

Coordinates (UTM NAD83 Zone 8N) Accuracy (m +/-

580354.0 6914310.0 6.0

Sample SOa

https://deliver.ch2m.com/sites/TM1/Photos_2016_0103/CH16-201-BH012A_2016-03-12_133259.jpg



CH16-201-BH012A

2016-03-12 13:33:17

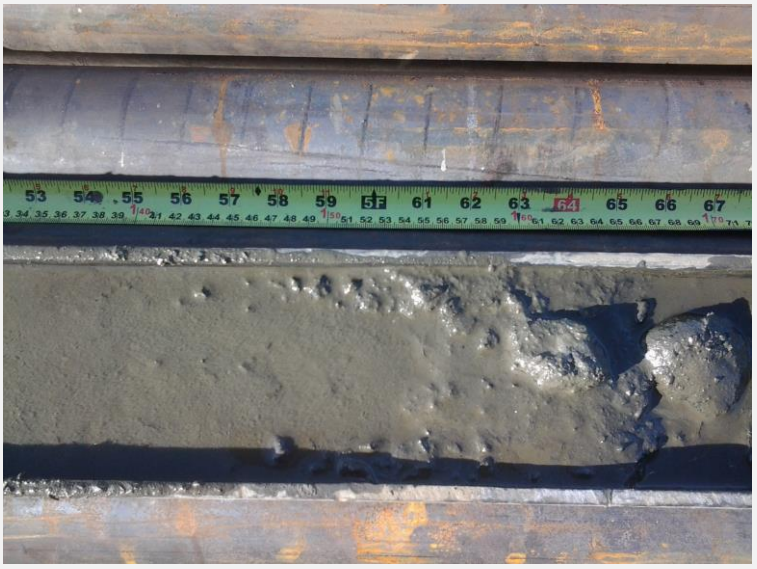
Field Team Travis Munson

Coordinates (UTM NAD83 Zone 8N) Accuracy (m +/-

580354.0 6914310.0 6.0

Sample SOa

https://deliver.ch2m.com/sites/TM1/Photos_2016_0103/CH16-201-BH012A_2016-03-12_133317.jpg



CH16-201-BH012A

2016-03-12 13:33:34

Field Team Travis Munson

Coordinates (UTM NAD83 Zone 8N) Accuracy (m +/-

580354.0 6914310.0 6.0

Sample SOa

https://deliver.ch2m.com/sites/TM1/Photos_2016_0103/CH16-201-BH012A_2016-03-12_133334.jpg



CH16-201-CP018

2016-03-13 13:38:37

Field Team Travis Munson

Coordinates (UTM NAD83 Zone 8N)		Accuracy (m +/-
580671.0	6914264.0	8.0

CPT setup; note hanging casing

https://deliver.ch2m.com/sites/TM1/Photos_2016_0103/CH16-201-CP018_2016-03-13_133837.jpg



CH16-201-CP018

2016-03-13 16:21:51

Field Team Travis Munson

Coordinates (UTM NAD83 Zone 8N)		Accuracy (m +/-
580683.0	6914268.0	8.0

Soil recovered at top of seismic source

https://deliver.ch2m.com/sites/TM1/Photos_2016_0103/CH16-201-CP018_2016-03-13_162152.jpg



CH16-201-CP025

2016-03-06 13:49:03

Field Team B. Edwards, Conetec

Coordinates (UTM NAD83 Zone 8N)		Accuracy (m +/-
580154.0	6914374.0	2.1

Site prep cp025 on cvd pond. Pad cleared for loading. 12cm freeboard, 85cm total.

https://deliver.ch2m.com/sites/TM1/Photos_2016_0103/_2016-03-06_134903.jpg



CH16-201-CP025

2016-03-06 14:32:25

Field Team R. Di Panfilo

Coordinates (UTM NAD83 Zone 8N)		Accuracy (m +/-
580373.0	6914566.0	2.4

CH16-201-CP025

https://deliver.ch2m.com/sites/TM1/Photos_2016_0103/CVP_CVP_2016-03-06_143225.jpg



CH16-201-CP025

2016-03-06 14:33:29

Field Team R. Di Panfilo

Coordinates (UTM NAD83 Zone 8N)		Accuracy (m +/-
580355.0	6914561.0	2.1

CH16-201-CP025

https://deliver.ch2m.com/sites/TM1/Photos_2016_0103/CVP_CVP_2016-03-06_143330.jpg



CH16-201-CP025

2016-03-06 14:34:44

Field Team R. Di Panfilo

Coordinates (UTM NAD83 Zone 8N)		Accuracy (m +/-
580379.0	6914566.0	2.1

CH16-201-CP025

https://deliver.ch2m.com/sites/TM1/Photos_2016_0103/CVP_CVP_2016-03-06_143445.jpg



CH16-201-CP025

2016-03-06 14:39:08

Field Team R. Di Panfilo

Coordinates (UTM NAD83 Zone 8N)		Accuracy (m +/-
580315.0	6914560.0	2.1

CH16-201-CP025

https://deliver.ch2m.com/sites/TM1/Photos_2016_0103/CVP_CVP_2016-03-06_143908.jpg



CH16-201-CP025

2016-03-06 14:42:44

Field Team B. Edwards, Conetec

Coordinates (UTM NAD83 Zone 8N)		Accuracy (m +/-
580190.0	6914430.0	1.5

Depth sounding at CP025

https://deliver.ch2m.com/sites/TM1/Photos_2016_0103/CVP_2016-03-06_144244.jpg



CH16-201-CP025

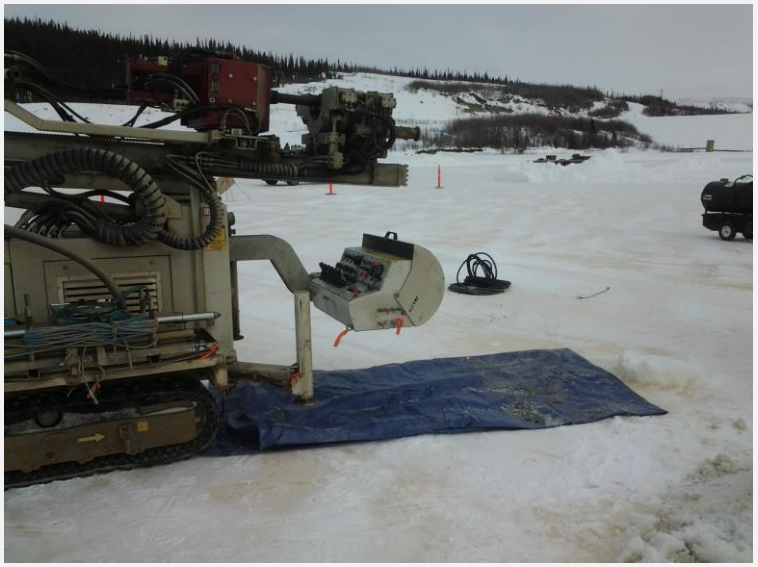
2016-03-06 15:04:59

Field Team B. Edwards, Conetec

Coordinates (UTM NAD83 Zone 8N)		Accuracy (m +/-
580189.0	6914434.0	1.75

Tarp under drill rig for drip catchment

https://deliver.ch2m.com/sites/TM1/Photos_2016_0103/CVP_CP025_2016-03-06_150727.jpg



CH16-201-CP025

2016-03-06 15:19:58

Field Team B. Edwards, Conetec

Coordinates (UTM NAD83 Zone 8N)		Accuracy (m +/-
580200.0	6914422.0	1.8

Depth sounding tool for soft bottom.

https://deliver.ch2m.com/sites/TM1/Photos_2016_0103/CVP_CP025_2016-03-06_151958.jpg



CH16-201-CP025

2016-03-06 15:24:33

Field Team B. Edwards, Conetec

Coordinates (UTM NAD83 Zone 8N)		Accuracy (m +/-
580201.0	6914436.0	1.5

Rig setup. Front jacks.

https://deliver.ch2m.com/sites/TM1/Photos_2016_0103/CVD_CP025_2016-03-06_152433.jpg



CH16-201-CP025

2016-03-06 15:26:00

Field Team B. Edwards, Conetec

Coordinates (UTM NAD83 Zone 8N)		Accuracy (m +/-
580201.0	6914436.0	1.5

Rig setup. Rear jack pads

https://deliver.ch2m.com/sites/TM1/Photos_2016_0103/CVD_CP025_2016-03-06_152600.jpg



CH16-201-CP025

2016-03-06 15:27:44

Field Team B. Edwards, Conetec

Coordinates (UTM NAD83 Zone 8N)		Accuracy (m +/-
580225.0	6914429.0	1.5

Drill pad layout

https://deliver.ch2m.com/sites/TM1/Photos_2016_0103/CVP_CP025_2016-03-06_152744.jpg



CH16-201-CP025

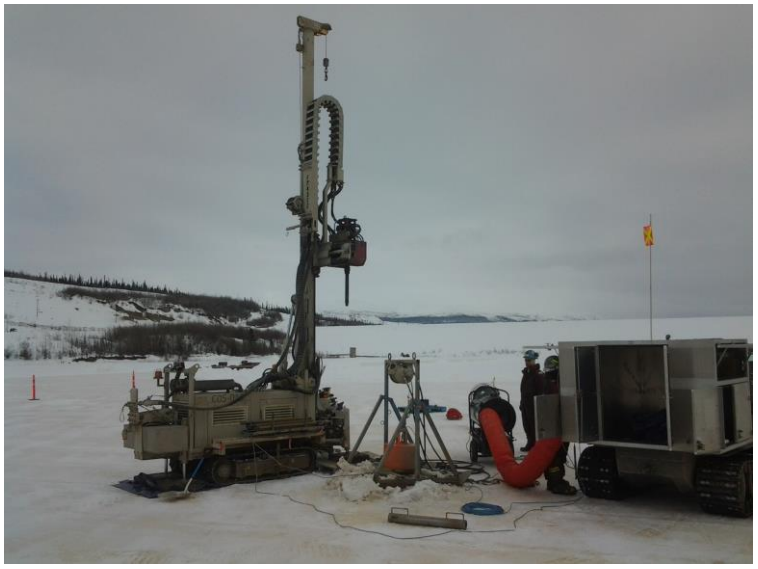
2016-03-06 16:23:00

Field Team B. Edwards, Conetec

Coordinates (UTM NAD83 Zone 8N)		Accuracy (m +/-
580193.0	6914435.0	2.4

Rig setup. Testing cone penetrometer.

https://deliver.ch2m.com/sites/TM1/Photos_2016_0103/CVP_CP025_2016-03-06_162300.jpg



CH16-201-CP025

2016-03-06 16:52:10

Field Team B. Edwards, Conetec

Coordinates (UTM NAD83 Zone 8N)		Accuracy (m +/-
580229.0	6914468.0	8.0

Drill pad layout. Traffic control.

https://deliver.ch2m.com/sites/TM1/Photos_2016_0103/CVP_CP025_2016-03-06_165210.jpg



CH16-201-CP026

2016-03-12 15:49:24

Field Team Travis Munson

Coordinates (UTM NAD83 Zone 8N)		Accuracy (m +/-
580336.0	6914425.0	8.0

150 cm^2 CPT probe for use in sludge

https://deliver.ch2m.com/sites/TM1/Photos_2016_0103/CH16-201-CP026_2016-03-12_154924.jpg



CH16-201-CP026

2016-03-12 15:49:49

Field Team Travis Munson

Coordinates (UTM NAD83 Zone 8N)		Accuracy (m +/-
580336.0	6914425.0	8.0

150 cm^2 CPT probe for use in sludge

https://deliver.ch2m.com/sites/TM1/Photos_2016_0103/CH16-201-CP026_2016-03-12_154949.jpg



CH16-201-CP026

2016-03-12 16:10:53

Field Team P. Mamo

Coordinates (UTM NAD83 Zone 8N)		Accuracy (m +/-
580322.0	6914442.0	48.0

CPt at CP026

https://deliver.ch2m.com/sites/TM1/Photos_2016_0103/CH16-201-CP026__2016-03-12_161053.jpg



CH16-201-CP026

2016-03-12 16:13:22

Field Team P. Mamo

Coordinates (UTM NAD83 Zone 8N)		Accuracy (m +/-
580322.0	6914442.0	48.0

CPt at CP026

https://deliver.ch2m.com/sites/TM1/Photos_2016_0103/CH16-201-CP026__2016-03-12_161322.jpg



CH16-201-CP026

2016-03-12 16:37:15

Field Team Travis Munson

Coordinates (UTM NAD83 Zone 8N)		Accuracy (m +/-
580340.0	6914390.0	8.0

Ferrous residue on porous stone.

https://deliver.ch2m.com/sites/TM1/Photos_2016_0103/CH16-201-CP026_2016-03-12_163715.jpg



Attachment 5
Bathymetry and Sub-bottom Profile Reports from Aurora Geosciences

Hydrographic and Sub-Bottom Profiling Survey – Cross Valley Dam Pond

NTS: 105K/06, Faro Mining Complex, Yukon Territory, Canada

WORK PERFORMED:
October 20 – 27, 2015

Prepared for:

ch2m.

Prepared by:

AURORA GEOSCIENCES

DRAFT TECHNICAL REPORT
Hydrographic and Sub-Bottom Profiling Survey – Cross Valley Dam Pond

Effective Date: August 22, 2016

Prepared for:
CH2M Hill Canada Limited
Whitehorse, YT Y1A 4N2

Prepared by:
Aurora Geosciences Ltd.
34A Laberge Road, Whitehorse, Yukon, Y1A5Y9
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1 INTRODUCTION

Aurora Geosciences Ltd. was retained by CH2M Hill Canada Limited to conduct bathymetric and sub-bottom profiling of the Cross Valley Dam (CVD) and Intermediate Dam (ID) ponds at the Faro Mine, Faro, Yukon Territory. Only the multi-beam bathymetry and sub-bottom surveys on the CVD Pond were completed during the 2015 survey due to the onset of cold weather and subsequent formation of ice, rendering further boat work on the ponds impossible. Work on the Intermediate Dam pond was completed in June 2016 and is described in a separate report. The single-beam bathymetry was completed on the CVD Pond in June 2016 along with some supporting RTK measurements.

Complete coverage of the CVD Pond bathymetry was obtained through a multi-beam sonar investigation, coupled with a supplemental single-beam sonar survey in shallow areas, and RTK-GPS survey (to define the shoreline). The survey revealed greater depths toward the North as well as Western side of the pond, producing a maximum depth of 14.68 metres.

Acoustic sub-bottom profiling was also completed on the pond with a line spacing of 10m.

All geographic locations in this report are relative to North American Datum 1983 (CSRS) and all elevations are orthometric heights relative to the HT2 geoid. Non-geodetic coordinates are expressed in Universal Transverse Mercator Zone 8N metric coordinates. All measurements are expressed in the metric SI system.

2 LOCATION & ACCESS

The crew was based in the town of Faro, YT for the duration of the project and accessed the CVD Pond daily by truck and then by 16-foot aluminum boat. The pond is approximately 15 kilometers north-northwest of the town of Faro; Figure 1 is a map of the CVD Pond within the Faro Mine area.

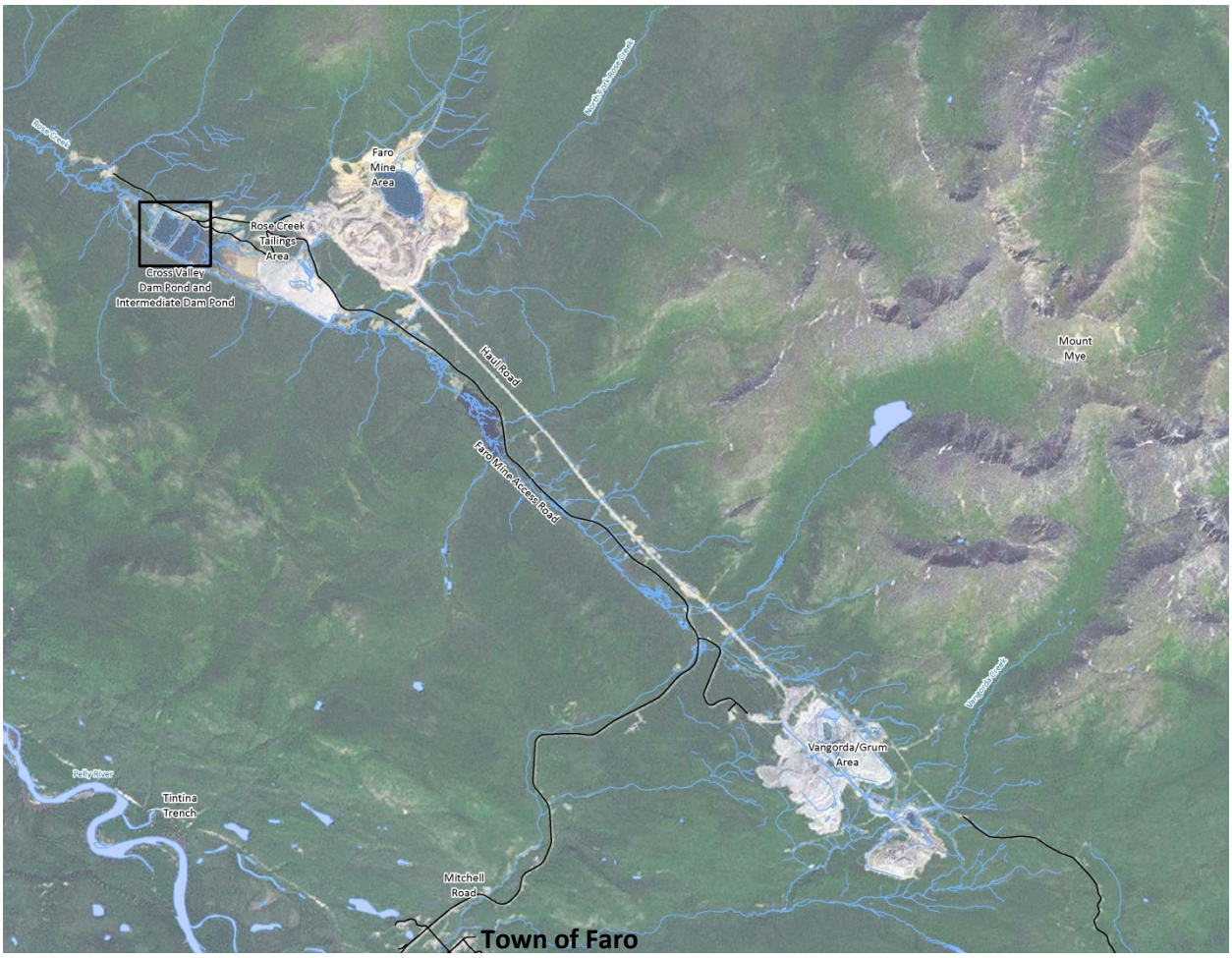


Figure 1: Location map of the CVD pond within the Faro Mine area. Map is from the CH2M Hill Agreement 10201-7-100723. The distance from the Town of Faro to the CVD Pond is approximately 15 km.

3 WORK PROGRAM

This section describes the October 2015 and June 2016 work programs conducted at the CVD Pond. A bathymetric survey was completed comprising of multi-beam sonar, selected areas of single-beam sonar, selected lead-line measurements and RTK-GPS survey both for shoreline definition and for single-beam line extensions to allow comparison to existing topographic data; this is described in Section 3.1. A sub-bottom survey was completed using a 4-24 kHz chirped acoustic signal; this is described in Section 3.2. Figure 2 shows the line-path of the multi-beam bathymetry (yellow), 2015 single-beam bathymetry (black), sub-bottom profiling (red) and RTK shoreline survey points (blue symbols). A complete project log detailing the work performed by the Aurora Geosciences field crew is in Appendix I.

QA/QC of the surveys is examined in Section 3.3.

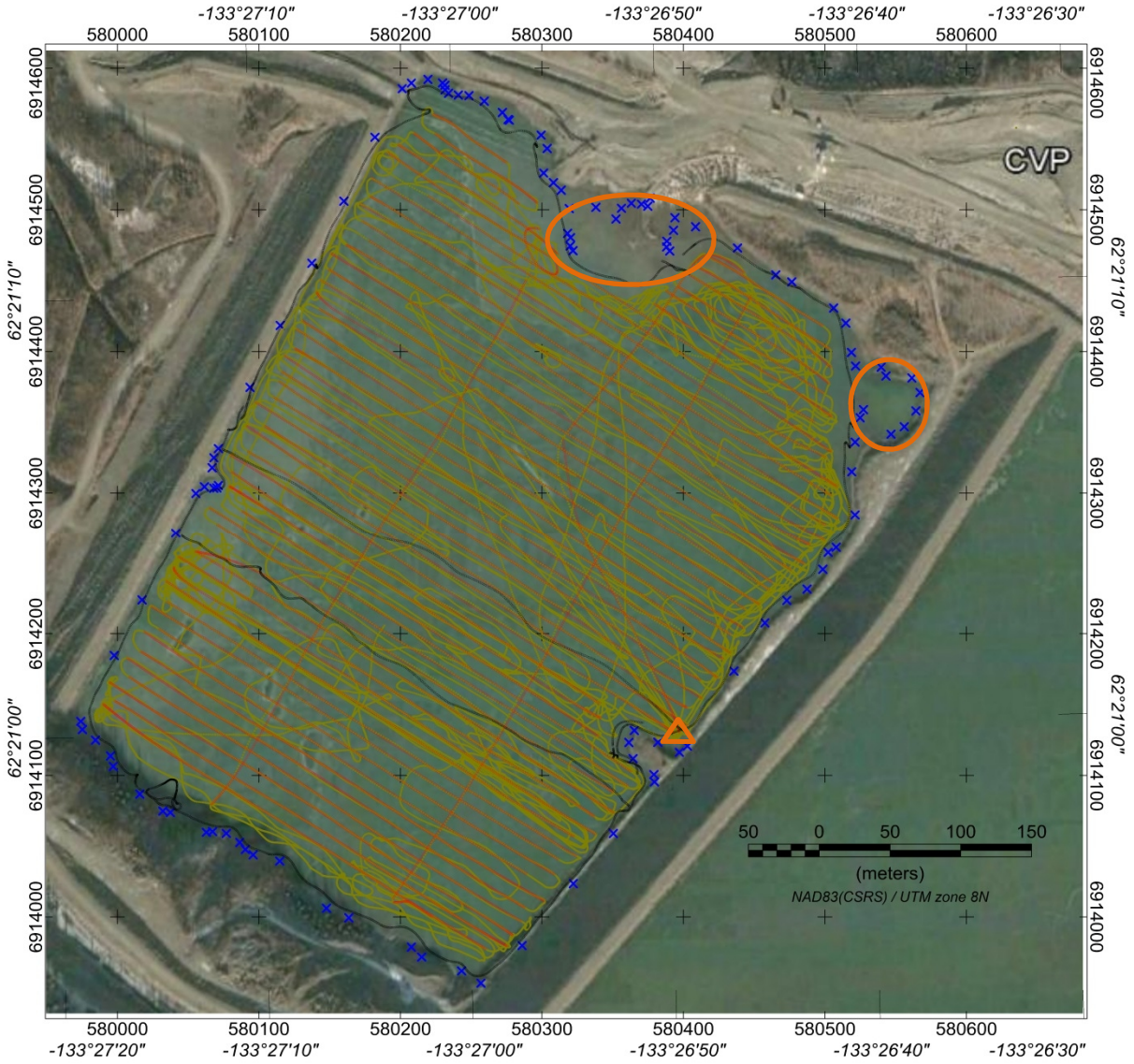


Figure 2: Surveys on CVD Pond. Yellow shows the path of the multi-beam bathymetry, red of the sub-bottom profiling, black of the 2015 single-beam bathymetry and the blue symbols are the shore GPS measurements. The location of the CVP monument used for a GPS base is shown in the north-east corner. Areas shown in orange are shallow water where no data were collected. Daily check-in location is shown by the orange triangle.

3.1 Bathymetric Survey

The multi-beam bathymetric survey provides an extremely high resolution depth database of the CVD Pond, with a data density of approximately 3.6 cm. Positional data were determined through an RTK GPS streaming data to the multi-beam system, with the GPS base station set up at the nearby CVP control point. The shoreline was also surveyed using RTK GPS, to both define the areal limit of the pond and to measure the water elevation. A single-beam sonar survey supplemented the multi-beam survey in shallow water, though with a much lower data density. There are two areas on the north side of the pond that were not surveyed using either method due to the very shallow water, as well as obstacles in

the water (rocks, metallic debris). In addition, two traverses of the pond were done using the single-beam survey, to compare with the multi-beam dataset.

The single-beam survey was a lower priority than the planned multi-beam and sub-bottom surveys of the Intermediate Dam Pond (not completed). However, due to the daily tear down time of the multi-beam equipment, the crew was able to collect some single-beam data on the CVD Pond in 2015 without any impact on production of multi-beam or sub-bottom data collection despite this not conforming to the stated priority.

Multi-beam data collection was completed and single-beam data collection was partially completed at CVD Pond in 2015 and six traverses of the pond were done using the single-beam survey in 2016 to compare with the multi-beam dataset. No bathymetric data were collected at the Intermediate Dam Pond due to the onset of cold weather and ice formation in 2015.

3.1.1 Equipment

The crew was equipped with the following instruments and equipment:

Equipment:	1	VS101 Hemisphere GPS box s/n: AA1129-14928-00016
	2	A21 Hemisphere GPS sensors s/n: 7179, 7169
	1	Digibar S water velocity sensor s/n: 4714
	1	MB1 multi-beam sonar head s/n: 206
	1	RTAII real time appliance s/n: 220083
	1	Digibar V water velocity sensor (sonar head) s/n: 5683
	1	IMU S-108 Subsea Motion Sensor s/n: 4078
		Miscellaneous multi-beam cables, brackets and equipment
	1	Trimble GeoExplorer XT2008
	1	Garmin GPSmap 527
	1	Airmar SS510 smart transducer
		Miscellaneous single-beam cables, brackets and equipment
	1	Leica GS15 sensor rover s/n 1502720
	1	Leica GS14 sensor base s/n 2806121
	1	Leica CS15 controller s/n 2907005
	1	Pac Crest ADL Vantage Pro Radio s/n 13086191
	1	Pac Crest Radio s/n 1301949
		Miscellaneous GPS cables, tripods and equipment
Communications:	4	VHF handheld radios
	1	DeLorme InReach
Vehicles & Vessels:	1	Flat deck truck
	1	Truck Trailer
	1	Arctic Cat ATV
	1	16ft aluminium boat
	1	Inflatable Zodiac rescue boat
	1	6 HP outboard motor
	1	2 HP electric motor
Safety:	4	Government certified personal floatation devices (PFDs)
	2	ATV helmets
	4	Hard hats

	100	Nitrate gloves
	9	Tyvek suits
	8	Safety glasses
	4	High Visibility Vests
	2	Fire extinguisher
	2	Level 2 First aid kit
	4	Spare paddles
	2	15m floating rope
	2	Bailers
Computers & Software:	1	Laptop with Edgetech Discover Sub-Bottom 4.0
	1	Laptop with HyPack 2015, SonarWiz 6
	1	Laptop with Image, SMC IMU Config, Digibar Pro 3.0
Other	20	6 mil plastic garbage bags
	1	Pressure washer
	1	Water tank
	1	Office box
	1	Geophysical Toolbox

3.1.2 Survey Specifications & Field Procedures

All manufacturer and model information for equipment referenced in this section can be found in Section 3.1.1.

3.1.2.1 RTK GPS

A GPS base station was established daily with the Leica GS14 antenna over the permanent control marker 2010-P5 at CVP. As this primary control monument was suitable for all areas of the CVD pond, a secondary control network was not established.

For the 2016 points, the published position for 2010-P5 was inadvertently not programmed into the GPS base prior to starting work in the field and an arbitrary position was therefore used the first day. For consistency the arbitrary base position was used throughout the 2016 survey and all RTK data were corrected by a post-survey datum shift to align the base with the published position.

As per the published *Survey Standards for Faro Mine Closure* included with CH2M Hill Agreement 10201-7-100723, the coordinates for the antenna established at 2010-P5 are 6914557.921 N, 580635.174 E (NAD83 CSRS Epoch 2002, UTM Zone 8 coordinates with a CSF of 0.999505) with an orthometric height above the HT2 Geoid Model of 1060.480 m. This base location was broadcast continuously via radio to the Leica GS15 rover so that a phase-corrected RTK solution was being transferred to the multi-beam equipment via NMEA string at all times during multi-beam sonar collection.

Point RTK positions with the Leica GS15 antenna were taken along the shoreline to constrain the gridding of the water depths in the shallows and to provide a measure of the water-surface elevation. Where the shoreline is straight, station spacing is nominally 50 m, with decreasing station spacing as required to capture smaller scale shoreline features; these points are shown as blue crosses in Figure 2.

In 2016, point RTK positions were also recorded as rough extensions of all single-beam lines, extending roughly 15 m back from the shoreline.

Also in 2016, RTK positions were taken during single-beam collection and matched to the single-beam data by time-stamp.

3.1.2.2 Multi-Beam Sonar

An Odom Teledyne MB1 multi-beam echo-sounder was used for the collection of primary bathymetric data from all areas of the CVD Pond, in areas with water depths greater than approximately 1 m. The sonar head was equipped with a sensor that monitored changes in water velocity from fluctuations in water temperature and purity. A motion sensor was also used to monitor the heave, pitch and roll of the boat. The later was calibrated each morning to account for slight variations in crew weight as well as position. A Hemisphere marine GPS unit with two widely spaced antennae, positioned perpendicular to the sonar head (parallel to the axis of the vessel), provided precision bearings at all times. The Leica GS15 rover with a radio link to a base antenna was attached 1.09 metres directly above the sonar head to provide high accuracy positional data. The part of the system above water is shown in Figure 3.



Figure 3: Universal mounting pole with three GPS antennae and subsea motion sensor visible.

Each day the MB1 sonar head, RTK sensor and all secondary control instruments were bolted to the same place on a universal mounting pole, ensuring constant registration relative to the boat across multiple days of surveying. Data from all instruments were fed to an Odem Real Time Appliance for time registration and for interfacing with laptop computers.

A pair of onboard computers was used to control and monitor the instruments, while simultaneously recording data. One laptop, equipped with Odom Image, monitored the sonar head and water velocity sensor. The second laptop, equipped with Hypack 2015, recorded all data and plotted results allowing for real time feedback on quality and coverage.

The crew conducted a series of control tests at the beginning and end of each day. A control station was established at 580395, 6914126 (NAD83 UTM Zone 8N coordinates) by the suspension of a survey flag over the pond shown by the orange triangle in Figure 2; GPS and multi-beam sonar data were recorded for a minimum of 30 seconds during check-ins at this control station. Patch test data were recorded during normal data collection each day to correct potential errors arising from mounting variations as well as pitch, roll and yaw motion. Patch test corrections generated by the Hypack software were negligible and were not applied to the final data set. Water velocity data were collected by a second water velocity sensor independent of the sonar head that was lowered to the pond floor, producing a water velocity profile for the full depth of the pond with data points collection every 10 cm. 12 casts were attempted in various locations to assess any spatial variability of the acoustic velocity.

The MB1 sonar head operated at 170-220 kHz and is capable of recording a 120˚ swath which, over flat terrain, is approximately 4 x the water column depth. As a quality control measure to account for variations in the pond floor and potential noise near the edge of the swath, the crew aimed for an initial 33% overlap in data, with occasional insufficient overlap to be cleaned up at the end of the survey. These were identified in preliminary processing and all were successfully in-filled on the final day of surveying resulting in a complete contiguous dataset. Data was collected across the full 120˚ swath with a total of 512 beams and preserved in the raw files. In practice, the useful data swath was approximately 80˚ and the pond was, in general, much shallower than expected, resulting in many extra passes to ensure complete data coverage. As another quality control measure, the Hypack software was configured so as to not log any data if a phase-corrected RTK signal was not present. Occasional drops in RTK signal quality due to temporary loss of radio-link therefore created data gaps obvious to the operator during data collection and were immediately rectified by a repeat pass over the affected area for complete coverage.

Line spacing for the multi-beam survey was variable, although initial passes follow the same bearing (122˚) as the intended sub-bottom lines. Target boat speed was approximately 3 knots, though care was taken in shallower areas to protect the sensitive equipment.

3.1.2.3 Single-Beam Sonar

The single-beam bathymetry survey was conducted to fill in data voids in shallow water where use of the multi-beam transducer was not practical. Fill-ins were done along the entire perimeter of the Cross Valley Dam Pond and attempts were made to fill in shallow areas at the north and north-east edges of the pond. These shallow areas proved to be unnavigable even for the inflatable zodiac, which was used instead of the 14-ft vessel for the 2015 single-beam survey.

In 2015, only two EW reference lines were surveyed to create a secondary control database against which to measure the multi-beam bathymetry data, the other planned reference lines were not completed due to the onset of winter and ice on the pond. For consistency, all six of the planned lines were surveyed in 2016 and the 2015 lines were not used in the analysis. Four of these lines spanned the width of the pond at a bearing of approximately 122˚ and set 100 m apart. The two other lines spanned the length of the pond at a bearing of 30˚ and were spaced 150 m apart.

Data were collected at a 1 second interval with data from the Airmar SS510 transducer. The transducer operates at a frequency of 200 kHz with a beam width of 9˚. Target boat speed was 2 knots in open water but speeds in potentially shallow areas were lower.

In 2015, data from the Trimble Geoexplorer GPS antenna and the Airmar transducer were streamed to the Trimble GeoXT controller for storage. The vertical offset between the GPS antenna and the transducer was 1.1 m. There was no horizontal offset.

In 2016, data from the Airmar transducer were streamed to the Trimble GeoXT controller for storage and were georeferenced using data from the RTK-GPS Leica GS15 rover. A 17 second offset was applied to the single-beam sonar data prior to time-stamp matching to account for the different time convention (GPS versus UTC time) used by each instrument. The vertical offset between the GPS antenna and the transducer was 1.44 m. There was no horizontal offset.

3.1.2.4 Lead-Line Measurements

In 2016, lead-line measurements were taken to create a tertiary database against which to measure the other bathymetric data, however because of an impending shortage of safety personnel at the Faro Mine area, the lead-line survey was cut short and only six points were measured on the CVD Pond.

A best effort was made to make the measurement when the lead-line was plumb but the survey vessel was not anchored during the measurements and there was significant drift from high winds at the time of the lead-line survey so some bias towards longer measurements because of the angled line is expected. Additionally, the operators often observed significant muck on the lead-line after retrieval so the weight may have been penetrating some centimeters beyond the mudline as measured by the sonar data.

3.1.3 Data Processing

3.1.3.1 RTK-GPS

For the 2016 portion of the survey, the use of an arbitrary initial reference point required that a datum shift be applied to all raw data to reposition the base station to the published position of 2010-P5. All points were shifted -2.005 m N, 1.733 m E and elevation was shifted -6.501 m.

Data were logged to the Leica receiver, exported to csv files and then edited to correct labelling or entry errors; the raw daily base and rover files, as well as the exported rover files are included with the data package of this report. The 2015 positional quality is shown in Figure 4 and the 2015 height quality in Figure 5 as reported by the Leica Geo Office software package from the raw rover files (with no post-processing); both have a 95% confidence level well below 10 cm. The effective positional and height quality is better than the histograms portray because, as indicated in Section 3.1.2.2, the multi-beam unit was configured so as to not log any data if a phase-corrected RTK signal from the base was not present. On a handful of occasions the RTK radio link was down, but the operator noticed the data gap while surveying and immediately re-surveyed the missing section with RTK corrected positional and height data. These data nevertheless remain in the GPS database shown in Figure 4 and Figure 5.

The position and height data for Oct 21 were mistakenly not independently recorded on the GPS rover and are therefore not included in the histograms. However, as the operator did not see any data gaps during collection, these data are known to be of good quality.

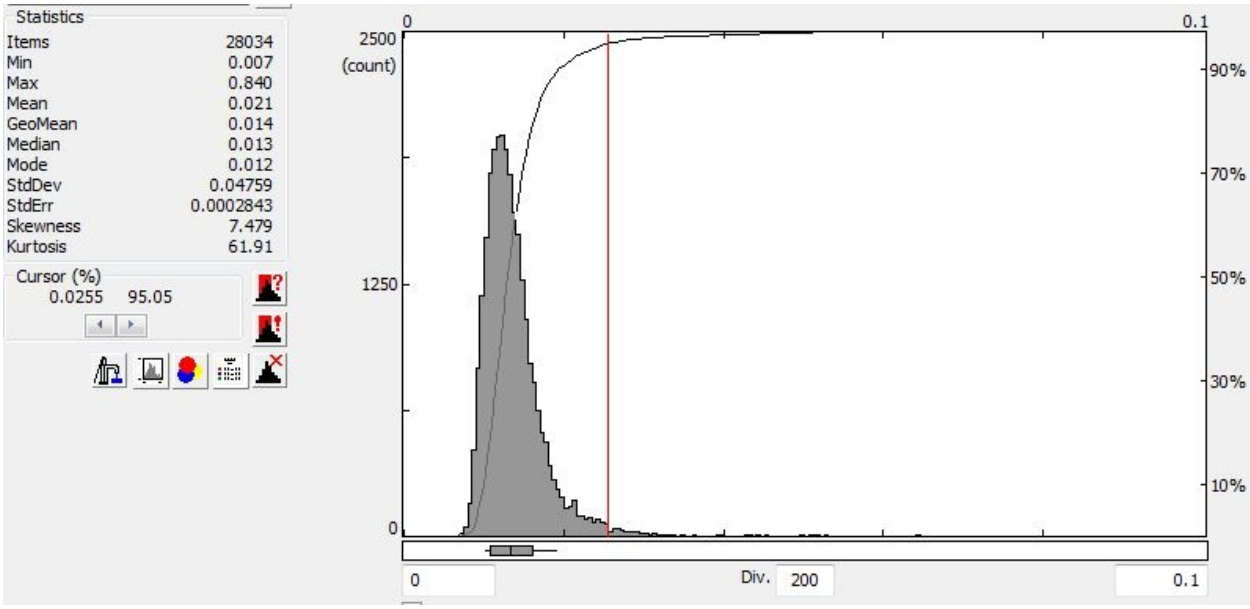


Figure 4: Position quality of GPS solutions during multi-beam bathymetry acquisition. The red line shows the 95% of the position quality is at 0.026 m.

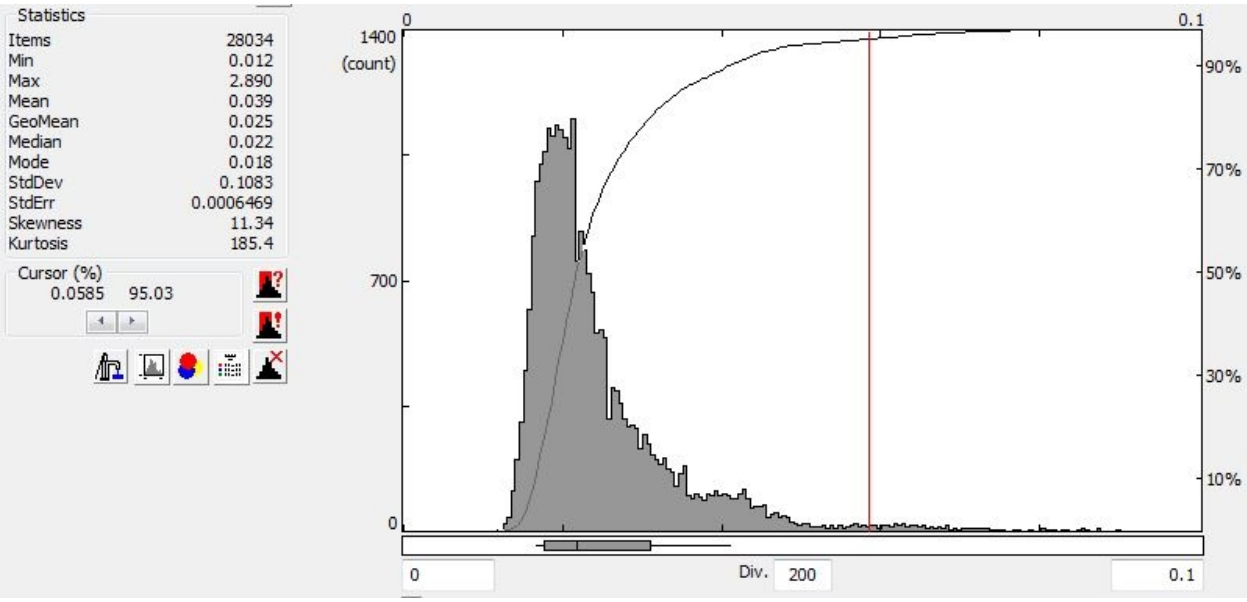


Figure 5: Height quality of GPS solutions during multi-beam bathymetry acquisition. The red line shows the 95% of the height quality is at 0.059 m.

3.1.3.2 Single-Beam Sonar

For the 2015 survey, base GPS data were exported to RINEX format and processed with Trimble Pathfinder software to obtain a differentially corrected position. The Trimble Geoexplorer GPS used with the single-beam sonar was not equipped with an RTK radio link to the base; the solutions are therefore not phase corrected and the accuracy is significantly less than those of the multi-beam sonar; an estimate of horizontal accuracy for the 4956 positons as reported by the Pathfinder software in shown in Table 1.

Table 1: Estimated accuracy of single-beam horizontal position.

Estimated accuracy range	Percentage of points
0 – 5 cm	0%
5 – 15 cm	0%
15 – 30 cm	66.87%
30 – 50 cm	33.05%
0.5 – 1 m	0.06 %
1 – 2 m	0.02 %

The base location used for the Pathfinder correction is taken from the average measured position of the GPS base and is reported in the processing log file. A datum shift of 0.432 m (north), 4.171 m (east) and -9.260 (elevation) was applied to correct the base station to the published location of point CVP 2010-P5. Acoustic water velocity was assumed to be 1500 m/s during acquisition and this is corrected to 1426 m/s, a measured average velocity for the pond (Section 3.1.3.3 and Figure 6).

For the 2016 data, RTK GPS data were exported and matched by timestamp to the single-beam data with a time-shift of 17 seconds to account for a GPS to UTC time datum adjustment.

In 2016, pond bottom elevations were calculated by subtracting depths derived from the single-beam from the elevation of the single-beam sonar head as measured by the RTK GPS. In 2015, pond bottom elevations were calculated by subtracting depths derived from the Hypack software from the average elevation of the shoreline as measured by the RTK GPS (1028.6792 m).

3.1.3.3 Multi-beam Sonar

Multi-beam sonar data were processed using Hypack's Hysweep 64-bit Editor. Beam angle limits of 40 degrees were imposed on both port and starboard sides for all data, with lower limits being applied where deemed necessary by visual inspection. An over/under filter and a Savitzky-Goalay filter were applied to highlight and remove potentially erroneous data. All data were then visually inspected in batches of 1000 swaths or less. Single spike anomalies and areas of high noise were removed. In general, the data collected at the widest angle from the sonar head were unreliable and discarded.

Secondary instrumentation data were also inspected and areas where high heave, pitch, roll or speed were recorded, were removed from the dataset. Water velocity data were inspected, showing little variation across time and location. Averaged values from 4 casts were used to create a water velocity profile from 0 m to 14 m, shown in Figure 6. Values from this profile are applied to all data and recorded depths were adjusted accordingly in the Hypack software.

Pond bottom elevations were calculated by subtracting depths derived from the Hypack software from the average elevation of the shoreline as measured by the RTK GPS (1028.6792 m).

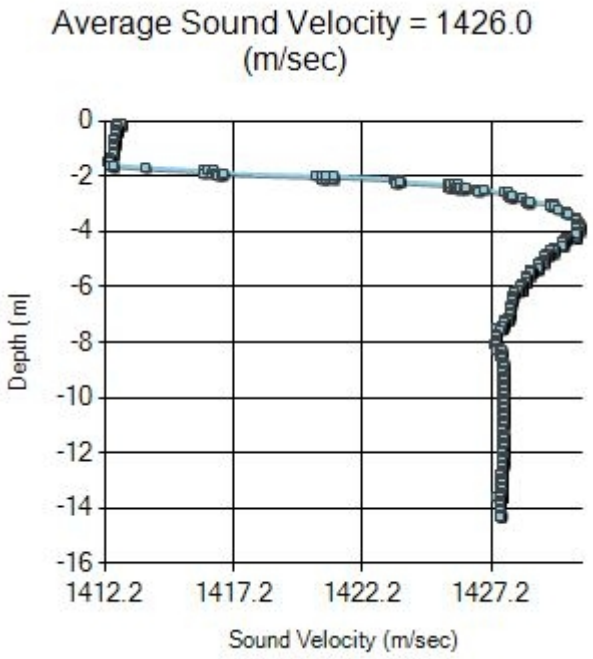


Figure 6: Average acoustic water velocity profile.

Multi-beam data collected on October 23rd and 24th were subject to time shift errors by malfunctions in the RTAII real-time appliance. These errors were not detectable from the Hypack software used for data collection and were only evident during post-processing. From discussions of this malfunction with the instrument supplier, the appropriate solution to correct the issue is to individually correct each time entry.

Time stamps assigned by the RTAII appear in the raw logging files as an incrementing value representing the number of seconds since midnight. Whenever the time shift error occurred, this time stamp value would suddenly decrease while other data continued to be logged correctly at regular intervals with correct times. Data from all sources would be logged in chronological order in the same file regardless of any time stamp error, making it possible to identify and calculate the value of any time shift. A script was written to create a new log file for each time shift error and adjust erroneous time stamps to match the nearest correct time stamp (usually every 0.050 - 0.100 seconds.) A total of 19 errors were corrected in data collected October 23rd, and 30 errors in data collected on October 24th.

RTK GPS points taken at 95 shoreline locations adjacent to the surveyed area were assigned a depth of 0 m and used to interpolate a full shoreline. Orthometric heights are recorded for these shoreline locations. This shoreline data was integrated with all multi-beam and single-beam bathymetry data to

create all grids and contour files associated with this pond. Gridded bathymetry data were created using a 0.5 m cell size and windowed to exclude points outside of the RTK GPS surveyed perimeter created by the gridding algorithm. No filters were applied to the final bathymetry grids. All 25 cm and 50 cm contours were made after 3 passes of a 3x3 Hanning filter on the bathymetry grid.

3.1.4 Products

Folder / File	Description
Raw data/Multi-beam/Raw/*.hsx	Raw multi-beam data in Hypack Raw format
Raw data/Single-beam /*.obs	Raw single-beam data in GeoXT format, with supporting files for both 2015 and 2016 CVD surveys.
Raw data/Multi-beam/Time Edit/*.hsx	Time error-corrected data in Hypack Raw format
Raw data/GPS/Base/*.m00 and Rover/*.m00	Base and rover GPS data from Oct 21-24 are associated with bathymetry and shoreline data in Leica m00 format. Data from June 17 are associated with single-beam bathymetry and on-shore extensions.
Processed data/GPS/CVD Pond shoreline/*.csv and *.txt	Corrected shoreline rover GPS data in ASCII formats.
Processed data/GPS/Daily Surveying/*.csv and *.txt	Corrected rover GPS data in ASCII formats. Data from Oct 21-24 are associated with multi-beam data.
Processed data/GPS/CVD shoreline extensions/*.xyz	Corrected rover GPS data in ASCII formats.
Processed data/GPS/Daily check-ins/*.csv and *.txt	Corrected rover GPS data in ASCII formats. Data from Oct 21-24 are associated with multi-beam data.
Processed data/GPS/channels.txt	Description of columns for ASCII GPS files.
Processed data/Lead-line/CVD lead lines.xyz	Lead-line data for CVD pond, collected in 2016.
Processed data/Lead-line/channels.txt	Description of columns for ASCII lead-line file.
Processed data/Multi-beam/bathymetry final.xyz	Master ASCII database of all final bathymetry data in depth of water.
Processed data/Single-beam/CVD single-beam secondary data.xyz	Master ASCII database of all secondary control single-beam data from common transect lines.
Processed data/Single-beam/channels.xyz	Description of cloumns for ASCII single-beam data.
Processed data/Multi-beam/feature channels.txt	Description of columns for ASCII final bathymetry and secondary control databases.

Processed data/Multi-beam/water velocity profile.vel	Master ASCII database of averaged water velocity profiles.
Processed data/Multi-beam/*checkins.xyz	ASCII database of all bathymetry check-in data.
Processed data/Multi-beam/0.5m elevation rasterized/ESRI/CVD_pondBottom_Elevation_0,5_esri.flt*	ESRI raster grid at 0.5 m cell size with supporting files.
Processed data/Multi-beam/0.5m elevation rasterized/ESRI/CVD_pondBottom_Elevation_0,5.grd	Geosoft raster grid at 0.5 m cell size with supporting files.
Processed data/Multi-beam/500 25cm contours.dxf	1:500 scale 25cm contours of depth, with a 3 pass 3x3 Hanning filter in AutoCAD version12 DXF format
Processed data/Multi-beam/1250 50cm contours.dxf	1:1250 scale 50cm contours of depth, with a 3 pass 3x3 Hanning filter in AutoCAD version12 DXF format
Figures/Bathymetry 500.pdf	1:500 scale map with gridded bathymetry (depth) data and 25cm contours in PDF format
Figures/Bathymetry 1250.pdf	1:1250 scale map with gridded bathymetry (depth) data and 50cm contours in PDF format

3.2 Sub-Bottom Survey

Acoustic sub-bottom data collection was completed at CVD Pond, but no sub-bottom data were collected at the Intermediate Dam Pond in 2015 due to the cold temperatures and ice formation. This was completed in 2016 and is described in a separate report. The data were collected at lines with 10 m spacing. The coverage is slightly less complete than the bathymetric data set due to survey restrictions in shallow water from the sub bottom instrument as illustrated in Figure 2.

3.2.1 Equipment

The crew was equipped with the following instruments and equipment:

Equipment:	1	EdgeTech SB-424 towfish s/n: 38803
	1	Edgetech 3100P sub-bottom topside unit s/n: 38688
	1	Leica GS15 sensor rover s/n 1502720
	1	Leica GS14 sensor base s/n 2806121
	1	Leica CS15 controller s/n 2907005
	1	Pac Crest ADL Vantage Pro Radio s/n 13086191
	1	Pac Crest Radio s/n 1301949
		Miscellaneous GPS cables, tripods and equipment
Communications:	4	VHF handheld radios
	1	DeLorme InReach
Vehicles:	1	Flat deck truck
	1	Truck Trailer
	1	Arctic Cat ATV

	1	16ft aluminium boat
	1	Inflatable Zodiac rescue boat
	1	6 HP outboard motor
	1	2 HP electric motor
Safety:	4	Government certified personal floatation devices (PFDs)
	2	ATV helmets
	4	Hard hats
	100	Nitrate gloves
	9	Tyvek suits
	8	Safety glasses
	4	High Visibility Vests
	2	Fire extinguisher
	2	Level 2 First aid kit
	4	Spare paddles
	2	15m floating rope
	2	Bailers
Computers & Software:	1	Laptop with Edgetech Discover Sub-Bottom 4.0
Other:	20	6 mil plastic garbage bags
	1	Pressure washer
	1	Water tank
	1	Office box
	1	Geophysical Toolbox

3.2.2 Survey Specifications & Field Procedures

3.2.2.1 RTK GPS

A GPS base station was established daily over the permanent control marker 2010-P5 at CVD. As this primary control monument was suitable for all areas of the CVD pond, a secondary control network was not established.

As per the published *Survey Standards for Faro Mine Closure* included with CH2M Hill Agreement 10201-7-100723, the coordinates for the antenna established at 2010-P5 are 6914557.921 N, 580635.174 E (NAD83 CSRS Epoch 2002, UTM Zone 8 coordinates with a CSF of 0.999505) with an orthometric height above the HT2 Geoid Model of 1060.480 m. This base location was broadcast continuously via radio to the rover so that a phase-corrected RTK solution was being transferred to the sub-bottom equipment via NMEA string at all times during data collection.

3.2.2.2 Sub-bottom Profiling

Sub-bottom profiling was performed along 54 lines running 122˚ west to east across the pond, and along 3 perpendicular tie-lines for cross reference. Survey line spacing was 10 m with tie-lines being profiled at uneven spacing, in an attempt to profile different features that appeared during the initial passes.

Target boat speed was approximately 3 knots and attempts were made to maintain constant speeds in an effort to avoid distorting produced images.

The Edgetech SB-424 towfish, 3100P topside unit and Discover software were used to collect all sub-bottom data. The SB-424 is capable of outputting a variety of FM chirps, each of which was tested before surveying began. Of the chirps tested, it was decided that the highest range of frequencies available (4-24kHz) provided the best resolution; whereas limiting the signal to lower frequencies seemed to offer no significant advantage with regard to depth of penetration.

3.2.3 Data Processing

3.2.3.1 RTK

Data were logged to the Leica receiver and exported to csv files; both raw daily base and rover files, in addition to the exported rover files, are included with the data package of this report. The positional quality is shown in Figure 7 and the height quality in Figure 8 as reported by the Leica Geo Office software package from the raw rover files (with no post-processing); both have a 95% confidence level well below 10 cm.

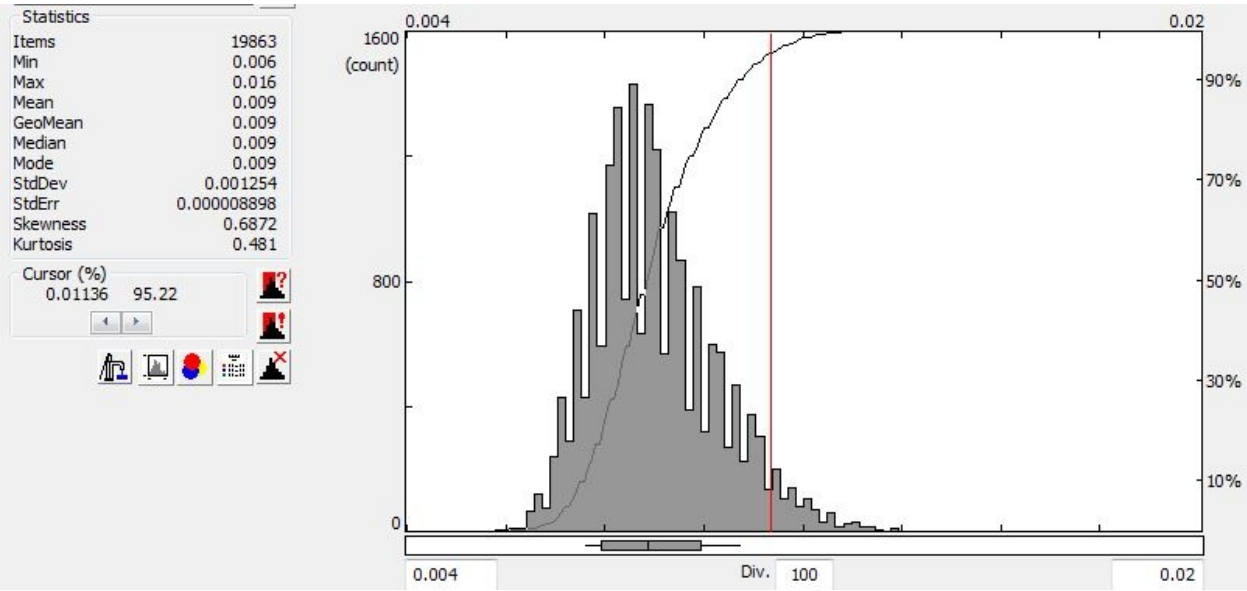


Figure 7: Position quality of GPS solutions during sub-bottom profiling acquisition. The red line shows the 95% of the position quality is at 0.011 m.

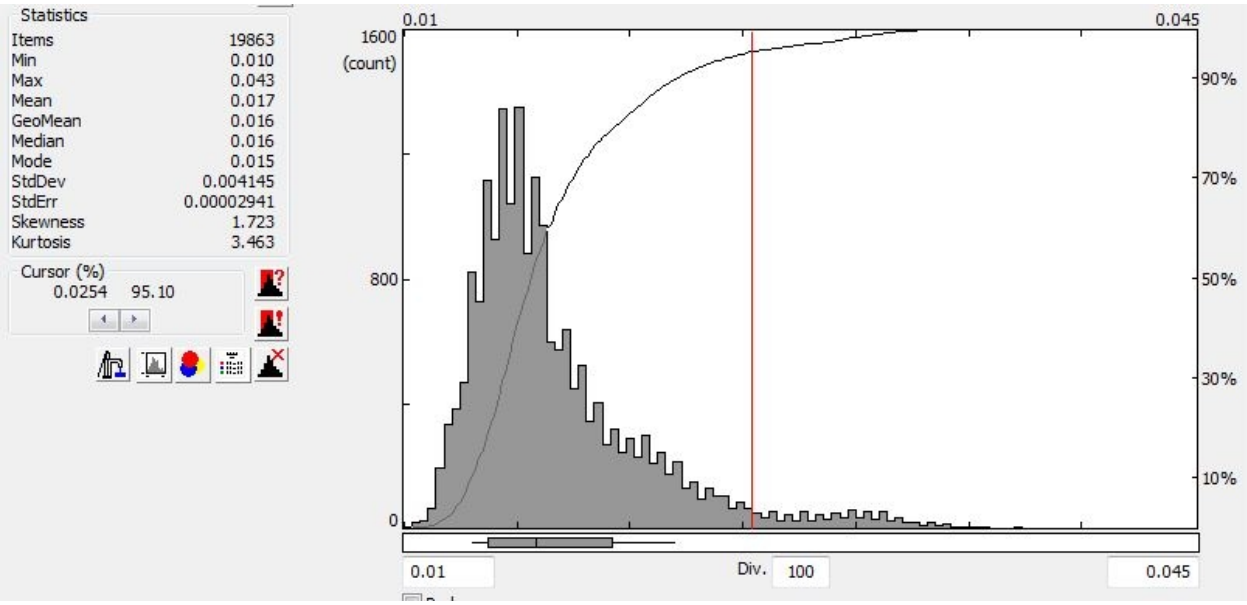


Figure 8: Height quality of GPS solutions during sub-bottom profiling acquisition. The red line shows the 95% of the height quality is at 0.025 m.

3.2.3.2 Sub-Bottom

Initial processing of sub-bottom profiles was performed with SonarWiz 6. User gain controls were adjusted to increase the visibility of responses at depth and have a minimal impact on near surface responses. Once set, this gain was applied universally across all lines allowing for objective comparisons between them. Auto-detection of the pond bottom was used but was insufficiently accurate. All features, including the pond bottom, were drawn in after visual inspection. Features were first drawn on the 3 perpendicular tie-lines. The depths of these features were then plotted to all sonargrams and used only as visual cues to calibrate the drawing of all subsequent features. Tie-line feature depths were not included in the final dataset. .

Definitions of Features

Feature A – this is the mudline, first signal to return indicating the bottom of the water column.

Feature B – There are two main divisions for Feature B. The first is a package of layered sediment, with each individual layer typically 25 cm thick. On the north side of the pond, the thickest package of layered sediment outlines a well-defined pit. The layers are not always well defined – sometimes because the layer is too thin and only a single non-reflective layer is being imaged, but also sometimes because the response grades from well-defined layers to a more homogeneous mass sitting on top of Feature C (see below). It's possible that a single thin layer of high reflectance material similar to Feature C is not detectable, and therefore is included in the thickness of Feature C.

Line 44 shows many of these features from the north end of the pond, while Line 4 shows similar features from the south end of the pond. There is another pit-like feature imaged in Line 4, but it is not visible on the two adjacent lines.

The second division included in Feature B is more irregular layers sitting on top of Feature C. These are more common in the middle of the pond and are typified by the response on Line 35.

There are only a few cases where multiple instances of Feature B are stacked. An example of this on the west end of Line 3.

Feature C – This is a high reflectance layer that underlays large areas of the pond. There is a rough correlation between high thickness of Feature C and shallower water. The difference between Feature C and Feature D is subtle.

Feature D – This is very similar to Feature C, but has a mottled texture with very small irregular areas of lower reflectance. Lineaments of high thickness of Feature D tend to follow bathymetric relief; on steeper slopes, Feature C tends to be absent resulting in a greater thickness of Feature D. This supports the interpretation that Feature C represents fines which slough off on the steeper slopes. Examples of this are the scarps in the southeast corner of the pond, in the middle of the pond (Lines 21-28) and all along the western edge of the pond.

There are also greater thicknesses of Feature D in between the two spits protruding into the ponds on lines 18, 19 and 20.

Feature E – This feature outlines all areas where the high reflectance of features C and D is no longer present but enough reflectance to outline some texture remains.

Feature F – This feature represents areas where no textured reflectance is discernable but some traces of the signal are still being reflected. When present above other features, it clearly outlines a lack of a returning signal. When present below all other features, it is an arbitrarily chosen limit specific to the gain settings used during data processing, where the plotted response still appears more gray than blank. Because the gain settings were kept constant on all sonograms, the relative thickness of this layer at depth could be representative of the rate of signal attenuation.

Feature G – This feature represents all areas that show weaker responses than feature F. With the gain settings used during data processing, this feature appeared more white or blank than gray. The lower limit of this feature is always the first multiple from the mudline (Feature A) which is generally quite strong and masks any deeper responses.

Export and Processing of Features

The features described above were identified on a line-by-line basis and images of each EW line with the interpreted features are included with this report. Features were validated through cross-referencing with the NS lines but no feature lines were drawn on the NS lines. The data on the EW lines were exported to an ASCII master database and AutoCAD v12 DXFs with all the interpreted features that were produced for each line. As no core or velocity data were available at the time of processing, the velocities of all layers are assumed to be 1500 m/s upon export and all data downstream of the export are in metres. The data should be transformed back to the time domain and all depths and thicknesses re-calculated once further data become available.

To calculate the thickness of each feature the distance to the feature defined above it is extracted from the master database. Feature A is the first arrival of the pulse and represents the mudline; this feature is present in all sub-bottom data. Several of the features are interleaved and to obtain a total thickness, the sub-features (e.g. B1 and B2) are summed. The summed feature thicknesses are exported to ASCII and are gridded with a minimum curvature algorithm and a cell size of 2.0 m, which is an appropriate cell-size for 10 m line-spacing. Grids are provided in both Geosoft and ESRI formats. Contours for each feature are made at 10 cm intervals and are exported in AutoCAD v12 DXF format.

Cross-Sections

Cross-sections were produced at 50 m intervals for the pond in both the east-west and north-south directions. A database was developed for each cross-section with 1m resolution and the final bathymetric database is sampled to obtain the pond bottom along the cross-section.

The down-line sub-bottom data interval is 0.25 – 0.30 m and the line spacing is approximately 10m. Many of the features are sparsely distributed over the pond and therefore a Triangular Irregular Network (TIN) method is used with linear interpolation between TIN points to sample each sub-feature along the cross-sections. This ensures no gridding artifacts from sparse data, typical of other gridding algorithms, are sampled into the cross-sections. Nevertheless, line-to-line features that run obliquely to the line direction and that are small relative to the lines spacing of 10 m, have artifacts in between the lines. This is particularly apparent on the cross-section at 6914100 N.

The bathymetric dataset is superior to that defined by Feature A in the sub-bottom data and the depth of each sub-feature relative to Feature A is more robust than the absolute depth. Therefore the depth of each sub-feature is calculated below Feature A and then this depth is subtracted from the bottom, determined by the bathymetric survey (so as to use the higher quality dataset). This method does transfer some small scale roughness imaged in the bathymetry survey to the lower resolution sub-bottom layers. An example is shown in Figure 9, where the circles area illustrates the roughness introduced into the cross-section. Although the left-hand panel (L27.jpg) is oblique to the right-hand panel (6414350.pdf), the excerpts circled in blue are approximately coincident.

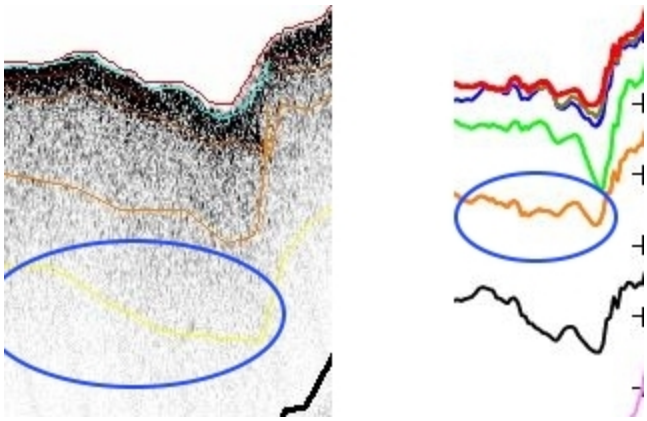


Figure 9: Example of introduced roughness to the sub-bottom dataset. The left-hand panel is an interpreted section (L27.jpg), the right-hand panel is a cross-section (6914350.pdf) with introduced small scale roughness.

3.2.4 Sub-bottom Products

The following files and figures are appended to this report:

Folder / File	Description
Raw data/Sub-Bottom/*.jsf	Sub-bottom data by line in EdgeTech jsf format (see Appendix III.
Raw data/Sub-Bottom/on-water control CVP/*.jsf	Sub-bottom raw data at the on-water control point.
Raw data/Sub-Bottom/faro freq tests/*.jsf	Sub-bottom on-site tests with different waveforms.
Raw data/GPS/Base/*.m00 and Rover/*.m00	Base and rover GPS data from Oct 25 are associated with sub-bottom data in Leica m00 format.
Processed data/GPS/Daily Surveying/*.csv and *.txt	Corrected rover GPS data in ASCII formats. Data from Oct 25 are associated with sub-bottom data.
Processed data/GPS/Daily check-ins/*.csv and *.txt	Corrected rover GPS data in ASCII formats. Data from Oct 25 are associated with sub-bottom data.
Processed data/GPS/channels.txt	Description of columns for ASCII GPS files.
Processed data/Sub-bottom/Interpreted sub-bottom - depth.xyz	Master ASCII database of all interpreted sub-bottom features in depth from mudline.
Processed data/Sub-bottom/Interpreted sub-bottom - elevation.xyz	Master ASCII database of all interpreted sub-bottom features in elevations.
Processed data/Sub-bottom/ channels.txt	Description of columns for ASCII master sub-bottom database.
Processed data/Sub-bottom/Feature thickness/ASCII XYZ/Feature_*.xyz	Calculated thickness of each sub-bottom feature.
Processed data/Sub-bottom/Feature thickness/ASCII XYZ/channels.txt	Description of columns for ASCII feature thickness.
Processed data/Sub-bottom/Feature thickness/DXF contours/Feature*.dxf	Contour of feature thickness (interval of 0.1 m) in AutoCAD version12 DXF format.
Processed data/Sub-bottom/Feature thickness/ESRI grids	Raster grid at 2 m cell size of feature thickness.
Processed data/Sub-bottom/Feature thickness/Geosoft grids	Raster grid at 2 m cell size of feature thickness.
Processed data/Sub-bottom/Images	Images of processed data for every line with interpreted layers in jpg format.
Processed data/Sub-bottom/Line-by-line DXFs	Interpreted layers in AutoCAD version12 DXF format.
Figures/Cross-sections/DXFs	EW and NS cross-sections with bathymetry and interpreted sub-bottom layers in AutoCAD version12 DXF format.
Figures/Cross-sections/PDFs	EW and NS cross-sections with bathymetry and interpreted sub-bottom layers in PDF format.

3.3 Quality Control Checks

3.3.1 Common Transects

Six transects were completed across the pond in 2016 with the single-beam transducer to create a dataset suitable for comparison with the multi-beam data. These six lines represent 1504 single-beam readings which, on average, are 0.2 m shallower than the multi-beam data for the same location and have a maximum difference of 2.24 m (Figure 10). The transect paths are shown in Figure 11 while the transect data are shown in Figure 12 and Figure 13.

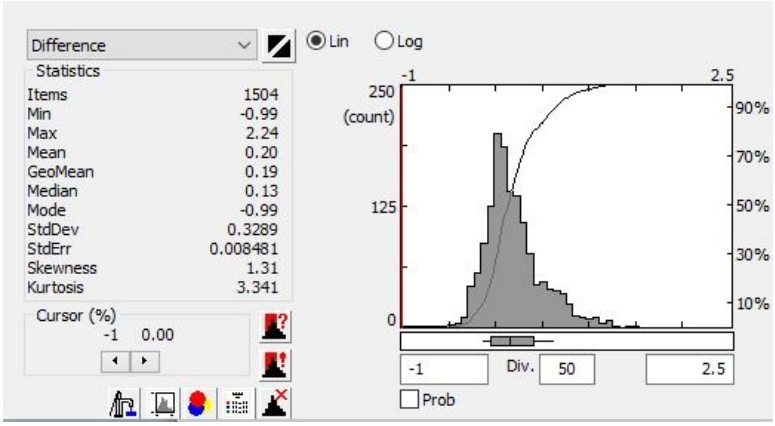


Figure 10: Histogram of difference between single-beam and multi-beam surveys.

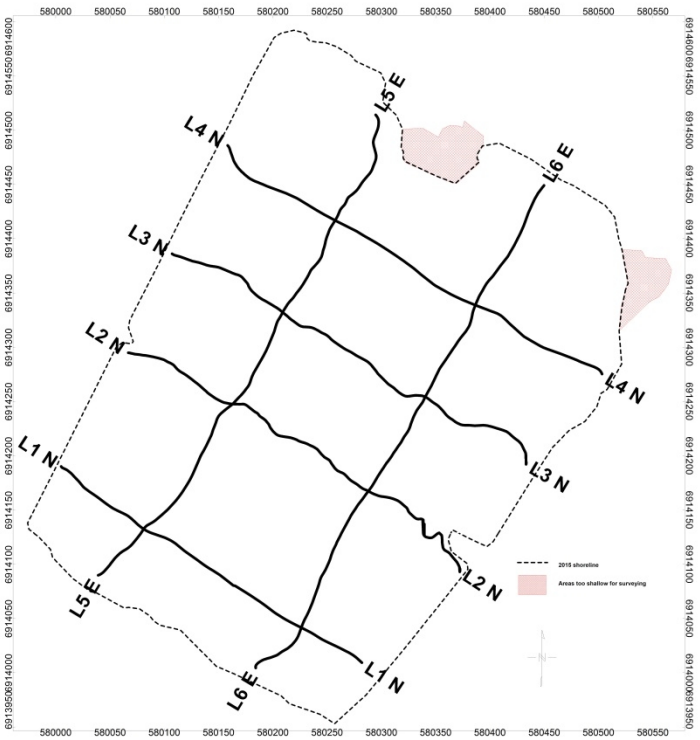


Figure 11: Single-beam common transects surveyed in 2016 and shoreline from 2015.

The purpose of the single-beam data collection is to provide an independent check (in addition to the lead-line dataset) on the multi-beam data. The distribution of the differences shows a bias towards deeper measurements for the multi-beam but also has positive skewness, indicating a larger range on the positive end (Figure 10). Examination of transects shown in Figure 12 show that many of these positive outliers, circled in blue, are not random; they often occur where the pond bottom has a steep gradient.

One possible explanation for this systematic difference is that in an area of steep bottom topography, the footprint of the sonar will cover a wide range of depths. The multi-beam system is calibrated with a pair of GPS antenna for heading determination and pitch, roll and heave detectors. Although the beam width is larger than the single beam (120˚ versus 9˚), the multi-beam operates with 512 beams over the 120˚ instead of a single beam over 9˚. The wider footprint per beam and the lack of heading and motion detectors on the single-beam instrumentation means there is greater ambiguity in imaging a dipping subsurface. The observed discrepancy between the datasets would be consistent with the single-beam taking the earliest reflection as bottom.

The area at the junction of transects 4 and 6 shows higher variability in the single-beam data than the multi-beam data. The fact that this high variability is observed in two perpendicular transects argues against an instrument malfunction cause; the reason for the effect is unknown.

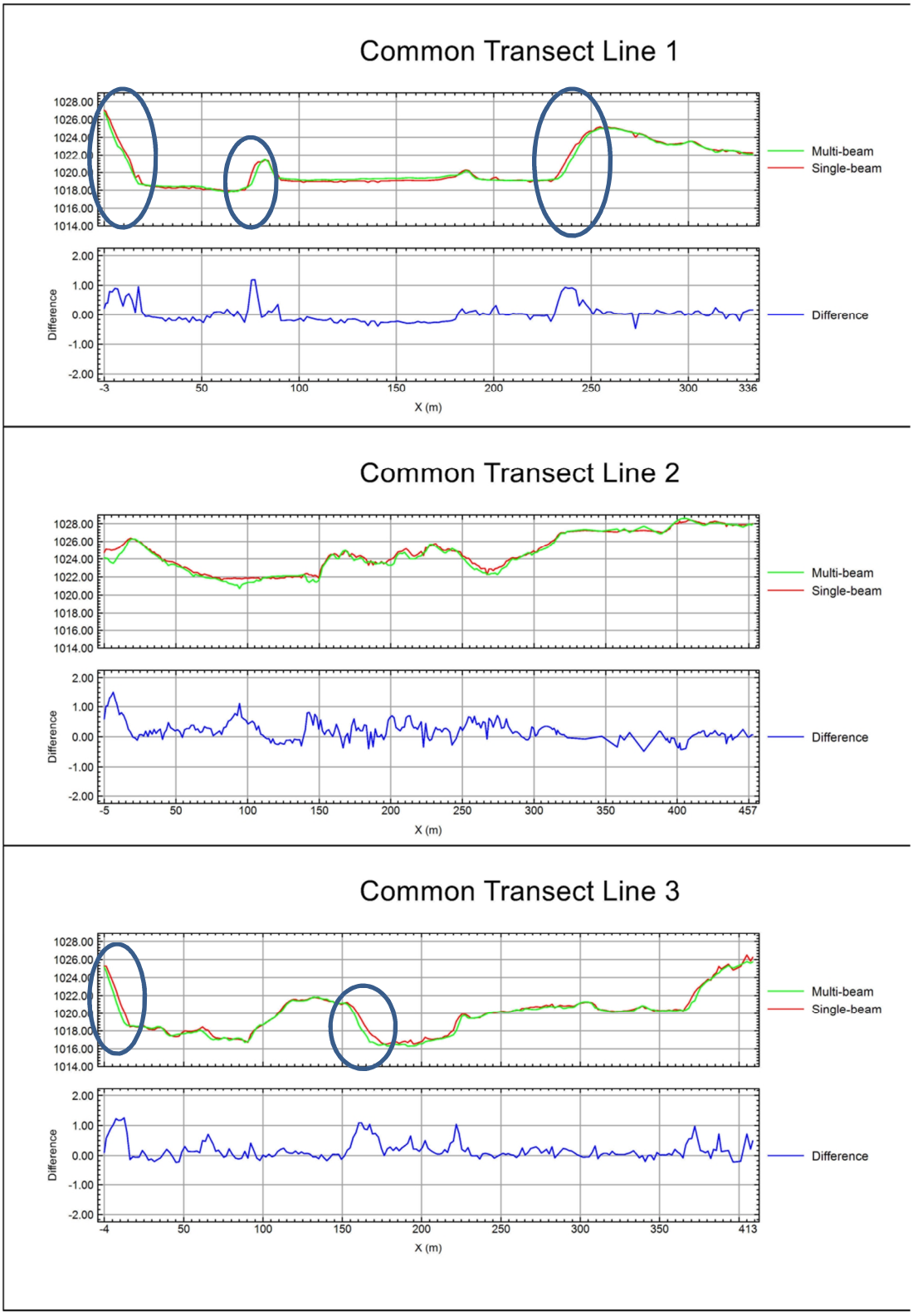


Figure 12: Common single-beam and multi-beam transects 1, 2 and 3, showing pond bottom elevation (top panel) and single-beam / multi-beam difference (bottom panel). Blue ellipses show areas of steep bottom gradient and where a systematic difference between single-beam and multi-beam depth is observed.

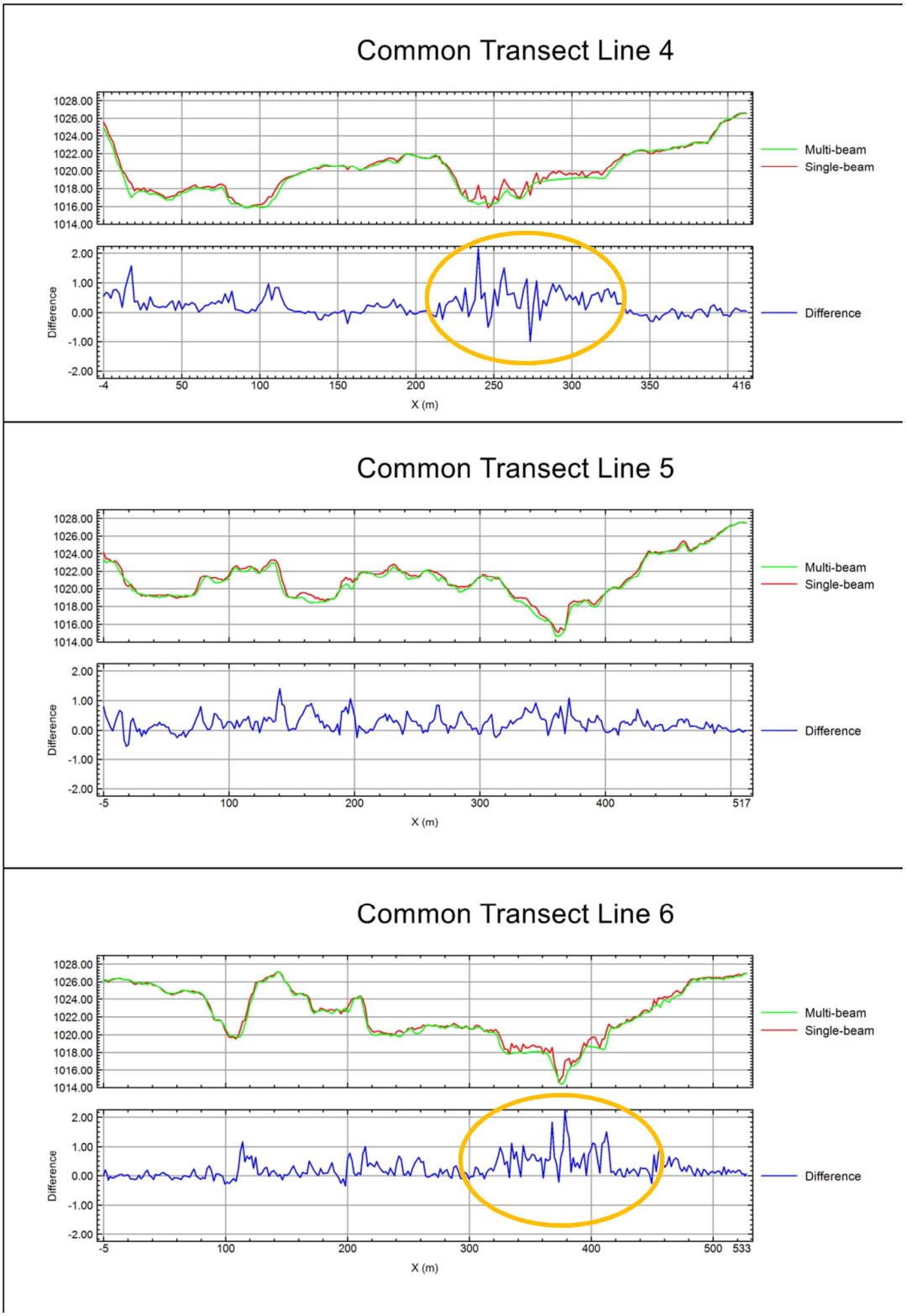


Figure 13: Common single-beam and multi-beam transects 4, 5 and 6, showing pond bottom elevation (top panel) and single-beam / multi-beam difference (bottom panel). The orange ellipses show an area of single-beam roughness, near the junction of transects 4 and 6.

3.3.2 Lead-line comparisons

Six lead-line measurements were made at CVD pond in 2016 and are detailed in Table 2 – the full planned lead-line dataset was not collected because the site safety officer could no longer remain on site and a premature demobilization of the Aurora crew was required. The lead-line points were not sufficiently close to the single-beam lines to allow a direct comparison.

Table 2: Lead-line measurements at CVD Pond. UTM coordinates are in NAD83 (CSRS) datum and elevations are metres above the HT2 geoid.

Point	UTM Easting (m)	UTM Northing (m)	Water Depth (m)	Lead-line derived bottom elevation (m)	Sonar derived bottom elevation (m)	Difference (m)
CVD 1	580316.7	6914146	7.4	1022.6632	1022.7132	-0.05
CVD 2	580346.1	6914133	2.7	1027.3632	1028.1116	-0.75
CVD 3	580128.9	6914267	8.2	1021.8632	1022.1312	-0.27
CVD 4	580167	6914246	8.4	1021.6632	1021.907	-0.24
CVD 5	580245.5	6914213	7.4	1022.6632	1022.8937	-0.23
CVD 6	580279.8	6914180	6	1024.0632	1023.9936	0.07

It should be noted that the greatest discrepancy at CVD 2 is in shallow water. Because the water elevation when the lead-line measurements were collected in 2016 is much higher than when the sonar data were collected in 2015, the water would have been too shallow for the multi-beam equipment and the sonar derived depth at CVD 2 is either an interpolation between shore line and single-beam point or single-beam point and multi-beam point and is therefore subject to much greater error than the other points.

Ignoring CVD 2, the mean difference is nevertheless biased negative (-0.14 m) which indicates the lead-line measurements are in general deeper than the multi-beam measurements. This bias is in part due to the methodology as the boat was not anchored while taking the measurements and was drifting significantly in the wind. Efforts to take the best data possible were made, but the lead-lines were to not vertical at the time of measurement which would explain the deep bias. Also adding to the deep bias of the lead-line measurements, based on the observations of ubiquitous and thick mud on the weighted part of the line, it was clear that the bottom of ID pond is very soft in places and the weight would have had significant penetration.

3.3.3 Daily check-ins

GPS, multi-beam and sub-bottom data were collected during QA/QC check-ins at the beginning and end of each day. A control station was established at 580395, 6914126 (NAD83 UTM Zone 8N coordinates) by the suspension of a survey flag over the pond shown by the orange triangle in Figure 2; GPS and multi-beam sonar data were recorded for a minimum of 30 seconds during check-ins at this control station. Although not exemplary as a control station, this was deemed the best option that would be accessible by the survey vessel. The topography and geometry of the shoreline did not offer many

suitable options to set up the control flag and consequently the water depth of chosen check-in site was shallower than ideal.

To allow meaningful comparison from day to day, the full range of the sonar swath was windowed to a small section (approximately 1 X 0.1 m) that was common to several days. Although small, this area does compare on the order of 125 individual multi-beam measurements which is sufficient for statistical analysis. The depths were gridded and then differenced to an arbitrary reference (the first day). The statistics of the differenced grids are instructive to the repeatability of the survey and are shown in Figure 14 for the days with sufficient overlap for good statistical analysis.

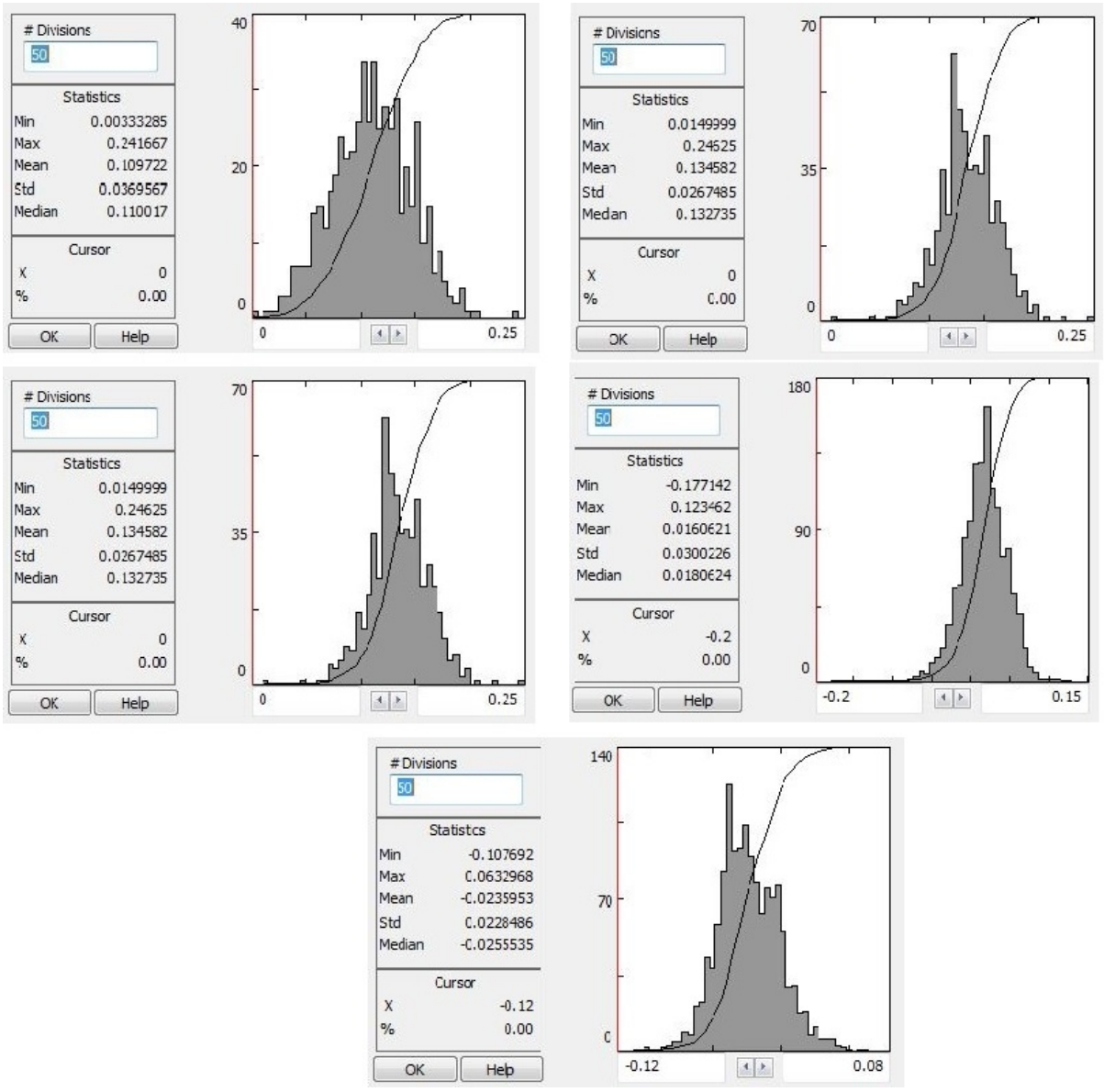


Figure 14: Histograms of the differenced grids from multi-beam control points.

The mean difference between the reference control point and individual repeats at that control point vary from a few centimeters to 13.4 centimeters. The standard deviation of the differenced grids is more consistent at 2 – 4 cm. This indicates that the 95% confidence level, which is approximately 2 standard deviations, is on the order of 6 cm. The larger datum shifts between the individual control readings are interpreted to be variations in the water elevation and not a representative measure of survey error. Variation of the water elevation was not measured systematically throughout the survey however there was approximately a 10 cm water elevation change in between Oct 21 and Oct 23 when two suites of shoreline measurements were taken, consistent with the above interpretation.

The sub-bottom control point data, taken at the same location and same methodology as the multi-beam data, from the single day of surveying are shown in Figure 15 (morning) and Figure 16 (afternoon). Qualitatively, the responses are equivalent, demonstrating proper equipment function.

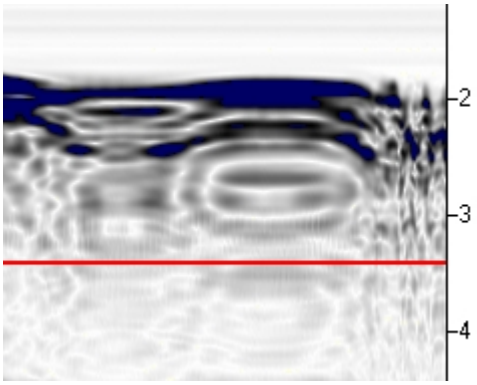


Figure 15: Morning sub-bottom data at the flagged control point at 580395, 6914126 (NAD83 UTM Zone 8N coordinates) .

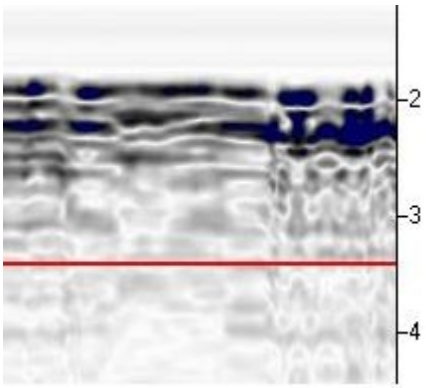


Figure 16: Afternoon sub-bottom data at the flagged control point at 580395, 6914126 (NAD83 UTM Zone 8N coordinates).

4 DISCUSSION AND INTERPRETATION

4.1 Bathymetry

The mean elevation of the shoreline during the 2015 survey is 1028.679 m (orthometric height above the HT2 geoid) with a standard deviation of 4.6 cm (n=111).

The total volume of water in the CVD Pond during the 2015 survey, given a shoreline at 1028.679 m, is 1,413,045.8 cubic metres. There is no allowance in this calculation for the water in the shallow areas where no data were collected, but a rough estimate indicated that this extra amount of water would be a small amount, on the order of 0.25% of the total pond volume.

The multi-beam sonar survey provides a very high resolution dataset of the water depth shown in Figure 17. The maximum depth of the pond is 14.68m in the northern part of the pond. There are several lineaments of sharp relief, interpreted to reflect dikes or pits that were part of the design of CVD pond, prior to its flooding.

Agreement was generally good between the lead-line depths, single-beam transects and the multi-beam data, providing confidence in the data veracity of all three products. The notable exceptions are depth mismatches between the single-beam and multi-beam in areas of high pond bottom slope and one area of the pond where high variability is noted in the single-beam dataset. The multi-beam system is designed to account for slope in the calculation of depths while the single-beam is a simpler system that likely takes the first (i.e. most shallow) reflector and this would explain the discrepancy. Because of the more advanced instrumentation and strategy to account for such topography, the multi-beam is the preferred dataset.

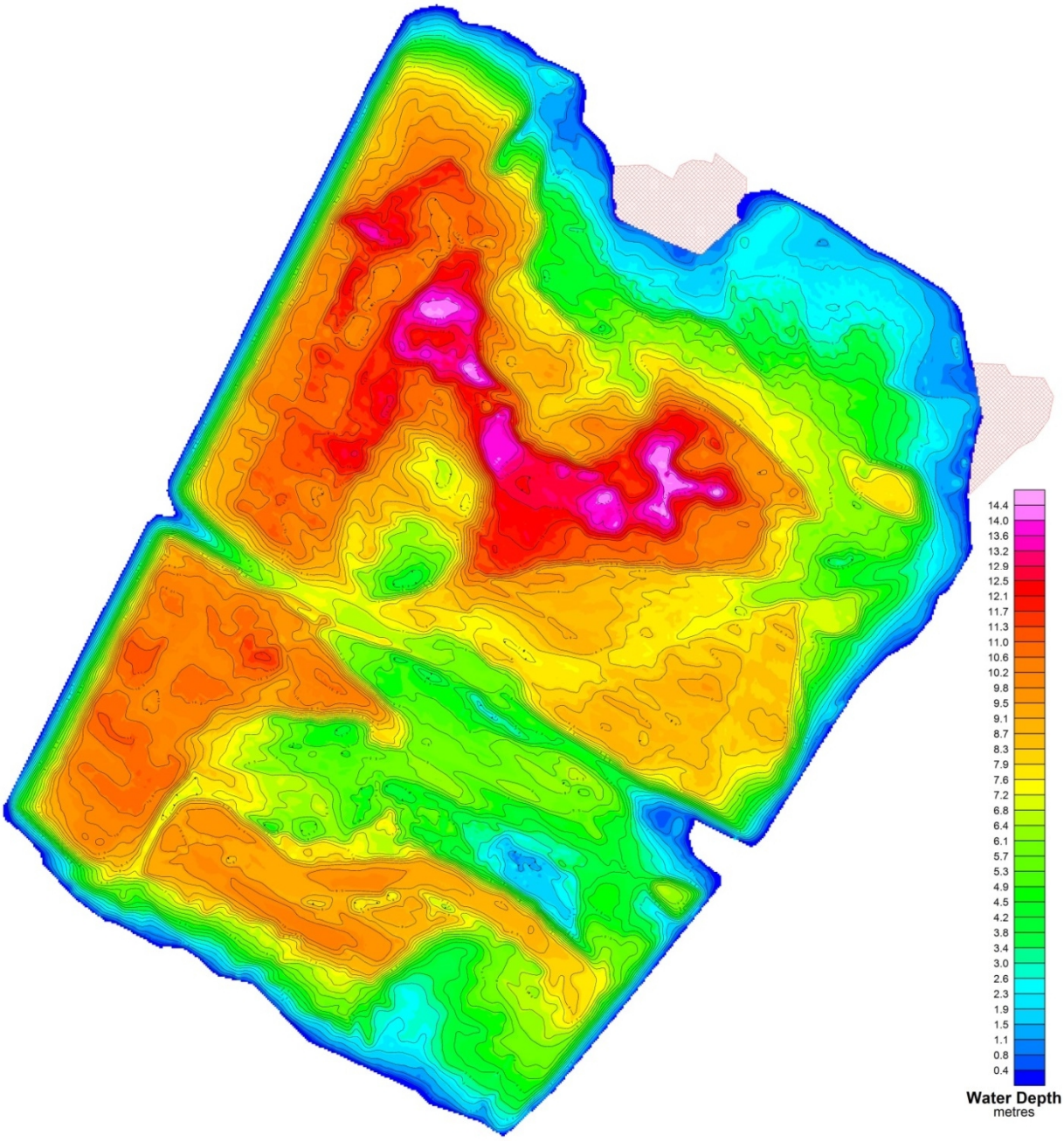


Figure 17: Bathymetry of CVD Pond.

4.2 Sub-bottom

The sub-bottom data of the CVD pond is markedly different from that of the ID pond where thick packages of the equivalent of Feature B are ubiquitously imaged. Additionally a distinct reflector is often seen below the Feature B equivalent at the ID pond while this was not observed at CVD pond. Both datasets support an interpretation of Feature B representing tailings but the nature of Features C through G are not clear and, with the hindsight of the data from the ID pond, calls into question whether

they represent real manifestations of sub-bottom variation at all. The two subsurface logs obtained in the winter of 2015-2016 do not lend themselves to drawing conclusion on these features

Despite the ambiguity of the interpretation of the sub-bottom data at CVD a few comments can be made from the sections as well as from examination of the bathymetric data with the sub-bottom data.

The layered material which defines Feature B is well correlated with bounding escarpments, particularly in the south of the pond as seen in Figure 19 and . These features appear to represent a constructed pit where layers of sediment (fines from the polishing mill) were settled.

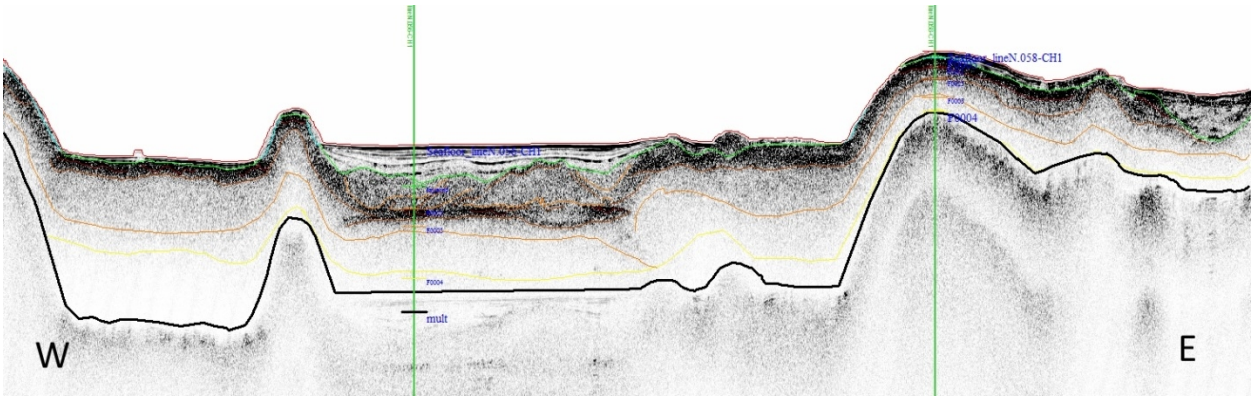


Figure 18: L4 sub-bottom profile. The trace of this profile is shown as a red line in Figure 19.

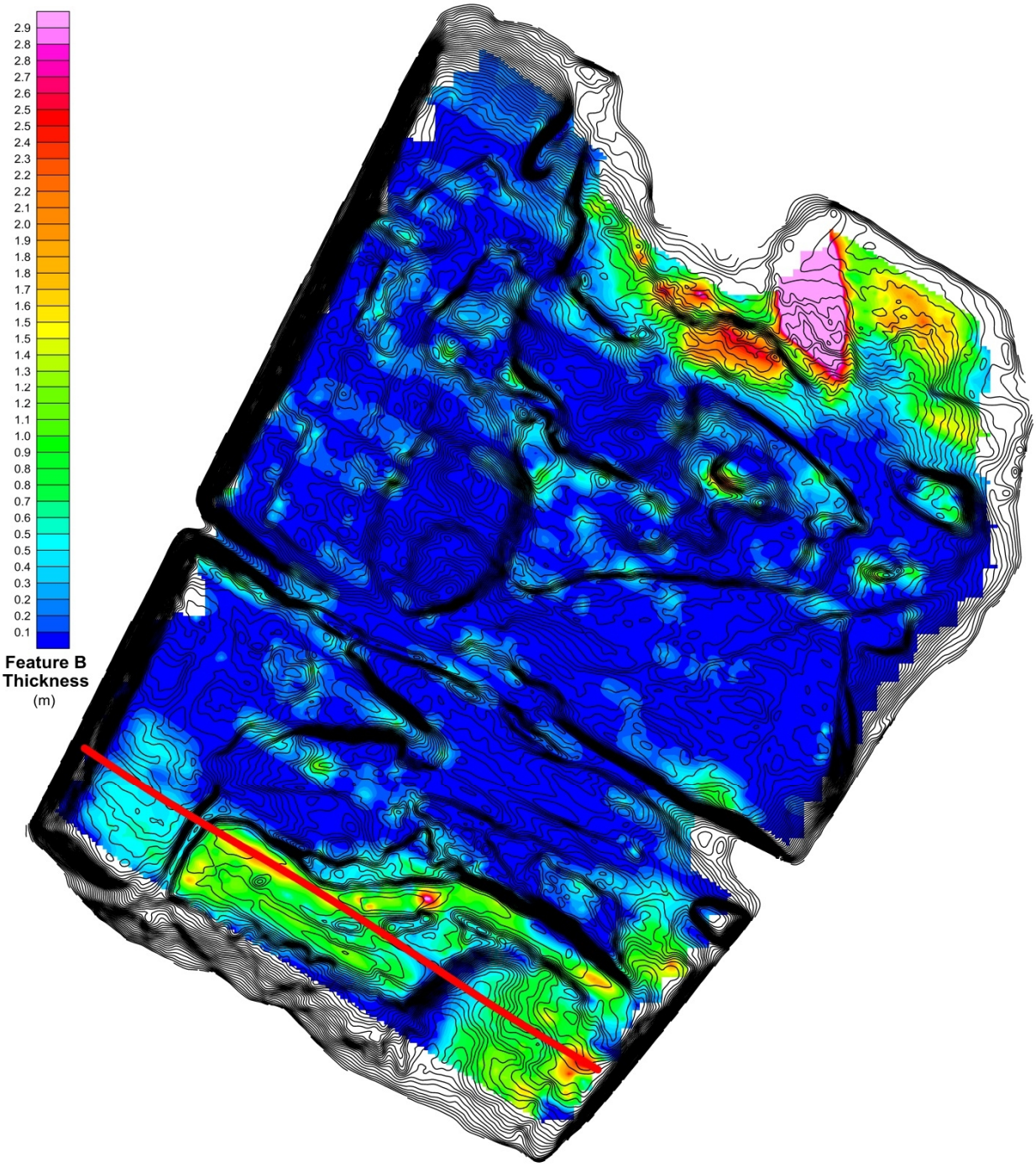


Figure 19: Feature B thickness with bathymetry contours. The red line shows the trace of L4, the profile of which is Figure 18.

Feature D thickness, the color contour in Figure 21, is well correlated with steep slopes. Figure 20 shows the profile for L26 which is drawn as a red line in Figure 21. On the slopes, the character of the response changes and does not have the layer of very high amplitude reflectance, prevalent in most of the

section. Because of the lack of this high reflectance layer, represented by Feature C, Feature D thickens here. The interpretation is that Feature C represents finer material which has sloughed off the steeper slopes, leaving only the coarser material represented by Feature D. This interpretation should be verified with ground data.

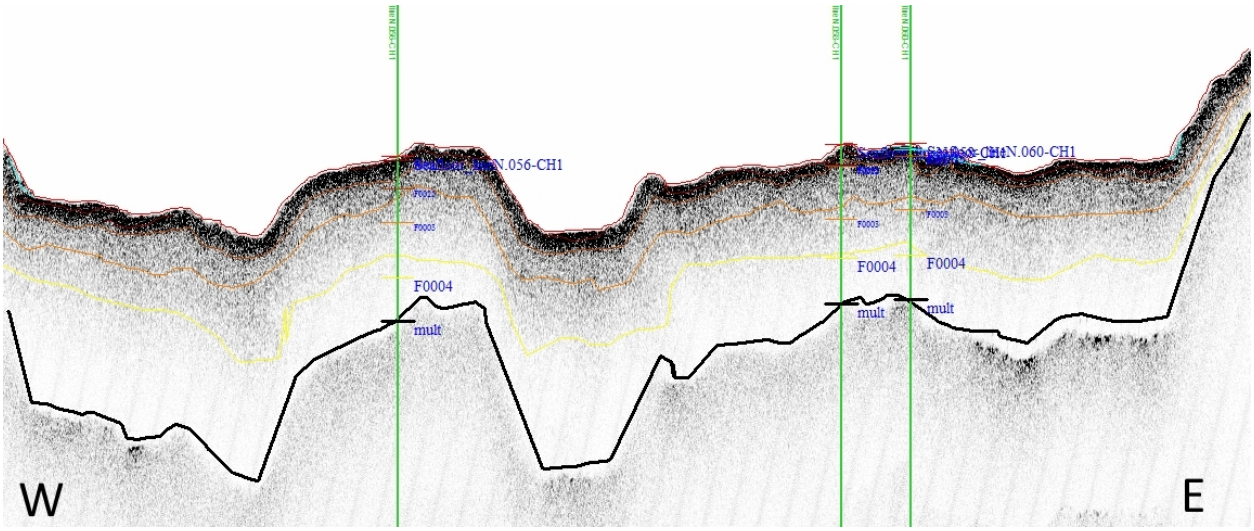


Figure 20: L26 sub-bottom profile. The trace of this profile is shown as a red line in Figure 21.

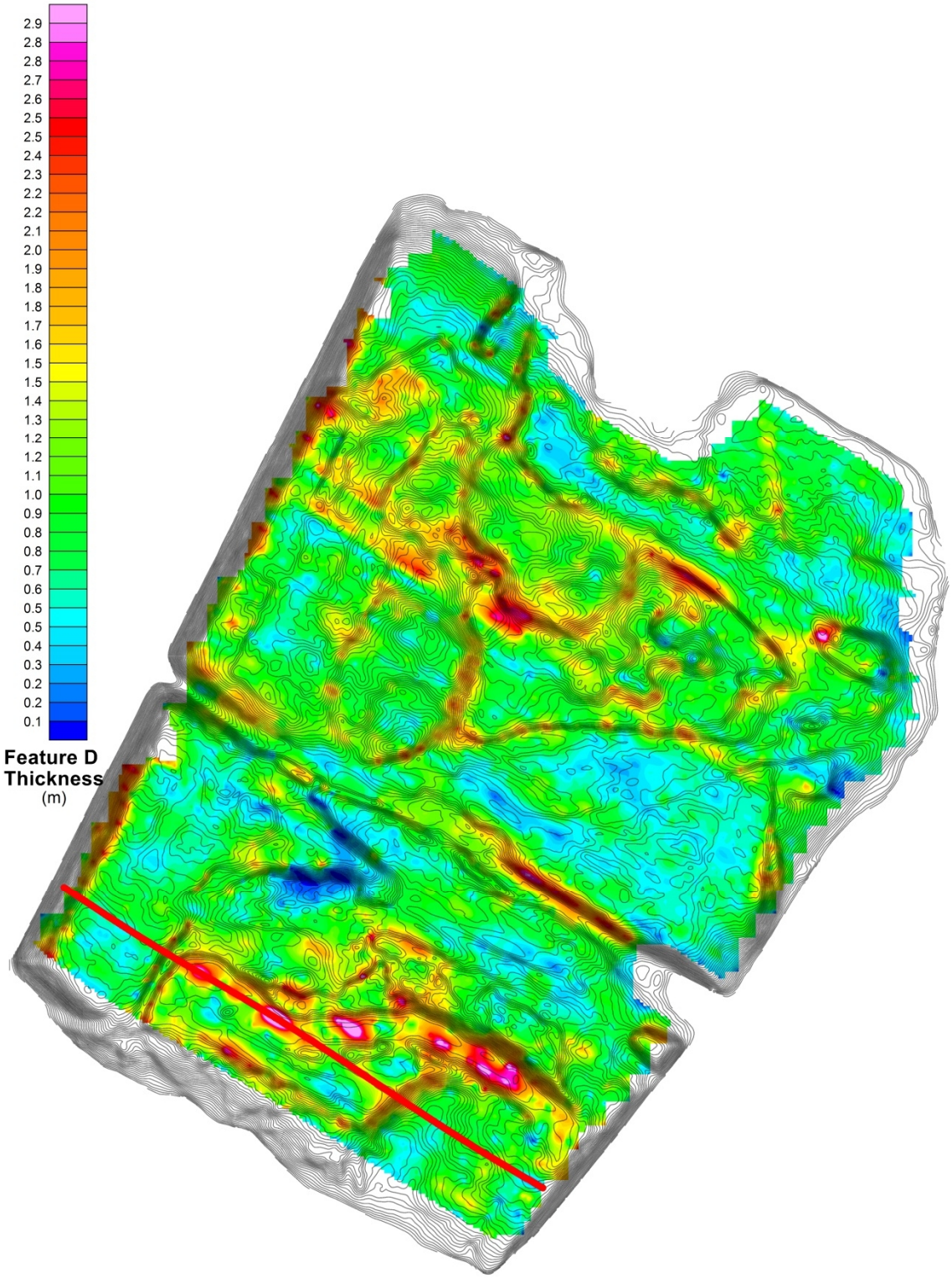


Figure 21: Bathymetry contours with Feature D thickness colour contour underlay. The red line shows the trace of L26, the profile of which is Figure 20.

Ground Penetrating Radar (GPR) is a complementary technique to acoustic sub-bottom profiling; GPR relies on a contrast in dielectric constant to image different sub-bottom material while the acoustic profiler depends on velocity and density contrasts. The depth of penetration of GPR may be limited, particularly in conductive environments.

The acoustic profiling data acquisition is slow and sometimes impossible to collect in shallow water. While this was not a serious problem at CVD, the Intermediate Dam Pond has a significant portion of the pond that is very shallow. A GPR survey on the ice may be an economical alternative / complement to shallow acoustic sub-bottom profiling, particularly when the ice is frozen directly to the pond bed; GPR coupling to the bed is maximized in the absence of a strong ice-water reflective interface.

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Dave Hildes, P.Geo., Ph. D.
Geophysicist

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Shawn Scott,
Geophysical Technician

Appendix I

Project Log

AURORA GEOSCIENCES

CHM-15537-YT

	Shawn Scott	Darrell Epps	Hannah Warrington	Dave Hildes
Total	1	1	1	1
Tue 20-Oct-2015	Mobe	Mobe	Mobe	Mobe
Wed 21-Oct-2015	Multi-beam	Shore Support	Shore Support	Multi-beam/Demobe
Thu 22-Oct-2015	Multi-beam	Multi-beam	Shore Support	N/A
Fri 23-Oct-2015	Multi-beam/Single Beam	Multi-beam/ RTK GPS	Shore Support	N/A
Sat 24-Oct-2015	Multi-beam	Multi-beam	Shore Support	N/A
Sun 25-Oct-2015	Sub-bottom	Sub-bottom	Shore Support	N/A
Mon 26-Oct-2015	Weather day	Weather day	Weather day	N/A
Tue 27-Oct-2015	Demobe	Demobe	Demobe	N/A

AURORA GEOSCIENCES

Production Summary

	CVP Multi-beam	CVP Single-beam	CVP Sub-bottom	Intermediate Multi-beam	Intermediate Single-beam	Intermediate Sub-bottom
Estimate percentage completed	100	30	100	0	0	0
Tue 20-Oct-2015	mobe and orientation					
Wed 21-Oct-2015	25					
Thu 22-Oct-2015	35					
Fri 23-Oct-2015	30	30				
Sat 24-Oct-2015	10					
Sun 25-Oct-2015			100			
Mon 26-Oct-2015	0	0	0	0	0	0
Tue 27-Oct-2015	shoreline RTK GPS points and demobe					

AURORA GEOSCIENCES

Faro Bathymetry and Sub-Bottom

DATE:	October-20-15

PREPARED BY:

Shawn Scott

Comments

Weather

Clear turning to slightly overcast. +5 in Whitehorse

LOGISTICS

Type	*Contractor/Renter*	*Hrs or units*
Truck	AGL	1
Trailer	AGL	1
Boat	AGL	1
Sub-bottom 424	Rental	0
Multibeam MB1 & controller	Rental	1
Single Beam	AGL	0
ATV & trub trailer	AGL	0

Crew

Position	*Contractor*	*Hrs or units*
Geophysicist	Dave Hildes	10
Geophysicist	Darrell Epps	10
Technician	Shawn Scott	10
Field Hand	Hannah Warrington	10

Notes (production comments, incidents, other)

Mobilized to Faro from Whitehorse via truck around 7:30am and completed hazard assessment. Arrived in Faro around noon, grabbed a bite to eat and then completed the TES orientation and safety orientation with Robin. Completed a site visit with Robin later in the afternoon and logistics planning.

AURORA GEOSCIENCES

Faro Bathymetry and Sub-Bottom

DATE:	October-21-15

PREPARED BY:
Shawn Scott

LOGISTICS

Type	*Contractor/Renter*	*Hrs or units*
Truck	AGL	1
Trailer	AGL	1
Boat	AGL	1
Sub-bottom 424	Rental	0
Multibeam MB1 & controller	Rental	1
Single Beam	AGL	0
ATV & trub trailer	AGL	1

Crew

Position	*Contractor*	*Hrs or units*
Geophysicist	Dave Hildes	10
Geophysicist	Darrell Epps	10
Technician	Shawn Scott	10
Field Hand	Hannah Warrington	10

Comments

Weather

Snow in the morning. Clear in the afternoon

Notes (production comments, incidents, other)

Safety Meeting at CH2MHill office at 8am
Set up through the morning. Initial set up and unloading took longer than what is anticipated for daily set up.
Calibration of instruments and intial tests in the early afternoon.
Multibeam surveying started at approximately 14:45 and ended at 16:40.
No issues with data aquisition and early progress is encouraging.
Approximately 25% of CVP is completed.
All equipment and apparell cleaned with safe water and equipment packed at end of day by 18:00. Must prepare to leave earlier in future days to avoid a late checkout at CH2MH office.
Dave Hildes demobed at the end of the day and is no longer on site.

AURORA GEOSCIENCES

Faro Bathymetry and Sub-Bottom

DATE:	October-22-15

PREPARED BY:

Shawn Scott

Comments

Weather

Snow in the morning again, rain in the afternoon. One sliver of sun in the late afternoon.

LOGISTICS

Type	*Contractor/Renter*	*Hrs or units*
Truck	AGL	1
Trailer	AGL	1
Boat	AGL	1
Sub-bottom 424	Rental	0
Multibeam MB1 & controller	Rental	1
Single Beam	AGL	0
ATV & trub trailer	AGL	1

Crew

Position	*Contractor*	*Hrs or units*
Geophysicist	Darrell Epps	10
Technician	Shawn Scott	10
Field Hand	Hannah Warrington	10

Notes (production comments, incidents, other)

Safety Meeting at CH2MHill office at 800am
Reviewed boating AHA and FLRA with Robin.
Day was spent continuing multi-beam surveying on the CVP.
Networking issues with instruments caused an hour's delay when we first set out.
Most of the data acquisition was in shallow water, requiring many, many passes to get good coverage.
RTK coverage failed momentarily at the end of the day, the issue was resolved in time for a last qc checkpoint reading.
Checked out at 540pm.

AURORA GEOSCIENCES

Faro Bathymetry and Sub-Bottom

DATE:	October-23-15

PREPARED BY:
Shawn Scott

LOGISTICS

Type	*Contractor/Renter*	*Hrs or units*
Truck	AGL	1
Trailer	AGL	1
Boat	AGL	1
Sub-bottom 424	Rental	0
Multibeam MB1 & controller	Rental	1
Single Beam	AGL	1
ATV & trub trailer	AGL	1

Crew

Position	*Contractor*	*Hrs or units*
Geophysicist	Darrell Epps	10
Technician	Shawn Scott	10
Field Hand	Hannah Warrington	10

Comments

Weather

Snow in the morning yet again, sunny by noon.

Notes (production comments, incidents, other)

Safety Meeting at CH2MHill office at 800am

On the water by 1030am. Started the day by continuing the multibeam bathymetry but RTA had wasn't able to connect until an hour later. Did a sound velocity cast and check-in with RTK while waiting. Finished most of the multibeam with a bit of cleanup to be done tomorrow. In order to maximize our efficiency without risking a late checkout at the CH2MHill office, we completed the labour intensive tear down work early. With the time left before we needed to be off site, we collected RTA GPS data along the shore of the CVP and also collected some single beam data with the zodiac along the perimeter where it is too shallow for the large boat.

Checked out of CH2MHIll at 550pm.

AURORA GEOSCIENCES

Faro Bathymetry and Sub-Bottom

DATE:	October-24-15

PREPARED BY:
Shawn Scott

LOGISTICS

Type	*Contractor/Renter*	*Hrs or units*
Truck	AGL	1
Trailer	AGL	1
Boat	AGL	1
Sub-bottom 424	Rental	0
Multibeam MB1 & controller	Rental	1
Single Beam	AGL	1
ATV & trub trailer	AGL	1

Crew

Position	*Contractor*	*Hrs or units*
Geophysicist	Darrell Epps	10
Technician	Shawn Scott	10
Field Hand	Hannah Warrington	10

Comments

Weather

Cloudy to start the day and then sunny through the afternoon.

Notes (production comments, incidents, other)

Safety Meeting at CH2MHill office at 800am
On the water by 945am. Continued problems waiting for the RTA to warm up. Spent most of the day doing detail work to ensure full coverage for the multibeam survey. Spent some time at the end of the day trying to prepapre for sub-bottom survey for tomorrow.
Continued problems connecting to the Digibar -S sound velocity probe, managed two complete casts but spent much more time attempting to read data from it. Tried again to access shallow areas to the north of the pond but again struck a large rock. Had the same problem there the day before in the zodiac and have found no safe solution to surveying there.
Checked out of CH2MHIll at 550pm.

AURORA GEOSCIENCES

Faro Bathymetry and Sub-Bottom

DATE:	October-25-15

PREPARED BY:
Shawn Scott

LOGISTICS

Type	*Contractor/Renter*	*Hrs or units*
Truck	AGL	1
Trailer	AGL	1
Boat	AGL	1
Sub-bottom 424	Rental	1
Multibeam MB1 & controller	Rental	1
Single Beam	AGL	1
ATV & trub trailer	AGL	1

Crew

Position	*Contractor*	*Hrs or units*
Geophysicist	Darrell Epps	10
Technician	Shawn Scott	10
Field Hand	Hannah Warrington	10

Comments

Weather

Sunny and clear. Cold though, ice on edges of the water.

Notes (production comments, incidents, other)

Safety Meeting at CH2MHill office at 800am
On the water by 930am.
Set up the sub-bottom and tested several lines repeatedly with different frequency chirps. Ran survey all day with few problems.
Finished the day with little time to spare but completed the sub-bottom survey on the Cross Valley Dam.
Checked out of CH2MHIll at 555pm.

AURORA GEOSCIENCES

Faro Bathymetry and Sub-Bottom

DATE:	October-26-15

PREPARED BY:
Shawn Scott

LOGISTICS

Type	*Contractor/Renter*	*Hrs or units*
Truck	AGL	1
Trailer	AGL	1
Boat	AGL	1
Sub-bottom 424	Rental	1
Multibeam MB1 & controller	Rental	1
Single Beam	AGL	1
ATV & trub trailer	AGL	1

Crew

Position	*Contractor*	*Hrs or units*
Geophysicist	Darrell Epps	10
Technician	Shawn Scott	10
Field Hand	Hannah Warrington	10

Comments

Weather

Sunny all day but significantly colder. Ice fully covering both ponds all day.

Notes (production comments, incidents, other)

Safety Meeting at CH2MHill office at 800am
Arrived at ponds to discover they were both completely covered in ice. Contacted CH2MHill and notified them of the problem, saying we would carry on preparing to work in hopes of the ice melting. We continued to monitor the ice thickness and maintained close contact with Robin and Robert of CH2MHill, who felt it was unsafe to attempt to launch a boat on either pond. The ice did not melt and we were advised to consider today a weather day and return ready to work in the morning, should conditions allow.

AURORA GEOSCIENCES

Faro Bathymetry and Sub-Bottom

DATE:	October-27-15

PREPARED BY:
Shawn Scott

Comments

Weather
overcast and temperature hovering around -5

LOGISTICS

Type	*Contractor/Renter*	*Hrs or units*
Truck	AGL	1
Trailer	AGL	1
Boat	AGL	1
Sub-bottom 424	Rental	1
Multibeam MB1 & controller	Rental	1
Single Beam	AGL	1
ATV & trub trailer	AGL	1

Crew

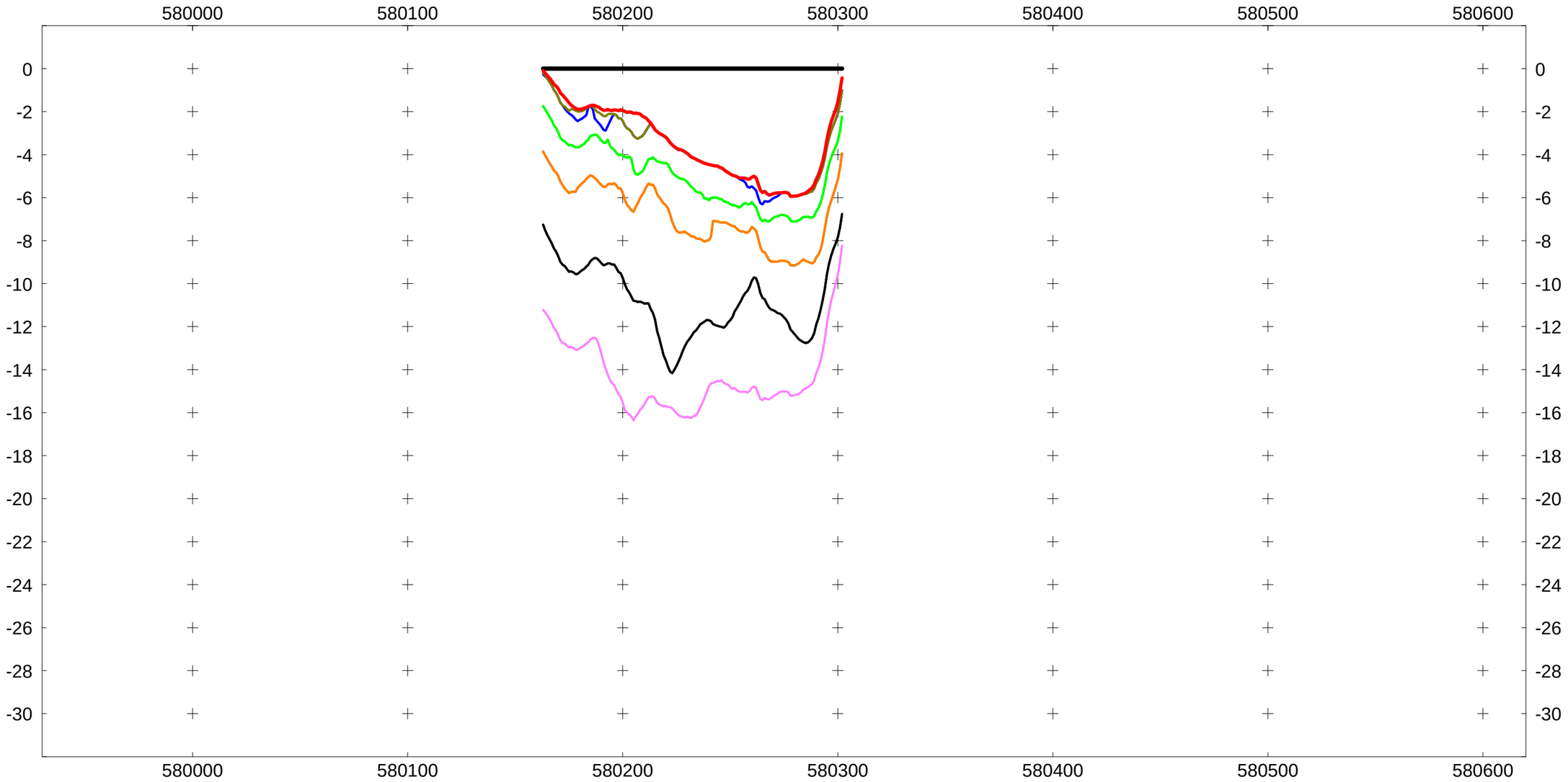
Position	*Contractor*	*Hrs or units*
Geophysicist	Darrell Epps	10
Technician	Shawn Scott	10
Field Hand	Hannah Warrington	10

Notes (production comments, incidents, other)

The weather stayed below zero overnight and the short term forecast calls for more of the same. Discussions between CH2M Hill and Aurora Geosciences determined that the survey could not proceed any longer due to the ice on the ponds and that the data collection/field work would be ended. Collected some shoreline RTK-GPS points in the morning and then left site around 11am. Loaded up equipment and instruments after lunch and demobilized via truck back to Whitehorse around 3pm.

Appendix II

Cross-sections



LEGEND

- Water :
- Bottom :
- Feature B :
- Feature C :
- Feature D :
- Feature E :
- Feature F :
- Feature G :

Scale (horizontal)

25 0 25 50

(meters)

Scale (vertical) exaggeration X10

2.5 0 2.5 5

(meters)

X-AXIS - NAD83 (CSRS) UTM Zone 8N Easting

Y-AXIS - Depth relative to Water Surface

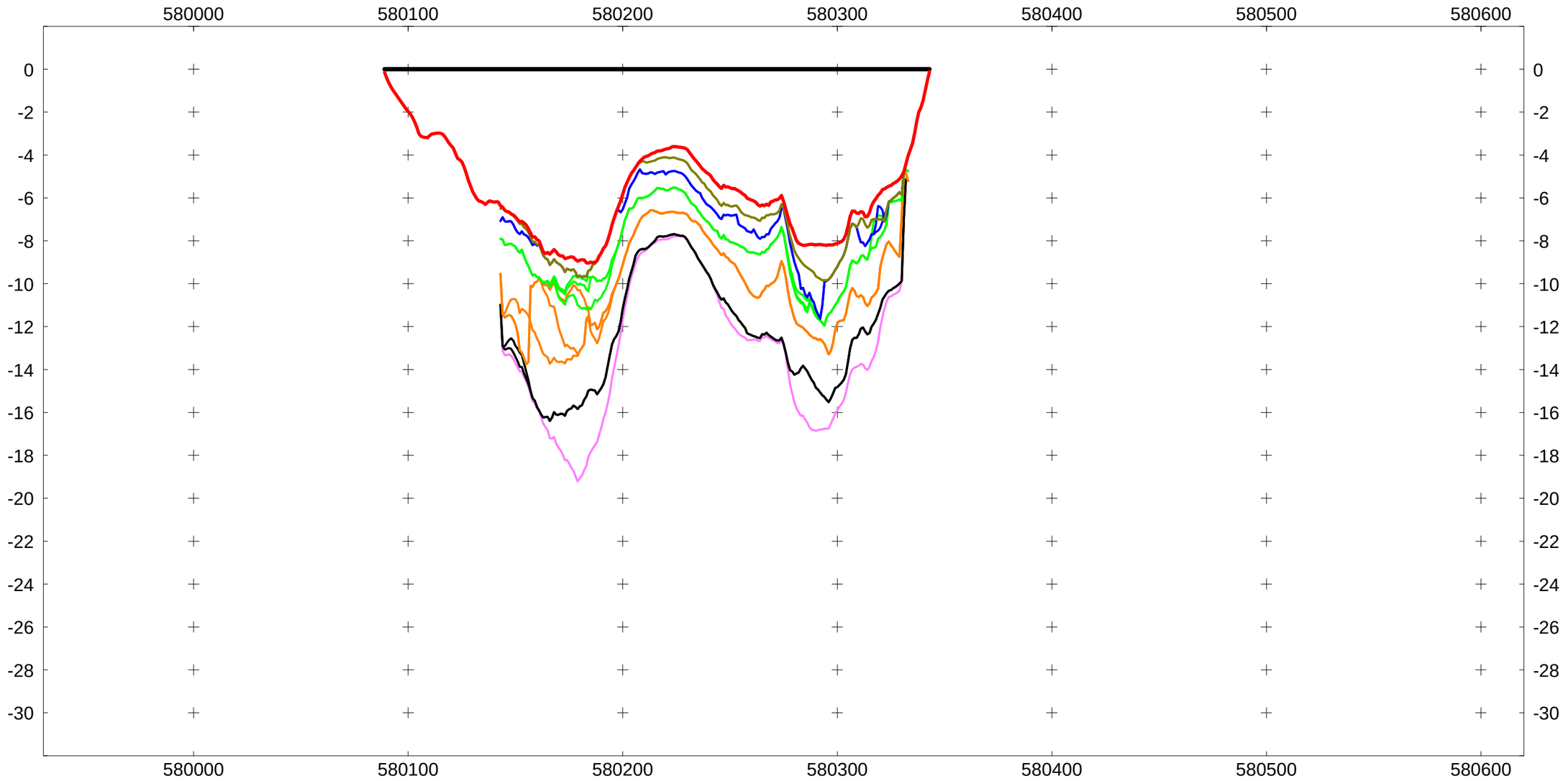
CH2M HILL LTD.

CROSS VALLEY DAM POND
Bathymetric and Sub-Bottom Survey
Cross section at UTMN 6914000

Surveyed Oct 20-26, 2015
Faro Mining Complex
NTS: 105k/06

Surveyed by: SS & DE
Map drawn: Dec 10, 2015
NAD83 UTM Zone 8N

AURORA GEOSCIENCES LTD.



LEGEND

- Water :
- Bottom :
- Feature B :
- Feature C :
- Feature D :
- Feature E :
- Feature F :
- Feature G :

Scale (horizontal)

25 0 25 50

(meters)

Scale (vertical) exaggeration X10

2.5 0 2.5 5

(meters)

X-AXIS - NAD83 (CSRS) UTM Zone 8N Easting

Y-AXIS - Depth relative to Water Surface

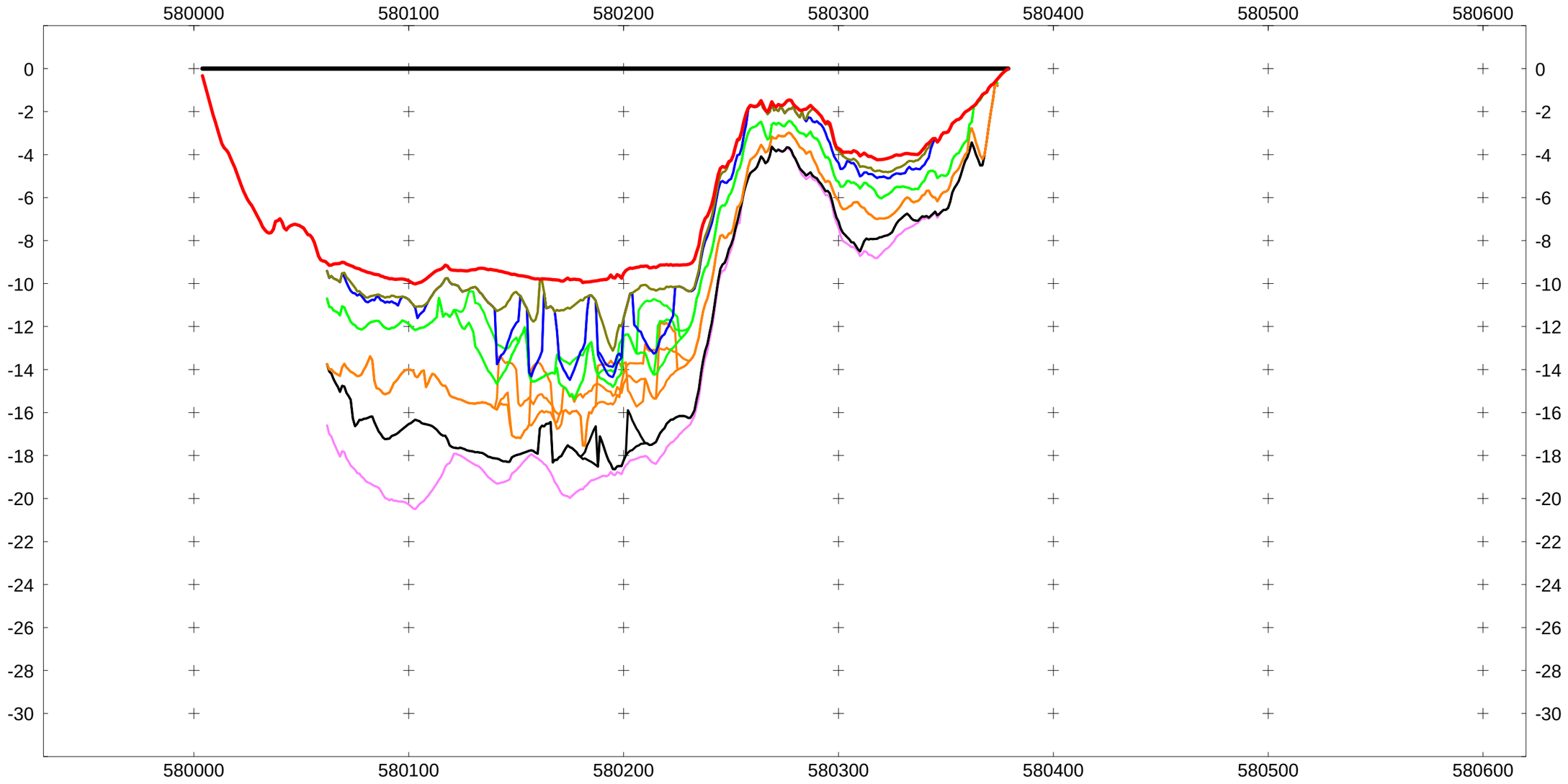
CH2M HILL LTD.

CROSS VALLEY DAM POND
Bathymetric and Sub-Bottom Survey
Cross section at UTMN 6914050

Surveyed Oct 20-26, 2015
Faro Mining Complex
NTS: 105k/06

Surveyed by: SS & DE
Map drawn: Dec 10, 2015
NAD83 UTM Zone 8N

AURORA GEOSCIENCES LTD.



LEGEND

- Water :
- Bottom :
- Feature B :
- Feature C :
- Feature D :
- Feature E :
- Feature F :
- Feature G :

Scale (horizontal)

25 0 25 50

(meters)

Scale (vertical) exaggeration X10

2.5 0 2.5 5

(meters)

X-AXIS - NAD83 (CSRS) UTM Zone 8N Easting

Y-AXIS - Depth relative to Water Surface

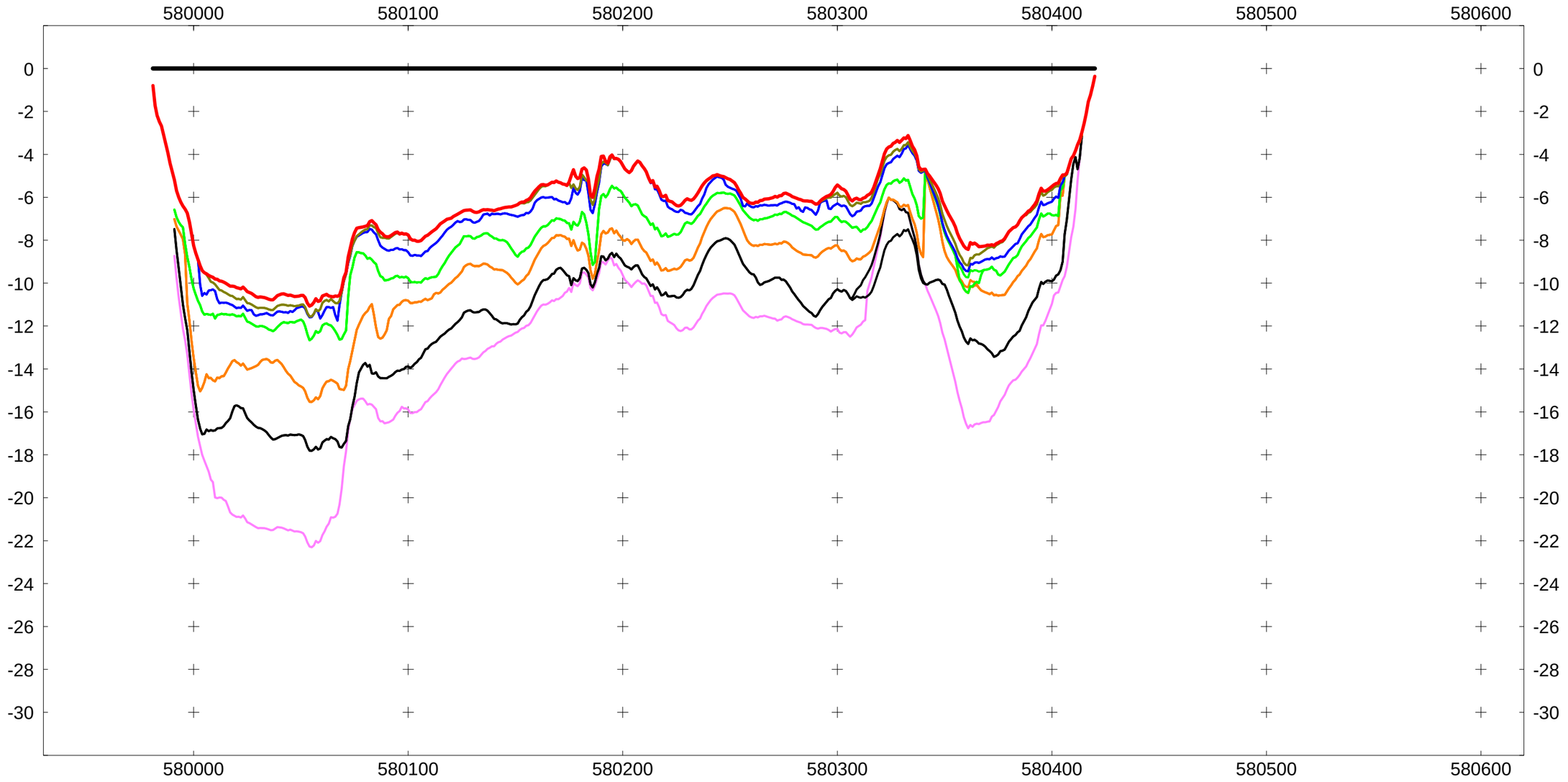
CH2M HILL LTD.

CROSS VALLEY DAM POND
Bathymetric and Sub-Bottom Survey
Cross section at UTMN 6914100

Surveyed Oct 20-26, 2015
Faro Mining Complex
NTS: 105k/06

Surveyed by: SS & DE
Map drawn: Dec 10, 2015
NAD83 UTM Zone 8N

AURORA GEOSCIENCES LTD.



LEGEND

- Water :
- Bottom :
- Feature B :
- Feature C :
- Feature D :
- Feature E :
- Feature F :
- Feature G :

Scale (horizontal)

25 0 25 50

(meters)

Scale (vertical) exaggeration X10

2.5 0 2.5 5

(meters)

X-AXIS - NAD83 (CSRS) UTM Zone 8N Easting

Y-AXIS - Depth relative to Water Surface

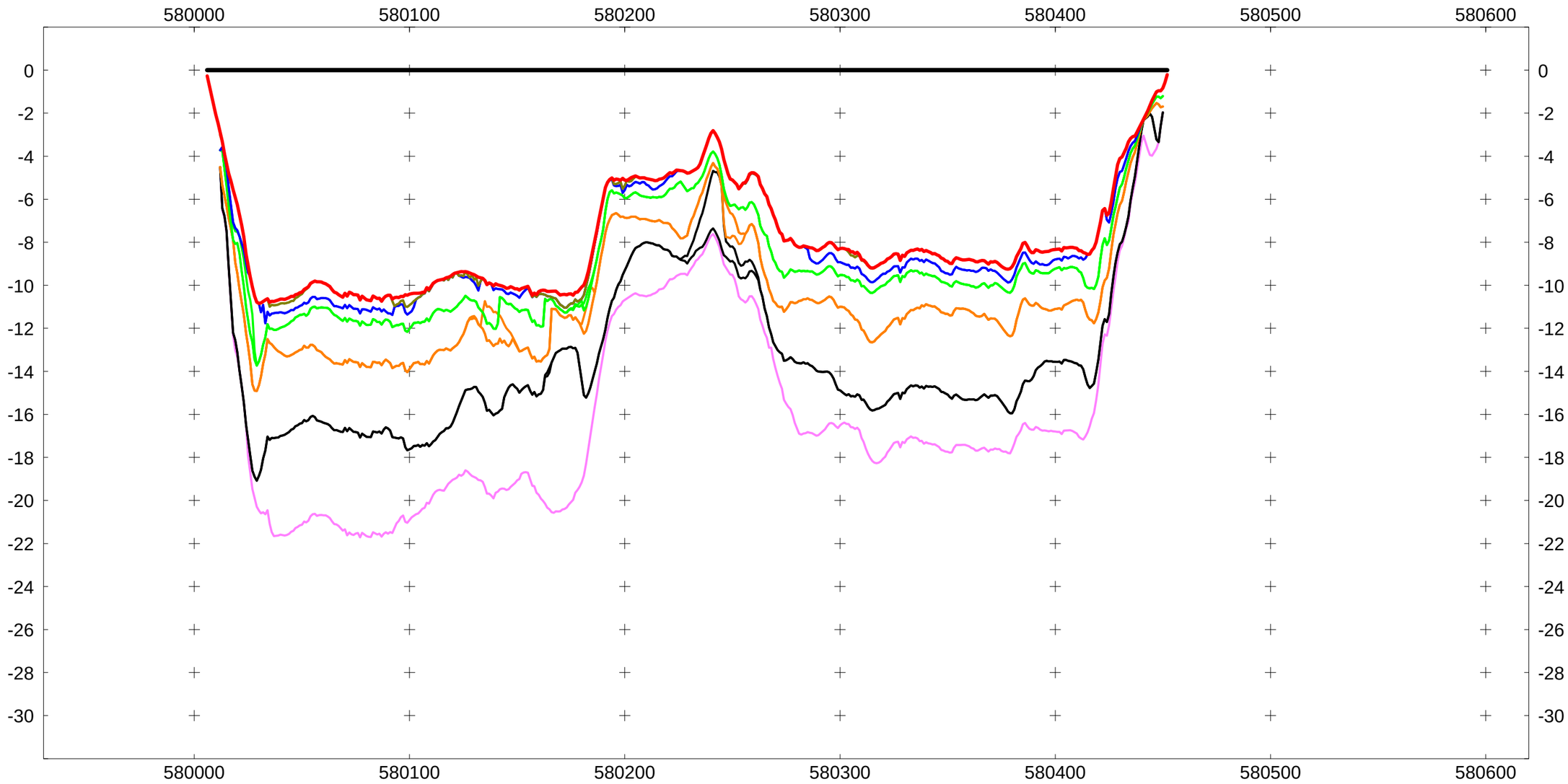
CH2M HILL LTD.

CROSS VALLEY DAM POND
Bathymetric and Sub-Bottom Survey
Cross section at UTMN 6914150

Surveyed Oct 20-26, 2015
Faro Mining Complex
NTS: 105k/06

Surveyed by: SS & DE
Map drawn: Dec 10, 2015
NAD83 UTM Zone 8N

AURORA GEOSCIENCES LTD.



LEGEND

- Water :
- Bottom :
- Feature B :
- Feature C :
- Feature D :
- Feature E :
- Feature F :
- Feature G :

Scale (horizontal)

25 0 25 50

(meters)

Scale (vertical) exaggeration X10

2.5 0 2.5 5

(meters)

X-AXIS - NAD83 (CSRS) UTM Zone 8N Easting

Y-AXIS - Depth relative to Water Surface

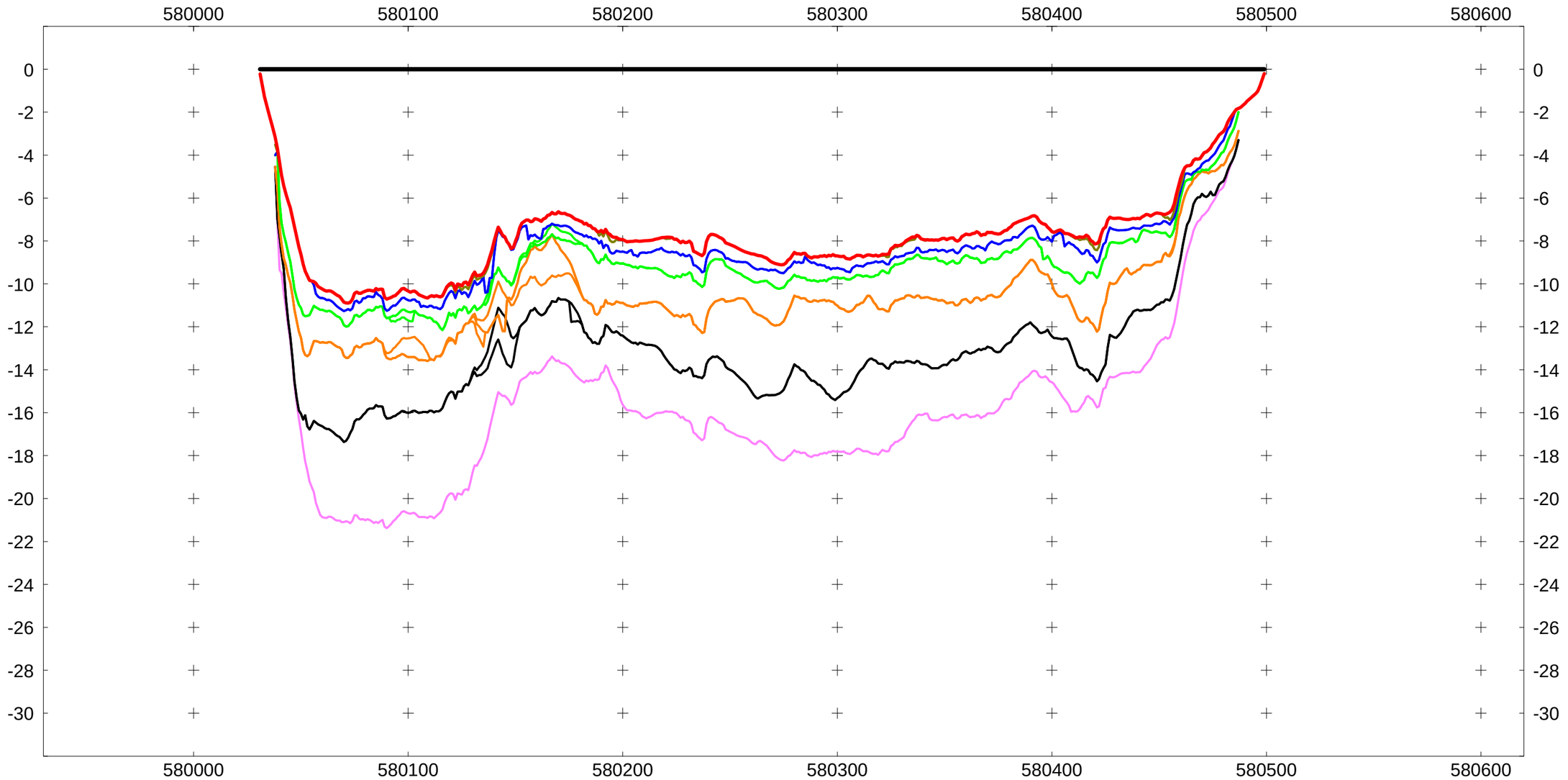
CH2M HILL LTD.

CROSS VALLEY DAM POND
Bathymetric and Sub-Bottom Survey
Cross section at UTMN 6914200

Surveyed Oct 20-26, 2015
Faro Mining Complex
NTS: 105k/06

Surveyed by: SS & DE
Map drawn: Dec 10, 2015
NAD83 UTM Zone 8N

AURORA GEOSCIENCES LTD.



LEGEND

- Water :
- Bottom :
- Feature B :
- Feature C :
- Feature D :
- Feature E :
- Feature F :
- Feature G :

Scale (horizontal)

25 0 25 50

(meters)

Scale (vertical) exaggeration X10

2.5 0 2.5 5

(meters)

X-AXIS - NAD83 (CSRS) UTM Zone 8N Easting

Y-AXIS - Depth relative to Water Surface

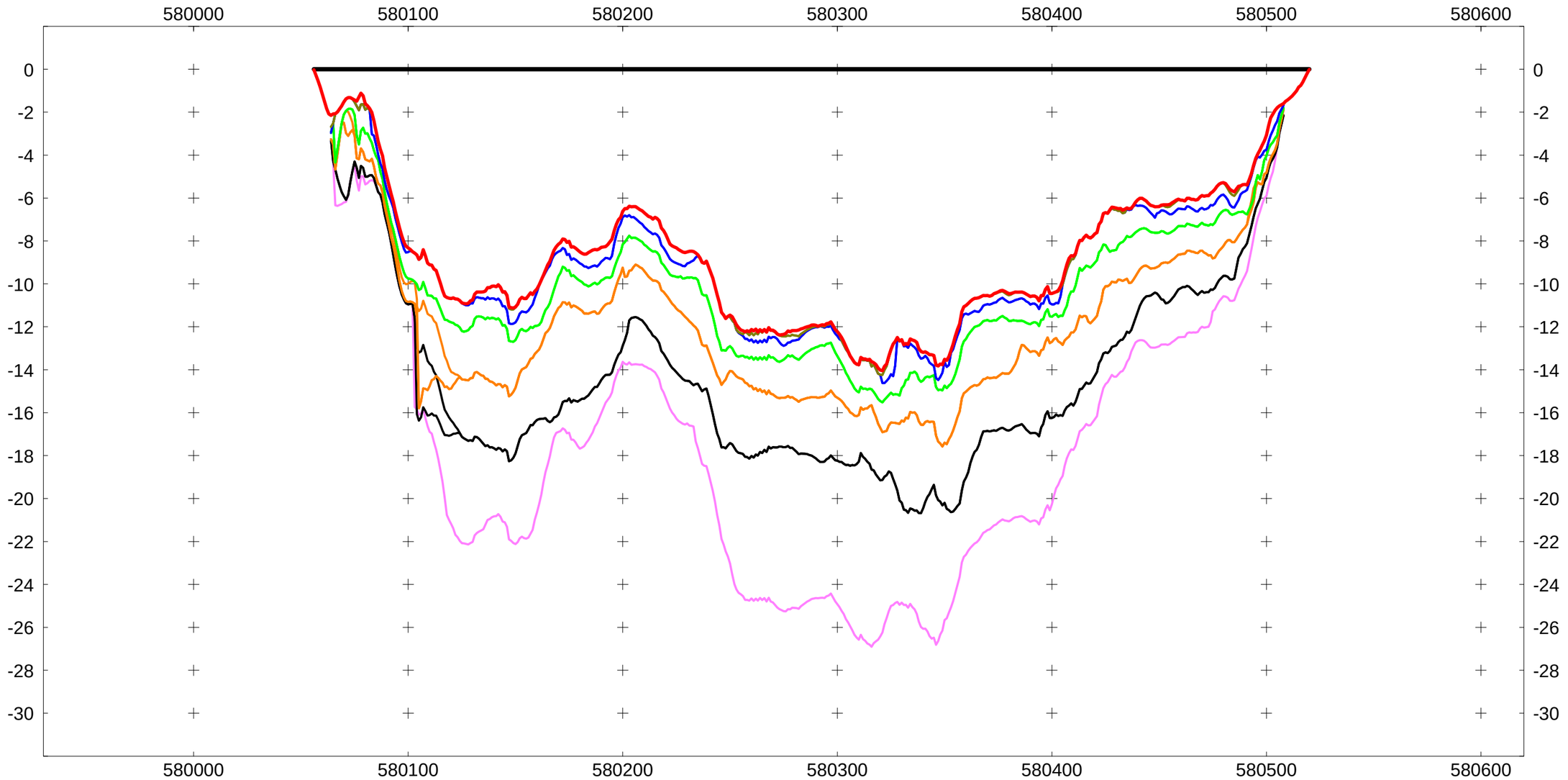
CH2M HILL LTD.

CROSS VALLEY DAM POND
Bathymetric and Sub-Bottom Survey
Cross section at UTMN 6914250

Surveyed Oct 20-26, 2015
Faro Mining Complex
NTS: 105k/06

Surveyed by: SS & DE
Map drawn: Dec 10, 2015
NAD83 UTM Zone 8N

AURORA GEOSCIENCES LTD.



LEGEND

- Water :
- Bottom :
- Feature B :
- Feature C :
- Feature D :
- Feature E :
- Feature F :
- Feature G :

Scale (horizontal)

25 0 25 50

(meters)

Scale (vertical) exaggeration X10

2.5 0 2.5 5

(meters)

X-AXIS - NAD83 (CSRS) UTM Zone 8N Easting

Y-AXIS - Depth relative to Water Surface

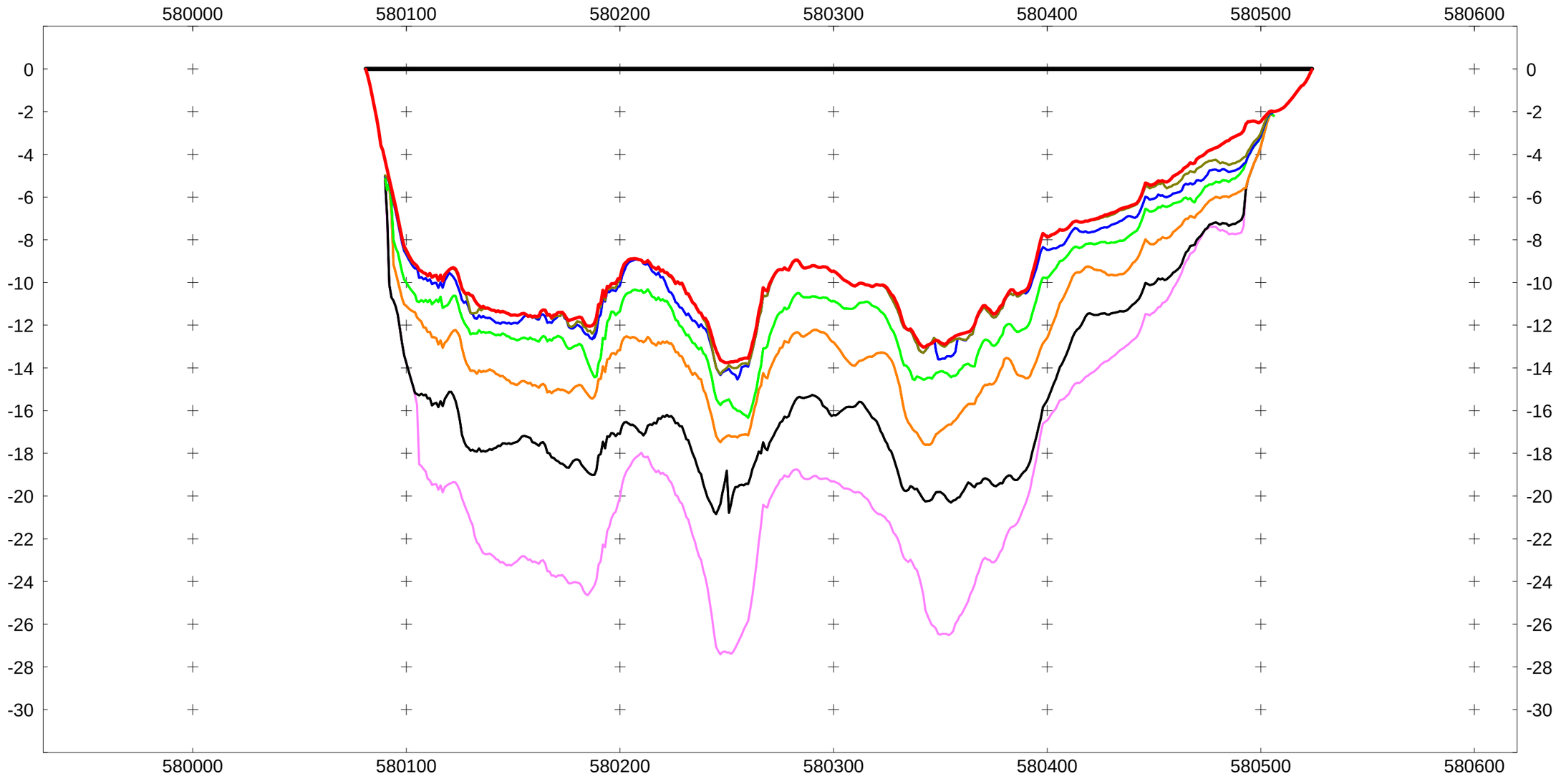
CH2M HILL LTD.

CROSS VALLEY DAM POND
Bathymetric and Sub-Bottom Survey
Cross section at UTMN 6914300

Surveyed Oct 20-26, 2015
Faro Mining Complex
NTS: 105k/06

Surveyed by: SS & DE
Map drawn: Dec 10, 2015
NAD83 UTM Zone 8N

AURORA GEOSCIENCES LTD.



LEGEND

Water :
Bottom :
Feature B :
Feature C :
Feature D :
Feature E :
Feature F :
Feature G :

Scale (horizontal)

25 0 25 50
(meters)

Scale (vertical) exaggeration X10

2.5 0 2.5 5
(meters)

X-AXIS - NAD83 (CSRS) UTM Zone 8N Easting

Y-AXIS - Depth relative to Water Surface

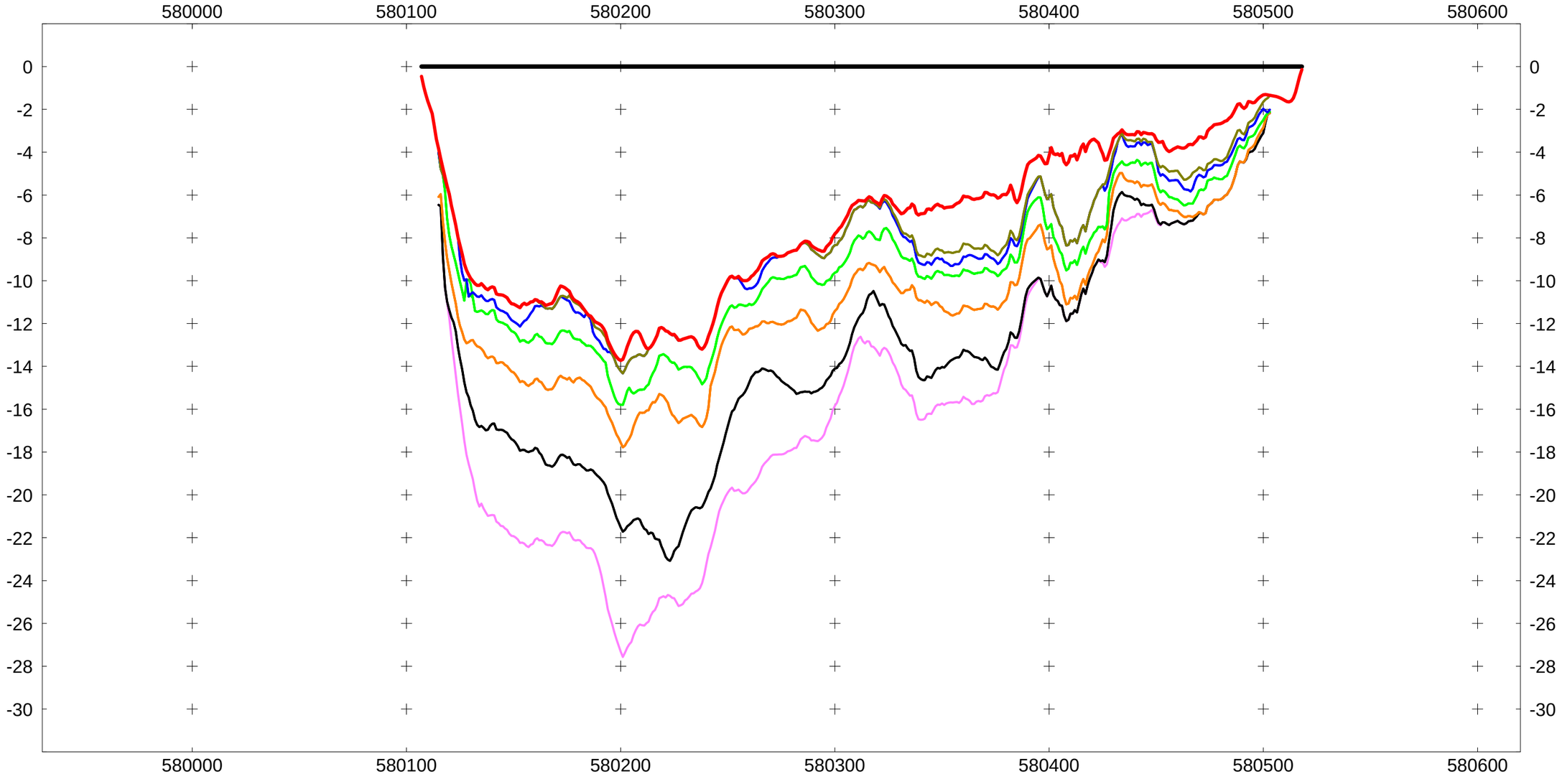
CH2M HILL LTD.

CROSS VALLEY DAM POND
Bathymetric and Sub-Bottom Survey
Cross section at UTMN 6914350

Surveyed Oct 20-26, 2015
Faro Mining Complex
NTS: 105k/06

Surveyed by: SS & DE
Map drawn: Dec 10, 2015
NAD83 UTM Zone 8N

AURORA GEOSCIENCES LTD.



LEGEND

- Water :
- Bottom :
- Feature B :
- Feature C :
- Feature D :
- Feature E :
- Feature F :
- Feature G :

Scale (horizontal)

25 0 25 50

(meters)

Scale (vertical) exaggeration X10

2.5 0 2.5 5

(meters)

X-AXIS - NAD83 (CSRS) UTM Zone 8N Easting

Y-AXIS - Depth relative to Water Surface

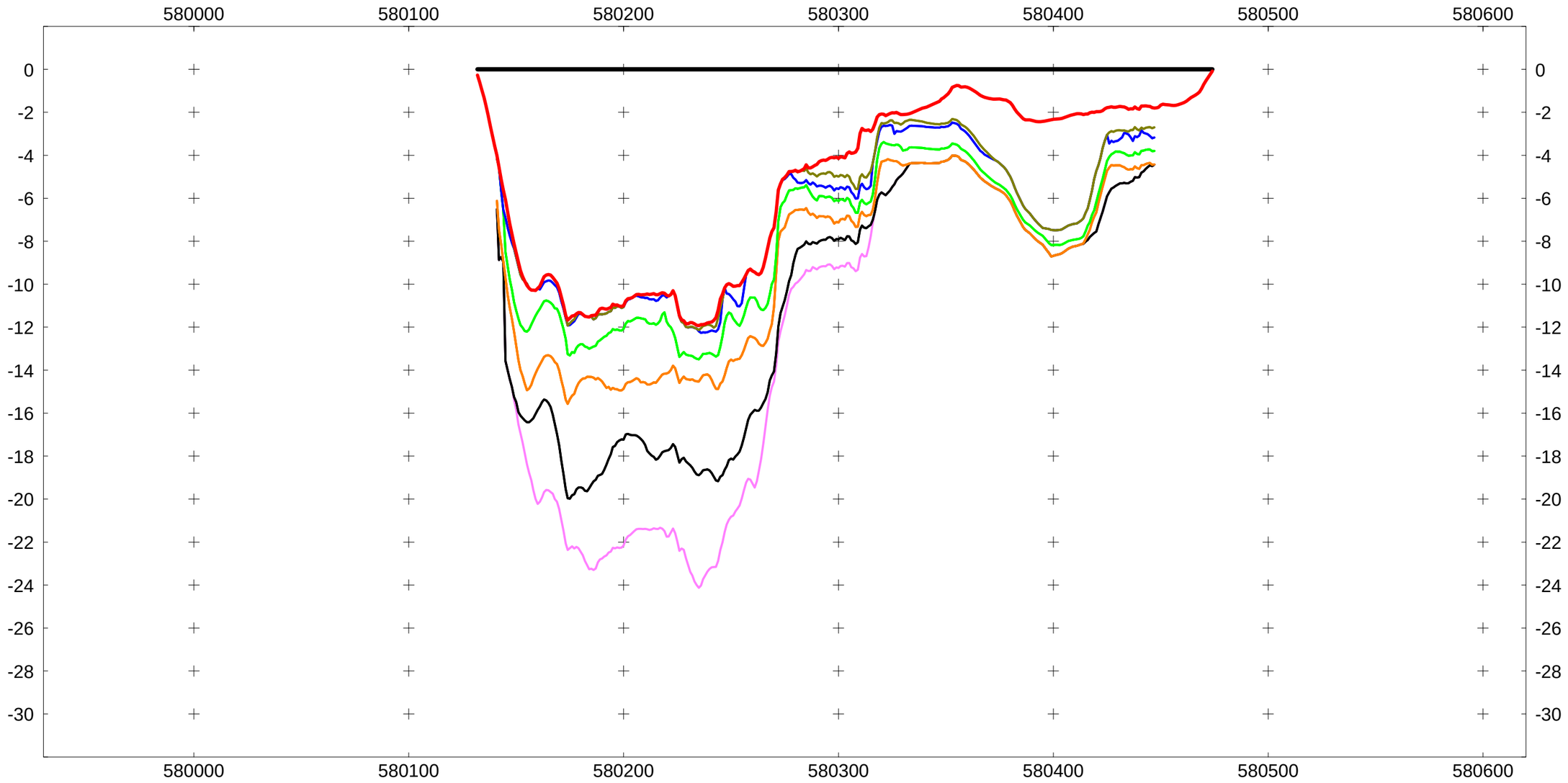
CH2M HILL LTD.

CROSS VALLEY DAM POND
Bathymetric and Sub-Bottom Survey
Cross section at UTMN 6914400

Surveyed Oct 20-26, 2015
Faro Mining Complex
NTS: 105k/06

Surveyed by: SS & DE
Map drawn: Dec 10, 2015
NAD83 UTM Zone 8N

AURORA GEOSCIENCES LTD.



LEGEND

- Water :
- Bottom :
- Feature B :
- Feature C :
- Feature D :
- Feature E :
- Feature F :
- Feature G :

Scale (horizontal)

25 0 25 50

(meters)

Scale (vertical) exaggeration X10

2.5 0 2.5 5

(meters)

X-AXIS - NAD83 (CSRS) UTM Zone 8N Easting

Y-AXIS - Depth relative to Water Surface

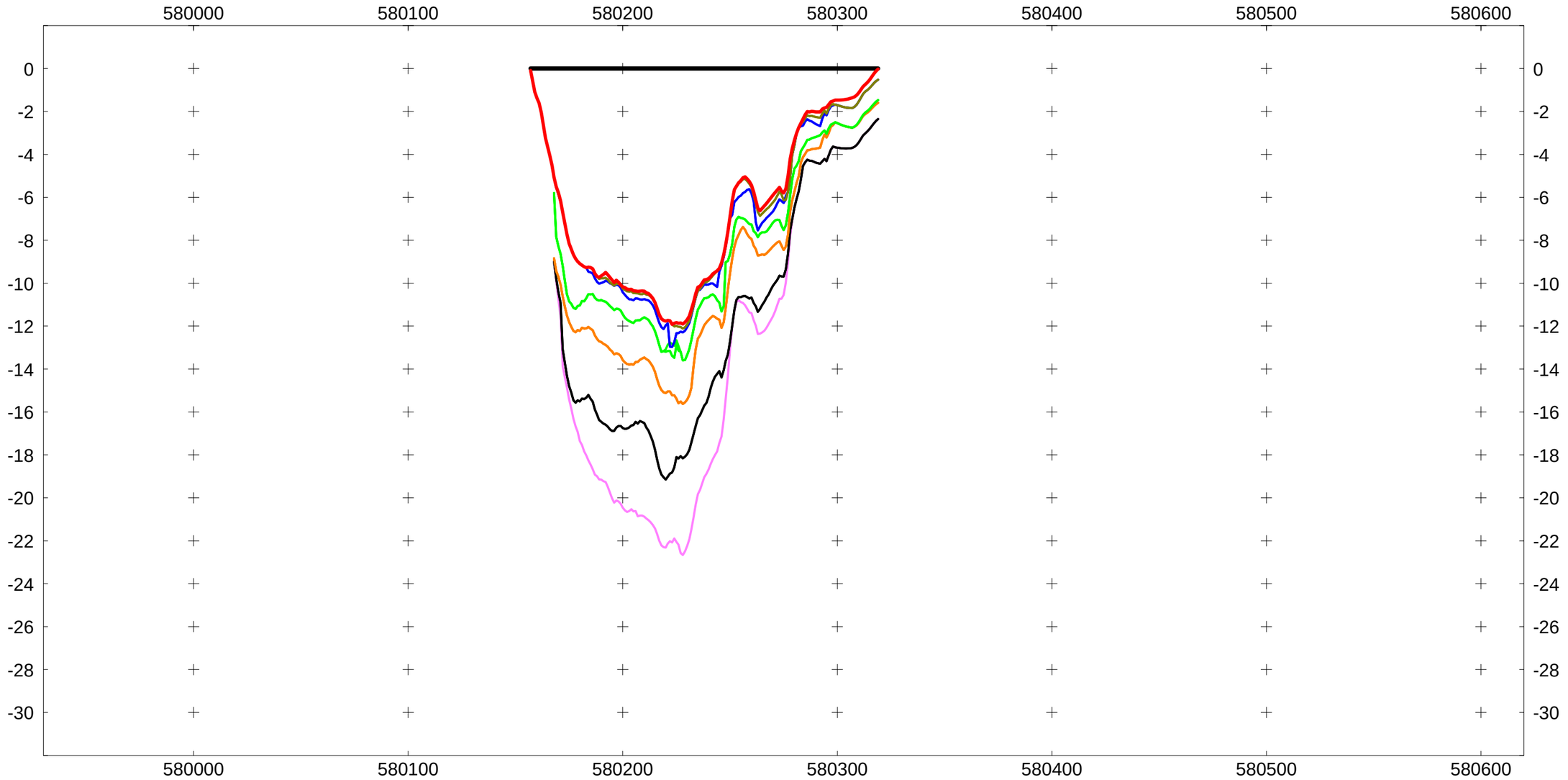
CH2M HILL LTD.

CROSS VALLEY DAM POND
Bathymetric and Sub-Bottom Survey
Cross section at UTMN 6914450

Surveyed Oct 20-26, 2015
Faro Mining Complex
NTS: 105k/06

Surveyed by: SS & DE
Map drawn: Dec 10, 2015
NAD83 UTM Zone 8N

AURORA GEOSCIENCES LTD.



LEGEND

- Water :
- Bottom :
- Feature B :
- Feature C :
- Feature D :
- Feature E :
- Feature F :
- Feature G :

Scale (horizontal)

25 0 25 50

(meters)

Scale (vertical) exaggeration X10

2.5 0 2.5 5

(meters)

X-AXIS - NAD83 (CSRS) UTM Zone 8N Easting

Y-AXIS - Depth relative to Water Surface

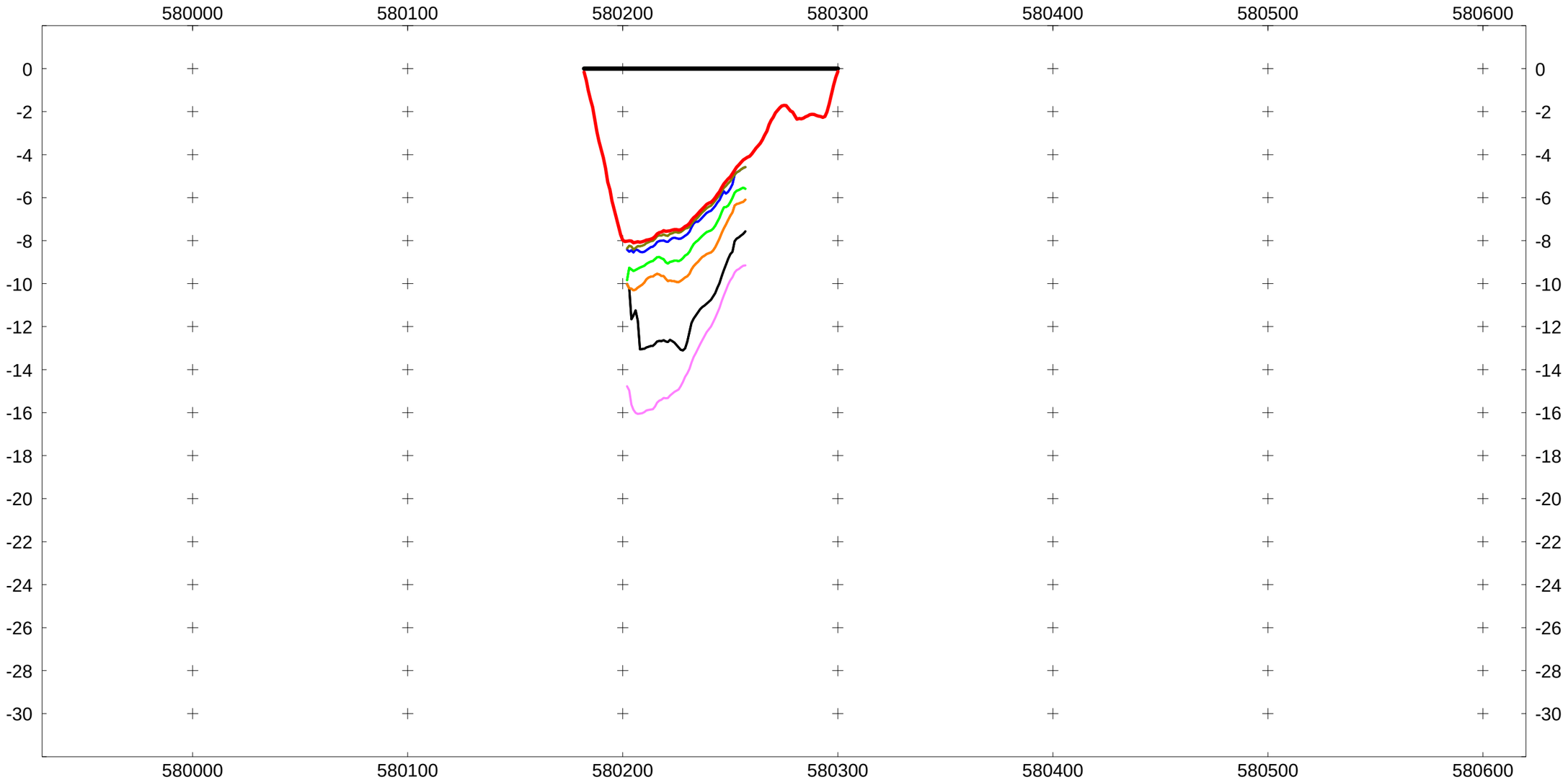
CH2M HILL LTD.

CROSS VALLEY DAM POND
Bathymetric and Sub-Bottom Survey
Cross section at UTMN 6914500

Surveyed Oct 20-26, 2015
Faro Mining Complex
NTS: 105k/06

Surveyed by: SS & DE
Map drawn: Dec 10, 2015
NAD83 UTM Zone 8N

AURORA GEOSCIENCES LTD.



LEGEND

- Water :
- Bottom :
- Feature B :
- Feature C :
- Feature D :
- Feature E :
- Feature F :
- Feature G :

Scale (horizontal)

25 0 25 50

(meters)

Scale (vertical) exaggeration X10

2.5 0 2.5 5

(meters)

X-AXIS - NAD83 (CSRS) UTM Zone 8N Easting

Y-AXIS - Depth relative to Water Surface

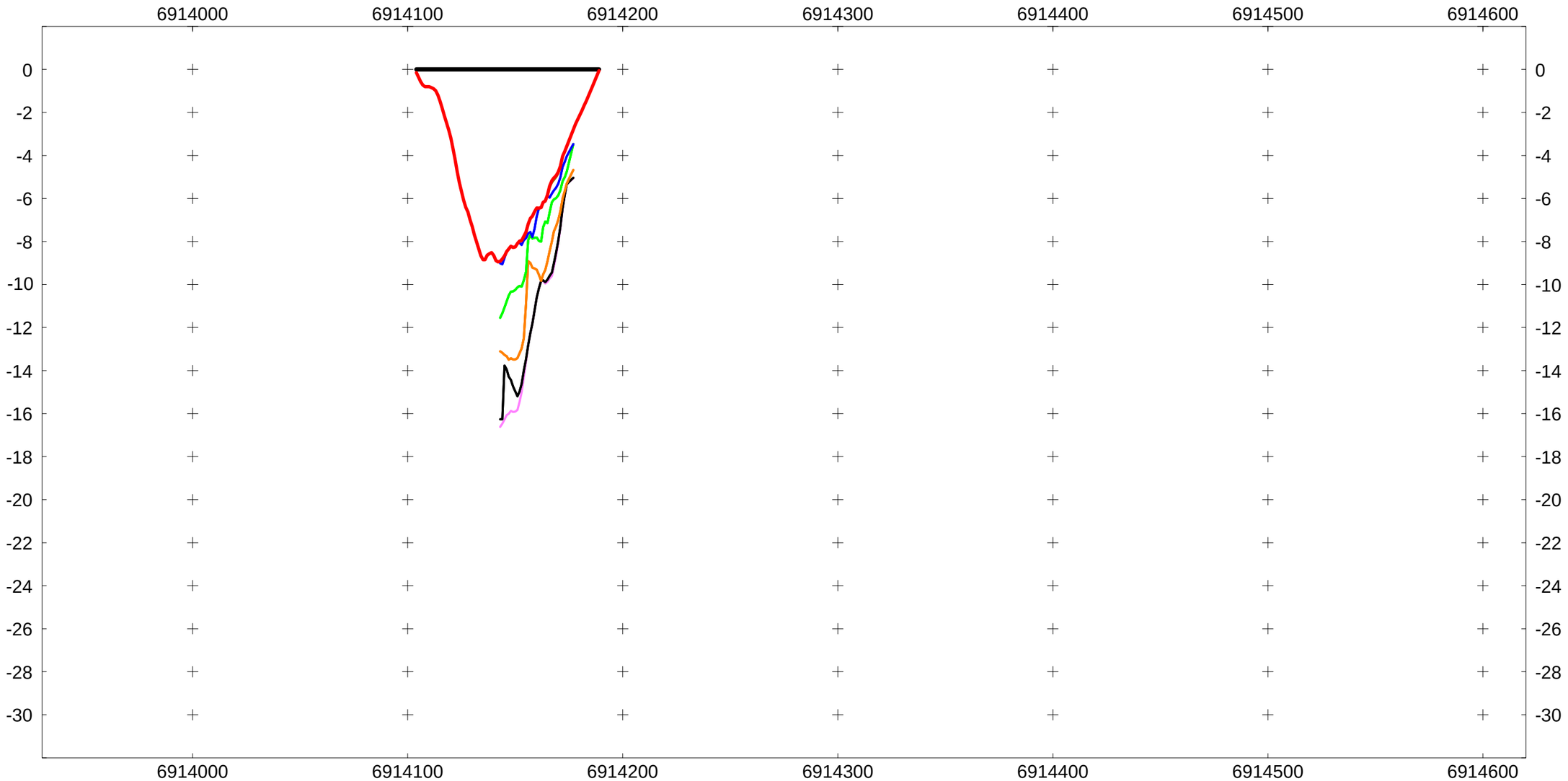
CH2M HILL LTD.

CROSS VALLEY DAM POND
Bathymetric and Sub-Bottom Survey
Cross section at UTMN 6914550

Surveyed Oct 20-26, 2015
Faro Mining Complex
NTS: 105k/06

Surveyed by: SS & DE
Map drawn: Dec 10, 2015
NAD83 UTM Zone 8N

AURORA GEOSCIENCES LTD.



LEGEND

Water :
Bottom :
Feature B :
Feature C :
Feature D :
Feature E :
Feature F :
Feature G :

Scale (horizontal)

25 0 25 50
(meters)

Scale (vertical) exaggeration X10

2.5 0 2.5 5
(meters)

X-AXIS - NAD83 (CSRS) UTM Zone 8N Northing

Y-AXIS - Depth relative to Water Surface

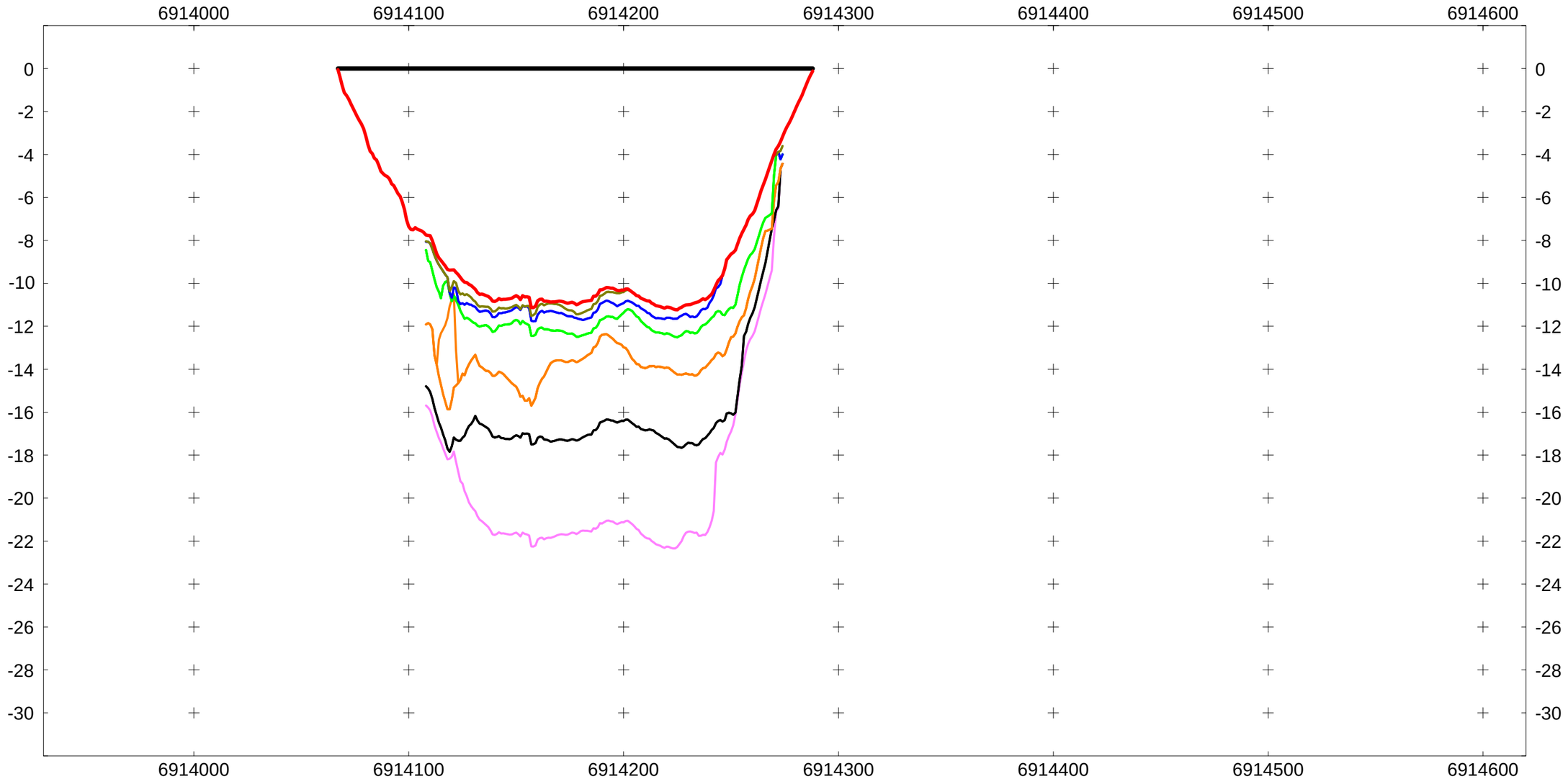
CH2M HILL LTD.

CROSS VALLEY DAM POND
Bathymetric and Sub-Bottom Survey
Cross section at UTME 580000

Surveyed Oct 20-26, 2015
Faro Mining Complex
NTS: 105k/06

Surveyed by: SS & DE
Map drawn: Dec 10, 2015
NAD83 UTM Zone 8N

AURORA GEOSCIENCES LTD.



LEGEND

Water :
Bottom :
Feature B :
Feature C :
Feature D :
Feature E :
Feature F :
Feature G :

Scale (horizontal)

25 0 25 50
(meters)

Scale (vertical) exaggeration X10

2.5 0 2.5 5
(meters)

X-AXIS - NAD83 (CSRS) UTM Zone 8N Northing

Y-AXIS - Depth relative to Water Surface

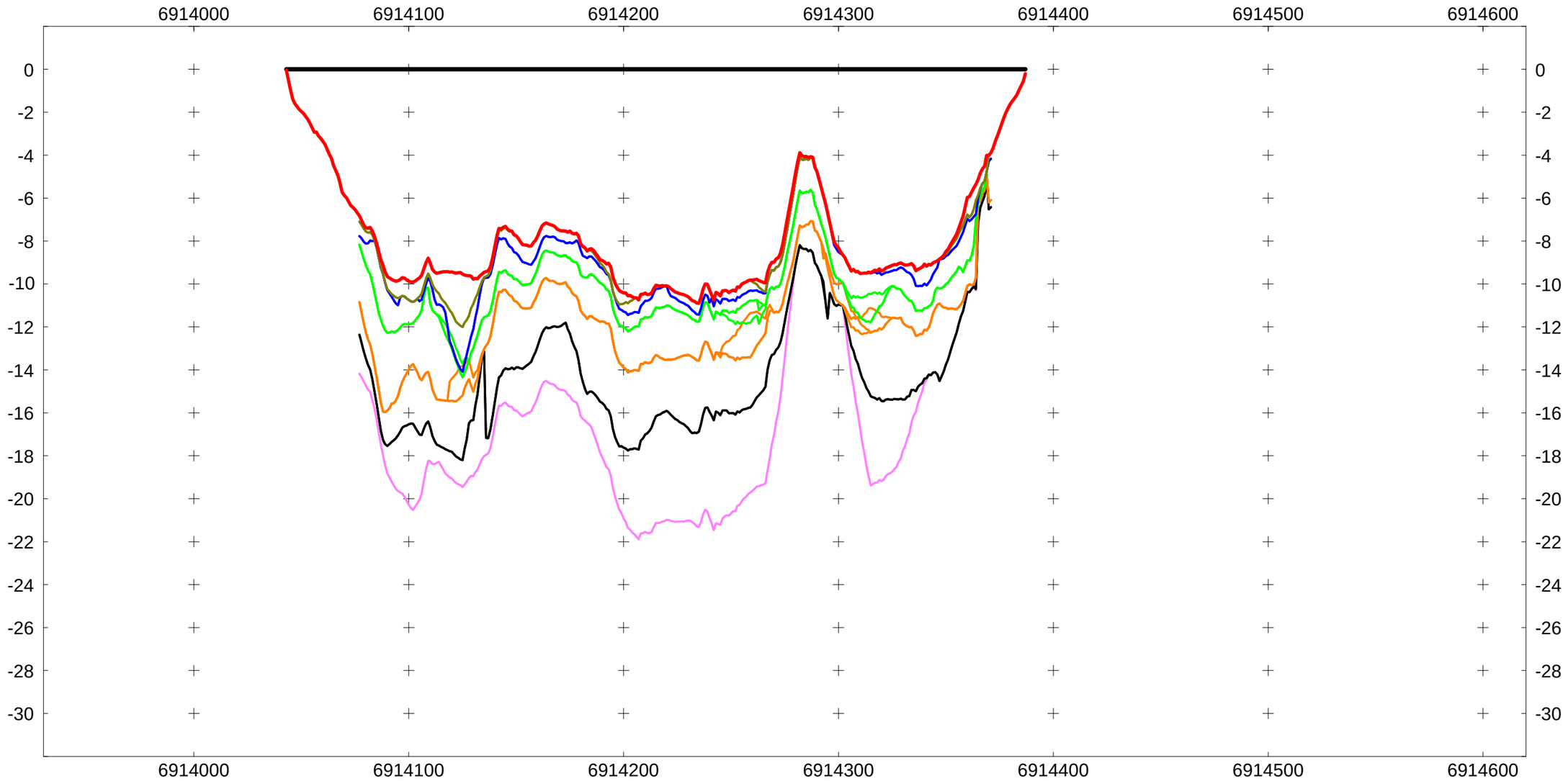
CH2M HILL LTD.

CROSS VALLEY DAM POND
Bathymetric and Sub-Bottom Survey
Cross section at UTME 580050

Surveyed Oct 20-26, 2015
Faro Mining Complex
NTS: 105k/06

Surveyed by: SS & DE
Map drawn: Dec 10, 2015
NAD83 UTM Zone 8N

AURORA GEOSCIENCES LTD.



LEGEND

- Water :
- Bottom :
- Feature B :
- Feature C :
- Feature D :
- Feature E :
- Feature F :
- Feature G :

Scale (horizontal)

25 0 25 50

(meters)

Scale (vertical) exaggeration X10

2.5 0 2.5 5

(meters)

X-AXIS - NAD83 (CSRS) UTM Zone 8N Northing

Y-AXIS - Depth relative to Water Surface

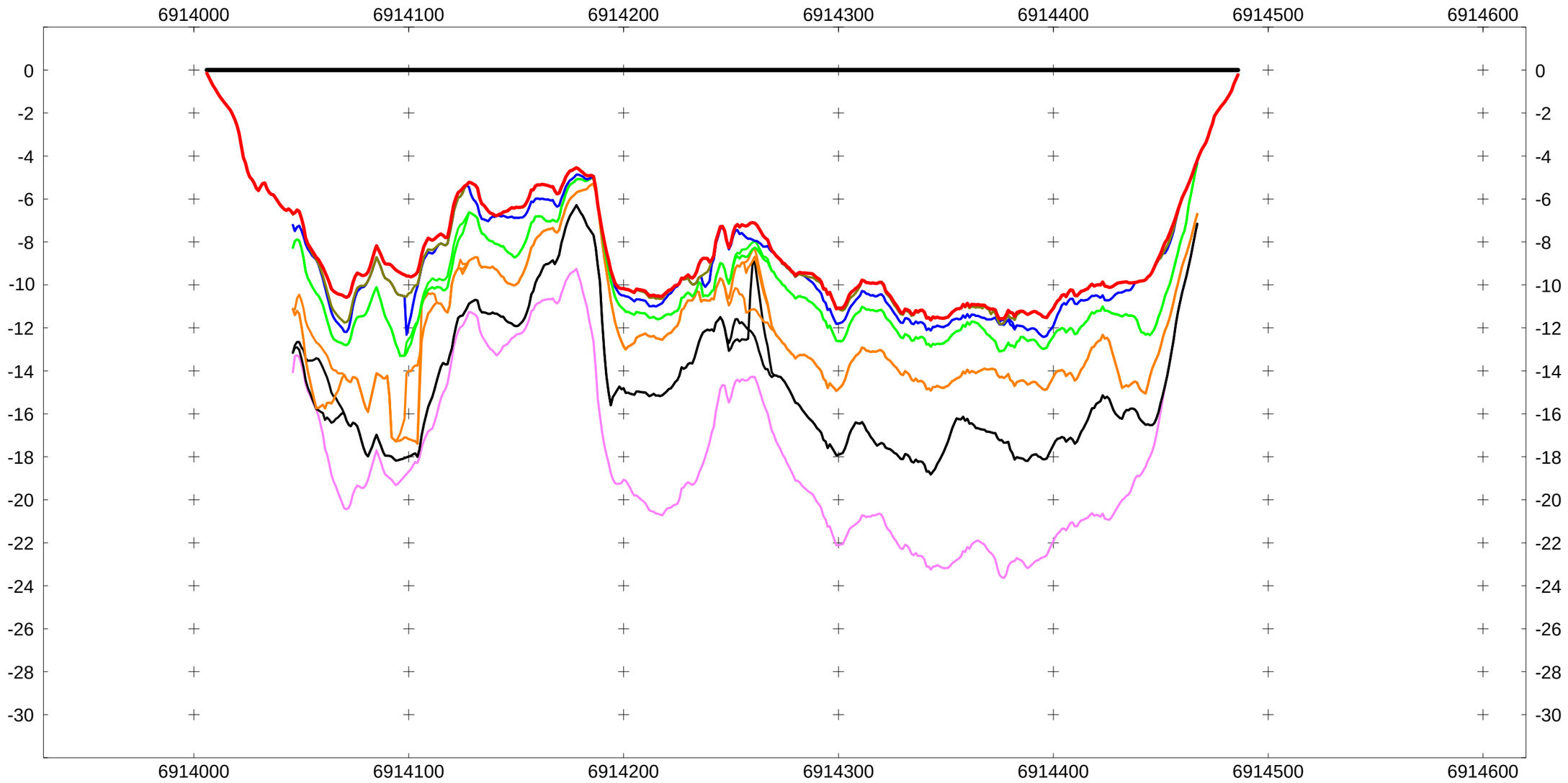
CH2M HILL LTD.

CROSS VALLEY DAM POND
Bathymetric and Sub-Bottom Survey
Cross section at UTME 580100

Surveyed Oct 20-26, 2015
Faro Mining Complex
NTS: 105k/06

Surveyed by: SS & DE
Map drawn: Dec 10, 2015
NAD83 UTM Zone 8N

AURORA GEOSCIENCES LTD.



LEGEND

- Water :
- Bottom :
- Feature B :
- Feature C :
- Feature D :
- Feature E :
- Feature F :
- Feature G :

Scale (horizontal)

25 0 25 50

(meters)

Scale (vertical) exaggeration X10

2.5 0 2.5 5

(meters)

X-AXIS - NAD83 (CSRS) UTM Zone 8N Northing

Y-AXIS - Depth relative to Water Surface

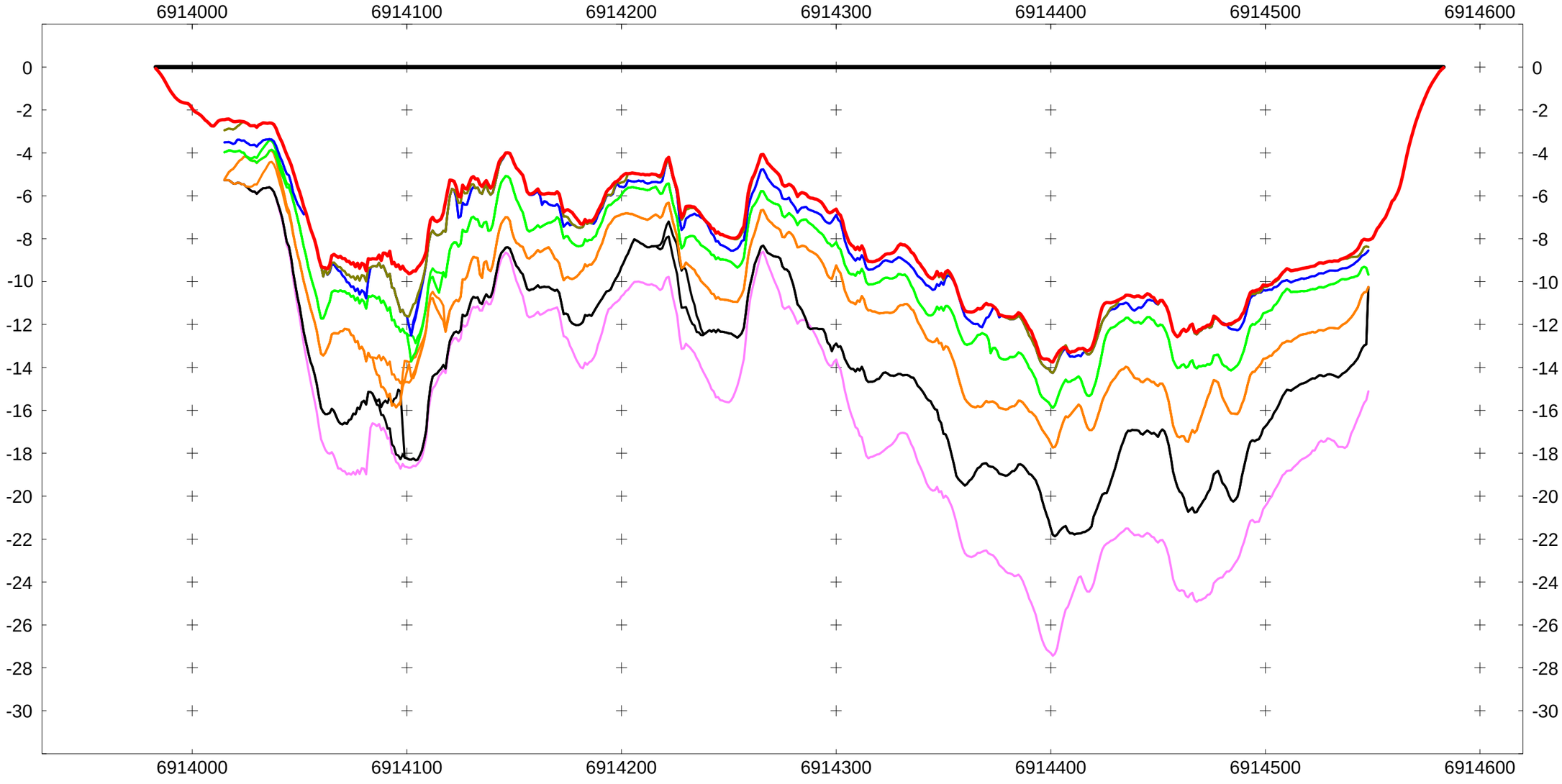
CH2M HILL LTD.

CROSS VALLEY DAM POND
Bathymetric and Sub-Bottom Survey
Cross section at UTME 580150

Surveyed Oct 20-26, 2015
Faro Mining Complex
NTS: 105k/06

Surveyed by: SS & DE
Map drawn: Dec 10, 2015
NAD83 UTM Zone 8N

AURORA GEOSCIENCES LTD.



LEGEND

- Water :
- Bottom :
- Feature B :
- Feature C :
- Feature D :
- Feature E :
- Feature F :
- Feature G :

Scale (horizontal)

25 0 25 50

(meters)

Scale (vertical) exaggeration X10

2.5 0 2.5 5

(meters)

X-AXIS - NAD83 (CSRS) UTM Zone 8N Northing

Y-AXIS - Depth relative to Water Surface

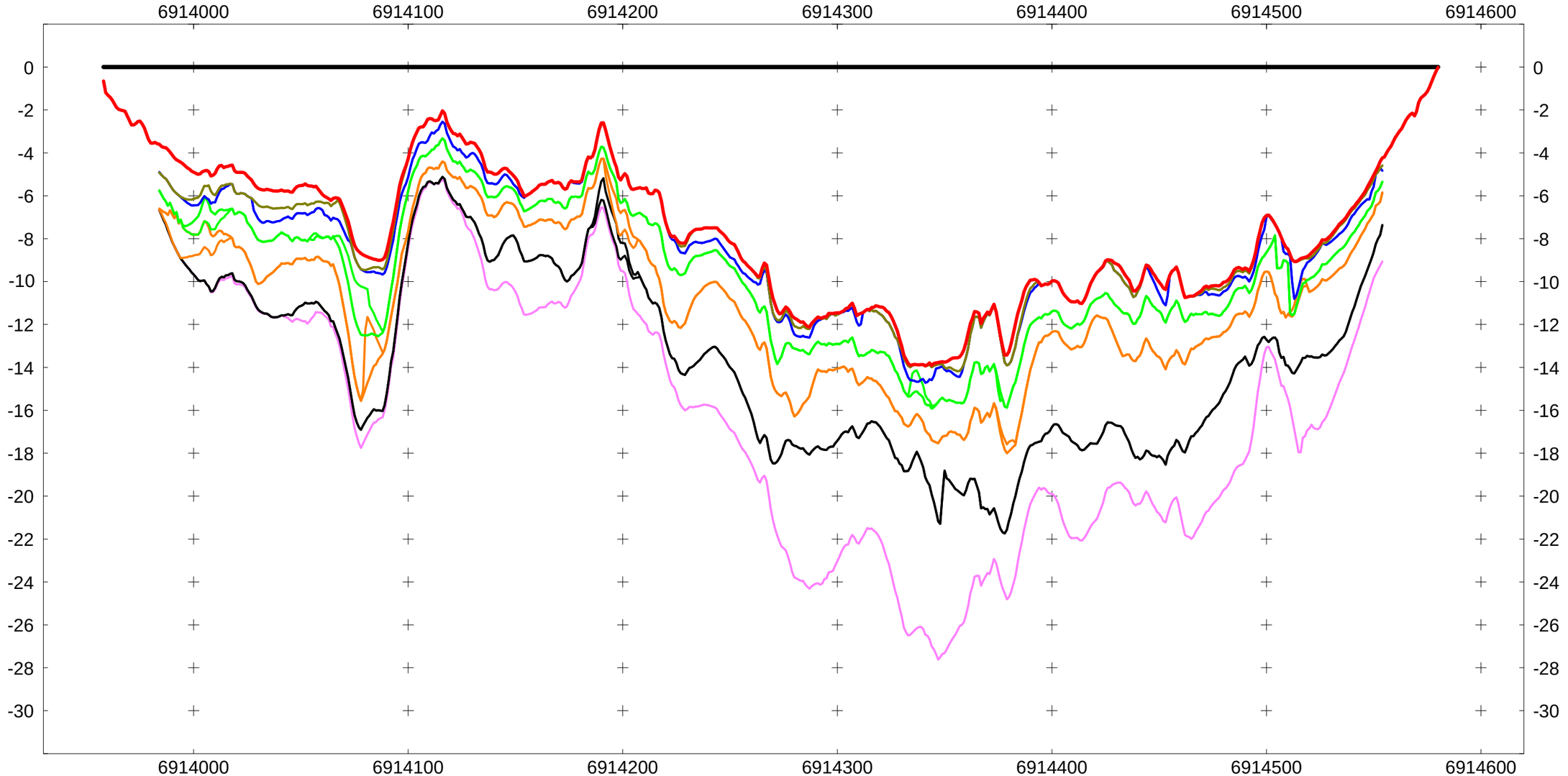
CH2M HILL LTD.

CROSS VALLEY DAM POND
Bathymetric and Sub-Bottom Survey
Cross section at UTME 580200

Surveyed Oct 20-26, 2015
Faro Mining Complex
NTS: 105k/06

Surveyed by: SS & DE
Map drawn: Dec 10, 2015
NAD83 UTM Zone 8N

AURORA GEOSCIENCES LTD.



LEGEND

- Water :
- Bottom :
- Feature B :
- Feature C :
- Feature D :
- Feature E :
- Feature F :
- Feature G :

Scale (horizontal)

25 0 25 50

(meters)

Scale (vertical) exaggeration X10

2.5 0 2.5 5

(meters)

X-AXIS - NAD83 (CSRS) UTM Zone 8N Northing

Y-AXIS - Depth relative to Water Surface

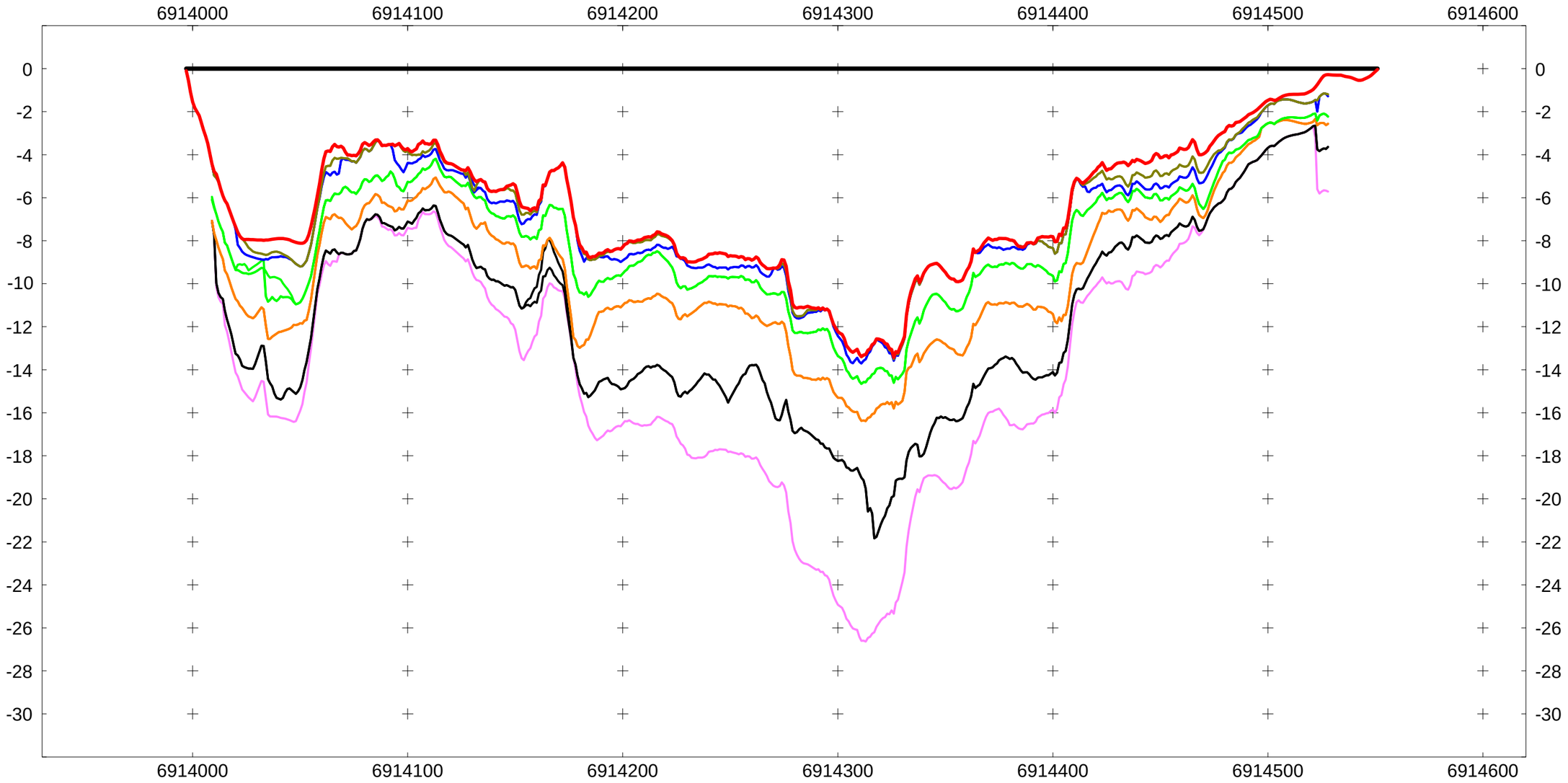
CH2M HILL LTD.

CROSS VALLEY DAM POND
Bathymetric and Sub-Bottom Survey
Cross section at UTME 580250

Surveyed Oct 20-26, 2015
Faro Mining Complex
NTS: 105k/06

Surveyed by: SS & DE
Map drawn: Dec 10, 2015
NAD83 UTM Zone 8N

AURORA GEOSCIENCES LTD.



LEGEND

Water :
Bottom :
Feature B :
Feature C :
Feature D :
Feature E :
Feature F :
Feature G :

Scale (horizontal)

25 0 25 50
(meters)

Scale (vertical) exaggeration X10

2.5 0 2.5 5
(meters)

X-AXIS - NAD83 (CSRS) UTM Zone 8N Northing

Y-AXIS - Depth relative to Water Surface

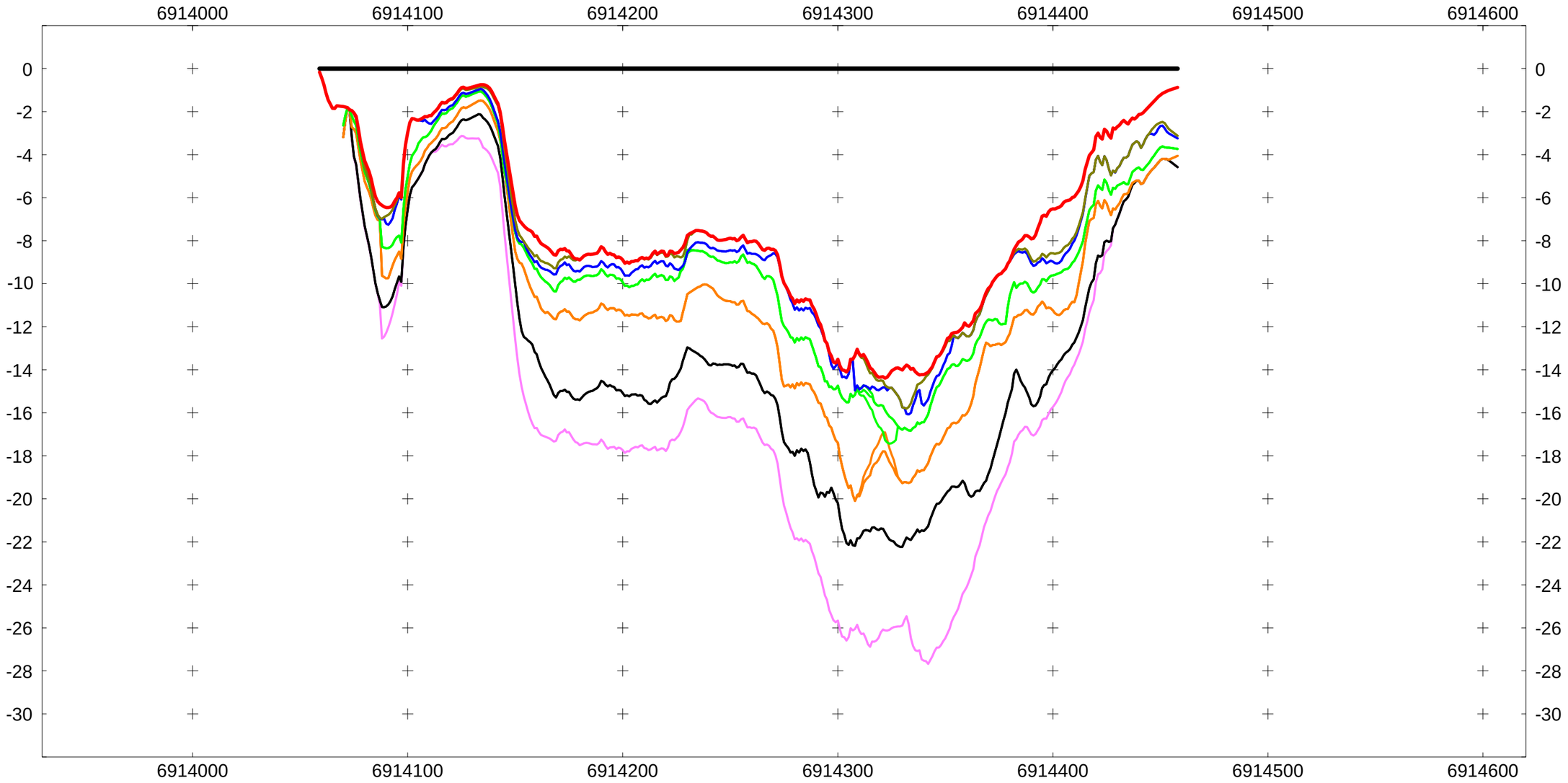
CH2M HILL LTD.

CROSS VALLEY DAM POND
Bathymetric and Sub-Bottom Survey
Cross section at UTME 580300

Surveyed Oct 20-26, 2015
Faro Mining Complex
NTS: 105k/06

Surveyed by: SS & DE
Map drawn: Dec 10, 2015
NAD83 UTM Zone 8N

AURORA GEOSCIENCES LTD.



LEGEND

- Water :
- Bottom :
- Feature B :
- Feature C :
- Feature D :
- Feature E :
- Feature F :
- Feature G :

Scale (horizontal)

25 0 25 50

(meters)

Scale (vertical) exaggeration X10

2.5 0 2.5 5

(meters)

X-AXIS - NAD83 (CSRS) UTM Zone 8N Northing

Y-AXIS - Depth relative to Water Surface

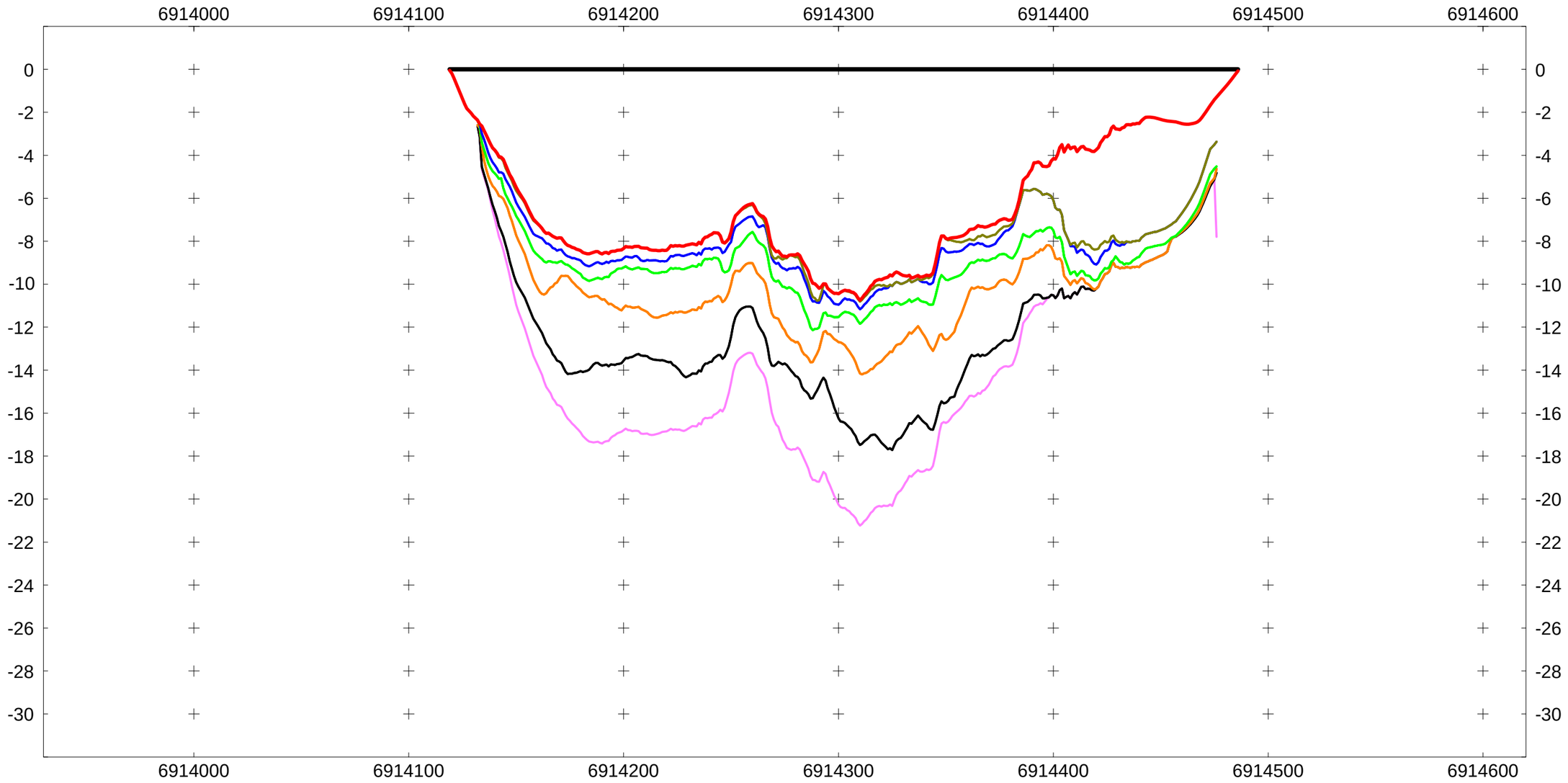
CH2M HILL LTD.

CROSS VALLEY DAM POND
Bathymetric and Sub-Bottom Survey
Cross section at UTME 580350

Surveyed Oct 20-26, 2015
Faro Mining Complex
NTS: 105k/06

Surveyed by: SS & DE
Map drawn: Dec 10, 2015
NAD83 UTM Zone 8N

AURORA GEOSCIENCES LTD.



LEGEND

- Water :
- Bottom :
- Feature B :
- Feature C :
- Feature D :
- Feature E :
- Feature F :
- Feature G :

Scale (horizontal)

25 0 25 50

(meters)

Scale (vertical) exaggeration X10

2.5 0 2.5 5

(meters)

X-AXIS - NAD83 (CSRS) UTM Zone 8N Northing

Y-AXIS - Depth relative to Water Surface

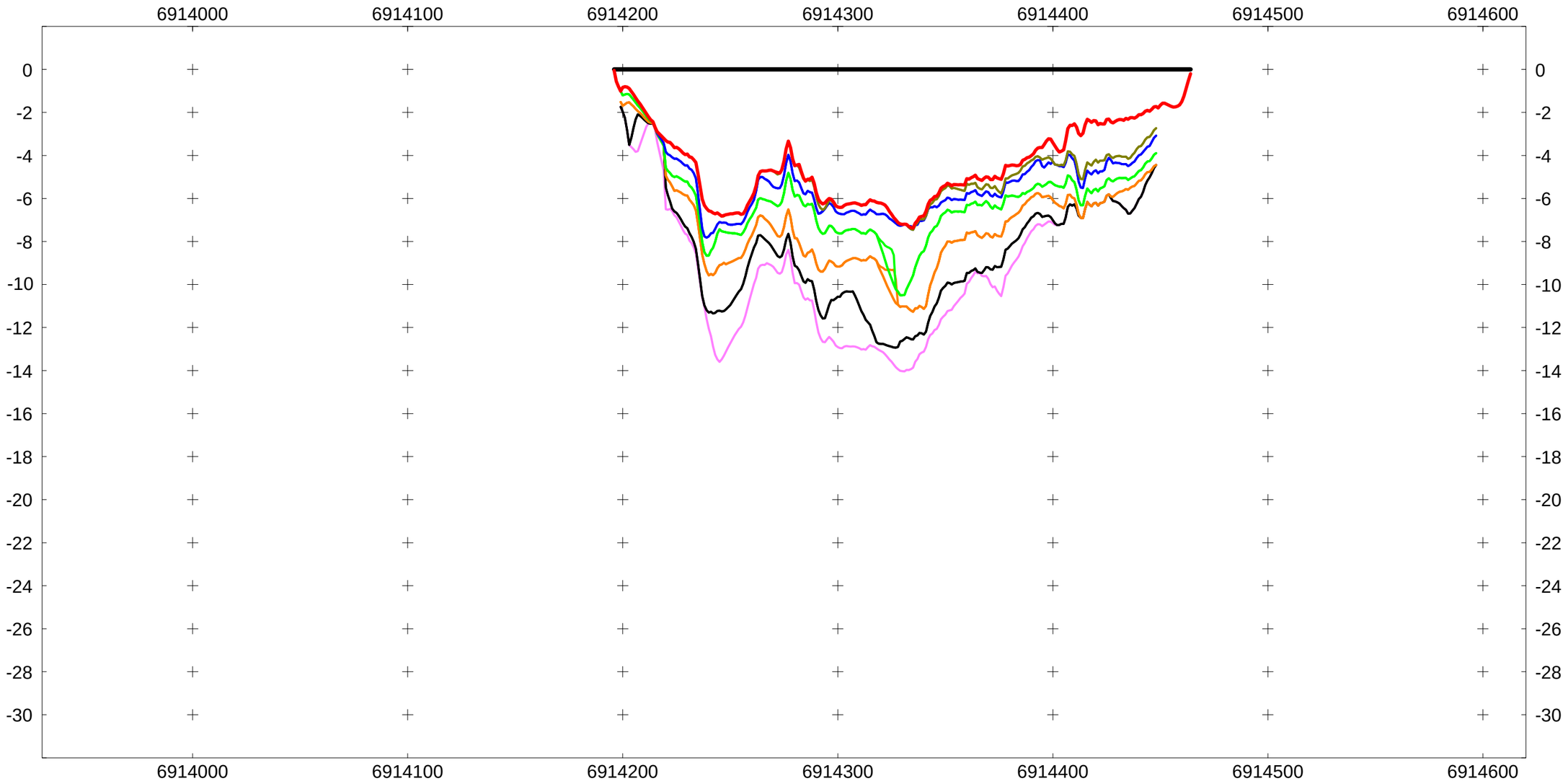
CH2M HILL LTD.

CROSS VALLEY DAM POND
Bathymetric and Sub-Bottom Survey
Cross section at UTME 580400

Surveyed Oct 20-26, 2015
Faro Mining Complex
NTS: 105k/06

Surveyed by: SS & DE
Map drawn: Dec 10, 2015
NAD83 UTM Zone 8N

AURORA GEOSCIENCES LTD.



LEGEND

- Water :
- Bottom :
- Feature B :
- Feature C :
- Feature D :
- Feature E :
- Feature F :
- Feature G :

Scale (horizontal)

25 0 25 50

(meters)

Scale (vertical) exaggeration X10

2.5 0 2.5 5

(meters)

X-AXIS - NAD83 (CSRS) UTM Zone 8N Northing

Y-AXIS - Depth relative to Water Surface

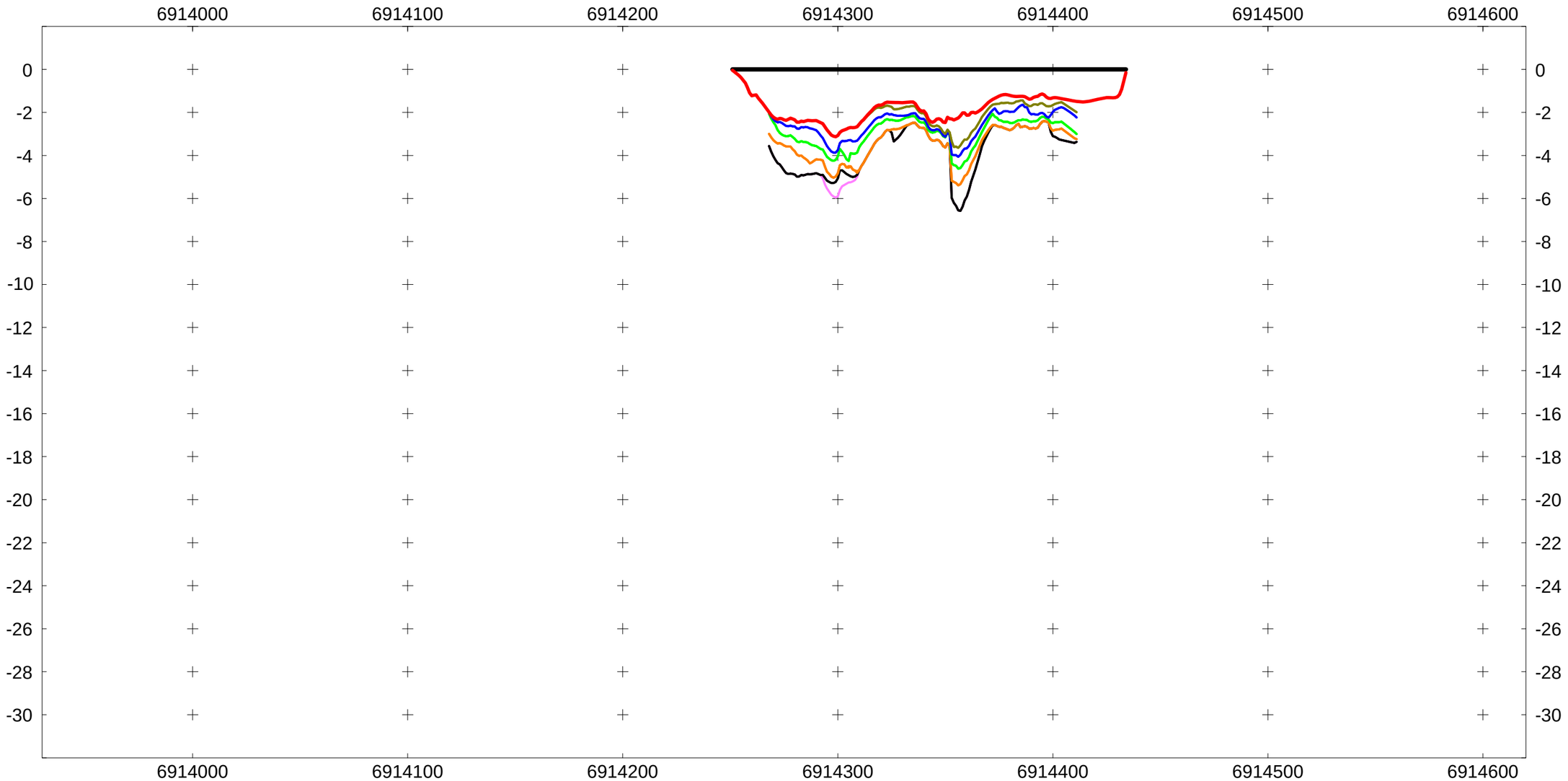
CH2M HILL LTD.

CROSS VALLEY DAM POND
Bathymetric and Sub-Bottom Survey
Cross section at UTME 580450

Surveyed Oct 20-26, 2015
Faro Mining Complex
NTS: 105k/06

Surveyed by: SS & DE
Map drawn: Dec 10, 2015
NAD83 UTM Zone 8N

AURORA GEOSCIENCES LTD.



LEGEND

- Water :
- Bottom :
- Feature B :
- Feature C :
- Feature D :
- Feature E :
- Feature F :
- Feature G :

Scale (horizontal)

25 0 25 50

(meters)

Scale (vertical) exaggeration X10

2.5 0 2.5 5

(meters)

X-AXIS - NAD83 (CSRS) UTM Zone 8N Northing

Y-AXIS - Depth relative to Water Surface

CH2M HILL LTD.

CROSS VALLEY DAM POND
Bathymetric and Sub-Bottom Survey
Cross section at UTME 580500

Surveyed Oct 20-26, 2015
Faro Mining Complex
NTS: 105k/06

Surveyed by: SS & DE
Map drawn: Dec 10, 2015
NAD83 UTM Zone 8N

AURORA GEOSCIENCES LTD.

Appendix III

EdgeTech jsf format

EDGETECH SONAR DATA FILE FORMAT

DESCRIPTION OF THE EDGETECH (.jsf) FILE FORMAT

Document No. 990-0000048-1000

Revision: 1.8 / October 2009

Email: sales@edgetech.com
Web: http://www.edgetech.com

4 Little Brook Road
West Wareham, MA 02576
Tel: (508) 291-0057
Fax: (508) 291-2491

141 Holland Drive, Suite 1
Boca Raton, FL 33487
Tel: (561) 995-7767
Fax: (561) 995-7761

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INTRODUCTION

EdgeTech topsides by default record in JSF file format, which consists of a set of messages. Each message begins with a 16-byte header which indicates the type of data to follow and its size. Different types of data will have different message numbers (Message Type field). Sonar data is recorded on a per-channel basis. Therefore, for a single frequency side-scan system there will be two messages per ping – one for port (channel 0) and one for starboard (channel 1). Other types of sensors (such as pitch roll) will have their own message numbers as well, and will similarly have a single message per reading set. A typical file might have the following:

Header1: Sonar Data for Subsystem SSL and channel 0 (Port Side)
Sonar Data Header for Message 1 (Ping number 1, Port, Time Stamp)
Sonar Data for Message 1 (16-bit integers – one per sample)

Header2: Sonar Data for Subsystem SSL and channel 1 (Starboard Side)
Sonar Data Header for Message 2 (Ping number 1, Starboard, Time Stamp)
Sonar Data for Message 2 (16-bit integers – one per sample)

Header3: Pitch Roll reading
Serial Device Standard Header (Time Stamp)
Pitch Roll Data Structure

Header4: Sonar Data for Subsystem SB
Sonar Data Header for Message 4 (Ping number 1, Time Stamp)
Sonar Data for Message 4 (16-bit integer pairs – one pair per sample)

Since data is stored in a binary format, the byte ordering of 16-bit and 32-bit values is important. JSF uses little endian (Intel) format for binary data where the least significant bytes are stored first. This is the native format for Intel x86 computers such as the IBM PC and compatibles. If data is read on a big endian machine (such as most Sun Workstations), you will need to byte reverse the data so that the 2 bytes of a 16-bit value are flipped, and the 4 bytes of a 32-bit value are flipped (Bytes 0, 1, 2, 3 become Bytes 3, 2, 1, 0).

EdgeTech topsides often have an option to limit the size of created files, and will generate a sequence of files for a long data run. In this case, the concatenation of these files will yield a valid JSF file for a longer run time if desired.

This document describes the messages of common interest to those processing JSF files. It is not intended to be a complete description of all valid messages.

C/C++ Code Example for Reading a JSF File

Here is a C code example for reading an entire JSF file.

```
void readFile(char *fileName)
{
  FILE *fid;
  int i;
  SonarMessageHeaderType hdr; /* Basic 16-byte message header */

  fid = fopen(fileName, “rb”);
  if (fid == NULL) return;

  while(!feof(fid))
  {
    if (fread(&hdr, sizeof(hdr), 1, fid) != 1)
      break;
    if (hdr.startOfMessage != SONAR_MESSAGE_HEADER_START)
    {
      printf(“Invalid file format\n”);
      break;
    }
    for(i = 0; i < hdr.byteCount; i++)
    {
      if (getc(fid) == EOF)
      {
        printf(“Invalid file format\n”);
        break;
      }
    }
    printf(“Message Type %d\n”, hdr.sonarMessage);
  }
  fclose(fid);
}
```

Details of data structure of the types of messages in a JSF file are described below.

16-Byte Message Header

A JSF file is a collection of messages, and every message in a JSF file begins with a sixteen byte long header. It identifies the type and size of the message, as well as the originating subsystem and channel.

Byte Offsets	Description	Size
0 – 1	Marker for the Start of Header (always 0x1601)	UINT16
2	Version number of protocol used (e.g.10)	UINT8
3	Session Identifier	UINT8
4 – 5	Message Type (e.g. 80 = Sonar Trace Data)	UINT16
6	Command Type 2 = Normal data source	UINT8
7	Subsystem Number 0 = Sub-bottom 20 = Single or Lower Frequency Side Scan 21 = Higher Frequency Side Scan	UINT8
8	Channel for a Multi-Channel Subsystem For Side Scan Subsystems, 0 = Port, 1 = Starboard For Serial Ports: Port #	UINT8
9	Sequence Number	UINT8
10 – 11	Reserved	UINT16
12 – 15	Size of following Message in Bytes	UINT32

Every message header begins (bytes 0 - 1) with a 0x1601 start of a message header marker. This serves as a sanity check during file processing.

The Protocol level (byte 2) indicates which revision of this specification was used to write that message. Messages of differing protocol levels may be interspersed in the same file. Maintaining backward compatibility in the public interface is a priority. Protocol level changes involve additional messages or changes to the non-public portion of the interface.

The session identifier (byte 3) is used for internal routing and can be ignored.

The Message Type field (bytes 4 - 5) defines the type of data to follow. Some data formats of interest are detailed in the following sections. If the Message Type field contains an unwanted or unknown (i.e. not defined below) type, use the Size of the message (bytes 12 – 15) to skip over the data to the next Message Header.

The message protocol is used for command and control as well as data. The command type field (byte 6) while of interest during real time operation can normally be ignored when reading JSF files.

The subsystem number (byte 7) is used to determine the source of the data. Common subsystem assignments are as follows:

Sub-bottom data - 0

Single frequency sidescan data - 20

Lower frequency data of a dual frequency sidescan	- 20
Higher frequency data of a dual frequency sidescan	- 21
Raw serial data	- 100
Parsed serial data	- 101

The channel (byte 8) is zero for single channel (most sub-bottom) systems. For most sidescan systems, it is zero for port and one for starboard. For serial port data the channel number is the logical port number, which often differs from the physical COM port in use.

The sequence number (byte 9) and reserved fields (bytes 10 - 11) can normally be ignored when reading JSF files.

The byte count (bytes 12 – 15) is the number of bytes until the next start of message header. This is the amount of additional data to read if processing the current message, or the amount of data to skip over if the current message is not of interest.

Message Type 80: Sonar Data Message (jsfdefs.h)

The Sonar Data Message consists of a single ping (receiver sounding period) of data for a single channel (such as Port Side Low Frequency Side-Scan). Standard sidescan sub-systems have two channels of data, port and starboard. Standard sub-bottom sub-systems have a single channel of data. Data files with higher channel counts exist. Which fields have data present depends on the system used and data acquisition procedures. This message may contain data from multiple non-acoustic sensors. Non-acoustic data contained in this message will often not be time interpolated. EdgeTech strongly recommends that if high positional or situational accuracy is required that the individual sensor messages be processed. Otherwise, this may be the only message that will need to be interpreted in a JSF file. Validity flags indicate which auxiliary fields are populated. By convention, if a value is not present the field is set to 0.

A Sonar Data Message consists of a 240-byte header, which is very similar to a traditional SEGY header, and the actual acoustic sample data follows the header. This 240-byte header described below:

Byte Offsets	Description	Size
0 – 3	Ping Time in seconds [since the start of time based on time() function] (1/1/1970) (added in protocol version 8)[1]	INT32
4 – 7	Starting Depth (window offset) in samples - usually zero	UINT32
8 – 11	Ping Number (increments with each ping)	UINT32
12 – 15	Reserved – Do not use	INT16 x 2
16 – 17	MSBs – Most Significant Bits – High order bits to extend 16 bit unsigned short values to 20 bits. The 4 MSB bits become the most significant portion of the new 20 bit value. Bits 0 - 3 – start frequency Bits 4 - 7 – end frequency Bits 8 – 11 – samples in this packet Bits 12 – 15 – reserved (added in protocol version 10)(see description below)	UINT16
18 – 27	Reserved – Do not use	INT16 x 5
28 – 29	ID Code (always 1) 1 = Seismic Data	INT16
30 – 31	Validity Flag (See mapping below)	UINT16
32 – 33	Reserved – Do not use	UINT16
34 – 35	Data Format 0 = 1 short per sample - Envelope Data 1 = 2 shorts per sample - Analytic Signal Data, (Real, Imaginary)	INT16
36 – 37	Distance from Antenna to Tow point in Centimeters, Aft + (Fish Aft = +)	INT16
38 – 39	Distance from Antenna to Tow Point in Centimeters, Starboard + (Fish to Starboard = +)	INT16
40 – 43	Reserved – Do not use	INT16 x 2

The Most Significant Bits fields are used to extend sixteen bit integers to twenty bits. These are added as needed when the range of possible values exceeds what can be stored in a sixteen bit integer. The simplest way to use these additional bits is to treat the value as a 32 bit integer, the existing value becomes the least significant 16 bits, the MSB field becomes the next most significant 4 bits with the most significant 12 bits set to zeros.

[1] NOTE: For protocol revisions 7 and before this field was always zero.

Validity flags bitmap:
Bit 0: Lat Lon or XY valid
Bit 1: Course valid
Bit 2: Speed valid
Bit 3: Heading valid
Bit 4: Pressure valid
Bit 5: Pitch roll valid
Bit 6: Altitude valid
Bit 7: Reserved
Bit 8: Water temperature valid
Bit 9: Depth valid
Bit 10: Annotation valid
Bit 11: Cable counter valid
Bit 12: KP valid
Bit 13: Position interpolated

Navigation Data

This is most often the position at the last navigation fix. See the time NMEA Navigation Data fields for the time of the fix. On most systems, position is not time interpolated and should not be used for mosaicing or other processing requiring high accuracy positioning. Validity flags indicate whether these fields are valid and interpolated. The representation of the navigation data depends on the coordinate-units field. For Latitude / Longitude representations, a positive value designates east of the Greenwich Meridian or north of the equator.

Byte Offsets	Description	Size
44 – 47	Kilometer of pipe (see bytes 30-31)	FLOAT32
48 – 79	Reserved – Do not use	INT16 x 16
80 – 83	X in millimeters or decimeters or Longitude in Minutes of Arc / 10000 (see bytes 30-31 and 88-89)	INT32
84 – 87	Y in millimeters or decimeters or Latitude in 0.0001 Minutes of Arc (see bytes 30-31 and 88-89)	INT32
88 – 89	Coordinate Units 1 = X, Y in millimeters 2 = Longitude, Latitude in minutes of arc times 10^{-4} 3 = X, Y in decimeters	INT16

Pulse Information

This data describes the transmitted pulse characteristics, as well as sampling parameters.

Byte Offsets	Description	Size
90 – 113	Annotation String (ASCII Data)	UINT8 x 24
114 – 115	Number of data samples in this packet See bytes 16 – 17 for MSB information Note: Very large sample sizes require multiple packets.	UINT16
116 – 119	Sampling Interval in Nanoseconds	UINT32
120 – 121	Gain Factor of ADC	UINT16
122 – 123	User Transmit Level Setting (0 – 100) percent	INT16
124 – 125	Reserved – Do not use	INT16
126 – 127	Transmit pulse starting frequency in decahertz (daHz) (units of 10Hz) See bytes 17 – 18 for MSB information	UINT16
128 – 129	Transmit pulse ending frequency in decahertz (daHz)(units of 10Hz) See bytes 16 – 17 for MSB information	UINT16
130 – 131	Sweep Length in milliseconds	UINT16
132 – 135	Pressure in milliPSI (1 unit = 1/1000 PSI) (see bytes 30-31)	INT32
136 - 139	Depth in millimeters (if not = 0) (see bytes 30-31)	INT32
140 – 141	Sample Freq of the data in hertz, modulo 65536 NOTE *	UINT16
142 – 143	Outgoing pulse identifier	UINT16
144 – 147	Altitude in millimeters (If bottom tracking valid) 0 implies not filled (see bytes 30-31)	INT32
148 - 155	Reserved – Do not use	INT32 x 2

NOTE* : For all data types EXCEPT RAW (Data Format = 2) this is the Sampling Frequency of the data. For RAW data, this is one-half the Sample Frequency of the data (Fs/2). All values are modulo 65536. Use this in conjunction with the Sample interval (Bytes 114-115) to calculate correct sample rate.

CPU Time

The time that the Acoustic data was recorded. The time of the start of the ping of data represented by the following trace data is the Ping Time.

The Ping Time in seconds since 1/1/1970, (in the same time base as the device messages that follow), is contained in bytes 0-3. The millisecondsToday field (bytes 200-203), MODULO 1000, will yield the milliseconds in current second, compatible with the time stamp of the device messages. This time stamp is only valid for data recorded in Protocol Revision 8 and above.

The Ping Time can also be determined from the Year, Day, Hour, Minute and Seconds as per bytes 156 to 165. Thus provides 1 second level accuracy and resolution. For higher resolution (milliseconds) use the Year, and Day values of bytes 156 to 159, and then use the milliSecondsToday value of bytes 200-203 to complete the timestamp. System time is set to UTC, regardless of time zone. This time format is backwards compatible with all older Protocol Revisions.

These 2 time stamps are equivalent and identical.

Byte Offsets	Description	Size
156 – 157	Year (e.g. 2009) (see Bytes 0-3) (Should not be used)	INT16
158 – 159	Day (1 – 366) (Should not be used)	INT16
160 – 161	Hour (see Bytes 200-203) (Should not be used)	INT16
162 – 163	Minute (Should not be used)	INT16
164 – 165	Second (should not be used)	INT16
166 – 167	Time Basis (always 3)	INT16

Weighting Factor

The trace data is transmitted as sixteen bit integers in block floating point format per message. This saves bandwidth and storage space while preserving dynamic range. The weighting factor MUST BE applied to each of the sixteen bit integer values to restore the original floating point value.

Byte Offsets	Description	Size
168 – 169	Weighting Factor N (Signed Value!) Defined as 2^{-N}	INT16
170 – 171	Number of pulses in the water	INT16

Orientation Sensor Data

These fields contain useful information about the attitude of the sonar sensor. The Compass heading will be magnetic heading of the towfish. If a Gyro sensor is properly interfaced to the Discover Topside acquisition unit, with a valid NMEA HDT message, this field will contain the Gyro heading, relative to true north

Byte Offsets	Description	Size
172 – 173	Compass Heading (0 to 360) in units of 1/100 degree (see bytes 30-31)	UINT16
174 – 175	Pitch: Scale by 180 / 32768 to get degrees, + = bow up (see bytes 30-31)	INT16
176 – 177	Roll: Scale by 180 / 32768 to get degrees, + = port up (see bytes 30-31)	INT16
178 – 179	Tow fish electronics Temperature, in unit of 1/10th degree C	INT16

Miscellaneous Data

Byte Offsets	Description	Size
180 – 181	Reserved – Do not use	INT16
182 – 183	Trigger Source 0 = Internal 1 = External 2 = Coupled	INT16
184 – 185	Mark Number 0 = No Mark	UINT16

NMEA Navigation Data

These fields contain the time of the last position fix. If the position data is interpolated this will be the same as the CPU and ping time.

Byte Offsets	Description	Size
186 – 187	Hour (0 – 23)	INT16
188 – 189	Minutes (0 – 59)	INT16
190 – 191	Seconds (0 – 59)	INT16
192 – 193	Course	INT16
194 – 195	Speed	INT16
196 – 197	Day (1 – 366)	INT16
198 – 199	Year	INT16

Other Miscellaneous Data

Byte Offsets	Description	Size
200 – 203	Milliseconds today (since midnight) (use in conjunction with Year / Day to get time of Ping)	UINT32
204 – 205	Maximum Absolute Value of ADC samples in this packet	UINT16
206 – 207	Reserved – Do not use	INT16
208 – 209	Reserved – Do not use	INT16
210 – 215	Sonar Software Version Number - ASCII	INT8 x 6
216 – 219	Initial Spherical Correction Factor (Useful for multi-ping / deep application) * 100	INT32
220 – 221	Packet Number Each ping starts with packet 1	UINT16
222 – 223	100 times the A/D Decimation Factor. Data is normally sampled at a high Rate. Digital filters are applied to precisely limit the signal bandwidth.	INT16
224 – 225	Decimation Factor after the FFT	INT16
226 – 227	Water Temperature in units of 1/10 degree C (see bytes 30-31)	INT16
228 – 231	Layback in meters	FLOAT32
232 – 235	Reserved – Do not use	INT32
236 – 237	Cable Out in decimeters (see bytes 30-31)	UINT16
238 – 239	Reserved – Do not use	UINT16

Sonar Trace Data

Sonar trace data follows the 240-byte header and consists of sixteen bit integer values. The number of integers to be read can be found by multiplying the number of samples in the trace (bytes 114-115) by the number of integers per sample for the data type used (1 or 2). Further doubling will yield the byte size of the data section. This should exactly match the preceding Message Header byte count, (bytes 12 –15) less the header size of 240.

Each of the data sample values then needs to be scaled by the weighting factor thus:

ScaledDatasample = datasample * 2^(-N). (NOTE Sign !)

Future expansions of this data format will use floating point values to represent samples, and will result in other valid values for Data Format (bytes 34-35). Data readers will be more robust if this data section is skipped over if the Data Type does not match the 4 values presented here.

Message Type 82: Side Scan Data Message (sidescandefs.h)

Side-Scan Data Messages are no longer used and only described here for historical reasons. While configuring a sonar to generate these messages is still possible, new systems are not configured in that manner. If your sonar is storing Side-Scan Data Messages the configuration should be changed to store Sonar Data Messages instead. Side-Scan Data Messages are never stored by Discover, and are only encountered in data stored by sonar. This data is almost always compressed rendering it unusable without further processing. A Side-Scan Data Message is similar to a Sonar Data Message. It contains the exactly the same acoustic data. While the Side Scan Data Message was intended for Side Scan data, it can also be used for Sub-bottom data. The system configuration determines which type of data is actually stored. Each Side Scan Data Message has an 80 byte header, the content of which is defined below. As with Sonar Data Messages, unused fields should be set to 0.

Byte Offsets	Description	Size
0 – 1	Subsystem (0 .. n)	UINT16
2 – 3	Channel Number (0 .. n)	UINT16
4 – 7	Ping number (increments with each ping period)	UINT32
8 – 9	Packet number (1..n) Each ping starts with packet 1	UINT16
10 – 11	TriggerSource (0 = internal, 1 = external)	UINT16
12 – 15	Samples in this packet	UINT32
16 – 19	Sample interval in ns of stored data	UINT32
20 – 23	Starting Depth (window offset) in samples	UINT32
24 – 25	Weighting Factor : Defined as 2^{-N} volts	INT16
26 – 27	Gain factor of ADC	UINT16
28 – 29	Maximum absolute value for ADC samples for this packet	UINT16
30 – 31	Range Setting (in decameters) (meters times 10)	UINT16
32 – 33	Unique pulse identifier	UINT16
34 – 35	Mark Number (0 = no mark)	UINT16
36 – 37	Data format 0 = 1 short per sample - envelope data the total number of bytes of data to follow is 2 * samples 1 = 2 shorts per sample - stored as real(1), imag(1), the total number of bytes of data to follow is 4 * samples	UINT16
38	Number of simultaneous pulses in the water	UINT8
39	Reserved – Do not use	UINT8

Computer date / time data acquired

Byte Offsets	Description	Size
40 – 43	Milliseconds today	UINT32
44 – 45	Year	INT16
46 – 47	Day of year (1 – 366)	UINT16
48 – 49	Hour of day (0 – 23)	UINT16
50 – 51	Minute (0 – 59)	UINT16
52 – 53	Second (0 – 59)	UINT16

Auxiliary sensor information

Byte Offsets	Description	Size
54 – 55	Compass heading in minutes (0 – 360) x 60	UINT16
56 – 57	Pitch Scale by 180 / 32768 to get degrees, + = bow up	INT16
58 – 59	Roll Scale by 180 / 32768 to get degrees, + = port up	INT16
60 – 61	Heave (centimeters)	INT16
62 – 63	Yaw (minutes)	INT16
64 – 67	Pressure in units of 1/1000 PSI	UINT32
68 – 69	Temperature in units of 1/10 of a degree Celsius	INT16
70 – 71	Water Temperature in units of 1/10 of a degree Celsius	INT16
72 – 75	Altitude in millimeters (or -1 if no valid reading)	INT32
76 – 79	Reserved – Do not use	UINT8 x 4

Sonar Trace Data

Sonar trace data follows the 80-byte header and consists of sixteen bit integer values. The number of integers to be read can be found by multiplying the number of samples in the trace (bytes 12-15) by the number of integers per sample for the data type used (1 or 2). Further doubling will yield the byte size of the data section. This should exactly match the preceding 16 byte Message Header byte count, (bytes 12 –15) less the header size of 80. Each of the data sample values then needs to be scaled by the weighting factor thus:

ScaledDatasample = datasample * 2^(- N).

Message Type 2020: Pitch Roll Data

A pitch roll message consists of a single reading from a pitch roll sensor such as a Seatex MRU, TSS or Octans device. Not all devices provide all data for the defined structure. Use the validity flags to determine which fields are populated.

Byte Offsets	Description	Size
0 – 3	Time in seconds (since the start of time based on time() function) (1/1/1970)	INT32
4 – 7	Milliseconds in the current second	INT32
8 – 11	Reserved – Do not use	UINT8 x 4
12 – 13	Acceleration in x: Multiply by (20 * 1.5) / (32768) to get Gs	INT16
14 – 15	Acceleration in y: Multiply by (20 * 1.5) / (32768) to get Gs	INT16
16 – 17	Acceleration in z: Multiply by (20 * 1.5) / (32768) to get Gs	INT16
18 – 19	Rate Gyro in x: Multiply by (500 * 1.5) / (32768) to get Degrees/Sec	INT16
20 – 21	Rate Gyro in y: Multiply by (500 * 1.5) / (32768) to get Degrees/Sec	INT16
22 – 23	Rate Gyro in y: Multiply by (500 * 1.5) / (32768) to get Degrees/Sec	INT16
24 – 25	Pitch Multiply by (180.0 / 32768.0) to get Degrees Bow up is positive	INT16
26 – 27	Roll: Multiply by (180.0 / 32768.0) to get Degrees Port up is positive	INT16
28 – 29	Temperature in units of 1/10 of a degree Celsius	INT16
30 – 31	Device specific info. This is device specific info provided for Diagnostic purposes	UINT16
32 – 33	Estimated Heave in millimeters	INT16
34 – 35	Heading in units of 0.01 Degrees (0…360)	UINT16
36 – 39	Data valid flags Bit 0: ax Bit 1: ay Bit 2: az Bit 3: rx Bit 4: ry Bit 5: rz Bit 6: pitch Bit 7: roll Bit 8: heave Bit 9: heading Bit 10: temperature Bit 11: devInfo	INT32
40 – 43	Reserved – Do not use	INT32

Message Type 2002: NMEA String

A NMEA String consists of a time stamp followed by a NMEA string as read from a GPS, Gyro or other device. Each message is a single NMEA string excluding the <CR>/<LF>.

Byte Offsets	Description	Size
0 – 3	Time in seconds since 1970	INT32
4 – 7	Milliseconds in the current second	INT32
8	Source, 1 = Sonar, 2 = Discover, 3 = ETSI	INT8
9 – 11	Reserved – Do not use	UINT8 x 3
12 – To Message Length	NMEA string data	INT8 x remaining length

Message Type 2060: Pressure Sensor Reading

If a pressure sensor is present in the system these messages will be in the data stream.

A single pressure sensor reading is provided, along with a time-stamp. While pressure sensors can be configured in different units, the default is PSI absolute.

Byte Offsets	Description	Size
0 – 3	Time in seconds (since the start of time based on time() function).	INT32
4 – 7	Milliseconds in the current second.	INT32
8 – 11	Reserved – Do not use	UNIT8 x 4
12 – 15	Pressure in units of 1/1000th of a PSI	INT32
16 – 19	Temperature in units of 1/1000th of degree Celsius.	INT32
20 – 23	Salinity in Parts Per Million	INT32
24 – 27	Data valid flags: Bit 0: pressure Bit 1: temp Bit 2: salt PPM Bit 3: conductivity Bit 4: sound velocity	INT32
28 – 31	Conductivity in micro-Siemens per cm	INT32
32 – 35	Velocity of Sound in mm per second	INT32
36 – 75	Reserved – Do not use	INT 32 x 10

Message Type 2080: Doppler Velocity Log Data (DVL)

This is data from a DVL (if fitted) and often includes velocity and altitude readings.

Byte Offsets	Description	Size
0 – 3	Time in seconds (since the start of time based on time() function).	INT32
4 – 7	Milliseconds in the current second.	INT32
8 – 11	Reserved – Do not use	UINT8 x 4
12 – 15	Flags. Indicates which values are present. Bit 0: X, Y Velocity present Bit 1: 1 => Velocity in ship coordinates 0 => Earth coordinates Bit 2: Z (Vertical Velocity) present Bit 3: X, Y Water Velocity present Bit 4: Z (Vertical Water Velocity) present Bit 5: Distance to bottom present Bit 6: Heading present Bit 7: Pitch present Bit 8: Roll present Bit 9: Temperature present Bit 10: Depth present Bit 11: Salinity present Bit 12: Sound velocity present ------- Bit 31: Error detected	UINT32
16 – 31	4 Integers: Distance to bottom in cm for up to 4 beams.	INT32 x 4
	A 0 value indicates an invalid or non-existing reading.	
32 – 33	X Velocity with respect to the bottom in mm / second Positive => Starboard or East. -32768 indicates an invalid reading.	INT16
34 – 35	Y Velocity: Positive => Forward or North (mm/second)	INT16
36 – 37	Z Vertical Velocity: Positive => Upward (mm/second)	INT16
38 – 39	X Velocity with respect to a water layer in mm / second Positive => Starboard or East	INT16 x 3
40 - 41	Y Velocity: Positive => Forward or North	
42 - 43	Z Vertical Velocity: Positive => Upward	
44 - 45	Depth from depth sensor in decimeters	UINT16
46 - 47	Pitch -180 to +180 degree (units = 0.01 of a degree) + Bow up	INT16
48 - 49	Roll -180 to +180 degrees (units = 0.01 of a degree) + Port up	INT16
50 - 51	Heading: 0 to 360 degrees (in units of 0.01 of a degree)	UINT16
52 - 53	Salinity in 1 part per thousand	UINT16
54 - 55	Temperature in units of 1/100 of a degree Celsius	INT16
56 - 57	Sound velocity in meters per second	INT16
58 - 71	Reserved – Do not use	INT16 x 7

Message Type 2090: Situation Message

A situation message is a composite of several motion / position sensors. This message is not commonly used. The detailed data structure is shown below:

Byte Offsets	Description	Size
0 - 3	Time in seconds (since the start of time based on time() function).	INT32
4 - 7	Milliseconds in the current second.	INT32
8 - 11	Reserved – Do not use	INT8 x 4
12 - 15	Validity Flags Validity Flags indicate which of the following fields are valid. If the corresponding bit is set the field is valid. Bit 0 : microsecondTimestamp Bit 1 : latitude Bit 2 : longitude Bit 3 : depth Bit 4 : heading Bit 5 : pitch Bit 6 : roll Bit 7 : XRelativePosition Bit 8 : YRelativePosition Bit 9 : ZRelativePosition Bit 10 : XVelocity Bit 11 : YVelocity Bit 12 : ZVelocity Bit 13 : NorthVelocity Bit 14 : EastVelocity Bit 15 : downVelocity Bit 16 : XAngularRate Bit 17 : YAngularRate Bit 18 : ZAngularRate Bit 19 : XAcceleration Bit 20 : YAcceleration Bit 21 : ZAcceleration Bit 22 : latitudeStandardDeviation Bit 23 : longitudeStandardDeviation Bit 24 : depthStandardDeviation Bit 25 : headingStandardDeviation Bit 26 : pitchStandardDeviation Bit 27 : rollStandardDeviation	UINT32
16 - 19	Reserved – Do not use	UINT x 4
20 - 27	Microsecond timestamp, us since 12:00:00 am GMT, January 1, 1970	UINT64
28 - 35	Double float: Latitude in degrees, north is positive	FLOAT64
36 - 43	Double float: Longitude in degrees, east is positive	FLOAT64
44 - 51	Double float: Depth in meters	FLOAT64
52 - 59	Double float: Heading in degrees	FLOAT64
60 - 67	Double float: Pitch in degrees, bow up is positive	FLOAT64
68 – 75	Double float: Roll in degrees, port up is positive	FLOAT64
76 - 83	Double float: X, forward, relative position in meters, surge	FLOAT64
84 - 91	Double float: Y, starboard, relative position in meters, sway	FLOAT64

92 - 99	Double float: Z, downward, relative position in meters, heave	FLOAT64
100 - 107	Double float: X, forward, velocity in meters per second	FLOAT64
108 - 115	Double float: Y, starboard, velocity in meters per second	FLOAT64
116 - 123	Double float: Z, downward, velocity in meters per second	FLOAT64
124 - 131	Double float: North velocity in meters per second	FLOAT64
132 - 139	Double float: East velocity in meters per second	FLOAT64
140 - 147	Double float: Down velocity in meters per second	FLOAT64
148 - 155	Double float: X angular rate in degrees per second, port up is positive	FLOAT64
156 - 163	Double float: Y angular rate in degrees per second, bow up is positive	FLOAT64
164 - 171	Double float: Z angular rate in degrees per second, starboard is positive	FLOAT64
172 - 179	Double float: X, forward, acceleration in meters per second per second	FLOAT64
180 - 187	Double float: Y, starboard, acceleration in meters per second per second	FLOAT64
188 - 195	Double float: Z, downward, acceleration in meters per second per second	FLOAT64
196 - 203	Double float: Latitude standard deviation in meters	FLOAT64
204 - 211	Double float: Longitude standard deviation in meters	FLOAT64
212 - 219	Double float: Depth standard deviation in meters	FLOAT64
220 - 227	Double float: Heading standard deviation in degrees	FLOAT64
228 - 235	Double float: Pitch standard deviation in degrees	FLOAT64
236 - 243	Double float: Roll standard deviation in degrees	FLOAT64
244 - 275	Reserved – Do not use	UINT16 x 16

Message Type 182: System Information Message

The system information message contains details of the system used to acquire data. This message is normally present at the beginning of a JSF file, and may be repeated if configuration parameters change.

Byte Offsets	Description	Size
0 - 3	System Type	INT32
4 – 7	Reserved – Do not use	
8 – 11	Version Number of Sonar Software used to generate data	INT32
12 – 19	Reserved – Do not use	
20 – 23	Serial Number of Tow Vehicle used to collect data	INT32
24 – End	Reserved – Do not use	

The size of the System Information Message is subject to change as more detailed information is may be added in future versions of the software. The byte count in the

message header should be used to determine the total size of the structure and get to the next message in the file.

The System Type is the major type of system used to collect data. To date, the following system types are defined:

System Type Number	Description
1	2xxx Series, Combined Sub-Bottom / Side Scan with SIB Electronics
2	2xxx Series, Combined Sub-Bottom / Side Scan with FSIC Electronics
4	4300-MPX (Multi-Ping)
5	3200-XS, Sub-Bottom Profiler with AIC Electronics
6	4400-SAS, 12-Channel Side Scan
7	3200-XS, Sub Bottom Profiler with SIB Electronics
11	4200 Limited Multipulse Dual Frequency Side Scan
14	3100-P, Sub Bottom Profiler
16	2xxx Series, Dual Side Scan with SIB Electronics
17	4200 Multipulse Dual Frequency Side Scan
18	4700 Dynamic Focus
19	4200 Dual Frequency Side Scan
20	4200 Dual Frequency non Simultaneous Side Scan
21	2200-MP Combined Sub-Bottom / Dual Frequency Multipulse Side Scan
23	4600 Bathymetric System
128	4100, 272 /560A Side Scan

Hydrographic and Sub-Bottom Profiling Survey – Intermediate Dam Pond

NTS: 105K/06, Faro Mining Complex, Yukon Territory, Canada

WORK PERFORMED:
June 10-18, 2016

Prepared for:

ch2m.

Prepared by:

AURORA GEOSCIENCES

TECHNICAL REPORT
Hydrographic and Sub-Bottom Profiling Survey – Intermediate Dam Pond

Effective Date: August 12, 2016

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1 INTRODUCTION

Aurora Geosciences Ltd. was retained by CH2M Hill Canada Limited to conduct bathymetric and sub-bottom profiling of the Cross Valley Dam Pond and the Intermediate Dam Pond at the Faro Mine, Faro, Yukon Territory. Primary surveys of the Cross Valley Dam Pond were completed in October 2015 when the onset of cold weather rendered further boat work on the ponds impossible. The focus of this report is the bathymetric and sub-bottom surveying completed on the Intermediate Dam Pond in June, 2016.

Complete coverage of the Intermediate Dam Pond bathymetry was obtained through a multi-beam sonar investigation, coupled with a supplemental single-beam sonar survey in shallow areas, and a RTK-GPS survey to define the shoreline. The survey revealed greater depths toward the southwestern side of the pond, producing a maximum depth of 7.32 metres.

Acoustic sub-bottom profiling was also completed on the pond with a nominal line spacing of 5m.

All geographic locations in this report are relative to North American Datum 1983 (CSRS) and all elevations are orthometric heights relative to the HT2 geoid. Non-geodetic coordinates are expressed in Universal Transverse Mercator Zone 8N metric coordinates. All measurements are expressed in the metric SI system.

2 LOCATION & ACCESS

The crew was based in the town of Faro, YT for the duration of the project and accessed the Intermediate Dam Pond daily by truck and then by 16-foot aluminum boat. The pond is approximately 15 kilometers north-northwest of the town of Faro; Figure 1 is a map of the Intermediate Dam Pond within the Faro Mine area.

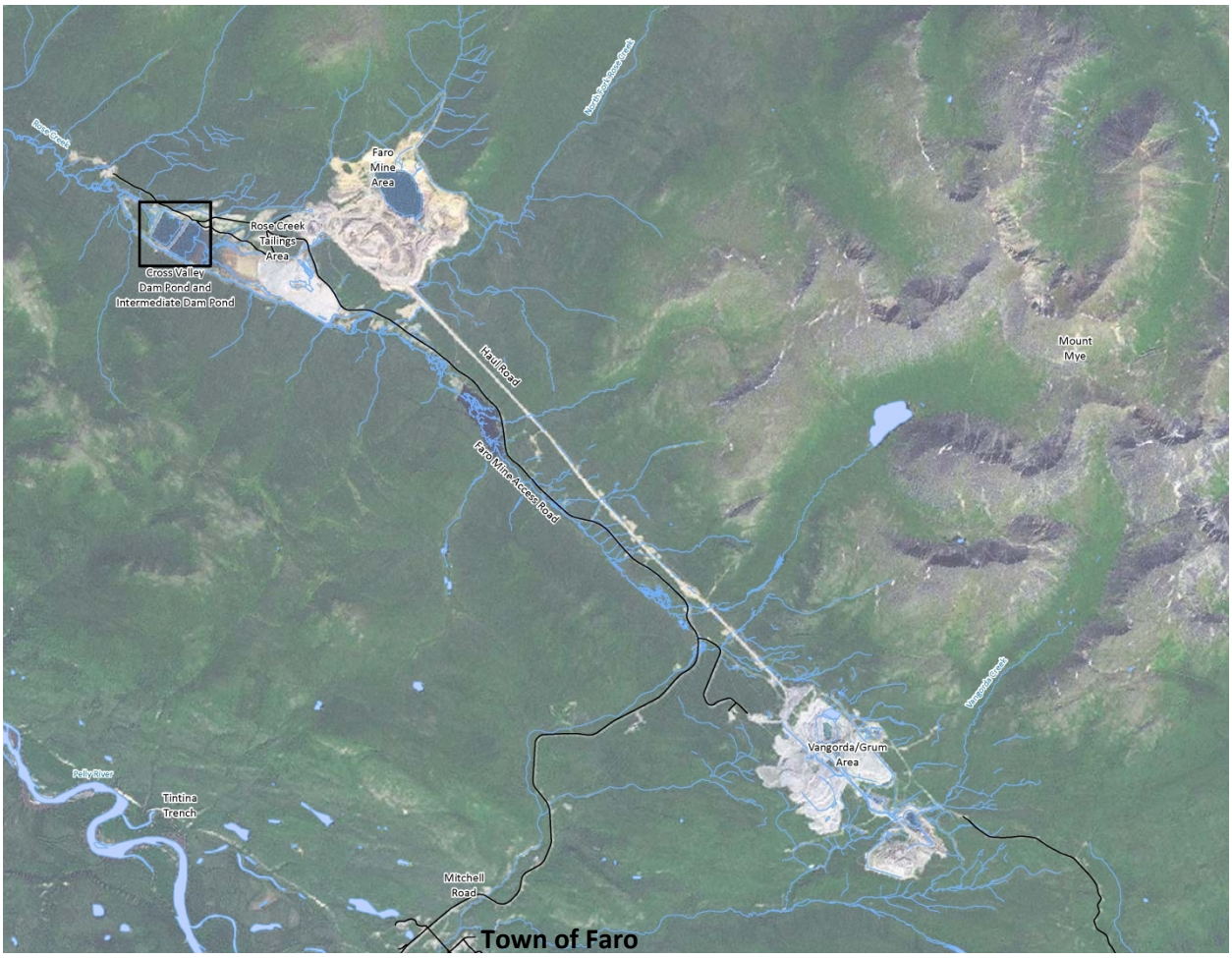


Figure 1: Location map of the Intermediate Dam Pond within the Faro Mine area. Map is from the CH2M Hill Agreement 10201-7-100723. The distance from the Town of Faro to the Intermediate Dam Pond is approximately 15 km.

3 WORK PROGRAM

This section describes the June 2016 work program conducted at the Intermediate Dam Pond. A bathymetric survey was completed comprising of multi-beam sonar, selected areas of single-beam sonar, selected lines of lead-line measurements and RTK-GPS survey both for shoreline definition and for single-beam line extensions to allow comparison to existing topographic data; this is described in Section 0. A sub-bottom survey was completed using a 4-24 kHz chirped acoustic signal; this is described in Section 3.2. Figure 2 shows the line-path of the multi-beam bathymetry (yellow), single-beam bathymetry (black), sub-bottom profiling (red) and RTK shoreline survey points (blue crosses). A complete project log detailing the work performed by the Aurora Geosciences field crew is in Appendix I.

QA/QC of the surveys is examined in Section 3.3.

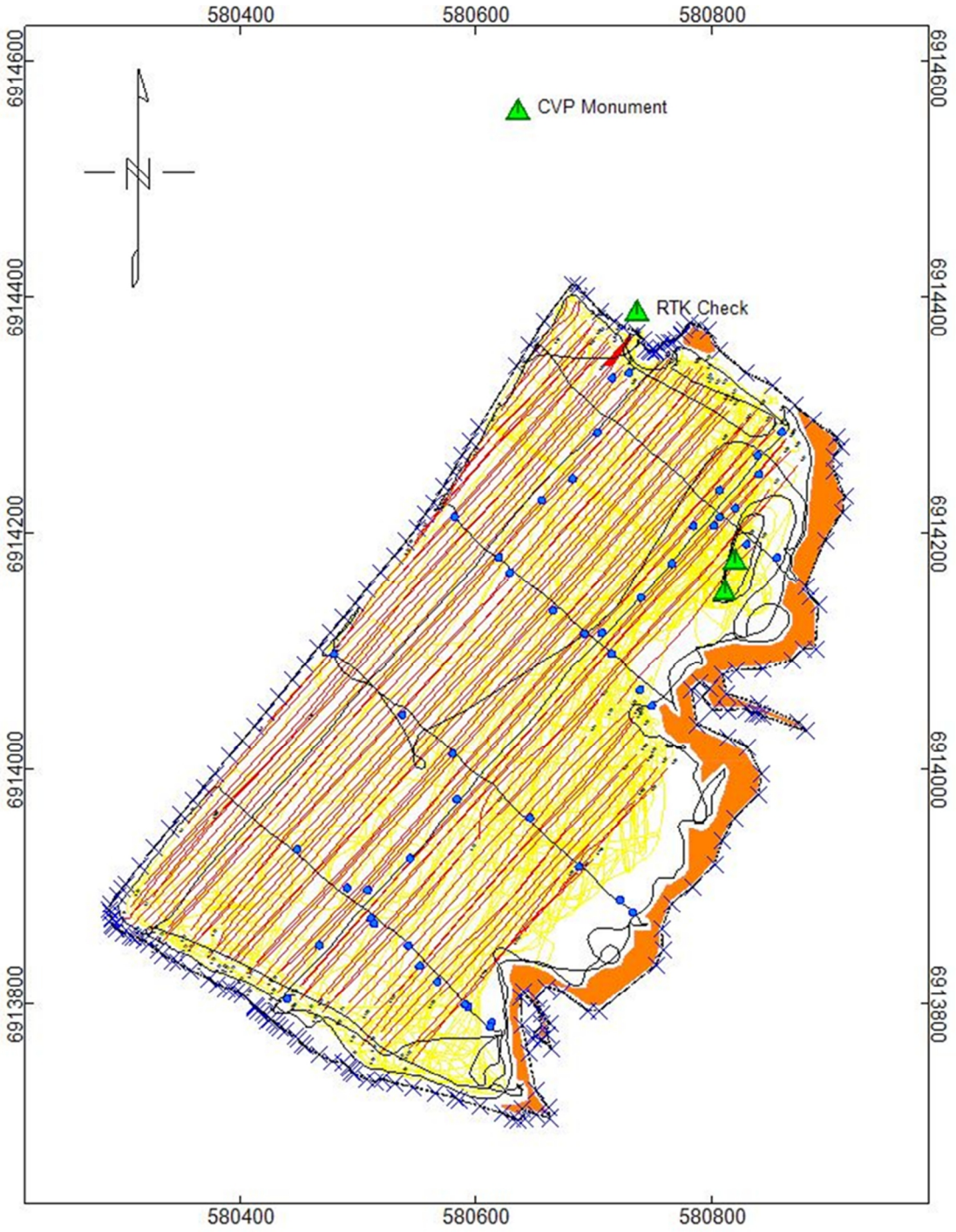


Figure 2: Surveys on the Intermediate Dam Pond. Yellow shows the path of the multi-beam bathymetry, red of the sub-bottom profiling, black of the single-beam bathymetry, blue circles are the lead-line measurements and the blue x-symbols are the shore GPS measurements. The location of the CVP monument used for a GPS base is shown in the northwest corner. Areas shown in orange are shallow water where no data were collected. Daily multi-beam and sub-bottom check-in locations at 580819E, 6914176N & 580810E, 6914150N (NAD83 UTM Zone 8N) as described in Section 3.1.2.2 are shown by the green triangles. An RTK daily check-in point at 580736E, 6914386N (NAD83 UTM Zone 8N) as described in Section 3.1.2.1 is also shown by a green triangle.

3.1 Bathymetric Survey

The multi-beam bathymetric survey provides an extremely high resolution depth database of the Intermediate Dam Pond, with a data density of approximately 3.6 cm. Positional data were determined through an RTK GPS streaming data to the multi-beam system, with the GPS base station set up at the nearby CVP control point. The shoreline was also surveyed using RTK GPS, to define the areal limit of the pond. Water elevation was measured twice daily with RTK GPS. A single-beam sonar survey supplemented the multi-beam survey in shallow water, though with a much lower data density. There are small areas on the southeastern side of the pond that were not surveyed using either method due to the very shallow water. In addition, six traverses of the pond were done using the single-beam survey, to compare with the multi-beam dataset.

3.1.1 Equipment

The crew was equipped with the following instruments and equipment:

Equipment:	2	ANTCOM G3ANT GPS Antennas s/n: 346853,346854
	1	Minos X velocity sensor s/n: 30337
	1	MB1 multi-beam sonar head s/n: 206
	1	RTAII real time appliance s/n: 220083
	1	Digibar V water velocity sensor (sonar head) s/n: 5683
	1	Coda F-175 motion sensor s/n: F70012
		Miscellaneous multi-beam cables, brackets and equipment
	1	Trimble GeoExplorer XT2008
	1	Garmin GPSmap 527
	1	Airmar SS510 smart transducer
		Miscellaneous single-beam cables, brackets and equipment
	1	Leica GS15 sensor rover s/n 1502720
	1	Leica GS14 sensor base s/n 2802696
	1	Leica CS15 controller s/n 2907005
	1	Pac Crest ADL Vantage Pro Radio s/n 13086191
	1	Pac Crest Radio s/n 1301949
		Miscellaneous GPS cables, tripods and equipment
	1	50m lead-line and reel
Communications:	4	VHF handheld radios
	1	SAT phone
Vehicles & Vessels:	1	Flat deck truck
	1	Truck Trailer
	1	Arctic Cat ATV
	1	16ft aluminum boat
	1	Inflatable Zodiac rescue boat
	1	6 HP outboard motor
	1	20 HP outboard motor
Safety:	4	Government certified personal floatation devices (PFDs)
	2	ATV helmets
	4	Hard hats
	200	Nitrate gloves
	12	Tyvek suits

	8	Safety glasses
	4	High Visibility Vests
	2	Fire extinguisher
	2	Level 2 First aid kit
	4	Spare paddles
	2	15m floating rope
	2	Bailers
Computers & Software:	1	Laptop with Edgetech Discover Sub-Bottom 4.0
	1	Laptop with HyPack 2015, SonarWiz 6
	1	Laptop with Image, SMC IMU Config, Digibar Pro 3.0
Other	20	6 mil plastic garbage bags
	1	Pressure washer
	1	Water tank
	1	Office box
	1	Geophysical Toolbox

3.1.2 Survey Specifications & Field Procedures

All manufacturer and model information for equipment referenced in this section can be found in Section **Error! Reference source not found.**.

3.1.2.1 RTK GPS

A GPS base station was established daily with the Leica GS14 antenna over the permanent control marker 2010-P5 at CVD. The published position for 2010-P5 was inadvertently not programmed into the GPS base prior to starting work in the field and an arbitrary position was therefore used the first day. For consistency the arbitrary base position was used throughout the survey and all RTK data were corrected by a post-survey datum shift to align the base with the published position. The initial (arbitrary) reference point recorded by the base station was broadcast continuously via radio to the Leica GS15 rover so that a phase-corrected RTK solution was being transferred to the multi-beam bathymetric equipment via NMEA string at all times during data collection. The use of this initial reference point requires a datum shift be applied to all raw data.

An RTK check-in point was established on the northwest end of the ID pond at 580736E, 6914386N (NAD83 CSRS Epoch 2002 UTM Zone 8N) and measurements were taken there once or twice daily. The daily check-in values are provided in Section 3.3.2.

As per the published *Survey Standards for Faro Mine Closure* included with CH2M Hill Agreement 10201-7-100723, the coordinates for the antenna established at 2010-P5 are 6914557.921 N, 580635.174 E (NAD83 CSRS Epoch 2002, UTM Zone 8 coordinates with a CSF of 0.999505) with an orthometric height above the HT2 Geoid Model of 1060.480 m. The post-survey datum shift applied was to align the arbitrary base position to this accepted position.

Point RTK positions with the Leica GS15 antenna were taken along the shoreline to constrain the gridding of the water depths in the shallows and to provide a measure of the water-surface elevation. Where the shoreline is straight, station spacing is at minimum 50 m, with decreasing station spacing as

required to capture smaller scale shoreline features; these points are shown as blue crosses in Figure 2. Point RTK positions were also recorded as extensions of all single-beam check lines, extending roughly 15 m back from the shoreline.

RTK positions were taken during single-beam collection and matched to the single-beam data by time-stamp.

3.1.2.2 Multi-Beam Sonar

An Odom Teledyne MB1 multi-beam echo-sounder was used for the collection of primary bathymetric data from all areas of the Intermediate Pond, in areas with water depths greater than approximately 1 m. The sonar head was equipped with a sensor that monitored changes in water velocity from fluctuations in water temperature and purity. A motion sensor was also used to monitor the heave, pitch and roll of the boat. The latter was calibrated each morning to account for slight variations in crew weight as well as position. An Antcom marine GPS unit with two widely spaced antennae, positioned perpendicular to the sonar head (parallel to the axis of the vessel), provided precision bearings at all times. The Leica GS15 rover with a radio link to a base antenna was attached 1.345 metres directly above the sonar head to provide high accuracy positional data. The part of the system above water is shown in Figure 3.



Figure 3: Universal mounting pole with three GPS antennae and subsea motion sensor visible.

Each day the MB1 sonar head, RTK sensor and all secondary control instruments were bolted to the same place on a universal mounting pole, ensuring constant registration relative to the boat across multiple days of surveying. Data from all instruments were fed to an Odem Real Time Appliance for time registration and for interfacing with laptop computers.

A pair of onboard computers was used to control and monitor the instruments, while simultaneously recording data. One laptop, equipped with Odom Image, monitored the sonar head and water velocity

sensor. The second laptop, equipped with Hypack 2015, recorded all data and plotted results allowing for real time feedback on quality and coverage.

The crew conducted a series of control tests at the beginning and end of each day. Control stations, shown by green triangles in Figure 2, were established at 580819E, 6914176N & 580810E, 6914150N (NAD83 UTM Zone 8N) by driving poles into the pond floor. GPS and multi-beam sonar data were recorded while traversing north to south, from pole to pole. The purpose was to collect data at the same physical location, guided by the poles, multiple times to establish the repeatability of the multi-beam data.

Patch test data were collected over flat areas and slopes to correct potential errors arising from mounting variations as well as pitch, roll and yaw motion. Water velocity data were collected by a second water velocity sensor independent of the sonar head that was lowered to the pond floor, producing a water velocity profile for the full depth of the pond with data points collection every 10 cm.

The MB1 sonar head operates at 170-220 kHz and is capable of recording a 120˚ swath which, over flat terrain, is approximately 4 x the water column depth. As a quality control measure to account for variations in the pond floor and potential noise near the edge of the swath, the crew aimed for an initial 33% overlap in data, with occasional insufficient overlap. Secondary passes were completed as necessary to fill in gaps caused by fluctuations in pond depth identified in preliminary processing and all were successfully in-filled aside from the shallow southeast edge of the pond resulting in an almost complete contiguous dataset. Data were collected across the full 120˚ swath with a total of 512 beams and preserved in the raw files. In practice, the useful data swath was approximately 80˚ and the pond was shallow enough to require many extra passes to ensure complete data coverage. As a further quality control measure, the Hypack software was configured so as to not log any data if a phase-corrected RTK signal was not present. Occasional drops in RTK signal quality therefore created data gaps requiring further passes for complete coverage.

Line spacing for the multi-beam survey was variable, although initial passes follow the same bearing (41˚) as the intended sub-bottom lines. Target boat speed was approximately 3 knots, though care was taken in shallower areas to protect the sensitive equipment.

3.1.2.3 Single-Beam Sonar

The single-beam bathymetry survey was conducted to fill in data voids in shallow water where use of the multi-beam transducer was not practical. Attempts to fill in shallow areas at the southeastern edge of the pond were met with limited success because of the extreme shallowness of the pond there.

Six reference lines were also surveyed to create a secondary control database against which to measure the multi-beam bathymetry data. Four of these lines spanned the width of the pond, at a bearing of approximately 131˚ and set 150 m apart. The two other lines spanned the length of the pond at a bearing of 41˚, were spaced 175 m apart and coincided with two of the sub-bottom profiling lines.

Data were collected at a 1 second interval with data from the Airmar SS510 transducer. The transducer operates at a frequency of 200 kHz with a beam width of 9˚. Target boat speed was 2 knots in open

water but speeds in potentially shallow areas were lower. Data from the Airmar transducer were streamed to the Trimble GeoXT controller for storage and were georeferenced using data from the RTK-GPS Leica GS15 rover. A 17 second offset was applied to the single-beam sonar data prior to time-stamp matching to account for the different time convention (GPS versus UTC time) used by each instrument. The vertical offset between the GPS antenna and the transducer was 1.44 m. There was no horizontal offset.

3.1.2.4 Lead-Line Measurements

Lead-line measurements were taken to create a tertiary database against which to measure the other bathymetric data. Forty nine points were measured around the ID pond with an effort to collect points along the single-beam traverses to create three coincident datasets.

A best effort was made to make the measurement when the lead-line was plumb but the survey vessel was not anchored during the measurements and there was significant drift from high winds at the time of the lead-line survey so some bias towards longer measurements because of the angled line is expected. Additionally, the operators often observed significant muck on the lead-line after retrieval so the weight may have been penetrating some centimeters beyond the mudline as measured by the sonar data.

3.1.3 Data Processing

3.1.3.1 RTK-GPS

The use of an arbitrary initial reference point required that a datum shift be applied to all raw data to reposition the base station to the published position of 2010-P5. All points were shifted -2.005 m N, 1.733 m E and elevation was shifted -6.501 m.

Data were logged to the Leica receiver and exported to csv files; the raw daily base and rover files, as well as the exported rover files are included with the data package of this report. The positional quality is shown in Figure 4 (multi-beam) & Figure 5 (single-beam) and the height quality in Figure 6 (multi-beam) & Figure 7 (single-beam) as reported by the Leica Geo Office software package from the raw rover files with no post-processing; all have a 95% confidence level well below 10 cm. The effective positional and height quality for the multi-beam collection is better than the histograms portray because, as indicated in Section 3.1.2.2, the multi-beam unit was configured so as to not log any data if a phase-corrected RTK signal from the base was not present. Some data with no RTK link remain in the database despite not being used by the multi-beam system. These are typically at the end of the file and likely represent recording while putting away equipment.

Baseline and DOP data were obtained by post-processing with Leica Geo Office. Although the base station was operating correctly and RTK corrections were being received on June 17, the file of the GPS readings did not record properly on the base. The consequence is that some meta-products for the GPS (baseline and DOP information) is not available for June 17.

Water level and data from RTK check-ins are discussed below in Section 3.3.2.

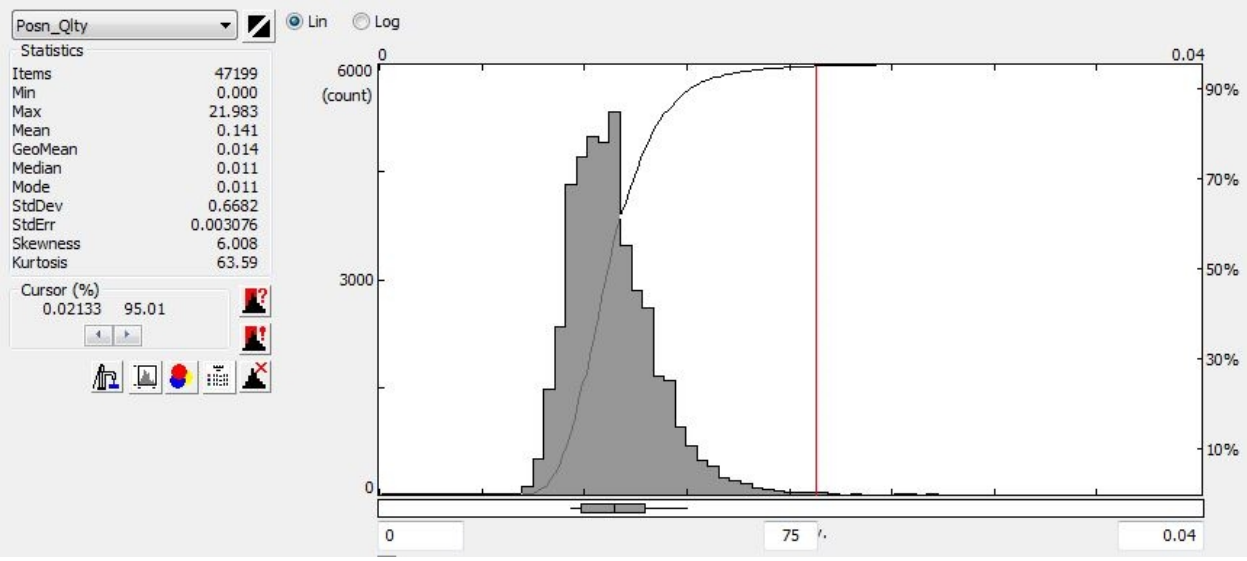


Figure 4: Position quality of GPS solutions during multi-beam bathymetry acquisition. The red line shows the 95% of the position quality is at 0.021 m.

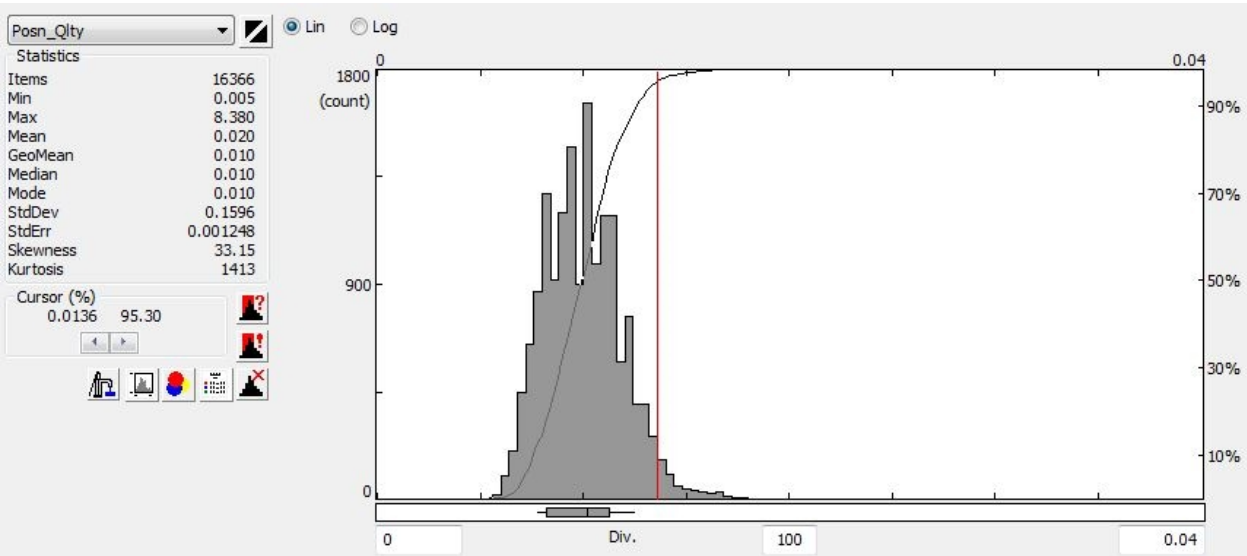


Figure 5: Position quality of GPS solutions during single-beam bathymetry acquisition. The red line shows the 95% of the position quality is at 0.014 m.

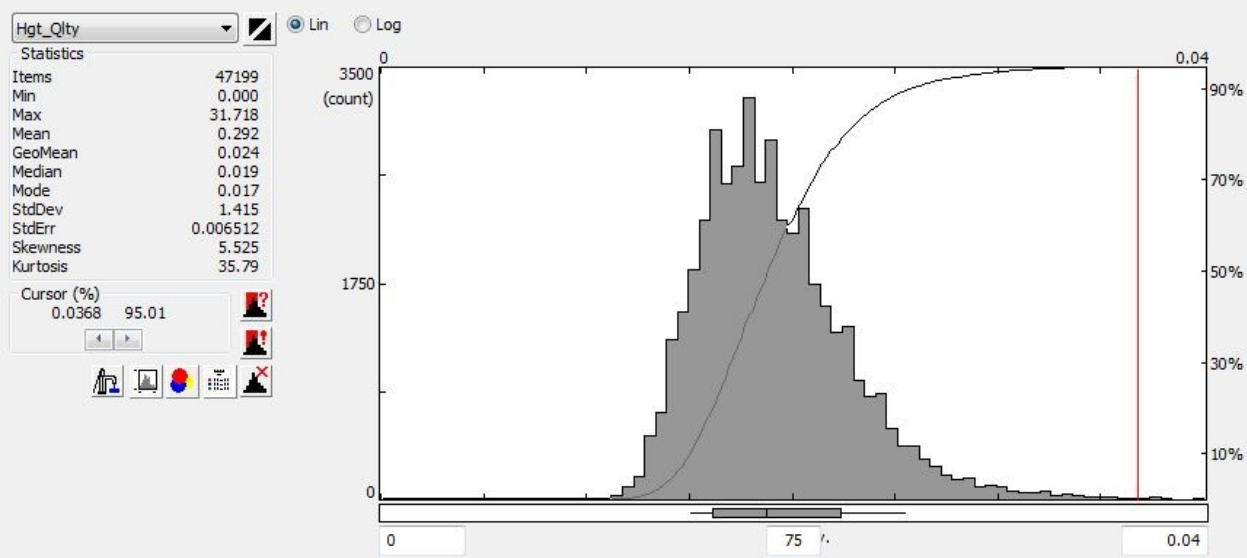


Figure 6: Height quality of GPS solutions during multi-beam bathymetry acquisition. The red line shows the 95% of the height quality is at 0.037 m.

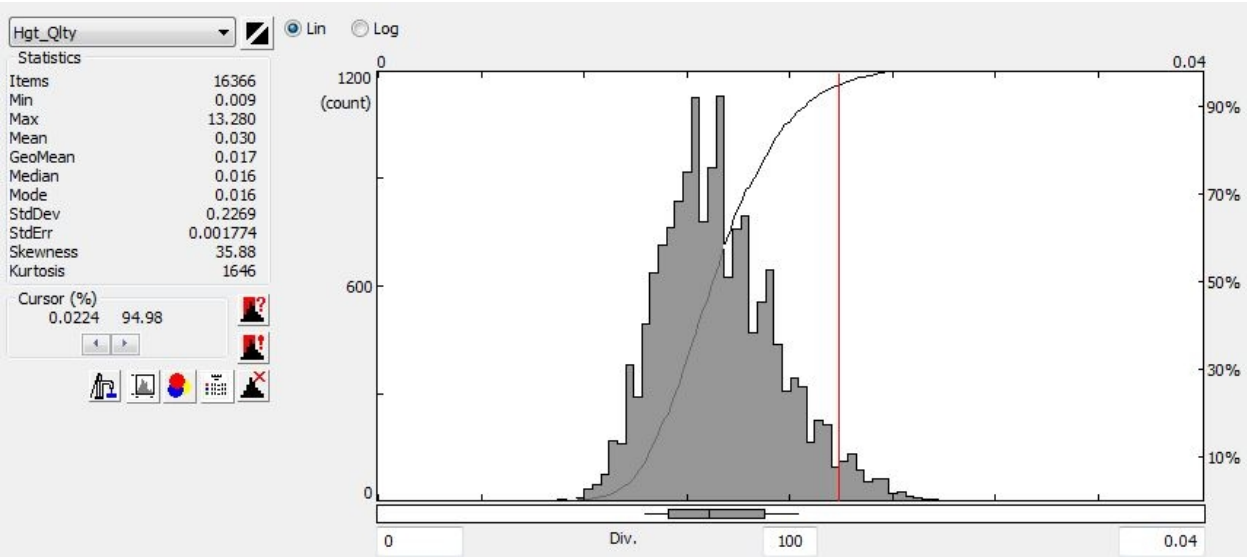


Figure 7: Height quality of GPS solutions during single-beam bathymetry acquisition. The red line shows the 95% of the height quality is at 0.022 m.

3.1.3.2 Single-Beam Sonar

RTK GPS data were exported and matched by timestamp to the single-beam data with a time-shift of 17 seconds to account for a GPS to UTC time datum adjustment.

Acoustic water velocity was assumed to be 1500 m/s during acquisition and this is corrected to 1455 m/s, a measured average velocity for the pond (Section 3.1.3.3 and Figure 8).

Pond bottom elevations were calculated by subtracting depths derived from the single-beam from the elevation of the single-beam sonar head as measured by the RTK GPS. Water elevation measurements and shoreline measurements were not used in the pond bottom elevation determination wherever sonar data were collected.

3.1.3.3 Multi-beam Sonar

Multi-beam sonar data were processed using Hypack's Hysweep 64-bit Editor. Beam angle limits of 40 degrees were imposed on both port and starboard sides for all data, with lower limits being applied where deemed necessary by visual inspection. An over/under filter and a Savitzky-Goalay filter were applied to highlight and remove potentially erroneous data. All data were then visually inspected in batches of 1000 swaths or less. Single spike anomalies and areas of high noise were removed. In general, the data collected at the widest angle from the sonar head were unreliable and discarded.

Secondary instrumentation data were also inspected and areas where high heave, pitch, roll or speed were recorded, were removed from the dataset. Water velocity data were inspected, showing little variation across time and location. Averaged values from 4 casts were used to create a water velocity profile from 0 m to 7 m, shown in Figure 8. Values from this profile are applied to all data and recorded depths were adjusted accordingly in the Hypack software.

Pond bottom elevations were calculated by subtracting depths derived from the Hypack software from the average elevation of the multi-beam sonar head as measured by the RTK GPS (1045.490 m). Water elevation measurements and shoreline measurements were not used in the pond bottom elevation determination wherever sonar data were collected.

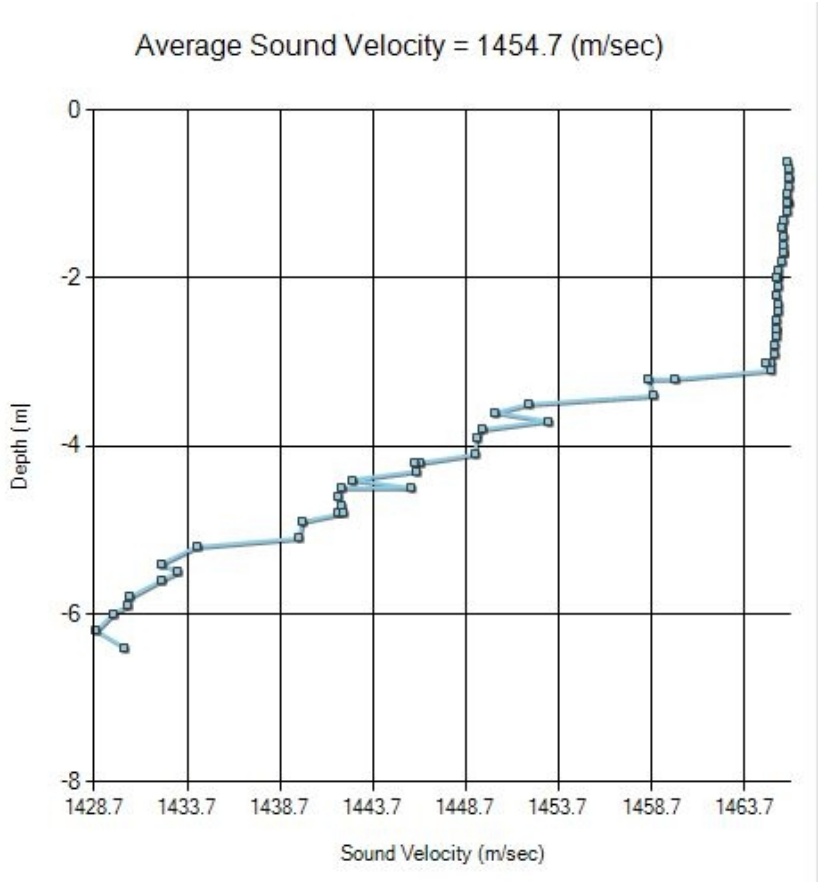


Figure 8: Average acoustic water velocity profile.

RTK GPS points taken at 203 shoreline locations adjacent to the surveyed area were used to interpolate a full shoreline. Orthometric heights are recorded for these shoreline locations. This shoreline data was integrated with all multi-beam and single-beam bathymetry data to create all grids and contour files associated with this pond. Gridded bathymetry data were created using a 0.5 m cell size and windowed to exclude points outside the RTK GPS surveyed perimeter created by the gridding algorithm. No filters were applied to the final bathymetry grids. All 25 cm and 50 cm contours were made after 3 passes of a 3x3 Hanning filter on the bathymetry grid.

3.1.4 Bathymetry Products

The following files and figures are appended to this report

Folder / File	Description
Raw data/Multi-beam/Raw/*.hsx	Raw multi-beam data in Hypack Raw format
Raw data/Single-beam /*.obs	Raw single-beam data in GeoXT format, with supporting files
Raw data/GPS/Base/*.m00 and Rover/*.m00	Base and rover GPS data from June 12&13 are associated with multi-beam data in Leica m00 format.

Processed data/GPS/*.csv	GPS data in ASCII formats with baseline information, DOP values, positional quality. Data from June 12&13 are associated with multi-beam data.
Processed data/GPS/channels.txt	Description of columns for ASCII GPS files.
Processed data/Bathymetry/ID pond elevation_complete.xyz	Master ASCII database of all final bathymetry data, combined with single beam and shore-line RTK Expressed in project coordinates, not water depth..
Processed data/Bathymetry/0.5m rasterized/ID pond elevation_0.5.xyz	Rasterized version of the complete bathymetric data at 0.5 m cell size in ASCII format.
Processed data/Bathymetry/0.5m rasterized/ID pond elevation.flt	Rasterized version of the complete bathymetric data at 0.5 m cell size in ESRI float raster grid format.
Processed data/Bathymetry/0.5m rasterized/ID pond elevation with shore extensions.flt	Rasterized version of the complete bathymetric data at 0.5 m cell size in ESRI float raster grid format including the extensions onto the shore.
Processed data/Bathymetry/ID pond lead-lines.xyz	Master ASCII database of all lead-line measurements.
Processed data/Bathymetry/ID pond shoreline extensions.xyz	Master ASCII database of elevations measured on the shore located as extensions to the single-beam data lines..
Processed data/Bathymetry/ID pond shoreline interpolation.xyz	Master ASCII database of the shoreline measurements, rasterized to 1 m.
Processed data/Bathymetry/ID pond shoreline measured.xyz	Master ASCII database of all shoreline measurements.
Processed data/Bathymetry/ID pond single-beam.xyz	Master ASCII database of all single-beam data including secondary control from common transect lines and data in water too shallow for the multi-beam survey.
Processed data/Multi-beam/feature channels.txt	Description of columns for ASCII pond elevation databases.
Processed data/Bathymetry/water velocity profile.vel	Master ASCII database of averaged water velocity profiles.
Processed data/Bathymetry/ID pond elevation contous_500.dxf	1:500 scale 25cm contours of depth, made from the 0.5 raster pond elevation with a 7 passes of a 3x3 Hanning filter in AutoCAD version12 DXF format.
Processed data/Bathymetry/ID pond elevation contous_1500.dxf	1:1500 scale 25cm contours of depth, made from the 0.5 raster pond elevation with a 7 passes of a 3x3 Hanning filter in AutoCAD version12 DXF format .
Figures/ID pond bottom elevation 500.pdf	1:500 scale map with gridded mudline elevation and 25 cm contours in PDF format
Figures/ID pond bottom elevation 1250.pdf	1:1250 scale map with gridded mudline elevation and 25 cm contours in PDF format

3.2 Sub-Bottom Survey

Acoustic sub-bottom data collection was completed at Intermediate Dam Pond with a nominal line spacing of 5 metres. The coverage is slightly less complete than the bathymetric data set due to survey restrictions in shallow water from the sub-bottom instrument as illustrated in Figure 2.

3.2.1 Equipment

The crew was equipped with the following instruments and equipment:

Equipment:	1	EdgeTech SB-424 towfish s/n: 38803
	1	Edgetech 3100P sub-bottom topside unit s/n: 38688
	1	Leica GS15 sensor rover s/n 1502720
	1	Leica GS14 sensor base s/n 2802696
	1	Leica CS15 controller s/n 2907005
	1	Pac Crest ADL Vantage Pro Radio s/n 13086191
	1	Pac Crest Radio s/n 1301949
		Miscellaneous GPS cables, tripods and equipment
Communications:	4	VHF handheld radios
	1	SAT phone
Vehicles:	1	Flat deck truck
	1	Truck Trailer
	1	Arctic Cat ATV
	1	16ft aluminium boat
	1	Inflatable Zodiac rescue boat
	1	6 HP outboard motor
	1	2 HP electric motor
Safety:	4	Government certified personal floatation devices (PFDs)
	2	ATV helmets
	4	Hard hats
	100	Nitrate gloves
	9	Tyvek suits
	8	Safety glasses
	4	High Visibility Vests
	2	Fire extinguisher
	2	Level 2 First aid kit
	4	Spare paddles
	2	15m floating rope
	2	Bailers
Computers & Software:	1	Laptop with Edgetech Discover Sub-Bottom 4.0
Other:	20	6 mil plastic garbage bags
	1	Pressure washer
	1	Water tank
	1	Office box
	1	Geophysical Toolbox

3.2.2 Survey Specifications & Field Procedures

3.2.2.1 RTK GPS

A GPS base station was established daily with the Leica GS14 antenna over the permanent control marker 2010-P5 at CVD. The published position for 2010-P5 was inadvertently not programmed into the GPS base prior to starting work in the field and an arbitrary position was used the first day. For consistency the arbitrary base position was used throughout the survey and all RTK data were corrected by a post-survey datum shift to align the base with the published position. The initial (arbitrary) reference point recorded by the base station was broadcast continuously via radio to the Leica GS15 rover so that a phase-corrected RTK solution was being transferred to the sub-bottom equipment via NMEA string at all times during data collection. The use of this initial reference point requires a datum shift be applied to all raw data.

An RTK check-in point was established on the north-west end of the ID pond at 580736E, 6914386N (NAD83 CSRS Epoch 2002 UTM Zone 8N) and measurements were taken there once or twice daily. The daily check-in values are provided in Section 3.3.2.

As per the published *Survey Standards for Faro Mine Closure* included with CH2M Hill Agreement 10201-7-100723, the coordinates for the antenna established at 2010-P5 are 6914557.921 N, 580635.174 E (NAD83 CSRS Epoch 2002, UTM Zone 8 coordinates with a CSF of 0.999505) with an orthometric height above the HT2 Geoid Model of 1060.480 m. The post-survey datum shift applied was to align the arbitrary base position to this accepted position.

3.2.2.2 Sub-bottom Profiling

Sub-bottom profiling was performed along 75 lines running 41˚ across the pond, and along 6 perpendicular tie-lines for cross reference. Survey line spacing was 5 m with tie-lines being profiled at uneven spacing, in an attempt to profile different features that appeared during the initial passes. Target boat speed was approximately 3 knots and attempts were made to maintain constant speeds in an effort to avoid distorting produced images.

The Edgetech SB-424 towfish, 3100P topside unit and Discover software were used to collect all sub-bottom data. The SB-424 is capable of outputting a variety of FM chirps, each of which was tested before surveying began. Of the chirps tested, it was decided that the highest range of frequencies available (4-24 kHz) provided the best resolution; whereas limiting the signal to lower frequencies seemed to offer no significant advantage with regard to depth of penetration.

The crew conducted a series of control tests at the beginning and end of each day. Control stations, shown by green triangles in Figure 2, were established at 580819E, 6914176N & 580810E, 6914150N (NAD83 UTM Zone 8N) by driving poles into the pond floor. GPS and sub-bottom data were recorded while traversing north to south, from pole to pole. The purpose was to collect data at the same physical location, guided by the poles, multiple times to establish the repeatability of the sub-bottom data.

3.2.3 Data Processing

3.2.3.1 RTK

The use of an arbitrary initial reference point required a datum shift be applied to all raw data to reposition the base station to the published position of 2010-P5. All points were shifted -2.005 m N, 1.733 m E and elevation was shifted -6.501 m.

Data were logged to the Leica receiver and exported to csv files; both raw daily base and rover files, in addition to the exported rover files, are included with the data package of this report. The positional quality is shown in Figure 9 and the height quality in Figure 10 as reported by the Leica Geo Office software package from the raw rover files with no post-processing; both have a 95% confidence level well below 10 cm.

Baseline and DOP data were obtained by post-processing with Leica Geo Office. Although the base station was operating correctly and RTK corrections were being received on June 17, the file of the GPS readings did not record properly on the base. The consequence of this is that some meta-products for the GPS (baseline and DOP information) are not available for June 17.

Water level and data from RTK check-ins are discussed below in Section 3.3.2.

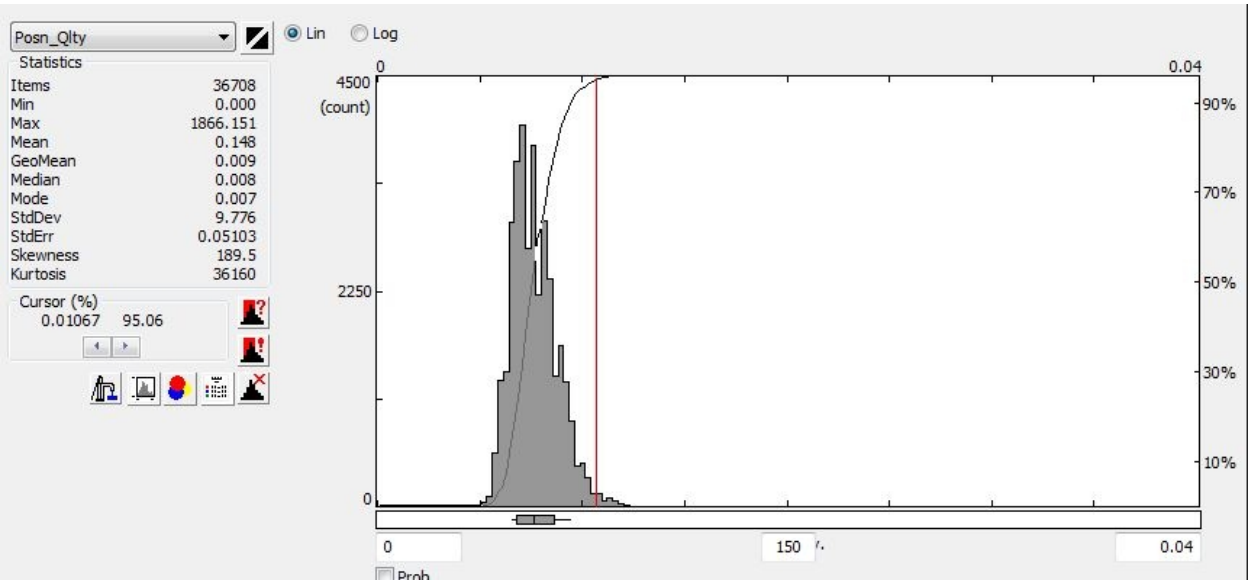


Figure 9: Position quality of GPS solutions during sub-bottom profiling acquisition. The red line shows the 95% of the position quality is at 0.011 m.

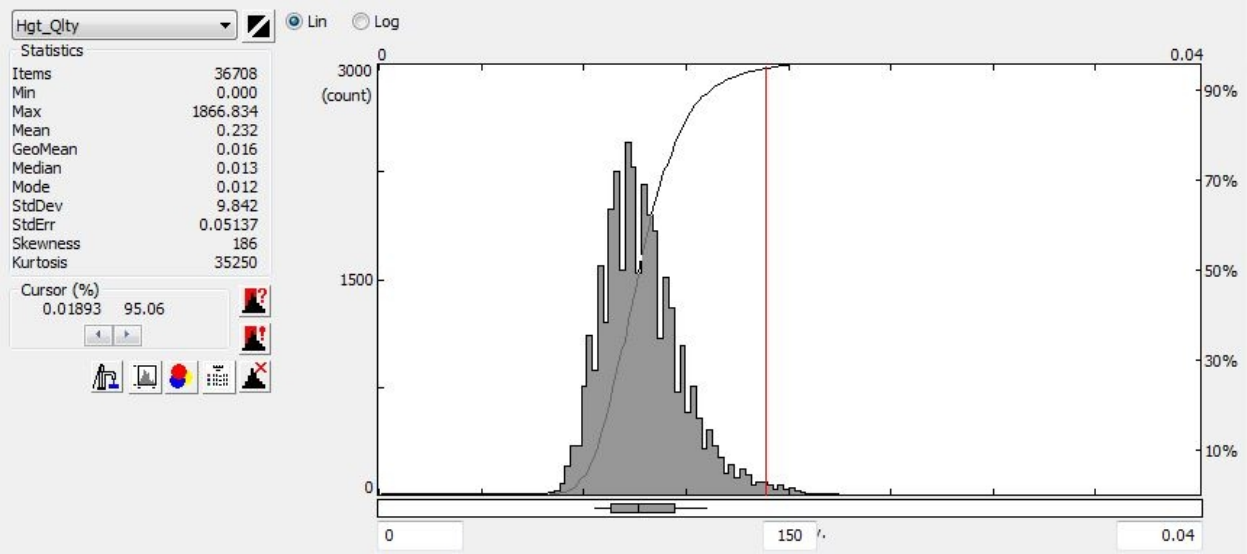


Figure 10: Height quality of GPS solutions during sub-bottom profiling acquisition. The red line shows the 95% of the height quality is at 0.019 m.

3.2.3.2 Sub-Bottom

Initial processing of sub-bottom profiles was performed with SonarWiz 6. User gain controls were adjusted to increase the visibility of responses at depth and have a minimal impact on near surface responses. Once set, this gain was applied universally across all lines allowing for objective comparisons between them. Auto-detection of the pond floor was used but was insufficiently accurate. All features, including the pond floor, were drawn in after visual inspection. Features were first drawn on the perpendicular tie-lines. The depths of these features were then plotted to all sonargrams and used only as visual cues to calibrate the drawing of all subsequent features. Tie-line feature depths were not included in the final dataset.

Definitions of Features

Feature 1U – This is the upper limit of a package of layered sediment with each individual layer typically 25 cm thick. The layers are not always well defined – sometimes because the layer is too thin but also sometimes because the response grades from well-defined layers to a more homogeneous mass sitting on top of Feature 2 (see below). This feature likely represents layered tailings deposited in a tailings pond environment, which are expected to have strong horizontal layering resulting in high sonar reflectance as observed in Feature 1.

Feature 1D – This is the lower limit of Feature 1.

Feature 2U – This is the upper limit of a mostly homogeneous feature that show a markedly weaker response than the layered sediment of Feature 1. These areas are sometimes clearly delineated and sometimes are the result of a more gradual fading of response. They are always susceptible to being dominated by multiples of stronger reflectors higher in the stratigraphy and could simply represent a complete loss of signal at depth. Although the signal often appears greatly attenuated within Feature 2,

strong responses from underlying features such as interpreted bedrock are still occasionally seen. This feature likely represents the fluvial or glacio-fluvial quaternary sediments on bedrock. Although these deposits are not likely homogeneous, they are not be expected to have the strong horizontal layering that results in high sonar reflectance as seen in Feature 1.

Feature 2D – This is the lower limit of Feature 2. When this feature is present directly above Feature 5 it represents, with Feature 2U, the thickness of Feature 2. When not present (Feature 2U is underlain by Feature 4) the thickness of Feature 2 remains undefined.

Feature 4 – This feature is used to represent areas where no well-defined bottom layer is discernable. It is the opposite pair of Feature 5; wherever Feature 5 is not defined, Feature 4 is. As Feature 4 is defined by a lack of discernable response, the depths assigned are not reliable.

Feature 5 – This is a strong well defined layer with no apparent sediment layers below it, possibly representative of bedrock.

An example of a section with Features 1,2 & 5 in shown Figure 11.

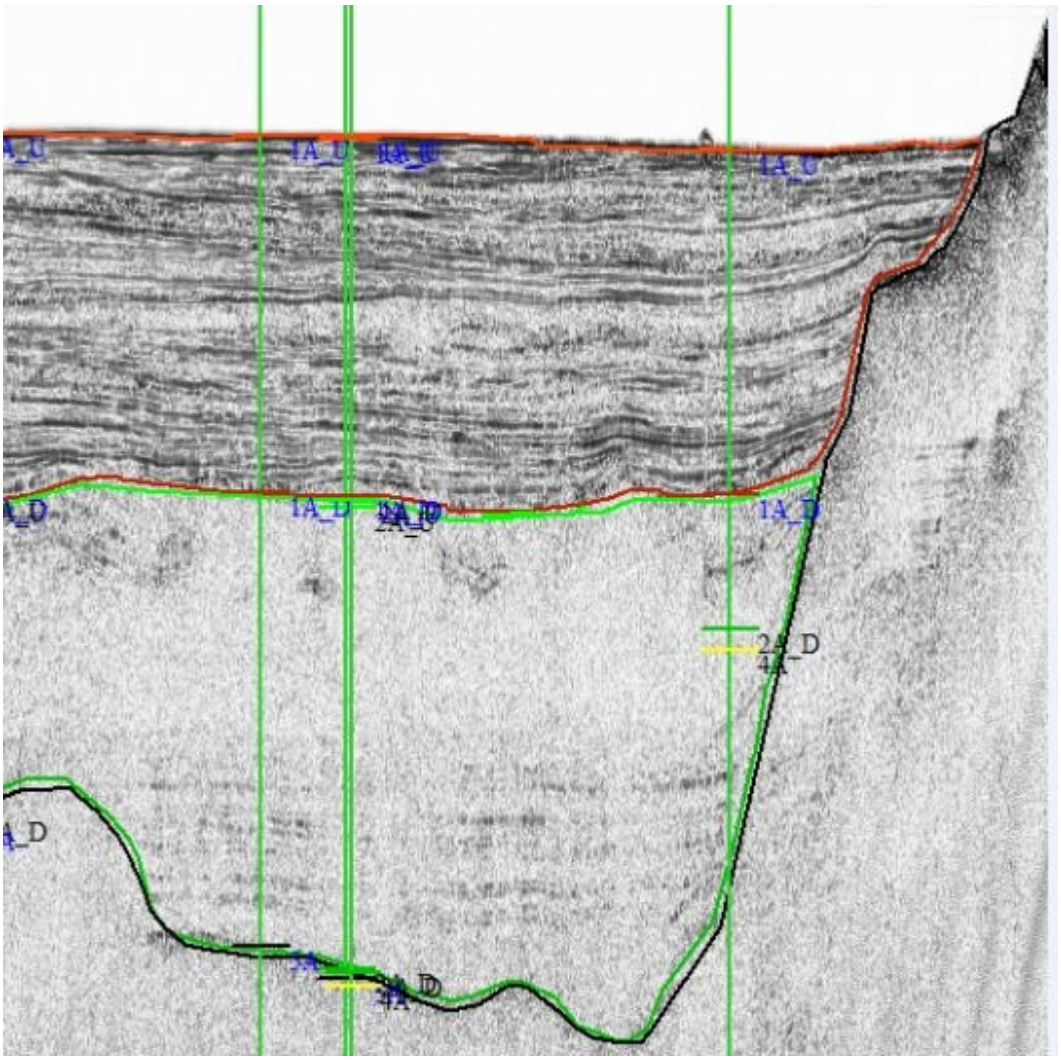


Figure 11: Sonargram showing homogenous feature (Feature 2), under clearly layered sediment (Feature 1) and above a defined bottom feature (Feature 5). Vertical lines represent the location of tie lines.

Export and Processing of Features

The features described above were identified on a line-by-line basis and images of each line with the interpreted features are included with this report. Features were validated through cross-referencing with the six perpendicular tie-lines. The data on the NS lines were exported to an ASCII master database and AutoCAD v12 DXFs with all the interpreted features were produced for each line. The velocities of all layers are assumed to be 1500 m/s upon export and all data downstream of the export are in metres.

The feature thicknesses are exported to ASCII and are gridded with a minimum curvature algorithm and a cell size of 1.0 m, which is an appropriate cell size for 5 m line-spacing. Grids are provided in both ASCII and ESRI formats. Contours for each feature are made at 10 cm intervals and are exported in AutoCAD v12 DXF format.

Cross-Sections

Cross-sections were produced at 50 m intervals for the pond in both the east-west and north-south directions. A database was developed for each cross-section with 1 m resolution and the final bathymetric database is sampled to obtain the pond bottom along the cross-section.

3.2.4 Sub-bottom Products

The following files and figures are appended to this report:

Folder / File	Description
Raw data/Sub-bottom/*.jsf	Sub-bottom data by line in EdgeTech jsf format (see Appendix III.
Raw data/GPS/Base/*.m00 and Rover/*.m00	Base and rover GPS data from June 14 & 15 are associated with sub-bottom data in Leica m00 format.
Processed data/GPS/Daily Surveying/*.csv and *.txt	GPS data in ASCII formats with baseline information, DOP values, positional quality. Data from June 14 & 15 are associated with sub-bottom data.
Processed data/GPS/channels.txt	Description of columns for ASCII GPS files.
Processed data/Sub-bottom/Feature lines/ASCII/ID pond subbottom_all_Features.xyz	Master ASCII database of all interpreted sub-bottom features.
Processed data/Sub-bottom/Feature lines/ASCII/ID pond subbottom_*.xyz	ASCII Database of feature "*".
Processed data/Sub-bottom/Feature lines/ASCII/ Feature_lines_channels.txt	Description of columns for ASCII sub-bottom databases.
Processed data/Sub-bottom/Line-by-line DXFs/*.dxf	Interpreted sub-bottom features in AutoCAD version12 DXF format.
Processed data/Sub-bottom/Feature thickness/ASCII XYZ/Feature_*.xyz	Calculated thickness of each sub-bottom feature.
Processed data/Sub-bottom/Feature thickness/ASCII XYZ/Feature_thickness_channels.txt	Description of columns for ASCII feature thickness.
Processed data/Sub-bottom/Feature thickness/DXF contours/Feature*.dxf	Contour of feature thickness (interval of 0.25 m) after 10 passes with a 3X3 Hanning filter in AutoCAD version12 DXF format.
Processed data/Sub-bottom/Feature thickness/ESRI grids	Raster grid at 1 m cell size of feature thickness in ARC float raster format.
Processed data/Sub-bottom/Feature thickness/Geosoft grids	Raster grid at 1 m cell size of feature thicknessin Geosoft grid format.
Processed data/ID pond sonargrams/*.jpg	Images of processed data for every line with interpreted layers in jpg format.
Figures/Cross-sections/DXFs	EW and NS cross-sections (50 m spacing) with bathymetry and interpreted sub-bottom layers in AutoCAD version12 DXF format.
Figures/Cross-sections/PDFs	EW and NS cross-sections (50 m spacing) with bathymetry and interpreted sub-bottom layers in PDF format.

3.3 Quality Control Checks

3.3.1 Common Transects

3.3.1.1 Single-beam & Multi-beam

Six transects were completed across the pond with the single-beam transducer to create a dataset suitable for comparison with the multi-beam data. These 6 lines represent 1352 single-beam locations which, on average, are 0.02 m deeper than the multi-beam data for the same location and have a maximum absolute difference of 1.42 m (Figure 12). Transects are shown in Figure 13.

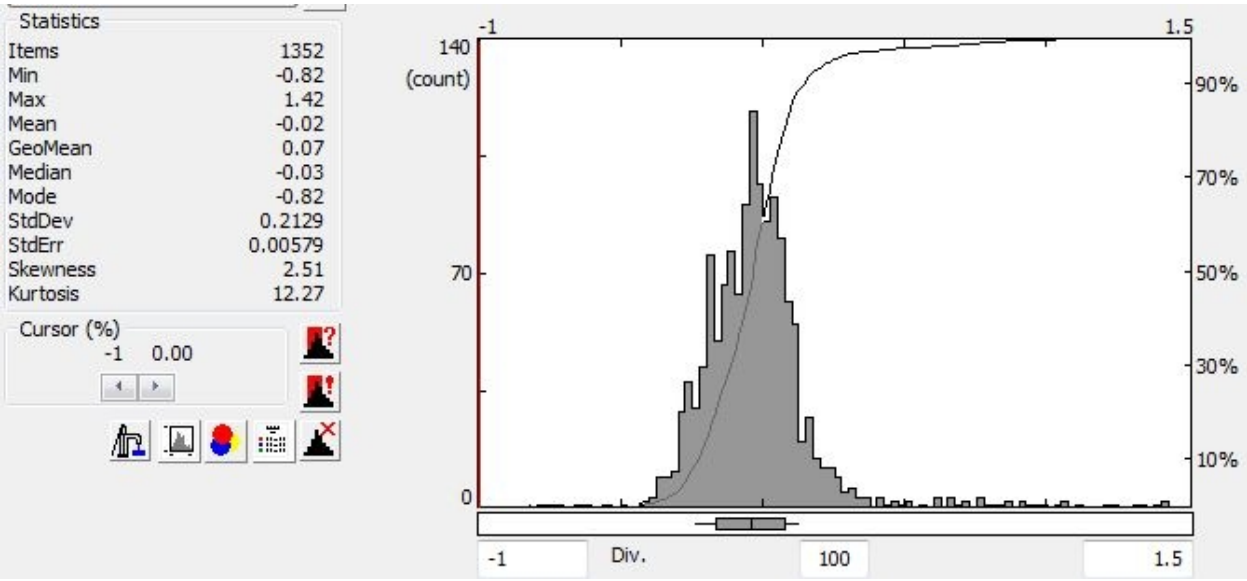


Figure 12: Histogram of difference between single-beam and multi-beam readings.

The purpose of the single-beam data collection is to provide an independent check (in addition to the lead-line dataset) on the multi-beam data. The distribution of the differences is centered close to zero but has a high kurtosis and skewness, indicating high level of outliers particularly on the positive end (Figure 12). Examination of transects shown in Figure 13 show that these outliers, circled in blue, are not random; they occur where the pond bottom has a steep gradient. When the outliers are rejected until the kurtosis is approximately equal to 3 (the kurtosis of a normal Gaussian distribution), the standard deviation is 0.16 m.

One possible explanation for this systematic difference is that in an area of steep bottom topography, the footprint of the sonar will cover a wide range of depths. The multi-beam system is calibrated with a pair of GPS antenna for heading determination and pitch, roll and heave detectors. Although the beam width is larger than the single beam (120˚ versus 9˚), the multi-beam operates with 512 beams over the 120˚ instead of a single beam over 9˚. The wider footprint per beam and the lack of heading and motion detectors on the single-beam instrumentation means there is greater ambiguity in imaging a dipping subsurface. The observed discrepancy between the datasets would be consistent with the single-beam taking the earliest reflection as bottom.

There was some corrugation in the raw multi-beam dataset that is likely a result of imperfect calibration or a calibration that was slipping in time. This was particularly apparent in the morning of the first day of collection, June 12th. Most of this artifact was successfully removed in post-processing, however there is a small residual effect that cannot be removed. An example of this residual corrugation, which has an amplitude of several decimeters, is shown by the orange ellipse in Figure 13. It should be noted that the residual corrugation is not systematically biased and averages to zero therefore calculations of the water volume in the pond will not be significantly affected.



Figure 13: Common single-beam and multi-beam transects, showing pond bottom elevation (top panel) and single-beam / multi-beam difference (bottom panel). Blue ellipses show areas of steep bottom gradient and where a systematic difference between single-beam and multi-beam depth is observed. The orange ellipse shows an example of residual corrugation, likely caused by an imperfect calibration.

3.3.1.2 Lead-line comparisons

Preferentially along the same six single-beam transects, 49 lead-line measurements were taken and the histogram of the difference between the 49 lead-line and the multi-beam measurements is shown in Figure 14. Because of the nearly coincident lead-line measurements and single-beam measurements, comparisons can also be made between these two datasets and this is shown in Figure 15. The criterion for comparison was that the lead-line needed to be within 5 m of the single-beam reading. Both difference datasets are biased negative (-0.26 m and -0.31 m) which indicates the lead-line measurements are in general deeper than both the multi-beam and single-beam measurements. This bias is in part due to the methodology as the boat was not anchored while taking the measurements and was drifting significantly in the wind. Efforts to take the best data possible were made, but the lead-lines were to not vertical at the time of measurement which would explain the deep bias. Also adding to the deep bias of the lead-line measurements, based on the observations of ubiquitous and thick mud on the weighted part of the line, it was clear that the bottom of ID pond is very soft in places and the weight would have had significant penetration.

Despite the bias, the distribution is fairly well matched to a normal Gaussian distribution. No systematic difference is seen between the comparisons of lead-line and single-beam and lead-line and multi-beam (Figure 16).

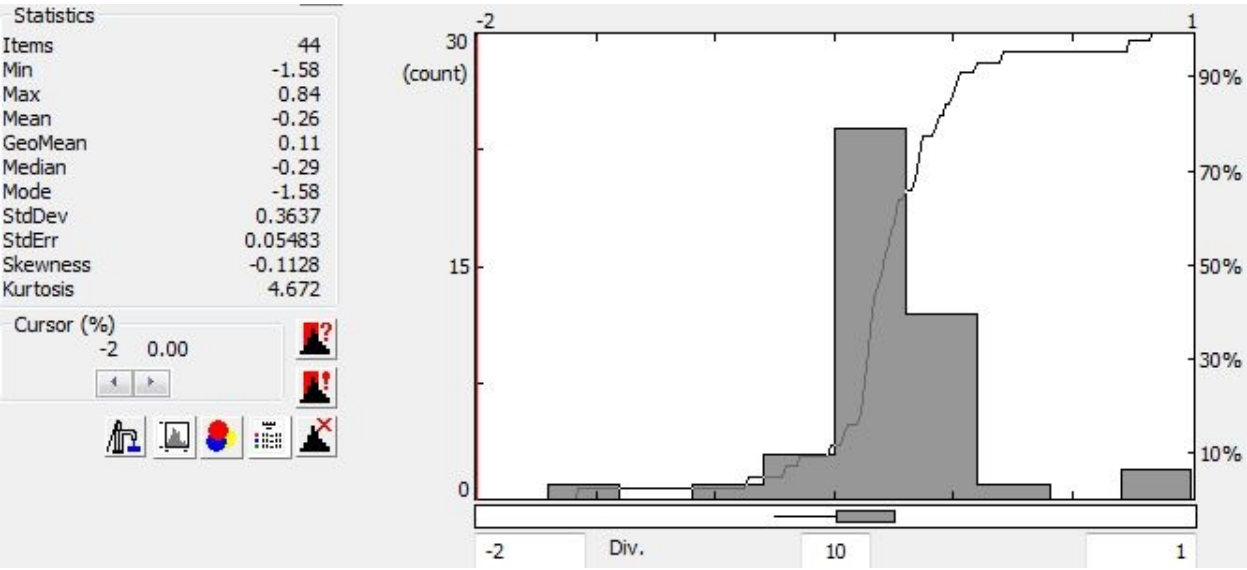


Figure 14: Histogram of difference between lead-line measurements and multi-beam readings.

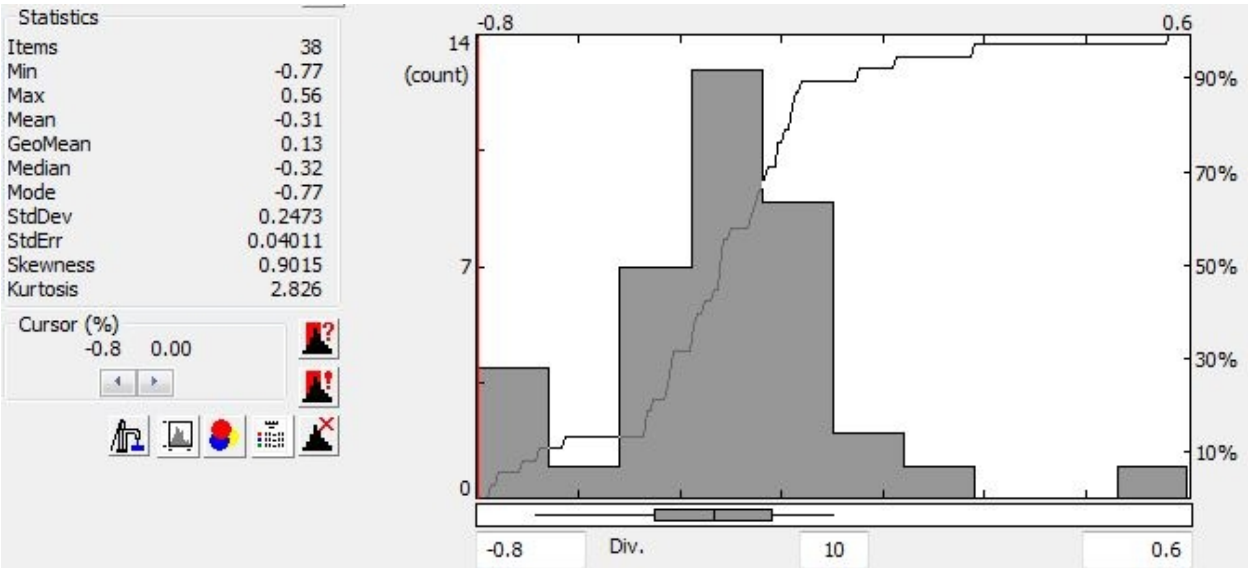


Figure 15: Histogram of difference between lead-line measurements and single-beam readings.

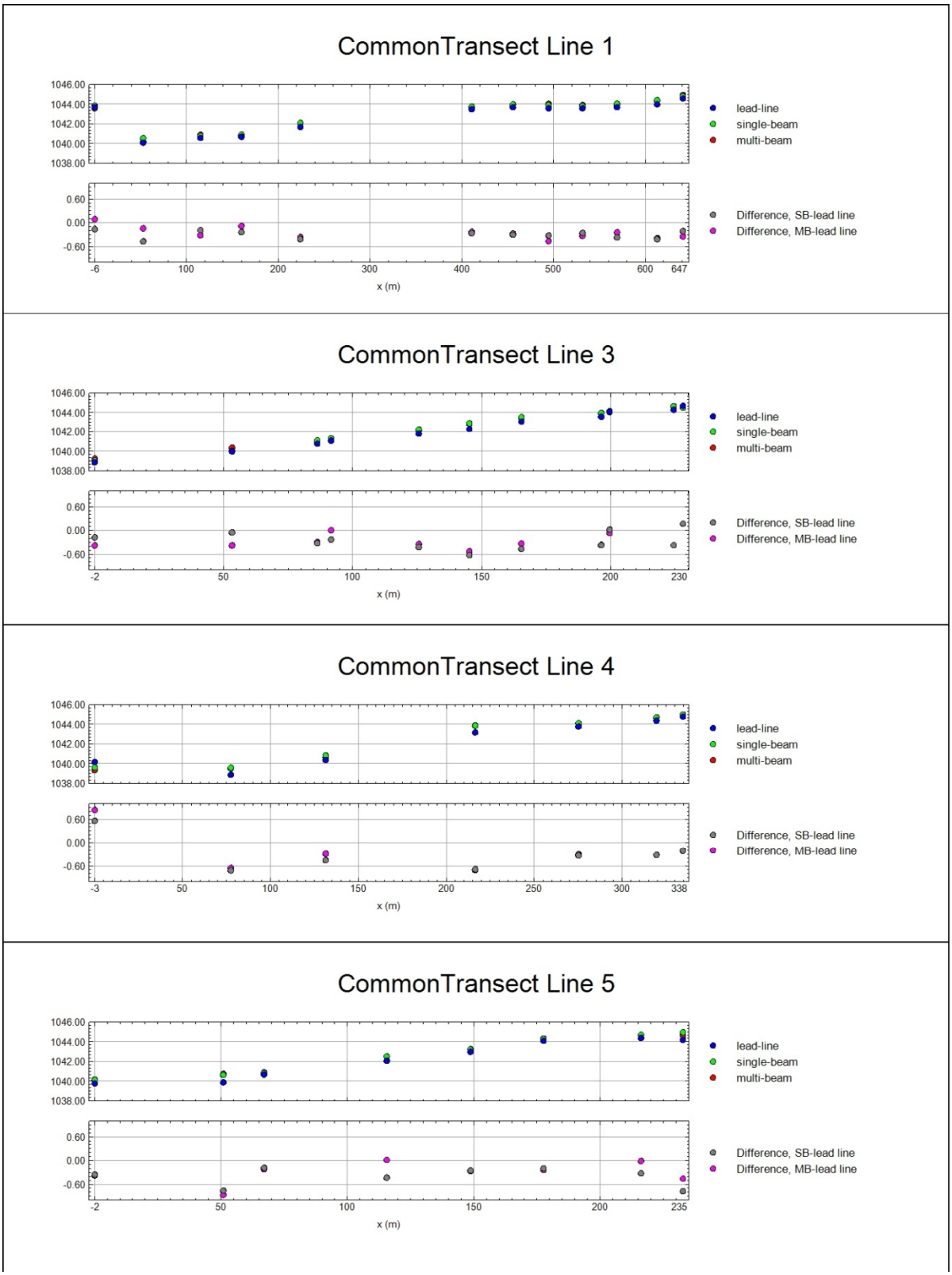


Figure 16: Common lead-line measurements along single-beam transects and comparisons with multi-beam data, showing pond bottom elevation (top panel) and differences (bottom panel).

3.3.2 Daily check-ins

3.3.2.1 GPS Control

A distinct location (the north side of a protruding pipe) on the northwest side of the pond was chosen as a daily check-in station to directly test the consistency of the Leica RTK GPS system from which all positioning in the ID pond was measured. Measurements were taken once or twice a day and the results are tabulated in Table 1.

The repeatability of the elevation is within 3.5 cm with a standard deviation of 1.2 cm, while the repeatability of the easting and northing are 2.5 cm and 1.5 cm respectively while the standard deviations are 8 mm and 5 mm respectively.

Table 1: RTK GPS data from check-in control adjacent to ID pond.

Date	Time	Easting	Northing	Orthometric Height
2016-06-11	12:26:06	580736.109	6914386.867	1047.662
2016-06-12	7:49:15	580736.084	6914386.854	1047.664
2016-06-13	8:03:05	580736.085	6914386.859	1047.685
2016-06-13	16:20:57	580736.095	6914386.861	1047.679
2016-06-14	9:56:16	580736.089	6914386.863	1047.674
2016-06-14	15:51:57	580736.089	6914386.859	1047.679
2016-06-15	7:54:24	580736.087	6914386.862	1047.681
2016-06-15	16:02:09	580736.095	6914386.854	1047.697
2016-06-16	8:20:07	580736.086	6914386.859	1047.691
2016-06-17	9:53:52	580736.104	6914386.869	1047.689
2016-06-17	22:57:13	580736.100	6914386.862	1047.697
	Mean	**580736.093**	**6914386.861**	**1047.682**
	Range	**0.025**	**0.015**	**0.035**
	Standard Dev.	**0.008**	**0.005**	**0.012**

3.3.2.2 ID pond water level

The water elevation of the ID pond was measured once or twice a day and the results are tabulated in Table 2.

The repeatability of the elevation is within 10.5 cm with a standard deviation of 2.6 cm; this range is much larger than that of the RTK check-in control but this variability reflects both measurement / system error and a true change in water elevation. The drop in water level is also seen in the shoreline elevations, shown in Figure 17, where the data on the left of the black line were collected on June 16 and the data on the right of the blackline were collected on June 17. The drop in ID pond water elevation by several centimetres is consistent with both datasets, although the drop in the shoreline

elevations is greater. The interpretation of why the shoreline elevation shows a greater drop is that most of the points measured on June 17th are from the eastern side of the pond where the mud was very soft and although best efforts were made to get the true pond surface elevation, there was penetration of the GPS pole into the mud, biasing the water elevation lower. A shoreline elevation of 1045.976 m, the average of all the shoreline measurements, was used in the shallow water interpolation between the most shallow sonar measurement (usually single-beam) and the shoreline. The change in water level noted on June 17th is not significant in the calculation of the pond bottom elevation because it only affects a small area (shallow water) and the true differences is not as great as the shoreline measurements indicate because of the bias introduced by penetration into the soft mud.

Table 2: RTK GPS water elevation data of the ID pond.

Date	Time	Orthometric Height
2016-06-11	12:28:12	1046.035
2016-06-12	7:52:01	1046.043
2016-06-13	8:04:55	1046.035
2016-06-13	16:19:53	1046.030
2016-06-14	15:49:33	1046.043
2016-06-14	15:50:43	1046.036
2016-06-15	7:57:02	1046.023
2016-06-15	16:04:26	1046.028
2016-06-16	8:23:58	1046.063
2016-06-17	9:56:10	1046.027
2016-06-17	22:58:44	1045.958
	Mean	**1046.029**
	Range	**0.105**
	Standard Dev.	**0.026**

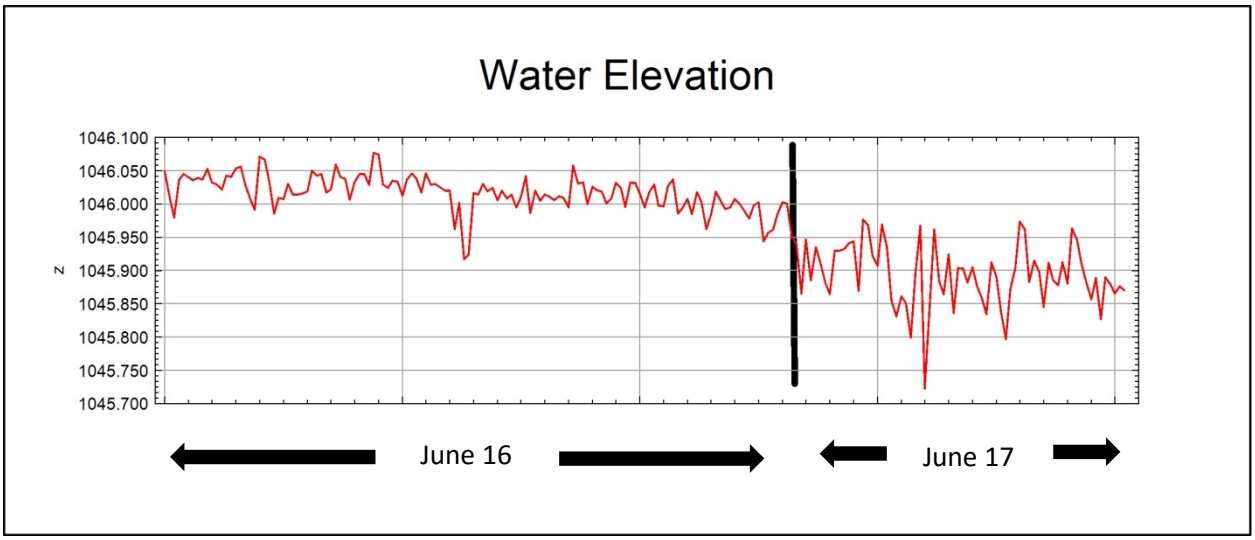


Figure 17: Shoreline elevation. The vertical black line represents the break between the points collected on June 16th and 17th.

3.3.2.1 Bathymetric check-ins

Multi-beam check-in data were collected as described in Section 3.1.2.2 at the start and end of every multi-beam survey day, creating a swath of data approximately 3.5 m wide and 40 m long. The data were gridded with a cell size of 10 cm giving between 8883 and 10143 common points for comparison. The mean difference between the reference control pass (morning pass of first day) and subsequent passes vary from 6 centimeters to 11 centimeters as shown in Figure 18. The standard deviation of the differenced grids is more consistent at 3.6 – 6.2 cm. This indicates that the 95% confidence level, which is approximately 2 standard deviations, is on the order of 9 cm.

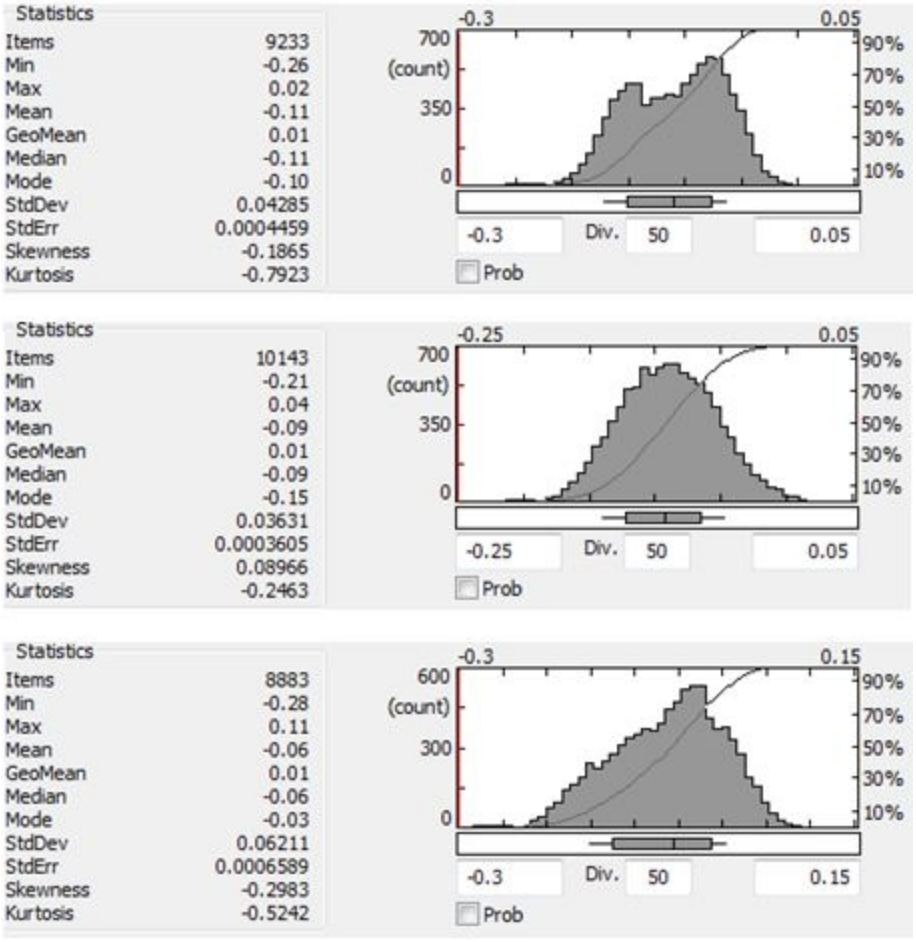


Figure 18: Histograms of the differenced grids from multi-beam daily check-ins as described in Section 3.1.2.2.

3.3.2.2 Sub-bottom check-ins

Sub-bottom check-in data were collected as described in Section 3.2.2.2 at the start and end of every sub-bottom survey day, the results of which are shown in Figure 19. No quantitative analysis was performed on these data, but the data are visually consistent between the 4 passes and as the interpreted features were identified visually from the sonargrams, this is an appropriate level of comparison. The control data demonstrates the sub-bottom equipment was in good working order prior to and immediately following the two days of surveying.

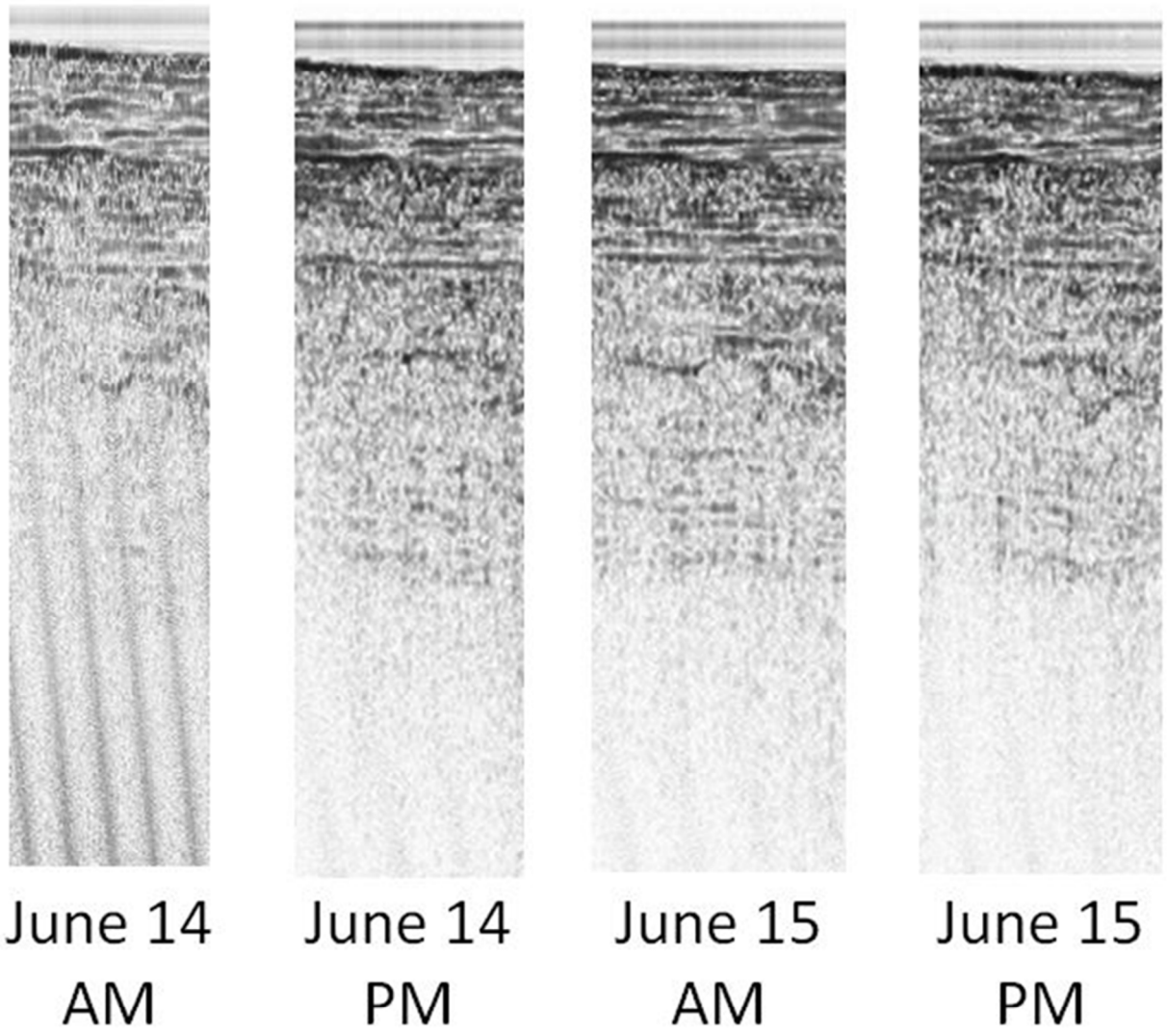


Figure 19: Sonargrams from the sub-bottom control passes.

4 DISCUSSION AND INTERPRETATION

4.1 Bathymetry

The multi-beam sonar survey provides a very high resolution dataset of the pond bottom as shown in Figure 20. The maximum depth of the pond is 7.8 m in the most western part of the pond. The pond bottom is mostly featureless and is dominated by shallowing slope to the east.

Agreement was generally good between the lead-line depths, single-beam transects and the multi-beam data, providing confidence in the data veracity of all three products. The notable exceptions are depth mismatches between the single-beam and multi-beam in areas of high pond bottom slope. The multi-

beam system is designed to account for slope in the calculation of depths while the single-beam is a simpler system that likely takes the first (i.e. most shallow) reflector and this would explain the discrepancy. Because of the more advanced instrumentation and strategy to account for such topography, the multi-beam is the preferred dataset.

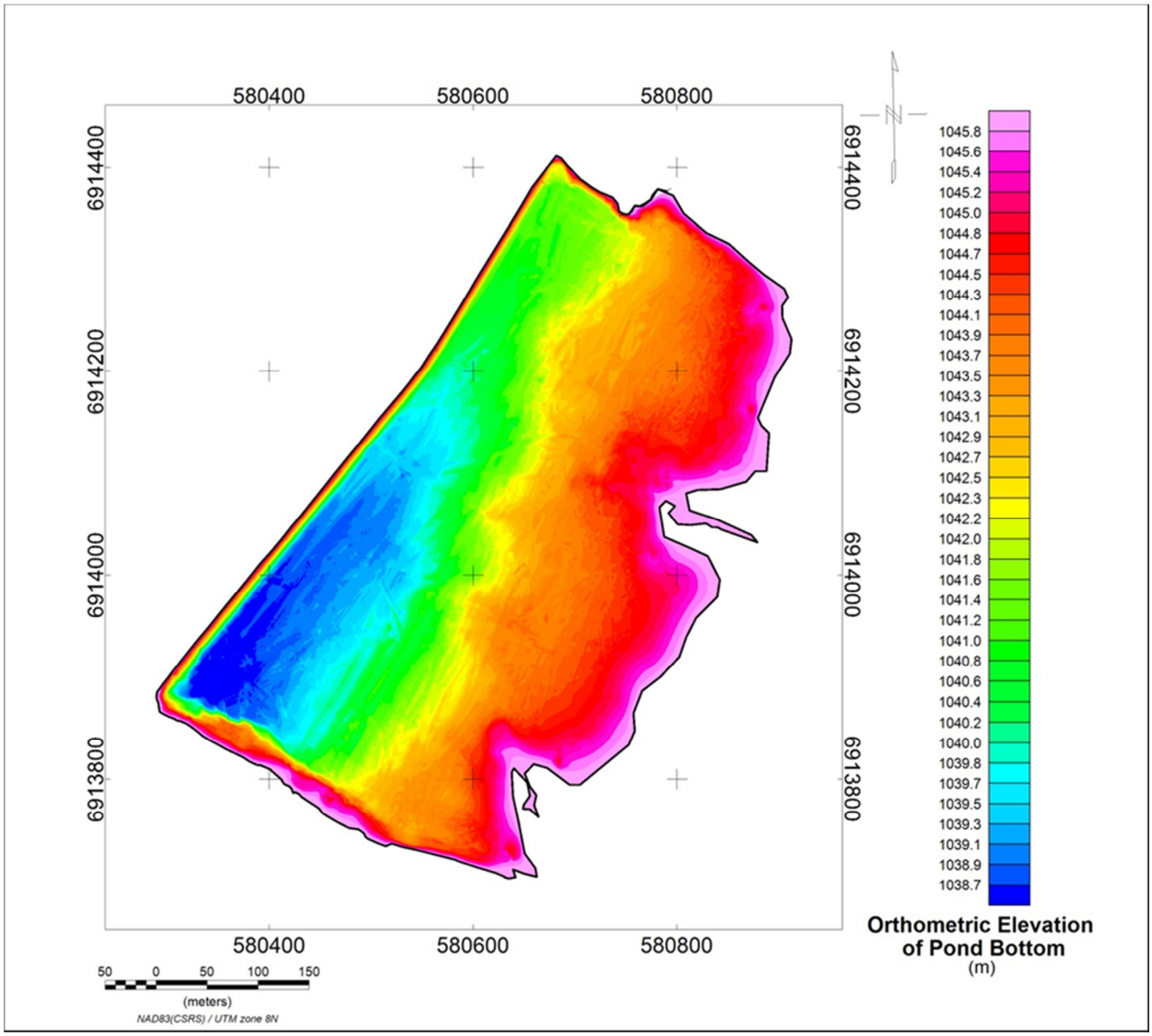


Figure 20: Intermediate Dam Pond elevation of pond bottom.

4.2 Sub-bottom

The Intermediate Dam Pond had many strong reflectors, some of which exhibited well-layered packages of sediment, interpreted to be tailings. A deeper reflector in much of the pond is identified and interpreted as bedrock. The thicknesses of Features 1 and 2 as defined above are shown in Figure 21 and Figure 22 respectively. The thickness of the features is greater on the western edge of the pond.

Feature 1, which is more robustly defined, is thickest in the northern part of the pond. The sections of pond with no thickness defined for Feature 2 is where no bottom of Feature 2 was identified.

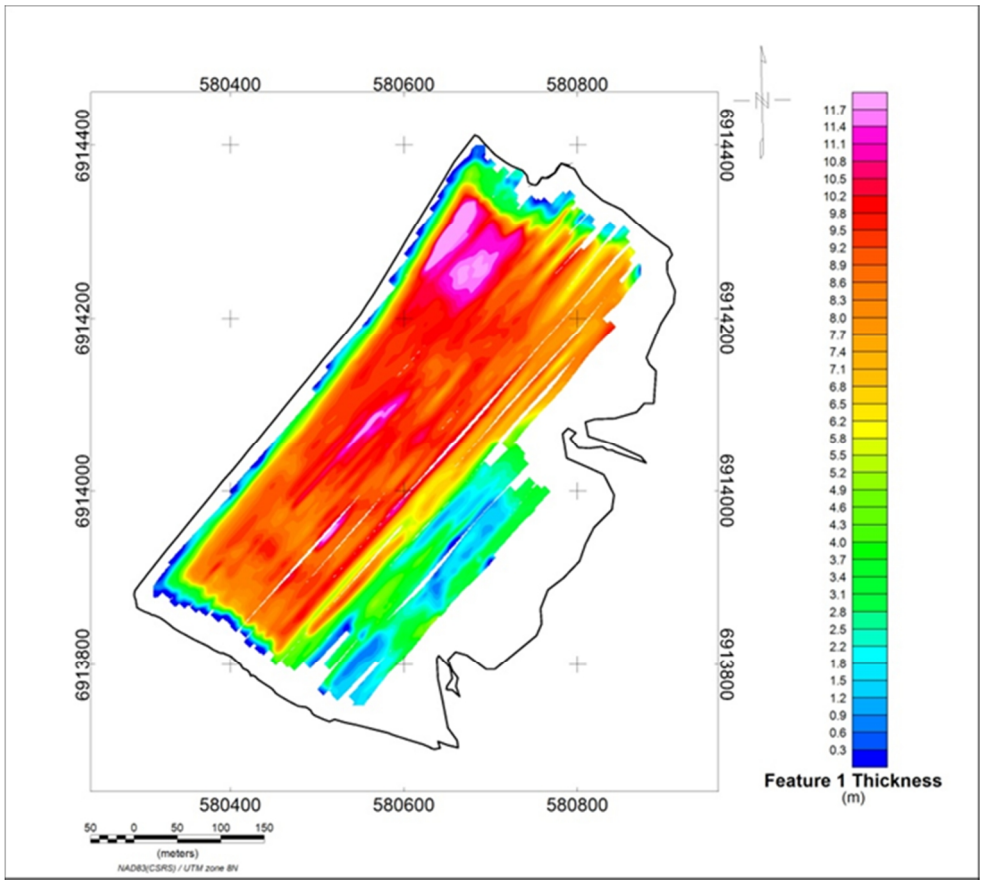


Figure 21: Thickness of interpreted Feature 1.

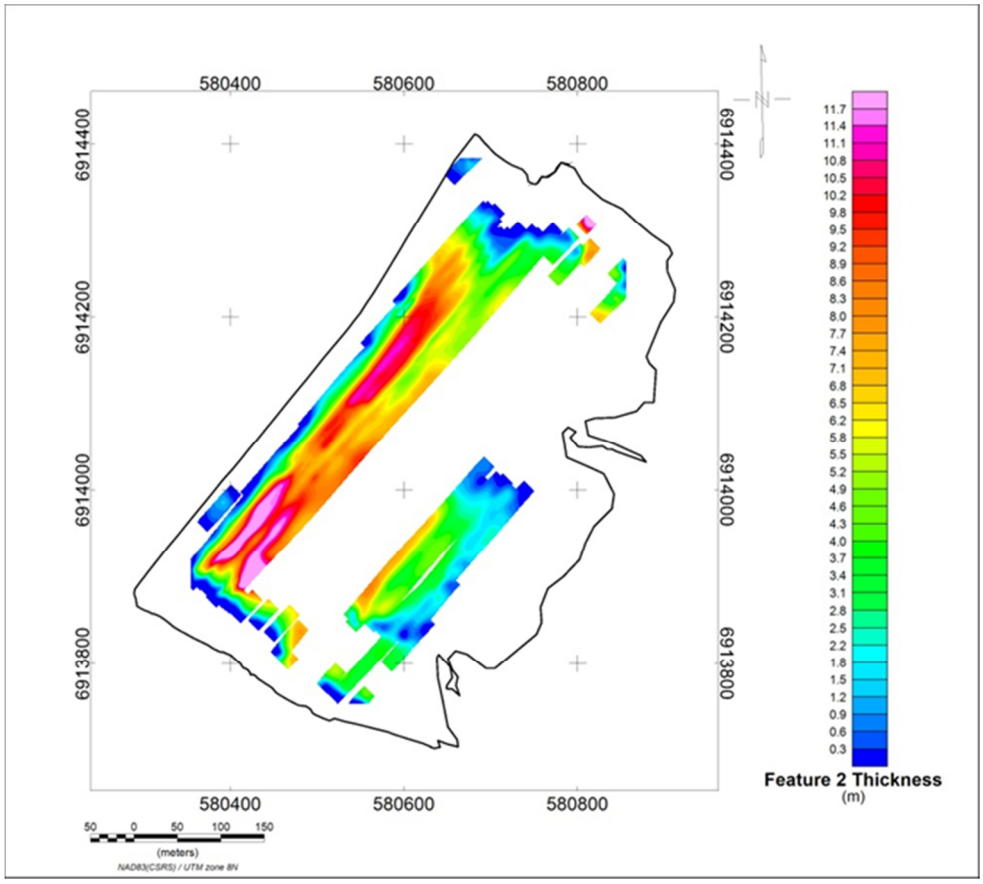


Figure 22: Thickness of interpreted Feature 2.

4.2.1 Alignment with Cone Penetration Soundings

Attempts to corroborate data with logs from cone penetration tests were not successful. Two of the soundings (CP14 and CP17) were conducted in areas where the sub-bottom profile showed no detectable bottom. One of the soundings (CP16) hit refusal later than the sub-bottom interpretation predicted, however this sounding took place 4 m away from any profile and as seen in Figure 23 hit what appears to be a steep incline in the pond wall and is therefore subject to large error because of the extrapolated location. The three other soundings (CP15, CP17 & CP 19) registered refusal as shallower than the interpreted sub-bottom bedrock, an example of which is shown in Figure 24. The default velocity in the processing software is 1500 m/s but to raise the interpreted bottom up to the refusal depth from CP15, CP17 and CP19 requires a sonic velocity of 1290 m/s. This is too slow to be physically reasonable for a sonic velocity in mud.

An alternate interpretation would be to assume the base of the Feature 1 represents bedrock and refusal. However, this interpretation would require a sonic velocity of 2500 – 3000 m/s which is too high for a sonic velocity in mud. Additionally at the CVD pond, soundings show several metres of penetration before refusal with a complete absence of Feature 1 in the sonargrams.

Therefore the final interpretation of what the features represent and how they relate to the core penetration soundings remain ambiguous. Velocities were left at 1500 m/s for all images and data included with this report.

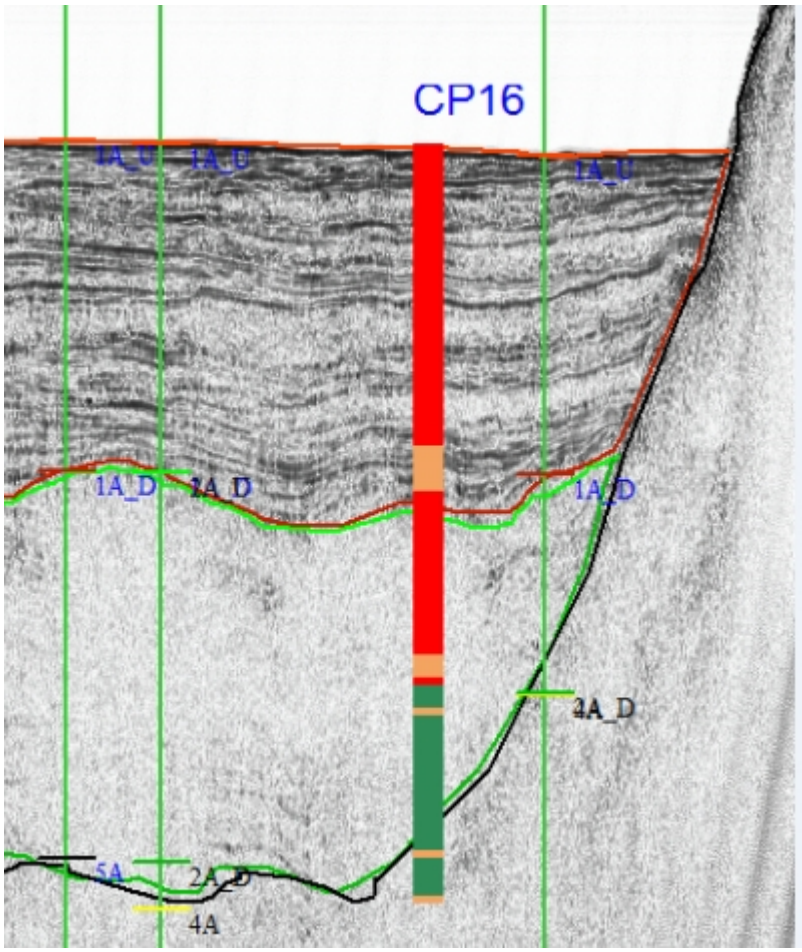


Figure 23: Location of sounding log CH-16-201-CP16 extrapolated to the nearest point on a 2-D axis sonogram axis can create errors close to steep pond walls.

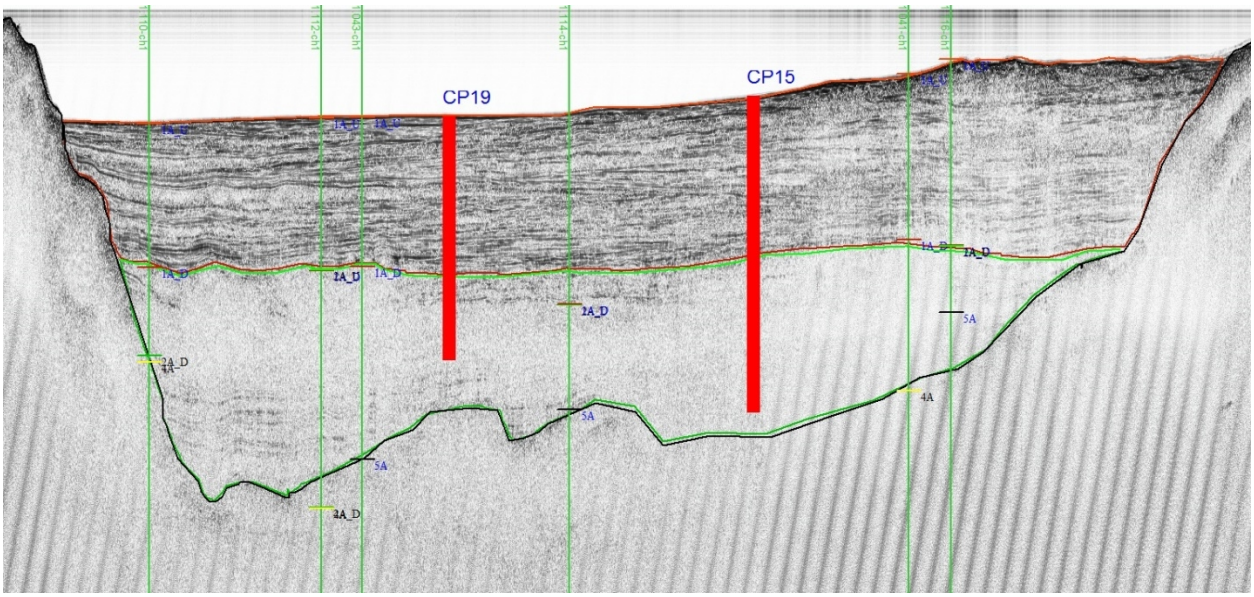


Figure 24: Sounding logs from CP19 and CP15 show refusal above interpreted bedrock surface.

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Dave Hildes, P.Geo., Ph. D.
Geophysicist

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Shawn Scott,
Geophysical Technician

Appendix I

Project Log

AURORA GEOSCIENCES

Weather Day	PERSONNEL : 27 Person-Days BAD WEATHER : 0 Person-Weather Days DAYS ON THE JOB : 8 days				
weather day *1/2 weather day*	Men-Weather Days	Shawn Scott	Kel Sax	Sahara Dove	Dave Hildes
Current Job	0	8	7	9	3
``	*	Mobe		Mobe	
Sat 11-Jun-2016	*	Orientation, setup	Orientation, setup	Orientation, setup	
Sun 12-Jun-2016	*	Multi-beam	Multi-beam	Safety	
Mon 13-Jun-2016	*	Multi-beam	Multi-beam	Safety	
Tue 14-Jun-2016	*	Sub-bottom	Sub-bottom	Safety	
Wed 15-Jun-2016	*	Sub-bottom	Sub-bottom	Safety	
Thu 16-Jun-2016	*	Single-beam, lead lines	Single-beam, lead lines	Safety and RTK	Mobe
Fri 17-Jun-2016	*	Demobe	Single-beam, lead lines, tear down	Safety and tear down	Single-beam, lead lines, RTK, tear down
Sat 18-Jun-2016	*			Demobe	Demobe

AURORA GEOSCIENCES

CHM-16069-YT Faro Bathymetry 2016

	IP Multi-beam (%)	IP Sub-bottom (%)	IP Single-beam (%)	IP Lead-lines (%)	IP RTK (%)	CVD Single Beam (%)	CVD Lead -ines (%)	CVD RTK (%)
% Completed	100	100	100	100	100	100	18	100
Fri 10-Jun-2016								
Sat 11-Jun-2016								
Sun 12-Jun-2016	55							
Mon 13-Jun-2016	45							
Tue 14-Jun-2016		60						
Wed 15-Jun-2016		40			20			
Thu 16-Jun-2016			100	100	30			
Fri 17-Jun-2016					50	100	18	100
Sat 18-Jun-2016								

AURORA GEOSCIENCES

CHM-16069-YT Faro Bathymetry 2016

DATE:	Friday, June 10, 2016

PREPARED BY:

Shawn Scott

Comments

Weather
Sunny and warm.

LOGISTICS

Type	*Contractor*	*Hrs or units*

Notes (production comments, incidents, other)
Left Whitehorse at 6pm, arrived safe in Faro 10pm.

AURORA GEOSCIENCES

CHM-16069-YT Faro Bathymetry 2016

DATE:	Saturday, June 11, 2016

PREPARED BY:

Shawn Scott

Comments

Weather

Mixed sun and cloud.

LOGISTICS

Type	*Contractor*	*Hrs or units*

Notes (production comments, incidents, other)

Arrived on site at 9am. Had safety orientation with Parsons, then had a safety orientation and logistics meeting with Benn and Chuck at CH2M. Set up the site in the early afternoon, unloaded boat and gear. Set up boat for multibeam survey and set control station pins in place

AURORA GEOSCIENCES

CHM-16069-YT Faro Bathymetry 2016

DATE:	Sunday, June 12, 2016

PREPARED BY:

Shawn Scott

Comments

Weather
Mixed sun and cloud.

LOGISTICS

Type	*Contractor*	*Hrs or units*

Notes (production comments, incidents, other)
Safety meeting at CH2M office at 730.
Day 1 of multibeam
7pm

AURORA GEOSCIENCES

CHM-16069-YT Faro Bathymetry 2016

DATE:	Monday, June 13, 2016

PREPARED BY:

Shawn Scott

Comments

Weather
Mixed sun and cloud.

LOGISTICS

Type	*Contractor*	*Hrs or units*

Notes (production comments, incidents, other)
Safety meeting at CH2M office at 730. Multibeam day 2 some surveying cleaned equipment with pressure washer

AURORA GEOSCIENCES

CHM-16069-YT Faro Bathymetry 2016

DATE:	Tuesday, June 14, 2016

PREPARED BY:

Shawn Scott

Comments

Weather

High winds at times, storm clouds with audible thunder for a short while in the afternoon.

LOGISTICS

Type	*Contractor*	*Hrs or units*

Notes (production comments, incidents, other)

Safety meeting at CH2M office at 730.

Sub-bottom day 1. 530pm

AURORA GEOSCIENCES

CHM-16069-YT Faro Bathymetry 2016

DATE:	Wednesday, June 15, 2016

PREPARED BY:

Shawn Scott

Comments

Weather
Mixed sun and cloud.

LOGISTICS

Type	*Contractor*	*Hrs or units*

Notes (production comments, incidents, other)
Safety meeting at CH2M office at 730.
Sub-bottom day 2. 630pm rtk shore

AURORA GEOSCIENCES

CHM-16069-YT Faro Bathymetry 2016

DATE:	Thursday, June 16, 2016

PREPARED BY:

Shawn Scott

Comments

Weather
Mixed sun and cloud.

LOGISTICS

Type	*Contractor*	*Hrs or units*

Notes (production comments, incidents, other)
Safety meeting at CH2M office at 730. single beam survey lines, shallows, leadline, return gear via small's, clean gear, rtk shore

AURORA GEOSCIENCES

CHM-16069-YT Faro Bathymetry 2016

DATE:	Friday, June 17, 2016

PREPARED BY:

Shawn Scott

Comments

Weather

Mixed sun and cloud.

LOGISTICS

Type	*Contractor*	*Hrs or units*

Notes (production comments, incidents, other)

Safety meeting at CH2M office at 730.
moved to cvd, single beam survey lines, lead lines, rtk shore, rtk line extensions. GPS malfunction took several hours to hours, had to cut out most of the CVD lead lining to get the equipment out of the water and cleaned as there was to be no safety officer on-site tomorrow. Day went long to complete work.

AURORA GEOSCIENCES

CHM-16069-YT Faro Bathymetry 2016

DATE:	Saturday, June 18, 2016

PREPARED BY:

Shawn Scott

Comments

Weather

Mixed sun and cloud.

LOGISTICS

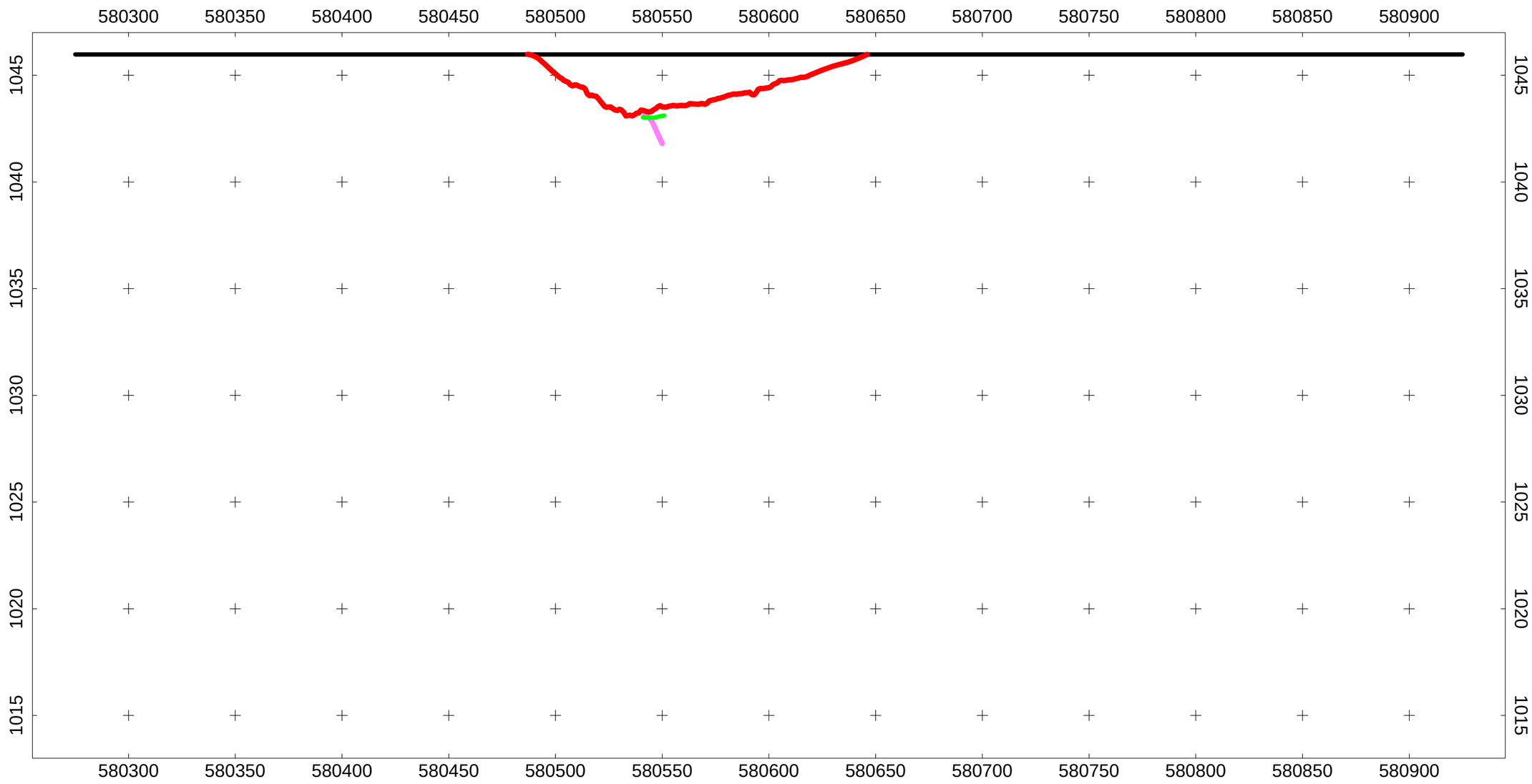
Type	*Contractor*	*Hrs or units*

Notes (production comments, incidents, other)

Crew demoblizes to Whitehorse.

Appendix II

Cross-sections



LEGEND

- Water :
- Mudline :
- Feature 1 - Upper :
- Feature 1 - Lower :
- Feature 2 - Upper :
- Feature 2 - Lower :
- Feature 4 :
- Feature 5 :

Scale (horizontal)

25 0 25 50

(meters)

Scale (vertical) exaggeration X10

2.5 0 2.5 5

(meters)

X-AXIS - NAD83 (CSRS) UTM Zone 8N Northing

Y-AXIS - Orthometric elevation

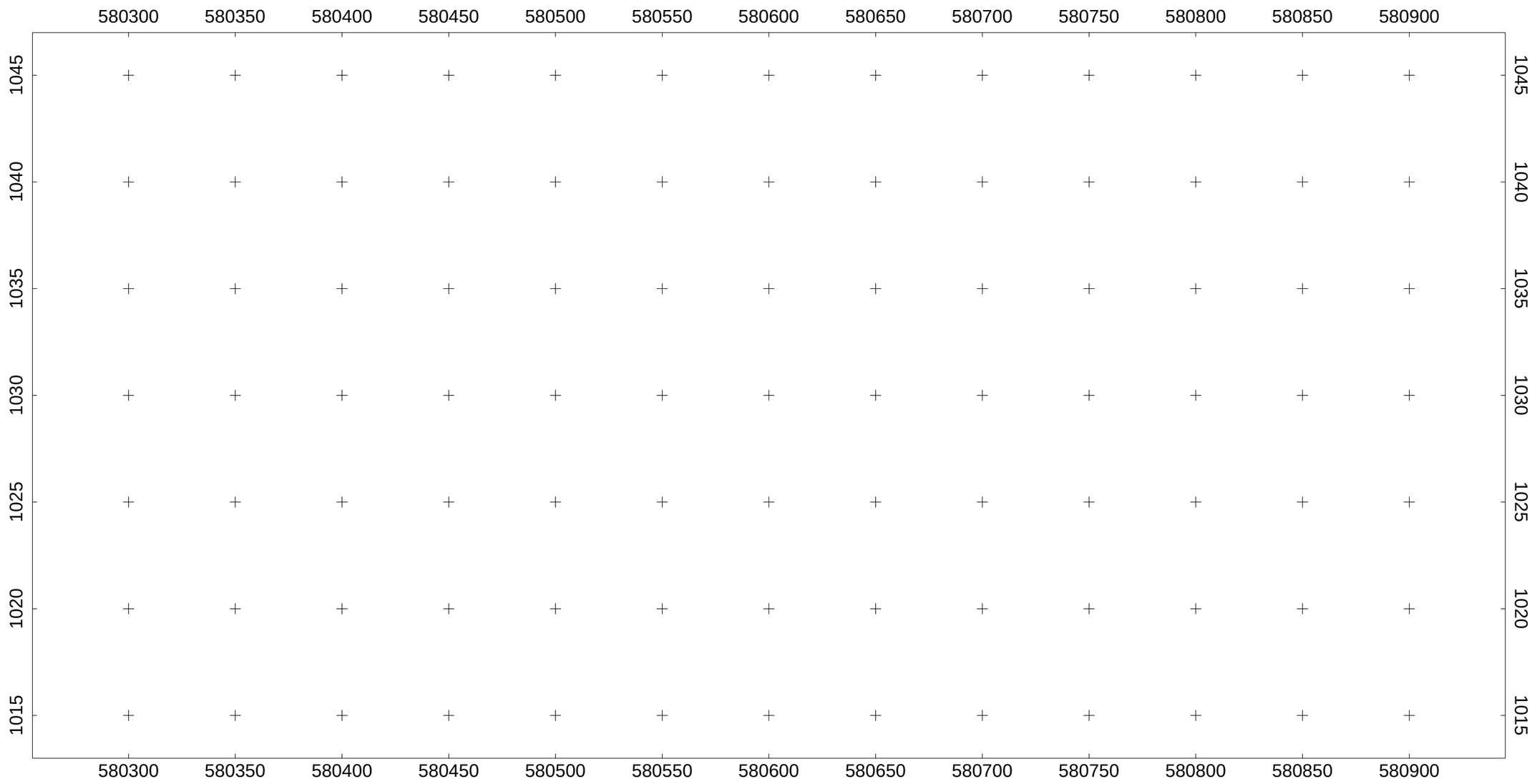
CH2M HILL LTD.

INTERMEDIATE DAM POND
Bathymetric and Sub-Bottom Survey
Cross section at UTMN 6913750

Surveyed Jun 11-18, 2016
Faro Mining Complex
NTS: 105k/06

Surveyed by: SS
Map drawn: Jul 27, 2016
NAD83 UTM Zone 8N

AURORA GEOSCIENCES LTD.



LEGEND

- Water :
- Mudline :
- Feature 1 - Upper :
- Feature 1 - Lower :
- Feature 2 - Upper :
- Feature 2 - Lower :
- Feature 4 :
- Feature 5 :

Scale (horizontal)

25 0 25 50

(meters)

Scale (vertical) exaggeration X10

2.5 0 2.5 5

(meters)

X-AXIS - NAD83 (CSRS) UTM Zone 8N Northing

Y-AXIS - Orthometric elevation

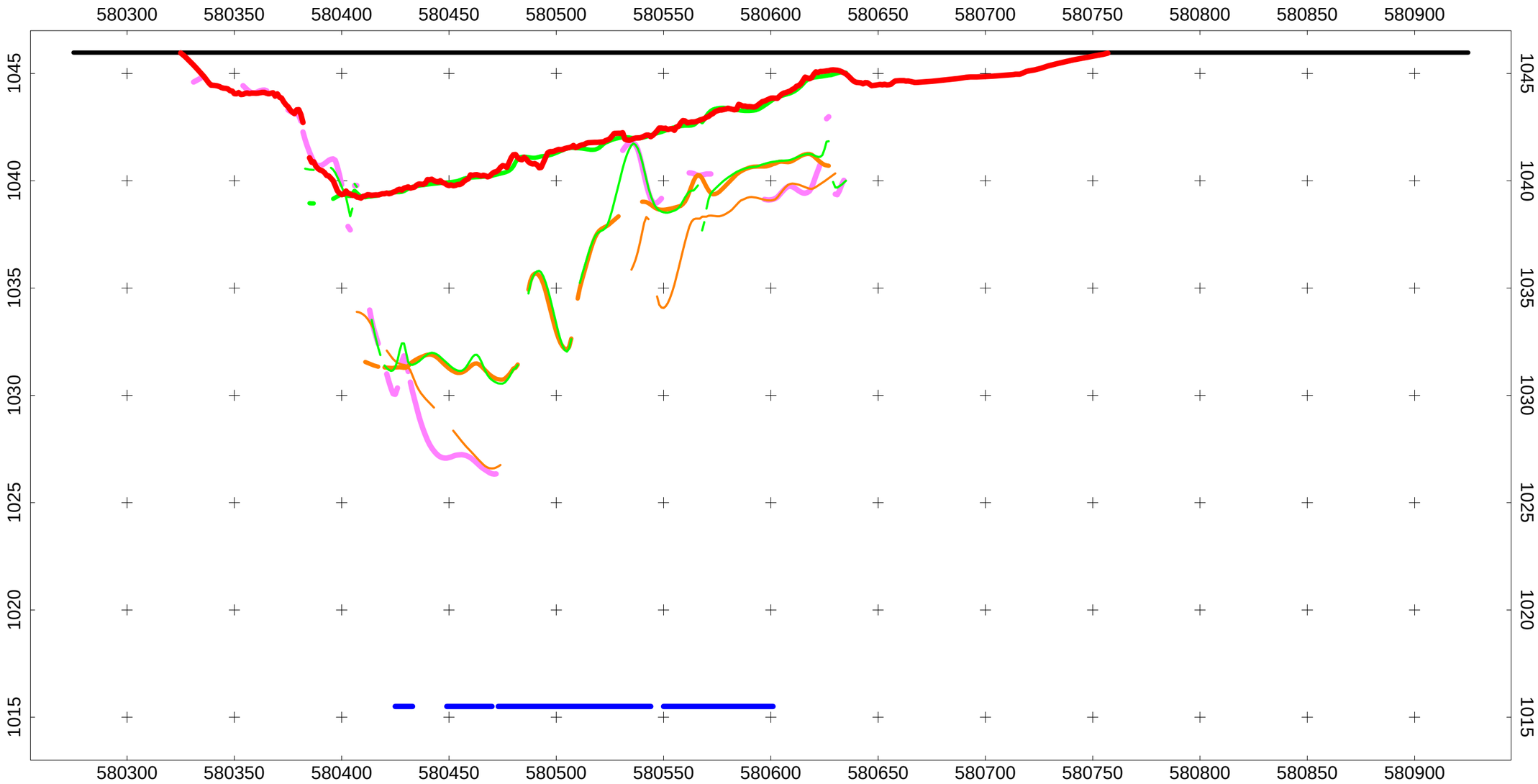
CH2M HILL LTD.

INTERMEDIATE DAM POND
Bathymetric and Sub-Bottom Survey
Cross section at UTMN 6913800

Surveyed Jun 11-18, 2016
Faro Mining Complex
NTS: 105k/06

Surveyed by: SS
Map drawn: Jul 27, 2016
NAD83 UTM Zone 8N

AURORA GEOSCIENCES LTD.



LEGEND

- Water :
- Mudline :
- Feature 1 - Upper :
- Feature 1 - Lower :
- Feature 2 - Upper :
- Feature 2 - Lower :
- Feature 4 :
- Feature 5 :

Scale (horizontal)

25 0 25 50

(meters)

Scale (vertical) exaggeration X10

2.5 0 2.5 5

(meters)

X-AXIS - NAD83 (CSRS) UTM Zone 8N Northing

Y-AXIS - Orthometric elevation

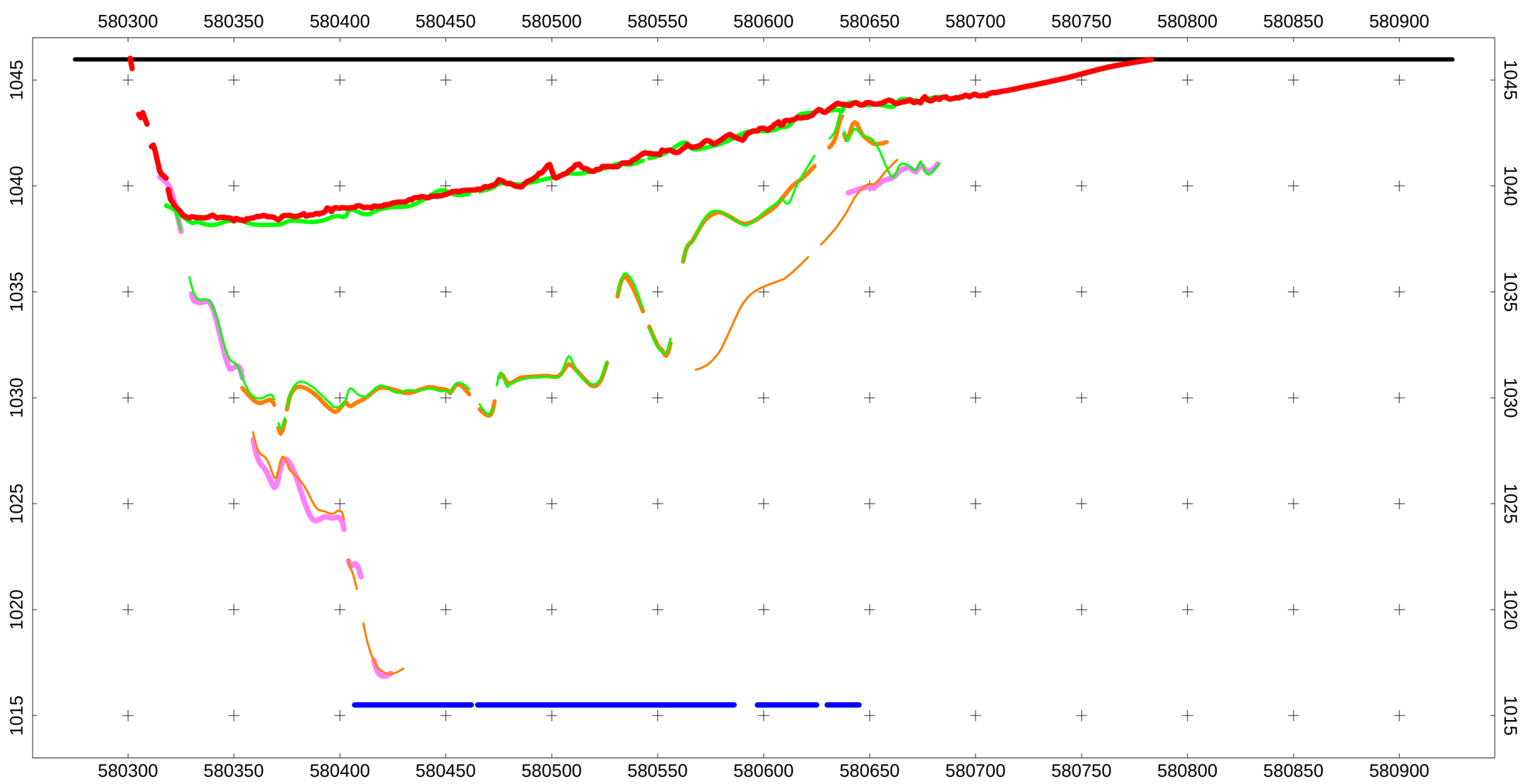
CH2M HILL LTD.

INTERMEDIATE DAM POND
Bathymetric and Sub-Bottom Survey
Cross section at UTMN 6913850

Surveyed Jun 11-18, 2016
Faro Mining Complex
NTS: 105k/06

Surveyed by: SS
Map drawn: Jul 27, 2016
NAD83 UTM Zone 8N

AURORA GEOSCIENCES LTD.



LEGEND

- Water :
- Mudline :
- Feature 1 - Upper :
- Feature 1 - Lower :
- Feature 2 - Upper :
- Feature 2 - Lower :
- Feature 4 :
- Feature 5 :

Scale (horizontal)

25 0 25 50

(meters)

Scale (vertical) exaggeration X10

2.5 0 2.5 5

(meters)

X-AXIS - NAD83 (CSRS) UTM Zone 8N Northing

Y-AXIS - Orthometric elevation

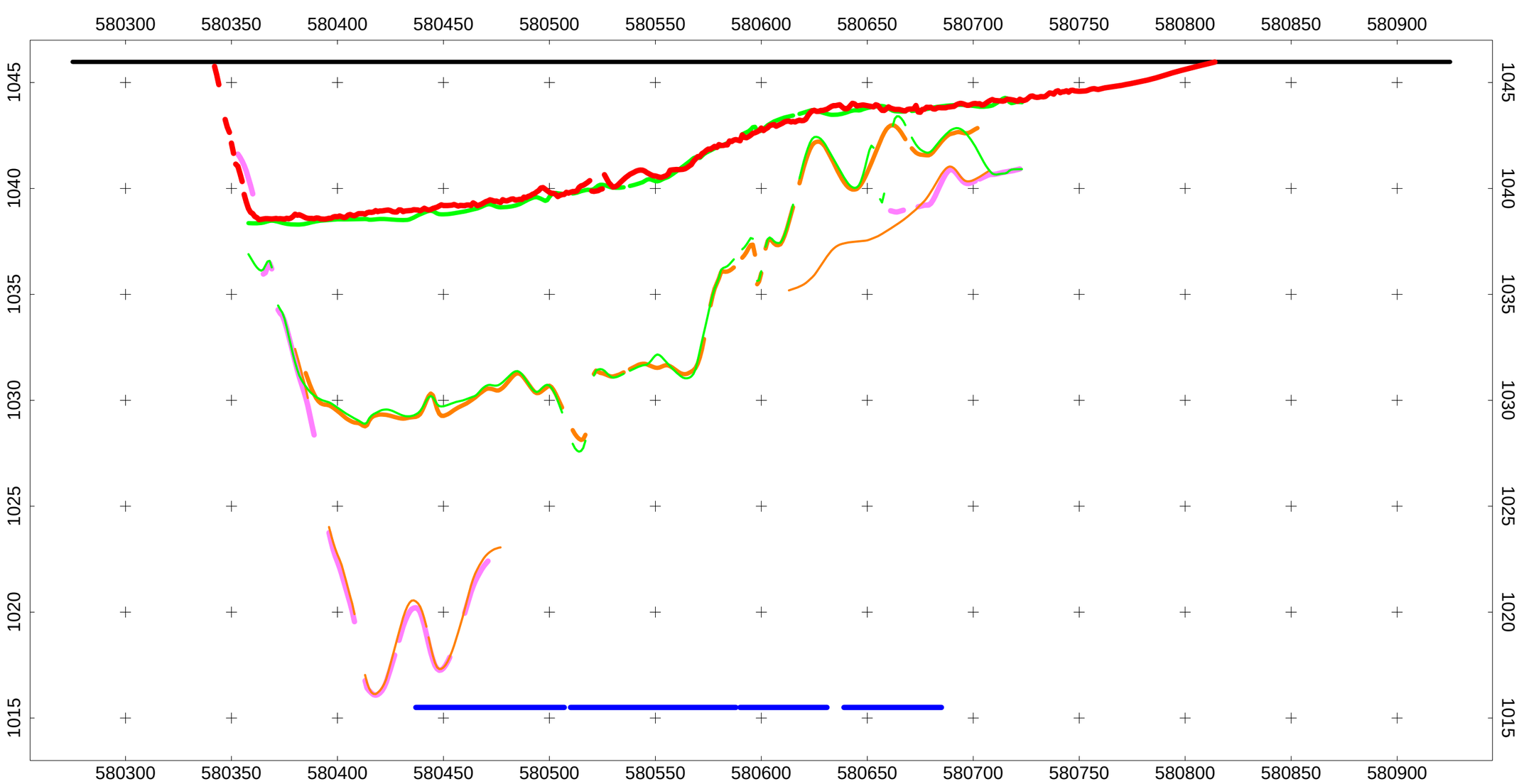
CH2M HILL LTD.

INTERMEDIATE DAM POND
Bathymetric and Sub-Bottom Survey
Cross section at UTMN 6913900

Surveyed Jun 11-18, 2016
Faro Mining Complex
NTS: 105k/06

Surveyed by: SS
Map drawn: Jul 27, 2016
NAD83 UTM Zone 8N

AURORA GEOSCIENCES LTD.



LEGEND

- Water :
- Mudline :
- Feature 1 - Upper :
- Feature 1 - Lower :
- Feature 2 - Upper :
- Feature 2 - Lower :
- Feature 4 :
- Feature 5 :

Scale (horizontal)

25 0 25 50

(meters)

Scale (vertical) exaggeration X10

2.5 0 2.5 5

(meters)

X-AXIS - NAD83 (CSRS) UTM Zone 8N Northing

Y-AXIS - Orthometric elevation

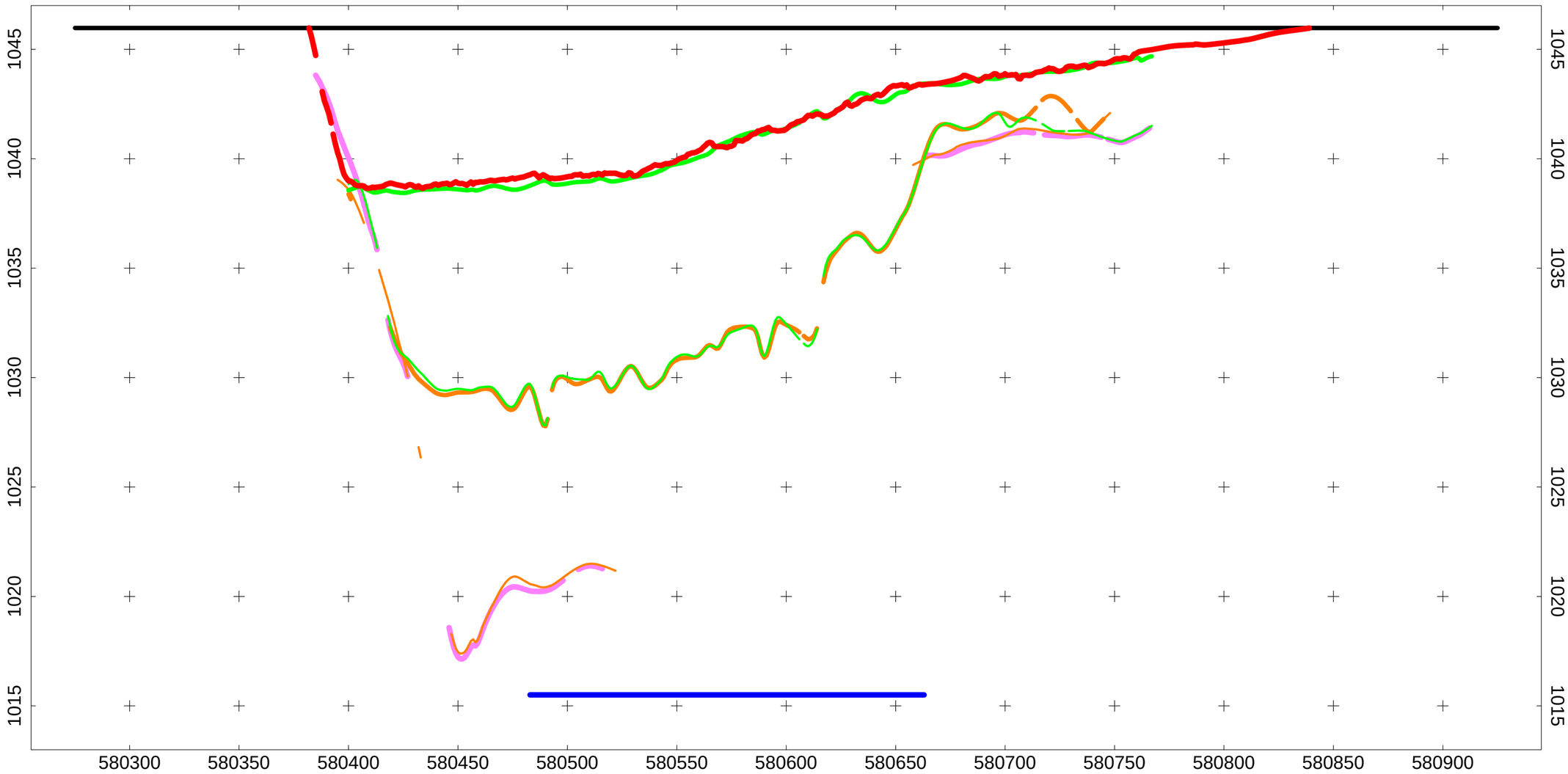
CH2M HILL LTD.

INTERMEDIATE DAM POND
Bathymetric and Sub-Bottom Survey
Cross section at UTMN 6913950

Surveyed Jun 11-18, 2016
Faro Mining Complex
NTS: 105k/06

Surveyed by: SS
Map drawn: Jul 27, 2016
NAD83 UTM Zone 8N

AURORA GEOSCIENCES LTD.



LEGEND

- Water :
- Mudline :
- Feature 1 - Upper :
- Feature 1 - Lower :
- Feature 2 - Upper :
- Feature 2 - Lower :
- Feature 4 :
- Feature 5 :

Scale (horizontal)

25 0 25 50

(meters)

Scale (vertical) exaggeration X10

2.5 0 2.5 5

(meters)

X-AXIS - NAD83 (CSRS) UTM Zone 8N Northing

Y-AXIS - Orthometric elevation

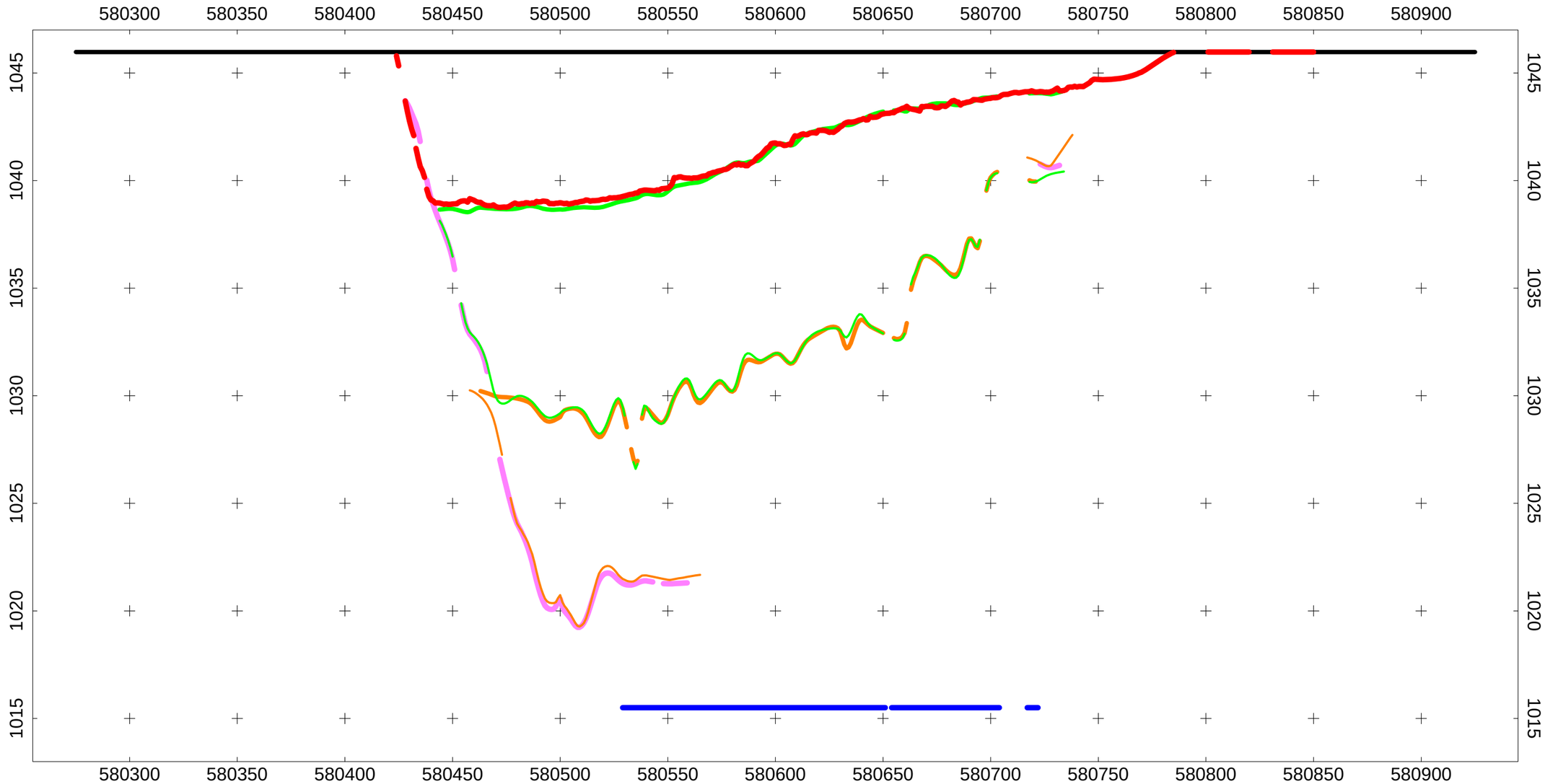
CH2M HILL LTD.

INTERMEDIATE DAM POND
Bathymetric and Sub-Bottom Survey
Cross section at UTMN 6914000

Surveyed Jun 11-18, 2016
Faro Mining Complex
NTS: 105k/06

Surveyed by: SS
Map drawn: Jul 27, 2016
NAD83 UTM Zone 8N

AURORA GEOSCIENCES LTD.



LEGEND

- Water :
- Mudline :
- Feature 1 - Upper :
- Feature 1 - Lower :
- Feature 2 - Upper :
- Feature 2 - Lower :
- Feature 4 :
- Feature 5 :

Scale (horizontal)

25 0 25 50

(meters)

Scale (vertical) exaggeration X10

2.5 0 2.5 5

(meters)

X-AXIS - NAD83 (CSRS) UTM Zone 8N Northing

Y-AXIS - Orthometric elevation

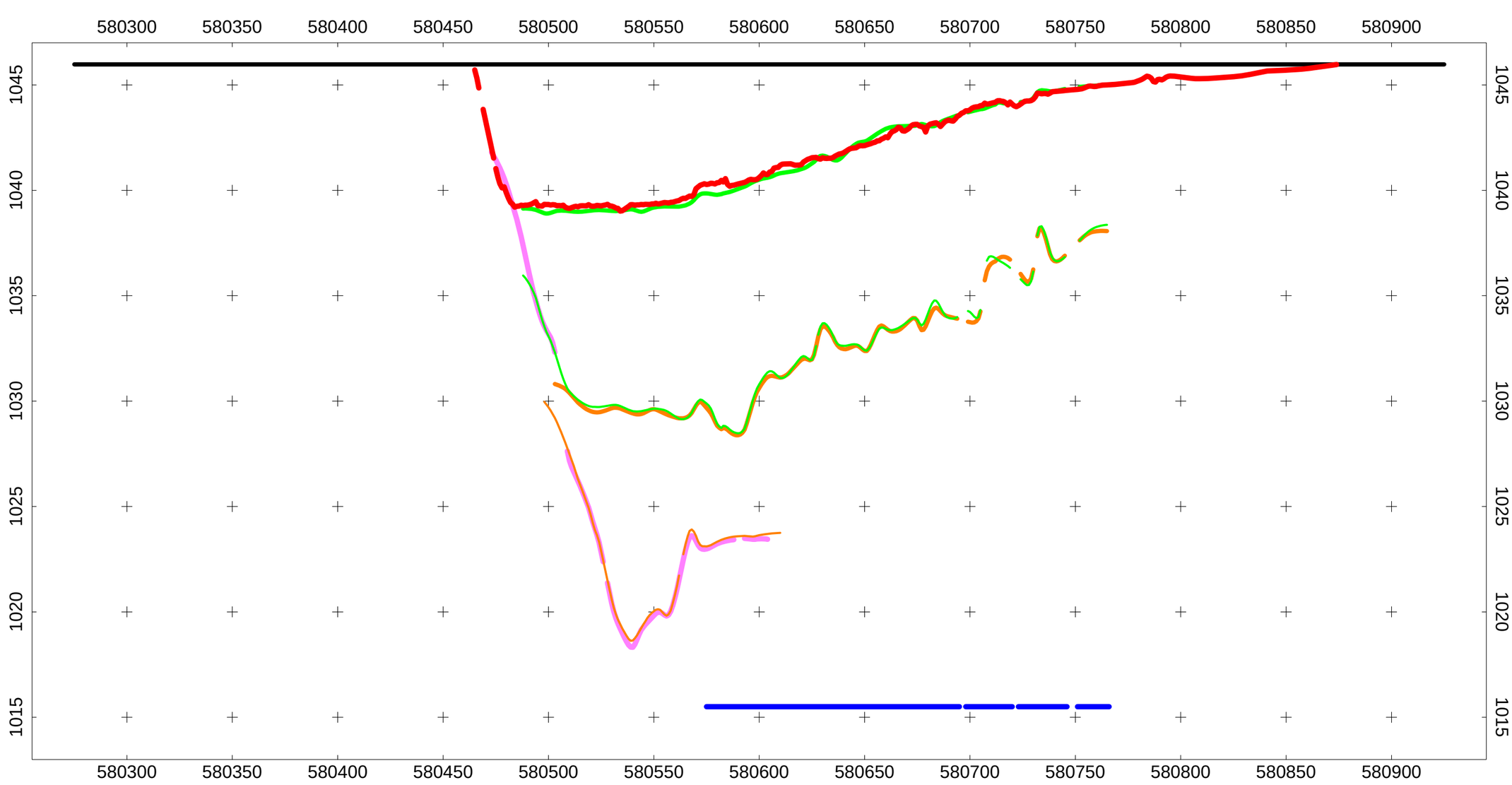
CH2M HILL LTD.

INTERMEDIATE DAM POND
Bathymetric and Sub-Bottom Survey
Cross section at UTMN 6914050

Surveyed Jun 11-18, 2016
Faro Mining Complex
NTS: 105k/06

Surveyed by: SS
Map drawn: Jul 27, 2016
NAD83 UTM Zone 8N

AURORA GEOSCIENCES LTD.



LEGEND

- Water :
- Mudline :
- Feature 1 - Upper :
- Feature 1 - Lower :
- Feature 2 - Upper :
- Feature 2 - Lower :
- Feature 4 :
- Feature 5 :

Scale (horizontal)

25 0 25 50

(meters)

Scale (vertical) exaggeration X10

2.5 0 2.5 5

(meters)

X-AXIS - NAD83 (CSRS)
UTM Zone 8N Northing

Y-AXIS - Orthometric elevation

CH2M HILL LTD.

INTERMEDIATE DAM POND
Bathymetric and Sub-Bottom Survey
Cross section at UTMN 6914100

Surveyed Jun 11-18, 2016
Faro Mining Complex
NTS: 105k/06

Surveyed by: SS
Map drawn: Jul 27, 2016
NAD83 UTM Zone 8N

AURORA GEOSCIENCES LTD.



LEGEND

- Water :
- Mudline :
- Feature 1 - Upper :
- Feature 1 - Lower :
- Feature 2 - Upper :
- Feature 2 - Lower :
- Feature 4 :
- Feature 5 :

Scale (horizontal)

25 0 25 50

(meters)

Scale (vertical) exaggeration X10

2.5 0 2.5 5

(meters)

X-AXIS - NAD83 (CSRS) UTM Zone 8N Northing

Y-AXIS - Orthometric elevation

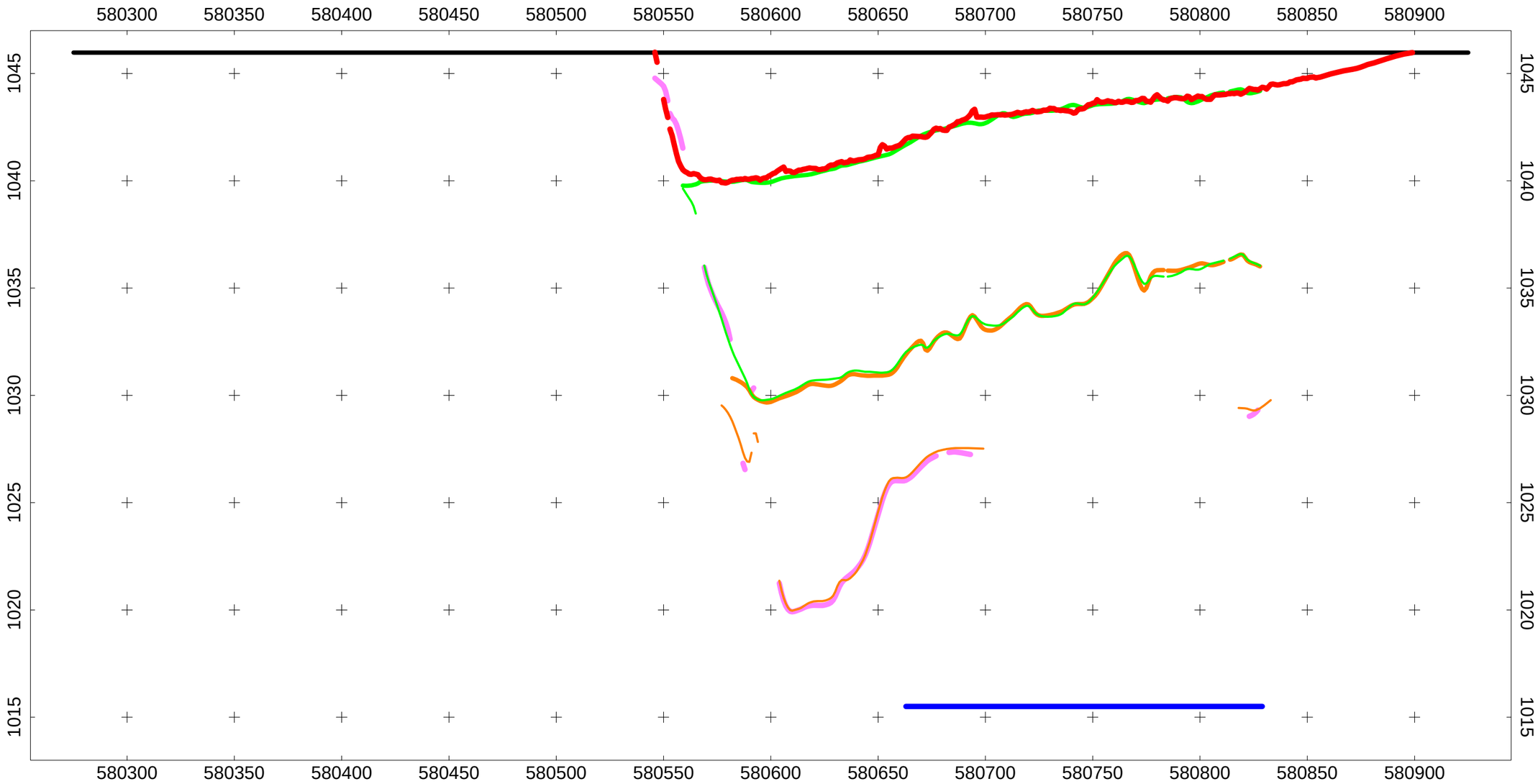
CH2M HILL LTD.

INTERMEDIATE DAM POND
Bathymetric and Sub-Bottom Survey
Cross section at UTMN 6914150

Surveyed Jun 11-18, 2016
Faro Mining Complex
NTS: 105k/06

Surveyed by: SS
Map drawn: Jul 27, 2016
NAD83 UTM Zone 8N

AURORA GEOSCIENCES LTD.



LEGEND

- Water :
- Mudline :
- Feature 1 - Upper :
- Feature 1 - Lower :
- Feature 2 - Upper :
- Feature 2 - Lower :
- Feature 4 :
- Feature 5 :

Scale (horizontal)

25 0 25 50

(meters)

Scale (vertical) exaggeration X10

2.5 0 2.5 5

(meters)

X-AXIS - NAD83 (CSRS) UTM Zone 8N Northing

Y-AXIS - Orthometric elevation

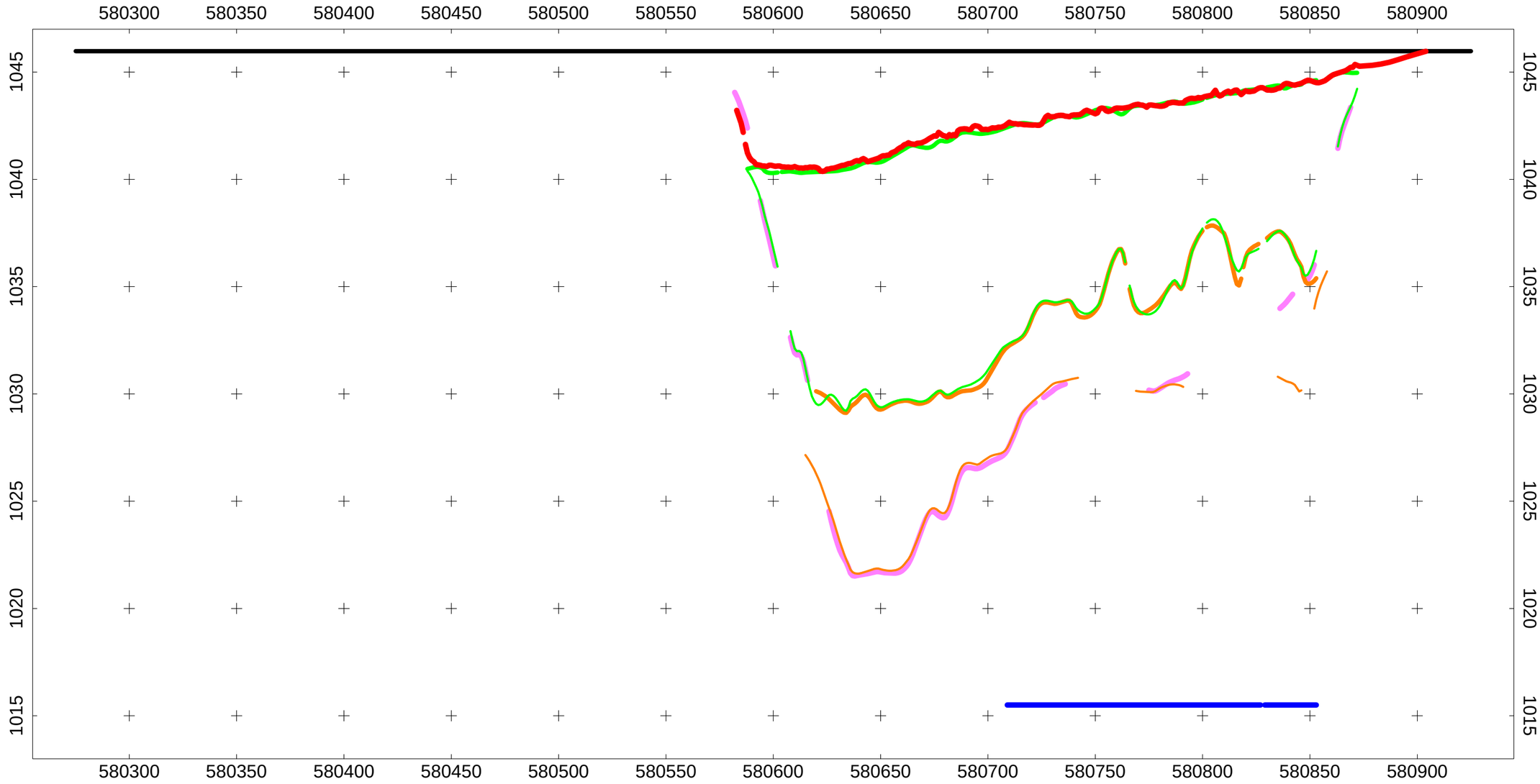
CH2M HILL LTD.

INTERMEDIATE DAM POND
Bathymetric and Sub-Bottom Survey
Cross section at UTMN 6914200

Surveyed Jun 11-18, 2016
Faro Mining Complex
NTS: 105k/06

Surveyed by: SS
Map drawn: Jul 27, 2016
NAD83 UTM Zone 8N

AURORA GEOSCIENCES LTD.



LEGEND

- Water :
- Mudline :
- Feature 1 - Upper :
- Feature 1 - Lower :
- Feature 2 - Upper :
- Feature 2 - Lower :
- Feature 4 :
- Feature 5 :

Scale (horizontal)

25 0 25 50

(meters)

Scale (vertical) exaggeration X10

2.5 0 2.5 5

(meters)

X-AXIS - NAD83 (CSRS) UTM Zone 8N Northing

Y-AXIS - Orthometric elevation

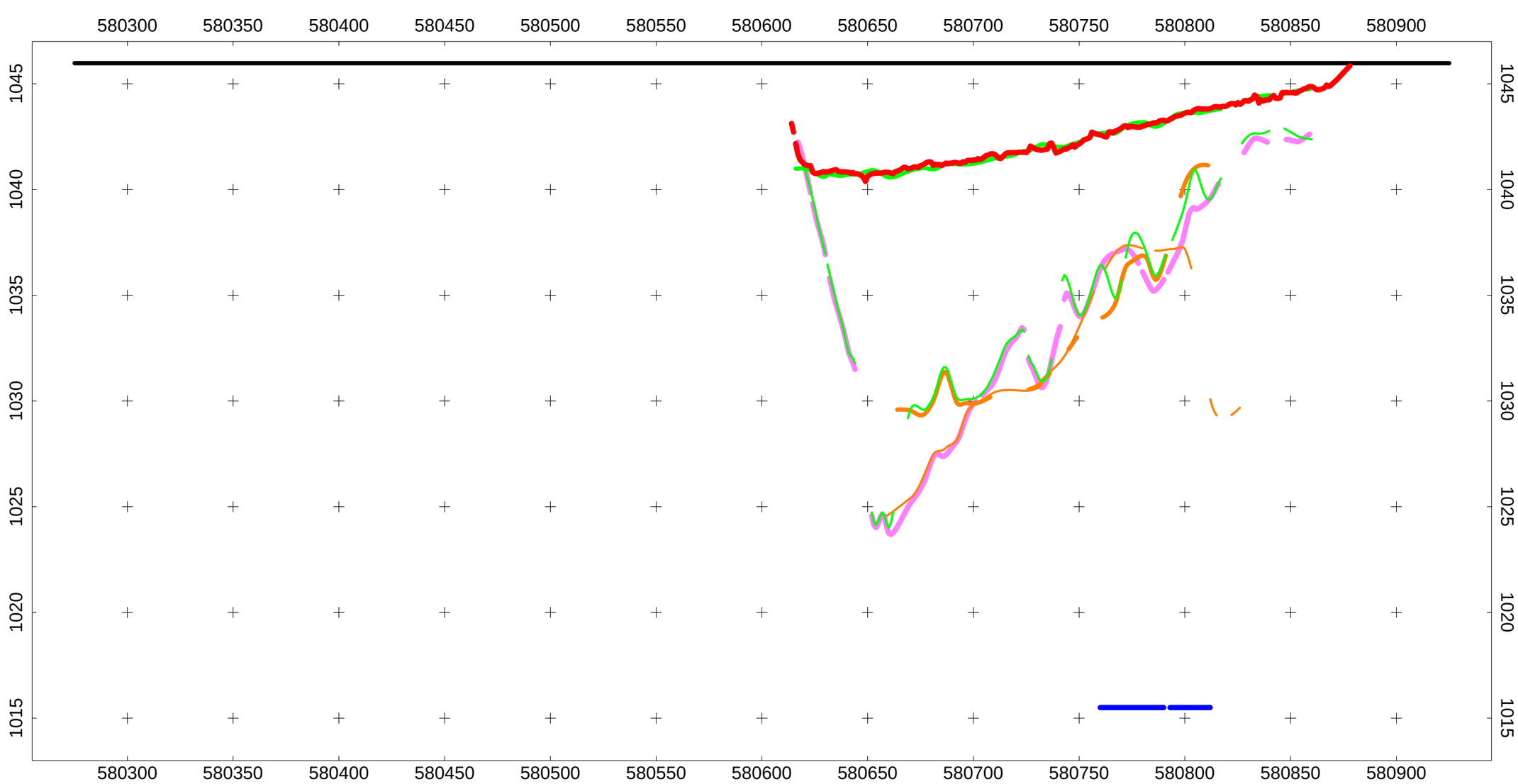
CH2M HILL LTD.

INTERMEDIATE DAM POND
Bathymetric and Sub-Bottom Survey
Cross section at UTMN 6914250

Surveyed Jun 11-18, 2016
Faro Mining Complex
NTS: 105k/06

Surveyed by: SS
Map drawn: Jul 27, 2016
NAD83 UTM Zone 8N

AURORA GEOSCIENCES LTD.



LEGEND

- Water :
- Mudline :
- Feature 1 - Upper :
- Feature 1 - Lower :
- Feature 2 - Upper :
- Feature 2 - Lower :
- Feature 4 :
- Feature 5 :

Scale (horizontal)

25 0 25 50

(meters)

Scale (vertical) exaggeration X10

2.5 0 2.5 5

(meters)

X-AXIS - NAD83 (CSRS)
UTM Zone 8N Northing

Y-AXIS - Orthometric elevation

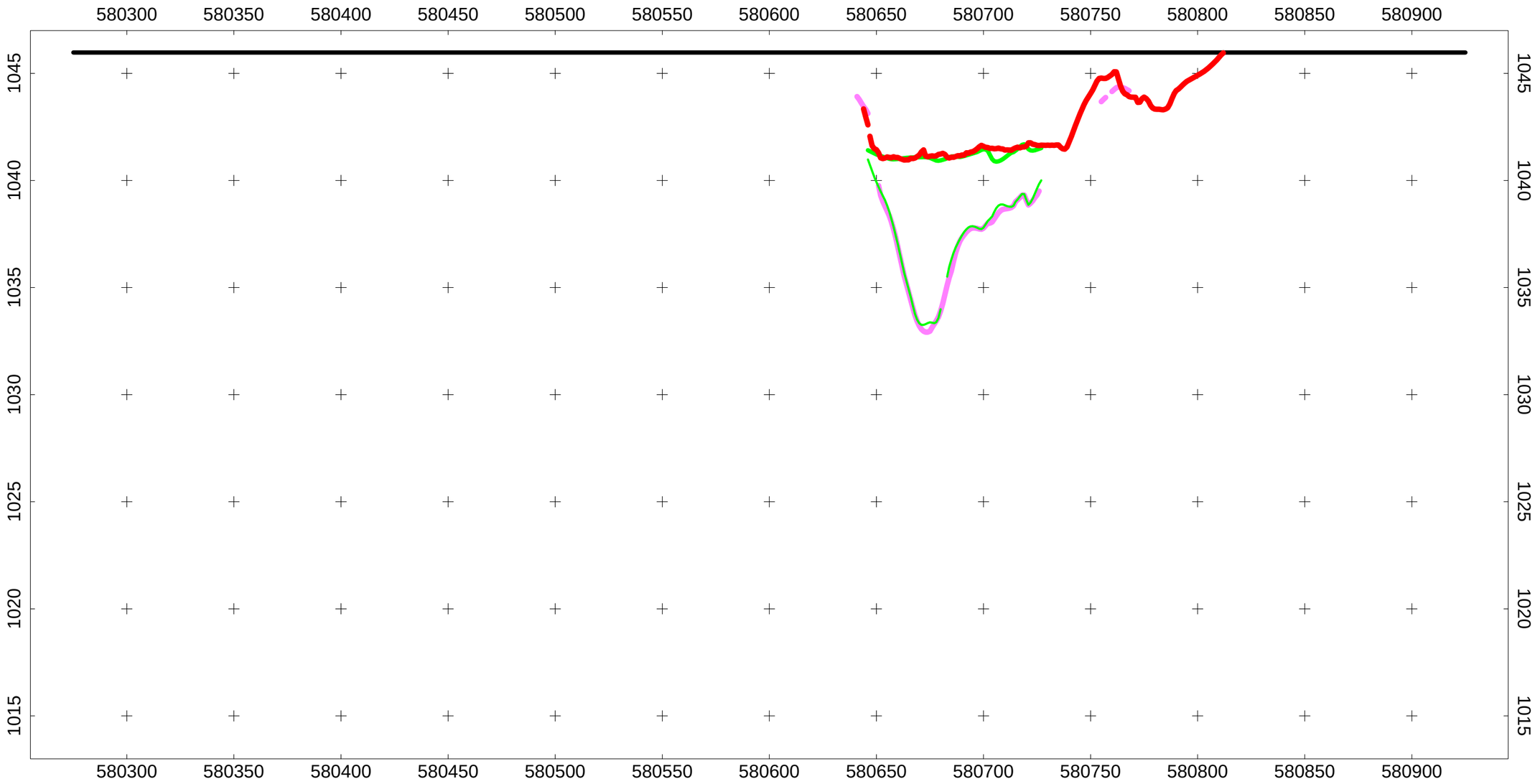
CH2M HILL LTD.

INTERMEDIATE DAM POND
Bathymetric and Sub-Bottom Survey
Cross section at UTMN 6914300

Surveyed Jun 11-18, 2016
Faro Mining Complex
NTS: 105k/06

Surveyed by: SS
Map drawn: Jul 27, 2016
NAD83 UTM Zone 8N

AURORA GEOSCIENCES LTD.



LEGEND

- Water :
- Mudline :
- Feature 1 - Upper :
- Feature 1 - Lower :
- Feature 2 - Upper :
- Feature 2 - Lower :
- Feature 4 :
- Feature 5 :

Scale (horizontal)

25 0 25 50

(meters)

Scale (vertical) exaggeration X10

2.5 0 2.5 5

(meters)

X-AXIS - NAD83 (CSRS) UTM Zone 8N Northing

Y-AXIS - Orthometric elevation

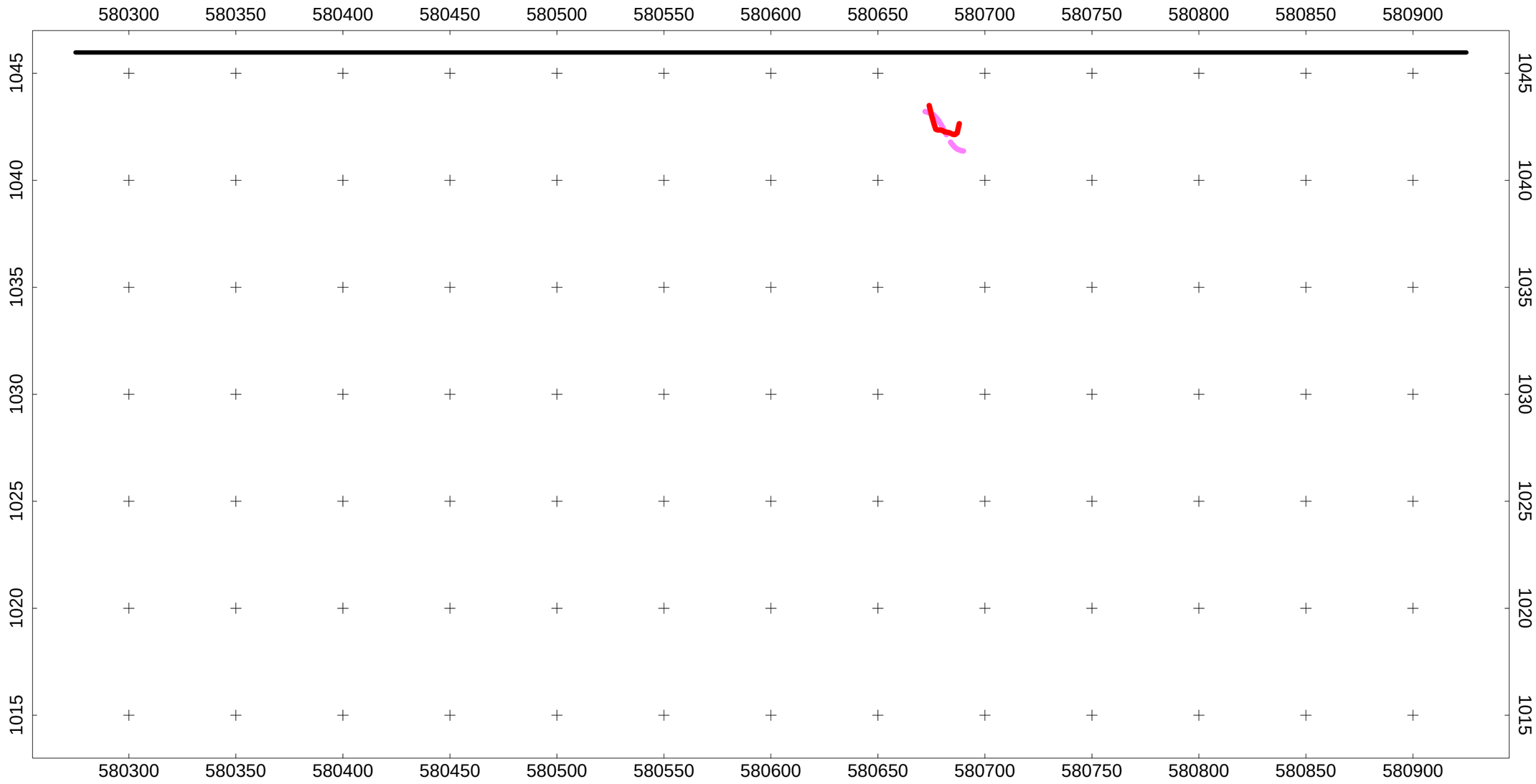
CH2M HILL LTD.

INTERMEDIATE DAM POND
Bathymetric and Sub-Bottom Survey
Cross section at UTMN 6914350

Surveyed Jun 11-18, 2016
Faro Mining Complex
NTS: 105k/06

Surveyed by: SS
Map drawn: Jul 27, 2016
NAD83 UTM Zone 8N

AURORA GEOSCIENCES LTD.



LEGEND

- Water :
- Mudline :
- Feature 1 - Upper :
- Feature 1 - Lower :
- Feature 2 - Upper :
- Feature 2 - Lower :
- Feature 4 :
- Feature 5 :

Scale (horizontal)

25 0 25 50

(meters)

Scale (vertical) exaggeration X10

2.5 0 2.5 5

(meters)

X-AXIS - NAD83 (CSRS) UTM Zone 8N Northing

Y-AXIS - Orthometric elevation

CH2M HILL LTD.

INTERMEDIATE DAM POND
Bathymetric and Sub-Bottom Survey
Cross section at UTMN 6914400

Surveyed Jun 11-18, 2016
Faro Mining Complex
NTS: 105k/06

Surveyed by: SS
Map drawn: Jul 27, 2016
NAD83 UTM Zone 8N

AURORA GEOSCIENCES LTD.



LEGEND

- Water :
- Mudline :
- Feature 1 - Upper :
- Feature 1 - Lower :
- Feature 2 - Upper :
- Feature 2 - Lower :
- Feature 4 :
- Feature 5 :

Scale (horizontal)

25 0 25 50

(meters)

Scale (vertical) exaggeration X10

2.5 0 2.5 5

(meters)

X-AXIS - NAD83 (CSRS)
UTM Zone 8N Northing

Y-AXIS - Orthometric elevation

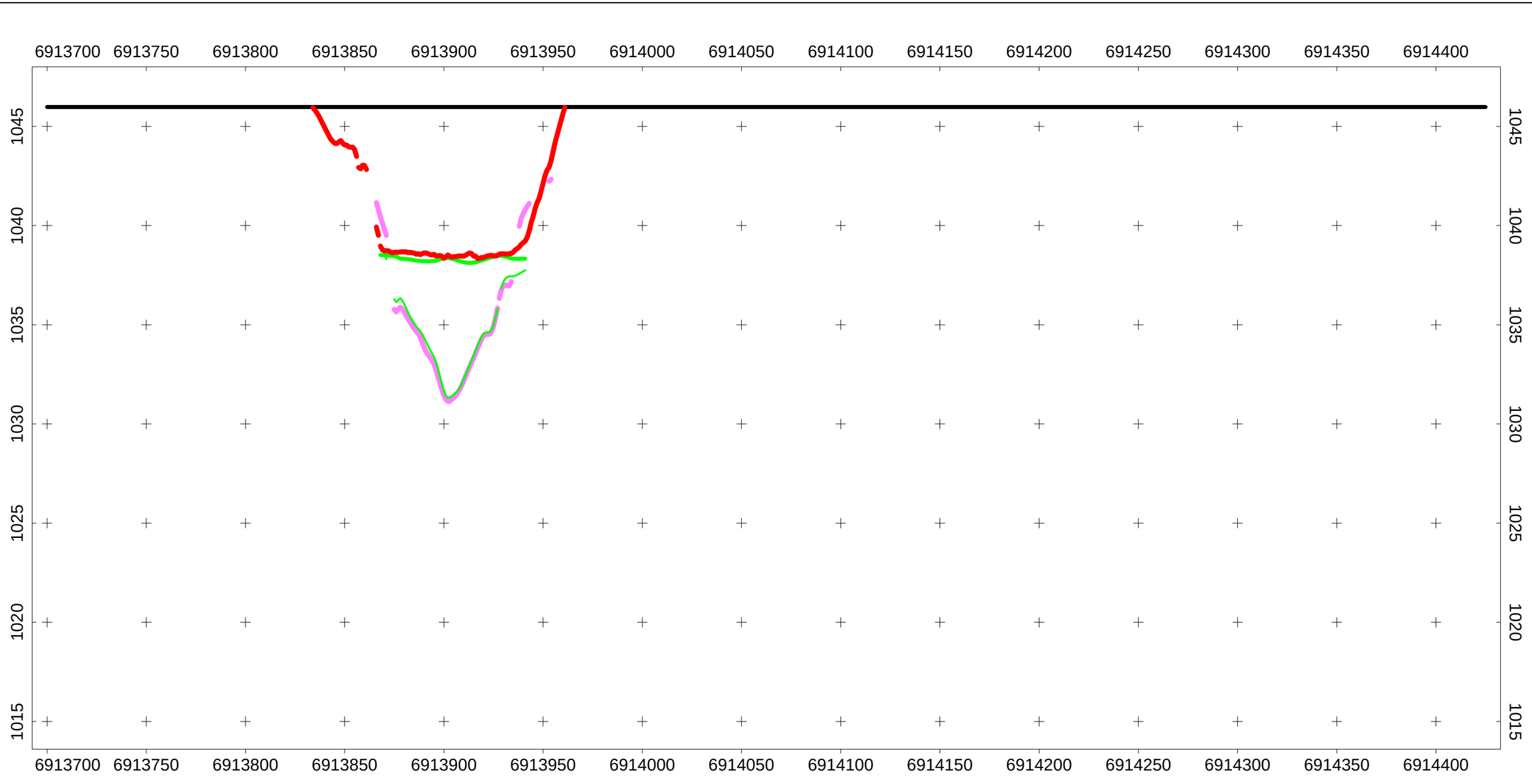
CH2M HILL LTD.

INTERMEDIATE DAM POND
Bathymetric and Sub-Bottom Survey
Cross section at UTME 580300

Surveyed Jun 11-18, 2016
Faro Mining Complex
NTS: 105k/06

Surveyed by: SS
Map drawn: Jul 27, 2016
NAD83 UTM Zone 8N

AURORA GEOSCIENCES LTD.



LEGEND

- Water :
- Mudline :
- Feature 1 - Upper :
- Feature 1 - Lower :
- Feature 2 - Upper :
- Feature 2 - Lower :
- Feature 4 :
- Feature 5 :

Scale (horizontal)

25 0 25 50

(meters)

Scale (vertical) exaggeration X10

2.5 0 2.5 5

(meters)

X-AXIS - NAD83 (CSRS)
UTM Zone 8N Northing

Y-AXIS - Orthometric elevation

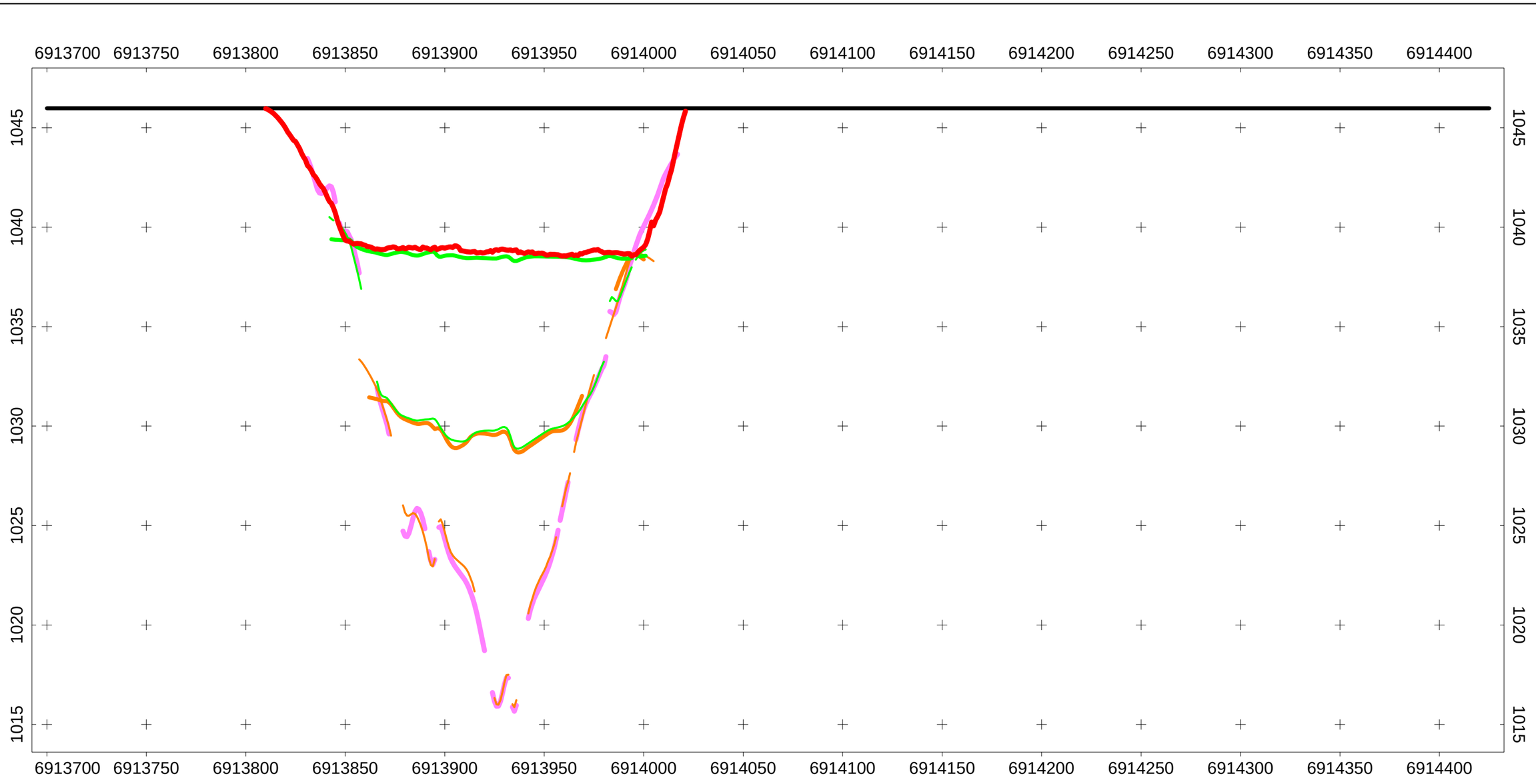
CH2M HILL LTD.

INTERMEDIATE DAM POND
Bathymetric and Sub-Bottom Survey
Cross section at UTME 580350

Surveyed Jun 11-18, 2016
Faro Mining Complex
NTS: 105k/06

Surveyed by: SS
Map drawn: Jul 27, 2016
NAD83 UTM Zone 8N

AURORA GEOSCIENCES LTD.



LEGEND

- Water :
- Mudline :
- Feature 1 - Upper :
- Feature 1 - Lower :
- Feature 2 - Upper :
- Feature 2 - Lower :
- Feature 4 :
- Feature 5 :

Scale (horizontal)

25 0 25 50

(meters)

Scale (vertical) exaggeration X10

2.5 0 2.5 5

(meters)

X-AXIS - NAD83 (CSRS) UTM Zone 8N Northing

Y-AXIS - Orthometric elevation

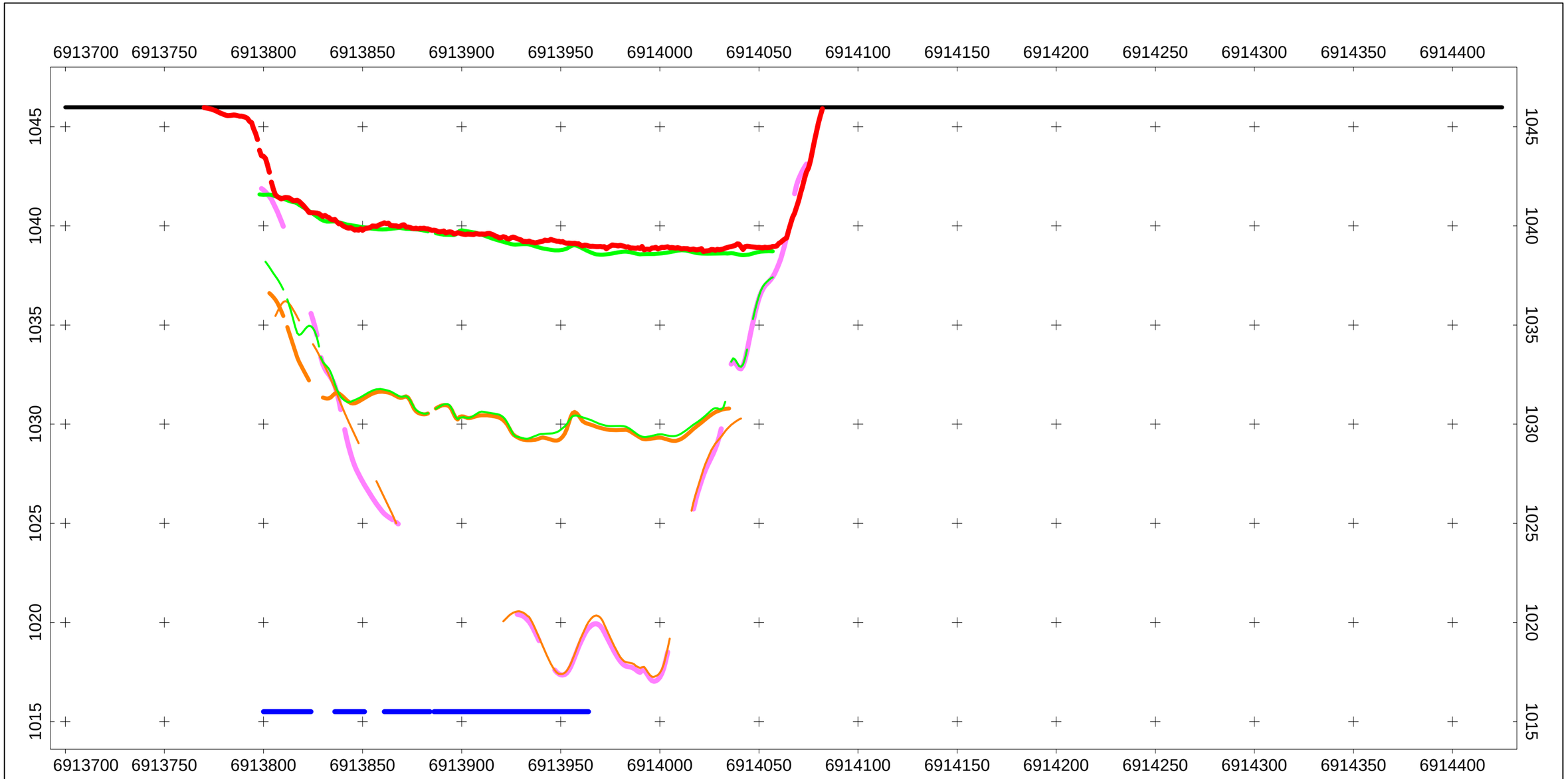
CH2M HILL LTD.

INTERMEDIATE DAM POND
Bathymetric and Sub-Bottom Survey
Cross section at UTME 580400

Surveyed Jun 11-18, 2016
Faro Mining Complex
NTS: 105k/06

Surveyed by: SS
Map drawn: Jul 27, 2016
NAD83 UTM Zone 8N

AURORA GEOSCIENCES LTD.



LEGEND

- Water :
- Mudline :
- Feature 1 - Upper :
- Feature 1 - Lower :
- Feature 2 - Upper :
- Feature 2 - Lower :
- Feature 4 :
- Feature 5 :

Scale (horizontal)

25 0 25 50

(meters)

Scale (vertical) exaggeration X10

2.5 0 2.5 5

(meters)

X-AXIS - NAD83 (CSRS)
UTM Zone 8N Northing

Y-AXIS - Orthometric elevation

CH2M HILL LTD.

INTERMEDIATE DAM POND
Bathymetric and Sub-Bottom Survey
Cross section at UTME 580450

Surveyed Jun 11-18, 2016
Faro Mining Complex
NTS: 105k/06

Surveyed by: SS
Map drawn: Jul 27, 2016
NAD83 UTM Zone 8N

AURORA GEOSCIENCES LTD.



LEGEND

- Water :
- Mudline :
- Feature 1 - Upper :
- Feature 1 - Lower :
- Feature 2 - Upper :
- Feature 2 - Lower :
- Feature 4 :
- Feature 5 :

Scale (horizontal)

25 0 25 50

(meters)

Scale (vertical) exaggeration X10

2.5 0 2.5 5

(meters)

X-AXIS - NAD83 (CSRS)
UTM Zone 8N Northing

Y-AXIS - Orthometric elevation

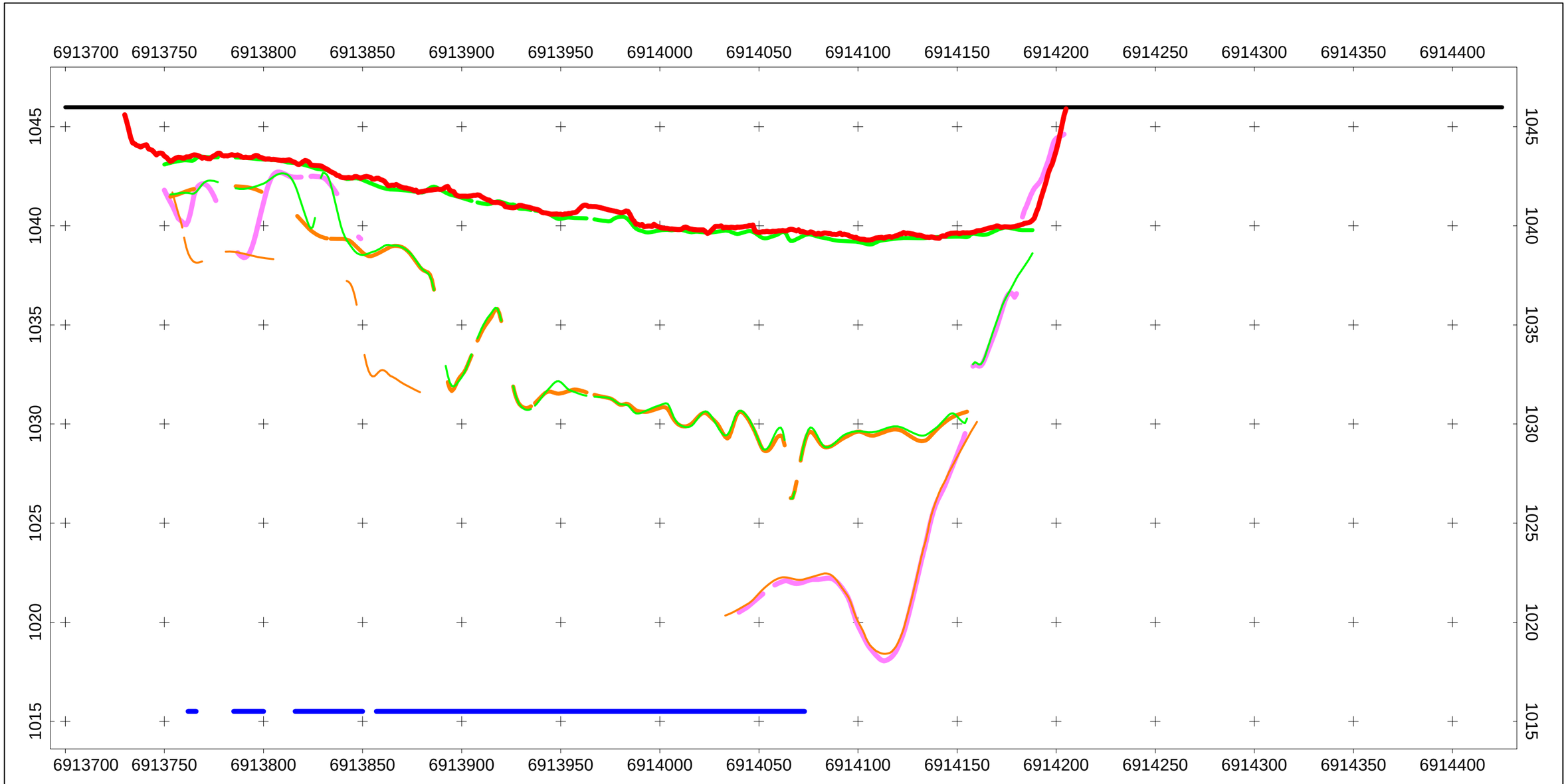
CH2M HILL LTD.

INTERMEDIATE DAM POND
Bathymetric and Sub-Bottom Survey
Cross section at UTME 580500

Surveyed Jun 11-18, 2016
Faro Mining Complex
NTS: 105k/06

Surveyed by: SS
Map drawn: Jul 27, 2016
NAD83 UTM Zone 8N

AURORA GEOSCIENCES LTD.



LEGEND

- Water :
- Mudline :
- Feature 1 - Upper :
- Feature 1 - Lower :
- Feature 2 - Upper :
- Feature 2 - Lower :
- Feature 4 :
- Feature 5 :

Scale (horizontal)

25 0 25 50

(meters)

Scale (vertical) exaggeration X10

2.5 0 2.5 5

(meters)

X-AXIS - NAD83 (CSRS)
UTM Zone 8N Northing

Y-AXIS - Orthometric elevation

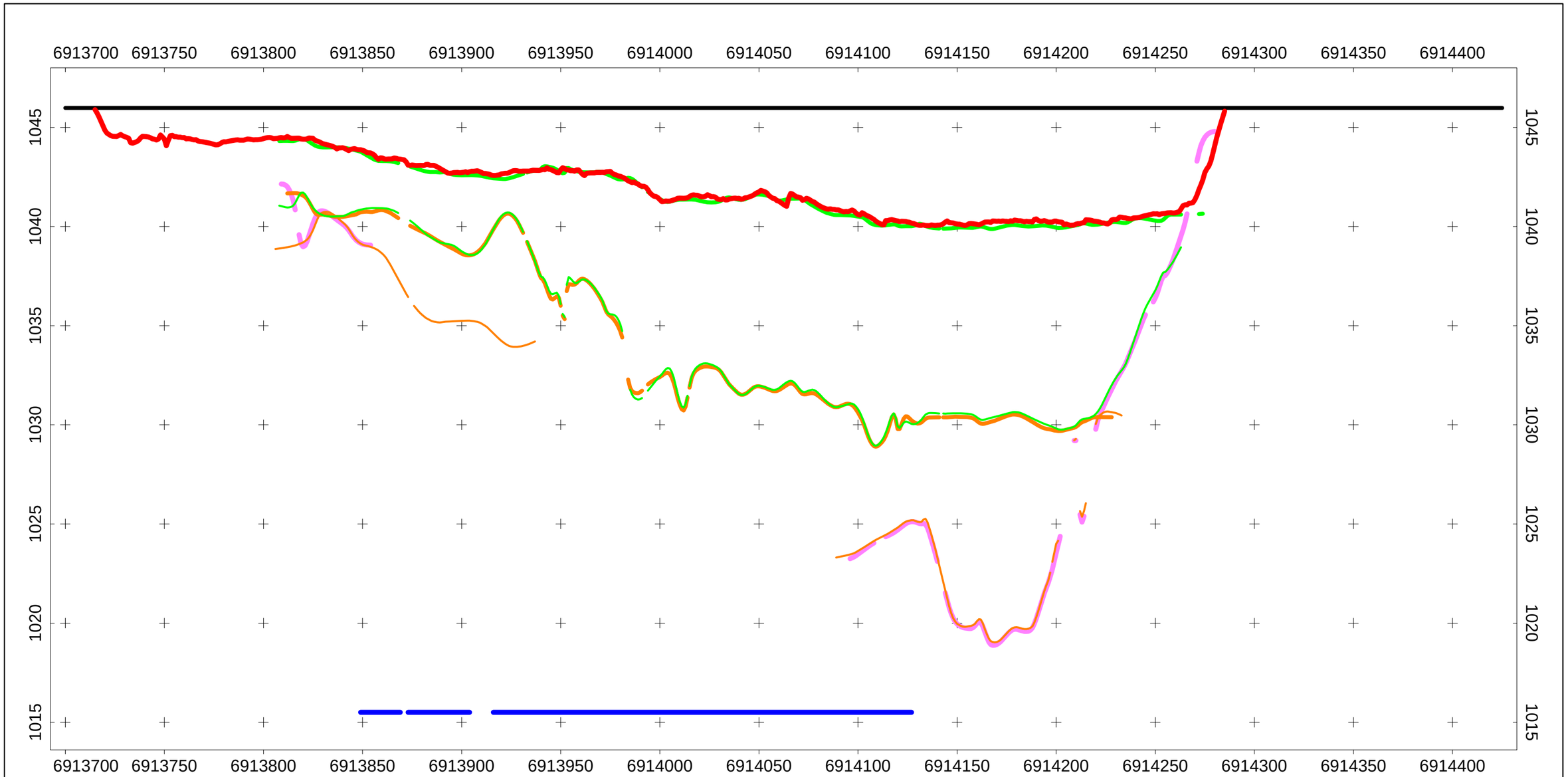
CH2M HILL LTD.

INTERMEDIATE DAM POND
Bathymetric and Sub-Bottom Survey
Cross section at UTME 580550

Surveyed Jun 11-18, 2016
Faro Mining Complex
NTS: 105k/06

Surveyed by: SS
Map drawn: Jul 27, 2016
NAD83 UTM Zone 8N

AURORA GEOSCIENCES LTD.



LEGEND

- Water :
- Mudline :
- Feature 1 - Upper :
- Feature 1 - Lower :
- Feature 2 - Upper :
- Feature 2 - Lower :
- Feature 4 :
- Feature 5 :

Scale (horizontal)

25 0 25 50

(meters)

Scale (vertical) exaggeration X10

2.5 0 2.5 5

(meters)

X-AXIS - NAD83 (CSRS)
UTM Zone 8N Northing

Y-AXIS - Orthometric elevation

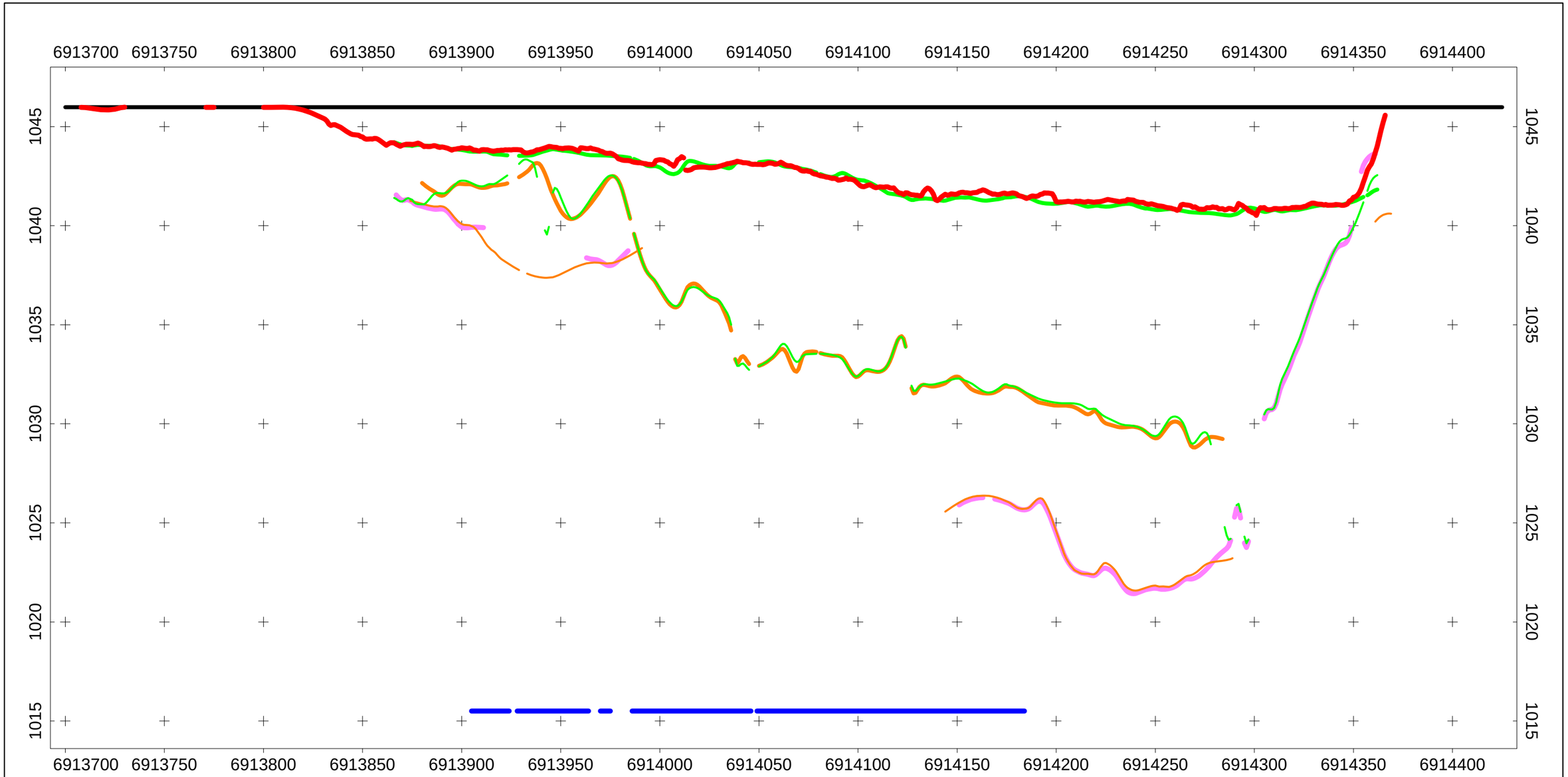
CH2M HILL LTD.

INTERMEDIATE DAM POND
Bathymetric and Sub-Bottom Survey
Cross section at UTME 580600

Surveyed Jun 11-18, 2016
Faro Mining Complex
NTS: 105k/06

Surveyed by: SS
Map drawn: Jul 27, 2016
NAD83 UTM Zone 8N

AURORA GEOSCIENCES LTD.



LEGEND

- Water :
- Mudline :
- Feature 1 - Upper :
- Feature 1 - Lower :
- Feature 2 - Upper :
- Feature 2 - Lower :
- Feature 4 :
- Feature 5 :

Scale (horizontal)

25 0 25 50

(meters)

Scale (vertical) exaggeration X10

2.5 0 2.5 5

(meters)

X-AXIS - NAD83 (CSRS)
UTM Zone 8N Northing

Y-AXIS - Orthometric elevation

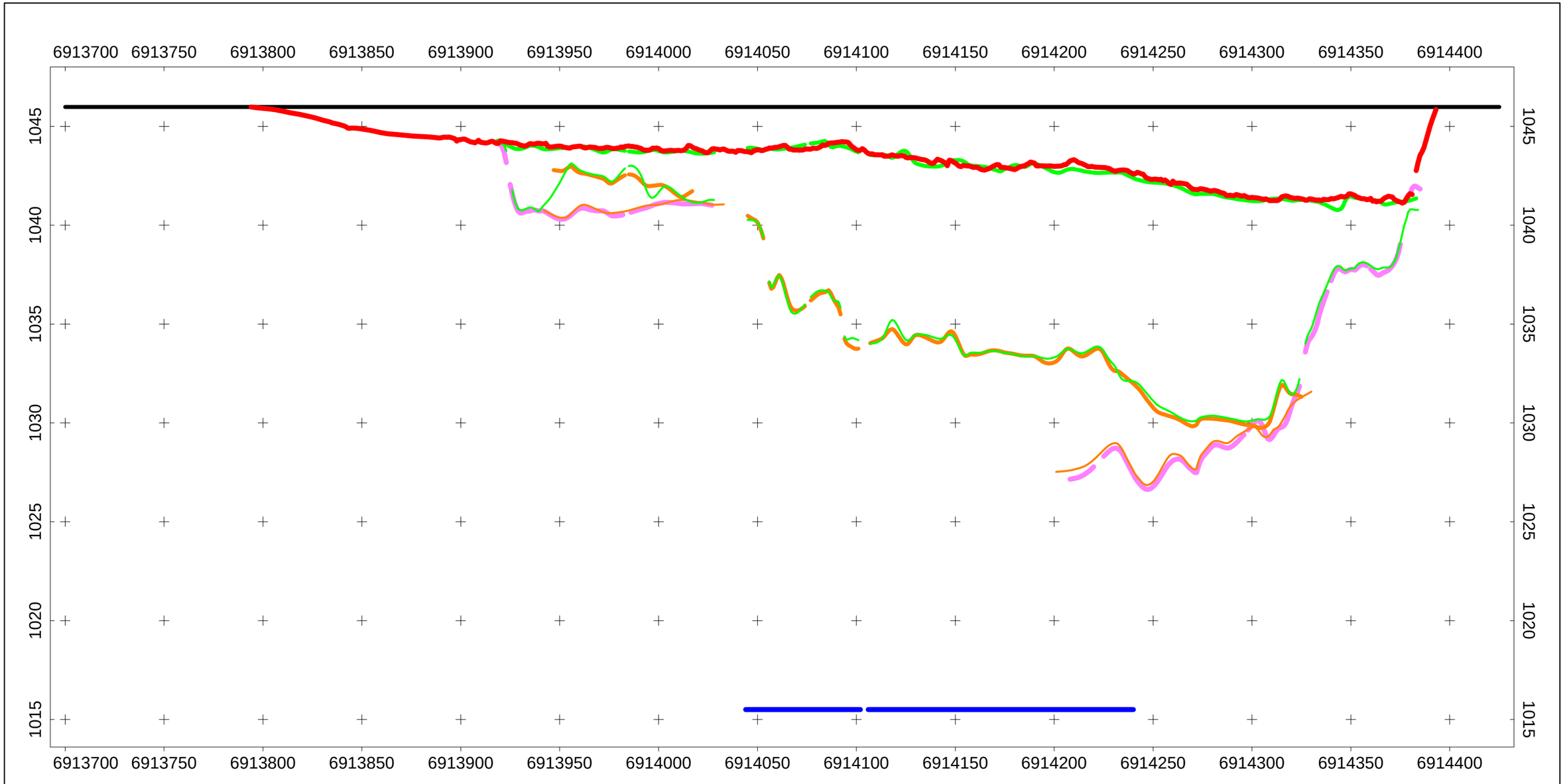
CH2M HILL LTD.

INTERMEDIATE DAM POND
Bathymetric and Sub-Bottom Survey
Cross section at UTME 580650

Surveyed Jun 11-18, 2016
Faro Mining Complex
NTS: 105k/06

Surveyed by: SS
Map drawn: Jul 27, 2016
NAD83 UTM Zone 8N

AURORA GEOSCIENCES LTD.



LEGEND

- Water :
- Mudline :
- Feature 1 - Upper :
- Feature 1 - Lower :
- Feature 2 - Upper :
- Feature 2 - Lower :
- Feature 4 :
- Feature 5 :

Scale (horizontal)

25 0 25 50

(meters)

Scale (vertical) exaggeration X10

2.5 0 2.5 5

(meters)

X-AXIS - NAD83 (CSRS)
UTM Zone 8N Northing

Y-AXIS - Orthometric elevation

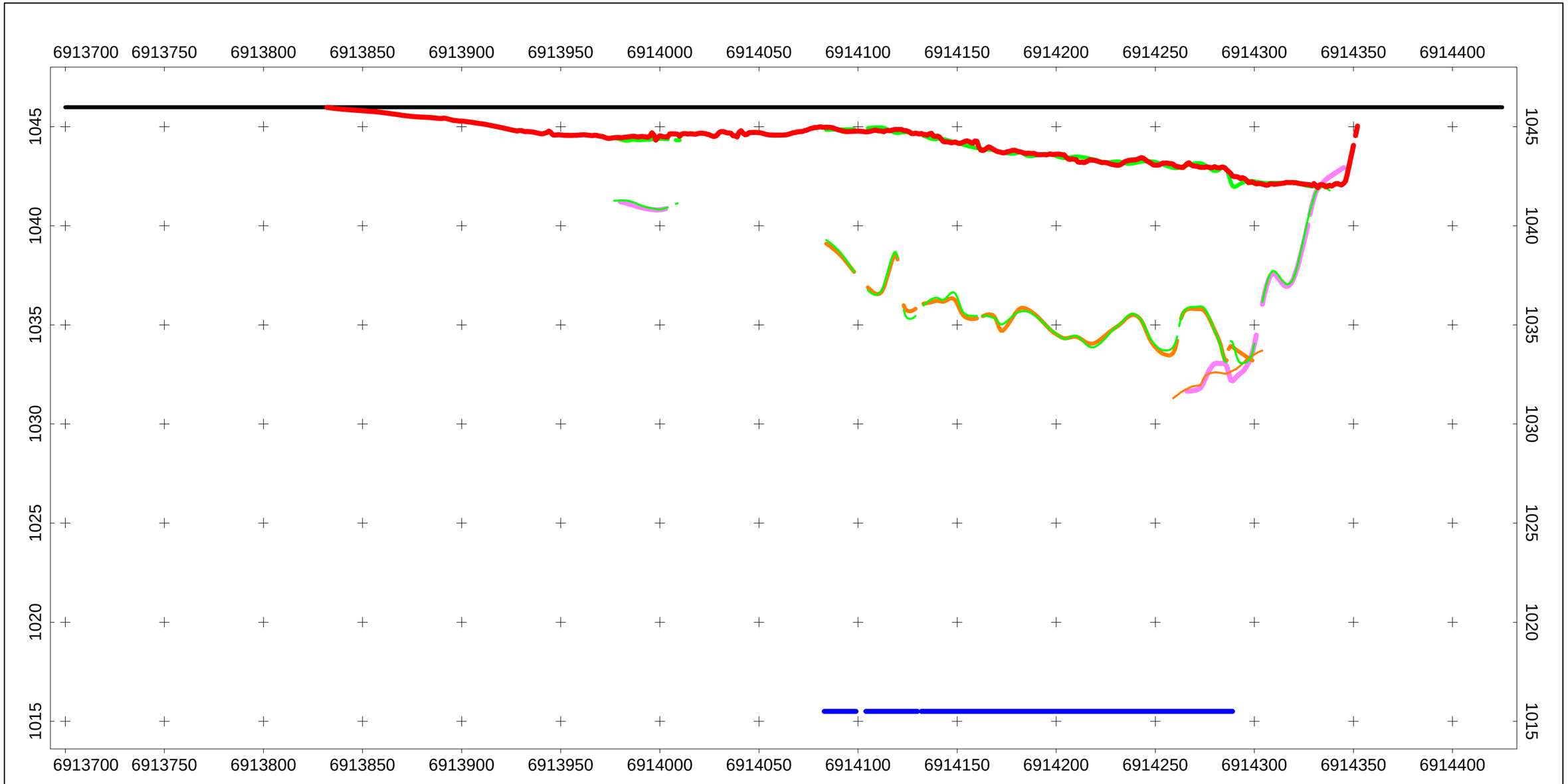
CH2M HILL LTD.

INTERMEDIATE DAM POND
Bathymetric and Sub-Bottom Survey
Cross section at UTME 580700

Surveyed Jun 11-18, 2016
Faro Mining Complex
NTS: 105k/06

Surveyed by: SS
Map drawn: Jul 27, 2016
NAD83 UTM Zone 8N

AURORA GEOSCIENCES LTD.



LEGEND

- Water :
- Mudline :
- Feature 1 - Upper :
- Feature 1 - Lower :
- Feature 2 - Upper :
- Feature 2 - Lower :
- Feature 4 :
- Feature 5 :

Scale (horizontal)

25 0 25 50

(meters)

Scale (vertical) exaggeration X10

2.5 0 2.5 5

(meters)

X-AXIS - NAD83 (CSRS)
UTM Zone 8N Northing

Y-AXIS - Orthometric elevation

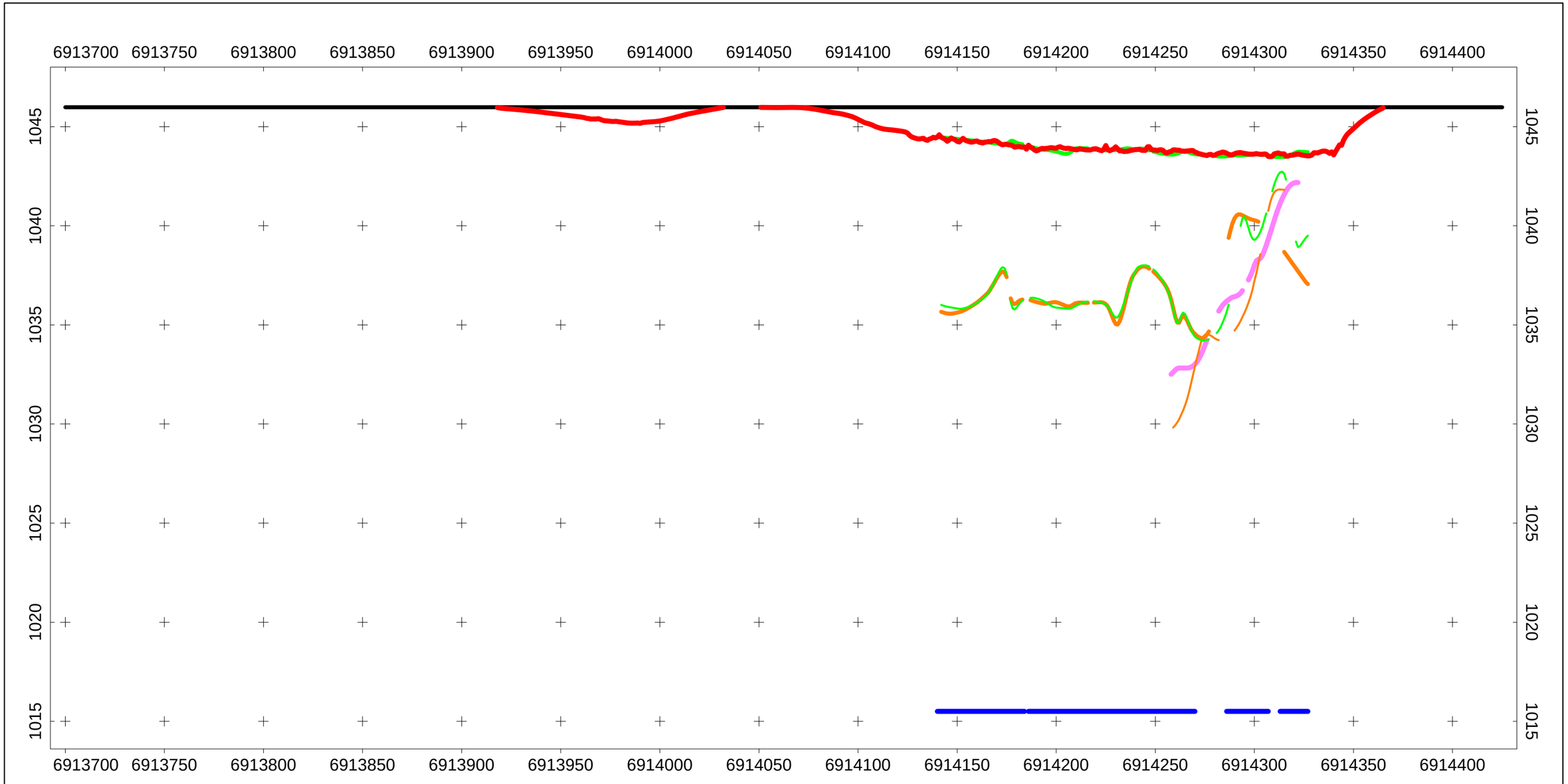
CH2M HILL LTD.

INTERMEDIATE DAM POND
Bathymetric and Sub-Bottom Survey
Cross section at UTME 580750

Surveyed Jun 11-18, 2016
Faro Mining Complex
NTS: 105k/06

Surveyed by: SS
Map drawn: Jul 27, 2016
NAD83 UTM Zone 8N

AURORA GEOSCIENCES LTD.



LEGEND

- Water :
- Mudline :
- Feature 1 - Upper :
- Feature 1 - Lower :
- Feature 2 - Upper :
- Feature 2 - Lower :
- Feature 4 :
- Feature 5 :

Scale (horizontal)

25 0 25 50

(meters)

Scale (vertical) exaggeration X10

2.5 0 2.5 5

(meters)

X-AXIS - NAD83 (CSRS)
UTM Zone 8N Northing

Y-AXIS - Orthometric elevation

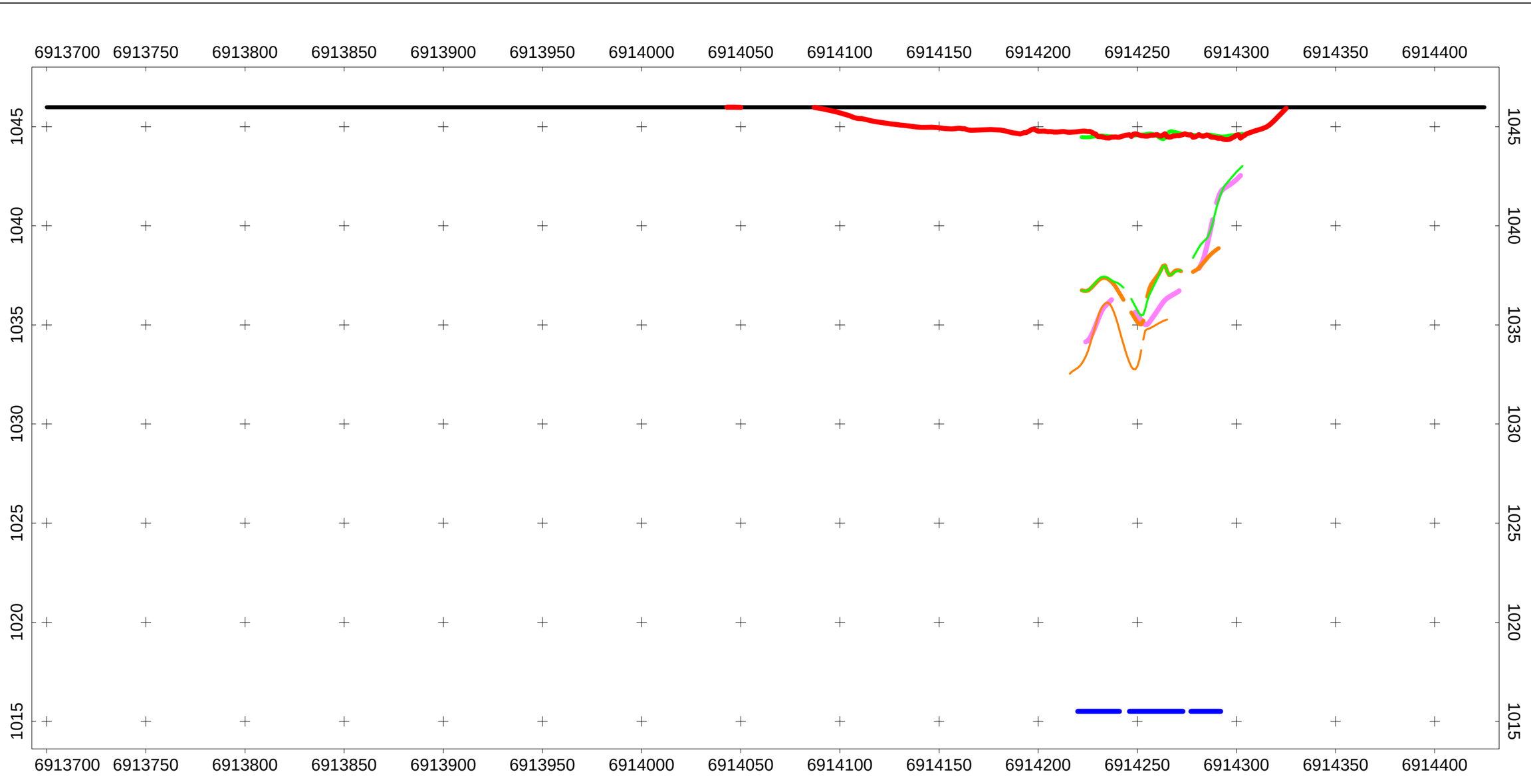
CH2M HILL LTD.

INTERMEDIATE DAM POND
Bathymetric and Sub-Bottom Survey
Cross section at UTME 580800

Surveyed Jun 11-18, 2016
Faro Mining Complex
NTS: 105k/06

Surveyed by: SS
Map drawn: Jul 27, 2016
NAD83 UTM Zone 8N

AURORA GEOSCIENCES LTD.



LEGEND

- Water :
- Mudline :
- Feature 1 - Upper :
- Feature 1 - Lower :
- Feature 2 - Upper :
- Feature 2 - Lower :
- Feature 4 :
- Feature 5 :

Scale (horizontal)

25 0 25 50

(meters)

Scale (vertical) exaggeration X10

2.5 0 2.5 5

(meters)

X-AXIS - NAD83 (CSRS)
UTM Zone 8N Northing

Y-AXIS - Orthometric elevation

CH2M HILL LTD.

INTERMEDIATE DAM POND
Bathymetric and Sub-Bottom Survey
Cross section at UTME 580850

Surveyed Jun 11-18, 2016
Faro Mining Complex
NTS: 105k/06

Surveyed by: SS
Map drawn: Jul 27, 2016
NAD83 UTM Zone 8N

AURORA GEOSCIENCES LTD.



LEGEND

- Water :
- Mudline :
- Feature 1 - Upper :
- Feature 1 - Lower :
- Feature 2 - Upper :
- Feature 2 - Lower :
- Feature 4 :
- Feature 5 :

Scale (horizontal)

25 0 25 50

(meters)

Scale (vertical) exaggeration X10

2.5 0 2.5 5

(meters)

X-AXIS - NAD83 (CSRS)
UTM Zone 8N Northing

Y-AXIS - Orthometric elevation

CH2M HILL LTD.

INTERMEDIATE DAM POND
Bathymetric and Sub-Bottom Survey
Cross section at UTME 580900

Surveyed Jun 11-18, 2016
Faro Mining Complex
NTS: 105k/06

Surveyed by: SS
Map drawn: Jul 27, 2016
NAD83 UTM Zone 8N

AURORA GEOSCIENCES LTD.

Appendix III

EdgeTech jsf format

EDGETECH SONAR DATA FILE FORMAT

DESCRIPTION OF THE EDGETECH (.jsf) FILE FORMAT

Document No. 990-0000048-1000

Revision: 1.8 / October 2009

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INTRODUCTION

EdgeTech topsides by default record in JSF file format, which consists of a set of messages. Each message begins with a 16-byte header which indicates the type of data to follow and its size. Different types of data will have different message numbers (Message Type field). Sonar data is recorded on a per-channel basis. Therefore, for a single frequency side-scan system there will be two messages per ping – one for port (channel 0) and one for starboard (channel 1). Other types of sensors (such as pitch roll) will have their own message numbers as well, and will similarly have a single message per reading set. A typical file might have the following:

Header1: Sonar Data for Subsystem SSL and channel 0 (Port Side)
Sonar Data Header for Message 1 (Ping number 1, Port, Time Stamp)
Sonar Data for Message 1 (16-bit integers – one per sample)

Header2: Sonar Data for Subsystem SSL and channel 1 (Starboard Side)
Sonar Data Header for Message 2 (Ping number 1, Starboard, Time Stamp)
Sonar Data for Message 2 (16-bit integers – one per sample)

Header3: Pitch Roll reading
Serial Device Standard Header (Time Stamp)
Pitch Roll Data Structure

Header4: Sonar Data for Subsystem SB
Sonar Data Header for Message 4 (Ping number 1, Time Stamp)
Sonar Data for Message 4 (16-bit integer pairs – one pair per sample)

Since data is stored in a binary format, the byte ordering of 16-bit and 32-bit values is important. JSF uses little endian (Intel) format for binary data where the least significant bytes are stored first. This is the native format for Intel x86 computers such as the IBM PC and compatibles. If data is read on a big endian machine (such as most Sun Workstations), you will need to byte reverse the data so that the 2 bytes of a 16-bit value are flipped, and the 4 bytes of a 32-bit value are flipped (Bytes 0, 1, 2, 3 become Bytes 3, 2, 1, 0).

EdgeTech topsides often have an option to limit the size of created files, and will generate a sequence of files for a long data run. In this case, the concatenation of these files will yield a valid JSF file for a longer run time if desired.

This document describes the messages of common interest to those processing JSF files. It is not intended to be a complete description of all valid messages.

C/C++ Code Example for Reading a JSF File

Here is a C code example for reading an entire JSF file.

```
void readFile(char *fileName)
{
  FILE *fid;
  int i;
  SonarMessageHeaderType hdr; /* Basic 16-byte message header */

  fid = fopen(fileName, “rb”);
  if (fid == NULL) return;

  while(!feof(fid))
  {
    if (fread(&hdr, sizeof(hdr), 1, fid) != 1)
      break;
    if (hdr.startOfMessage != SONAR_MESSAGE_HEADER_START)
    {
      printf(“Invalid file format\n”);
      break;
    }
    for(i = 0; i < hdr.byteCount; i++)
    {
      if (getc(fid) == EOF)
      {
        printf(“Invalid file format\n”);
        break;
      }
    }
    printf(“Message Type %d\n”, hdr.sonarMessage);
  }
  fclose(fid);
}
```

Details of data structure of the types of messages in a JSF file are described below.

16-Byte Message Header

A JSF file is a collection of messages, and every message in a JSF file begins with a sixteen byte long header. It identifies the type and size of the message, as well as the originating subsystem and channel.

Byte Offsets	Description	Size
0 – 1	Marker for the Start of Header (always 0x1601)	UINT16
2	Version number of protocol used (e.g.10)	UINT8
3	Session Identifier	UINT8
4 – 5	Message Type (e.g. 80 = Sonar Trace Data)	UINT16
6	Command Type 2 = Normal data source	UINT8
7	Subsystem Number 0 = Sub-bottom 20 = Single or Lower Frequency Side Scan 21 = Higher Frequency Side Scan	UINT8
8	Channel for a Multi-Channel Subsystem For Side Scan Subsystems, 0 = Port, 1 = Starboard For Serial Ports: Port #	UINT8
9	Sequence Number	UINT8
10 – 11	Reserved	UINT16
12 – 15	Size of following Message in Bytes	UINT32

Every message header begins (bytes 0 - 1) with a 0x1601 start of a message header marker. This serves as a sanity check during file processing.

The Protocol level (byte 2) indicates which revision of this specification was used to write that message. Messages of differing protocol levels may be interspersed in the same file. Maintaining backward compatibility in the public interface is a priority. Protocol level changes involve additional messages or changes to the non-public portion of the interface.

The session identifier (byte 3) is used for internal routing and can be ignored.

The Message Type field (bytes 4 - 5) defines the type of data to follow. Some data formats of interest are detailed in the following sections. If the Message Type field contains an unwanted or unknown (i.e. not defined below) type, use the Size of the message (bytes 12 – 15) to skip over the data to the next Message Header.

The message protocol is used for command and control as well as data. The command type field (byte 6) while of interest during real time operation can normally be ignored when reading JSF files.

The subsystem number (byte 7) is used to determine the source of the data. Common subsystem assignments are as follows:

Sub-bottom data - 0

Single frequency sidescan data - 20

Lower frequency data of a dual frequency sidescan	- 20
Higher frequency data of a dual frequency sidescan	- 21
Raw serial data	- 100
Parsed serial data	- 101

The channel (byte 8) is zero for single channel (most sub-bottom) systems. For most sidescan systems, it is zero for port and one for starboard. For serial port data the channel number is the logical port number, which often differs from the physical COM port in use.

The sequence number (byte 9) and reserved fields (bytes 10 - 11) can normally be ignored when reading JSF files.

The byte count (bytes 12 – 15) is the number of bytes until the next start of message header. This is the amount of additional data to read if processing the current message, or the amount of data to skip over if the current message is not of interest.

Message Type 80: Sonar Data Message (jsfdefs.h)

The Sonar Data Message consists of a single ping (receiver sounding period) of data for a single channel (such as Port Side Low Frequency Side-Scan). Standard sidescan sub-systems have two channels of data, port and starboard. Standard sub-bottom sub-systems have a single channel of data. Data files with higher channel counts exist. Which fields have data present depends on the system used and data acquisition procedures. This message may contain data from multiple non-acoustic sensors. Non-acoustic data contained in this message will often not be time interpolated. EdgeTech strongly recommends that if high positional or situational accuracy is required that the individual sensor messages be processed. Otherwise, this may be the only message that will need to be interpreted in a JSF file. Validity flags indicate which auxiliary fields are populated. By convention, if a value is not present the field is set to 0.

A Sonar Data Message consists of a 240-byte header, which is very similar to a traditional SEGY header, and the actual acoustic sample data follows the header. This 240-byte header described below:

Byte Offsets	Description	Size
0 – 3	Ping Time in seconds [since the start of time based on time() function] (1/1/1970) (added in protocol version 8)[1]	INT32
4 – 7	Starting Depth (window offset) in samples - usually zero	UINT32
8 – 11	Ping Number (increments with each ping)	UINT32
12 – 15	Reserved – Do not use	INT16 x 2
16 – 17	MSBs – Most Significant Bits – High order bits to extend 16 bit unsigned short values to 20 bits. The 4 MSB bits become the most significant portion of the new 20 bit value. Bits 0 - 3 – start frequency Bits 4 - 7 – end frequency Bits 8 – 11 – samples in this packet Bits 12 – 15 – reserved (added in protocol version 10)(see description below)	UINT16
18 – 27	Reserved – Do not use	INT16 x 5
28 – 29	ID Code (always 1) 1 = Seismic Data	INT16
30 – 31	Validity Flag (See mapping below)	UINT16
32 – 33	Reserved – Do not use	UINT16
34 – 35	Data Format 0 = 1 short per sample - Envelope Data 1 = 2 shorts per sample - Analytic Signal Data, (Real, Imaginary)	INT16
36 – 37	Distance from Antenna to Tow point in Centimeters, Aft + (Fish Aft = +)	INT16
38 – 39	Distance from Antenna to Tow Point in Centimeters, Starboard + (Fish to Starboard = +)	INT16
40 – 43	Reserved – Do not use	INT16 x 2

The Most Significant Bits fields are used to extend sixteen bit integers to twenty bits. These are added as needed when the range of possible values exceeds what can be stored in a sixteen bit integer. The simplest way to use these additional bits is to treat the value as a 32 bit integer, the existing value becomes the least significant 16 bits, the MSB field becomes the next most significant 4 bits with the most significant 12 bits set to zeros.

[1] NOTE: For protocol revisions 7 and before this field was always zero.

Validity flags bitmap:
Bit 0: Lat Lon or XY valid
Bit 1: Course valid
Bit 2: Speed valid
Bit 3: Heading valid
Bit 4: Pressure valid
Bit 5: Pitch roll valid
Bit 6: Altitude valid
Bit 7: Reserved
Bit 8: Water temperature valid
Bit 9: Depth valid
Bit 10: Annotation valid
Bit 11: Cable counter valid
Bit 12: KP valid
Bit 13: Position interpolated

Navigation Data

This is most often the position at the last navigation fix. See the time NMEA Navigation Data fields for the time of the fix. On most systems, position is not time interpolated and should not be used for mosaicing or other processing requiring high accuracy positioning. Validity flags indicate whether these fields are valid and interpolated. The representation of the navigation data depends on the coordinate-units field. For Latitude / Longitude representations, a positive value designates east of the Greenwich Meridian or north of the equator.

Byte Offsets	Description	Size
44 – 47	Kilometer of pipe (see bytes 30-31)	FLOAT32
48 – 79	Reserved – Do not use	INT16 x 16
80 – 83	X in millimeters or decimeters or Longitude in Minutes of Arc / 10000 (see bytes 30-31 and 88-89)	INT32
84 – 87	Y in millimeters or decimeters or Latitude in 0.0001 Minutes of Arc (see bytes 30-31 and 88-89)	INT32
88 – 89	Coordinate Units 1 = X, Y in millimeters 2 = Longitude, Latitude in minutes of arc times 10^{-4} 3 = X, Y in decimeters	INT16

Pulse Information

This data describes the transmitted pulse characteristics, as well as sampling parameters.

Byte Offsets	Description	Size
90 – 113	Annotation String (ASCII Data)	UINT8 x 24
114 – 115	Number of data samples in this packet See bytes 16 – 17 for MSB information Note: Very large sample sizes require multiple packets.	UINT16
116 – 119	Sampling Interval in Nanoseconds	UINT32
120 – 121	Gain Factor of ADC	UINT16
122 – 123	User Transmit Level Setting (0 – 100) percent	INT16
124 – 125	Reserved – Do not use	INT16
126 – 127	Transmit pulse starting frequency in decahertz (daHz) (units of 10Hz) See bytes 17 – 18 for MSB information	UINT16
128 – 129	Transmit pulse ending frequency in decahertz (daHz)(units of 10Hz) See bytes 16 – 17 for MSB information	UINT16
130 – 131	Sweep Length in milliseconds	UINT16
132 – 135	Pressure in milliPSI (1 unit = 1/1000 PSI) (see bytes 30-31)	INT32
136 - 139	Depth in millimeters (if not = 0) (see bytes 30-31)	INT32
140 – 141	Sample Freq of the data in hertz, modulo 65536 NOTE *	UINT16
142 – 143	Outgoing pulse identifier	UINT16
144 – 147	Altitude in millimeters (If bottom tracking valid) 0 implies not filled (see bytes 30-31)	INT32
148 - 155	Reserved – Do not use	INT32 x 2

NOTE* : For all data types EXCEPT RAW (Data Format = 2) this is the Sampling Frequency of the data. For RAW data, this is one-half the Sample Frequency of the data (Fs/2). All values are modulo 65536. Use this in conjunction with the Sample interval (Bytes 114-115) to calculate correct sample rate.

CPU Time

The time that the Acoustic data was recorded. The time of the start of the ping of data represented by the following trace data is the Ping Time.

The Ping Time in seconds since 1/1/1970, (in the same time base as the device messages that follow), is contained in bytes 0-3. The millisecondsToday field (bytes 200-203), MODULO 1000, will yield the milliseconds in current second, compatible with the time stamp of the device messages. This time stamp is only valid for data recorded in Protocol Revision 8 and above.

The Ping Time can also be determined from the Year, Day, Hour, Minute and Seconds as per bytes 156 to 165. Thus provides 1 second level accuracy and resolution. For higher resolution (milliseconds) use the Year, and Day values of bytes 156 to 159, and then use the milliSecondsToday value of bytes 200-203 to complete the timestamp. System time is set to UTC, regardless of time zone. This time format is backwards compatible with all older Protocol Revisions.

These 2 time stamps are equivalent and identical.

Byte Offsets	Description	Size
156 – 157	Year (e.g. 2009) (see Bytes 0-3) (Should not be used)	INT16
158 – 159	Day (1 – 366) (Should not be used)	INT16
160 – 161	Hour (see Bytes 200-203) (Should not be used)	INT16
162 – 163	Minute (Should not be used)	INT16
164 – 165	Second (should not be used)	INT16
166 – 167	Time Basis (always 3)	INT16

Weighting Factor

The trace data is transmitted as sixteen bit integers in block floating point format per message. This saves bandwidth and storage space while preserving dynamic range. The weighting factor MUST BE applied to each of the sixteen bit integer values to restore the original floating point value.

Byte Offsets	Description	Size
168 – 169	Weighting Factor N (Signed Value!) Defined as 2^{-N}	INT16
170 – 171	Number of pulses in the water	INT16

Orientation Sensor Data

These fields contain useful information about the attitude of the sonar sensor. The Compass heading will be magnetic heading of the towfish. If a Gyro sensor is properly interfaced to the Discover Topside acquisition unit, with a valid NMEA HDT message, this field will contain the Gyro heading, relative to true north

Byte Offsets	Description	Size
172 – 173	Compass Heading (0 to 360) in units of 1/100 degree (see bytes 30-31)	UINT16
174 – 175	Pitch: Scale by 180 / 32768 to get degrees, + = bow up (see bytes 30-31)	INT16
176 – 177	Roll: Scale by 180 / 32768 to get degrees, + = port up (see bytes 30-31)	INT16
178 – 179	Tow fish electronics Temperature, in unit of 1/10th degree C	INT16

Miscellaneous Data

Byte Offsets	Description	Size
180 – 181	Reserved – Do not use	INT16
182 – 183	Trigger Source 0 = Internal 1 = External 2 = Coupled	INT16
184 – 185	Mark Number 0 = No Mark	UINT16

NMEA Navigation Data

These fields contain the time of the last position fix. If the position data is interpolated this will be the same as the CPU and ping time.

Byte Offsets	Description	Size
186 – 187	Hour (0 – 23)	INT16
188 – 189	Minutes (0 – 59)	INT16
190 – 191	Seconds (0 – 59)	INT16
192 – 193	Course	INT16
194 – 195	Speed	INT16
196 – 197	Day (1 – 366)	INT16
198 – 199	Year	INT16

Other Miscellaneous Data

Byte Offsets	Description	Size
200 – 203	Milliseconds today (since midnight) (use in conjunction with Year / Day to get time of Ping)	UINT32
204 – 205	Maximum Absolute Value of ADC samples in this packet	UINT16
206 – 207	Reserved – Do not use	INT16
208 – 209	Reserved – Do not use	INT16
210 – 215	Sonar Software Version Number - ASCII	INT8 x 6
216 – 219	Initial Spherical Correction Factor (Useful for multi-ping / deep application) * 100	INT32
220 – 221	Packet Number Each ping starts with packet 1	UINT16
222 – 223	100 times the A/D Decimation Factor. Data is normally sampled at a high Rate. Digital filters are applied to precisely limit the signal bandwidth.	INT16
224 – 225	Decimation Factor after the FFT	INT16
226 – 227	Water Temperature in units of 1/10 degree C (see bytes 30-31)	INT16
228 – 231	Layback in meters	FLOAT32
232 – 235	Reserved – Do not use	INT32
236 – 237	Cable Out in decimeters (see bytes 30-31)	UINT16
238 – 239	Reserved – Do not use	UINT16

Sonar Trace Data

Sonar trace data follows the 240-byte header and consists of sixteen bit integer values. The number of integers to be read can be found by multiplying the number of samples in the trace (bytes 114-115) by the number of integers per sample for the data type used (1 or 2). Further doubling will yield the byte size of the data section. This should exactly match the preceding Message Header byte count, (bytes 12 –15) less the header size of 240.

Each of the data sample values then needs to be scaled by the weighting factor thus:

ScaledDatasample = datasample * 2^(-N). (NOTE Sign !)

Future expansions of this data format will use floating point values to represent samples, and will result in other valid values for Data Format (bytes 34-35). Data readers will be more robust if this data section is skipped over if the Data Type does not match the 4 values presented here.

Message Type 82: Side Scan Data Message (sidescandefs.h)

Side-Scan Data Messages are no longer used and only described here for historical reasons. While configuring a sonar to generate these messages is still possible, new systems are not configured in that manner. If your sonar is storing Side-Scan Data Messages the configuration should be changed to store Sonar Data Messages instead. Side-Scan Data Messages are never stored by Discover, and are only encountered in data stored by sonar. This data is almost always compressed rendering it unusable without further processing. A Side-Scan Data Message is similar to a Sonar Data Message. It contains the exactly the same acoustic data. While the Side Scan Data Message was intended for Side Scan data, it can also be used for Sub-bottom data. The system configuration determines which type of data is actually stored. Each Side Scan Data Message has an 80 byte header, the content of which is defined below. As with Sonar Data Messages, unused fields should be set to 0.

Byte Offsets	Description	Size
0 – 1	Subsystem (0 .. n)	UINT16
2 – 3	Channel Number (0 .. n)	UINT16
4 – 7	Ping number (increments with each ping period)	UINT32
8 – 9	Packet number (1..n) Each ping starts with packet 1	UINT16
10 – 11	TriggerSource (0 = internal, 1 = external)	UINT16
12 – 15	Samples in this packet	UINT32
16 – 19	Sample interval in ns of stored data	UINT32
20 – 23	Starting Depth (window offset) in samples	UINT32
24 – 25	Weighting Factor : Defined as 2^{-N} volts	INT16
26 – 27	Gain factor of ADC	UINT16
28 – 29	Maximum absolute value for ADC samples for this packet	UINT16
30 – 31	Range Setting (in decameters) (meters times 10)	UINT16
32 – 33	Unique pulse identifier	UINT16
34 – 35	Mark Number (0 = no mark)	UINT16
36 – 37	Data format 0 = 1 short per sample - envelope data the total number of bytes of data to follow is 2 * samples 1 = 2 shorts per sample - stored as real(1), imag(1), the total number of bytes of data to follow is 4 * samples	UINT16
38	Number of simultaneous pulses in the water	UINT8
39	Reserved – Do not use	UINT8

Computer date / time data acquired

Byte Offsets	Description	Size
40 – 43	Milliseconds today	UINT32
44 – 45	Year	INT16
46 – 47	Day of year (1 – 366)	UINT16
48 – 49	Hour of day (0 – 23)	UINT16
50 – 51	Minute (0 – 59)	UINT16
52 – 53	Second (0 – 59)	UINT16

Auxiliary sensor information

Byte Offsets	Description	Size
54 – 55	Compass heading in minutes (0 – 360) x 60	UINT16
56 – 57	Pitch Scale by 180 / 32768 to get degrees, + = bow up	INT16
58 – 59	Roll Scale by 180 / 32768 to get degrees, + = port up	INT16
60 – 61	Heave (centimeters)	INT16
62 – 63	Yaw (minutes)	INT16
64 – 67	Pressure in units of 1/1000 PSI	UINT32
68 – 69	Temperature in units of 1/10 of a degree Celsius	INT16
70 – 71	Water Temperature in units of 1/10 of a degree Celsius	INT16
72 – 75	Altitude in millimeters (or -1 if no valid reading)	INT32
76 – 79	Reserved – Do not use	UINT8 x 4

Sonar Trace Data

Sonar trace data follows the 80-byte header and consists of sixteen bit integer values. The number of integers to be read can be found by multiplying the number of samples in the trace (bytes 12-15) by the number of integers per sample for the data type used (1 or 2). Further doubling will yield the byte size of the data section. This should exactly match the preceding 16 byte Message Header byte count, (bytes 12 –15) less the header size of 80. Each of the data sample values then needs to be scaled by the weighting factor thus:

ScaledDatasample = datasample * 2^(- N).

Message Type 2020: Pitch Roll Data

A pitch roll message consists of a single reading from a pitch roll sensor such as a Seatex MRU, TSS or Octans device. Not all devices provide all data for the defined structure. Use the validity flags to determine which fields are populated.

Byte Offsets	Description	Size
0 – 3	Time in seconds (since the start of time based on time() function) (1/1/1970)	INT32
4 – 7	Milliseconds in the current second	INT32
8 – 11	Reserved – Do not use	UINT8 x 4
12 – 13	Acceleration in x: Multiply by (20 * 1.5) / (32768) to get Gs	INT16
14 – 15	Acceleration in y: Multiply by (20 * 1.5) / (32768) to get Gs	INT16
16 – 17	Acceleration in z: Multiply by (20 * 1.5) / (32768) to get Gs	INT16
18 – 19	Rate Gyro in x: Multiply by (500 * 1.5) / (32768) to get Degrees/Sec	INT16
20 – 21	Rate Gyro in y: Multiply by (500 * 1.5) / (32768) to get Degrees/Sec	INT16
22 – 23	Rate Gyro in y: Multiply by (500 * 1.5) / (32768) to get Degrees/Sec	INT16
24 – 25	Pitch Multiply by (180.0 / 32768.0) to get Degrees Bow up is positive	INT16
26 – 27	Roll: Multiply by (180.0 / 32768.0) to get Degrees Port up is positive	INT16
28 – 29	Temperature in units of 1/10 of a degree Celsius	INT16
30 – 31	Device specific info. This is device specific info provided for Diagnostic purposes	UINT16
32 – 33	Estimated Heave in millimeters	INT16
34 – 35	Heading in units of 0.01 Degrees (0…360)	UINT16
36 – 39	Data valid flags Bit 0: ax Bit 1: ay Bit 2: az Bit 3: rx Bit 4: ry Bit 5: rz Bit 6: pitch Bit 7: roll Bit 8: heave Bit 9: heading Bit 10: temperature Bit 11: devInfo	INT32
40 – 43	Reserved – Do not use	INT32

Message Type 2002: NMEA String

A NMEA String consists of a time stamp followed by a NMEA string as read from a GPS, Gyro or other device. Each message is a single NMEA string excluding the <CR>/<LF>.

Byte Offsets	Description	Size
0 – 3	Time in seconds since 1970	INT32
4 – 7	Milliseconds in the current second	INT32
8	Source, 1 = Sonar, 2 = Discover, 3 = ETSI	INT8
9 – 11	Reserved – Do not use	UINT8 x 3
12 – To Message Length	NMEA string data	INT8 x remaining length

Message Type 2060: Pressure Sensor Reading

If a pressure sensor is present in the system these messages will be in the data stream.

A single pressure sensor reading is provided, along with a time-stamp. While pressure sensors can be configured in different units, the default is PSI absolute.

Byte Offsets	Description	Size
0 – 3	Time in seconds (since the start of time based on time() function).	INT32
4 – 7	Milliseconds in the current second.	INT32
8 – 11	Reserved – Do not use	UNIT8 x 4
12 – 15	Pressure in units of 1/1000th of a PSI	INT32
16 – 19	Temperature in units of 1/1000th of degree Celsius.	INT32
20 – 23	Salinity in Parts Per Million	INT32
24 – 27	Data valid flags: Bit 0: pressure Bit 1: temp Bit 2: salt PPM Bit 3: conductivity Bit 4: sound velocity	INT32
28 – 31	Conductivity in micro-Siemens per cm	INT32
32 – 35	Velocity of Sound in mm per second	INT32
36 – 75	Reserved – Do not use	INT 32 x 10

Message Type 2080: Doppler Velocity Log Data (DVL)

This is data from a DVL (if fitted) and often includes velocity and altitude readings.

Byte Offsets	Description	Size
0 – 3	Time in seconds (since the start of time based on time() function).	INT32
4 – 7	Milliseconds in the current second.	INT32
8 – 11	Reserved – Do not use	UINT8 x 4
12 – 15	Flags. Indicates which values are present. Bit 0: X, Y Velocity present Bit 1: 1 => Velocity in ship coordinates 0 => Earth coordinates Bit 2: Z (Vertical Velocity) present Bit 3: X, Y Water Velocity present Bit 4: Z (Vertical Water Velocity) present Bit 5: Distance to bottom present Bit 6: Heading present Bit 7: Pitch present Bit 8: Roll present Bit 9: Temperature present Bit 10: Depth present Bit 11: Salinity present Bit 12: Sound velocity present ------- Bit 31: Error detected	UINT32
16 – 31	4 Integers: Distance to bottom in cm for up to 4 beams.	INT32 x 4
	A 0 value indicates an invalid or non-existing reading.	
32 – 33	X Velocity with respect to the bottom in mm / second Positive => Starboard or East. -32768 indicates an invalid reading.	INT16
34 – 35	Y Velocity: Positive => Forward or North (mm/second)	INT16
36 – 37	Z Vertical Velocity: Positive => Upward (mm/second)	INT16
38 – 39	X Velocity with respect to a water layer in mm / second Positive => Starboard or East	INT16 x 3
40 - 41	Y Velocity: Positive => Forward or North	
42 - 43	Z Vertical Velocity: Positive => Upward	
44 - 45	Depth from depth sensor in decimeters	UINT16
46 - 47	Pitch -180 to +180 degree (units = 0.01 of a degree) + Bow up	INT16
48 - 49	Roll -180 to +180 degrees (units = 0.01 of a degree) + Port up	INT16
50 - 51	Heading: 0 to 360 degrees (in units of 0.01 of a degree)	UINT16
52 - 53	Salinity in 1 part per thousand	UINT16
54 - 55	Temperature in units of 1/100 of a degree Celsius	INT16
56 - 57	Sound velocity in meters per second	INT16
58 - 71	Reserved – Do not use	INT16 x 7

Message Type 2090: Situation Message

A situation message is a composite of several motion / position sensors. This message is not commonly used. The detailed data structure is shown below:

Byte Offsets	Description	Size
0 - 3	Time in seconds (since the start of time based on time() function).	INT32
4 - 7	Milliseconds in the current second.	INT32
8 - 11	Reserved – Do not use	INT8 x 4
12 - 15	Validity Flags Validity Flags indicate which of the following fields are valid. If the corresponding bit is set the field is valid. Bit 0 : microsecondTimestamp Bit 1 : latitude Bit 2 : longitude Bit 3 : depth Bit 4 : heading Bit 5 : pitch Bit 6 : roll Bit 7 : XRelativePosition Bit 8 : YRelativePosition Bit 9 : ZRelativePosition Bit 10 : XVelocity Bit 11 : YVelocity Bit 12 : ZVelocity Bit 13 : NorthVelocity Bit 14 : EastVelocity Bit 15 : downVelocity Bit 16 : XAngularRate Bit 17 : YAngularRate Bit 18 : ZAngularRate Bit 19 : XAcceleration Bit 20 : YAcceleration Bit 21 : ZAcceleration Bit 22 : latitudeStandardDeviation Bit 23 : longitudeStandardDeviation Bit 24 : depthStandardDeviation Bit 25 : headingStandardDeviation Bit 26 : pitchStandardDeviation Bit 27 : rollStandardDeviation	UINT32
16 - 19	Reserved – Do not use	UINT x 4
20 - 27	Microsecond timestamp, us since 12:00:00 am GMT, January 1, 1970	UINT64
28 - 35	Double float: Latitude in degrees, north is positive	FLOAT64
36 - 43	Double float: Longitude in degrees, east is positive	FLOAT64
44 - 51	Double float: Depth in meters	FLOAT64
52 - 59	Double float: Heading in degrees	FLOAT64
60 - 67	Double float: Pitch in degrees, bow up is positive	FLOAT64
68 – 75	Double float: Roll in degrees, port up is positive	FLOAT64
76 - 83	Double float: X, forward, relative position in meters, surge	FLOAT64
84 - 91	Double float: Y, starboard, relative position in meters, sway	FLOAT64

92 - 99	Double float: Z, downward, relative position in meters, heave	FLOAT64
100 - 107	Double float: X, forward, velocity in meters per second	FLOAT64
108 - 115	Double float: Y, starboard, velocity in meters per second	FLOAT64
116 - 123	Double float: Z, downward, velocity in meters per second	FLOAT64
124 - 131	Double float: North velocity in meters per second	FLOAT64
132 - 139	Double float: East velocity in meters per second	FLOAT64
140 - 147	Double float: Down velocity in meters per second	FLOAT64
148 - 155	Double float: X angular rate in degrees per second, port up is positive	FLOAT64
156 - 163	Double float: Y angular rate in degrees per second, bow up is positive	FLOAT64
164 - 171	Double float: Z angular rate in degrees per second, starboard is positive	FLOAT64
172 - 179	Double float: X, forward, acceleration in meters per second per second	FLOAT64
180 - 187	Double float: Y, starboard, acceleration in meters per second per second	FLOAT64
188 - 195	Double float: Z, downward, acceleration in meters per second per second	FLOAT64
196 - 203	Double float: Latitude standard deviation in meters	FLOAT64
204 - 211	Double float: Longitude standard deviation in meters	FLOAT64
212 - 219	Double float: Depth standard deviation in meters	FLOAT64
220 - 227	Double float: Heading standard deviation in degrees	FLOAT64
228 - 235	Double float: Pitch standard deviation in degrees	FLOAT64
236 - 243	Double float: Roll standard deviation in degrees	FLOAT64
244 - 275	Reserved – Do not use	UINT16 x 16

Message Type 182: System Information Message

The system information message contains details of the system used to acquire data. This message is normally present at the beginning of a JSF file, and may be repeated if configuration parameters change.

Byte Offsets	Description	Size
0 - 3	System Type	INT32
4 – 7	Reserved – Do not use	
8 – 11	Version Number of Sonar Software used to generate data	INT32
12 – 19	Reserved – Do not use	
20 – 23	Serial Number of Tow Vehicle used to collect data	INT32
24 – End	Reserved – Do not use	

The size of the System Information Message is subject to change as more detailed information is may be added in future versions of the software. The byte count in the

message header should be used to determine the total size of the structure and get to the next message in the file.

The System Type is the major type of system used to collect data. To date, the following system types are defined:

System Type Number	Description
1	2xxx Series, Combined Sub-Bottom / Side Scan with SIB Electronics
2	2xxx Series, Combined Sub-Bottom / Side Scan with FSIC Electronics
4	4300-MPX (Multi-Ping)
5	3200-XS, Sub-Bottom Profiler with AIC Electronics
6	4400-SAS, 12-Channel Side Scan
7	3200-XS, Sub Bottom Profiler with SIB Electronics
11	4200 Limited Multipulse Dual Frequency Side Scan
14	3100-P, Sub Bottom Profiler
16	2xxx Series, Dual Side Scan with SIB Electronics
17	4200 Multipulse Dual Frequency Side Scan
18	4700 Dynamic Focus
19	4200 Dual Frequency Side Scan
20	4200 Dual Frequency non Simultaneous Side Scan
21	2200-MP Combined Sub-Bottom / Dual Frequency Multipulse Side Scan
23	4600 Bathymetric System
128	4100, 272 /560A Side Scan

Attachment 6
ALS Geotechnical and Geochemical Analytical Testing Results

CH2M HILL, INC
ATTN: Mark Cichy
2525 Airpark Drive
Redding CA 96001

Date Received: 19-MAR-16
Report Date: 25-APR-16 13:21 (MT)
Version: FINAL

Client Phone: 530-229-3203

Certificate of Analysis

Lab Work Order #: L1746804

Project P.O. #: 660403.20.01.01.02.04.LA PO=10201-7-100939
Job Reference: CVP AND IDP DRILLING 2016 201
C of C Numbers: ALS999_1
Legal Site Desc:

Amber Springer, B.Sc
Account Manager

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ALS ENVIRONMENTAL ANALYTICAL REPORT

Sample Details/Parameters	Result	Qualifier*	D.L.	Units	Extracted	Analyzed	Batch
L1746804-1 CH16-201-BH008_SOA1							
Sampled By: CLIENT on 10-MAR-16 @ 16:05							
Matrix: Soil							
Metals in Soil (CCME) with Extra Metals							
Mercury in Soil by CVAFS							
Mercury (Hg)	0.135		0.0050	mg/kg	30-MAR-16	02-APR-16	R3428986
Metals in Soil by CRC ICPMS							
Aluminum (Al)	29800		50	mg/kg	30-MAR-16	01-APR-16	R3429363
Antimony (Sb)	2.51		0.10	mg/kg	30-MAR-16	01-APR-16	R3429363
Arsenic (As)	31.2		0.10	mg/kg	30-MAR-16	01-APR-16	R3429363
Barium (Ba)	642		0.50	mg/kg	30-MAR-16	01-APR-16	R3429363
Beryllium (Be)	1.33		0.10	mg/kg	30-MAR-16	01-APR-16	R3429363
Bismuth (Bi)	0.66		0.20	mg/kg	30-MAR-16	01-APR-16	R3429363
Boron (B)	<5.0		5.0	mg/kg	30-MAR-16	01-APR-16	R3429363
Cadmium (Cd)	0.916		0.020	mg/kg	30-MAR-16	01-APR-16	R3429363
Calcium (Ca)	15900		50	mg/kg	30-MAR-16	01-APR-16	R3429363
Chromium (Cr)	135		0.50	mg/kg	30-MAR-16	01-APR-16	R3429363
Cobalt (Co)	33.4		0.10	mg/kg	30-MAR-16	01-APR-16	R3429363
Copper (Cu)	105		0.50	mg/kg	30-MAR-16	01-APR-16	R3429363
Iron (Fe)	56600		50	mg/kg	30-MAR-16	01-APR-16	R3429363
Lead (Pb)	144		0.50	mg/kg	30-MAR-16	01-APR-16	R3429363
Lithium (Li)	50.2		2.0	mg/kg	30-MAR-16	01-APR-16	R3429363
Magnesium (Mg)	18800		20	mg/kg	30-MAR-16	01-APR-16	R3429363
Manganese (Mn)	850		1.0	mg/kg	30-MAR-16	01-APR-16	R3429363
Molybdenum (Mo)	2.28		0.10	mg/kg	30-MAR-16	01-APR-16	R3429363
Nickel (Ni)	136		0.50	mg/kg	30-MAR-16	01-APR-16	R3429363
Phosphorus (P)	686		50	mg/kg	30-MAR-16	01-APR-16	R3429363
Potassium (K)	2920		100	mg/kg	30-MAR-16	01-APR-16	R3429363
Selenium (Se)	0.79		0.20	mg/kg	30-MAR-16	01-APR-16	R3429363
Silver (Ag)	0.49		0.10	mg/kg	30-MAR-16	01-APR-16	R3429363
Sodium (Na)	402		50	mg/kg	30-MAR-16	01-APR-16	R3429363
Strontium (Sr)	60.4		0.50	mg/kg	30-MAR-16	01-APR-16	R3429363
Thallium (Tl)	0.404		0.050	mg/kg	30-MAR-16	01-APR-16	R3429363
Tin (Sn)	<2.0		2.0	mg/kg	30-MAR-16	01-APR-16	R3429363
Titanium (Ti)	571		1.0	mg/kg	30-MAR-16	01-APR-16	R3429363
Uranium (U)	1.57		0.050	mg/kg	30-MAR-16	01-APR-16	R3429363
Vanadium (V)	72.2		0.20	mg/kg	30-MAR-16	01-APR-16	R3429363
Zinc (Zn)	407		2.0	mg/kg	30-MAR-16	01-APR-16	R3429363
Zirconium (Zr)	5.8		1.0	mg/kg	30-MAR-16	01-APR-16	R3429363
pH in Soil (1:2 Soil:Water Extraction)							
pH (1:2 soil:water)	7.54		0.10	pH		01-APR-16	R3429000
Miscellaneous Parameters							
Neutralization Potential (NP)	30		1.0	tCaCO3/1Kt	15-APR-16	15-APR-16	R3437568
Sulfur (S)-Total	3500		500	mg/kg	05-APR-16	05-APR-16	R3434580
Paste pH	7.44		0.10	pH		04-APR-16	R3429614
Atterberg limits							
Liquid Limit (LL)	53		1	%	07-APR-16	07-APR-16	R3433868
Plasticity Index (PI)	18		1	%	07-APR-16	07-APR-16	R3433868
Grain Size by Hydrometer							
Grain Size Curve	SEE ATTACHED				08-APR-16	08-APR-16	R3434612
Gravel (4.75mm - 3in.)	<1.0		1.0	%	08-APR-16	08-APR-16	R3434612
Coarse Sand (2.0mm - 4.75mm)	<1.0		1.0	%	08-APR-16	08-APR-16	R3434612
Medium Sand (0.425mm - 2.0mm)	1.1		1.0	%	08-APR-16	08-APR-16	R3434612
Fine Sand (0.075mm - 0.425mm)	1.7		1.0	%	08-APR-16	08-APR-16	R3434612
Silt (0.005mm - 0.075mm)	55.9		1.0	%	08-APR-16	08-APR-16	R3434612

* Refer to Referenced Information for Qualifiers (if any) and Methodology.

ALS ENVIRONMENTAL ANALYTICAL REPORT

Sample Details/Parameters	Result	Qualifier*	D.L.	Units	Extracted	Analyzed	Batch
L1746804-1 CH16-201-BH008_SOA1							
Sampled By: CLIENT on 10-MAR-16 @ 16:05							
Matrix: Soil							
Grain Size by Hydrometer							
Clay (<0.005mm)	41.4		1.0	%	08-APR-16	08-APR-16	R3434612
L1746804-2 CH16-201-BH008_SOA2							
Sampled By: CLIENT on 10-MAR-16 @ 16:05							
Matrix: Soil							
Metals in Soil (CCME) with Extra Metals							
Mercury in Soil by CVAFS							
Mercury (Hg)	0.0935		0.0050	mg/kg	30-MAR-16	02-APR-16	R3428986
Metals in Soil by CRC ICPMS							
Aluminum (Al)	19000		50	mg/kg	30-MAR-16	01-APR-16	R3429363
Antimony (Sb)	1.67		0.10	mg/kg	30-MAR-16	01-APR-16	R3429363
Arsenic (As)	27.1		0.10	mg/kg	30-MAR-16	01-APR-16	R3429363
Barium (Ba)	485		0.50	mg/kg	30-MAR-16	01-APR-16	R3429363
Beryllium (Be)	0.81		0.10	mg/kg	30-MAR-16	01-APR-16	R3429363
Bismuth (Bi)	0.39		0.20	mg/kg	30-MAR-16	01-APR-16	R3429363
Boron (B)	<5.0		5.0	mg/kg	30-MAR-16	01-APR-16	R3429363
Cadmium (Cd)	0.650		0.020	mg/kg	30-MAR-16	01-APR-16	R3429363
Calcium (Ca)	13000		50	mg/kg	30-MAR-16	01-APR-16	R3429363
Chromium (Cr)	79.0		0.50	mg/kg	30-MAR-16	01-APR-16	R3429363
Cobalt (Co)	23.4		0.10	mg/kg	30-MAR-16	01-APR-16	R3429363
Copper (Cu)	62.7		0.50	mg/kg	30-MAR-16	01-APR-16	R3429363
Iron (Fe)	40000		50	mg/kg	30-MAR-16	01-APR-16	R3429363
Lead (Pb)	84.7		0.50	mg/kg	30-MAR-16	01-APR-16	R3429363
Lithium (Li)	28.6		2.0	mg/kg	30-MAR-16	01-APR-16	R3429363
Magnesium (Mg)	12100		20	mg/kg	30-MAR-16	01-APR-16	R3429363
Manganese (Mn)	719		1.0	mg/kg	30-MAR-16	01-APR-16	R3429363
Molybdenum (Mo)	2.01		0.10	mg/kg	30-MAR-16	01-APR-16	R3429363
Nickel (Ni)	87.7		0.50	mg/kg	30-MAR-16	01-APR-16	R3429363
Phosphorus (P)	611		50	mg/kg	30-MAR-16	01-APR-16	R3429363
Potassium (K)	1460		100	mg/kg	30-MAR-16	01-APR-16	R3429363
Selenium (Se)	1.02		0.20	mg/kg	30-MAR-16	01-APR-16	R3429363
Silver (Ag)	0.32		0.10	mg/kg	30-MAR-16	01-APR-16	R3429363
Sodium (Na)	291		50	mg/kg	30-MAR-16	01-APR-16	R3429363
Strontium (Sr)	50.3		0.50	mg/kg	30-MAR-16	01-APR-16	R3429363
Thallium (Tl)	0.242		0.050	mg/kg	30-MAR-16	01-APR-16	R3429363
Tin (Sn)	<2.0		2.0	mg/kg	30-MAR-16	01-APR-16	R3429363
Titanium (Ti)	388		1.0	mg/kg	30-MAR-16	01-APR-16	R3429363
Uranium (U)	3.28		0.050	mg/kg	30-MAR-16	01-APR-16	R3429363
Vanadium (V)	43.6		0.20	mg/kg	30-MAR-16	01-APR-16	R3429363
Zinc (Zn)	261		2.0	mg/kg	30-MAR-16	01-APR-16	R3429363
Zirconium (Zr)	4.2		1.0	mg/kg	30-MAR-16	01-APR-16	R3429363
pH in Soil (1:2 Soil:Water Extraction)							
pH (1:2 soil:water)	7.39		0.10	pH		01-APR-16	R3429000
Miscellaneous Parameters							
Neutralization Potential (NP)	36		1.0	tCaCO3/1Kt	15-APR-16	15-APR-16	R3437568
Sulfur (S)-Total	3600		500	mg/kg	05-APR-16	05-APR-16	R3434580
Paste pH	7.32		0.10	pH		04-APR-16	R3429614
Atterberg limits							
Liquid Limit (LL)	43		1	%	07-APR-16	07-APR-16	R3433868
Plasticity Index (PI)	11		1	%	07-APR-16	07-APR-16	R3433868
Grain Size by Hydrometer							
Grain Size Curve	SEE ATTACHED				08-APR-16	08-APR-16	R3434612

* Refer to Referenced Information for Qualifiers (if any) and Methodology.

ALS ENVIRONMENTAL ANALYTICAL REPORT

Sample Details/Parameters	Result	Qualifier*	D.L.	Units	Extracted	Analyzed	Batch
L1746804-2 CH16-201-BH008_SOA2							
Sampled By: CLIENT on 10-MAR-16 @ 16:05							
Matrix: Soil							
Grain Size by Hydrometer							
Gravel (4.75mm - 3in.)	1.2		1.0	%	08-APR-16	08-APR-16	R3434612
Coarse Sand (2.0mm - 4.75mm)	10.8		1.0	%	08-APR-16	08-APR-16	R3434612
Medium Sand (0.425mm - 2.0mm)	29.2		1.0	%	08-APR-16	08-APR-16	R3434612
Fine Sand (0.075mm - 0.425mm)	18.7		1.0	%	08-APR-16	08-APR-16	R3434612
Silt (0.005mm - 0.075mm)	23.9		1.0	%	08-APR-16	08-APR-16	R3434612
Clay (<0.005mm)	16.2		1.0	%	08-APR-16	08-APR-16	R3434612
L1746804-3 CH16-201-BH008_SOB1							
Sampled By: CLIENT on 10-MAR-16 @ 16:05							
Matrix: Soil							
Grain Size by Hydrometer							
Grain Size Curve	SEE ATTACHED				08-APR-16	08-APR-16	R3434612
Gravel (4.75mm - 3in.)	3.7		1.0	%	08-APR-16	08-APR-16	R3434612
Coarse Sand (2.0mm - 4.75mm)	10.3		1.0	%	08-APR-16	08-APR-16	R3434612
Medium Sand (0.425mm - 2.0mm)	66.7		1.0	%	08-APR-16	08-APR-16	R3434612
Fine Sand (0.075mm - 0.425mm)	8.9		1.0	%	08-APR-16	08-APR-16	R3434612
Silt (0.005mm - 0.075mm)	3.1		1.0	%	08-APR-16	08-APR-16	R3434612
Clay (<0.005mm)	7.4		1.0	%	08-APR-16	08-APR-16	R3434612
L1746804-4 CH16-201-BH908_SOA2							
Sampled By: CLIENT on 10-MAR-16 @ 16:05							
Matrix: Soil							
Metals in Soil (CCME) with Extra Metals							
Mercury in Soil by CVAFS							
Mercury (Hg)	0.0537		0.0050	mg/kg	30-MAR-16	02-APR-16	R3428986
Metals in Soil by CRC ICPMS							
Aluminum (Al)	18200		50	mg/kg	30-MAR-16	01-APR-16	R3429363
Antimony (Sb)	1.91		0.10	mg/kg	30-MAR-16	01-APR-16	R3429363
Arsenic (As)	20.2		0.10	mg/kg	30-MAR-16	01-APR-16	R3429363
Barium (Ba)	329		0.50	mg/kg	30-MAR-16	01-APR-16	R3429363
Beryllium (Be)	0.73		0.10	mg/kg	30-MAR-16	01-APR-16	R3429363
Bismuth (Bi)	0.32		0.20	mg/kg	30-MAR-16	01-APR-16	R3429363
Boron (B)	<5.0		5.0	mg/kg	30-MAR-16	01-APR-16	R3429363
Cadmium (Cd)	0.454		0.020	mg/kg	30-MAR-16	01-APR-16	R3429363
Calcium (Ca)	7630		50	mg/kg	30-MAR-16	01-APR-16	R3429363
Chromium (Cr)	123		0.50	mg/kg	30-MAR-16	01-APR-16	R3429363
Cobalt (Co)	25.2		0.10	mg/kg	30-MAR-16	01-APR-16	R3429363
Copper (Cu)	54.6		0.50	mg/kg	30-MAR-16	01-APR-16	R3429363
Iron (Fe)	42600		50	mg/kg	30-MAR-16	01-APR-16	R3429363
Lead (Pb)	48.3		0.50	mg/kg	30-MAR-16	01-APR-16	R3429363
Lithium (Li)	25.4		2.0	mg/kg	30-MAR-16	01-APR-16	R3429363
Magnesium (Mg)	14000		20	mg/kg	30-MAR-16	01-APR-16	R3429363
Manganese (Mn)	596		1.0	mg/kg	30-MAR-16	01-APR-16	R3429363
Molybdenum (Mo)	1.48		0.10	mg/kg	30-MAR-16	01-APR-16	R3429363
Nickel (Ni)	131		0.50	mg/kg	30-MAR-16	01-APR-16	R3429363
Phosphorus (P)	530		50	mg/kg	30-MAR-16	01-APR-16	R3429363
Potassium (K)	890		100	mg/kg	30-MAR-16	01-APR-16	R3429363
Selenium (Se)	0.61		0.20	mg/kg	30-MAR-16	01-APR-16	R3429363
Silver (Ag)	0.23		0.10	mg/kg	30-MAR-16	01-APR-16	R3429363
Sodium (Na)	191		50	mg/kg	30-MAR-16	01-APR-16	R3429363
Strontium (Sr)	35.0		0.50	mg/kg	30-MAR-16	01-APR-16	R3429363
Thallium (Tl)	0.170		0.050	mg/kg	30-MAR-16	01-APR-16	R3429363

* Refer to Referenced Information for Qualifiers (if any) and Methodology.

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Sample Details/Parameters	Result	Qualifier*	D.L.	Units	Extracted	Analyzed	Batch
L1746804-4 CH16-201-BH908_SOA2							
Sampled By: CLIENT on 10-MAR-16 @ 16:05							
Matrix: Soil							
Metals in Soil by CRC ICPMS							
Tin (Sn)	<2.0		2.0	mg/kg	30-MAR-16	01-APR-16	R3429363
Titanium (Ti)	179		1.0	mg/kg	30-MAR-16	01-APR-16	R3429363
Uranium (U)	1.49		0.050	mg/kg	30-MAR-16	01-APR-16	R3429363
Vanadium (V)	38.7		0.20	mg/kg	30-MAR-16	01-APR-16	R3429363
Zinc (Zn)	167		2.0	mg/kg	30-MAR-16	01-APR-16	R3429363
Zirconium (Zr)	3.6		1.0	mg/kg	30-MAR-16	01-APR-16	R3429363
pH in Soil (1:2 Soil:Water Extraction)							
pH (1:2 soil:water)	7.46		0.10	pH		01-APR-16	R3429000
Miscellaneous Parameters							
Neutralization Potential (NP)	27		1.0	tCaCO3/1Kt	15-APR-16	15-APR-16	R3437568
Sulfur (S)-Total	2000		500	mg/kg	05-APR-16	05-APR-16	R3434580
Paste pH	7.23		0.10	pH		04-APR-16	R3429614
L1746804-5 CH16-201-BH007_SOA1							
Sampled By: CLIENT on 08-MAR-16 @ 14:13							
Matrix: Soil							
Metals in Soil (CCME) with Extra Metals							
Mercury in Soil by CVAFS							
Mercury (Hg)	0.0401		0.0050	mg/kg	30-MAR-16	02-APR-16	R3428986
Metals in Soil by CRC ICPMS							
Aluminum (Al)	12200		50	mg/kg	30-MAR-16	01-APR-16	R3429363
Antimony (Sb)	0.59		0.10	mg/kg	30-MAR-16	01-APR-16	R3429363
Arsenic (As)	7.52		0.10	mg/kg	30-MAR-16	01-APR-16	R3429363
Barium (Ba)	190		0.50	mg/kg	30-MAR-16	01-APR-16	R3429363
Beryllium (Be)	0.49		0.10	mg/kg	30-MAR-16	01-APR-16	R3429363
Bismuth (Bi)	0.22		0.20	mg/kg	30-MAR-16	01-APR-16	R3429363
Boron (B)	<5.0		5.0	mg/kg	30-MAR-16	01-APR-16	R3429363
Cadmium (Cd)	0.511		0.020	mg/kg	30-MAR-16	01-APR-16	R3429363
Calcium (Ca)	19200		50	mg/kg	30-MAR-16	01-APR-16	R3429363
Chromium (Cr)	48.0		0.50	mg/kg	30-MAR-16	01-APR-16	R3429363
Cobalt (Co)	13.4		0.10	mg/kg	30-MAR-16	01-APR-16	R3429363
Copper (Cu)	32.8		0.50	mg/kg	30-MAR-16	01-APR-16	R3429363
Iron (Fe)	23100		50	mg/kg	30-MAR-16	01-APR-16	R3429363
Lead (Pb)	37.7		0.50	mg/kg	30-MAR-16	01-APR-16	R3429363
Lithium (Li)	20.9		2.0	mg/kg	30-MAR-16	01-APR-16	R3429363
Magnesium (Mg)	7070		20	mg/kg	30-MAR-16	01-APR-16	R3429363
Manganese (Mn)	580		1.0	mg/kg	30-MAR-16	01-APR-16	R3429363
Molybdenum (Mo)	1.52		0.10	mg/kg	30-MAR-16	01-APR-16	R3429363
Nickel (Ni)	39.0		0.50	mg/kg	30-MAR-16	01-APR-16	R3429363
Phosphorus (P)	531		50	mg/kg	30-MAR-16	01-APR-16	R3429363
Potassium (K)	1600		100	mg/kg	30-MAR-16	01-APR-16	R3429363
Selenium (Se)	<0.20		0.20	mg/kg	30-MAR-16	01-APR-16	R3429363
Silver (Ag)	0.14		0.10	mg/kg	30-MAR-16	01-APR-16	R3429363
Sodium (Na)	306		50	mg/kg	30-MAR-16	01-APR-16	R3429363
Strontium (Sr)	75.2		0.50	mg/kg	30-MAR-16	01-APR-16	R3429363
Thallium (Tl)	0.150		0.050	mg/kg	30-MAR-16	01-APR-16	R3429363
Tin (Sn)	<2.0		2.0	mg/kg	30-MAR-16	01-APR-16	R3429363
Titanium (Ti)	341		1.0	mg/kg	30-MAR-16	01-APR-16	R3429363
Uranium (U)	0.901		0.050	mg/kg	30-MAR-16	01-APR-16	R3429363
Vanadium (V)	28.9		0.20	mg/kg	30-MAR-16	01-APR-16	R3429363
Zinc (Zn)	121		2.0	mg/kg	30-MAR-16	01-APR-16	R3429363
Zirconium (Zr)	3.5		1.0	mg/kg	30-MAR-16	01-APR-16	R3429363

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Sample Details/Parameters	Result	Qualifier*	D.L.	Units	Extracted	Analyzed	Batch
L1746804-5 CH16-201-BH007_SOA1							
Sampled By: CLIENT on 08-MAR-16 @ 14:13							
Matrix: Soil							
pH in Soil (1:2 Soil:Water Extraction)							
pH (1:2 soil:water)	8.22		0.10	pH		01-APR-16	R3429000
Miscellaneous Parameters							
Neutralization Potential (NP)	64		1.0	tCaCO3/1Kt	15-APR-16	15-APR-16	R3437568
Sulfur (S)-Total	1100		500	mg/kg	05-APR-16	05-APR-16	R3434580
Paste pH	7.69		0.10	pH		04-APR-16	R3429614
Grain Size by Hydrometer							
Grain Size Curve	SEE ATTACHED				08-APR-16	08-APR-16	R3434612
Gravel (4.75mm - 3in.)	4.2		1.0	%	08-APR-16	08-APR-16	R3434612
Coarse Sand (2.0mm - 4.75mm)	19.5		1.0	%	08-APR-16	08-APR-16	R3434612
Medium Sand (0.425mm - 2.0mm)	61.7		1.0	%	08-APR-16	08-APR-16	R3434612
Fine Sand (0.075mm - 0.425mm)	6.6		1.0	%	08-APR-16	08-APR-16	R3434612
Silt (0.005mm - 0.075mm)	2.0		1.0	%	08-APR-16	08-APR-16	R3434612
Clay (<0.005mm)	6.1		1.0	%	08-APR-16	08-APR-16	R3434612
L1746804-6 CH16-201-BH007_SOC							
Sampled By: CLIENT on 08-MAR-16 @ 14:43							
Matrix: Soil							
Grain Size by Hydrometer							
Grain Size Curve	SEE ATTACHED				08-APR-16	08-APR-16	R3434612
Gravel (4.75mm - 3in.)	18.1		1.0	%	08-APR-16	08-APR-16	R3434612
Coarse Sand (2.0mm - 4.75mm)	12.2		1.0	%	08-APR-16	08-APR-16	R3434612
Medium Sand (0.425mm - 2.0mm)	40.8		1.0	%	08-APR-16	08-APR-16	R3434612
Fine Sand (0.075mm - 0.425mm)	18.1		1.0	%	08-APR-16	08-APR-16	R3434612
Silt (0.005mm - 0.075mm)	2.4		1.0	%	08-APR-16	08-APR-16	R3434612
Clay (<0.005mm)	8.4		1.0	%	08-APR-16	08-APR-16	R3434612
L1746804-7 CH16-201-BH007_SOE1							
Sampled By: CLIENT on 08-MAR-16 @ 15:16							
Matrix: Soil							
Grain Size by Hydrometer							
Grain Size Curve	SEE ATTACHED				08-APR-16	08-APR-16	R3434612
Gravel (4.75mm - 3in.)	4.3		1.0	%	08-APR-16	08-APR-16	R3434612
Coarse Sand (2.0mm - 4.75mm)	10.3		1.0	%	08-APR-16	08-APR-16	R3434612
Medium Sand (0.425mm - 2.0mm)	56.0		1.0	%	08-APR-16	08-APR-16	R3434612
Fine Sand (0.075mm - 0.425mm)	20.2		1.0	%	08-APR-16	08-APR-16	R3434612
Silt (0.005mm - 0.075mm)	3.8		1.0	%	08-APR-16	08-APR-16	R3434612
Clay (<0.005mm)	5.5		1.0	%	08-APR-16	08-APR-16	R3434612
L1746804-8 CH16-201-BH007_SOE2							
Sampled By: CLIENT on 08-MAR-16 @ 15:16							
Matrix: Soil							
Metals in Soil (CCME) with Extra Metals							
Mercury in Soil by CVAFS							
Mercury (Hg)	0.0226		0.0050	mg/kg	30-MAR-16	02-APR-16	R3428986
Metals in Soil by CRC ICPMS							
Aluminum (Al)	16300		50	mg/kg	30-MAR-16	01-APR-16	R3429363
Antimony (Sb)	0.38		0.10	mg/kg	30-MAR-16	01-APR-16	R3429363
Arsenic (As)	15.5		0.10	mg/kg	30-MAR-16	01-APR-16	R3429363
Barium (Ba)	106		0.50	mg/kg	30-MAR-16	01-APR-16	R3429363
Beryllium (Be)	0.70		0.10	mg/kg	30-MAR-16	01-APR-16	R3429363
Bismuth (Bi)	0.26		0.20	mg/kg	30-MAR-16	01-APR-16	R3429363

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Sample Details/Parameters	Result	Qualifier*	D.L.	Units	Extracted	Analyzed	Batch
L1746804-8 CH16-201-BH007_SOE2							
Sampled By: CLIENT on 08-MAR-16 @ 15:16							
Matrix: Soil							
Metals in Soil by CRC ICPMS							
Boron (B)	<5.0		5.0	mg/kg	30-MAR-16	01-APR-16	R3429363
Cadmium (Cd)	0.313		0.020	mg/kg	30-MAR-16	01-APR-16	R3429363
Calcium (Ca)	6100		50	mg/kg	30-MAR-16	01-APR-16	R3429363
Chromium (Cr)	95.9		0.50	mg/kg	30-MAR-16	01-APR-16	R3429363
Cobalt (Co)	13.3		0.10	mg/kg	30-MAR-16	01-APR-16	R3429363
Copper (Cu)	34.9		0.50	mg/kg	30-MAR-16	01-APR-16	R3429363
Iron (Fe)	30100		50	mg/kg	30-MAR-16	01-APR-16	R3429363
Lead (Pb)	15.3		0.50	mg/kg	30-MAR-16	01-APR-16	R3429363
Lithium (Li)	23.7		2.0	mg/kg	30-MAR-16	01-APR-16	R3429363
Magnesium (Mg)	7770		20	mg/kg	30-MAR-16	01-APR-16	R3429363
Manganese (Mn)	458		1.0	mg/kg	30-MAR-16	01-APR-16	R3429363
Molybdenum (Mo)	1.49		0.10	mg/kg	30-MAR-16	01-APR-16	R3429363
Nickel (Ni)	58.2		0.50	mg/kg	30-MAR-16	01-APR-16	R3429363
Phosphorus (P)	701		50	mg/kg	30-MAR-16	01-APR-16	R3429363
Potassium (K)	1840		100	mg/kg	30-MAR-16	01-APR-16	R3429363
Selenium (Se)	<0.20		0.20	mg/kg	30-MAR-16	01-APR-16	R3429363
Silver (Ag)	0.11		0.10	mg/kg	30-MAR-16	01-APR-16	R3429363
Sodium (Na)	562		50	mg/kg	30-MAR-16	01-APR-16	R3429363
Strontium (Sr)	58.9		0.50	mg/kg	30-MAR-16	01-APR-16	R3429363
Thallium (Tl)	0.180		0.050	mg/kg	30-MAR-16	01-APR-16	R3429363
Tin (Sn)	<2.0		2.0	mg/kg	30-MAR-16	01-APR-16	R3429363
Titanium (Ti)	480		1.0	mg/kg	30-MAR-16	01-APR-16	R3429363
Uranium (U)	1.57		0.050	mg/kg	30-MAR-16	01-APR-16	R3429363
Vanadium (V)	36.5		0.20	mg/kg	30-MAR-16	01-APR-16	R3429363
Zinc (Zn)	67.6		2.0	mg/kg	30-MAR-16	01-APR-16	R3429363
Zirconium (Zr)	3.0		1.0	mg/kg	30-MAR-16	01-APR-16	R3429363
pH in Soil (1:2 Soil:Water Extraction)							
pH (1:2 soil:water)	8.13		0.10	pH		01-APR-16	R3429000
Miscellaneous Parameters							
Neutralization Potential (NP)	13		1.0	tCaCO3/1Kt	15-APR-16	15-APR-16	R3437568
Sulfur (S)-Total	900		500	mg/kg	05-APR-16	05-APR-16	R3434580
Paste pH	7.78		0.10	pH		04-APR-16	R3429614
L1746804-9 CH16-201-BH907_SOE2							
Sampled By: CLIENT on 08-MAR-16 @ 15:16							
Matrix: Soil							
Metals in Soil (CCME) with Extra Metals							
Mercury in Soil by CVAFS							
Mercury (Hg)	0.0130		0.0050	mg/kg	30-MAR-16	02-APR-16	R3428986
Metals in Soil by CRC ICPMS							
Aluminum (Al)	11800		50	mg/kg	30-MAR-16	01-APR-16	R3429363
Antimony (Sb)	0.25		0.10	mg/kg	30-MAR-16	01-APR-16	R3429363
Arsenic (As)	7.87		0.10	mg/kg	30-MAR-16	01-APR-16	R3429363
Barium (Ba)	65.2		0.50	mg/kg	30-MAR-16	01-APR-16	R3429363
Beryllium (Be)	0.46		0.10	mg/kg	30-MAR-16	01-APR-16	R3429363
Bismuth (Bi)	0.44		0.20	mg/kg	30-MAR-16	01-APR-16	R3429363
Boron (B)	<5.0		5.0	mg/kg	30-MAR-16	01-APR-16	R3429363
Cadmium (Cd)	0.167		0.020	mg/kg	30-MAR-16	01-APR-16	R3429363
Calcium (Ca)	4000		50	mg/kg	30-MAR-16	01-APR-16	R3429363
Chromium (Cr)	39.3		0.50	mg/kg	30-MAR-16	01-APR-16	R3429363
Cobalt (Co)	7.96		0.10	mg/kg	30-MAR-16	01-APR-16	R3429363
Copper (Cu)	19.7		0.50	mg/kg	30-MAR-16	01-APR-16	R3429363

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Sample Details/Parameters	Result	Qualifier*	D.L.	Units	Extracted	Analyzed	Batch
L1746804-9 CH16-201-BH907_SOE2							
Sampled By: CLIENT on 08-MAR-16 @ 15:16							
Matrix: Soil							
Metals in Soil by CRC ICPMS							
Iron (Fe)	21300		50	mg/kg	30-MAR-16	01-APR-16	R3429363
Lead (Pb)	8.75		0.50	mg/kg	30-MAR-16	01-APR-16	R3429363
Lithium (Li)	21.1		2.0	mg/kg	30-MAR-16	01-APR-16	R3429363
Magnesium (Mg)	6110		20	mg/kg	30-MAR-16	01-APR-16	R3429363
Manganese (Mn)	272		1.0	mg/kg	30-MAR-16	01-APR-16	R3429363
Molybdenum (Mo)	1.06		0.10	mg/kg	30-MAR-16	01-APR-16	R3429363
Nickel (Ni)	28.2		0.50	mg/kg	30-MAR-16	01-APR-16	R3429363
Phosphorus (P)	420		50	mg/kg	30-MAR-16	01-APR-16	R3429363
Potassium (K)	1220		100	mg/kg	30-MAR-16	01-APR-16	R3429363
Selenium (Se)	<0.20		0.20	mg/kg	30-MAR-16	01-APR-16	R3429363
Silver (Ag)	<0.10		0.10	mg/kg	30-MAR-16	01-APR-16	R3429363
Sodium (Na)	317		50	mg/kg	30-MAR-16	01-APR-16	R3429363
Strontium (Sr)	35.7		0.50	mg/kg	30-MAR-16	01-APR-16	R3429363
Thallium (Tl)	0.113		0.050	mg/kg	30-MAR-16	01-APR-16	R3429363
Tin (Sn)	<2.0		2.0	mg/kg	30-MAR-16	01-APR-16	R3429363
Titanium (Ti)	335		1.0	mg/kg	30-MAR-16	01-APR-16	R3429363
Uranium (U)	1.02		0.050	mg/kg	30-MAR-16	01-APR-16	R3429363
Vanadium (V)	29.1		0.20	mg/kg	30-MAR-16	01-APR-16	R3429363
Zinc (Zn)	47.5		2.0	mg/kg	30-MAR-16	01-APR-16	R3429363
Zirconium (Zr)	2.8		1.0	mg/kg	30-MAR-16	01-APR-16	R3429363
pH in Soil (1:2 Soil:Water Extraction)							
pH (1:2 soil:water)	8.23		0.10	pH		01-APR-16	R3429000
Miscellaneous Parameters							
Neutralization Potential (NP)	11		1.0	tCaCO3/1Kt	15-APR-16	15-APR-16	R3437568
Sulfur (S)-Total	700		500	mg/kg	05-APR-16	05-APR-16	R3434580
Paste pH	7.94		0.10	pH		04-APR-16	R3429614
L1746804-10 CH16-201-BH009_SOA1							
Sampled By: CLIENT on 09-MAR-16 @ 11:29							
Matrix: Soil							
Grain Size by Hydrometer							
Grain Size Curve	SEE ATTACHED				08-APR-16	08-APR-16	R3434612
Gravel (4.75mm - 3in.)	12.0		1.0	%	08-APR-16	08-APR-16	R3434612
Coarse Sand (2.0mm - 4.75mm)	12.1		1.0	%	08-APR-16	08-APR-16	R3434612
Medium Sand (0.425mm - 2.0mm)	46.6		1.0	%	08-APR-16	08-APR-16	R3434612
Fine Sand (0.075mm - 0.425mm)	12.9		1.0	%	08-APR-16	08-APR-16	R3434612
Silt (0.005mm - 0.075mm)	10.2		1.0	%	08-APR-16	08-APR-16	R3434612
Clay (<0.005mm)	6.2		1.0	%	08-APR-16	08-APR-16	R3434612
L1746804-11 CH16-201-BH009_SOA2							
Sampled By: CLIENT on 09-MAR-16 @ 11:29							
Matrix: Soil							
Metals in Soil (CCME) with Extra Metals							
Mercury in Soil by CVAFS							
Mercury (Hg)	0.0158		0.0050	mg/kg	30-MAR-16	02-APR-16	R3428986
Metals in Soil by CRC ICPMS							
Aluminum (Al)	13100		50	mg/kg	30-MAR-16	01-APR-16	R3429363
Antimony (Sb)	0.49		0.10	mg/kg	30-MAR-16	01-APR-16	R3429363
Arsenic (As)	8.15		0.10	mg/kg	30-MAR-16	01-APR-16	R3429363
Barium (Ba)	128		0.50	mg/kg	30-MAR-16	01-APR-16	R3429363
Beryllium (Be)	0.51		0.10	mg/kg	30-MAR-16	01-APR-16	R3429363
Bismuth (Bi)	0.39		0.20	mg/kg	30-MAR-16	01-APR-16	R3429363

* Refer to Referenced Information for Qualifiers (if any) and Methodology.

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Sample Details/Parameters	Result	Qualifier*	D.L.	Units	Extracted	Analyzed	Batch
L1746804-11 CH16-201-BH009_SOA2							
Sampled By: CLIENT on 09-MAR-16 @ 11:29							
Matrix: Soil							
Metals in Soil by CRC ICPMS							
Boron (B)	<5.0		5.0	mg/kg	30-MAR-16	01-APR-16	R3429363
Cadmium (Cd)	0.195		0.020	mg/kg	30-MAR-16	01-APR-16	R3429363
Calcium (Ca)	3510		50	mg/kg	30-MAR-16	01-APR-16	R3429363
Chromium (Cr)	27.1		0.50	mg/kg	30-MAR-16	01-APR-16	R3429363
Cobalt (Co)	8.62		0.10	mg/kg	30-MAR-16	01-APR-16	R3429363
Copper (Cu)	20.6		0.50	mg/kg	30-MAR-16	01-APR-16	R3429363
Iron (Fe)	18700		50	mg/kg	30-MAR-16	01-APR-16	R3429363
Lead (Pb)	18.8		0.50	mg/kg	30-MAR-16	01-APR-16	R3429363
Lithium (Li)	21.1		2.0	mg/kg	30-MAR-16	01-APR-16	R3429363
Magnesium (Mg)	5080		20	mg/kg	30-MAR-16	01-APR-16	R3429363
Manganese (Mn)	264		1.0	mg/kg	30-MAR-16	01-APR-16	R3429363
Molybdenum (Mo)	1.01		0.10	mg/kg	30-MAR-16	01-APR-16	R3429363
Nickel (Ni)	25.0		0.50	mg/kg	30-MAR-16	01-APR-16	R3429363
Phosphorus (P)	565		50	mg/kg	30-MAR-16	01-APR-16	R3429363
Potassium (K)	1230		100	mg/kg	30-MAR-16	01-APR-16	R3429363
Selenium (Se)	0.21		0.20	mg/kg	30-MAR-16	01-APR-16	R3429363
Silver (Ag)	<0.10		0.10	mg/kg	30-MAR-16	01-APR-16	R3429363
Sodium (Na)	309		50	mg/kg	30-MAR-16	01-APR-16	R3429363
Strontium (Sr)	35.6		0.50	mg/kg	30-MAR-16	01-APR-16	R3429363
Thallium (Tl)	0.143		0.050	mg/kg	30-MAR-16	01-APR-16	R3429363
Tin (Sn)	<2.0		2.0	mg/kg	30-MAR-16	01-APR-16	R3429363
Titanium (Ti)	412		1.0	mg/kg	30-MAR-16	01-APR-16	R3429363
Uranium (U)	0.950		0.050	mg/kg	30-MAR-16	01-APR-16	R3429363
Vanadium (V)	31.9		0.20	mg/kg	30-MAR-16	01-APR-16	R3429363
Zinc (Zn)	75.1		2.0	mg/kg	30-MAR-16	01-APR-16	R3429363
Zirconium (Zr)	<1.0		1.0	mg/kg	30-MAR-16	01-APR-16	R3429363
pH in Soil (1:2 Soil:Water Extraction)							
pH (1:2 soil:water)	7.79		0.10	pH		01-APR-16	R3429000
Miscellaneous Parameters							
Neutralization Potential (NP)	13		1.0	tCaCO3/1Kt	15-APR-16	15-APR-16	R3437568
Sulfur (S)-Total	1500		500	mg/kg	05-APR-16	05-APR-16	R3434580
Paste pH	7.42		0.10	pH		04-APR-16	R3429614
L1746804-12 CH16-201-BH009_SOB2							
Sampled By: CLIENT on 09-MAR-16 @ 12:01							
Matrix: Soil							
Metals in Soil (CCME) with Extra Metals							
Mercury in Soil by CVAFS							
Mercury (Hg)	0.0214		0.0050	mg/kg	30-MAR-16	02-APR-16	R3428986
Metals in Soil by CRC ICPMS							
Aluminum (Al)	14400		50	mg/kg	30-MAR-16	01-APR-16	R3429363
Antimony (Sb)	0.45		0.10	mg/kg	30-MAR-16	01-APR-16	R3429363
Arsenic (As)	11.2		0.10	mg/kg	30-MAR-16	01-APR-16	R3429363
Barium (Ba)	80.9		0.50	mg/kg	30-MAR-16	01-APR-16	R3429363
Beryllium (Be)	0.58		0.10	mg/kg	30-MAR-16	01-APR-16	R3429363
Bismuth (Bi)	0.30		0.20	mg/kg	30-MAR-16	01-APR-16	R3429363
Boron (B)	<5.0		5.0	mg/kg	30-MAR-16	01-APR-16	R3429363
Cadmium (Cd)	0.305		0.020	mg/kg	30-MAR-16	01-APR-16	R3429363
Calcium (Ca)	4580		50	mg/kg	30-MAR-16	01-APR-16	R3429363
Chromium (Cr)	38.5		0.50	mg/kg	30-MAR-16	01-APR-16	R3429363
Cobalt (Co)	10.8		0.10	mg/kg	30-MAR-16	01-APR-16	R3429363
Copper (Cu)	21.5		0.50	mg/kg	30-MAR-16	01-APR-16	R3429363

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Sample Details/Parameters	Result	Qualifier*	D.L.	Units	Extracted	Analyzed	Batch
L1746804-12 CH16-201-BH009_SOB2							
Sampled By: CLIENT on 09-MAR-16 @ 12:01							
Matrix: Soil							
Metals in Soil by CRC ICPMS							
Iron (Fe)	23400		50	mg/kg	30-MAR-16	01-APR-16	R3429363
Lead (Pb)	24.8		0.50	mg/kg	30-MAR-16	01-APR-16	R3429363
Lithium (Li)	22.2		2.0	mg/kg	30-MAR-16	01-APR-16	R3429363
Magnesium (Mg)	6600		20	mg/kg	30-MAR-16	01-APR-16	R3429363
Manganese (Mn)	357		1.0	mg/kg	30-MAR-16	01-APR-16	R3429363
Molybdenum (Mo)	0.75		0.10	mg/kg	30-MAR-16	01-APR-16	R3429363
Nickel (Ni)	32.1		0.50	mg/kg	30-MAR-16	01-APR-16	R3429363
Phosphorus (P)	604		50	mg/kg	30-MAR-16	01-APR-16	R3429363
Potassium (K)	1360		100	mg/kg	30-MAR-16	01-APR-16	R3429363
Selenium (Se)	0.24		0.20	mg/kg	30-MAR-16	01-APR-16	R3429363
Silver (Ag)	<0.10		0.10	mg/kg	30-MAR-16	01-APR-16	R3429363
Sodium (Na)	299		50	mg/kg	30-MAR-16	01-APR-16	R3429363
Strontium (Sr)	33.6		0.50	mg/kg	30-MAR-16	01-APR-16	R3429363
Thallium (Tl)	0.152		0.050	mg/kg	30-MAR-16	01-APR-16	R3429363
Tin (Sn)	<2.0		2.0	mg/kg	30-MAR-16	01-APR-16	R3429363
Titanium (Ti)	480		1.0	mg/kg	30-MAR-16	01-APR-16	R3429363
Uranium (U)	0.960		0.050	mg/kg	30-MAR-16	01-APR-16	R3429363
Vanadium (V)	33.9		0.20	mg/kg	30-MAR-16	01-APR-16	R3429363
Zinc (Zn)	81.9		2.0	mg/kg	30-MAR-16	01-APR-16	R3429363
Zirconium (Zr)	1.3		1.0	mg/kg	30-MAR-16	01-APR-16	R3429363
pH in Soil (1:2 Soil:Water Extraction)							
pH (1:2 soil:water)	7.52		0.10	pH		01-APR-16	R3429000
Miscellaneous Parameters							
Neutralization Potential (NP)	20		1.0	tCaCO3/1Kt	15-APR-16	15-APR-16	R3437568
Sulfur (S)-Total	1300		500	mg/kg	05-APR-16	05-APR-16	R3434580
Paste pH	7.18		0.10	pH		04-APR-16	R3429614
Atterberg limits							
Liquid Limit (LL)	23	NSSM	1	%	07-APR-16	07-APR-16	R3433868
Plasticity Index (PI)	2		1	%	07-APR-16	07-APR-16	R3433868
Grain Size by Hydrometer							
Grain Size Curve	SEE ATTACHED				08-APR-16	08-APR-16	R3434612
Gravel (4.75mm - 3in.)	23.0		1.0	%	08-APR-16	08-APR-16	R3434612
Coarse Sand (2.0mm - 4.75mm)	14.8		1.0	%	08-APR-16	08-APR-16	R3434612
Medium Sand (0.425mm - 2.0mm)	24.2		1.0	%	08-APR-16	08-APR-16	R3434612
Fine Sand (0.075mm - 0.425mm)	20.0		1.0	%	08-APR-16	08-APR-16	R3434612
Silt (0.005mm - 0.075mm)	10.7		1.0	%	08-APR-16	08-APR-16	R3434612
Clay (<0.005mm)	7.4		1.0	%	08-APR-16	08-APR-16	R3434612
Organic Matter by LOI at 375 deg C.							
Organic Matter	<1.0		1.0	%	08-APR-16	09-APR-16	R3434989
Loss on Ignition @ 375 C	<1.0		1.0	%	08-APR-16	09-APR-16	R3434989
L1746804-13 CH16-201-BH006A_SOA1							
Sampled By: CLIENT on 10-MAR-16 @ 14:39							
Matrix: Soil							
Metals in Soil (CCME) with Extra Metals							
Mercury in Soil by CVAFS							
Mercury (Hg)	0.247		0.0050	mg/kg	30-MAR-16	02-APR-16	R3428986
Metals in Soil by CRC ICPMS							
Aluminum (Al)	11700		50	mg/kg	30-MAR-16	01-APR-16	R3429363
Antimony (Sb)	1.85		0.10	mg/kg	30-MAR-16	01-APR-16	R3429363
Arsenic (As)	28.1		0.10	mg/kg	30-MAR-16	01-APR-16	R3429363
Barium (Ba)	553		0.50	mg/kg	30-MAR-16	01-APR-16	R3429363

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Sample Details/Parameters	Result	Qualifier*	D.L.	Units	Extracted	Analyzed	Batch
L1746804-13 CH16-201-BH006A_SOA1							
Sampled By: CLIENT on 10-MAR-16 @ 14:39							
Matrix: Soil							
Metals in Soil by CRC ICPMS							
Beryllium (Be)	0.57		0.10	mg/kg	30-MAR-16	01-APR-16	R3429363
Bismuth (Bi)	0.31		0.20	mg/kg	30-MAR-16	01-APR-16	R3429363
Boron (B)	<5.0		5.0	mg/kg	30-MAR-16	01-APR-16	R3429363
Cadmium (Cd)	0.509		0.020	mg/kg	30-MAR-16	01-APR-16	R3429363
Calcium (Ca)	6430		50	mg/kg	30-MAR-16	01-APR-16	R3429363
Chromium (Cr)	29.2		0.50	mg/kg	30-MAR-16	01-APR-16	R3429363
Cobalt (Co)	11.7		0.10	mg/kg	30-MAR-16	01-APR-16	R3429363
Copper (Cu)	50.5		0.50	mg/kg	30-MAR-16	01-APR-16	R3429363
Iron (Fe)	25700		50	mg/kg	30-MAR-16	01-APR-16	R3429363
Lead (Pb)	270		0.50	mg/kg	30-MAR-16	01-APR-16	R3429363
Lithium (Li)	23.4		2.0	mg/kg	30-MAR-16	01-APR-16	R3429363
Magnesium (Mg)	5340		20	mg/kg	30-MAR-16	01-APR-16	R3429363
Manganese (Mn)	535		1.0	mg/kg	30-MAR-16	01-APR-16	R3429363
Molybdenum (Mo)	1.16		0.10	mg/kg	30-MAR-16	01-APR-16	R3429363
Nickel (Ni)	26.1		0.50	mg/kg	30-MAR-16	01-APR-16	R3429363
Phosphorus (P)	694		50	mg/kg	30-MAR-16	01-APR-16	R3429363
Potassium (K)	1200		100	mg/kg	30-MAR-16	01-APR-16	R3429363
Selenium (Se)	0.30		0.20	mg/kg	30-MAR-16	01-APR-16	R3429363
Silver (Ag)	0.59		0.10	mg/kg	30-MAR-16	01-APR-16	R3429363
Sodium (Na)	252		50	mg/kg	30-MAR-16	01-APR-16	R3429363
Strontium (Sr)	40.3		0.50	mg/kg	30-MAR-16	01-APR-16	R3429363
Thallium (Tl)	0.306		0.050	mg/kg	30-MAR-16	01-APR-16	R3429363
Tin (Sn)	<2.0		2.0	mg/kg	30-MAR-16	01-APR-16	R3429363
Titanium (Ti)	446		1.0	mg/kg	30-MAR-16	01-APR-16	R3429363
Uranium (U)	1.53		0.050	mg/kg	30-MAR-16	01-APR-16	R3429363
Vanadium (V)	29.4		0.20	mg/kg	30-MAR-16	01-APR-16	R3429363
Zinc (Zn)	236		2.0	mg/kg	30-MAR-16	01-APR-16	R3429363
Zirconium (Zr)	1.8		1.0	mg/kg	30-MAR-16	01-APR-16	R3429363
pH in Soil (1:2 Soil:Water Extraction)							
pH (1:2 soil:water)	7.55		0.10	pH		01-APR-16	R3429000
Miscellaneous Parameters							
Neutralization Potential (NP)	17		1.0	tCaCO3/1Kt	15-APR-16	15-APR-16	R3437568
Sulfur (S)-Total	6200		500	mg/kg	05-APR-16	05-APR-16	R3434580
Paste pH	7.28		0.10	pH		04-APR-16	R3429614
L1746804-14 CH16-201-BH006A_SOA3							
Sampled By: CLIENT on 10-MAR-16 @ 14:39							
Matrix: Soil							
Metals in Soil (CCME) with Extra Metals							
Mercury in Soil by CVAFS							
Mercury (Hg)	0.656		0.0050	mg/kg	30-MAR-16	02-APR-16	R3428986
Metals in Soil by CRC ICPMS							
Aluminum (Al)	11800		50	mg/kg	30-MAR-16	01-APR-16	R3429363
Antimony (Sb)	3.13		0.10	mg/kg	30-MAR-16	01-APR-16	R3429363
Arsenic (As)	36.5		0.10	mg/kg	30-MAR-16	01-APR-16	R3429363
Barium (Ba)	320		0.50	mg/kg	30-MAR-16	01-APR-16	R3429363
Beryllium (Be)	0.59		0.10	mg/kg	30-MAR-16	01-APR-16	R3429363
Bismuth (Bi)	1.12		0.20	mg/kg	30-MAR-16	01-APR-16	R3429363
Boron (B)	<5.0		5.0	mg/kg	30-MAR-16	01-APR-16	R3429363
Cadmium (Cd)	0.331		0.020	mg/kg	30-MAR-16	01-APR-16	R3429363
Calcium (Ca)	4900		50	mg/kg	30-MAR-16	01-APR-16	R3429363
Chromium (Cr)	32.7		0.50	mg/kg	30-MAR-16	01-APR-16	R3429363

* Refer to Referenced Information for Qualifiers (if any) and Methodology.

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Sample Details/Parameters	Result	Qualifier*	D.L.	Units	Extracted	Analyzed	Batch
L1746804-14 CH16-201-BH006A_SOA3							
Sampled By: CLIENT on 10-MAR-16 @ 14:39							
Matrix: Soil							
Metals in Soil by CRC ICPMS							
Cobalt (Co)	12.9		0.10	mg/kg	30-MAR-16	01-APR-16	R3429363
Copper (Cu)	102		0.50	mg/kg	30-MAR-16	01-APR-16	R3429363
Iron (Fe)	35800		50	mg/kg	30-MAR-16	01-APR-16	R3429363
Lead (Pb)	711		0.50	mg/kg	30-MAR-16	01-APR-16	R3429363
Lithium (Li)	22.8		2.0	mg/kg	30-MAR-16	01-APR-16	R3429363
Magnesium (Mg)	5060		20	mg/kg	30-MAR-16	01-APR-16	R3429363
Manganese (Mn)	585		1.0	mg/kg	30-MAR-16	01-APR-16	R3429363
Molybdenum (Mo)	1.35		0.10	mg/kg	30-MAR-16	01-APR-16	R3429363
Nickel (Ni)	26.8		0.50	mg/kg	30-MAR-16	01-APR-16	R3429363
Phosphorus (P)	707		50	mg/kg	30-MAR-16	01-APR-16	R3429363
Potassium (K)	1900		100	mg/kg	30-MAR-16	01-APR-16	R3429363
Selenium (Se)	0.38		0.20	mg/kg	30-MAR-16	01-APR-16	R3429363
Silver (Ag)	1.52		0.10	mg/kg	30-MAR-16	01-APR-16	R3429363
Sodium (Na)	234		50	mg/kg	30-MAR-16	01-APR-16	R3429363
Strontium (Sr)	35.8		0.50	mg/kg	30-MAR-16	01-APR-16	R3429363
Thallium (Tl)	0.705		0.050	mg/kg	30-MAR-16	01-APR-16	R3429363
Tin (Sn)	<2.0		2.0	mg/kg	30-MAR-16	01-APR-16	R3429363
Titanium (Ti)	514		1.0	mg/kg	30-MAR-16	01-APR-16	R3429363
Uranium (U)	1.46		0.050	mg/kg	30-MAR-16	01-APR-16	R3429363
Vanadium (V)	34.9		0.20	mg/kg	30-MAR-16	01-APR-16	R3429363
Zinc (Zn)	300		2.0	mg/kg	30-MAR-16	01-APR-16	R3429363
Zirconium (Zr)	2.6		1.0	mg/kg	30-MAR-16	01-APR-16	R3429363
pH in Soil (1:2 Soil:Water Extraction)							
pH (1:2 soil:water)	6.99		0.10	pH		01-APR-16	R3429000
Miscellaneous Parameters							
Neutralization Potential (NP)	12		1.0	tCaCO3/1Kt	15-APR-16	15-APR-16	R3437568
Sulfur (S)-Total	10300		500	mg/kg	05-APR-16	05-APR-16	R3434580
L1746804-15 CH16-201-BH008_SOA3							
Sampled By: CLIENT on 10-MAR-16 @ 16:05							
Matrix: Soil							
Metals in Soil (CCME) with Extra Metals							
Mercury in Soil by CVAFS							
Mercury (Hg)	0.0545		0.0050	mg/kg	30-MAR-16	02-APR-16	R3428986
Metals in Soil by CRC ICPMS							
Aluminum (Al)	14200		50	mg/kg	30-MAR-16	01-APR-16	R3429363
Antimony (Sb)	0.76		0.10	mg/kg	30-MAR-16	01-APR-16	R3429363
Arsenic (As)	16.0		0.10	mg/kg	30-MAR-16	01-APR-16	R3429363
Barium (Ba)	316		0.50	mg/kg	30-MAR-16	01-APR-16	R3429363
Beryllium (Be)	0.67		0.10	mg/kg	30-MAR-16	01-APR-16	R3429363
Bismuth (Bi)	0.32		0.20	mg/kg	30-MAR-16	01-APR-16	R3429363
Boron (B)	<5.0		5.0	mg/kg	30-MAR-16	01-APR-16	R3429363
Cadmium (Cd)	0.691		0.020	mg/kg	30-MAR-16	01-APR-16	R3429363
Calcium (Ca)	8220		50	mg/kg	30-MAR-16	01-APR-16	R3429363
Chromium (Cr)	45.5		0.50	mg/kg	30-MAR-16	01-APR-16	R3429363
Cobalt (Co)	12.6		0.10	mg/kg	30-MAR-16	01-APR-16	R3429363
Copper (Cu)	38.5		0.50	mg/kg	30-MAR-16	01-APR-16	R3429363
Iron (Fe)	23400		50	mg/kg	30-MAR-16	01-APR-16	R3429363
Lead (Pb)	44.6		0.50	mg/kg	30-MAR-16	01-APR-16	R3429363
Lithium (Li)	24.4		2.0	mg/kg	30-MAR-16	01-APR-16	R3429363
Magnesium (Mg)	7370		20	mg/kg	30-MAR-16	01-APR-16	R3429363
Manganese (Mn)	767		1.0	mg/kg	30-MAR-16	01-APR-16	R3429363

* Refer to Referenced Information for Qualifiers (if any) and Methodology.

ALS ENVIRONMENTAL ANALYTICAL REPORT

Sample Details/Parameters	Result	Qualifier*	D.L.	Units	Extracted	Analyzed	Batch
L1746804-15 CH16-201-BH008_SOA3							
Sampled By: CLIENT on 10-MAR-16 @ 16:05							
Matrix: Soil							
Metals in Soil by CRC ICPMS							
Molybdenum (Mo)	1.64		0.10	mg/kg	30-MAR-16	01-APR-16	R3429363
Nickel (Ni)	47.4		0.50	mg/kg	30-MAR-16	01-APR-16	R3429363
Phosphorus (P)	629		50	mg/kg	30-MAR-16	01-APR-16	R3429363
Potassium (K)	1040		100	mg/kg	30-MAR-16	01-APR-16	R3429363
Selenium (Se)	1.76		0.20	mg/kg	30-MAR-16	01-APR-16	R3429363
Silver (Ag)	0.20		0.10	mg/kg	30-MAR-16	01-APR-16	R3429363
Sodium (Na)	232		50	mg/kg	30-MAR-16	01-APR-16	R3429363
Strontium (Sr)	42.4		0.50	mg/kg	30-MAR-16	01-APR-16	R3429363
Thallium (Tl)	0.190		0.050	mg/kg	30-MAR-16	01-APR-16	R3429363
Tin (Sn)	<2.0		2.0	mg/kg	30-MAR-16	01-APR-16	R3429363
Titanium (Ti)	392		1.0	mg/kg	30-MAR-16	01-APR-16	R3429363
Uranium (U)	4.39		0.050	mg/kg	30-MAR-16	01-APR-16	R3429363
Vanadium (V)	33.1		0.20	mg/kg	30-MAR-16	01-APR-16	R3429363
Zinc (Zn)	167		2.0	mg/kg	30-MAR-16	01-APR-16	R3429363
Zirconium (Zr)	3.3		1.0	mg/kg	30-MAR-16	01-APR-16	R3429363
pH in Soil (1:2 Soil:Water Extraction)							
pH (1:2 soil:water)	6.80		0.10	pH		01-APR-16	R3429000
Miscellaneous Parameters							
Neutralization Potential (NP)	17		1.0	tCaCO3/1Kt	15-APR-16	15-APR-16	R3437568
Sulfur (S)-Total	2200		500	mg/kg	05-APR-16	05-APR-16	R3434580
Paste pH	6.75		0.10	pH		04-APR-16	R3429614
L1746804-16 CH16-201-BH010A_SOA1							
Sampled By: CLIENT on 10-MAR-16 @ 10:14							
Matrix: Soil							
Metals in Soil (CCME) with Extra Metals							
Mercury in Soil by CVAFS							
Mercury (Hg)	0.0721		0.0050	mg/kg	30-MAR-16	02-APR-16	R3428986
Metals in Soil by CRC ICPMS							
Aluminum (Al)	16600		50	mg/kg	30-MAR-16	01-APR-16	R3429363
Antimony (Sb)	1.08		0.10	mg/kg	30-MAR-16	01-APR-16	R3429363
Arsenic (As)	21.9		0.10	mg/kg	30-MAR-16	01-APR-16	R3429363
Barium (Ba)	303		0.50	mg/kg	30-MAR-16	01-APR-16	R3429363
Beryllium (Be)	0.70		0.10	mg/kg	30-MAR-16	01-APR-16	R3429363
Bismuth (Bi)	0.34		0.20	mg/kg	30-MAR-16	01-APR-16	R3429363
Boron (B)	<5.0		5.0	mg/kg	30-MAR-16	01-APR-16	R3429363
Cadmium (Cd)	0.681		0.020	mg/kg	30-MAR-16	01-APR-16	R3429363
Calcium (Ca)	8470		50	mg/kg	30-MAR-16	01-APR-16	R3429363
Chromium (Cr)	49.4		0.50	mg/kg	30-MAR-16	01-APR-16	R3429363
Cobalt (Co)	24.4		0.10	mg/kg	30-MAR-16	01-APR-16	R3429363
Copper (Cu)	51.9		0.50	mg/kg	30-MAR-16	01-APR-16	R3429363
Iron (Fe)	23300		50	mg/kg	30-MAR-16	01-APR-16	R3429363
Lead (Pb)	66.7		0.50	mg/kg	30-MAR-16	01-APR-16	R3429363
Lithium (Li)	29.9		2.0	mg/kg	30-MAR-16	01-APR-16	R3429363
Magnesium (Mg)	7810		20	mg/kg	30-MAR-16	01-APR-16	R3429363
Manganese (Mn)	762		1.0	mg/kg	30-MAR-16	01-APR-16	R3429363
Molybdenum (Mo)	2.93		0.10	mg/kg	30-MAR-16	01-APR-16	R3429363
Nickel (Ni)	50.3		0.50	mg/kg	30-MAR-16	01-APR-16	R3429363
Phosphorus (P)	653		50	mg/kg	30-MAR-16	01-APR-16	R3429363
Potassium (K)	1360		100	mg/kg	30-MAR-16	01-APR-16	R3429363
Selenium (Se)	2.07		0.20	mg/kg	30-MAR-16	01-APR-16	R3429363
Silver (Ag)	0.26		0.10	mg/kg	30-MAR-16	01-APR-16	R3429363

* Refer to Referenced Information for Qualifiers (if any) and Methodology.

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Sample Details/Parameters	Result	Qualifier*	D.L.	Units	Extracted	Analyzed	Batch
L1746804-16 CH16-201-BH010A_SOA1							
Sampled By: CLIENT on 10-MAR-16 @ 10:14							
Matrix: Soil							
Metals in Soil by CRC ICPMS							
Sodium (Na)	329		50	mg/kg	30-MAR-16	01-APR-16	R3429363
Strontium (Sr)	43.7		0.50	mg/kg	30-MAR-16	01-APR-16	R3429363
Thallium (Tl)	0.264		0.050	mg/kg	30-MAR-16	01-APR-16	R3429363
Tin (Sn)	<2.0		2.0	mg/kg	30-MAR-16	01-APR-16	R3429363
Titanium (Ti)	493		1.0	mg/kg	30-MAR-16	01-APR-16	R3429363
Uranium (U)	5.51		0.050	mg/kg	30-MAR-16	01-APR-16	R3429363
Vanadium (V)	40.4		0.20	mg/kg	30-MAR-16	01-APR-16	R3429363
Zinc (Zn)	257		2.0	mg/kg	30-MAR-16	01-APR-16	R3429363
Zirconium (Zr)	3.0		1.0	mg/kg	30-MAR-16	01-APR-16	R3429363
pH in Soil (1:2 Soil:Water Extraction)							
pH (1:2 soil:water)	6.52		0.10	pH		01-APR-16	R3429000
Miscellaneous Parameters							
Neutralization Potential (NP)	15		1.0	tCaCO3/1Kt	15-APR-16	15-APR-16	R3437568
Sulfur (S)-Total	5000		500	mg/kg	05-APR-16	05-APR-16	R3434580
Paste pH	6.33		0.10	pH		04-APR-16	R3429614
L1746804-17 CH16-201-BH010A_SOA1							
Sampled By: CLIENT on 10-MAR-16 @ 10:14							
Matrix: Soil							
Atterberg limits							
Liquid Limit (LL)	62		1	%	07-APR-16	07-APR-16	R3433868
Plasticity Index (PI)	11		1	%	07-APR-16	07-APR-16	R3433868
Grain Size by Hydrometer							
Grain Size Curve	SEE ATTACHED				08-APR-16	08-APR-16	R3434612
Gravel (4.75mm - 3in.)	<1.0		1.0	%	08-APR-16	08-APR-16	R3434612
Coarse Sand (2.0mm - 4.75mm)	<1.0		1.0	%	08-APR-16	08-APR-16	R3434612
Medium Sand (0.425mm - 2.0mm)	2.1		1.0	%	08-APR-16	08-APR-16	R3434612
Fine Sand (0.075mm - 0.425mm)	21.0		1.0	%	08-APR-16	08-APR-16	R3434612
Silt (0.005mm - 0.075mm)	54.2		1.0	%	08-APR-16	08-APR-16	R3434612
Clay (<0.005mm)	21.9		1.0	%	08-APR-16	08-APR-16	R3434612
Organic Matter by LOI at 375 deg C.							
Organic Matter	9.2		1.0	%	08-APR-16	09-APR-16	R3434989
Loss on Ignition @ 375 C	11.4		1.0	%	08-APR-16	09-APR-16	R3434989
L1746804-18 CH16-201-BH010A_SOA2							
Sampled By: CLIENT on 10-MAR-16 @ 10:36							
Matrix: Soil							
Metals in Soil (CCME) with Extra Metals							
Mercury in Soil by CVAFS							
Mercury (Hg)	0.0396		0.0050	mg/kg	30-MAR-16	02-APR-16	R3428986
Metals in Soil by CRC ICPMS							
Aluminum (Al)	12900		50	mg/kg	30-MAR-16	01-APR-16	R3429363
Antimony (Sb)	0.46		0.10	mg/kg	30-MAR-16	01-APR-16	R3429363
Arsenic (As)	13.7		0.10	mg/kg	30-MAR-16	01-APR-16	R3429363
Barium (Ba)	188		0.50	mg/kg	30-MAR-16	01-APR-16	R3429363
Beryllium (Be)	0.57		0.10	mg/kg	30-MAR-16	01-APR-16	R3429363
Bismuth (Bi)	0.25		0.20	mg/kg	30-MAR-16	01-APR-16	R3429363
Boron (B)	<5.0		5.0	mg/kg	30-MAR-16	01-APR-16	R3429363
Cadmium (Cd)	0.450		0.020	mg/kg	30-MAR-16	01-APR-16	R3429363
Calcium (Ca)	6090		50	mg/kg	30-MAR-16	01-APR-16	R3429363
Chromium (Cr)	36.5		0.50	mg/kg	30-MAR-16	01-APR-16	R3429363
Cobalt (Co)	9.03		0.10	mg/kg	30-MAR-16	01-APR-16	R3429363

* Refer to Referenced Information for Qualifiers (if any) and Methodology.

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Sample Details/Parameters	Result	Qualifier*	D.L.	Units	Extracted	Analyzed	Batch
L1746804-18 CH16-201-BH010A_SOA2							
Sampled By: CLIENT on 10-MAR-16 @ 10:36							
Matrix: Soil							
Metals in Soil by CRC ICPMS							
Copper (Cu)	27.8		0.50	mg/kg	30-MAR-16	01-APR-16	R3429363
Iron (Fe)	17100		50	mg/kg	30-MAR-16	01-APR-16	R3429363
Lead (Pb)	19.4		0.50	mg/kg	30-MAR-16	01-APR-16	R3429363
Lithium (Li)	24.3		2.0	mg/kg	30-MAR-16	01-APR-16	R3429363
Magnesium (Mg)	6040		20	mg/kg	30-MAR-16	01-APR-16	R3429363
Manganese (Mn)	449		1.0	mg/kg	30-MAR-16	01-APR-16	R3429363
Molybdenum (Mo)	1.80		0.10	mg/kg	30-MAR-16	01-APR-16	R3429363
Nickel (Ni)	30.0		0.50	mg/kg	30-MAR-16	01-APR-16	R3429363
Phosphorus (P)	802		50	mg/kg	30-MAR-16	01-APR-16	R3429363
Potassium (K)	1190		100	mg/kg	30-MAR-16	01-APR-16	R3429363
Selenium (Se)	1.92		0.20	mg/kg	30-MAR-16	01-APR-16	R3429363
Silver (Ag)	0.15		0.10	mg/kg	30-MAR-16	01-APR-16	R3429363
Sodium (Na)	256		50	mg/kg	30-MAR-16	01-APR-16	R3429363
Strontium (Sr)	37.6		0.50	mg/kg	30-MAR-16	01-APR-16	R3429363
Thallium (Tl)	0.155		0.050	mg/kg	30-MAR-16	01-APR-16	R3429363
Tin (Sn)	<2.0		2.0	mg/kg	30-MAR-16	01-APR-16	R3429363
Titanium (Ti)	445		1.0	mg/kg	30-MAR-16	01-APR-16	R3429363
Uranium (U)	3.81		0.050	mg/kg	30-MAR-16	01-APR-16	R3429363
Vanadium (V)	31.2		0.20	mg/kg	30-MAR-16	01-APR-16	R3429363
Zinc (Zn)	105		2.0	mg/kg	30-MAR-16	01-APR-16	R3429363
Zirconium (Zr)	3.3		1.0	mg/kg	30-MAR-16	01-APR-16	R3429363
pH in Soil (1:2 Soil:Water Extraction)							
pH (1:2 soil:water)	6.11		0.10	pH		01-APR-16	R3429000
Miscellaneous Parameters							
Neutralization Potential (NP)	10		1.0	tCaCO3/1Kt	15-APR-16	15-APR-16	R3437568
Sulfur (S)-Total	5400		500	mg/kg	05-APR-16	05-APR-16	R3434580
Paste pH	5.90		0.10	pH		04-APR-16	R3429614
L1746804-19 CH16-201-BH010A_SOB2							
Sampled By: CLIENT on 10-MAR-16 @ 11:06							
Matrix: Soil							
Metals in Soil (CCME) with Extra Metals							
Mercury in Soil by CVAFS							
Mercury (Hg)	0.0532		0.0050	mg/kg	30-MAR-16	02-APR-16	R3428986
Metals in Soil by CRC ICPMS							
Aluminum (Al)	10400		50	mg/kg	30-MAR-16	01-APR-16	R3429363
Antimony (Sb)	0.99		0.10	mg/kg	30-MAR-16	01-APR-16	R3429363
Arsenic (As)	44.6		0.10	mg/kg	30-MAR-16	01-APR-16	R3429363
Barium (Ba)	299		0.50	mg/kg	30-MAR-16	01-APR-16	R3429363
Beryllium (Be)	0.59		0.10	mg/kg	30-MAR-16	01-APR-16	R3429363
Bismuth (Bi)	0.31		0.20	mg/kg	30-MAR-16	01-APR-16	R3429363
Boron (B)	<5.0		5.0	mg/kg	30-MAR-16	01-APR-16	R3429363
Cadmium (Cd)	0.770		0.020	mg/kg	30-MAR-16	01-APR-16	R3429363
Calcium (Ca)	120000		50	mg/kg	30-MAR-16	01-APR-16	R3429363
Chromium (Cr)	27.7		0.50	mg/kg	30-MAR-16	01-APR-16	R3429363
Cobalt (Co)	18.5		0.10	mg/kg	30-MAR-16	01-APR-16	R3429363
Copper (Cu)	32.7		0.50	mg/kg	30-MAR-16	01-APR-16	R3429363
Iron (Fe)	26800		50	mg/kg	30-MAR-16	01-APR-16	R3429363
Lead (Pb)	47.5		0.50	mg/kg	30-MAR-16	01-APR-16	R3429363
Lithium (Li)	20.9		2.0	mg/kg	30-MAR-16	01-APR-16	R3429363
Magnesium (Mg)	6490		20	mg/kg	30-MAR-16	01-APR-16	R3429363
Manganese (Mn)	611		1.0	mg/kg	30-MAR-16	01-APR-16	R3429363

* Refer to Referenced Information for Qualifiers (if any) and Methodology.

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Sample Details/Parameters	Result	Qualifier*	D.L.	Units	Extracted	Analyzed	Batch
L1746804-19 CH16-201-BH010A_SOB2							
Sampled By: CLIENT on 10-MAR-16 @ 11:06							
Matrix: Soil							
Metals in Soil by CRC ICPMS							
Molybdenum (Mo)	3.11		0.10	mg/kg	30-MAR-16	01-APR-16	R3429363
Nickel (Ni)	32.4		0.50	mg/kg	30-MAR-16	01-APR-16	R3429363
Phosphorus (P)	553		50	mg/kg	30-MAR-16	01-APR-16	R3429363
Potassium (K)	1510		100	mg/kg	30-MAR-16	01-APR-16	R3429363
Selenium (Se)	2.76		0.20	mg/kg	30-MAR-16	01-APR-16	R3429363
Silver (Ag)	0.21		0.10	mg/kg	30-MAR-16	01-APR-16	R3429363
Sodium (Na)	228		50	mg/kg	30-MAR-16	01-APR-16	R3429363
Strontium (Sr)	217		0.50	mg/kg	30-MAR-16	01-APR-16	R3429363
Thallium (Tl)	0.200		0.050	mg/kg	30-MAR-16	01-APR-16	R3429363
Tin (Sn)	<2.0		2.0	mg/kg	30-MAR-16	01-APR-16	R3429363
Titanium (Ti)	462		1.0	mg/kg	30-MAR-16	01-APR-16	R3429363
Uranium (U)	6.69		0.050	mg/kg	30-MAR-16	01-APR-16	R3429363
Vanadium (V)	32.7		0.20	mg/kg	30-MAR-16	01-APR-16	R3429363
Zinc (Zn)	259		2.0	mg/kg	30-MAR-16	01-APR-16	R3429363
Zirconium (Zr)	4.2		1.0	mg/kg	30-MAR-16	01-APR-16	R3429363
pH in Soil (1:2 Soil:Water Extraction)							
pH (1:2 soil:water)	7.45		0.10	pH		01-APR-16	R3429000
Miscellaneous Parameters							
Neutralization Potential (NP)	437		1.0	tCaCO3/1Kt	15-APR-16	15-APR-16	R3437568
Sulfur (S)-Total	3700		500	mg/kg	05-APR-16	05-APR-16	R3434580
Paste pH	7.32		0.10	pH		04-APR-16	R3429614
L1746804-20 CH16-201-BH010A_SOB4							
Sampled By: CLIENT on 10-MAR-16 @ 11:06							
Matrix: Soil							
Atterberg limits							
Liquid Limit (LL)	48		1	%	07-APR-16	07-APR-16	R3433868
Plasticity Index (PI)	10		1	%	07-APR-16	07-APR-16	R3433868
Grain Size by Hydrometer							
Grain Size Curve	SEE ATTACHED				08-APR-16	08-APR-16	R3434612
Gravel (4.75mm - 3in.)	<1.0		1.0	%	08-APR-16	08-APR-16	R3434612
Coarse Sand (2.0mm - 4.75mm)	<1.0		1.0	%	08-APR-16	08-APR-16	R3434612
Medium Sand (0.425mm - 2.0mm)	3.6		1.0	%	08-APR-16	08-APR-16	R3434612
Fine Sand (0.075mm - 0.425mm)	20.9		1.0	%	08-APR-16	08-APR-16	R3434612
Silt (0.005mm - 0.075mm)	56.7		1.0	%	08-APR-16	08-APR-16	R3434612
Clay (<0.005mm)	18.8		1.0	%	08-APR-16	08-APR-16	R3434612
Organic Matter by LOI at 375 deg C.							
Organic Matter	2.4		1.0	%	08-APR-16	09-APR-16	R3434989
Loss on Ignition @ 375 C	2.7		1.0	%	08-APR-16	09-APR-16	R3434989
L1746804-21 CH16-201-BH011_SOA1							
Sampled By: CLIENT on 11-MAR-16 @ 13:18							
Matrix: Soil							
Metals in Soil (CCME) with Extra Metals							
Mercury in Soil by CVAFS							
Mercury (Hg)	0.0759		0.0050	mg/kg	30-MAR-16	02-APR-16	R3428986
Metals in Soil by CRC ICPMS							
Aluminum (Al)	10300		50	mg/kg	30-MAR-16	01-APR-16	R3429363
Antimony (Sb)	1.70		0.10	mg/kg	30-MAR-16	01-APR-16	R3429363
Arsenic (As)	22.7		0.10	mg/kg	30-MAR-16	01-APR-16	R3429363
Barium (Ba)	304		0.50	mg/kg	30-MAR-16	01-APR-16	R3429363
Beryllium (Be)	0.51		0.10	mg/kg	30-MAR-16	01-APR-16	R3429363

* Refer to Referenced Information for Qualifiers (if any) and Methodology.

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Sample Details/Parameters	Result	Qualifier*	D.L.	Units	Extracted	Analyzed	Batch
L1746804-21 CH16-201-BH011_SOA1							
Sampled By: CLIENT on 11-MAR-16 @ 13:18							
Matrix: Soil							
Metals in Soil by CRC ICPMS							
Bismuth (Bi)	<0.20		0.20	mg/kg	30-MAR-16	01-APR-16	R3429363
Boron (B)	<5.0		5.0	mg/kg	30-MAR-16	01-APR-16	R3429363
Cadmium (Cd)	23.0		0.020	mg/kg	30-MAR-16	01-APR-16	R3429363
Calcium (Ca)	71800		50	mg/kg	30-MAR-16	01-APR-16	R3429363
Chromium (Cr)	29.5		0.50	mg/kg	30-MAR-16	01-APR-16	R3429363
Cobalt (Co)	101		0.10	mg/kg	30-MAR-16	01-APR-16	R3429363
Copper (Cu)	100		0.50	mg/kg	30-MAR-16	01-APR-16	R3429363
Iron (Fe)	30100		50	mg/kg	30-MAR-16	01-APR-16	R3429363
Lead (Pb)	197		0.50	mg/kg	30-MAR-16	01-APR-16	R3429363
Lithium (Li)	19.3		2.0	mg/kg	30-MAR-16	01-APR-16	R3429363
Magnesium (Mg)	43100		20	mg/kg	30-MAR-16	01-APR-16	R3429363
Manganese (Mn)	20800		1.0	mg/kg	30-MAR-16	01-APR-16	R3429363
Molybdenum (Mo)	1.90		0.10	mg/kg	30-MAR-16	01-APR-16	R3429363
Nickel (Ni)	147		0.50	mg/kg	30-MAR-16	01-APR-16	R3429363
Phosphorus (P)	395		50	mg/kg	30-MAR-16	01-APR-16	R3429363
Potassium (K)	1110		100	mg/kg	30-MAR-16	01-APR-16	R3429363
Selenium (Se)	0.43		0.20	mg/kg	30-MAR-16	01-APR-16	R3429363
Silver (Ag)	0.21		0.10	mg/kg	30-MAR-16	01-APR-16	R3429363
Sodium (Na)	316		50	mg/kg	30-MAR-16	01-APR-16	R3429363
Strontium (Sr)	152		0.50	mg/kg	30-MAR-16	01-APR-16	R3429363
Thallium (Tl)	0.772		0.050	mg/kg	30-MAR-16	01-APR-16	R3429363
Tin (Sn)	<2.0		2.0	mg/kg	30-MAR-16	01-APR-16	R3429363
Titanium (Ti)	306		1.0	mg/kg	30-MAR-16	01-APR-16	R3429363
Uranium (U)	4.28		0.050	mg/kg	30-MAR-16	01-APR-16	R3429363
Vanadium (V)	31.7		0.20	mg/kg	30-MAR-16	01-APR-16	R3429363
Zinc (Zn)	31600		2.0	mg/kg	30-MAR-16	01-APR-16	R3429363
Zirconium (Zr)	1.6		1.0	mg/kg	30-MAR-16	01-APR-16	R3429363
pH in Soil (1:2 Soil:Water Extraction)							
pH (1:2 soil:water)	9.06		0.10	pH		01-APR-16	R3429000
Miscellaneous Parameters							
Sulfur (S)-Total	3300		500	mg/kg	05-APR-16	05-APR-16	R3434580
L1746804-22 CH16-201-BH011_SOA2							
Sampled By: CLIENT on 11-MAR-16 @ 13:18							
Matrix: Soil							
Metals in Soil (CCME) with Extra Metals							
Mercury in Soil by CVAFS							
Mercury (Hg)	0.0364		0.0050	mg/kg	30-MAR-16	02-APR-16	R3428986
Metals in Soil by CRC ICPMS							
Aluminum (Al)	17600		50	mg/kg	30-MAR-16	03-APR-16	R3429363
Antimony (Sb)	2.42		0.10	mg/kg	30-MAR-16	03-APR-16	R3429363
Arsenic (As)	40.7		0.10	mg/kg	30-MAR-16	03-APR-16	R3429363
Barium (Ba)	171		0.50	mg/kg	30-MAR-16	03-APR-16	R3429363
Beryllium (Be)	0.71		0.10	mg/kg	30-MAR-16	03-APR-16	R3429363
Bismuth (Bi)	0.29		0.20	mg/kg	30-MAR-16	03-APR-16	R3429363
Boron (B)	<5.0		5.0	mg/kg	30-MAR-16	03-APR-16	R3429363
Cadmium (Cd)	0.811		0.020	mg/kg	30-MAR-16	03-APR-16	R3429363
Calcium (Ca)	15900		50	mg/kg	30-MAR-16	03-APR-16	R3429363
Chromium (Cr)	53.3		0.50	mg/kg	30-MAR-16	03-APR-16	R3429363
Cobalt (Co)	18.1		0.10	mg/kg	30-MAR-16	03-APR-16	R3429363
Copper (Cu)	39.0		0.50	mg/kg	30-MAR-16	03-APR-16	R3429363
Iron (Fe)	34500		50	mg/kg	30-MAR-16	03-APR-16	R3429363

* Refer to Referenced Information for Qualifiers (if any) and Methodology.

ALS ENVIRONMENTAL ANALYTICAL REPORT

Sample Details/Parameters	Result	Qualifier*	D.L.	Units	Extracted	Analyzed	Batch
L1746804-22 CH16-201-BH011_SOA2							
Sampled By: CLIENT on 11-MAR-16 @ 13:18							
Matrix: Soil							
Metals in Soil by CRC ICPMS							
Lead (Pb)	32.3		0.50	mg/kg	30-MAR-16	03-APR-16	R3429363
Lithium (Li)	36.6		2.0	mg/kg	30-MAR-16	03-APR-16	R3429363
Magnesium (Mg)	11100		20	mg/kg	30-MAR-16	03-APR-16	R3429363
Manganese (Mn)	939		1.0	mg/kg	30-MAR-16	03-APR-16	R3429363
Molybdenum (Mo)	1.41		0.10	mg/kg	30-MAR-16	03-APR-16	R3429363
Nickel (Ni)	62.9		0.50	mg/kg	30-MAR-16	03-APR-16	R3429363
Phosphorus (P)	702		50	mg/kg	30-MAR-16	03-APR-16	R3429363
Potassium (K)	2470		100	mg/kg	30-MAR-16	03-APR-16	R3429363
Selenium (Se)	0.27		0.20	mg/kg	30-MAR-16	03-APR-16	R3429363
Silver (Ag)	0.16		0.10	mg/kg	30-MAR-16	03-APR-16	R3429363
Sodium (Na)	405		50	mg/kg	30-MAR-16	03-APR-16	R3429363
Strontium (Sr)	64.1		0.50	mg/kg	30-MAR-16	03-APR-16	R3429363
Thallium (Tl)	0.256		0.050	mg/kg	30-MAR-16	03-APR-16	R3429363
Tin (Sn)	<2.0		2.0	mg/kg	30-MAR-16	03-APR-16	R3429363
Titanium (Ti)	553		1.0	mg/kg	30-MAR-16	03-APR-16	R3429363
Uranium (U)	0.961		0.050	mg/kg	30-MAR-16	03-APR-16	R3429363
Vanadium (V)	44.9		0.20	mg/kg	30-MAR-16	03-APR-16	R3429363
Zinc (Zn)	602		2.0	mg/kg	30-MAR-16	03-APR-16	R3429363
Zirconium (Zr)	2.3		1.0	mg/kg	30-MAR-16	03-APR-16	R3429363
pH in Soil (1:2 Soil:Water Extraction)							
pH (1:2 soil:water)	8.57		0.10	pH		01-APR-16	R3429000
Miscellaneous Parameters							
Neutralization Potential (NP)	35		1.0	tCaCO3/1Kt	15-APR-16	15-APR-16	R3437568
Sulfur (S)-Total	2500		500	mg/kg	05-APR-16	05-APR-16	R3434580
Paste pH	8.21		0.10	pH		04-APR-16	R3429614
L1746804-23 CH16-201-BH012_SOB							
Sampled By: CLIENT on 11-MAR-16 @ 16:07							
Matrix: Soil							
Metals in Soil (CCME) with Extra Metals							
Mercury in Soil by CVAFS							
Mercury (Hg)	0.0371		0.0050	mg/kg	30-MAR-16	02-APR-16	R3428986
Metals in Soil by CRC ICPMS							
Aluminum (Al)	11600		50	mg/kg	30-MAR-16	01-APR-16	R3429363
Antimony (Sb)	0.61		0.10	mg/kg	30-MAR-16	01-APR-16	R3429363
Arsenic (As)	10.7		0.10	mg/kg	30-MAR-16	01-APR-16	R3429363
Barium (Ba)	168		0.50	mg/kg	30-MAR-16	01-APR-16	R3429363
Beryllium (Be)	0.46		0.10	mg/kg	30-MAR-16	01-APR-16	R3429363
Bismuth (Bi)	0.22		0.20	mg/kg	30-MAR-16	01-APR-16	R3429363
Boron (B)	<5.0		5.0	mg/kg	30-MAR-16	01-APR-16	R3429363
Cadmium (Cd)	0.514		0.020	mg/kg	30-MAR-16	01-APR-16	R3429363
Calcium (Ca)	8110		50	mg/kg	30-MAR-16	01-APR-16	R3429363
Chromium (Cr)	29.9		0.50	mg/kg	30-MAR-16	01-APR-16	R3429363
Cobalt (Co)	10.6		0.10	mg/kg	30-MAR-16	01-APR-16	R3429363
Copper (Cu)	37.3		0.50	mg/kg	30-MAR-16	01-APR-16	R3429363
Iron (Fe)	19700		50	mg/kg	30-MAR-16	01-APR-16	R3429363
Lead (Pb)	33.1		0.50	mg/kg	30-MAR-16	01-APR-16	R3429363
Lithium (Li)	21.6		2.0	mg/kg	30-MAR-16	01-APR-16	R3429363
Magnesium (Mg)	5740		20	mg/kg	30-MAR-16	01-APR-16	R3429363
Manganese (Mn)	769		1.0	mg/kg	30-MAR-16	01-APR-16	R3429363
Molybdenum (Mo)	2.43		0.10	mg/kg	30-MAR-16	01-APR-16	R3429363
Nickel (Ni)	27.9		0.50	mg/kg	30-MAR-16	01-APR-16	R3429363

* Refer to Referenced Information for Qualifiers (if any) and Methodology.

ALS ENVIRONMENTAL ANALYTICAL REPORT

Sample Details/Parameters	Result	Qualifier*	D.L.	Units	Extracted	Analyzed	Batch
L1746804-23 CH16-201-BH012_SOB							
Sampled By: CLIENT on 11-MAR-16 @ 16:07							
Matrix: Soil							
Metals in Soil by CRC ICPMS							
Phosphorus (P)	728		50	mg/kg	30-MAR-16	01-APR-16	R3429363
Potassium (K)	990		100	mg/kg	30-MAR-16	01-APR-16	R3429363
Selenium (Se)	0.95		0.20	mg/kg	30-MAR-16	01-APR-16	R3429363
Silver (Ag)	0.14		0.10	mg/kg	30-MAR-16	01-APR-16	R3429363
Sodium (Na)	257		50	mg/kg	30-MAR-16	01-APR-16	R3429363
Strontium (Sr)	39.3		0.50	mg/kg	30-MAR-16	01-APR-16	R3429363
Thallium (Tl)	0.133		0.050	mg/kg	30-MAR-16	01-APR-16	R3429363
Tin (Sn)	<2.0		2.0	mg/kg	30-MAR-16	01-APR-16	R3429363
Titanium (Ti)	338		1.0	mg/kg	30-MAR-16	01-APR-16	R3429363
Uranium (U)	1.26		0.050	mg/kg	30-MAR-16	01-APR-16	R3429363
Vanadium (V)	29.1		0.20	mg/kg	30-MAR-16	01-APR-16	R3429363
Zinc (Zn)	138		2.0	mg/kg	30-MAR-16	01-APR-16	R3429363
Zirconium (Zr)	1.2		1.0	mg/kg	30-MAR-16	01-APR-16	R3429363
pH in Soil (1:2 Soil:Water Extraction)							
pH (1:2 soil:water)	7.26		0.10	pH		01-APR-16	R3429000
Miscellaneous Parameters							
PSA % < 75UM	33.6		0.10	%	07-APR-16	08-APR-16	R3434576
Neutralization Potential (NP)	22		1.0	tCaCO3/1Kt	15-APR-16	15-APR-16	R3437568
Sulfur (S)-Total	11400		500	mg/kg	05-APR-16	05-APR-16	R3434580
Paste pH	7.13		0.10	pH		04-APR-16	R3429614
Atterberg limits							
Liquid Limit (LL)	92	NSSM	1	%	07-APR-16	07-APR-16	R3433868
Plasticity Index (PI)	13		1	%	07-APR-16	07-APR-16	R3433868
Organic Matter by LOI at 375 deg C.							
Organic Matter	12.0		1.0	%	08-APR-16	09-APR-16	R3434989
Loss on Ignition @ 375 C	15.0		1.0	%	08-APR-16	09-APR-16	R3434989
L1746804-24 CH16-201-BH005B_SOA1							
Sampled By: CLIENT on 12-MAR-16 @ 12:09							
Matrix: Soil							
Metals in Soil (CCME) with Extra Metals							
Mercury in Soil by CVAFS							
Mercury (Hg)	0.112		0.0050	mg/kg	30-MAR-16	02-APR-16	R3428986
Metals in Soil by CRC ICPMS							
Aluminum (Al)	12400		50	mg/kg	30-MAR-16	01-APR-16	R3429363
Antimony (Sb)	4.58		0.10	mg/kg	30-MAR-16	01-APR-16	R3429363
Arsenic (As)	13.9		0.10	mg/kg	30-MAR-16	01-APR-16	R3429363
Barium (Ba)	365		0.50	mg/kg	30-MAR-16	01-APR-16	R3429363
Beryllium (Be)	0.45		0.10	mg/kg	30-MAR-16	01-APR-16	R3429363
Bismuth (Bi)	0.33		0.20	mg/kg	30-MAR-16	01-APR-16	R3429363
Boron (B)	<5.0		5.0	mg/kg	30-MAR-16	01-APR-16	R3429363
Cadmium (Cd)	0.700		0.020	mg/kg	30-MAR-16	01-APR-16	R3429363
Calcium (Ca)	20900		50	mg/kg	30-MAR-16	01-APR-16	R3429363
Chromium (Cr)	27.4		0.50	mg/kg	30-MAR-16	01-APR-16	R3429363
Cobalt (Co)	16.8		0.10	mg/kg	30-MAR-16	01-APR-16	R3429363
Copper (Cu)	57.7		0.50	mg/kg	30-MAR-16	01-APR-16	R3429363
Iron (Fe)	24400		50	mg/kg	30-MAR-16	01-APR-16	R3429363
Lead (Pb)	137		0.50	mg/kg	30-MAR-16	01-APR-16	R3429363
Lithium (Li)	22.0		2.0	mg/kg	30-MAR-16	01-APR-16	R3429363
Magnesium (Mg)	6380		20	mg/kg	30-MAR-16	01-APR-16	R3429363
Manganese (Mn)	760		1.0	mg/kg	30-MAR-16	01-APR-16	R3429363
Molybdenum (Mo)	3.18		0.10	mg/kg	30-MAR-16	01-APR-16	R3429363

* Refer to Referenced Information for Qualifiers (if any) and Methodology.

ALS ENVIRONMENTAL ANALYTICAL REPORT

Sample Details/Parameters	Result	Qualifier*	D.L.	Units	Extracted	Analyzed	Batch
L1746804-24 CH16-201-BH005B_SOA1							
Sampled By: CLIENT on 12-MAR-16 @ 12:09							
Matrix: Soil							
Metals in Soil by CRC ICPMS							
Nickel (Ni)	40.5		0.50	mg/kg	30-MAR-16	01-APR-16	R3429363
Phosphorus (P)	518		50	mg/kg	30-MAR-16	01-APR-16	R3429363
Potassium (K)	1410		100	mg/kg	30-MAR-16	01-APR-16	R3429363
Selenium (Se)	0.37		0.20	mg/kg	30-MAR-16	01-APR-16	R3429363
Silver (Ag)	0.30		0.10	mg/kg	30-MAR-16	01-APR-16	R3429363
Sodium (Na)	380		50	mg/kg	30-MAR-16	01-APR-16	R3429363
Strontium (Sr)	83.6		0.50	mg/kg	30-MAR-16	01-APR-16	R3429363
Thallium (Tl)	0.257		0.050	mg/kg	30-MAR-16	01-APR-16	R3429363
Tin (Sn)	<2.0		2.0	mg/kg	30-MAR-16	01-APR-16	R3429363
Titanium (Ti)	329		1.0	mg/kg	30-MAR-16	01-APR-16	R3429363
Uranium (U)	0.987		0.050	mg/kg	30-MAR-16	01-APR-16	R3429363
Vanadium (V)	27.4		0.20	mg/kg	30-MAR-16	01-APR-16	R3429363
Zinc (Zn)	488		2.0	mg/kg	30-MAR-16	01-APR-16	R3429363
Zirconium (Zr)	3.1		1.0	mg/kg	30-MAR-16	01-APR-16	R3429363
pH in Soil (1:2 Soil:Water Extraction)							
pH (1:2 soil:water)	8.04		0.10	pH		01-APR-16	R3429000
Miscellaneous Parameters							
Neutralization Potential (NP)	74		1.0	tCaCO3/1Kt	15-APR-16	15-APR-16	R3437568
Sulfur (S)-Total	6200		500	mg/kg	05-APR-16	05-APR-16	R3434580
Paste pH	7.41		0.10	pH		04-APR-16	R3429614
L1746804-25 CH16-201-BH011A_SOA							
Sampled By: CLIENT on 12-MAR-16 @ 17:46							
Matrix: Soil							
Metals in Soil (CCME) with Extra Metals							
Mercury in Soil by CVAFS							
Mercury (Hg)	0.0373		0.0050	mg/kg	30-MAR-16	02-APR-16	R3428986
Metals in Soil by CRC ICPMS							
Aluminum (Al)	3460		50	mg/kg	30-MAR-16	01-APR-16	R3429363
Antimony (Sb)	0.49		0.10	mg/kg	30-MAR-16	01-APR-16	R3429363
Arsenic (As)	9.03		0.10	mg/kg	30-MAR-16	01-APR-16	R3429363
Barium (Ba)	70.2		0.50	mg/kg	30-MAR-16	01-APR-16	R3429363
Beryllium (Be)	0.38		0.10	mg/kg	30-MAR-16	01-APR-16	R3429363
Bismuth (Bi)	<0.20		0.20	mg/kg	30-MAR-16	01-APR-16	R3429363
Boron (B)	<5.0		5.0	mg/kg	30-MAR-16	01-APR-16	R3429363
Cadmium (Cd)	29.9		0.020	mg/kg	30-MAR-16	01-APR-16	R3429363
Calcium (Ca)	49300		50	mg/kg	30-MAR-16	01-APR-16	R3429363
Chromium (Cr)	13.4		0.50	mg/kg	30-MAR-16	01-APR-16	R3429363
Cobalt (Co)	152		0.10	mg/kg	30-MAR-16	01-APR-16	R3429363
Copper (Cu)	292		0.50	mg/kg	30-MAR-16	01-APR-16	R3429363
Iron (Fe)	69000		50	mg/kg	30-MAR-16	01-APR-16	R3429363
Lead (Pb)	783		0.50	mg/kg	30-MAR-16	01-APR-16	R3429363
Lithium (Li)	2.5		2.0	mg/kg	30-MAR-16	01-APR-16	R3429363
Magnesium (Mg)	93500		20	mg/kg	30-MAR-16	01-APR-16	R3429363
Manganese (Mn)	32800		1.0	mg/kg	30-MAR-16	01-APR-16	R3429363
Molybdenum (Mo)	3.02		0.10	mg/kg	30-MAR-16	01-APR-16	R3429363
Nickel (Ni)	166		0.50	mg/kg	30-MAR-16	01-APR-16	R3429363
Phosphorus (P)	84		50	mg/kg	30-MAR-16	01-APR-16	R3429363
Potassium (K)	330		100	mg/kg	30-MAR-16	01-APR-16	R3429363
Selenium (Se)	<0.20		0.20	mg/kg	30-MAR-16	01-APR-16	R3429363
Silver (Ag)	0.11		0.10	mg/kg	30-MAR-16	01-APR-16	R3429363
Sodium (Na)	490		50	mg/kg	30-MAR-16	01-APR-16	R3429363

* Refer to Referenced Information for Qualifiers (if any) and Methodology.

ALS ENVIRONMENTAL ANALYTICAL REPORT

Sample Details/Parameters	Result	Qualifier*	D.L.	Units	Extracted	Analyzed	Batch
L1746804-25 CH16-201-BH011A_SOA							
Sampled By: CLIENT on 12-MAR-16 @ 17:46							
Matrix: Soil							
Metals in Soil by CRC ICPMS							
Strontium (Sr)	111		0.50	mg/kg	30-MAR-16	01-APR-16	R3429363
Thallium (Tl)	0.359		0.050	mg/kg	30-MAR-16	01-APR-16	R3429363
Tin (Sn)	<2.0		2.0	mg/kg	30-MAR-16	01-APR-16	R3429363
Titanium (Ti)	57.7		1.0	mg/kg	30-MAR-16	01-APR-16	R3429363
Uranium (U)	5.64		0.050	mg/kg	30-MAR-16	01-APR-16	R3429363
Vanadium (V)	22.6		0.20	mg/kg	30-MAR-16	01-APR-16	R3429363
Zinc (Zn)	46600		2.0	mg/kg	30-MAR-16	01-APR-16	R3429363
Zirconium (Zr)	1.9		1.0	mg/kg	30-MAR-16	01-APR-16	R3429363
Miscellaneous Parameters							
Neutralization Potential (NP)	511		1.0	tCaCO3/1Kt	15-APR-16	15-APR-16	R3437568
Sulfur (S)-Total	18000		500	mg/kg	05-APR-16	05-APR-16	R3434580
Paste pH	9.17		0.10	pH		31-MAR-16	R3428467
L1746804-26 CH16-201-BH011A_SOB							
Sampled By: CLIENT on 12-MAR-16 @ 18:07							
Matrix: Soil							
Metals in Soil (CCME) with Extra Metals							
Mercury in Soil by CVAFS							
Mercury (Hg)	0.0437		0.0050	mg/kg	30-MAR-16	02-APR-16	R3428986
Metals in Soil by CRC ICPMS							
Aluminum (Al)	2190		50	mg/kg	30-MAR-16	01-APR-16	R3429363
Antimony (Sb)	0.77		0.10	mg/kg	30-MAR-16	01-APR-16	R3429363
Arsenic (As)	9.75		0.10	mg/kg	30-MAR-16	01-APR-16	R3429363
Barium (Ba)	202		0.50	mg/kg	30-MAR-16	01-APR-16	R3429363
Beryllium (Be)	0.14		0.10	mg/kg	30-MAR-16	01-APR-16	R3429363
Bismuth (Bi)	<0.20		0.20	mg/kg	30-MAR-16	01-APR-16	R3429363
Boron (B)	<5.0		5.0	mg/kg	30-MAR-16	01-APR-16	R3429363
Cadmium (Cd)	29.6		0.020	mg/kg	30-MAR-16	01-APR-16	R3429363
Calcium (Ca)	126000		50	mg/kg	30-MAR-16	01-APR-16	R3429363
Chromium (Cr)	30.7		0.50	mg/kg	30-MAR-16	01-APR-16	R3429363
Cobalt (Co)	159		0.10	mg/kg	30-MAR-16	01-APR-16	R3429363
Copper (Cu)	109		0.50	mg/kg	30-MAR-16	01-APR-16	R3429363
Iron (Fe)	24700		50	mg/kg	30-MAR-16	01-APR-16	R3429363
Lead (Pb)	164		0.50	mg/kg	30-MAR-16	01-APR-16	R3429363
Lithium (Li)	2.1		2.0	mg/kg	30-MAR-16	01-APR-16	R3429363
Magnesium (Mg)	105000		20	mg/kg	30-MAR-16	01-APR-16	R3429363
Manganese (Mn)	44900		1.0	mg/kg	30-MAR-16	01-APR-16	R3429363
Molybdenum (Mo)	10.2		0.10	mg/kg	30-MAR-16	01-APR-16	R3429363
Nickel (Ni)	186		0.50	mg/kg	30-MAR-16	01-APR-16	R3429363
Phosphorus (P)	99		50	mg/kg	30-MAR-16	01-APR-16	R3429363
Potassium (K)	250		100	mg/kg	30-MAR-16	01-APR-16	R3429363
Selenium (Se)	<0.20		0.20	mg/kg	30-MAR-16	01-APR-16	R3429363
Silver (Ag)	0.10		0.10	mg/kg	30-MAR-16	01-APR-16	R3429363
Sodium (Na)	308		50	mg/kg	30-MAR-16	01-APR-16	R3429363
Strontium (Sr)	251		0.50	mg/kg	30-MAR-16	01-APR-16	R3429363
Thallium (Tl)	1.36		0.050	mg/kg	30-MAR-16	01-APR-16	R3429363
Tin (Sn)	<2.0		2.0	mg/kg	30-MAR-16	01-APR-16	R3429363
Titanium (Ti)	64.4		1.0	mg/kg	30-MAR-16	01-APR-16	R3429363
Uranium (U)	4.39		0.050	mg/kg	30-MAR-16	01-APR-16	R3429363
Vanadium (V)	17.8		0.20	mg/kg	30-MAR-16	01-APR-16	R3429363
Zinc (Zn)	45400		2.0	mg/kg	30-MAR-16	01-APR-16	R3429363
Zirconium (Zr)	2.3		1.0	mg/kg	30-MAR-16	01-APR-16	R3429363

* Refer to Referenced Information for Qualifiers (if any) and Methodology.

ALS ENVIRONMENTAL ANALYTICAL REPORT

Sample Details/Parameters	Result	Qualifier*	D.L.	Units	Extracted	Analyzed	Batch
L1746804-26 CH16-201-BH011A_SOB							
Sampled By: CLIENT on 12-MAR-16 @ 18:07							
Matrix: Soil							
Miscellaneous Parameters							
Neutralization Potential (NP)	623		1.0	tCaCO3/1Kt	15-APR-16	15-APR-16	R3437568
Sulfur (S)-Total	4400		500	mg/kg	05-APR-16	05-APR-16	R3434580
Paste pH	9.42		0.10	pH		31-MAR-16	R3428467
L1746804-27 CH16-201-BH012A_SOA1							
Sampled By: CLIENT on 12-MAR-16 @ 13:32							
Matrix: Soil							
Metals in Soil (CCME) with Extra Metals							
Mercury in Soil by CVAFS							
Mercury (Hg)	0.0540		0.0050	mg/kg	30-MAR-16	02-APR-16	R3428986
Metals in Soil by CRC ICPMS							
Aluminum (Al)	12000		50	mg/kg	30-MAR-16	01-APR-16	R3429363
Antimony (Sb)	0.88		0.10	mg/kg	30-MAR-16	01-APR-16	R3429363
Arsenic (As)	14.0		0.10	mg/kg	30-MAR-16	01-APR-16	R3429363
Barium (Ba)	233		0.50	mg/kg	30-MAR-16	01-APR-16	R3429363
Beryllium (Be)	0.54		0.10	mg/kg	30-MAR-16	01-APR-16	R3429363
Bismuth (Bi)	0.26		0.20	mg/kg	30-MAR-16	01-APR-16	R3429363
Boron (B)	<5.0		5.0	mg/kg	30-MAR-16	01-APR-16	R3429363
Cadmium (Cd)	0.455		0.020	mg/kg	30-MAR-16	01-APR-16	R3429363
Calcium (Ca)	7860		50	mg/kg	30-MAR-16	01-APR-16	R3429363
Chromium (Cr)	26.6		0.50	mg/kg	30-MAR-16	01-APR-16	R3429363
Cobalt (Co)	12.4		0.10	mg/kg	30-MAR-16	01-APR-16	R3429363
Copper (Cu)	35.3		0.50	mg/kg	30-MAR-16	01-APR-16	R3429363
Iron (Fe)	24200		50	mg/kg	30-MAR-16	01-APR-16	R3429363
Lead (Pb)	57.8		0.50	mg/kg	30-MAR-16	01-APR-16	R3429363
Lithium (Li)	20.2		2.0	mg/kg	30-MAR-16	01-APR-16	R3429363
Magnesium (Mg)	5860		20	mg/kg	30-MAR-16	01-APR-16	R3429363
Manganese (Mn)	705		1.0	mg/kg	30-MAR-16	01-APR-16	R3429363
Molybdenum (Mo)	1.35		0.10	mg/kg	30-MAR-16	01-APR-16	R3429363
Nickel (Ni)	30.9		0.50	mg/kg	30-MAR-16	01-APR-16	R3429363
Phosphorus (P)	579		50	mg/kg	30-MAR-16	01-APR-16	R3429363
Potassium (K)	1040		100	mg/kg	30-MAR-16	01-APR-16	R3429363
Selenium (Se)	0.26		0.20	mg/kg	30-MAR-16	01-APR-16	R3429363
Silver (Ag)	0.16		0.10	mg/kg	30-MAR-16	01-APR-16	R3429363
Sodium (Na)	203		50	mg/kg	30-MAR-16	01-APR-16	R3429363
Strontium (Sr)	34.2		0.50	mg/kg	30-MAR-16	01-APR-16	R3429363
Thallium (Tl)	0.172		0.050	mg/kg	30-MAR-16	01-APR-16	R3429363
Tin (Sn)	<2.0		2.0	mg/kg	30-MAR-16	01-APR-16	R3429363
Titanium (Ti)	336		1.0	mg/kg	30-MAR-16	01-APR-16	R3429363
Uranium (U)	1.07		0.050	mg/kg	30-MAR-16	01-APR-16	R3429363
Vanadium (V)	30.0		0.20	mg/kg	30-MAR-16	01-APR-16	R3429363
Zinc (Zn)	189		2.0	mg/kg	30-MAR-16	01-APR-16	R3429363
Zirconium (Zr)	<1.0		1.0	mg/kg	30-MAR-16	01-APR-16	R3429363
pH in Soil (1:2 Soil:Water Extraction)							
pH (1:2 soil:water)	7.69		0.10	pH		01-APR-16	R3429000
Miscellaneous Parameters							
Neutralization Potential (NP)	24		1.0	tCaCO3/1Kt	15-APR-16	15-APR-16	R3437568
Sulfur (S)-Total	1800		500	mg/kg	05-APR-16	05-APR-16	R3434580
Paste pH	7.37		0.10	pH		04-APR-16	R3430008
Atterberg limits							
Liquid Limit (LL)	23	NSSM	1	%	07-APR-16	07-APR-16	R3433868
Plasticity Index (PI)	2		1	%	07-APR-16	07-APR-16	R3433868

* Refer to Referenced Information for Qualifiers (if any) and Methodology.

ALS ENVIRONMENTAL ANALYTICAL REPORT

Sample Details/Parameters	Result	Qualifier*	D.L.	Units	Extracted	Analyzed	Batch
L1746804-27 CH16-201-BH012A_SOA1							
Sampled By: CLIENT on 12-MAR-16 @ 13:32							
Matrix: Soil							
Grain Size by Hydrometer							
Grain Size Curve	SEE ATTACHED				08-APR-16	08-APR-16	R3434612
Gravel (4.75mm - 3in.)	2.0		1.0	%	08-APR-16	08-APR-16	R3434612
Coarse Sand (2.0mm - 4.75mm)	9.0		1.0	%	08-APR-16	08-APR-16	R3434612
Medium Sand (0.425mm - 2.0mm)	29.8		1.0	%	08-APR-16	08-APR-16	R3434612
Fine Sand (0.075mm - 0.425mm)	34.1		1.0	%	08-APR-16	08-APR-16	R3434612
Silt (0.005mm - 0.075mm)	17.3		1.0	%	08-APR-16	08-APR-16	R3434612
Clay (<0.005mm)	7.9		1.0	%	08-APR-16	08-APR-16	R3434612
Organic Matter by LOI at 375 deg C.							
Organic Matter	1.7		1.0	%	08-APR-16	09-APR-16	R3434989
Loss on Ignition @ 375 C	1.8		1.0	%	08-APR-16	09-APR-16	R3434989
L1746804-28 CH16-201-BH012A_SOA2							
Sampled By: CLIENT on 12-MAR-16 @ 13:32							
Matrix: Soil							
Metals in Soil (CCME) with Extra Metals							
Mercury in Soil by CVAFS							
Mercury (Hg)	0.0255		0.0050	mg/kg	30-MAR-16	02-APR-16	R3428986
Metals in Soil by CRC ICPMS							
Aluminum (Al)	11600		50	mg/kg	30-MAR-16	01-APR-16	R3429363
Antimony (Sb)	0.53		0.10	mg/kg	30-MAR-16	01-APR-16	R3429363
Arsenic (As)	10.3		0.10	mg/kg	30-MAR-16	01-APR-16	R3429363
Barium (Ba)	111		0.50	mg/kg	30-MAR-16	01-APR-16	R3429363
Beryllium (Be)	0.42		0.10	mg/kg	30-MAR-16	01-APR-16	R3429363
Bismuth (Bi)	0.27		0.20	mg/kg	30-MAR-16	01-APR-16	R3429363
Boron (B)	<5.0		5.0	mg/kg	30-MAR-16	01-APR-16	R3429363
Cadmium (Cd)	0.314		0.020	mg/kg	30-MAR-16	01-APR-16	R3429363
Calcium (Ca)	5230		50	mg/kg	30-MAR-16	01-APR-16	R3429363
Chromium (Cr)	26.1		0.50	mg/kg	30-MAR-16	01-APR-16	R3429363
Cobalt (Co)	9.62		0.10	mg/kg	30-MAR-16	01-APR-16	R3429363
Copper (Cu)	21.7		0.50	mg/kg	30-MAR-16	01-APR-16	R3429363
Iron (Fe)	21300		50	mg/kg	30-MAR-16	01-APR-16	R3429363
Lead (Pb)	27.5		0.50	mg/kg	30-MAR-16	01-APR-16	R3429363
Lithium (Li)	23.3		2.0	mg/kg	30-MAR-16	01-APR-16	R3429363
Magnesium (Mg)	5800		20	mg/kg	30-MAR-16	01-APR-16	R3429363
Manganese (Mn)	470		1.0	mg/kg	30-MAR-16	01-APR-16	R3429363
Molybdenum (Mo)	0.87		0.10	mg/kg	30-MAR-16	01-APR-16	R3429363
Nickel (Ni)	24.9		0.50	mg/kg	30-MAR-16	01-APR-16	R3429363
Phosphorus (P)	519		50	mg/kg	30-MAR-16	01-APR-16	R3429363
Potassium (K)	990		100	mg/kg	30-MAR-16	01-APR-16	R3429363
Selenium (Se)	<0.20		0.20	mg/kg	30-MAR-16	01-APR-16	R3429363
Silver (Ag)	<0.10		0.10	mg/kg	30-MAR-16	01-APR-16	R3429363
Sodium (Na)	185		50	mg/kg	30-MAR-16	01-APR-16	R3429363
Strontium (Sr)	26.9		0.50	mg/kg	30-MAR-16	01-APR-16	R3429363
Thallium (Tl)	0.129		0.050	mg/kg	30-MAR-16	01-APR-16	R3429363
Tin (Sn)	<2.0		2.0	mg/kg	30-MAR-16	01-APR-16	R3429363
Titanium (Ti)	325		1.0	mg/kg	30-MAR-16	01-APR-16	R3429363
Uranium (U)	0.817		0.050	mg/kg	30-MAR-16	01-APR-16	R3429363
Vanadium (V)	24.0		0.20	mg/kg	30-MAR-16	01-APR-16	R3429363
Zinc (Zn)	109		2.0	mg/kg	30-MAR-16	01-APR-16	R3429363
Zirconium (Zr)	<1.0		1.0	mg/kg	30-MAR-16	01-APR-16	R3429363
pH in Soil (1:2 Soil:Water Extraction)							
pH (1:2 soil:water)	7.88		0.10	pH		01-APR-16	R3429000

* Refer to Referenced Information for Qualifiers (if any) and Methodology.

ALS ENVIRONMENTAL ANALYTICAL REPORT

Sample Details/Parameters	Result	Qualifier*	D.L.	Units	Extracted	Analyzed	Batch
L1746804-28 CH16-201-BH012A_SOA2							
Sampled By: CLIENT on 12-MAR-16 @ 13:32							
Matrix: Soil							
Miscellaneous Parameters							
Neutralization Potential (NP)	16		1.0	tCaCO3/1Kt	15-APR-16	15-APR-16	R3437568
Sulfur (S)-Total	2000		500	mg/kg	05-APR-16	05-APR-16	R3434580
Paste pH	7.45		0.10	pH		04-APR-16	R3430008
Atterberg limits							
Liquid Limit (LL)	19	NSSM	1	%	07-APR-16	07-APR-16	R3433868
Plasticity Index (PI)	<1		1	%	07-APR-16	07-APR-16	R3433868
Grain Size by Hydrometer							
Grain Size Curve	SEE ATTACHED				08-APR-16	08-APR-16	R3434612
Gravel (4.75mm - 3in.)	2.0		1.0	%	08-APR-16	08-APR-16	R3434612
Coarse Sand (2.0mm - 4.75mm)	12.1		1.0	%	08-APR-16	08-APR-16	R3434612
Medium Sand (0.425mm - 2.0mm)	42.0		1.0	%	08-APR-16	08-APR-16	R3434612
Fine Sand (0.075mm - 0.425mm)	27.6		1.0	%	08-APR-16	08-APR-16	R3434612
Silt (0.005mm - 0.075mm)	9.5		1.0	%	08-APR-16	08-APR-16	R3434612
Clay (<0.005mm)	6.9		1.0	%	08-APR-16	08-APR-16	R3434612
Organic Matter by LOI at 375 deg C.							
Organic Matter	<1.0		1.0	%	08-APR-16	09-APR-16	R3434989
Loss on Ignition @ 375 C	<1.0		1.0	%	08-APR-16	09-APR-16	R3434989
L1746804-29 CH16-201-BH012A_SOA4							
Sampled By: CLIENT on 12-MAR-16 @ 13:32							
Matrix: Soil							
Metals in Soil (CCME) with Extra Metals							
Mercury in Soil by CVAFS							
Mercury (Hg)	0.0280		0.0050	mg/kg	30-MAR-16	02-APR-16	R3428986
Metals in Soil by CRC ICPMS							
Aluminum (Al)	14900		50	mg/kg	30-MAR-16	04-APR-16	R3429363
Antimony (Sb)	0.67		0.10	mg/kg	30-MAR-16	04-APR-16	R3429363
Arsenic (As)	12.7		0.10	mg/kg	30-MAR-16	04-APR-16	R3429363
Barium (Ba)	170		0.50	mg/kg	30-MAR-16	04-APR-16	R3429363
Beryllium (Be)	0.56		0.10	mg/kg	30-MAR-16	04-APR-16	R3429363
Bismuth (Bi)	0.28		0.20	mg/kg	30-MAR-16	04-APR-16	R3429363
Boron (B)	<5.0		5.0	mg/kg	30-MAR-16	04-APR-16	R3429363
Cadmium (Cd)	0.377		0.020	mg/kg	30-MAR-16	04-APR-16	R3429363
Calcium (Ca)	6220		50	mg/kg	30-MAR-16	04-APR-16	R3429363
Chromium (Cr)	29.4		0.50	mg/kg	30-MAR-16	04-APR-16	R3429363
Cobalt (Co)	11.6		0.10	mg/kg	30-MAR-16	04-APR-16	R3429363
Copper (Cu)	30.9		0.50	mg/kg	30-MAR-16	04-APR-16	R3429363
Iron (Fe)	24500		50	mg/kg	30-MAR-16	04-APR-16	R3429363
Lead (Pb)	34.7		0.50	mg/kg	30-MAR-16	04-APR-16	R3429363
Lithium (Li)	25.5		2.0	mg/kg	30-MAR-16	04-APR-16	R3429363
Magnesium (Mg)	7240		20	mg/kg	30-MAR-16	04-APR-16	R3429363
Manganese (Mn)	607		1.0	mg/kg	30-MAR-16	04-APR-16	R3429363
Molybdenum (Mo)	1.21		0.10	mg/kg	30-MAR-16	04-APR-16	R3429363
Nickel (Ni)	32.1		0.50	mg/kg	30-MAR-16	04-APR-16	R3429363
Phosphorus (P)	783		50	mg/kg	30-MAR-16	04-APR-16	R3429363
Potassium (K)	1240		100	mg/kg	30-MAR-16	04-APR-16	R3429363
Selenium (Se)	0.22		0.20	mg/kg	30-MAR-16	04-APR-16	R3429363
Silver (Ag)	0.12		0.10	mg/kg	30-MAR-16	04-APR-16	R3429363
Sodium (Na)	237		50	mg/kg	30-MAR-16	04-APR-16	R3429363
Strontium (Sr)	34.8		0.50	mg/kg	30-MAR-16	04-APR-16	R3429363
Thallium (Tl)	0.172		0.050	mg/kg	30-MAR-16	04-APR-16	R3429363
Tin (Sn)	<2.0		2.0	mg/kg	30-MAR-16	04-APR-16	R3429363

* Refer to Referenced Information for Qualifiers (if any) and Methodology.

ALS ENVIRONMENTAL ANALYTICAL REPORT

Sample Details/Parameters	Result	Qualifier*	D.L.	Units	Extracted	Analyzed	Batch
L1746804-29 CH16-201-BH012A_SOA4							
Sampled By: CLIENT on 12-MAR-16 @ 13:32							
Matrix: Soil							
Metals in Soil by CRC ICPMS							
Titanium (Ti)	423		1.0	mg/kg	30-MAR-16	04-APR-16	R3429363
Uranium (U)	1.06		0.050	mg/kg	30-MAR-16	04-APR-16	R3429363
Vanadium (V)	33.5		0.20	mg/kg	30-MAR-16	04-APR-16	R3429363
Zinc (Zn)	131		2.0	mg/kg	30-MAR-16	04-APR-16	R3429363
Zirconium (Zr)	<1.0		1.0	mg/kg	30-MAR-16	04-APR-16	R3429363
pH in Soil (1:2 Soil:Water Extraction)							
pH (1:2 soil:water)	7.82		0.10	pH		01-APR-16	R3429000
Miscellaneous Parameters							
Neutralization Potential (NP)	24		1.0	tCaCO3/1Kt	15-APR-16	15-APR-16	R3437568
Sulfur (S)-Total	1800		500	mg/kg	05-APR-16	05-APR-16	R3434580
Paste pH	7.39		0.10	pH		04-APR-16	R3430008
Grain Size by Hydrometer							
Grain Size Curve	SEE ATTACHED				08-APR-16	08-APR-16	R3434612
Gravel (4.75mm - 3in.)	33.7		1.0	%	08-APR-16	08-APR-16	R3434612
Coarse Sand (2.0mm - 4.75mm)	18.0		1.0	%	08-APR-16	08-APR-16	R3434612
Medium Sand (0.425mm - 2.0mm)	24.9		1.0	%	08-APR-16	08-APR-16	R3434612
Fine Sand (0.075mm - 0.425mm)	14.3		1.0	%	08-APR-16	08-APR-16	R3434612
Silt (0.005mm - 0.075mm)	5.1		1.0	%	08-APR-16	08-APR-16	R3434612
Clay (<0.005mm)	4.0		1.0	%	08-APR-16	08-APR-16	R3434612
L1746804-30 CH16-201-CP018_SOA							
Sampled By: CLIENT on 13-MAR-16 @ 16:30							
Matrix: Soil							
Metals in Soil (CCME) with Extra Metals							
Mercury in Soil by CVAFS							
Mercury (Hg)	0.0855		0.0050	mg/kg	30-MAR-16	01-APR-16	R3428986
Metals in Soil by CRC ICPMS							
Aluminum (Al)	9080		50	mg/kg	30-MAR-16	01-APR-16	R3429363
Antimony (Sb)	55.7		0.10	mg/kg	30-MAR-16	01-APR-16	R3429363
Arsenic (As)	939		0.10	mg/kg	30-MAR-16	01-APR-16	R3429363
Barium (Ba)	316		0.50	mg/kg	30-MAR-16	01-APR-16	R3429363
Beryllium (Be)	0.45		0.10	mg/kg	30-MAR-16	01-APR-16	R3429363
Bismuth (Bi)	0.98		0.20	mg/kg	30-MAR-16	01-APR-16	R3429363
Boron (B)	<5.0		5.0	mg/kg	30-MAR-16	01-APR-16	R3429363
Cadmium (Cd)	25.7		0.020	mg/kg	30-MAR-16	01-APR-16	R3429363
Calcium (Ca)	7910		50	mg/kg	30-MAR-16	01-APR-16	R3429363
Chromium (Cr)	41.9		0.50	mg/kg	30-MAR-16	01-APR-16	R3429363
Cobalt (Co)	77.8		0.10	mg/kg	30-MAR-16	01-APR-16	R3429363
Copper (Cu)	1180		0.50	mg/kg	30-MAR-16	01-APR-16	R3429363
Iron (Fe)	168000		50	mg/kg	30-MAR-16	01-APR-16	R3429363
Lead (Pb)	6310		0.50	mg/kg	30-MAR-16	01-APR-16	R3429363
Lithium (Li)	12.3		2.0	mg/kg	30-MAR-16	01-APR-16	R3429363
Magnesium (Mg)	7420		20	mg/kg	30-MAR-16	01-APR-16	R3429363
Manganese (Mn)	4220		1.0	mg/kg	30-MAR-16	01-APR-16	R3429363
Molybdenum (Mo)	9.53		0.10	mg/kg	30-MAR-16	01-APR-16	R3429363
Nickel (Ni)	45.7		0.50	mg/kg	30-MAR-16	01-APR-16	R3429363
Phosphorus (P)	367		50	mg/kg	30-MAR-16	01-APR-16	R3429363
Potassium (K)	930		100	mg/kg	30-MAR-16	01-APR-16	R3429363
Selenium (Se)	0.80		0.20	mg/kg	30-MAR-16	01-APR-16	R3429363
Silver (Ag)	15.7		0.10	mg/kg	30-MAR-16	01-APR-16	R3429363
Sodium (Na)	89		50	mg/kg	30-MAR-16	01-APR-16	R3429363
Strontium (Sr)	43.1		0.50	mg/kg	30-MAR-16	01-APR-16	R3429363

* Refer to Referenced Information for Qualifiers (if any) and Methodology.

ALS ENVIRONMENTAL ANALYTICAL REPORT

Sample Details/Parameters	Result	Qualifier*	D.L.	Units	Extracted	Analyzed	Batch
L1746804-30 CH16-201-CP018_SOA							
Sampled By: CLIENT on 13-MAR-16 @ 16:30							
Matrix: Soil							
Metals in Soil by CRC ICPMS							
Thallium (Tl)	6.67		0.050	mg/kg	30-MAR-16	01-APR-16	R3429363
Tin (Sn)	4.0		2.0	mg/kg	30-MAR-16	01-APR-16	R3429363
Titanium (Ti)	77.6		1.0	mg/kg	30-MAR-16	01-APR-16	R3429363
Uranium (U)	3.49		0.050	mg/kg	30-MAR-16	01-APR-16	R3429363
Vanadium (V)	30.1		0.20	mg/kg	30-MAR-16	01-APR-16	R3429363
Zinc (Zn)	15500		2.0	mg/kg	30-MAR-16	01-APR-16	R3429363
Zirconium (Zr)	7.8		1.0	mg/kg	30-MAR-16	01-APR-16	R3429363
pH in Soil (1:2 Soil:Water Extraction)							
pH (1:2 soil:water)	6.20		0.10	pH		05-APR-16	R3430262
Miscellaneous Parameters							
Sulfur (S)-Total	110000		500	mg/kg	05-APR-16	05-APR-16	R3434580
Paste pH	6.42		0.10	pH		31-MAR-16	R3428467
L1746804-31 CH16-201-GS001_SOA							
Sampled By: CLIENT on 13-MAR-16 @ 17:20							
Matrix: Soil							
Metals in Soil (CCME) with Extra Metals							
Mercury in Soil by CVAFS							
Mercury (Hg)	0.0640		0.0050	mg/kg	30-MAR-16	02-APR-16	R3428986
Metals in Soil by CRC ICPMS							
Aluminum (Al)	7100		50	mg/kg	30-MAR-16	01-APR-16	R3429363
Antimony (Sb)	0.98		0.10	mg/kg	30-MAR-16	01-APR-16	R3429363
Arsenic (As)	18.0		0.10	mg/kg	30-MAR-16	01-APR-16	R3429363
Barium (Ba)	182		0.50	mg/kg	30-MAR-16	01-APR-16	R3429363
Beryllium (Be)	0.48		0.10	mg/kg	30-MAR-16	01-APR-16	R3429363
Bismuth (Bi)	<0.20		0.20	mg/kg	30-MAR-16	01-APR-16	R3429363
Boron (B)	<5.0		5.0	mg/kg	30-MAR-16	01-APR-16	R3429363
Cadmium (Cd)	21.7		0.020	mg/kg	30-MAR-16	01-APR-16	R3429363
Calcium (Ca)	153000		50	mg/kg	30-MAR-16	01-APR-16	R3429363
Chromium (Cr)	19.1		0.50	mg/kg	30-MAR-16	01-APR-16	R3429363
Cobalt (Co)	127		0.10	mg/kg	30-MAR-16	01-APR-16	R3429363
Copper (Cu)	151		0.50	mg/kg	30-MAR-16	01-APR-16	R3429363
Iron (Fe)	66800		50	mg/kg	30-MAR-16	01-APR-16	R3429363
Lead (Pb)	377		0.50	mg/kg	30-MAR-16	01-APR-16	R3429363
Lithium (Li)	10.9		2.0	mg/kg	30-MAR-16	01-APR-16	R3429363
Magnesium (Mg)	21700		20	mg/kg	30-MAR-16	01-APR-16	R3429363
Manganese (Mn)	30200		1.0	mg/kg	30-MAR-16	01-APR-16	R3429363
Molybdenum (Mo)	0.78		0.10	mg/kg	30-MAR-16	01-APR-16	R3429363
Nickel (Ni)	132		0.50	mg/kg	30-MAR-16	01-APR-16	R3429363
Phosphorus (P)	234		50	mg/kg	30-MAR-16	01-APR-16	R3429363
Potassium (K)	830		100	mg/kg	30-MAR-16	01-APR-16	R3429363
Selenium (Se)	0.21		0.20	mg/kg	30-MAR-16	01-APR-16	R3429363
Silver (Ag)	0.15		0.10	mg/kg	30-MAR-16	01-APR-16	R3429363
Sodium (Na)	535		50	mg/kg	30-MAR-16	01-APR-16	R3429363
Strontium (Sr)	251		0.50	mg/kg	30-MAR-16	01-APR-16	R3429363
Thallium (Tl)	0.509		0.050	mg/kg	30-MAR-16	01-APR-16	R3429363
Tin (Sn)	<2.0		2.0	mg/kg	30-MAR-16	01-APR-16	R3429363
Titanium (Ti)	196		1.0	mg/kg	30-MAR-16	01-APR-16	R3429363
Uranium (U)	4.63		0.050	mg/kg	30-MAR-16	01-APR-16	R3429363
Vanadium (V)	25.8		0.20	mg/kg	30-MAR-16	01-APR-16	R3429363
Zinc (Zn)	31100		2.0	mg/kg	30-MAR-16	01-APR-16	R3429363
Zirconium (Zr)	1.4		1.0	mg/kg	30-MAR-16	01-APR-16	R3429363

* Refer to Referenced Information for Qualifiers (if any) and Methodology.

ALS ENVIRONMENTAL ANALYTICAL REPORT

Sample Details/Parameters	Result	Qualifier*	D.L.	Units	Extracted	Analyzed	Batch
L1746804-31 CH16-201-GS001_SOA							
Sampled By: CLIENT on 13-MAR-16 @ 17:20							
Matrix: Soil							
Miscellaneous Parameters							
PSA % < 75UM	45.4		0.10	%	07-APR-16	08-APR-16	R3434576
Neutralization Potential (NP)	435		1.0	tCaCO3/1Kt	15-APR-16	15-APR-16	R3437568
Sulfur (S)-Total	2100		500	mg/kg	05-APR-16	05-APR-16	R3434580
Paste pH	8.20		0.10	pH		31-MAR-16	R3428467
L1746804-32 CH16-201-CP017_SOA							
Sampled By: CLIENT on 14-MAR-16 @ 13:00							
Matrix: Soil							
Metals in Soil (CCME) with Extra Metals							
Mercury in Soil by CVAFS							
Mercury (Hg)	4.07		0.025	mg/kg	30-MAR-16	02-APR-16	R3428986
Metals in Soil by CRC ICPMS							
Aluminum (Al)	2630		50	mg/kg	30-MAR-16	01-APR-16	R3429363
Antimony (Sb)	39.7		0.10	mg/kg	30-MAR-16	01-APR-16	R3429363
Arsenic (As)	1070		0.10	mg/kg	30-MAR-16	01-APR-16	R3429363
Barium (Ba)	359		0.50	mg/kg	30-MAR-16	01-APR-16	R3429363
Beryllium (Be)	0.20		0.10	mg/kg	30-MAR-16	01-APR-16	R3429363
Bismuth (Bi)	0.64		0.20	mg/kg	30-MAR-16	01-APR-16	R3429363
Boron (B)	<5.0		5.0	mg/kg	30-MAR-16	01-APR-16	R3429363
Cadmium (Cd)	9.47		0.020	mg/kg	30-MAR-16	01-APR-16	R3429363
Calcium (Ca)	7740		50	mg/kg	30-MAR-16	01-APR-16	R3429363
Chromium (Cr)	14.9		0.50	mg/kg	30-MAR-16	01-APR-16	R3429363
Cobalt (Co)	105		0.10	mg/kg	30-MAR-16	01-APR-16	R3429363
Copper (Cu)	851		0.50	mg/kg	30-MAR-16	01-APR-16	R3429363
Iron (Fe)	234000		50	mg/kg	30-MAR-16	01-APR-16	R3429363
Lead (Pb)	4050		0.50	mg/kg	30-MAR-16	01-APR-16	R3429363
Lithium (Li)	2.0		2.0	mg/kg	30-MAR-16	01-APR-16	R3429363
Magnesium (Mg)	3570		20	mg/kg	30-MAR-16	01-APR-16	R3429363
Manganese (Mn)	3180		1.0	mg/kg	30-MAR-16	01-APR-16	R3429363
Molybdenum (Mo)	4.93		0.10	mg/kg	30-MAR-16	01-APR-16	R3429363
Nickel (Ni)	29.7		0.50	mg/kg	30-MAR-16	01-APR-16	R3429363
Phosphorus (P)	262		50	mg/kg	30-MAR-16	01-APR-16	R3429363
Potassium (K)	290		100	mg/kg	30-MAR-16	01-APR-16	R3429363
Selenium (Se)	0.89		0.20	mg/kg	30-MAR-16	01-APR-16	R3429363
Silver (Ag)	11.8		0.10	mg/kg	30-MAR-16	01-APR-16	R3429363
Sodium (Na)	<50		50	mg/kg	30-MAR-16	01-APR-16	R3429363
Strontium (Sr)	42.0		0.50	mg/kg	30-MAR-16	01-APR-16	R3429363
Thallium (Tl)	5.49		0.050	mg/kg	30-MAR-16	01-APR-16	R3429363
Tin (Sn)	2.3		2.0	mg/kg	30-MAR-16	01-APR-16	R3429363
Titanium (Ti)	27.9		1.0	mg/kg	30-MAR-16	01-APR-16	R3429363
Uranium (U)	1.49		0.050	mg/kg	30-MAR-16	01-APR-16	R3429363
Vanadium (V)	13.7		0.20	mg/kg	30-MAR-16	01-APR-16	R3429363
Zinc (Zn)	5880		2.0	mg/kg	30-MAR-16	01-APR-16	R3429363
Zirconium (Zr)	2.3		1.0	mg/kg	30-MAR-16	01-APR-16	R3429363
pH in Soil (1:2 Soil:Water Extraction)							
pH (1:2 soil:water)	7.21		0.10	pH		01-APR-16	R3429000
Miscellaneous Parameters							
Neutralization Potential (NP)	71		1.0	tCaCO3/1Kt	15-APR-16	15-APR-16	R3437568
Sulfur (S)-Total	281000		500	mg/kg	05-APR-16	05-APR-16	R3434580
Paste pH	6.38		0.10	pH		04-APR-16	R3430008
Grain Size by Hydrometer							
Grain Size Curve	SEE ATTACHED				08-APR-16	08-APR-16	R3434612

* Refer to Referenced Information for Qualifiers (if any) and Methodology.

ALS ENVIRONMENTAL ANALYTICAL REPORT

Sample Details/Parameters	Result	Qualifier*	D.L.	Units	Extracted	Analyzed	Batch
L1746804-32 CH16-201-CP017_SOA							
Sampled By: CLIENT on 14-MAR-16 @ 13:00							
Matrix: Soil							
Grain Size by Hydrometer							
Gravel (4.75mm - 3in.)	<1.0		1.0	%	08-APR-16	08-APR-16	R3434612
Coarse Sand (2.0mm - 4.75mm)	<1.0		1.0	%	08-APR-16	08-APR-16	R3434612
Medium Sand (0.425mm - 2.0mm)	<1.0		1.0	%	08-APR-16	08-APR-16	R3434612
Fine Sand (0.075mm - 0.425mm)	9.3		1.0	%	08-APR-16	08-APR-16	R3434612
Silt (0.005mm - 0.075mm)	80.7		1.0	%	08-APR-16	08-APR-16	R3434612
Clay (<0.005mm)	10.0		1.0	%	08-APR-16	08-APR-16	R3434612
L1746804-33 CH16-201-CP016_SOA							
Sampled By: CLIENT on 15-MAR-16 @ 17:00							
Matrix: Soil							
Metals in Soil (CCME) with Extra Metals							
Mercury in Soil by CVAFS							
Mercury (Hg)	7.77		0.25	mg/kg	30-MAR-16	02-APR-16	R3428986
Metals in Soil by CRC ICPMS							
Aluminum (Al)	6460		50	mg/kg	30-MAR-16	01-APR-16	R3429363
Antimony (Sb)	58.6		0.10	mg/kg	30-MAR-16	01-APR-16	R3429363
Arsenic (As)	1100		0.10	mg/kg	30-MAR-16	01-APR-16	R3429363
Barium (Ba)	344		0.50	mg/kg	30-MAR-16	01-APR-16	R3429363
Beryllium (Be)	0.38		0.10	mg/kg	30-MAR-16	01-APR-16	R3429363
Bismuth (Bi)	0.87		0.20	mg/kg	30-MAR-16	01-APR-16	R3429363
Boron (B)	<5.0		5.0	mg/kg	30-MAR-16	01-APR-16	R3429363
Cadmium (Cd)	22.1		0.020	mg/kg	30-MAR-16	01-APR-16	R3429363
Calcium (Ca)	8260		50	mg/kg	30-MAR-16	01-APR-16	R3429363
Chromium (Cr)	36.7		0.50	mg/kg	30-MAR-16	01-APR-16	R3429363
Cobalt (Co)	90.4		0.10	mg/kg	30-MAR-16	01-APR-16	R3429363
Copper (Cu)	1340		0.50	mg/kg	30-MAR-16	01-APR-16	R3429363
Iron (Fe)	173000		50	mg/kg	30-MAR-16	01-APR-16	R3429363
Lead (Pb)	6680		0.50	mg/kg	30-MAR-16	01-APR-16	R3429363
Lithium (Li)	5.5		2.0	mg/kg	30-MAR-16	01-APR-16	R3429363
Magnesium (Mg)	6090		20	mg/kg	30-MAR-16	01-APR-16	R3429363
Manganese (Mn)	5150		1.0	mg/kg	30-MAR-16	01-APR-16	R3429363
Molybdenum (Mo)	8.96		0.10	mg/kg	30-MAR-16	01-APR-16	R3429363
Nickel (Ni)	48.1		0.50	mg/kg	30-MAR-16	01-APR-16	R3429363
Phosphorus (P)	358		50	mg/kg	30-MAR-16	01-APR-16	R3429363
Potassium (K)	880		100	mg/kg	30-MAR-16	01-APR-16	R3429363
Selenium (Se)	0.78		0.20	mg/kg	30-MAR-16	01-APR-16	R3429363
Silver (Ag)	16.8		0.10	mg/kg	30-MAR-16	01-APR-16	R3429363
Sodium (Na)	81		50	mg/kg	30-MAR-16	01-APR-16	R3429363
Strontium (Sr)	48.1		0.50	mg/kg	30-MAR-16	01-APR-16	R3429363
Thallium (Tl)	7.88		0.050	mg/kg	30-MAR-16	01-APR-16	R3429363
Tin (Sn)	4.4		2.0	mg/kg	30-MAR-16	01-APR-16	R3429363
Titanium (Ti)	65.5		1.0	mg/kg	30-MAR-16	01-APR-16	R3429363
Uranium (U)	3.04		0.050	mg/kg	30-MAR-16	01-APR-16	R3429363
Vanadium (V)	29.1		0.20	mg/kg	30-MAR-16	01-APR-16	R3429363
Zinc (Zn)	15400		2.0	mg/kg	30-MAR-16	01-APR-16	R3429363
Zirconium (Zr)	6.9		1.0	mg/kg	30-MAR-16	01-APR-16	R3429363
pH in Soil (1:2 Soil:Water Extraction)							
pH (1:2 soil:water)	6.29		0.10	pH		01-APR-16	R3429000
Miscellaneous Parameters							
Neutralization Potential (NP)	32		1.0	tCaCO3/1Kt	15-APR-16	15-APR-16	R3437568
Sulfur (S)-Total	180000		500	mg/kg	05-APR-16	05-APR-16	R3434580
Paste pH	5.67		0.10	pH		04-APR-16	R3430008

* Refer to Referenced Information for Qualifiers (if any) and Methodology.

ALS ENVIRONMENTAL ANALYTICAL REPORT

Sample Details/Parameters	Result	Qualifier*	D.L.	Units	Extracted	Analyzed	Batch
L1746804-33 CH16-201-CP016_SOA							
Sampled By: CLIENT on 15-MAR-16 @ 17:00							
Matrix: Soil							
Grain Size by Hydrometer							
Grain Size Curve	SEE ATTACHED				08-APR-16	08-APR-16	R3434612
Gravel (4.75mm - 3in.)	<1.0		1.0	%	08-APR-16	08-APR-16	R3434612
Coarse Sand (2.0mm - 4.75mm)	<1.0		1.0	%	08-APR-16	08-APR-16	R3434612
Medium Sand (0.425mm - 2.0mm)	<1.0		1.0	%	08-APR-16	08-APR-16	R3434612
Fine Sand (0.075mm - 0.425mm)	<1.0		1.0	%	08-APR-16	08-APR-16	R3434612
Silt (0.005mm - 0.075mm)	63.3		1.0	%	08-APR-16	08-APR-16	R3434612
Clay (<0.005mm)	36.6		1.0	%	08-APR-16	08-APR-16	R3434612
L1746804-34 CH16-201-CP916_SOA							
Sampled By: CLIENT on 15-MAR-16 @ 17:00							
Matrix: Soil							
Metals in Soil (CCME) with Extra Metals							
Mercury in Soil by CVAFS							
Mercury (Hg)	7.41		0.25	mg/kg	30-MAR-16	02-APR-16	R3428986
Metals in Soil by CRC ICPMS							
Aluminum (Al)	6560		50	mg/kg	30-MAR-16	01-APR-16	R3429363
Antimony (Sb)	58.6		0.10	mg/kg	30-MAR-16	01-APR-16	R3429363
Arsenic (As)	1100		0.10	mg/kg	30-MAR-16	01-APR-16	R3429363
Barium (Ba)	372		0.50	mg/kg	30-MAR-16	01-APR-16	R3429363
Beryllium (Be)	0.35		0.10	mg/kg	30-MAR-16	01-APR-16	R3429363
Bismuth (Bi)	0.82		0.20	mg/kg	30-MAR-16	01-APR-16	R3429363
Boron (B)	<5.0		5.0	mg/kg	30-MAR-16	01-APR-16	R3429363
Cadmium (Cd)	20.7		0.020	mg/kg	30-MAR-16	01-APR-16	R3429363
Calcium (Ca)	8170		50	mg/kg	30-MAR-16	01-APR-16	R3429363
Chromium (Cr)	36.6		0.50	mg/kg	30-MAR-16	01-APR-16	R3429363
Cobalt (Co)	89.2		0.10	mg/kg	30-MAR-16	01-APR-16	R3429363
Copper (Cu)	1290		0.50	mg/kg	30-MAR-16	01-APR-16	R3429363
Iron (Fe)	169000		50	mg/kg	30-MAR-16	01-APR-16	R3429363
Lead (Pb)	6400		0.50	mg/kg	30-MAR-16	01-APR-16	R3429363
Lithium (Li)	4.7		2.0	mg/kg	30-MAR-16	01-APR-16	R3429363
Magnesium (Mg)	5950		20	mg/kg	30-MAR-16	01-APR-16	R3429363
Manganese (Mn)	5110		1.0	mg/kg	30-MAR-16	01-APR-16	R3429363
Molybdenum (Mo)	8.71		0.10	mg/kg	30-MAR-16	01-APR-16	R3429363
Nickel (Ni)	44.9		0.50	mg/kg	30-MAR-16	01-APR-16	R3429363
Phosphorus (P)	351		50	mg/kg	30-MAR-16	01-APR-16	R3429363
Potassium (K)	920		100	mg/kg	30-MAR-16	01-APR-16	R3429363
Selenium (Se)	0.79		0.20	mg/kg	30-MAR-16	01-APR-16	R3429363
Silver (Ag)	16.4		0.10	mg/kg	30-MAR-16	01-APR-16	R3429363
Sodium (Na)	79		50	mg/kg	30-MAR-16	01-APR-16	R3429363
Strontium (Sr)	51.1		0.50	mg/kg	30-MAR-16	01-APR-16	R3429363
Thallium (Tl)	7.62		0.050	mg/kg	30-MAR-16	01-APR-16	R3429363
Tin (Sn)	4.4		2.0	mg/kg	30-MAR-16	01-APR-16	R3429363
Titanium (Ti)	76.9		1.0	mg/kg	30-MAR-16	01-APR-16	R3429363
Uranium (U)	2.95		0.050	mg/kg	30-MAR-16	01-APR-16	R3429363
Vanadium (V)	29.7		0.20	mg/kg	30-MAR-16	01-APR-16	R3429363
Zinc (Zn)	14700		2.0	mg/kg	30-MAR-16	01-APR-16	R3429363
Zirconium (Zr)	6.9		1.0	mg/kg	30-MAR-16	01-APR-16	R3429363
pH in Soil (1:2 Soil:Water Extraction)							
pH (1:2 soil:water)	6.24		0.10	pH		01-APR-16	R3429000
Miscellaneous Parameters							
Neutralization Potential (NP)	30		1.0	tCaCO3/1Kt	15-APR-16	15-APR-16	R3437568
Sulfur (S)-Total	174000		500	mg/kg	05-APR-16	05-APR-16	R3434580

* Refer to Referenced Information for Qualifiers (if any) and Methodology.

ALS ENVIRONMENTAL ANALYTICAL REPORT

Sample Details/Parameters	Result	Qualifier*	D.L.	Units	Extracted	Analyzed	Batch
L1746804-34 CH16-201-CP916_SOA							
Sampled By: CLIENT on 15-MAR-16 @ 17:00							
Matrix: Soil							
Paste pH	5.59		0.10	pH		04-APR-16	R3430008
Grain Size by Hydrometer							
Grain Size Curve	SEE ATTACHED				08-APR-16	08-APR-16	R3434612
Gravel (4.75mm - 3in.)	<1.0		1.0	%	08-APR-16	08-APR-16	R3434612
Coarse Sand (2.0mm - 4.75mm)	<1.0		1.0	%	08-APR-16	08-APR-16	R3434612
Medium Sand (0.425mm - 2.0mm)	<1.0		1.0	%	08-APR-16	08-APR-16	R3434612
Fine Sand (0.075mm - 0.425mm)	<1.0		1.0	%	08-APR-16	08-APR-16	R3434612
Silt (0.005mm - 0.075mm)	63.2		1.0	%	08-APR-16	08-APR-16	R3434612
Clay (<0.005mm)	36.7		1.0	%	08-APR-16	08-APR-16	R3434612

* Refer to Referenced Information for Qualifiers (if any) and Methodology.

Reference Information

Sample Parameter Qualifier Key:

Qualifier	Description
MS-B	Matrix Spike recovery could not be accurately calculated due to high analyte background in sample.
NSSM	Non-standard sample matrix. Modified methods were used for sample processing and analysis.
NSSM	Non-standard sample matrix. Modified methods were used for sample processing and analysis.

Test Method References:

ALS Test Code	Matrix	Test Description	Method Reference**
ATTERBERG-SK	Soil	Atterberg limits	CARTER CSSS 58

The liquid limit (or upper plastic limit) is the point at which the soil becomes semifluid, like softened butter. In operational terms, the liquid limit is defined as the water content at which a trapezoidal groove cut in moist soil is closed after 25 taps on a hard rubber plate (ASTM D-18, 1958).

The plastic limit (or lower plastic limit) is defined as the water content at which soil begins to crumble on being rolled into a thread 1/8 inch (or 3 mm) in diameter. It represents the lowest water content at which soil can be deformed readily without cracking.

The plastic index (which is the difference between the liquid and plastic limits) gives an indication of the "clayeyness" or plasticity of a clay and is employed in engineering classification systems for soils.

References: McKeague, J.A. 1978. Atterberg Limits pp 50 - 55 In: Soil Sampling and Methods of Analysis. Can. Soc. Soil Sci. p. 50 - 55

GRAIN SIZE-HYD-SK	Soil	Grain Size by Hydrometer	ASTM D422-63

Particle size curve is generated from dry sieving (particles > 2 mm), wet sieving (particles 2 mm-75 um and hydrometer readings (particles < 75 um)

GRAIN SIZE-HYD-SR-SK	Soil	% Particle size passing	ASTM D422-63

Particle size curve is generated from dry sieving (particles > 2 mm), wet sieving (particles 2 mm-75 um and hydrometer readings (particles < 75 um)

HG-200.2-CVAF-VA	Soil	Mercury in Soil by CVAFS	EPA 200.2/1631E (mod)

Soil samples are digested with nitric and hydrochloric acids, followed by analysis by CVAFS.

MET-200.2-CCMS-VA	Soil	Metals in Soil by CRC ICPMS	EPA 200.2/6020A (mod)

Soil samples are digested with nitric and hydrochloric acids, followed by analysis by CRC ICPMS.

Method Limitation: This method is not a total digestion technique. It is a very strong acid digestion that is intended to dissolve those metals that may be environmentally available. This method does not dissolve all silicate materials and may result in a partial extraction. depending on the sample matrix, for some metals, including, but not limited to Al, Ba, Be, Cr, Sr, Ti, Tl, and V.

NP-TU	Soil	Neutralization Potential (NP)	Sobek 3.2.3, MOD
OM-LOI-SK	Soil	Organic Matter by LOI at 375 deg C.	CSSS (1978) p. 160

The dry-ash method involves the removal of organic matter by combustion at 375 degrees C for a minimum of 16 hours. Samples are dried prior to combustion.

Reference: McKeague, J.A. Soil Sampling and Methods of Analysis. Can. Soc. Soil Sci.(1978) method 4.23

PH-1:2-VA	Soil	pH in Soil (1:2 Soil:Water Extraction)	BC WLAP METHOD: PH, ELECTROMETRIC, SOIL

This analysis is carried out in accordance with procedures described in the pH, Electrometric in Soil and Sediment method - Section B Physical/Inorganic and Misc. Constituents, BC Environmental Laboratory Manual 2007. The procedure involves mixing the dried (at <60°C) and sieved (No. 10 / 2mm) sample with deionized/distilled water at a 1:2 ratio of sediment to water. The pH of the solution is then measured using a standard pH probe.

PH-PASTE-VA	Soil	pH in Soil (Paste) by Meter	Carter-CSSS / APHA 4500 H

A soil extract produced by the saturated paste extraction procedure is analyzed by pH meter.

PSA-D1140-SK	Soil	% Particles < 75um (Fine)	ASTM D1140-15

An oven-dried sample is mixed with a dispersing agent. The sample is washed through a 200 mesh (75 um) sieve. The retained mass of sample is used to determine % passing 75 um.

S-TOT-LECO-SK	Soil	Total Sulphur by combustion method	ISO 15178:2000

The sample is ignited in a combustion analyzer where sulfur in the reduced SO2 gas is determined using a thermal conductivity detector.

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

Reference Information

Test Method References:

ALS Test Code	Matrix	Test Description	Method Reference**

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

Laboratory Definition Code	Laboratory Location
SK	ALS ENVIRONMENTAL - SASKATOON, SASKATCHEWAN, CANADA
TU	ALS ENVIRONMENTAL - TUCSON, ARIZONA, USA

Chain of Custody Numbers:

ALS999_1

GLOSSARY OF REPORT TERMS

Surrogates are compounds that are similar in behaviour to target analyte(s), but that do not normally occur in environmental samples. For applicable tests, surrogates are added to samples prior to analysis as a check on recovery. In reports that display the D.L. column, laboratory objectives for surrogates are listed there.
mg/kg - milligrams per kilogram based on dry weight of sample
mg/kg wwt - milligrams per kilogram based on wet weight of sample
mg/kg lwt - milligrams per kilogram based on lipid-adjusted weight
mg/L - unit of concentration based on volume, parts per million.
< - Less than.
D.L. - The reporting limit.
N/A - Result not available. Refer to qualifier code and definition for explanation.

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

Quality Control Report

Workorder: L1746804 Report Date: 25-APR-16

Client: CH2M HILL, INC
2525 Airpark Drive
Redding CA 96001
Contact: Mark Cichy

Test	Matrix	Reference	Result	Qualifier	Units	RPD	Limit	Analyzed
GRAIN SIZE-HYD-SK	**Soil**							
Batch R3434612								
WG2284114-1 DUP		**L1746804-12**						
Gravel (4.75mm - 3in.)		23.0	23.0		%	0.0	25	08-APR-16
Coarse Sand (2.0mm - 4.75mm)		14.8	14.8		%	0.0	25	08-APR-16
Medium Sand (0.425mm - 2.0mm)		24.2	26.0		%	7.1	25	08-APR-16
Fine Sand (0.075mm - 0.425mm)		20.0	17.9		%	11	25	08-APR-16
Silt (0.005mm - 0.075mm)		10.7	10.8		%	1.7	25	08-APR-16
Clay (<0.005mm)		7.4	7.5		%	1.9	25	08-APR-16
HG-200.2-CVAF-VA	**Soil**							
Batch R3428986								
WG2283433-4 CRM		**VA-NRC-STSD1**						
Mercury (Hg)			83.5		%		70-130	02-APR-16
WG2283433-5 CRM		**VA-NRC-PACS3**						
Mercury (Hg)			89.3		%		70-130	02-APR-16
WG2283469-4 CRM		**VA-NRC-STSD1**						
Mercury (Hg)			99.3		%		70-130	02-APR-16
WG2283469-5 CRM		**VA-NRC-PACS3**						
Mercury (Hg)			100.1		%		70-130	02-APR-16
WG2283487-4 CRM		**VA-NRC-STSD1**						
Mercury (Hg)			88.1		%		70-130	02-APR-16
WG2283487-5 CRM		**VA-NRC-PACS3**						
Mercury (Hg)			95.0		%		70-130	02-APR-16
WG2283433-2 DUP		**L1746804-31**						
Mercury (Hg)		0.0640	0.0590		mg/kg	8.1	40	02-APR-16
WG2283469-2 DUP		**L1746804-2**						
Mercury (Hg)		0.0935	0.0954		mg/kg	2.0	40	02-APR-16
WG2283487-2 DUP		**L1746804-28**						
Mercury (Hg)		0.0255	0.0321		mg/kg	23	40	02-APR-16
WG2283433-3 LCS								
Mercury (Hg)			89.6		%		70-130	02-APR-16
WG2283469-3 LCS								
Mercury (Hg)			93.2		%		70-130	02-APR-16
WG2283487-3 LCS								
Mercury (Hg)			88.3		%		70-130	02-APR-16
WG2283433-1 MB								
Mercury (Hg)			<0.0050		mg/kg		0.005	02-APR-16
WG2283469-1 MB								
Mercury (Hg)			<0.0050		mg/kg		0.005	02-APR-16

Quality Control Report

Workorder: L1746804 Report Date: 25-APR-16

Client: CH2M HILL, INC
2525 Airpark Drive
Redding CA 96001
Contact: Mark Cichy

Test	Matrix	Reference	Result	Qualifier	Units	RPD	Limit	Analyzed
HG-200.2-CVAF-VA	**Soil**							
Batch R3428986								
WG2283487-1 MB								
Mercury (Hg)			<0.0050		mg/kg		0.005	02-APR-16
WG2283433-6 MS		**L1746804-30**						
Mercury (Hg)			N/A	MS-B	%		-	01-APR-16
WG2283469-7 MS		**L1746804-1**						
Mercury (Hg)			101.0		%		70-130	02-APR-16
WG2283487-7 MS		**L1746804-29**						
Mercury (Hg)			102.9		%		70-130	02-APR-16
MET-200.2-CCMS-VA	**Soil**							
Batch R3429363								
WG2283433-4 CRM		**VA-NRC-STSD1**						
Aluminum (Al)			92.4		%		70-130	01-APR-16
Antimony (Sb)			88.4		%		70-130	01-APR-16
Arsenic (As)			92.4		%		70-130	01-APR-16
Barium (Ba)			88.7		%		70-130	01-APR-16
Beryllium (Be)			95.4		%		70-130	01-APR-16
Bismuth (Bi)			91.9		%		70-130	01-APR-16
Boron (B)			82.1		%		70-130	01-APR-16
Cadmium (Cd)			91.2		%		70-130	01-APR-16
Calcium (Ca)			102.9		%		70-130	01-APR-16
Chromium (Cr)			89.9		%		70-130	01-APR-16
Cobalt (Co)			92.1		%		70-130	01-APR-16
Copper (Cu)			91.5		%		70-130	01-APR-16
Iron (Fe)			90.7		%		70-130	01-APR-16
Lead (Pb)			91.9		%		70-130	01-APR-16
Lithium (Li)			98.1		%		70-130	01-APR-16
Magnesium (Mg)			90.5		%		70-130	01-APR-16
Manganese (Mn)			88.2		%		70-130	01-APR-16
Molybdenum (Mo)			95.9		%		70-130	01-APR-16
Nickel (Ni)			90.2		%		70-130	01-APR-16
Phosphorus (P)			89.9		%		70-130	01-APR-16
Potassium (K)			87.7		%		70-130	01-APR-16
Selenium (Se)			88.5		%		70-130	01-APR-16
Silver (Ag)			86.7		%		70-130	01-APR-16
Sodium (Na)			91.9		%		70-130	01-APR-16

Quality Control Report

Client: CH2M HILL, INC
2525 Airpark Drive
Redding CA 96001
Contact: Mark Cichy

Test	Matrix	Reference	Result	Qualifier	Units	RPD	Limit	Analyzed
MET-200.2-CCMS-VA	**Soil**							
Batch R3429363								
WG2283433-4 CRM		**VA-NRC-STSD1**						
Strontium (Sr)			99.8		%		70-130	01-APR-16
Thallium (Tl)			87.7		%		70-130	01-APR-16
Tin (Sn)			87.3		%		70-130	01-APR-16
Titanium (Ti)			78.8		%		70-130	01-APR-16
Vanadium (V)			91.8		%		70-130	01-APR-16
Zinc (Zn)			101.4		%		70-130	01-APR-16
WG2283433-5 CRM		**VA-NRC-PACS3**						
Aluminum (Al)			97.2		%		70-130	01-APR-16
Antimony (Sb)			89.4		%		70-130	01-APR-16
Arsenic (As)			90.3		%		70-130	01-APR-16
Barium (Ba)			97.9		%		70-130	01-APR-16
Beryllium (Be)			94.1		%		70-130	01-APR-16
Boron (B)			91.7		%		70-130	01-APR-16
Cadmium (Cd)			90.2		%		70-130	01-APR-16
Calcium (Ca)			99.1		%		70-130	01-APR-16
Chromium (Cr)			95.5		%		70-130	01-APR-16
Cobalt (Co)			94.5		%		70-130	01-APR-16
Copper (Cu)			94.7		%		70-130	01-APR-16
Iron (Fe)			95.7		%		70-130	01-APR-16
Lead (Pb)			93.0		%		70-130	01-APR-16
Lithium (Li)			93.5		%		70-130	01-APR-16
Magnesium (Mg)			101.2		%		70-130	01-APR-16
Manganese (Mn)			91.2		%		70-130	01-APR-16
Molybdenum (Mo)			91.3		%		70-130	01-APR-16
Nickel (Ni)			92.4		%		70-130	01-APR-16
Phosphorus (P)			89.3		%		70-130	01-APR-16
Potassium (K)			92.7		%		70-130	01-APR-16
Selenium (Se)			94.1		%		70-130	01-APR-16
Silver (Ag)			92.6		%		70-130	01-APR-16
Sodium (Na)			90.8		%		70-130	01-APR-16
Strontium (Sr)			102.7		%		70-130	01-APR-16
Thallium (Tl)			89.7		%		70-130	01-APR-16
Tin (Sn)			82.4		%		70-130	01-APR-16
Titanium (Ti)			93.0		%		70-130	01-APR-16

Quality Control Report

Client: CH2M HILL, INC
2525 Airpark Drive
Redding CA 96001
Contact: Mark Cichy

Test	Matrix	Reference	Result	Qualifier	Units	RPD	Limit	Analyzed
MET-200.2-CCMS-VA	**Soil**							
Batch R3429363								
WG2283433-5 CRM		**VA-NRC-PACS3**						
Uranium (U)			94.2		%		70-130	01-APR-16
Vanadium (V)			94.8		%		70-130	01-APR-16
Zinc (Zn)			93.1		%		70-130	01-APR-16
Zirconium (Zr)			96.7		%		70-130	01-APR-16
WG2283469-4 CRM		**VA-NRC-STSD1**						
Aluminum (Al)			104.8		%		70-130	01-APR-16
Antimony (Sb)			95.9		%		70-130	01-APR-16
Arsenic (As)			101.0		%		70-130	01-APR-16
Barium (Ba)			101.0		%		70-130	01-APR-16
Beryllium (Be)			106.2		%		70-130	01-APR-16
Bismuth (Bi)			100.4		%		70-130	01-APR-16
Boron (B)			95.6		%		70-130	01-APR-16
Cadmium (Cd)			96.1		%		70-130	01-APR-16
Calcium (Ca)			109.4		%		70-130	01-APR-16
Chromium (Cr)			105.0		%		70-130	01-APR-16
Cobalt (Co)			102.9		%		70-130	01-APR-16
Copper (Cu)			100.5		%		70-130	01-APR-16
Iron (Fe)			102.4		%		70-130	01-APR-16
Lead (Pb)			100.5		%		70-130	01-APR-16
Lithium (Li)			101.4		%		70-130	01-APR-16
Magnesium (Mg)			102.7		%		70-130	01-APR-16
Manganese (Mn)			102.0		%		70-130	01-APR-16
Molybdenum (Mo)			107.0		%		70-130	01-APR-16
Nickel (Ni)			102.7		%		70-130	01-APR-16
Phosphorus (P)			103.4		%		70-130	01-APR-16
Potassium (K)			102.0		%		70-130	01-APR-16
Selenium (Se)			96.6		%		70-130	01-APR-16
Silver (Ag)			96.1		%		70-130	01-APR-16
Sodium (Na)			109.4		%		70-130	01-APR-16
Strontium (Sr)			109.0		%		70-130	01-APR-16
Thallium (Tl)			94.6		%		70-130	01-APR-16
Tin (Sn)			94.3		%		70-130	01-APR-16
Titanium (Ti)			113.4		%		70-130	01-APR-16
Vanadium (V)			105.0		%		70-130	01-APR-16

Quality Control Report

Client: CH2M HILL, INC
2525 Airpark Drive
Redding CA 96001
Contact: Mark Cichy

Test	Matrix	Reference	Result	Qualifier	Units	RPD	Limit	Analyzed
MET-200.2-CCMS-VA	**Soil**							
Batch R3429363								
WG2283469-4 CRM		**VA-NRC-STSD1**						
Zinc (Zn)			99.3		%		70-130	01-APR-16
WG2283469-5 CRM		**VA-NRC-PACS3**						
Aluminum (Al)			109.9		%		70-130	01-APR-16
Antimony (Sb)			91.2		%		70-130	01-APR-16
Arsenic (As)			96.0		%		70-130	01-APR-16
Barium (Ba)			109.2		%		70-130	01-APR-16
Beryllium (Be)			101.0		%		70-130	01-APR-16
Boron (B)			95.6		%		70-130	01-APR-16
Cadmium (Cd)			96.3		%		70-130	01-APR-16
Calcium (Ca)			104.3		%		70-130	01-APR-16
Chromium (Cr)			102.9		%		70-130	01-APR-16
Cobalt (Co)			102.7		%		70-130	01-APR-16
Copper (Cu)			104.5		%		70-130	01-APR-16
Iron (Fe)			102.5		%		70-130	01-APR-16
Lead (Pb)			99.1		%		70-130	01-APR-16
Lithium (Li)			96.0		%		70-130	01-APR-16
Magnesium (Mg)			107.2		%		70-130	01-APR-16
Manganese (Mn)			101.6		%		70-130	01-APR-16
Molybdenum (Mo)			94.4		%		70-130	01-APR-16
Nickel (Ni)			102.7		%		70-130	01-APR-16
Phosphorus (P)			99.6		%		70-130	01-APR-16
Potassium (K)			100.8		%		70-130	01-APR-16
Selenium (Se)			93.9		%		70-130	01-APR-16
Silver (Ag)			94.8		%		70-130	01-APR-16
Sodium (Na)			104.6		%		70-130	01-APR-16
Strontium (Sr)			102.4		%		70-130	01-APR-16
Thallium (Tl)			93.5		%		70-130	01-APR-16
Tin (Sn)			87.8		%		70-130	01-APR-16
Titanium (Ti)			104.4		%		70-130	01-APR-16
Uranium (U)			100.7		%		70-130	01-APR-16
Vanadium (V)			104.1		%		70-130	01-APR-16
Zinc (Zn)			102.0		%		70-130	01-APR-16
Zirconium (Zr)			97.2		%		70-130	01-APR-16
WG2283487-4 CRM		**VA-NRC-STSD1**						

Quality Control Report

Client: CH2M HILL, INC
2525 Airpark Drive
Redding CA 96001
Contact: Mark Cichy

Test	Matrix	Reference	Result	Qualifier	Units	RPD	Limit	Analyzed
MET-200.2-CCMS-VA	**Soil**							
Batch R3429363								
WG2283487-4 CRM		**VA-NRC-STSD1**						
Aluminum (Al)			102.7		%		70-130	01-APR-16
Antimony (Sb)			93.6		%		70-130	01-APR-16
Arsenic (As)			99.7		%		70-130	01-APR-16
Barium (Ba)			99.9		%		70-130	01-APR-16
Beryllium (Be)			104.2		%		70-130	01-APR-16
Bismuth (Bi)			96.9		%		70-130	01-APR-16
Boron (B)			89.6		%		70-130	01-APR-16
Cadmium (Cd)			96.5		%		70-130	01-APR-16
Calcium (Ca)			101.9		%		70-130	01-APR-16
Chromium (Cr)			98.4		%		70-130	01-APR-16
Cobalt (Co)			99.9		%		70-130	01-APR-16
Copper (Cu)			96.4		%		70-130	01-APR-16
Iron (Fe)			100.3		%		70-130	01-APR-16
Lead (Pb)			96.2		%		70-130	01-APR-16
Lithium (Li)			107.3		%		70-130	01-APR-16
Magnesium (Mg)			98.3		%		70-130	01-APR-16
Manganese (Mn)			97.4		%		70-130	01-APR-16
Molybdenum (Mo)			103.7		%		70-130	01-APR-16
Nickel (Ni)			96.3		%		70-130	01-APR-16
Phosphorus (P)			96.3		%		70-130	01-APR-16
Potassium (K)			100.6		%		70-130	01-APR-16
Selenium (Se)			95.9		%		70-130	01-APR-16
Silver (Ag)			94.3		%		70-130	01-APR-16
Sodium (Na)			108.6		%		70-130	01-APR-16
Strontium (Sr)			108.5		%		70-130	01-APR-16
Thallium (Tl)			93.6		%		70-130	01-APR-16
Tin (Sn)			93.8		%		70-130	01-APR-16
Titanium (Ti)			101.3		%		70-130	01-APR-16
Vanadium (V)			100.7		%		70-130	01-APR-16
Zinc (Zn)			95.4		%		70-130	01-APR-16
WG2283487-5 CRM		**VA-NRC-PACS3**						
Aluminum (Al)			97.9		%		70-130	01-APR-16
Antimony (Sb)			85.6		%		70-130	01-APR-16
Arsenic (As)			90.4		%		70-130	01-APR-16

Quality Control Report

Client: CH2M HILL, INC
2525 Airpark Drive
Redding CA 96001
Contact: Mark Cichy

Test	Matrix	Reference	Result	Qualifier	Units	RPD	Limit	Analyzed
MET-200.2-CCMS-VA	**Soil**							
Batch R3429363								
WG2283487-5 CRM		**VA-NRC-PACS3**						
Barium (Ba)			92.2		%		70-130	01-APR-16
Beryllium (Be)			95.3		%		70-130	01-APR-16
Boron (B)			89.8		%		70-130	01-APR-16
Cadmium (Cd)			92.7		%		70-130	01-APR-16
Calcium (Ca)			99.2		%		70-130	01-APR-16
Chromium (Cr)			94.8		%		70-130	01-APR-16
Cobalt (Co)			95.5		%		70-130	01-APR-16
Copper (Cu)			96.6		%		70-130	01-APR-16
Iron (Fe)			97.8		%		70-130	01-APR-16
Lead (Pb)			95.7		%		70-130	01-APR-16
Lithium (Li)			100.3		%		70-130	01-APR-16
Magnesium (Mg)			101.8		%		70-130	01-APR-16
Manganese (Mn)			91.5		%		70-130	01-APR-16
Molybdenum (Mo)			91.5		%		70-130	01-APR-16
Nickel (Ni)			93.3		%		70-130	01-APR-16
Phosphorus (P)			87.9		%		70-130	01-APR-16
Potassium (K)			89.1		%		70-130	01-APR-16
Selenium (Se)			98.2		%		70-130	01-APR-16
Silver (Ag)			90.9		%		70-130	01-APR-16
Sodium (Na)			94.2		%		70-130	01-APR-16
Strontium (Sr)			98.9		%		70-130	01-APR-16
Thallium (Tl)			90.7		%		70-130	01-APR-16
Tin (Sn)			81.9		%		70-130	01-APR-16
Titanium (Ti)			90.9		%		70-130	01-APR-16
Uranium (U)			97.3		%		70-130	01-APR-16
Vanadium (V)			93.9		%		70-130	01-APR-16
Zinc (Zn)			95.9		%		70-130	01-APR-16
Zirconium (Zr)			97.8		%		70-130	01-APR-16
WG2283433-2 DUP		**L1746804-31**						
Aluminum (Al)		7100	6880		mg/kg	3.2	40	01-APR-16
Antimony (Sb)		0.98	0.92		mg/kg	7.1	30	01-APR-16
Arsenic (As)		18.0	17.6		mg/kg	1.9	30	01-APR-16
Barium (Ba)		182	177		mg/kg	2.8	40	01-APR-16
Beryllium (Be)		0.48	0.44					

Quality Control Report

Client: CH2M HILL, INC
2525 Airpark Drive
Redding CA 96001
Contact: Mark Cichy

Test	Matrix	Reference	Result	Qualifier	Units	RPD	Limit	Analyzed
MET-200.2-CCMS-VA	**Soil**							
Batch R3429363								
WG2283433-2 DUP		**L1746804-31**						
Beryllium (Be)		0.48	0.44		mg/kg	7.7	30	01-APR-16
Bismuth (Bi)		<0.20	<0.20	RPD-NA	mg/kg	N/A	30	01-APR-16
Boron (B)		<5.0	<5.0	RPD-NA	mg/kg	N/A	30	01-APR-16
Cadmium (Cd)		21.7	21.3		mg/kg	1.7	30	01-APR-16
Calcium (Ca)		153000	143000		mg/kg	7.3	30	01-APR-16
Chromium (Cr)		19.1	18.2		mg/kg	4.8	30	01-APR-16
Cobalt (Co)		127	133		mg/kg	4.5	30	01-APR-16
Copper (Cu)		151	156		mg/kg	2.9	30	01-APR-16
Iron (Fe)		66800	66900		mg/kg	0.2	30	01-APR-16
Lead (Pb)		377	374		mg/kg	0.8	40	01-APR-16
Lithium (Li)		10.9	10.2		mg/kg	6.9	30	01-APR-16
Magnesium (Mg)		21700	22800		mg/kg	4.9	30	01-APR-16
Manganese (Mn)		30200	30500		mg/kg	1.0	30	01-APR-16
Molybdenum (Mo)		0.78	0.71		mg/kg	10	40	01-APR-16
Nickel (Ni)		132	133		mg/kg	0.6	30	01-APR-16
Phosphorus (P)		234	220		mg/kg	6.0	30	01-APR-16
Potassium (K)		830	810		mg/kg	2.7	40	01-APR-16
Selenium (Se)		0.21	<0.20	RPD-NA	mg/kg	N/A	30	01-APR-16
Silver (Ag)		0.15	0.15		mg/kg	4.8	40	01-APR-16
Sodium (Na)		535	570		mg/kg	6.2	40	01-APR-16
Strontium (Sr)		251	234		mg/kg	6.9	40	01-APR-16
Thallium (Tl)		0.509	0.497		mg/kg	2.4	30	01-APR-16
Tin (Sn)		<2.0	<2.0	RPD-NA	mg/kg	N/A	40	01-APR-16
Titanium (Ti)		196	190		mg/kg	3.3	40	01-APR-16
Uranium (U)		4.63	4.65		mg/kg	0.4	30	01-APR-16
Vanadium (V)		25.8	25.3		mg/kg	2.0	30	01-APR-16
Zinc (Zn)		31100	31000		mg/kg	0.2	30	01-APR-16
Zirconium (Zr)		1.4	1.3		mg/kg	5.7	30	01-APR-16
WG2283469-2 DUP		**L1746804-2**						
Aluminum (Al)		19000	19500		mg/kg	2.4	40	01-APR-16
Antimony (Sb)		1.67	1.96		mg/kg	16	30	01-APR-16
Arsenic (As)		27.1	26.8		mg/kg	1.1	30	01-APR-16
Barium (Ba)		485	489		mg/kg	0.8	40	01-APR-16

Quality Control Report

Client: CH2M HILL, INC
2525 Airpark Drive
Redding CA 96001
Contact: Mark Cichy

Test	Matrix	Reference	Result	Qualifier	Units	RPD	Limit	Analyzed
MET-200.2-CCMS-VA	**Soil**							
Batch R3429363								
WG2283469-2 DUP		**L1746804-2**						
Beryllium (Be)		0.81	0.86		mg/kg	6.3	30	01-APR-16
Bismuth (Bi)		0.39	0.43		mg/kg	9.9	30	01-APR-16
Boron (B)		<5.0	<5.0	RPD-NA	mg/kg	N/A	30	01-APR-16
Cadmium (Cd)		0.650	0.694		mg/kg	6.5	30	01-APR-16
Calcium (Ca)		13000	11200		mg/kg	14	30	01-APR-16
Chromium (Cr)		79.0	87.4		mg/kg	10	30	01-APR-16
Cobalt (Co)		23.4	24.0		mg/kg	2.3	30	01-APR-16
Copper (Cu)		62.7	66.4		mg/kg	5.8	30	01-APR-16
Iron (Fe)		40000	42200		mg/kg	5.3	30	01-APR-16
Lead (Pb)		84.7	92.0		mg/kg	8.3	40	01-APR-16
Lithium (Li)		28.6	30.5		mg/kg	6.7	30	01-APR-16
Magnesium (Mg)		12100	12000		mg/kg	0.7	30	01-APR-16
Manganese (Mn)		719	740		mg/kg	2.9	30	01-APR-16
Molybdenum (Mo)		2.01	2.09		mg/kg	3.7	40	01-APR-16
Nickel (Ni)		87.7	95.7		mg/kg	8.7	30	01-APR-16
Phosphorus (P)		611	616		mg/kg	0.9	30	01-APR-16
Potassium (K)		1460	1530		mg/kg	4.8	40	01-APR-16
Selenium (Se)		1.02	1.04		mg/kg	1.4	30	01-APR-16
Silver (Ag)		0.32	0.37		mg/kg	12	40	01-APR-16
Sodium (Na)		291	286		mg/kg	1.8	40	01-APR-16
Strontium (Sr)		50.3	48.6		mg/kg	3.4	40	01-APR-16
Thallium (Tl)		0.242	0.255		mg/kg	5.2	30	01-APR-16
Tin (Sn)		<2.0	<2.0	RPD-NA	mg/kg	N/A	40	01-APR-16
Titanium (Ti)		388	344		mg/kg	12	40	01-APR-16
Uranium (U)		3.28	2.84		mg/kg	14	30	01-APR-16
Vanadium (V)		43.6	42.8		mg/kg	1.8	30	01-APR-16
Zinc (Zn)		261	260		mg/kg	0.5	30	01-APR-16
Zirconium (Zr)		4.2	4.3		mg/kg	3.1	30	01-APR-16
WG2283487-2 DUP		**L1746804-28**						
Aluminum (Al)		11600	12100		mg/kg	4.1	40	01-APR-16
Antimony (Sb)		0.53	0.61		mg/kg	14	30	01-APR-16
Arsenic (As)		10.3	12.3		mg/kg	18	30	01-APR-16
Barium (Ba)		111	139		mg/kg	23	40	01-APR-16

Quality Control Report

Client: CH2M HILL, INC
2525 Airpark Drive
Redding CA 96001
Contact: Mark Cichy

Test	Matrix	Reference	Result	Qualifier	Units	RPD	Limit	Analyzed
MET-200.2-CCMS-VA	**Soil**							
Batch R3429363								
WG2283487-2 DUP		**L1746804-28**						
Beryllium (Be)		0.42	0.47		mg/kg	11	30	01-APR-16
Bismuth (Bi)		0.27	0.22		mg/kg	19	30	01-APR-16
Boron (B)		<5.0	<5.0	RPD-NA	mg/kg	N/A	30	01-APR-16
Cadmium (Cd)		0.314	0.344		mg/kg	9.1	30	01-APR-16
Calcium (Ca)		5230	5540		mg/kg	5.8	30	01-APR-16
Chromium (Cr)		26.1	27.9		mg/kg	6.4	30	01-APR-16
Cobalt (Co)		9.62	10.6		mg/kg	9.8	30	01-APR-16
Copper (Cu)		21.7	27.3		mg/kg	23	30	01-APR-16
Iron (Fe)		21300	22600		mg/kg	6.2	30	01-APR-16
Lead (Pb)		27.5	34.5		mg/kg	22	40	01-APR-16
Lithium (Li)		23.3	21.5		mg/kg	7.6	30	01-APR-16
Magnesium (Mg)		5800	5680		mg/kg	2.1	30	01-APR-16
Manganese (Mn)		470	525		mg/kg	11	30	01-APR-16
Molybdenum (Mo)		0.87	1.04		mg/kg	17	40	01-APR-16
Nickel (Ni)		24.9	28.6		mg/kg	14	30	01-APR-16
Phosphorus (P)		519	602		mg/kg	15	30	01-APR-16
Potassium (K)		990	900		mg/kg	9.0	40	01-APR-16
Selenium (Se)		<0.20	0.22	RPD-NA	mg/kg	N/A	30	01-APR-16
Silver (Ag)		<0.10	0.11	RPD-NA	mg/kg	N/A	40	01-APR-16
Sodium (Na)		185	191		mg/kg	3.1	40	01-APR-16
Strontium (Sr)		26.9	25.0		mg/kg	7.1	40	01-APR-16
Thallium (Tl)		0.129	0.136		mg/kg	5.5	30	01-APR-16
Tin (Sn)		<2.0	<2.0	RPD-NA	mg/kg	N/A	40	01-APR-16
Titanium (Ti)		325	342		mg/kg	5.2	40	01-APR-16
Uranium (U)		0.817	0.990		mg/kg	19	30	01-APR-16
Vanadium (V)		24.0	28.4		mg/kg	17	30	01-APR-16
Zinc (Zn)		109	124		mg/kg	13	30	01-APR-16
Zirconium (Zr)		<1.0	1.0	RPD-NA	mg/kg	N/A	30	01-APR-16
WG2283433-3 LCS								
Aluminum (Al)			96.1		%		70-130	01-APR-16
Antimony (Sb)			93.0		%		70-130	01-APR-16
Arsenic (As)			98.6		%		70-130	01-APR-16
Barium (Ba)			100.4		%		70-130	01-APR-16

Quality Control Report

Client: CH2M HILL, INC
2525 Airpark Drive
Redding CA 96001
Contact: Mark Cichy

Test	Matrix	Reference	Result	Qualifier	Units	RPD	Limit	Analyzed
MET-200.2-CCMS-VA	**Soil**							
Batch R3429363								
WG2283433-3 LCS								
Beryllium (Be)			97.3		%		70-130	01-APR-16
Bismuth (Bi)			90.8		%		70-130	01-APR-16
Boron (B)			89.7		%		70-130	01-APR-16
Cadmium (Cd)			89.2		%		70-130	01-APR-16
Calcium (Ca)			100.9		%		70-130	01-APR-16
Chromium (Cr)			99.5		%		70-130	01-APR-16
Cobalt (Co)			96.7		%		70-130	01-APR-16
Copper (Cu)			93.3		%		70-130	01-APR-16
Iron (Fe)			96.4		%		70-130	01-APR-16
Lead (Pb)			91.5		%		70-130	01-APR-16
Lithium (Li)			99.8		%		70-130	01-APR-16
Magnesium (Mg)			96.3		%		70-130	01-APR-16
Manganese (Mn)			94.7		%		70-130	01-APR-16
Molybdenum (Mo)			102.0		%		70-130	01-APR-16
Nickel (Ni)			94.8		%		70-130	01-APR-16
Phosphorus (P)			102.9		%		70-130	01-APR-16
Potassium (K)			98.0		%		70-130	01-APR-16
Selenium (Se)			98.4		%		70-130	01-APR-16
Silver (Ag)			90.2		%		70-130	01-APR-16
Sodium (Na)			97.0		%		70-130	01-APR-16
Strontium (Sr)			100.4		%		70-130	01-APR-16
Thallium (Tl)			91.1		%		70-130	01-APR-16
Tin (Sn)			89.6		%		70-130	01-APR-16
Titanium (Ti)			94.8		%		70-130	01-APR-16
Uranium (U)			93.3		%		70-130	01-APR-16
Vanadium (V)			100.1		%		70-130	01-APR-16
Zinc (Zn)			87.1		%		70-130	01-APR-16
Zirconium (Zr)			97.8		%		70-130	01-APR-16
WG2283469-3 LCS								
Aluminum (Al)			102.4		%		70-130	01-APR-16
Antimony (Sb)			93.1		%		70-130	01-APR-16
Arsenic (As)			99.5		%		70-130	01-APR-16
Barium (Ba)			103.9		%		70-130	01-APR-16
Beryllium (Be)			96.2		%		70-130	01-APR-16

Quality Control Report

Client: CH2M HILL, INC
2525 Airpark Drive
Redding CA 96001
Contact: Mark Cichy

Test	Matrix	Reference	Result	Qualifier	Units	RPD	Limit	Analyzed
MET-200.2-CCMS-VA	**Soil**							
Batch R3429363								
WG2283469-3 LCS								
Bismuth (Bi)			91.7		%		70-130	01-APR-16
Boron (B)			90.6		%		70-130	01-APR-16
Cadmium (Cd)			94.7		%		70-130	01-APR-16
Calcium (Ca)			100.0		%		70-130	01-APR-16
Chromium (Cr)			99.4		%		70-130	01-APR-16
Cobalt (Co)			97.8		%		70-130	01-APR-16
Copper (Cu)			94.2		%		70-130	01-APR-16
Iron (Fe)			108.1		%		70-130	01-APR-16
Lead (Pb)			90.7		%		70-130	01-APR-16
Lithium (Li)			94.1		%		70-130	01-APR-16
Magnesium (Mg)			96.4		%		70-130	01-APR-16
Manganese (Mn)			101.4		%		70-130	01-APR-16
Molybdenum (Mo)			99.2		%		70-130	01-APR-16
Nickel (Ni)			96.6		%		70-130	01-APR-16
Phosphorus (P)			100.1		%		70-130	01-APR-16
Potassium (K)			97.0		%		70-130	01-APR-16
Selenium (Se)			98.5		%		70-130	01-APR-16
Silver (Ag)			88.2		%		70-130	01-APR-16
Sodium (Na)			97.9		%		70-130	01-APR-16
Strontium (Sr)			99.2		%		70-130	01-APR-16
Thallium (Tl)			89.8		%		70-130	01-APR-16
Tin (Sn)			92.9		%		70-130	01-APR-16
Titanium (Ti)			100.2		%		70-130	01-APR-16
Uranium (U)			93.2		%		70-130	01-APR-16
Vanadium (V)			100.1		%		70-130	01-APR-16
Zinc (Zn)			88.7		%		70-130	01-APR-16
Zirconium (Zr)			93.2		%		70-130	01-APR-16
WG2283487-3 LCS								
Aluminum (Al)			96.6		%		70-130	01-APR-16
Antimony (Sb)			92.6		%		70-130	01-APR-16
Arsenic (As)			99.9		%		70-130	01-APR-16
Barium (Ba)			103.0		%		70-130	01-APR-16
Beryllium (Be)			93.3		%		70-130	01-APR-16
Bismuth (Bi)			91.3		%		70-130	01-APR-16

Quality Control Report

Client: CH2M HILL, INC
2525 Airpark Drive
Redding CA 96001
Contact: Mark Cichy

Test	Matrix	Reference	Result	Qualifier	Units	RPD	Limit	Analyzed
MET-200.2-CCMS-VA	**Soil**							
Batch R3429363								
WG2283487-3 LCS								
Boron (B)			88.1		%		70-130	01-APR-16
Cadmium (Cd)			97.3		%		70-130	01-APR-16
Calcium (Ca)			97.2		%		70-130	01-APR-16
Chromium (Cr)			98.5		%		70-130	01-APR-16
Cobalt (Co)			97.8		%		70-130	01-APR-16
Copper (Cu)			93.7		%		70-130	01-APR-16
Iron (Fe)			104.3		%		70-130	01-APR-16
Lead (Pb)			94.0		%		70-130	01-APR-16
Lithium (Li)			101.4		%		70-130	01-APR-16
Magnesium (Mg)			94.7		%		70-130	01-APR-16
Manganese (Mn)			97.6		%		70-130	01-APR-16
Molybdenum (Mo)			98.9		%		70-130	01-APR-16
Nickel (Ni)			94.3		%		70-130	01-APR-16
Phosphorus (P)			97.8		%		70-130	01-APR-16
Potassium (K)			93.8		%		70-130	01-APR-16
Selenium (Se)			97.2		%		70-130	01-APR-16
Silver (Ag)			90.9		%		70-130	01-APR-16
Sodium (Na)			103.3		%		70-130	01-APR-16
Strontium (Sr)			99.1		%		70-130	01-APR-16
Thallium (Tl)			90.9		%		70-130	01-APR-16
Tin (Sn)			95.0		%		70-130	01-APR-16
Titanium (Ti)			99.1		%		70-130	01-APR-16
Uranium (U)			93.4		%		70-130	01-APR-16
Vanadium (V)			99.5		%		70-130	01-APR-16
Zinc (Zn)			89.1		%		70-130	01-APR-16
Zirconium (Zr)			94.5		%		70-130	01-APR-16
WG2283433-1 MB								
Aluminum (Al)			<50		mg/kg		50	01-APR-16
Antimony (Sb)			<0.10		mg/kg		0.1	01-APR-16
Arsenic (As)			<0.10		mg/kg		0.1	01-APR-16
Barium (Ba)			<0.50		mg/kg		0.5	01-APR-16
Beryllium (Be)			<0.10		mg/kg		0.1	01-APR-16
Bismuth (Bi)			<0.20		mg/kg		0.2	01-APR-16
Boron (B)			<5.0		mg/kg		5	01-APR-16

Quality Control Report

Client: CH2M HILL, INC
2525 Airpark Drive
Redding CA 96001
Contact: Mark Cichy

Test	Matrix	Reference	Result	Qualifier	Units	RPD	Limit	Analyzed
MET-200.2-CCMS-VA	**Soil**							
Batch R3429363								
WG2283433-1 MB								
Cadmium (Cd)			<0.020		mg/kg		0.02	01-APR-16
Calcium (Ca)			<50		mg/kg		50	01-APR-16
Chromium (Cr)			<0.50		mg/kg		0.5	01-APR-16
Cobalt (Co)			<0.10		mg/kg		0.1	01-APR-16
Copper (Cu)			<0.50		mg/kg		0.5	01-APR-16
Iron (Fe)			<50		mg/kg		50	01-APR-16
Lead (Pb)			<0.50		mg/kg		0.5	01-APR-16
Lithium (Li)			<2.0		mg/kg		2	01-APR-16
Magnesium (Mg)			<20		mg/kg		20	01-APR-16
Manganese (Mn)			<1.0		mg/kg		1	01-APR-16
Molybdenum (Mo)			<0.10		mg/kg		0.1	01-APR-16
Nickel (Ni)			<0.50		mg/kg		0.5	01-APR-16
Phosphorus (P)			<50		mg/kg		50	01-APR-16
Potassium (K)			<100		mg/kg		100	01-APR-16
Selenium (Se)			<0.20		mg/kg		0.2	01-APR-16
Silver (Ag)			<0.10		mg/kg		0.1	01-APR-16
Sodium (Na)			<50		mg/kg		50	01-APR-16
Strontium (Sr)			<0.50		mg/kg		0.5	01-APR-16
Thallium (Tl)			<0.050		mg/kg		0.05	01-APR-16
Tin (Sn)			<2.0		mg/kg		2	01-APR-16
Titanium (Ti)			<1.0		mg/kg		1	01-APR-16
Uranium (U)			<0.050		mg/kg		0.05	01-APR-16
Vanadium (V)			<0.20		mg/kg		0.2	01-APR-16
Zinc (Zn)			<2.0		mg/kg		2	01-APR-16
Zirconium (Zr)			<1.0		mg/kg		1	01-APR-16
WG2283469-1 MB								
Aluminum (Al)			<50		mg/kg		50	01-APR-16
Antimony (Sb)			<0.10		mg/kg		0.1	01-APR-16
Arsenic (As)			<0.10		mg/kg		0.1	01-APR-16
Barium (Ba)			<0.50		mg/kg		0.5	01-APR-16
Beryllium (Be)			<0.10		mg/kg		0.1	01-APR-16
Bismuth (Bi)			<0.20		mg/kg		0.2	01-APR-16
Boron (B)			<5.0		mg/kg		5	01-APR-16
Cadmium (Cd)			<0.020		mg/kg		0.02	01-APR-16

Quality Control Report

Client: CH2M HILL, INC
2525 Airpark Drive
Redding CA 96001
Contact: Mark Cichy

Test	Matrix	Reference	Result	Qualifier	Units	RPD	Limit	Analyzed
MET-200.2-CCMS-VA	**Soil**							
Batch R3429363								
WG2283469-1 MB								
Calcium (Ca)			<50		mg/kg		50	01-APR-16
Chromium (Cr)			<0.50		mg/kg		0.5	01-APR-16
Cobalt (Co)			<0.10		mg/kg		0.1	01-APR-16
Copper (Cu)			<0.50		mg/kg		0.5	01-APR-16
Iron (Fe)			<50		mg/kg		50	01-APR-16
Lead (Pb)			<0.50		mg/kg		0.5	01-APR-16
Lithium (Li)			<2.0		mg/kg		2	01-APR-16
Magnesium (Mg)			<20		mg/kg		20	01-APR-16
Manganese (Mn)			<1.0		mg/kg		1	01-APR-16
Molybdenum (Mo)			<0.10		mg/kg		0.1	01-APR-16
Nickel (Ni)			<0.50		mg/kg		0.5	01-APR-16
Phosphorus (P)			<50		mg/kg		50	01-APR-16
Potassium (K)			<100		mg/kg		100	01-APR-16
Selenium (Se)			<0.20		mg/kg		0.2	01-APR-16
Silver (Ag)			<0.10		mg/kg		0.1	01-APR-16
Sodium (Na)			<50		mg/kg		50	01-APR-16
Strontium (Sr)			<0.50		mg/kg		0.5	01-APR-16
Thallium (Tl)			<0.050		mg/kg		0.05	01-APR-16
Tin (Sn)			<2.0		mg/kg		2	01-APR-16
Titanium (Ti)			<1.0		mg/kg		1	01-APR-16
Uranium (U)			<0.050		mg/kg		0.05	01-APR-16
Vanadium (V)			<0.20		mg/kg		0.2	01-APR-16
Zinc (Zn)			<2.0		mg/kg		2	01-APR-16
Zirconium (Zr)			<1.0		mg/kg		1	01-APR-16
WG2283487-1 MB								
Aluminum (Al)			<50		mg/kg		50	03-APR-16
Antimony (Sb)			<0.10		mg/kg		0.1	03-APR-16
Arsenic (As)			<0.10		mg/kg		0.1	03-APR-16
Barium (Ba)			<0.50		mg/kg		0.5	03-APR-16
Beryllium (Be)			<0.10		mg/kg		0.1	03-APR-16
Bismuth (Bi)			<0.20		mg/kg		0.2	03-APR-16
Boron (B)			<5.0		mg/kg		5	03-APR-16
Cadmium (Cd)			<0.020		mg/kg		0.02	03-APR-16
Calcium (Ca)			<50		mg/kg		50	03-APR-16

Quality Control Report

Client: CH2M HILL, INC
2525 Airpark Drive
Redding CA 96001
Contact: Mark Cichy

Test	Matrix	Reference	Result	Qualifier	Units	RPD	Limit	Analyzed
MET-200.2-CCMS-VA	**Soil**							
Batch R3429363								
WG2283487-1 MB								
Chromium (Cr)			<0.50		mg/kg		0.5	03-APR-16
Cobalt (Co)			<0.10		mg/kg		0.1	03-APR-16
Copper (Cu)			<0.50		mg/kg		0.5	03-APR-16
Iron (Fe)			<50		mg/kg		50	03-APR-16
Lead (Pb)			<0.50		mg/kg		0.5	03-APR-16
Lithium (Li)			<2.0		mg/kg		2	03-APR-16
Magnesium (Mg)			<20		mg/kg		20	03-APR-16
Manganese (Mn)			<1.0		mg/kg		1	03-APR-16
Molybdenum (Mo)			<0.10		mg/kg		0.1	03-APR-16
Nickel (Ni)			<0.50		mg/kg		0.5	03-APR-16
Phosphorus (P)			<50		mg/kg		50	03-APR-16
Potassium (K)			<100		mg/kg		100	03-APR-16
Selenium (Se)			<0.20		mg/kg		0.2	03-APR-16
Silver (Ag)			<0.10		mg/kg		0.1	03-APR-16
Sodium (Na)			<50		mg/kg		50	03-APR-16
Strontium (Sr)			<0.50		mg/kg		0.5	03-APR-16
Thallium (Tl)			<0.050		mg/kg		0.05	03-APR-16
Tin (Sn)			<2.0		mg/kg		2	03-APR-16
Titanium (Ti)			<1.0		mg/kg		1	03-APR-16
Uranium (U)			<0.050		mg/kg		0.05	03-APR-16
Vanadium (V)			<0.20		mg/kg		0.2	03-APR-16
Zinc (Zn)			<2.0		mg/kg		2	03-APR-16
Zirconium (Zr)			<1.0		mg/kg		1	03-APR-16
WG2283433-6 MS		**L1746804-30**						
Aluminum (Al)			N/A	MS-B	%		-	01-APR-16
Antimony (Sb)			85.7		%		70-130	01-APR-16
Arsenic (As)			85.3		%		70-130	01-APR-16
Barium (Ba)			N/A	MS-B	%		-	01-APR-16
Beryllium (Be)			93.8		%		70-130	01-APR-16
Bismuth (Bi)			91.1		%		70-130	01-APR-16
Boron (B)			77.6		%		70-130	01-APR-16
Cadmium (Cd)			87.2		%		70-130	01-APR-16
Calcium (Ca)			N/A	MS-B	%		-	01-APR-16
Chromium (Cr)			90.2		%		70-130	01-APR-16

Quality Control Report

Client: CH2M HILL, INC
2525 Airpark Drive
Redding CA 96001
Contact: Mark Cichy

Test	Matrix	Reference	Result	Qualifier	Units	RPD	Limit	Analyzed
MET-200.2-CCMS-VA	**Soil**							
Batch R3429363								
WG2283433-6 MS		**L1746804-30**						
Cobalt (Co)			87.9		%		70-130	01-APR-16
Copper (Cu)			N/A	MS-B	%		-	01-APR-16
Iron (Fe)			N/A	MS-B	%		-	01-APR-16
Lead (Pb)			N/A	MS-B	%		-	01-APR-16
Lithium (Li)			87.3		%		70-130	01-APR-16
Magnesium (Mg)			N/A	MS-B	%		-	01-APR-16
Manganese (Mn)			N/A	MS-B	%		-	01-APR-16
Molybdenum (Mo)			90.4		%		70-130	01-APR-16
Nickel (Ni)			89.6		%		70-130	01-APR-16
Phosphorus (P)			94.8		%		70-130	01-APR-16
Potassium (K)			92.4		%		70-130	01-APR-16
Selenium (Se)			84.9		%		70-130	01-APR-16
Silver (Ag)			80.0		%		70-130	01-APR-16
Sodium (Na)			89.6		%		70-130	01-APR-16
Strontium (Sr)			89.6		%		70-130	01-APR-16
Thallium (Tl)			86.7		%		70-130	01-APR-16
Tin (Sn)			76.2		%		70-130	01-APR-16
Titanium (Ti)			88.4		%		70-130	01-APR-16
Uranium (U)			96.0		%		70-130	01-APR-16
Vanadium (V)			93.8		%		70-130	01-APR-16
Zinc (Zn)			N/A	MS-B	%		-	01-APR-16
WG2283469-7 MS		**L1746804-1**						
Aluminum (Al)			N/A	MS-B	%		-	01-APR-16
Antimony (Sb)			88.5		%		70-130	01-APR-16
Arsenic (As)			89.6		%		70-130	01-APR-16
Barium (Ba)			N/A	MS-B	%		-	01-APR-16
Beryllium (Be)			98.7		%		70-130	01-APR-16
Bismuth (Bi)			88.8		%		70-130	01-APR-16
Boron (B)			83.1		%		70-130	01-APR-16
Cadmium (Cd)			89.2		%		70-130	01-APR-16
Calcium (Ca)			N/A	MS-B	%		-	01-APR-16
Chromium (Cr)			82.1		%		70-130	01-APR-16
Cobalt (Co)			90.5		%		70-130	01-APR-16
Copper (Cu)			82.1		%		70-130	01-APR-16

Quality Control Report

Client: CH2M HILL, INC
2525 Airpark Drive
Redding CA 96001
Contact: Mark Cichy

Test	Matrix	Reference	Result	Qualifier	Units	RPD	Limit	Analyzed
MET-200.2-CCMS-VA	**Soil**							
Batch R3429363								
WG2283469-7 MS		**L1746804-1**						
Iron (Fe)			N/A	MS-B	%		-	01-APR-16
Lead (Pb)			89.7		%		70-130	01-APR-16
Lithium (Li)			88.2		%		70-130	01-APR-16
Magnesium (Mg)			N/A	MS-B	%		-	01-APR-16
Manganese (Mn)			N/A	MS-B	%		-	01-APR-16
Molybdenum (Mo)			93.0		%		70-130	01-APR-16
Nickel (Ni)			83.8		%		70-130	01-APR-16
Phosphorus (P)			93.7		%		70-130	01-APR-16
Potassium (K)			86.5		%		70-130	01-APR-16
Selenium (Se)			81.7		%		70-130	01-APR-16
Silver (Ag)			92.4		%		70-130	01-APR-16
Sodium (Na)			92.2		%		70-130	01-APR-16
Strontium (Sr)			89.3		%		70-130	01-APR-16
Thallium (Tl)			84.9		%		70-130	01-APR-16
Tin (Sn)			81.5		%		70-130	01-APR-16
Titanium (Ti)			N/A	MS-B	%		-	01-APR-16
Uranium (U)			94.8		%		70-130	01-APR-16
Vanadium (V)			93.7		%		70-130	01-APR-16
Zinc (Zn)			N/A	MS-B	%		-	01-APR-16
WG2283487-7 MS		**L1746804-29**						
Aluminum (Al)			N/A	MS-B	%		-	04-APR-16
Antimony (Sb)			97.3		%		70-130	04-APR-16
Arsenic (As)			94.6		%		70-130	04-APR-16
Barium (Ba)			70.8		%		70-130	04-APR-16
Beryllium (Be)			95.5		%		70-130	04-APR-16
Bismuth (Bi)			94.9		%		70-130	04-APR-16
Boron (B)			85.9		%		70-130	04-APR-16
Cadmium (Cd)			96.6		%		70-130	04-APR-16
Calcium (Ca)			N/A	MS-B	%		-	04-APR-16
Chromium (Cr)			92.7		%		70-130	04-APR-16
Cobalt (Co)			94.4		%		70-130	04-APR-16
Copper (Cu)			93.2		%		70-130	04-APR-16
Iron (Fe)			N/A	MS-B	%		-	04-APR-16
Lead (Pb)			95.1		%		70-130	04-APR-16

Quality Control Report

Client: CH2M HILL, INC
2525 Airpark Drive
Redding CA 96001
Contact: Mark Cichy

Test	Matrix	Reference	Result	Qualifier	Units	RPD	Limit	Analyzed
MET-200.2-CCMS-VA	**Soil**							
Batch R3429363								
WG2283487-7 MS		**L1746804-29**						
Lithium (Li)			94.8		%		70-130	04-APR-16
Magnesium (Mg)			N/A	MS-B	%		-	04-APR-16
Manganese (Mn)			N/A	MS-B	%		-	04-APR-16
Molybdenum (Mo)			89.0		%		70-130	04-APR-16
Nickel (Ni)			93.2		%		70-130	04-APR-16
Phosphorus (P)			85.6		%		70-130	04-APR-16
Potassium (K)			96.3		%		70-130	04-APR-16
Selenium (Se)			86.0		%		70-130	04-APR-16
Silver (Ag)			91.9		%		70-130	04-APR-16
Sodium (Na)			94.1		%		70-130	04-APR-16
Strontium (Sr)			88.1		%		70-130	04-APR-16
Thallium (Tl)			94.9		%		70-130	04-APR-16
Tin (Sn)			90.1		%		70-130	04-APR-16
Titanium (Ti)			N/A	MS-B	%		-	04-APR-16
Uranium (U)			97.5		%		70-130	04-APR-16
Vanadium (V)			96.3		%		70-130	04-APR-16
Zinc (Zn)			84.9		%		70-130	04-APR-16
OM-LOI-SK	**Soil**							
Batch R3434989								
WG2286377-1 DUP		**L1746804-20**						
Organic Matter		2.4	2.2		%	6.0	20	09-APR-16
Loss on Ignition @ 375 C		2.7	2.5		%	6.9	25	09-APR-16
WG2286377-3 IRM		**SAL2001**						
Organic Matter			106.7		%		80-120	09-APR-16
Loss on Ignition @ 375 C			106.8		%		80-120	09-APR-16
WG2286377-2 MB								
Organic Matter			<1.0		%		1	09-APR-16
Loss on Ignition @ 375 C			<1.0		%		1	09-APR-16
PH-1:2-VA	**Soil**							
Batch R3429000								
WG2283469-2 DUP		**L1746804-2**						
pH (1:2 soil:water)		7.39	7.39	J	pH	0.00	0.3	01-APR-16
WG2283487-2 DUP		**L1746804-28**						
pH (1:2 soil:water)		7.88	7.90	J	pH	0.02	0.3	01-APR-16

Quality Control Report

Client: CH2M HILL, INC
2525 Airpark Drive
Redding CA 96001
Contact: Mark Cichy

Test	Matrix	Reference	Result	Qualifier	Units	RPD	Limit	Analyzed
PH-1:2-VA	**Soil**							
Batch R3429000								
WG2283469-6 IRM		**VA-ALP-SRS1507**						
pH (1:2 soil:water)			7.72		pH		7.52-8.12	01-APR-16
WG2283487-6 IRM		**VA-ALP-SRS1507**						
pH (1:2 soil:water)			7.75		pH		7.52-8.12	01-APR-16
Batch R3430262								
WG2283433-8 DUP		**L1746804-30**						
pH (1:2 soil:water)		6.20	6.22	J	pH	0.02	0.3	05-APR-16
WG2283433-7 IRM		**VA-ALP-SRS1507**						
pH (1:2 soil:water)			7.81		pH		7.52-8.12	05-APR-16
PH-PASTE-VA	**Soil**							
Batch R3428467								
WG2283406-4 DUP		**L1746804-25**						
Paste pH		9.17	9.02	J	pH	0.15	0.3	31-MAR-16
WG2283406-3 IRM		**VA-ALP-SRS1507**						
Paste pH			7.33		pH		7.02-7.62	31-MAR-16
WG2283406-2 LCS								
Paste pH			6.74		pH		6.44-7.64	31-MAR-16
Batch R3429614								
WG2283470-4 DUP		**L1746856-5**						
Paste pH		7.06	7.01	J	pH	0.05	0.3	04-APR-16
WG2283470-3 IRM		**VA-ALP-SRS1507**						
Paste pH			7.30		pH		7.02-7.62	04-APR-16
WG2283470-2 LCS								
Paste pH			6.83		pH		6.44-7.64	04-APR-16
Batch R3430008								
WG2283492-4 DUP		**L1746804-28**						
Paste pH		7.45	7.43	J	pH	0.02	0.3	04-APR-16
WG2283492-3 IRM		**VA-ALP-SRS1507**						
Paste pH			7.29		pH		7.02-7.62	04-APR-16
WG2283492-2 LCS								
Paste pH			6.86		pH		6.44-7.64	04-APR-16
PSA-D1140-SK	**Soil**							
Batch R3434576								
WG2284127-1 DUP		**L1746804-31**						
PSA % < 75UM		45.4	44.7	J	%	0.72	5	08-APR-16
WG2284127-2 IRM		**10-105_SOIL**						
PSA % < 75UM			77.5		%		69-79	08-APR-16

Quality Control Report

Client: CH2M HILL, INC
2525 Airpark Drive
Redding CA 96001
Contact: Mark Cichy

Test	Matrix	Reference	Result	Qualifier	Units	RPD	Limit	Analyzed
S-TOT-LECO-SK	**Soil**							
Batch R3434580								
WG2284018-1 DUP		**L1746804-11**						
Sulfur (S)-Total		1500	1500		mg/kg	1.9	30	05-APR-16
WG2284018-4 DUP		**L1746804-31**						
Sulfur (S)-Total		2100	1500	J	mg/kg	600	1000	05-APR-16
WG2284018-2 IRM		**1646A_SOIL**						
Sulfur (S)-Total			3000		mg/kg		2500-4600	05-APR-16
WG2284018-5 IRM		**1646A_SOIL**						
Sulfur (S)-Total			2700		mg/kg		2500-4600	05-APR-16
WG2284018-3 MB								
Sulfur (S)-Total			<500		mg/kg		500	05-APR-16
WG2284018-6 MB								
Sulfur (S)-Total			<500		mg/kg		500	05-APR-16

Quality Control Report

Workorder: L1746804 Report Date: 25-APR-16

Client: CH2M HILL, INC
2525 Airpark Drive
Redding CA 96001
Contact: Mark Cichy

Legend:

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

Sample Parameter Qualifier Definitions:

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

Quality Control Report

Workorder: L1746804 Report Date: 25-APR-16

Client: CH2M HILL, INC
2525 Airpark Drive
Redding CA 96001
Contact: Mark Cichy

Hold Time Exceedances:

ALS Product Description	Sample ID	Sampling Date	Date Processed	Rec. HT	Actual HT	Units	Qualifier
Physical Tests							
Organic Matter by LOI at 375 deg C.							
	12	09-MAR-16 12:01	09-APR-16 00:00	28	31	days	EHT
	17	10-MAR-16 10:14	09-APR-16 00:00	28	30	days	EHT
	20	10-MAR-16 11:06	09-APR-16 00:00	28	30	days	EHT

Legend & Qualifier Definitions:

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

Notes*:
Where actual sampling date is not provided to ALS, the date (& time) of receipt is used for calculation purposes.
Where actual sampling time is not provided to ALS, the earlier of 12 noon on the sampling date or the time (& date) of receipt is used for calculation purposes. Samples for L1746804 were received on 19-MAR-16 20:00.

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

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

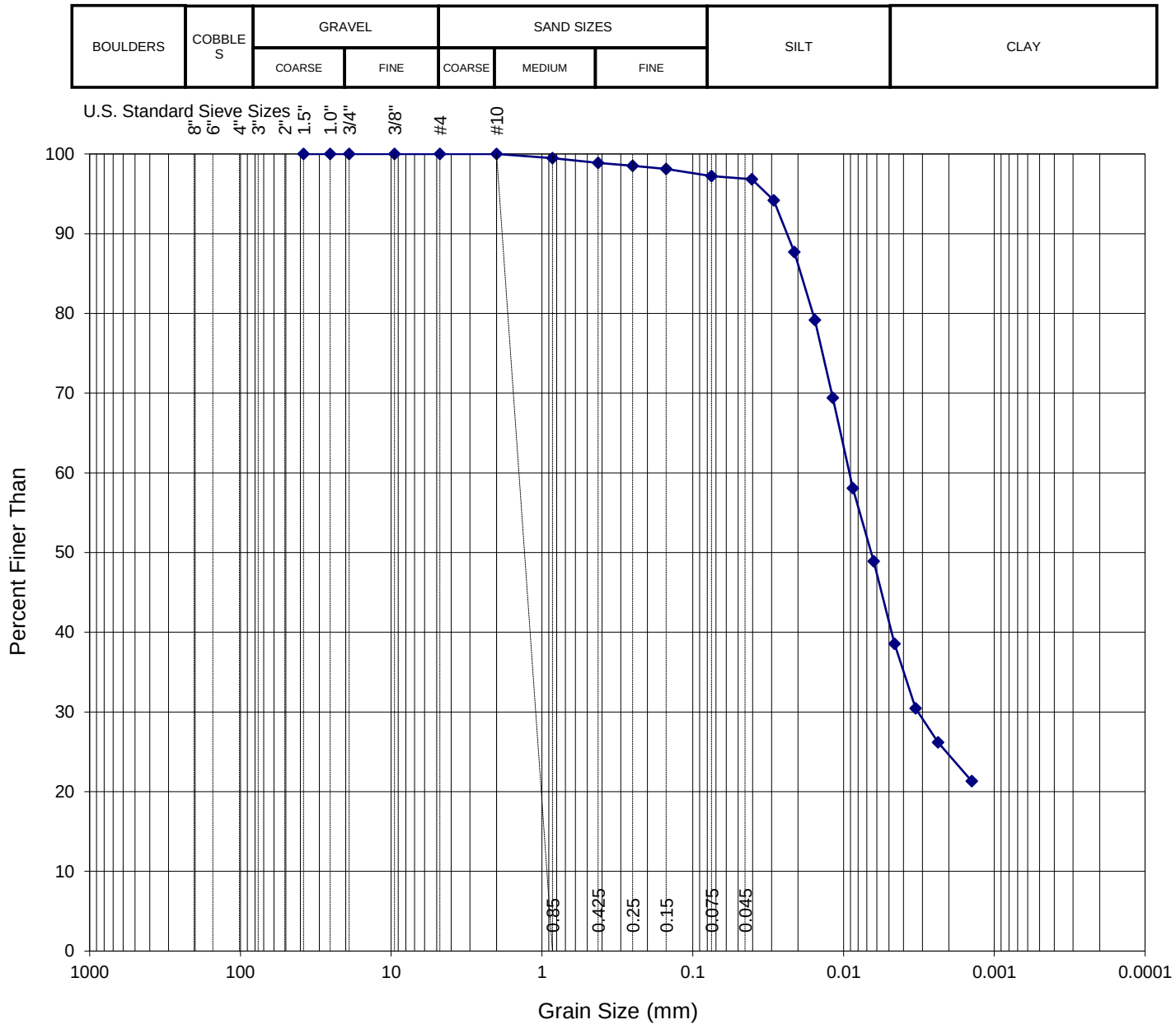
Please note that this report may contain QC results from anonymous Sample Duplicates and Matrix Spikes that do not originate from this Work Order.

ALS Laboratory Group

819-58th Street, Saskatoon,SK

PARTICLE SIZE DISTRIBUTION CURVE

Client Name:	CH2M HILL, INC
Project Number:	CHM400-CHM200-VA
Client Sample ID	CH16-201-BH008_SOA1
Lab Sample ID	L1746804-1
Date Sample Received	19-Mar-16
Test Completion Date:	01-Apr-16
Analyst:	HML



METHOD DESCRIPTION

Method Reference: ASTM D 422 - 63 (2002)

Dispersion method: Mechanical

Dispesion period: 1 minute cm/s

Soil classification system used: ASTM D422-63 Classification

DESCRIPTION OF SAND AND GRAVEL PARTICLES

Shape: Angular

Hardness: Hard

SUMMARY OF RESULTS

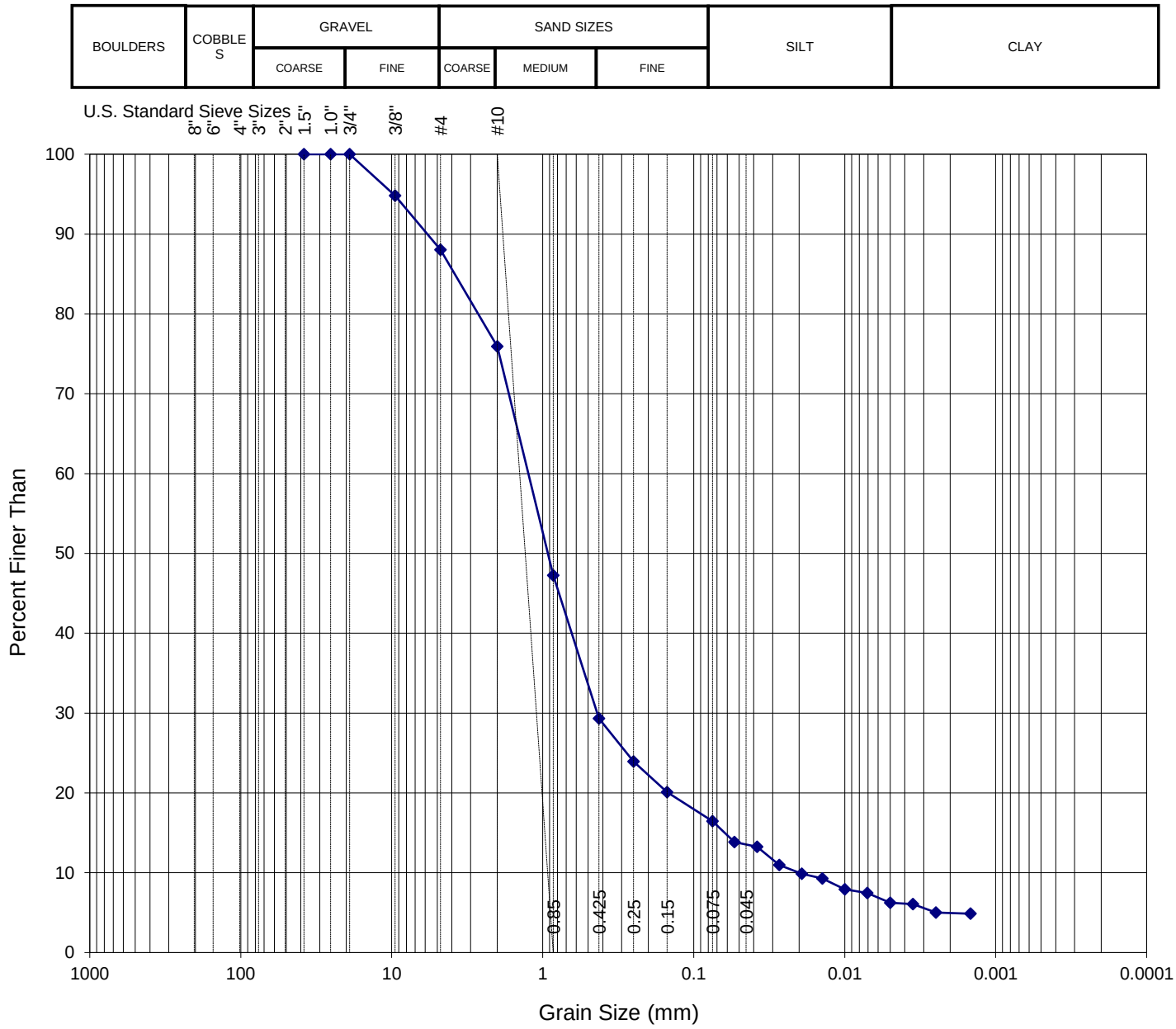
GRAIN SIZE	WT %	DIA. RANGE (mm)
% GRAVEL :	<1	> 4.75
% COARSE SAND :	<1	2.0 - 4.75
% MEDIUM SAND :	1.13	0.425 - 2.0
% FINE SAND :	1.66	0.075 - 0.425
% SILT :	55.87	0.075 - 0.005
% CLAY :	41.35	< 0.005

ALS Laboratory Group

819-58th Street, Saskatoon,SK

PARTICLE SIZE DISTRIBUTION CURVE

Client Name:	CH2M HILL, INC
Project Number:	CHM400-CHM200-VA
Client Sample ID	CH16-201-BH009_SOA1
Lab Sample ID	L1746804-10
Date Sample Received	19-Mar-16
Test Completion Date:	01-Apr-16
Analyst:	HML



METHOD DESCRIPTION

Method Reference: ASTM D 422 - 63 (2002)

Dispersion method: Mechanical

Dispesion period: 1 minute cm/s

Soil classification system used: ASTM D422-63 Classification

DESCRIPTION OF SAND AND GRAVEL PARTICLES

Shape: Angular

Hardness: Hard

SUMMARY OF RESULTS

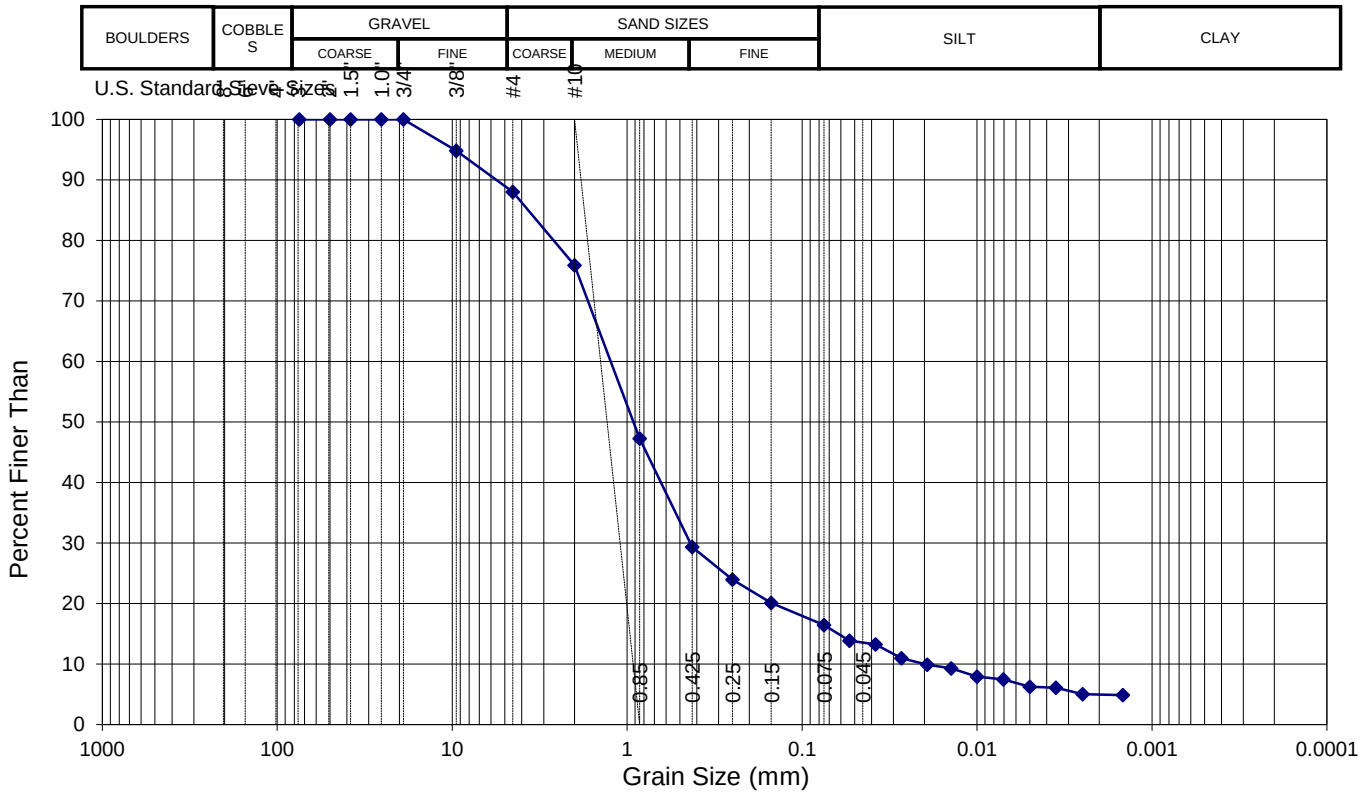
GRAIN SIZE	WT %	DIA. RANGE (mm)
% GRAVEL :	11.95	> 4.75
% COARSE SAND :	12.13	2.0 - 4.75
% MEDIUM SAND :	46.58	0.425 - 2.0
% FINE SAND :	12.87	0.075 - 0.425
% SILT :	10.23	0.075 - 0.005
% CLAY :	6.24	< 0.005

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PARTICLE SIZE DISTRIBUTION CURVE

Client Name:	CH2M HILL, INC
Project Number:	CHM400-CHM200-VA
Client Sample ID	CH16-201-BH009_SOA1
Lab Sample ID	L1746804-10
Date Sample Received	19-Mar-16
Test Completion Date:	01-Apr-16
Analyst:	HML



PARTICLE SIZE DISTRIBUTION

Particle Size range (mm)	Weight %	Passing %	Method
> 300 mm	0	100	Sieve
75 mm	0	100	Sieve
50 mm	0	100	Sieve
37.5 mm	0	100	Sieve
25 mm	0	100	Sieve
19 mm	0	100	Sieve
9.5 mm	5	94.827164	Sieve
4.75 mm	6	88.384925	Sieve
2 mm	12	75.912216	Sieve
0.85 mm	29	47.258084	Sieve
0.425 mm	18	29.335646	Sieve
0.25 mm	5	23.942703	Sieve
0.106 mm	6	17.974884	Sieve
0.075 mm	2	16.470644	Hydrometer
0.045 mm	3	13.515388	Hydrometer
0.033 mm	1	12.19238	Hydrometer
0.023 mm	2	10.40387	Hydrometer
0.017 mm	1	9.6304962	Hydrometer
0.012 mm	1	8.5874972	Hydrometer
0.009 mm	1	7.7594328	Hydrometer
0.006 mm	1	6.8285237	Hydrometer
0.005 mm	1	6.2439075	Hydrometer
0.0046 mm	0	6.2000994	Hydrometer
0.003 mm	1	5.5425067	Hydrometer
0.002 mm	1	4.5194231	Hydrometer
0.0015 mm	1	4.0078814	Hydrometer
0.001 mm	1	3.4963396	Hydrometer

METHOD DESCRIPTION

Method Reference: ASTM D 422 - 63 (2002)

Dispersion method: Mechanical

Dispesion period: 1 minute cm/s

Soil classification system used: Unified Soil Classification

DESCRIPTION OF SAND AND GRAVEL PARTICLES

Shape: Angular

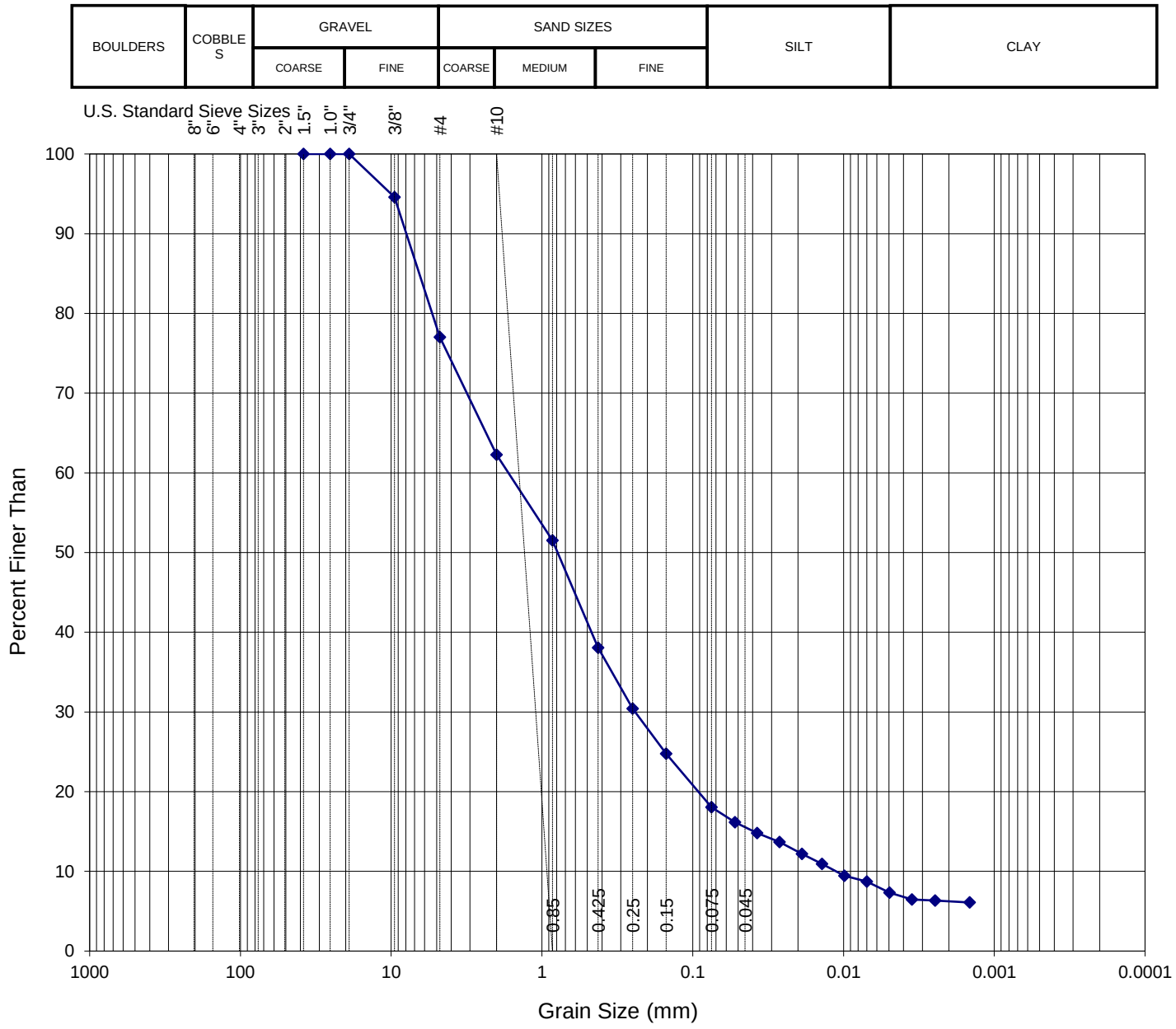
Hardness: Hard

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PARTICLE SIZE DISTRIBUTION CURVE

Client Name: CH2M HILL, INC
Project Number: CHM400-CHM200-VA
Client Sample ID CH16-201-BH009_SOB2
Lab Sample ID L1746804-12
Date Sample Received 19-Mar-16
Test Completion Date: 01-Apr-16
Analyst: HML



METHOD DESCRIPTION

Method Reference: ASTM D 422 - 63 (2002)

Dispersion method: Mechanical

Dispesion period: 1 minute cm/s

Soil classification system used: ASTM D422-63 Classification

DESCRIPTION OF SAND AND GRAVEL PARTICLES

Shape: Angular
Hardness: Hard

SUMMARY OF RESULTS

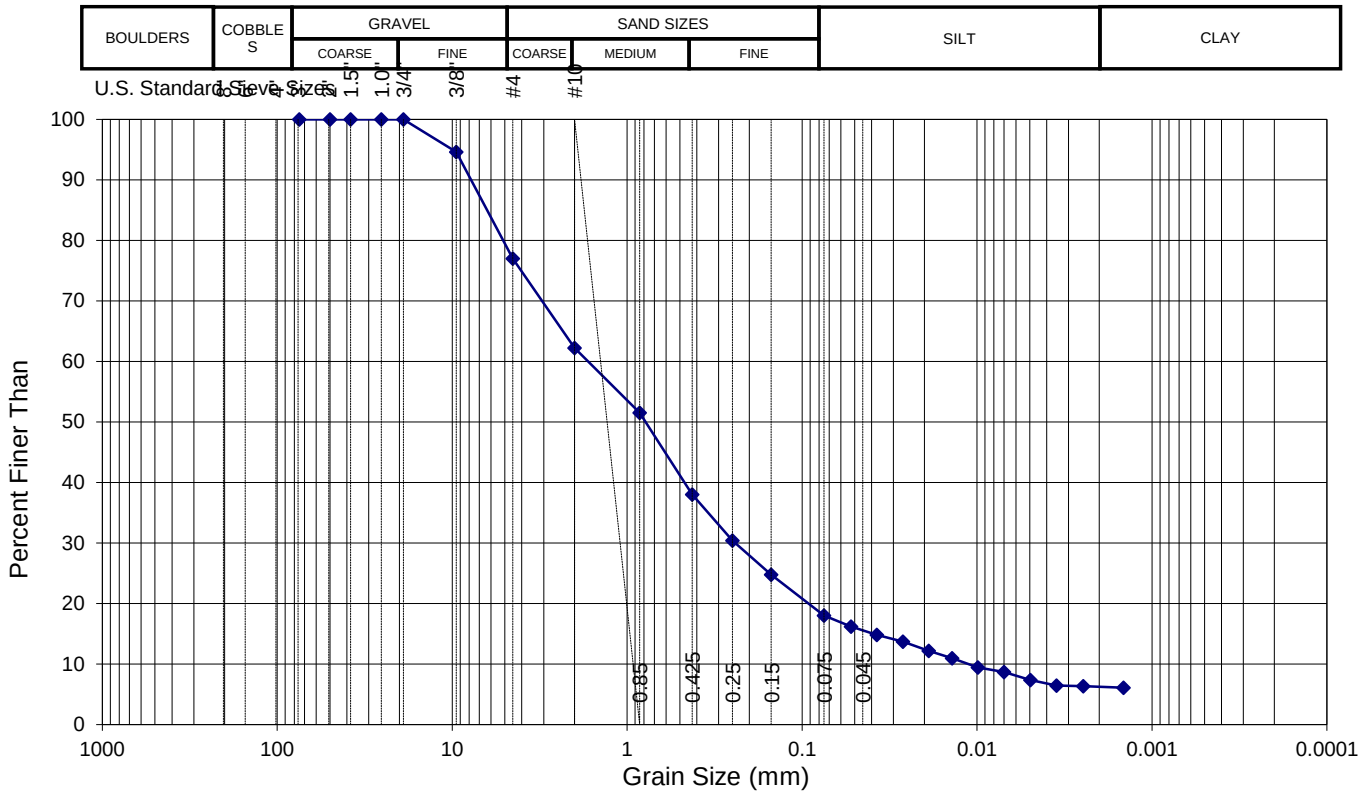
GRAIN SIZE	WT %	DIA. RANGE (mm)
% GRAVEL :	22.99	> 4.75
% COARSE SAND :	14.76	2.0 - 4.75
% MEDIUM SAND :	24.20	0.425 - 2.0
% FINE SAND :	20.00	0.075 - 0.425
% SILT :	10.66	0.075 - 0.005
% CLAY :	7.38	< 0.005

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PARTICLE SIZE DISTRIBUTION CURVE

Client Name:	CH2M HILL, INC
Project Number:	CHM400-CHM200-VA
Client Sample ID	CH16-201-BH009_SOB2
Lab Sample ID	L1746804-12
Date Sample Received	19-Mar-16
Test Completion Date:	01-Apr-16
Analyst:	HML



PARTICLE SIZE DISTRIBUTION

Particle Size range (mm)	Weight %	Passing %	Method
> 300 mm	0	100	Sieve
75 mm	0	100	Sieve
50 mm	0	100	Sieve
37.5 mm	0	100	Sieve
25 mm	0	100	Sieve
19 mm	0	100	Sieve
9.5 mm	5	94.597095	Sieve
4.75 mm	17	77.893576	Sieve
2 mm	16	62.25198	Sieve
0.85 mm	11	51.504987	Sieve
0.425 mm	13	38.048286	Sieve
0.25 mm	8	30.423648	Sieve
0.106 mm	10	20.827532	Sieve
0.075 mm	3	18.047843	Hydrometer
0.045 mm	3	15.500358	Hydrometer
0.033 mm	1	14.357649	Hydrometer
0.023 mm	1	12.996525	Hydrometer
0.017 mm	1	11.725647	Hydrometer
0.012 mm	1	10.251607	Hydrometer
0.009 mm	1	9.2308416	Hydrometer
0.006 mm	1	8.0439179	Hydrometer
0.005 mm	1	7.3766414	Hydrometer
0.0046 mm	0	7.1308809	Hydrometer
0.003 mm	1	6.4098469	Hydrometer
0.002 mm	0	6.2905021	Hydrometer
0.0015 mm	0	6.2308297	Hydrometer
0.001 mm	0	6.1711572	Hydrometer

METHOD DESCRIPTION

Method Reference: ASTM D 422 - 63 (2002)

Dispersion method: Mechanical

Dispesion period: 1 minute cm/s

Soil classification system used: Unified Soil Classification

DESCRIPTION OF SAND AND GRAVEL PARTICLES

Shape: Angular

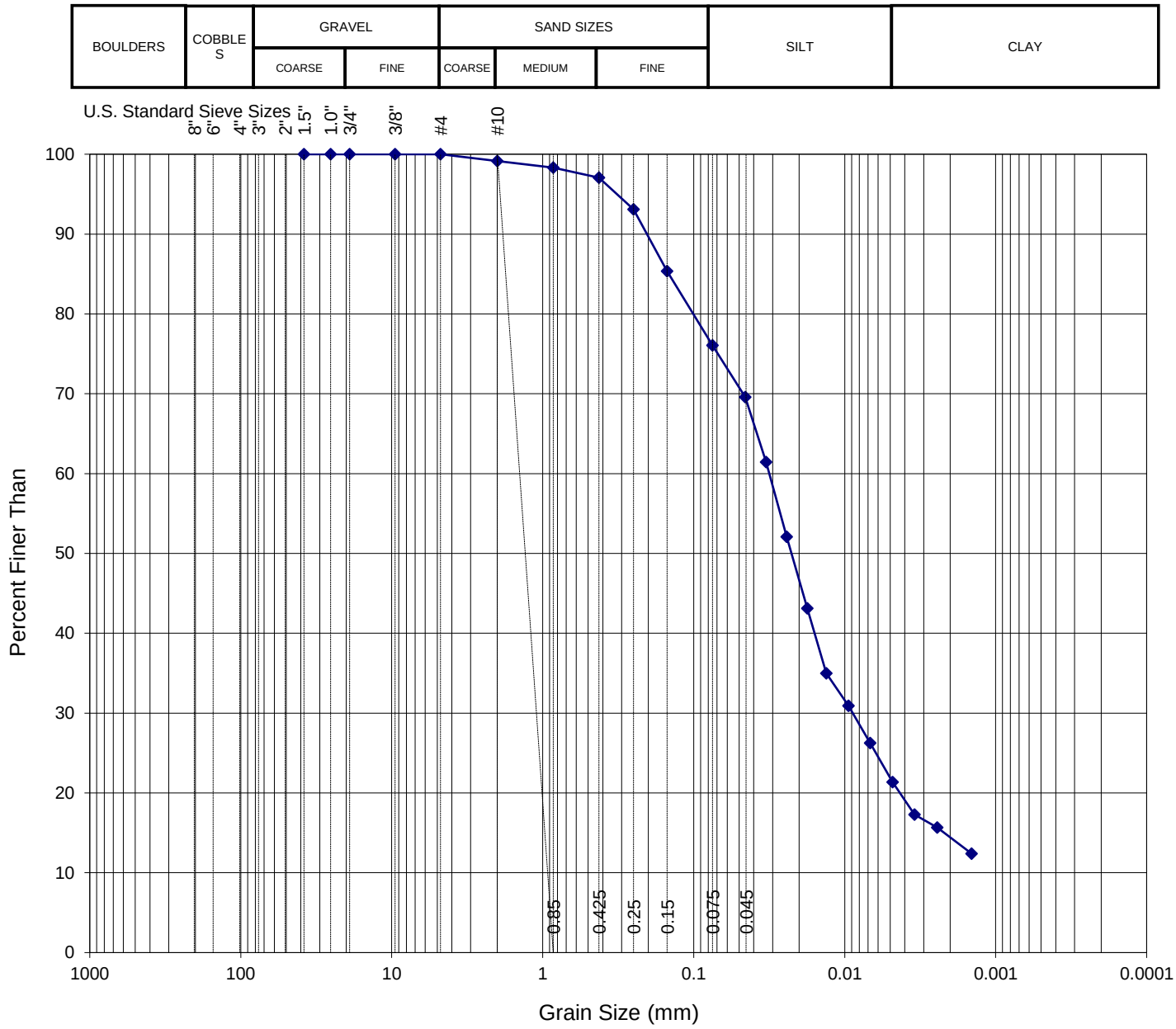
Hardness: Hard

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PARTICLE SIZE DISTRIBUTION CURVE

Client Name:	CH2M HILL, INC
Project Number:	CHM400-CHM200-VA
Client Sample ID	CH16-201-BH010A_SOA1
Lab Sample ID	L1746804-17
Date Sample Received	19-Mar-16
Test Completion Date:	01-Apr-16
Analyst:	HML



METHOD DESCRIPTION

Method Reference: ASTM D 422 - 63 (2002)

Dispersion method: Mechanical

Dispesion period: 1 minute cm/s

Soil classification system used: ASTM D422-63 Classification

DESCRIPTION OF SAND AND GRAVEL PARTICLES

Shape: Angular

Hardness: Hard

SUMMARY OF RESULTS

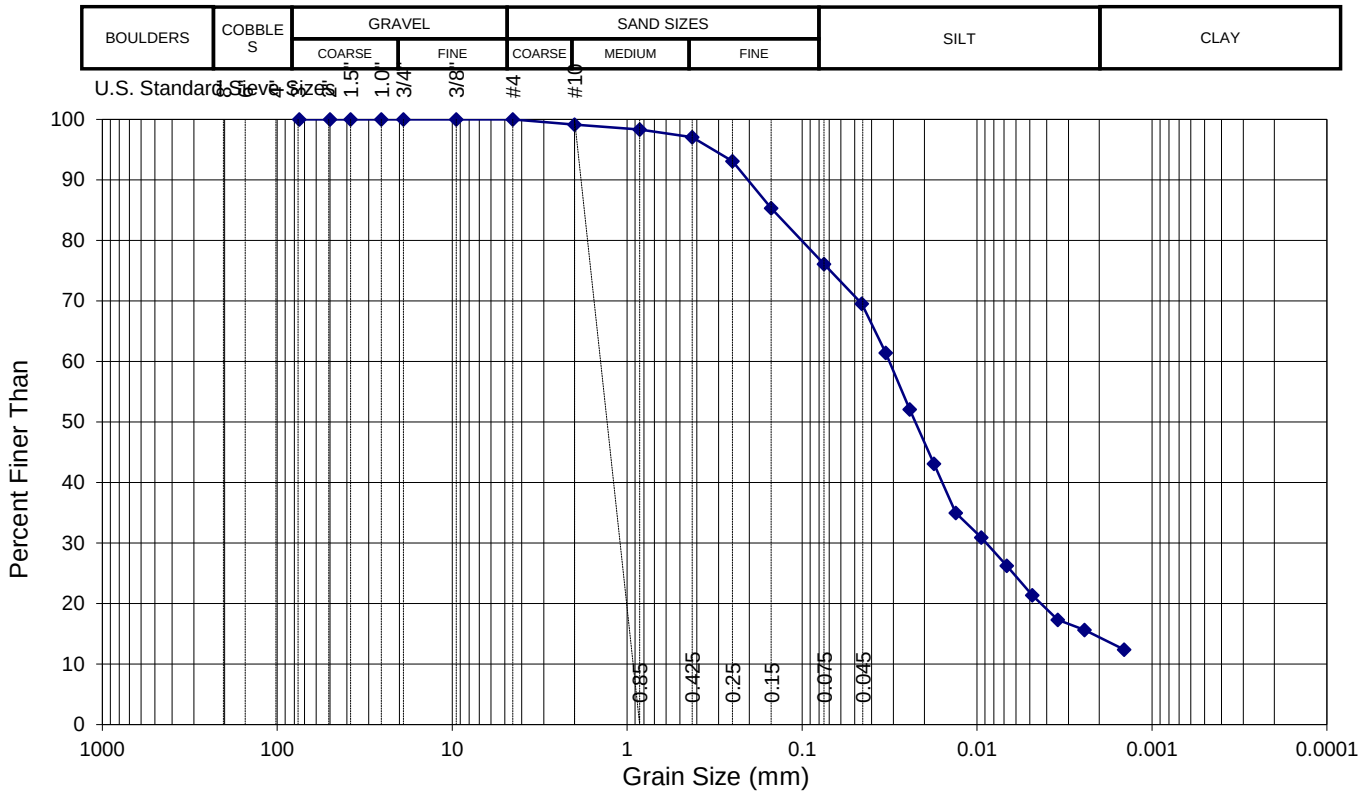
GRAIN SIZE	WT %	DIA. RANGE (mm)
% GRAVEL :	<1	> 4.75
% COARSE SAND :	<1	2.0 - 4.75
% MEDIUM SAND :	2.09	0.425 - 2.0
% FINE SAND :	20.99	0.075 - 0.425
% SILT :	54.20	0.075 - 0.005
% CLAY :	21.87	< 0.005

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PARTICLE SIZE DISTRIBUTION CURVE

Client Name:	CH2M HILL, INC
Project Number:	CHM400-CHM200-VA
Client Sample ID	CH16-201-BH010A_SOA1
Lab Sample ID	L1746804-17
Date Sample Received	19-Mar-16
Test Completion Date:	01-Apr-16
Analyst:	HML



PARTICLE SIZE DISTRIBUTION

Particle Size range (mm)	Weight %	Passing %	Method
> 300 mm	0	100	Sieve
75 mm	0	100	Sieve
50 mm	0	100	Sieve
37.5 mm	0	100	Sieve
25 mm	0	100	Sieve
19 mm	0	100	Sieve
9.5 mm	0	100	Sieve
4.75 mm	0	100	Sieve
2 mm	1	99.150765	Sieve
0.85 mm	1	98.327324	Sieve
0.425 mm	1	97.063481	Sieve
0.25 mm	4	93.096806	Sieve
0.106 mm	13	79.909301	Sieve
0.075 mm	4	76.070211	Hydrometer
0.045 mm	7	69.179658	Hydrometer
0.033 mm	8	61.209537	Hydrometer
0.023 mm	11	50.375552	Hydrometer
0.017 mm	8	41.929958	Hydrometer
0.012 mm	8	33.673816	Hydrometer
0.009 mm	4	30.126792	Hydrometer
0.006 mm	6	24.30496	Hydrometer
0.005 mm	3	21.798094	Hydrometer
0.0046 mm	1	20.693721	Hydrometer
0.003 mm	4	16.569313	Hydrometer
0.002 mm	2	14.965869	Hydrometer
0.0015 mm	1	14.164147	Hydrometer
0.001 mm	1	13.362424	Hydrometer

METHOD DESCRIPTION

Method Reference: ASTM D 422 - 63 (2002)

Dispersion method: Mechanical

Dispesion period: 1 minute cm/s

Soil classification system used: Unified Soil Classification

DESCRIPTION OF SAND AND GRAVEL PARTICLES

Shape: Angular

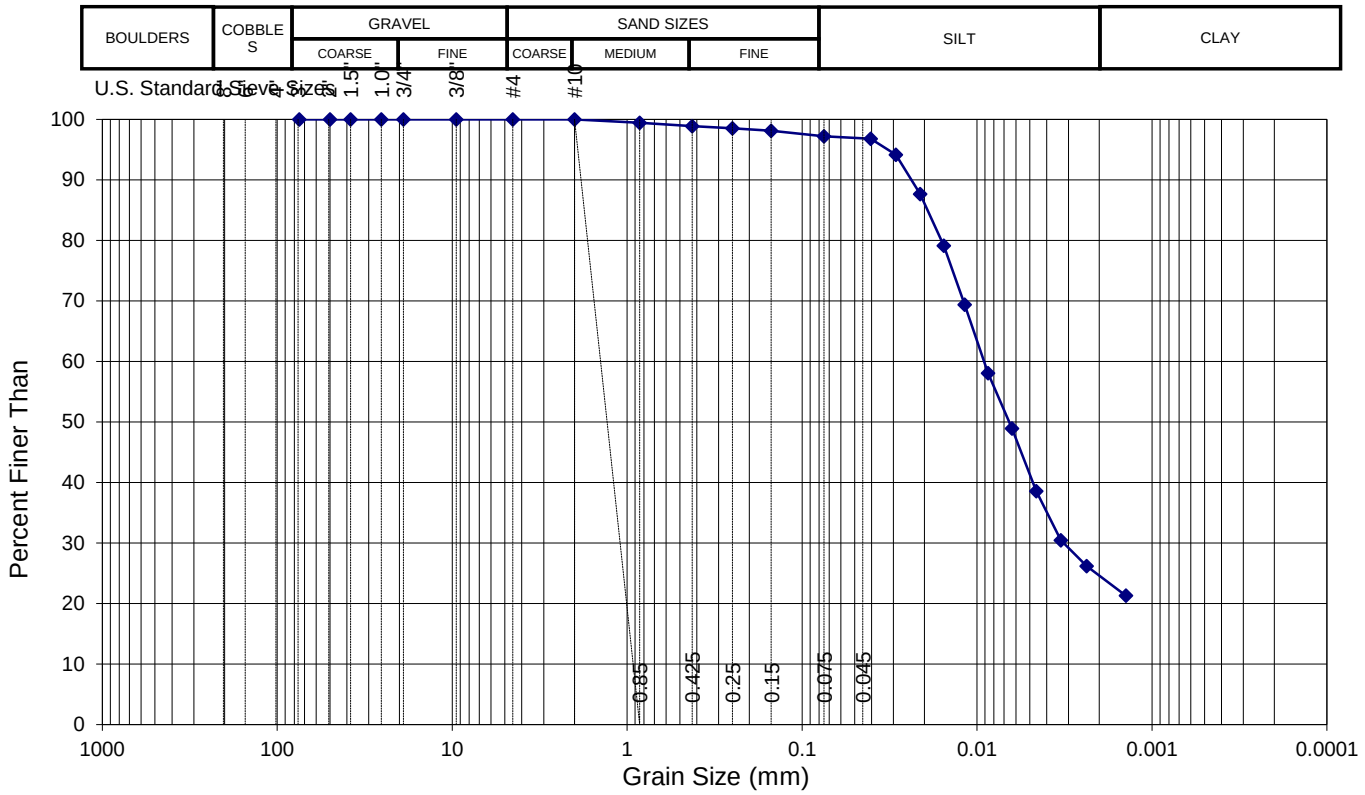
Hardness: Hard

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PARTICLE SIZE DISTRIBUTION CURVE

Client Name:	CH2M HILL, INC
Project Number:	CHM400-CHM200-VA
Client Sample ID	CH16-201-BH008_SOA1
Lab Sample ID	L1746804-1
Date Sample Received	19-Mar-16
Test Completion Date:	01-Apr-16
Analyst:	HML



PARTICLE SIZE DISTRIBUTION

Particle Size range (mm)	Weight %	Passing %	Method
> 300 mm	0	100	Sieve
75 mm	0	100	Sieve
50 mm	0	100	Sieve
37.5 mm	0	100	Sieve
25 mm	0	100	Sieve
19 mm	0	100	Sieve
9.5 mm	0	100	Sieve
4.75 mm	0	100	Sieve
2 mm	0	100	Sieve
0.85 mm	1	99.466159	Sieve
0.425 mm	1	98.872033	Sieve
0.25 mm	0	98.50829	Sieve
0.106 mm	1	97.58472	Sieve
0.075 mm	0	97.214894	Hydrometer
0.045 mm	0	96.872345	Hydrometer
0.033 mm	2	95.083591	Hydrometer
0.023 mm	6	89.197103	Hydrometer
0.017 mm	8	81.406587	Hydrometer
0.012 mm	11	70.021443	Hydrometer
0.009 mm	11	59.264919	Hydrometer
0.006 mm	12	47.012452	Hydrometer
0.005 mm	6	41.029431	Hydrometer
0.0046 mm	2	38.636223	Hydrometer
0.003 mm	10	29.00667	Hydrometer
0.002 mm	4	24.563267	Hydrometer
0.0015 mm	2	22.341566	Hydrometer
0.001 mm	2	20.119865	Hydrometer

METHOD DESCRIPTION

Method Reference: ASTM D 422 - 63 (2002)

Dispersion method: Mechanical

Dispesion period: 1 minute cm/s

Soil classification system used: Unified Soil Classification

DESCRIPTION OF SAND AND GRAVEL PARTICLES

Shape: Angular

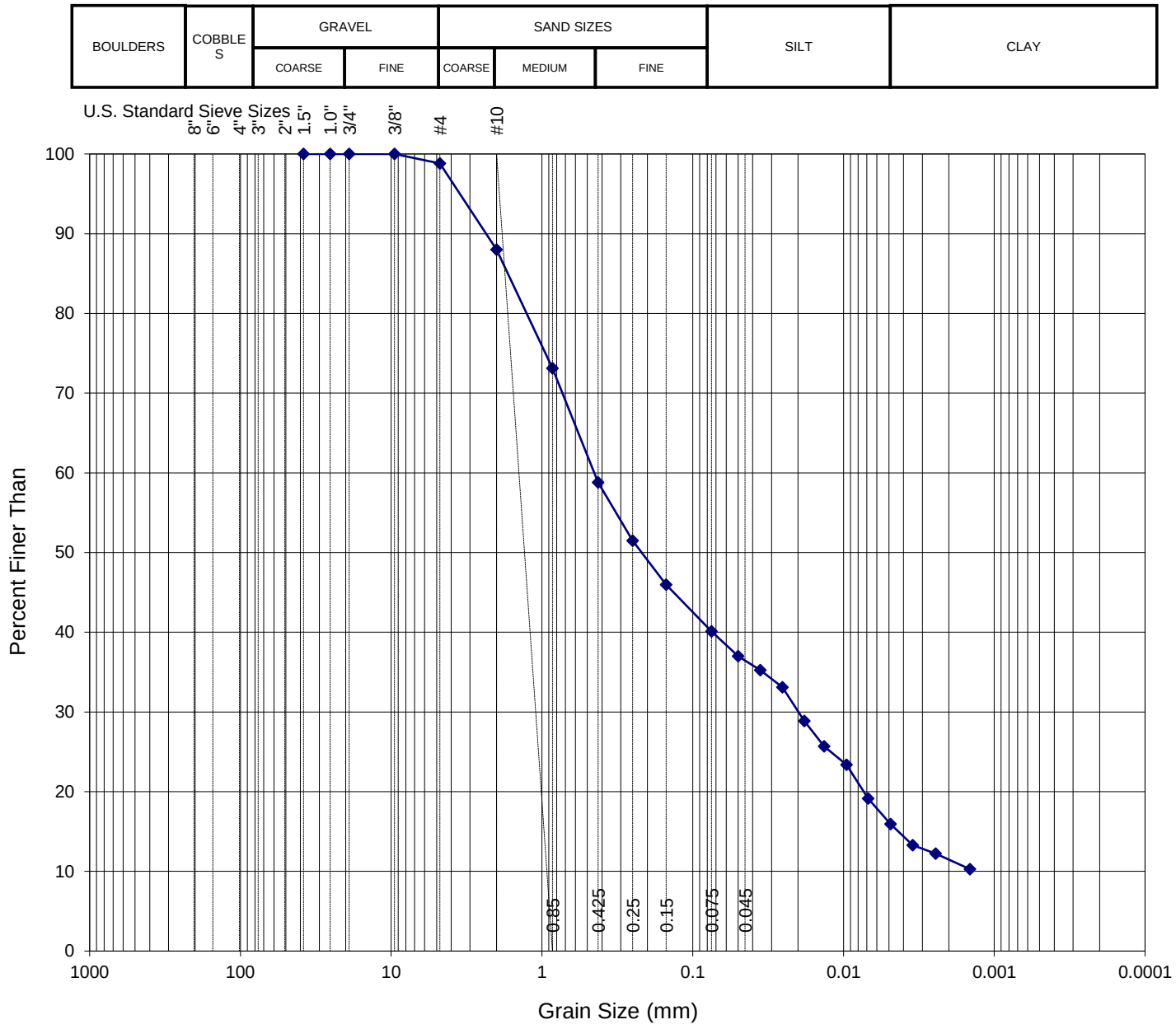
Hardness: Hard

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PARTICLE SIZE DISTRIBUTION CURVE

Client Name:	CH2M HILL, INC
Project Number:	CHM400-CHM200-VA
Client Sample ID	CH16-201-BH008_SOA2
Lab Sample ID	L1746804-2
Date Sample Received	19-Mar-16
Test Completion Date:	01-Apr-16
Analyst:	HML



METHOD DESCRIPTION

Method Reference: ASTM D 422 - 63 (2002)

Dispersion method: Mechanical

Dispesion period: 1 minute cm/s

Soil classification system used: ASTM D422-63 Classification

DESCRIPTION OF SAND AND GRAVEL PARTICLES

Shape: Angular

Hardness: Hard

SUMMARY OF RESULTS

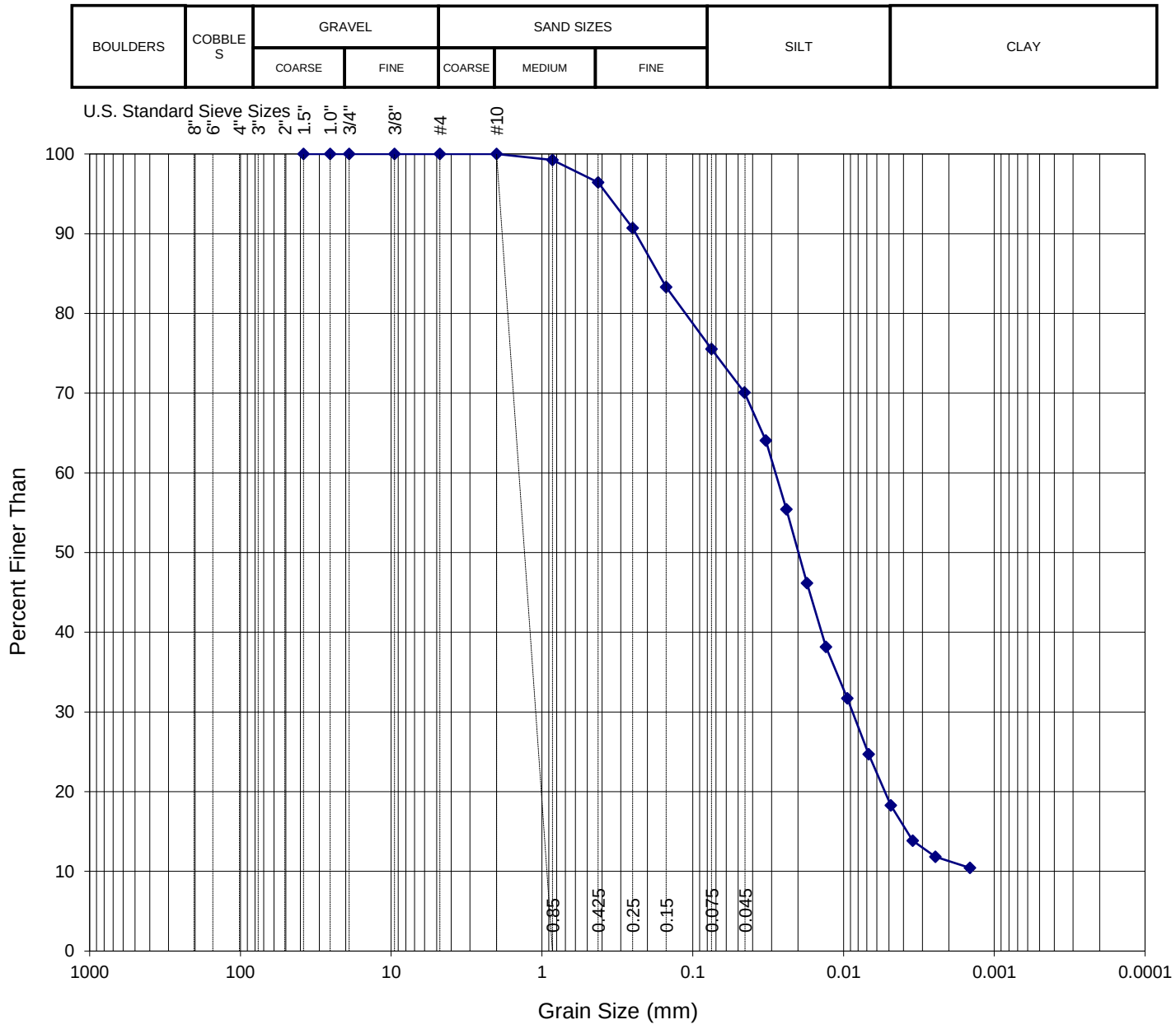
GRAIN SIZE	WT %	DIA. RANGE (mm)
% GRAVEL :	1.19	> 4.75
% COARSE SAND :	10.81	2.0 - 4.75
% MEDIUM SAND :	29.20	0.425 - 2.0
% FINE SAND :	18.67	0.075 - 0.425
% SILT :	23.93	0.075 - 0.005
% CLAY :	16.19	< 0.005

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PARTICLE SIZE DISTRIBUTION CURVE

Client Name:	CH2M HILL, INC
Project Number:	CHM400-CHM200-VA
Client Sample ID	CH16-201-BH010A_SOB4
Lab Sample ID	L1746804-20
Date Sample Received	19-Mar-16
Test Completion Date:	01-Apr-16
Analyst:	HML



METHOD DESCRIPTION

Method Reference: ASTM D 422 - 63 (2002)

Dispersion method: Mechanical

Dispesion period: 1 minute cm/s

Soil classification system used: ASTM D422-63 Classification

DESCRIPTION OF SAND AND GRAVEL PARTICLES

Shape: Angular

Hardness: Hard

SUMMARY OF RESULTS

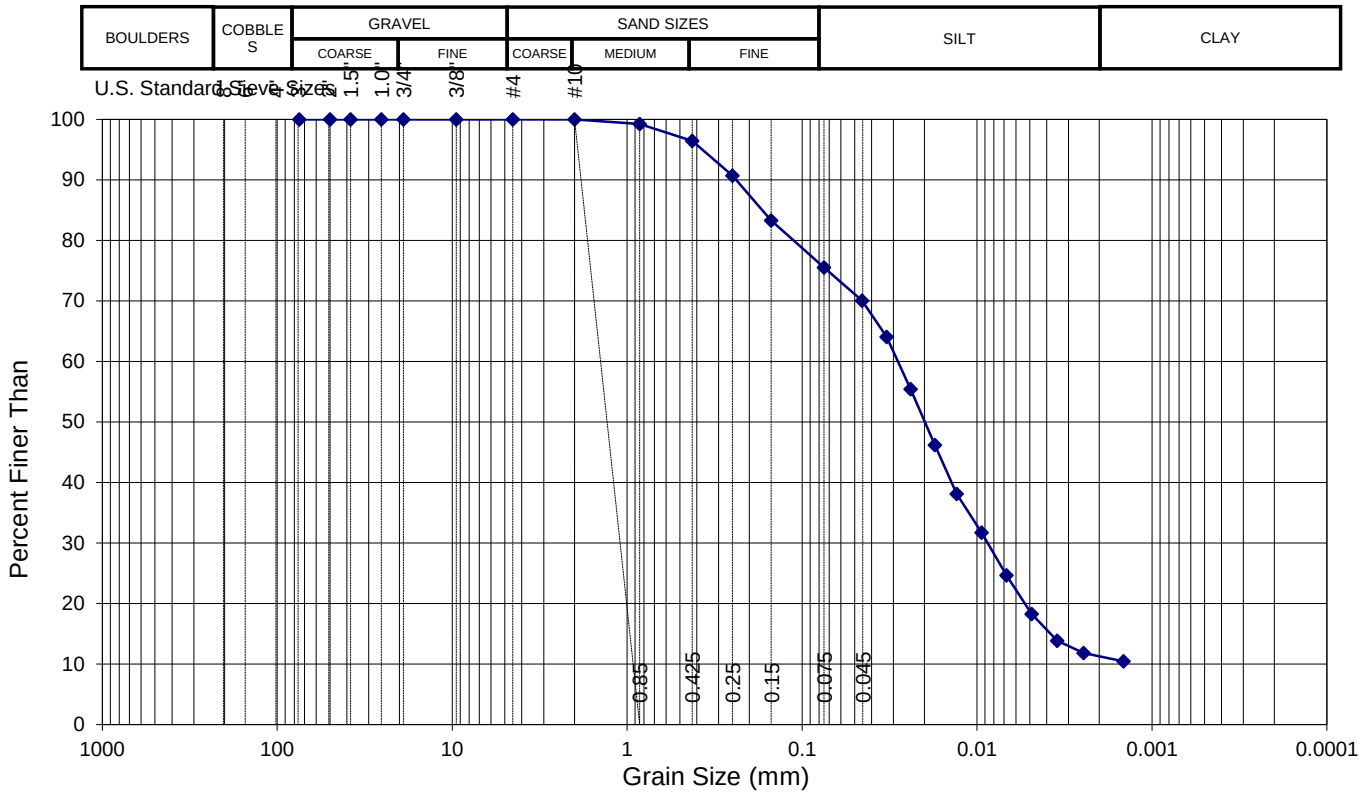
GRAIN SIZE	WT %	DIA. RANGE (mm)
% GRAVEL :	<1	> 4.75
% COARSE SAND :	<1	2.0 - 4.75
% MEDIUM SAND :	3.57	0.425 - 2.0
% FINE SAND :	20.88	0.075 - 0.425
% SILT :	56.74	0.075 - 0.005
% CLAY :	18.80	< 0.005

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PARTICLE SIZE DISTRIBUTION CURVE

Client Name:	CH2M HILL, INC
Project Number:	CHM400-CHM200-VA
Client Sample ID	CH16-201-BH010A_SOB4
Lab Sample ID	L1746804-20
Date Sample Received	19-Mar-16
Test Completion Date:	01-Apr-16
Analyst:	HML



PARTICLE SIZE DISTRIBUTION

Particle Size range (mm)	Weight %	Passing %	Method
> 300 mm	0	100	Sieve
75 mm	0	100	Sieve
50 mm	0	100	Sieve
37.5 mm	0	100	Sieve
25 mm	0	100	Sieve
19 mm	0	100	Sieve
9.5 mm	0	100	Sieve
4.75 mm	0	100	Sieve
2 mm	0	100	Sieve
0.85 mm	1	99.238275	Sieve
0.425 mm	3	96.426476	Sieve
0.25 mm	6	90.724376	Sieve
0.106 mm	12	78.753321	Sieve
0.075 mm	3	75.544276	Hydrometer
0.045 mm	6	69.902292	Hydrometer
0.033 mm	6	64.140584	Hydrometer
0.023 mm	10	54.096695	Hydrometer
0.017 mm	9	45.357058	Hydrometer
0.012 mm	9	36.2637	Hydrometer
0.009 mm	6	30.595311	Hydrometer
0.006 mm	9	22.05003	Hydrometer
0.005 mm	3	18.726483	Hydrometer
0.0046 mm	1	17.430923	Hydrometer
0.003 mm	5	12.909473	Hydrometer
0.002 mm	2	10.943751	Hydrometer
0.0015 mm	1	9.9608901	Hydrometer
0.001 mm	1	8.9780291	Hydrometer

METHOD DESCRIPTION

Method Reference: ASTM D 422 - 63 (2002)

Dispersion method: Mechanical

Dispesion period: 1 minute cm/s

Soil classification system used: Unified Soil Classification

DESCRIPTION OF SAND AND GRAVEL PARTICLES

Shape: Angular

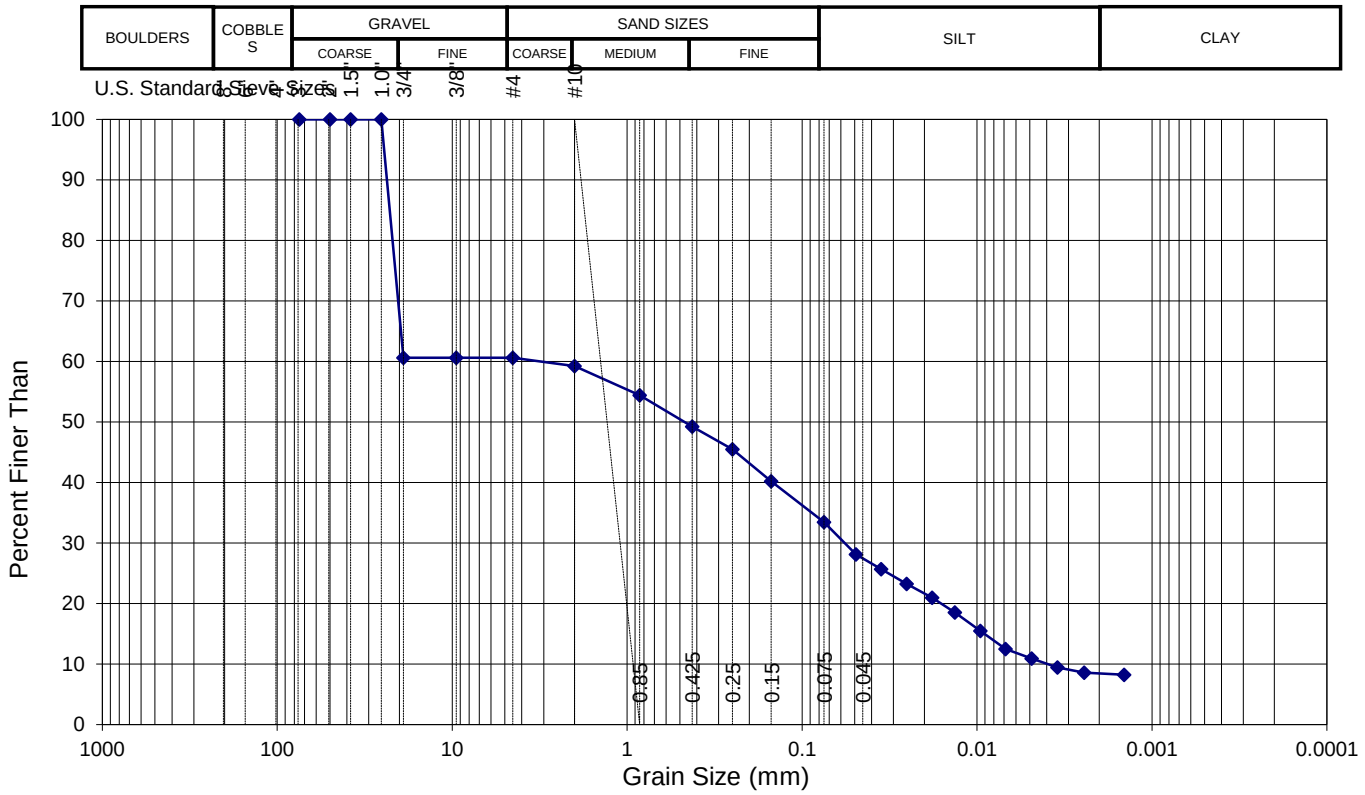
Hardness: Hard

ALS Laboratory Group

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PARTICLE SIZE DISTRIBUTION CURVE

Client Name:	CH2M HILL, INC
Project Number:	CHM400-CHM200-VA
Client Sample ID	CH16-201-BH012_SOB
Lab Sample ID	L1746804-23
Date Sample Received	19-Mar-16
Test Completion Date:	06-Apr-16
Analyst:	HML



PARTICLE SIZE DISTRIBUTION

Particle Size range (mm)	Weight %	Passing %	Method
> 300 mm	0	100	Sieve
75 mm	0	100	Sieve
50 mm	0	100	Sieve
37.5 mm	0	100	Sieve
25 mm	2	97.539664	Sieve
19 mm	37	60.634623	Sieve
9.5 mm	0	60.634623	Sieve
4.75 mm	0	60.634623	Sieve
2 mm	1	59.218761	Sieve
0.85 mm	5	54.437211	Sieve
0.425 mm	5	49.246435	Sieve
0.25 mm	4	45.486681	Sieve
0.106 mm	9	36.266177	Sieve
0.075 mm	3	33.47452	Hydrometer
0.045 mm	6	27.370266	Hydrometer
0.033 mm	2	25.132273	Hydrometer
0.023 mm	3	22.536081	Hydrometer
0.017 mm	2	20.406362	Hydrometer
0.012 mm	3	17.444851	Hydrometer
0.009 mm	3	14.85456	Hydrometer
0.006 mm	3	11.796412	Hydrometer
0.005 mm	1	11.011869	Hydrometer
0.0046 mm	0	10.63105	Hydrometer
0.003 mm	2	9.0670349	Hydrometer
0.002 mm	1	8.2355797	Hydrometer
0.0015 mm	0	7.8198522	Hydrometer
0.001 mm	0	7.4041246	Hydrometer

METHOD DESCRIPTION

Method Reference: ASTM D 422 - 63 (2002)

Dispersion method: Mechanical

Dispesion period: 1 minute cm/s

Soil classification system used: Unified Soil Classification

DESCRIPTION OF SAND AND GRAVEL PARTICLES

Shape: Angular

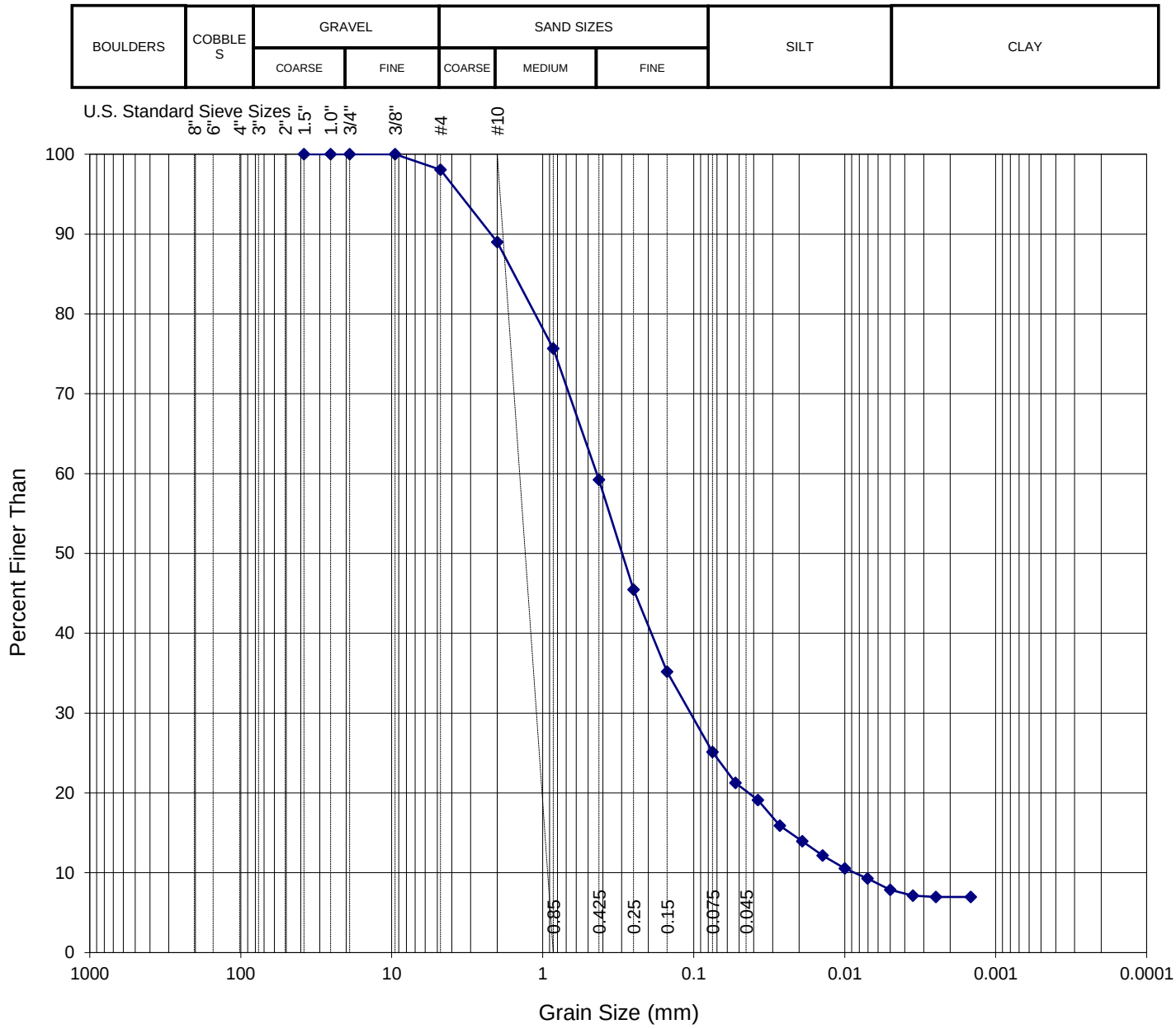
Hardness: Hard

ALS Laboratory Group

819-58th Street, Saskatoon,SK

PARTICLE SIZE DISTRIBUTION CURVE

Client Name:	CH2M HILL, INC
Project Number:	CHM400-CHM200-VA
Client Sample ID	CH16-201-BH012A_SOA1
Lab Sample ID	L1746804-27
Date Sample Received	19-Mar-16
Test Completion Date:	01-Apr-16
Analyst:	HML



METHOD DESCRIPTION

Method Reference: ASTM D 422 - 63 (2002)

Dispersion method: Mechanical

Dispesion period: 1 minute cm/s

Soil classification system used: ASTM D422-63 Classification

DESCRIPTION OF SAND AND GRAVEL PARTICLES

Shape: Angular

Hardness: Hard

SUMMARY OF RESULTS

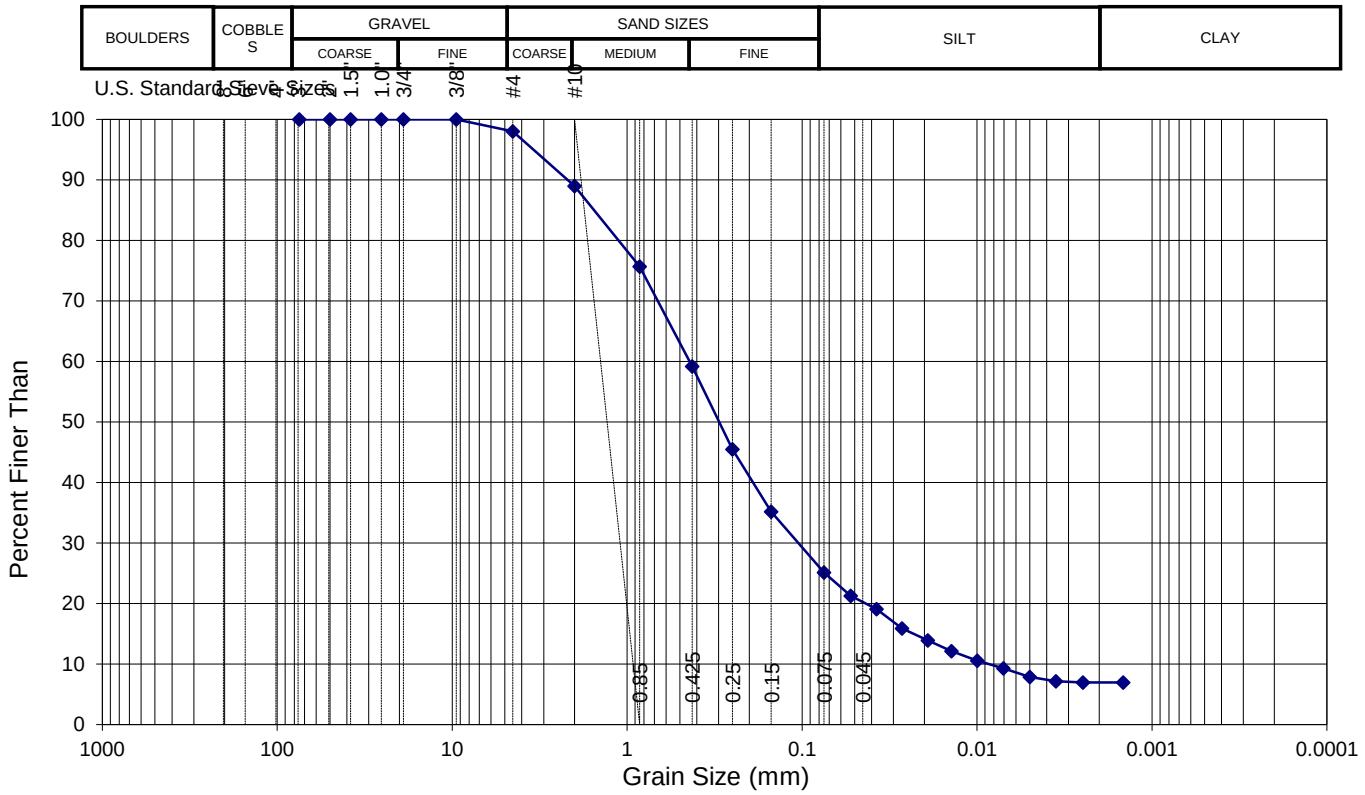
GRAIN SIZE	WT %	DIA. RANGE (mm)
% GRAVEL :	1.96	> 4.75
% COARSE SAND :	9.04	2.0 - 4.75
% MEDIUM SAND :	29.78	0.425 - 2.0
% FINE SAND :	34.07	0.075 - 0.425
% SILT :	17.27	0.075 - 0.005
% CLAY :	7.87	< 0.005

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819-58th Street, Saskatoon,SK

PARTICLE SIZE DISTRIBUTION CURVE

Client Name:	CH2M HILL, INC
Project Number:	CHM400-CHM200-VA
Client Sample ID	CH16-201-BH012A_SOA1
Lab Sample ID	L1746804-27
Date Sample Received	19-Mar-16
Test Completion Date:	01-Apr-16
Analyst:	HML



PARTICLE SIZE DISTRIBUTION

Particle Size range (mm)	Weight %	Passing %	Method
> 300 mm	0	100	Sieve
75 mm	0	100	Sieve
50 mm	0	100	Sieve
37.5 mm	0	100	Sieve
25 mm	0	100	Sieve
19 mm	0	100	Sieve
9.5 mm	0	100	Sieve
4.75 mm	2	98.13799	Sieve
2 mm	9	88.997598	Sieve
0.85 mm	13	75.6721	Sieve
0.425 mm	16	59.215542	Sieve
0.25 mm	14	45.473069	Sieve
0.106 mm	16	29.288318	Sieve
0.075 mm	4	25.142257	Hydrometer
0.045 mm	5	20.157825	Hydrometer
0.033 mm	2	17.73785	Hydrometer
0.023 mm	3	14.9221	Hydrometer
0.017 mm	2	13.194549	Hydrometer
0.012 mm	2	11.346565	Hydrometer
0.009 mm	1	10.12453	Hydrometer
0.006 mm	2	8.556386	Hydrometer
0.005 mm	1	7.8691712	Hydrometer
0.0046 mm	0	7.6700939	Hydrometer
0.003 mm	1	7.0551376	Hydrometer
0.002 mm	0	6.8848858	Hydrometer
0.0015 mm	0	6.7997599	Hydrometer
0.001 mm	0	6.7146339	Hydrometer

METHOD DESCRIPTION

Method Reference: ASTM D 422 - 63 (2002)

Dispersion method: Mechanical

Dispesion period: 1 minute cm/s

Soil classification system used: Unified Soil Classification

DESCRIPTION OF SAND AND GRAVEL PARTICLES

Shape: Angular

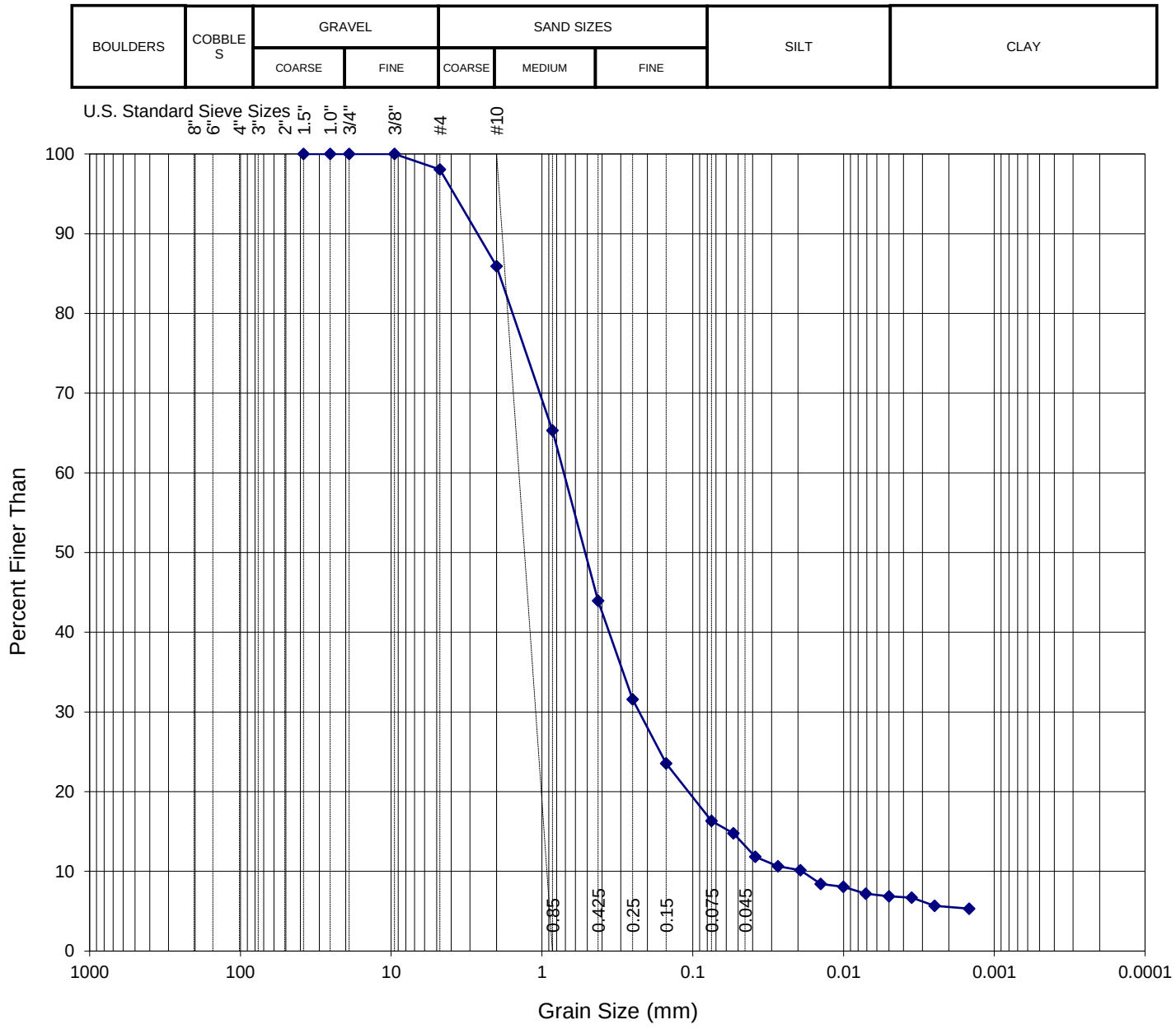
Hardness: Hard

ALS Laboratory Group

819-58th Street, Saskatoon,SK

PARTICLE SIZE DISTRIBUTION CURVE

Client Name:	CH2M HILL, INC
Project Number:	CHM400-CHM200-VA
Client Sample ID	CH16-201-BH012A_SOA2
Lab Sample ID	L1746804-28
Date Sample Received	19-Mar-16
Test Completion Date:	01-Apr-16
Analyst:	HML



METHOD DESCRIPTION

Method Reference: ASTM D 422 - 63 (2002)

Dispersion method: Mechanical

Dispesion period: 1 minute cm/s

Soil classification system used: ASTM D422-63 Classification

DESCRIPTION OF SAND AND GRAVEL PARTICLES

Shape: Angular

Hardness: Hard

SUMMARY OF RESULTS

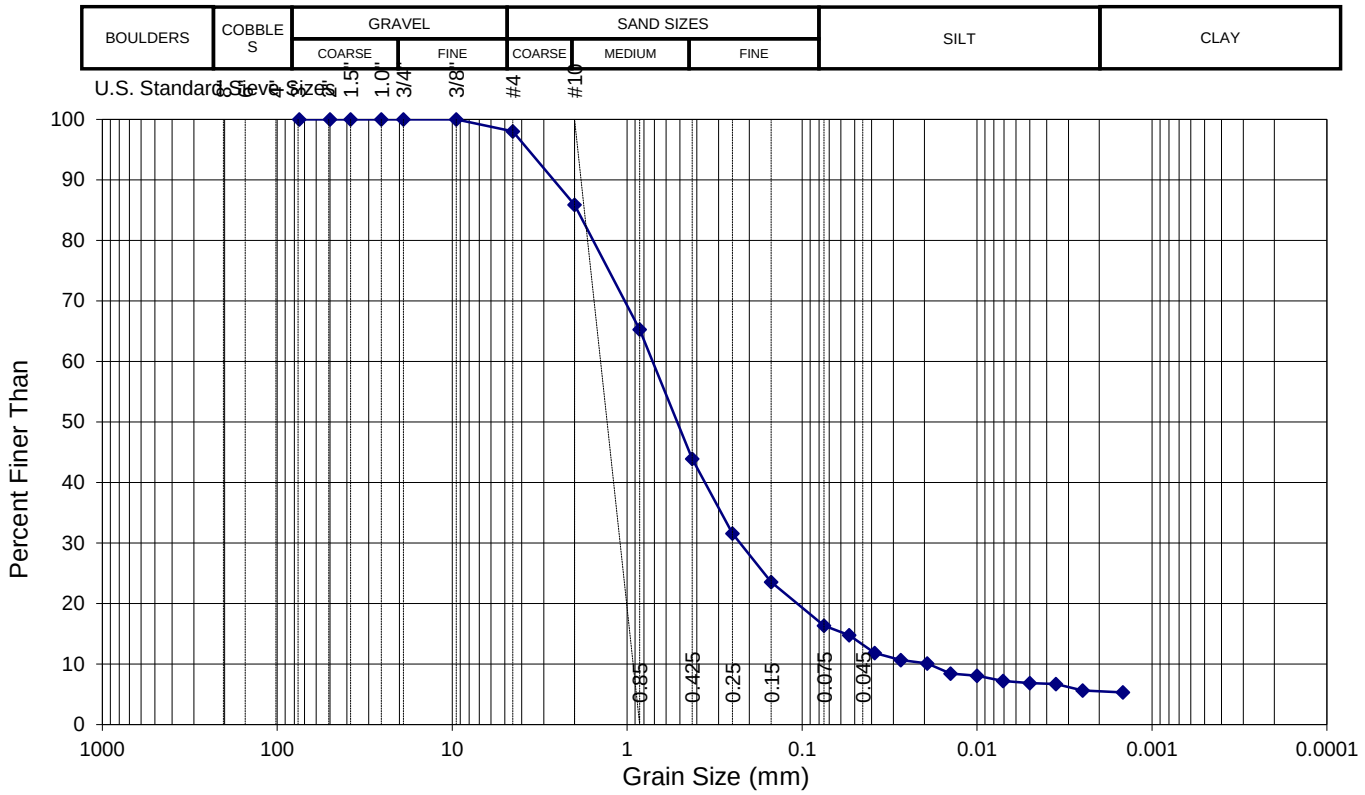
GRAIN SIZE	WT %	DIA. RANGE (mm)
% GRAVEL :	1.96	> 4.75
% COARSE SAND :	12.14	2.0 - 4.75
% MEDIUM SAND :	41.97	0.425 - 2.0
% FINE SAND :	27.59	0.075 - 0.425
% SILT :	9.47	0.075 - 0.005
% CLAY :	6.87	< 0.005

ALS Laboratory Group

819-58th Street, Saskatoon,SK

PARTICLE SIZE DISTRIBUTION CURVE

Client Name:	CH2M HILL, INC
Project Number:	CHM400-CHM200-VA
Client Sample ID	CH16-201-BH012A_SOA2
Lab Sample ID	L1746804-28
Date Sample Received	19-Mar-16
Test Completion Date:	01-Apr-16
Analyst:	HML



PARTICLE SIZE DISTRIBUTION

Particle Size range (mm)	Weight %	Passing %	Method
> 300 mm	0	100	Sieve
75 mm	0	100	Sieve
50 mm	0	100	Sieve
37.5 mm	0	100	Sieve
25 mm	0	100	Sieve
19 mm	0	100	Sieve
9.5 mm	0	100	Sieve
4.75 mm	2	98.135994	Sieve
2 mm	12	85.90247	Sieve
0.85 mm	21	65.294702	Sieve
0.425 mm	21	43.936694	Sieve
0.25 mm	12	31.575913	Sieve
0.106 mm	12	19.318175	Sieve
0.075 mm	3	16.34207	Hydrometer
0.045 mm	3	13.095982	Hydrometer
0.033 mm	2	11.263447	Hydrometer
0.023 mm	1	10.368556	Hydrometer
0.017 mm	1	9.3592048	Hydrometer
0.012 mm	1	8.2325067	Hydrometer
0.009 mm	0	7.7672845	Hydrometer
0.006 mm	1	7.0304823	Hydrometer
0.005 mm	0	6.8674943	Hydrometer
0.0046 mm	0	6.820442	Hydrometer
0.003 mm	1	6.1662683	Hydrometer
0.002 mm	1	5.1790331	Hydrometer
0.0015 mm	0	4.6854155	Hydrometer
0.001 mm	0	4.191798	Hydrometer

METHOD DESCRIPTION

Method Reference: ASTM D 422 - 63 (2002)

Dispersion method: Mechanical

Dispesion period: 1 minute cm/s

Soil classification system used: Unified Soil Classification

DESCRIPTION OF SAND AND GRAVEL PARTICLES

Shape: Angular

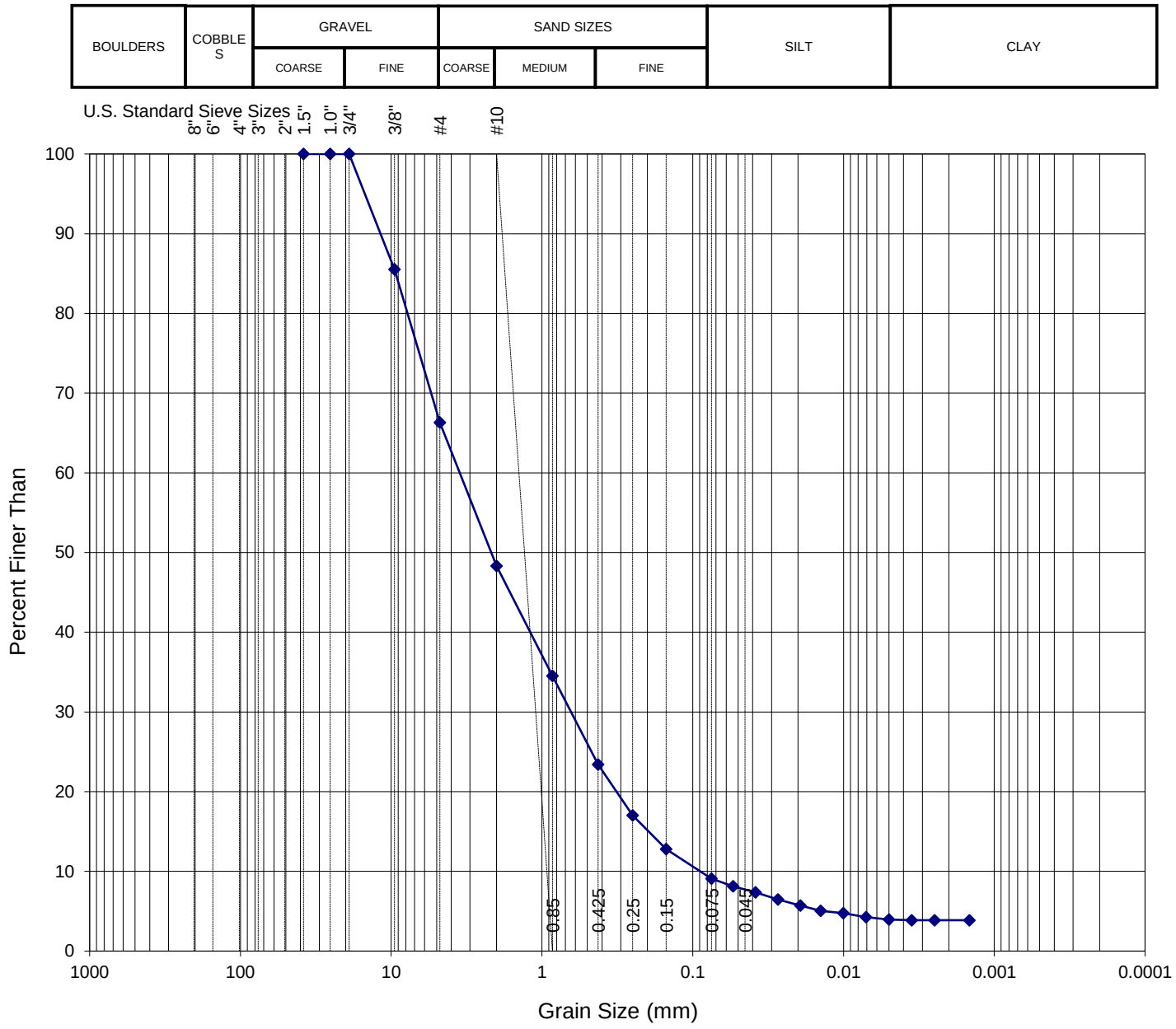
Hardness: Hard

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PARTICLE SIZE DISTRIBUTION CURVE

Client Name:	CH2M HILL, INC
Project Number:	CHM400-CHM200-VA
Client Sample ID	CH16-201-BH012A_SOA4
Lab Sample ID	L1746804-29
Date Sample Received	19-Mar-16
Test Completion Date:	01-Apr-16
Analyst:	HML



METHOD DESCRIPTION

Method Reference: ASTM D 422 - 63 (2002)

Dispersion method: Mechanical

Dispesion period: 1 minute cm/s

Soil classification system used: ASTM D422-63 Classification

DESCRIPTION OF SAND AND GRAVEL PARTICLES

Shape: Angular

Hardness: Hard

SUMMARY OF RESULTS

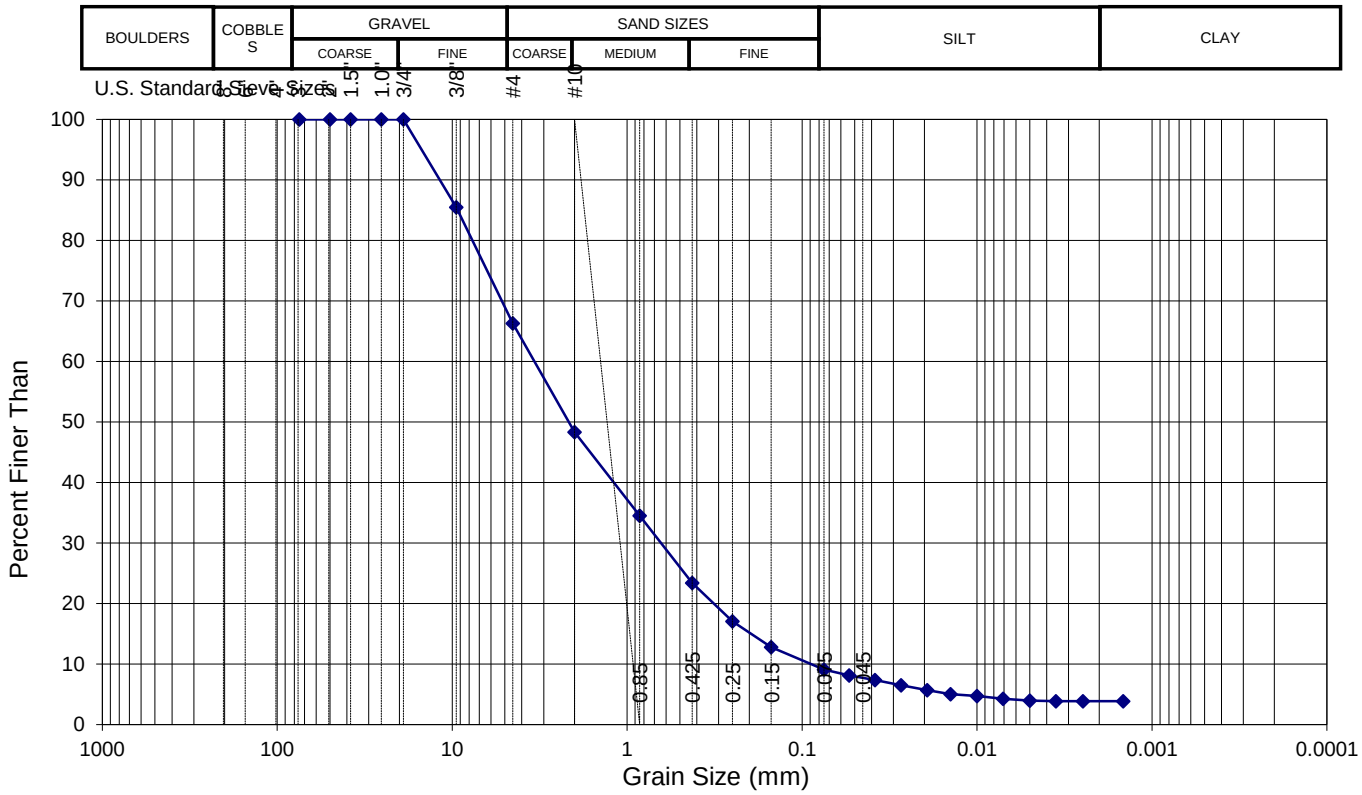
GRAIN SIZE	WT %	DIA. RANGE (mm)
% GRAVEL :	33.69	> 4.75
% COARSE SAND :	17.99	2.0 - 4.75
% MEDIUM SAND :	24.91	0.425 - 2.0
% FINE SAND :	14.33	0.075 - 0.425
% SILT :	5.11	0.075 - 0.005
% CLAY :	3.97	< 0.005

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PARTICLE SIZE DISTRIBUTION CURVE

Client Name: CH2M HILL, INC
Project Number: CHM400-CHM200-VA
Client Sample ID CH16-201-BH012A_SOA4
Lab Sample ID L1746804-29
Date Sample Received 19-Mar-16
Test Completion Date: 01-Apr-16
Analyst: HML



PARTICLE SIZE DISTRIBUTION

Particle Size range (mm)	Weight %	Passing %	Method
> 300 mm	0	100	Sieve
75 mm	0	100	Sieve
50 mm	0	100	Sieve
37.5 mm	0	100	Sieve
25 mm	0	100	Sieve
19 mm	0	100	Sieve
9.5 mm	14	85.5086	Sieve
4.75 mm	18	67.273575	Sieve
2 mm	19	48.326306	Sieve
0.85 mm	14	34.531364	Sieve
0.425 mm	11	23.414025	Sieve
0.25 mm	6	17.036516	Sieve
0.106 mm	6	10.62131	Sieve
0.075 mm	2	9.0832919	Hydrometer
0.045 mm	1	7.6928029	Hydrometer
0.033 mm	1	6.944548	Hydrometer
0.023 mm	1	6.0757039	Hydrometer
0.017 mm	1	5.4096679	Hydrometer
0.012 mm	1	4.8835856	Hydrometer
0.009 mm	0	4.575539	Hydrometer
0.006 mm	0	4.1083525	Hydrometer
0.005 mm	0	3.9701599	Hydrometer
0.0046 mm	0	3.9433378	Hydrometer
0.003 mm	0	3.8727263	Hydrometer
0.002 mm	0	3.8727263	Hydrometer
0.0015 mm	0	3.8727263	Hydrometer
0.001 mm	0	3.8727263	Hydrometer

METHOD DESCRIPTION

Method Reference: ASTM D 422 - 63 (2002)
Dispersion method: Mechanical
Dispesion period: 1 minute cm/s
Soil classification system used: Unified Soil Classification

DESCRIPTION OF SAND AND GRAVEL PARTICLES

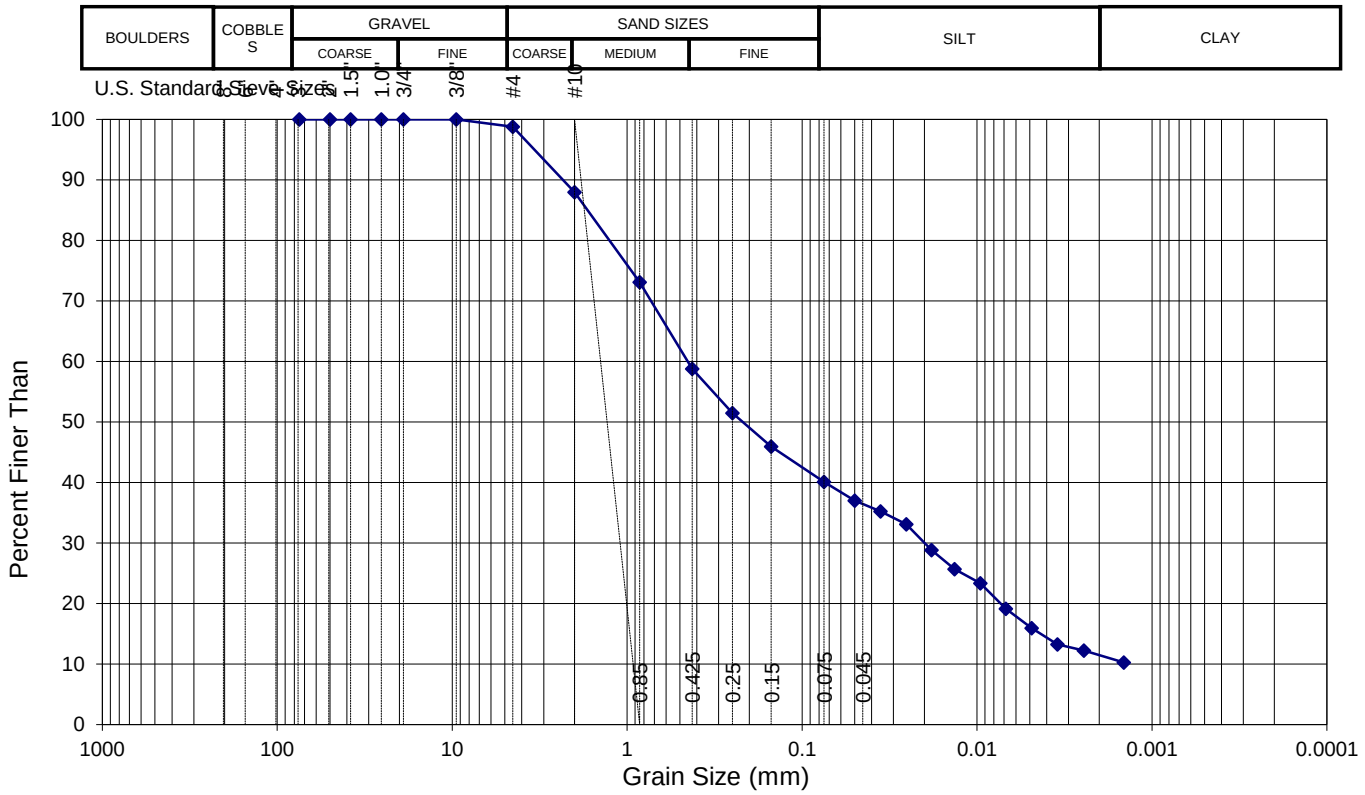
Shape: Angular
Hardness: Hard

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PARTICLE SIZE DISTRIBUTION CURVE

Client Name:	CH2M HILL, INC
Project Number:	CHM400-CHM200-VA
Client Sample ID	CH16-201-BH008_SOA2
Lab Sample ID	L1746804-2
Date Sample Received	19-Mar-16
Test Completion Date:	01-Apr-16
Analyst:	HML



PARTICLE SIZE DISTRIBUTION

Particle Size range (mm)	Weight %	Passing %	Method
> 300 mm	0	100	Sieve
75 mm	0	100	Sieve
50 mm	0	100	Sieve
37.5 mm	0	100	Sieve
25 mm	0	100	Sieve
19 mm	0	100	Sieve
9.5 mm	0	100	Sieve
4.75 mm	1	98.866031	Sieve
2 mm	11	87.997013	Sieve
0.85 mm	15	73.101581	Sieve
0.425 mm	14	58.792058	Sieve
0.25 mm	7	51.490952	Sieve
0.106 mm	9	42.538354	Sieve
0.075 mm	2	40.124429	Hydrometer
0.045 mm	4	36.389483	Hydrometer
0.033 mm	2	34.696271	Hydrometer
0.023 mm	3	31.710163	Hydrometer
0.017 mm	4	28.061645	Hydrometer
0.012 mm	3	24.82251	Hydrometer
0.009 mm	2	22.485391	Hydrometer
0.006 mm	5	17.754263	Hydrometer
0.005 mm	2	16.151594	Hydrometer
0.0046 mm	1	15.431157	Hydrometer
0.003 mm	3	12.793166	Hydrometer
0.002 mm	1	11.754904	Hydrometer
0.0015 mm	1	11.235772	Hydrometer
0.001 mm	1	10.716641	Hydrometer

METHOD DESCRIPTION

Method Reference: ASTM D 422 - 63 (2002)

Dispersion method: Mechanical

Dispesion period: 1 minute cm/s

Soil classification system used: Unified Soil Classification

DESCRIPTION OF SAND AND GRAVEL PARTICLES

Shape: Angular

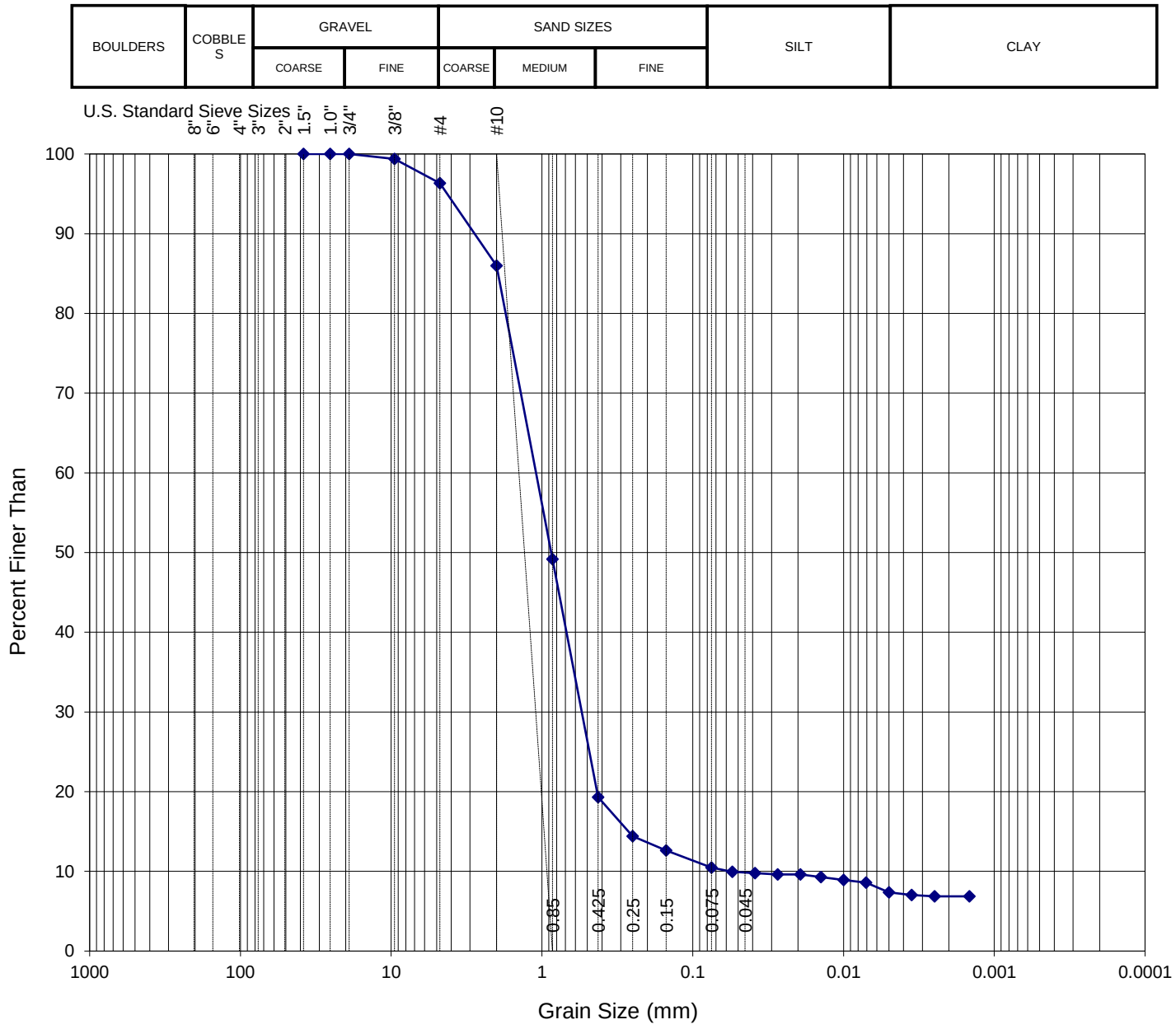
Hardness: Hard

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PARTICLE SIZE DISTRIBUTION CURVE

Client Name:	CH2M HILL, INC
Project Number:	CHM400-CHM200-VA
Client Sample ID	CH16-201-BH008_SOB1
Lab Sample ID	L1746804-3
Date Sample Received	19-Mar-16
Test Completion Date:	01-Apr-16
Analyst:	HML



METHOD DESCRIPTION

Method Reference: ASTM D 422 - 63 (2002)

Dispersion method: Mechanical

Dispesion period: 1 minute cm/s

Soil classification system used: ASTM D422-63 Classification

DESCRIPTION OF SAND AND GRAVEL PARTICLES

Shape: Angular

Hardness: Hard

SUMMARY OF RESULTS

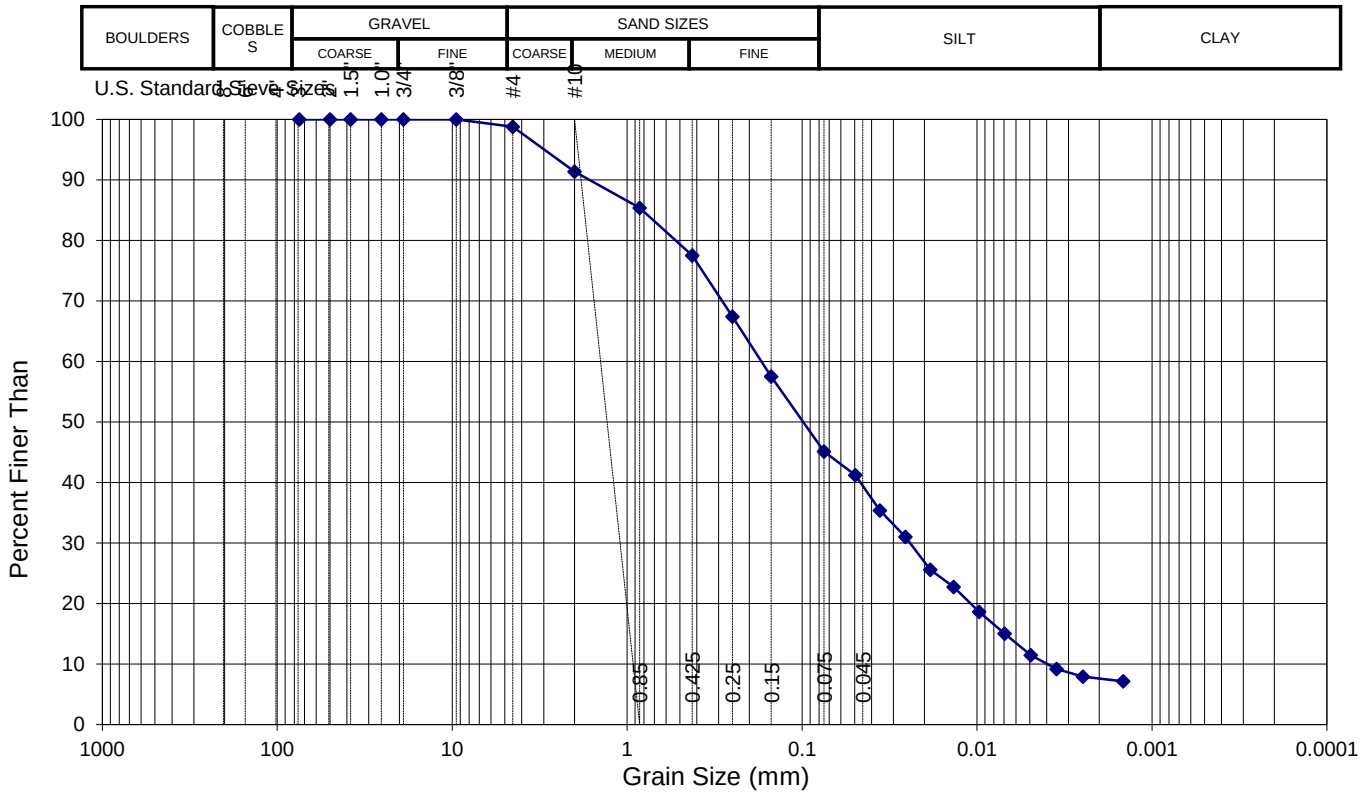
GRAIN SIZE	WT %	DIA. RANGE (mm)
% GRAVEL :	3.68	> 4.75
% COARSE SAND :	10.34	2.0 - 4.75
% MEDIUM SAND :	66.67	0.425 - 2.0
% FINE SAND :	8.85	0.075 - 0.425
% SILT :	3.07	0.075 - 0.005
% CLAY :	7.39	< 0.005

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PARTICLE SIZE DISTRIBUTION CURVE

Client Name:	CH2M HILL, INC
Project Number:	CHM400-CHM200-VA
Client Sample ID	CH16-201-GS001_SOA
Lab Sample ID	L1746804-31
Date Sample Received	19-Mar-16
Test Completion Date:	06-Apr-16
Analyst:	HML



PARTICLE SIZE DISTRIBUTION

Particle Size range (mm)	Weight %	Passing %	Method
> 300 mm	0	100	Sieve
75 mm	0	100	Sieve
50 mm	0	100	Sieve
37.5 mm	0	100	Sieve
25 mm	0	100	Sieve
19 mm	0	100	Sieve
9.5 mm	0	100	Sieve
4.75 mm	1	98.826455	Sieve
2 mm	7	91.388981	Sieve
0.85 mm	6	85.382777	Sieve
0.425 mm	8	77.507641	Sieve
0.25 mm	10	67.417406	Sieve
0.106 mm	17	50.25357	Sieve
0.075 mm	5	45.140926	Hydrometer
0.045 mm	6	39.220421	Hydrometer
0.033 mm	5	34.15486	Hydrometer
0.023 mm	5	28.996321	Hydrometer
0.017 mm	4	24.72331	Hydrometer
0.012 mm	4	21.033639	Hydrometer
0.009 mm	3	17.666085	Hydrometer
0.006 mm	4	13.349096	Hydrometer
0.005 mm	2	11.579358	Hydrometer
0.0046 mm	1	10.934831	Hydrometer
0.003 mm	2	8.5622962	Hydrometer
0.002 mm	1	7.2921774	Hydrometer
0.0015 mm	1	6.657118	Hydrometer
0.001 mm	1	6.0220586	Hydrometer

METHOD DESCRIPTION

Method Reference: ASTM D 422 - 63 (2002)

Dispersion method: Mechanical

Dispesion period: 1 minute cm/s

Soil classification system used: Unified Soil Classification

DESCRIPTION OF SAND AND GRAVEL PARTICLES

Shape: Angular

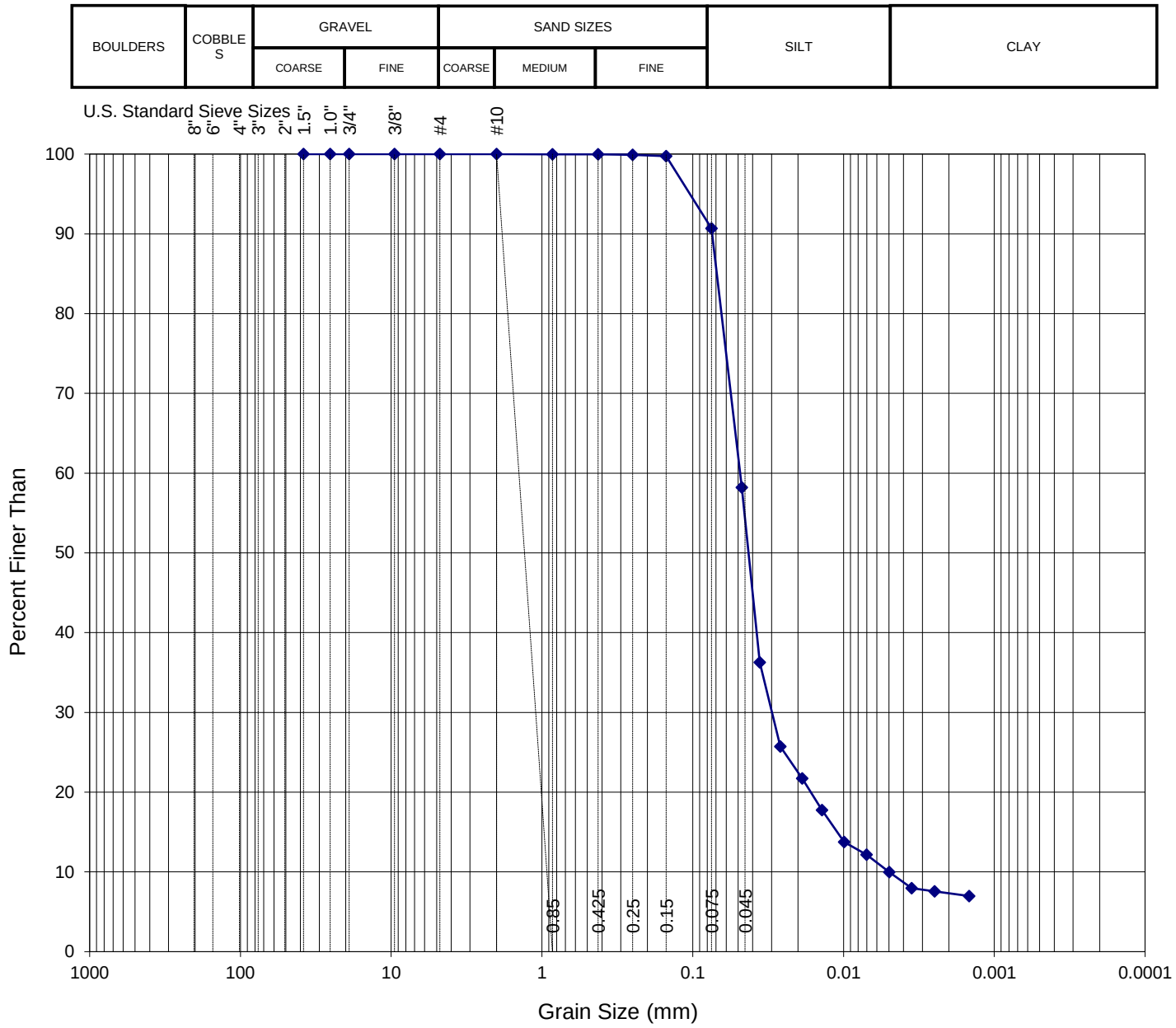
Hardness: Hard

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PARTICLE SIZE DISTRIBUTION CURVE

Client Name:	CH2M HILL, INC
Project Number:	CHM400-CHM200-VA
Client Sample ID	CH16-201-CP017_SOA
Lab Sample ID	L1746804-32
Date Sample Received	19-Mar-16
Test Completion Date:	01-Apr-16
Analyst:	HML



METHOD DESCRIPTION

Method Reference: ASTM D 422 - 63 (2002)

Dispersion method: Mechanical

Dispesion period: 1 minute cm/s

Soil classification system used: ASTM D422-63 Classification

DESCRIPTION OF SAND AND GRAVEL PARTICLES

Shape: Angular

Hardness: Hard

SUMMARY OF RESULTS

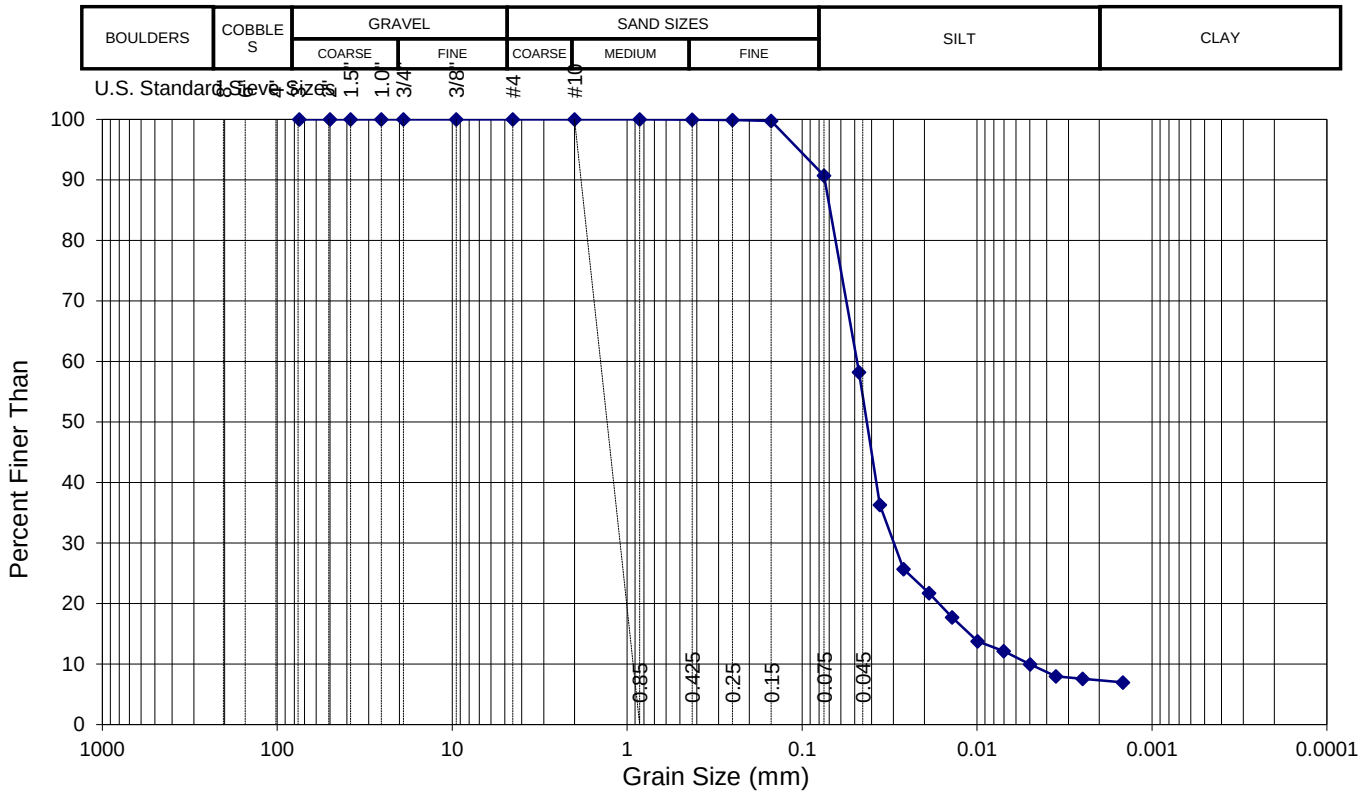
GRAIN SIZE	WT %	DIA. RANGE (mm)
% GRAVEL :	<1	> 4.75
% COARSE SAND :	<1	2.0 - 4.75
% MEDIUM SAND :	<1	0.425 - 2.0
% FINE SAND :	9.27	0.075 - 0.425
% SILT :	80.69	0.075 - 0.005
% CLAY :	10.00	< 0.005

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PARTICLE SIZE DISTRIBUTION CURVE

Client Name:	CH2M HILL, INC
Project Number:	CHM400-CHM200-VA
Client Sample ID	CH16-201-CP017_SOA
Lab Sample ID	L1746804-32
Date Sample Received	19-Mar-16
Test Completion Date:	01-Apr-16
Analyst:	HML



PARTICLE SIZE DISTRIBUTION

Particle Size range (mm)	Weight %	Passing %	Method
> 300 mm	0	100	Sieve
75 mm	0	100	Sieve
50 mm	0	100	Sieve
37.5 mm	0	100	Sieve
25 mm	0	100	Sieve
19 mm	0	100	Sieve
9.5 mm	0	100	Sieve
4.75 mm	0	100	Sieve
2 mm	0	100	Sieve
0.85 mm	0	99.986445	Sieve
0.425 mm	0	99.960531	Sieve
0.25 mm	0	99.919467	Sieve
0.106 mm	5	94.433334	Sieve
0.075 mm	4	90.692115	Hydrometer
0.045 mm	37	53.737366	Hydrometer
0.033 mm	21	33.041609	Hydrometer
0.023 mm	9	23.977876	Hydrometer
0.017 mm	4	20.284535	Hydrometer
0.012 mm	4	15.86069	Hydrometer
0.009 mm	3	13.249911	Hydrometer
0.006 mm	2	11.060358	Hydrometer
0.005 mm	1	9.9967863	Hydrometer
0.0046 mm	1	9.4512446	Hydrometer
0.003 mm	2	7.7702924	Hydrometer
0.002 mm	0	7.3898912	Hydrometer
0.0015 mm	0	7.1996906	Hydrometer
0.001 mm	0	7.00949	Hydrometer

METHOD DESCRIPTION

Method Reference: ASTM D 422 - 63 (2002)

Dispersion method: Mechanical

Dispesion period: 1 minute cm/s

Soil classification system used: Unified Soil Classification

DESCRIPTION OF SAND AND GRAVEL PARTICLES

Shape: Angular

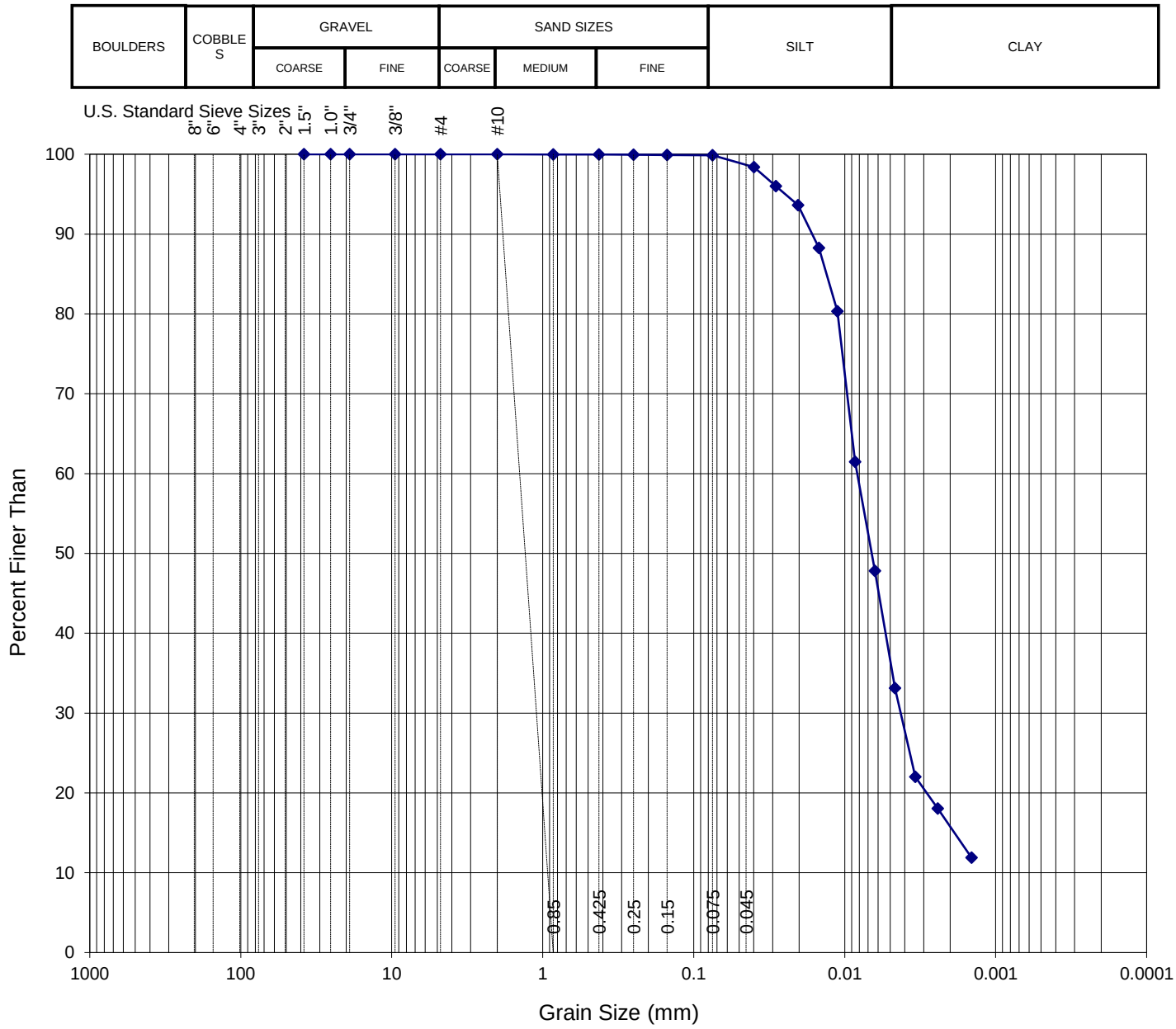
Hardness: Hard

ALS Laboratory Group

819-58th Street, Saskatoon,SK

PARTICLE SIZE DISTRIBUTION CURVE

Client Name:	CH2M HILL, INC
Project Number:	CHM400-CHM200-VA
Client Sample ID	CH16-201-CP016_SOA
Lab Sample ID	L1746804-33
Date Sample Received	19-Mar-16
Test Completion Date:	01-Apr-16
Analyst:	HML



METHOD DESCRIPTION

Method Reference: ASTM D 422 - 63 (2002)

Dispersion method: Mechanical

Dispesion period: 1 minute cm/s

Soil classification system used: ASTM D422-63 Classification

DESCRIPTION OF SAND AND GRAVEL PARTICLES

Shape: Angular

Hardness: Hard

SUMMARY OF RESULTS

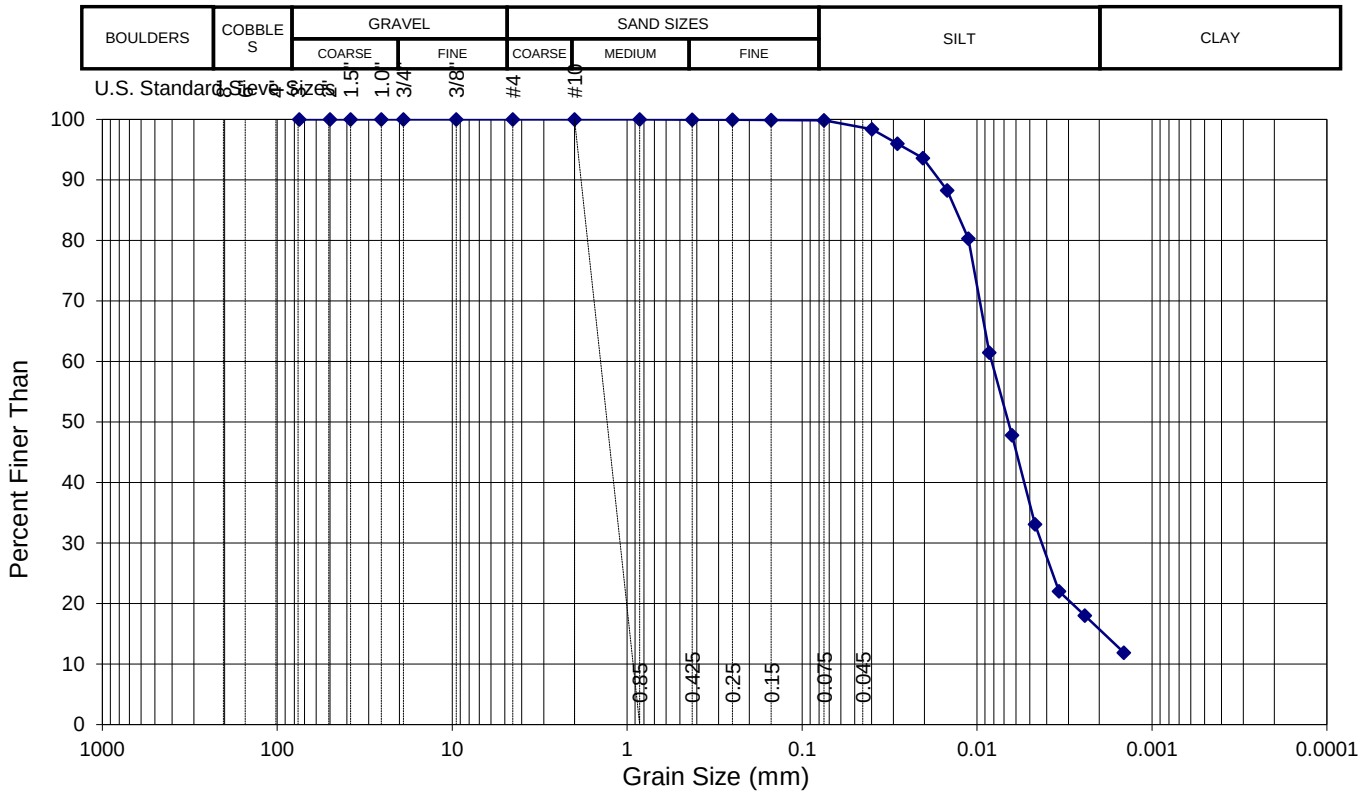
GRAIN SIZE	WT %	DIA. RANGE (mm)
% GRAVEL :	<1	> 4.75
% COARSE SAND :	<1	2.0 - 4.75
% MEDIUM SAND :	<1	0.425 - 2.0
% FINE SAND :	<1	0.075 - 0.425
% SILT :	63.29	0.075 - 0.005
% CLAY :	36.57	< 0.005

ALS Laboratory Group

819-58th Street, Saskatoon,SK

PARTICLE SIZE DISTRIBUTION CURVE

Client Name:	CH2M HILL, INC
Project Number:	CHM400-CHM200-VA
Client Sample ID	CH16-201-CP016_SOA
Lab Sample ID	L1746804-33
Date Sample Received	19-Mar-16
Test Completion Date:	01-Apr-16
Analyst:	HML



PARTICLE SIZE DISTRIBUTION

Particle Size range (mm)	Weight %	Passing %	Method
> 300 mm	0	100	Sieve
75 mm	0	100	Sieve
50 mm	0	100	Sieve
37.5 mm	0	100	Sieve
25 mm	0	100	Sieve
19 mm	0	100	Sieve
9.5 mm	0	100	Sieve
4.75 mm	0	100	Sieve
2 mm	0	100	Sieve
0.85 mm	0	99.977983	Sieve
0.425 mm	0	99.967669	Sieve
0.25 mm	0	99.940893	Sieve
0.106 mm	0	99.885884	Sieve
0.075 mm	0	99.863339	Hydrometer
0.045 mm	1	98.597615	Hydrometer
0.033 mm	2	96.942598	Hydrometer
0.023 mm	3	94.383314	Hydrometer
0.017 mm	4	90.375865	Hydrometer
0.012 mm	8	82.12375	Hydrometer
0.009 mm	17	64.873712	Hydrometer
0.006 mm	20	44.993336	Hydrometer
0.005 mm	9	36.178197	Hydrometer
0.0046 mm	4	32.649632	Hydrometer
0.003 mm	12	20.403115	Hydrometer
0.002 mm	4	16.371127	Hydrometer
0.0015 mm	2	14.355133	Hydrometer
0.001 mm	2	12.33914	Hydrometer

METHOD DESCRIPTION

Method Reference: ASTM D 422 - 63 (2002)

Dispersion method: Mechanical

Dispesion period: 1 minute cm/s

Soil classification system used: Unified Soil Classification

DESCRIPTION OF SAND AND GRAVEL PARTICLES

Shape: Angular

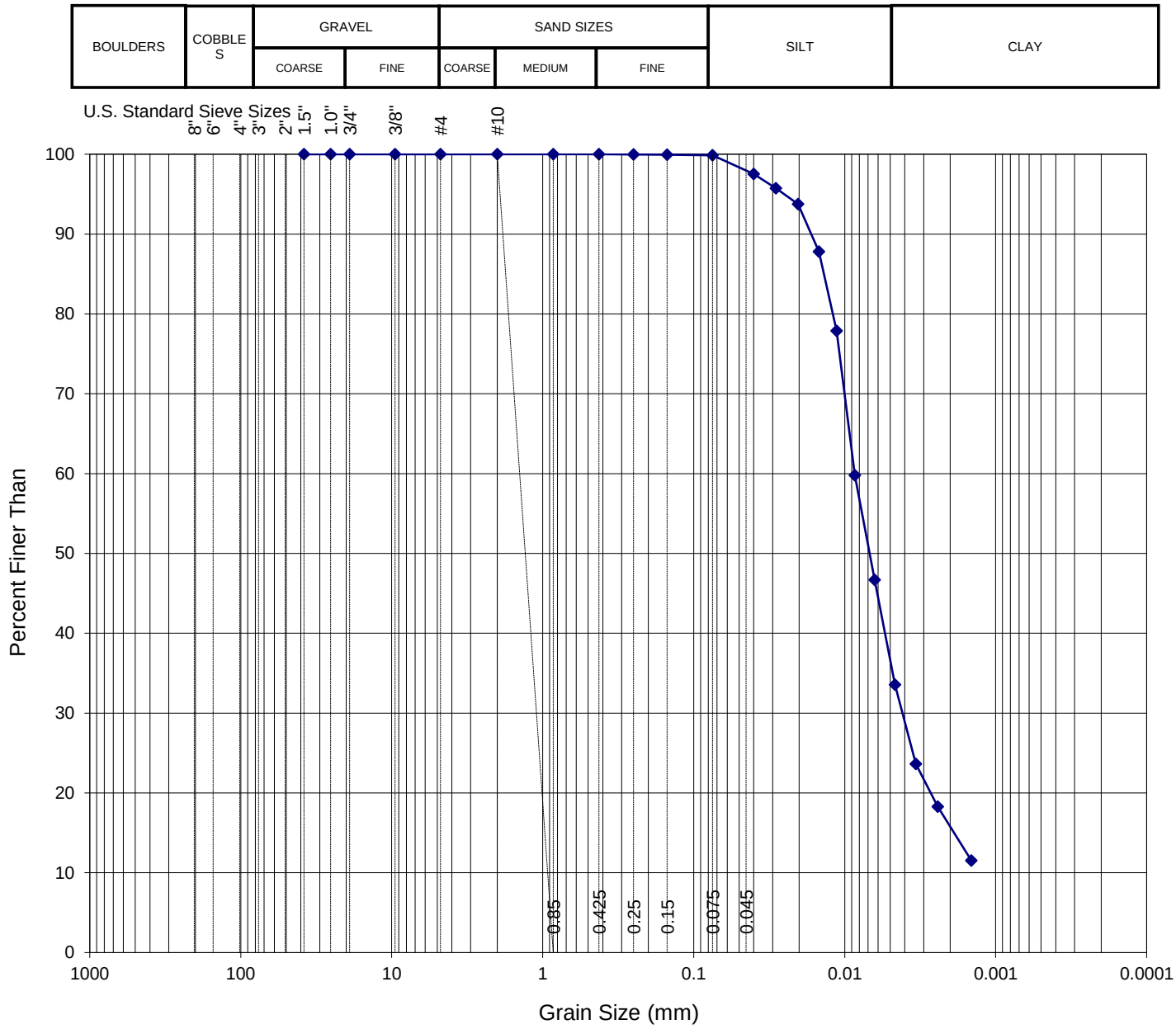
Hardness: Hard

ALS Laboratory Group

819-58th Street, Saskatoon,SK

PARTICLE SIZE DISTRIBUTION CURVE

Client Name:	CH2M HILL, INC
Project Number:	CHM400-CHM200-VA
Client Sample ID	CH16-201-CP916_SOA
Lab Sample ID	L1746804-34
Date Sample Received	19-Mar-16
Test Completion Date:	01-Apr-16
Analyst:	HML



METHOD DESCRIPTION

Method Reference: ASTM D 422 - 63 (2002)

Dispersion method: Mechanical

Dispesion period: 1 minute cm/s

Soil classification system used: ASTM D422-63 Classification

DESCRIPTION OF SAND AND GRAVEL PARTICLES

Shape: Angular

Hardness: Hard

SUMMARY OF RESULTS

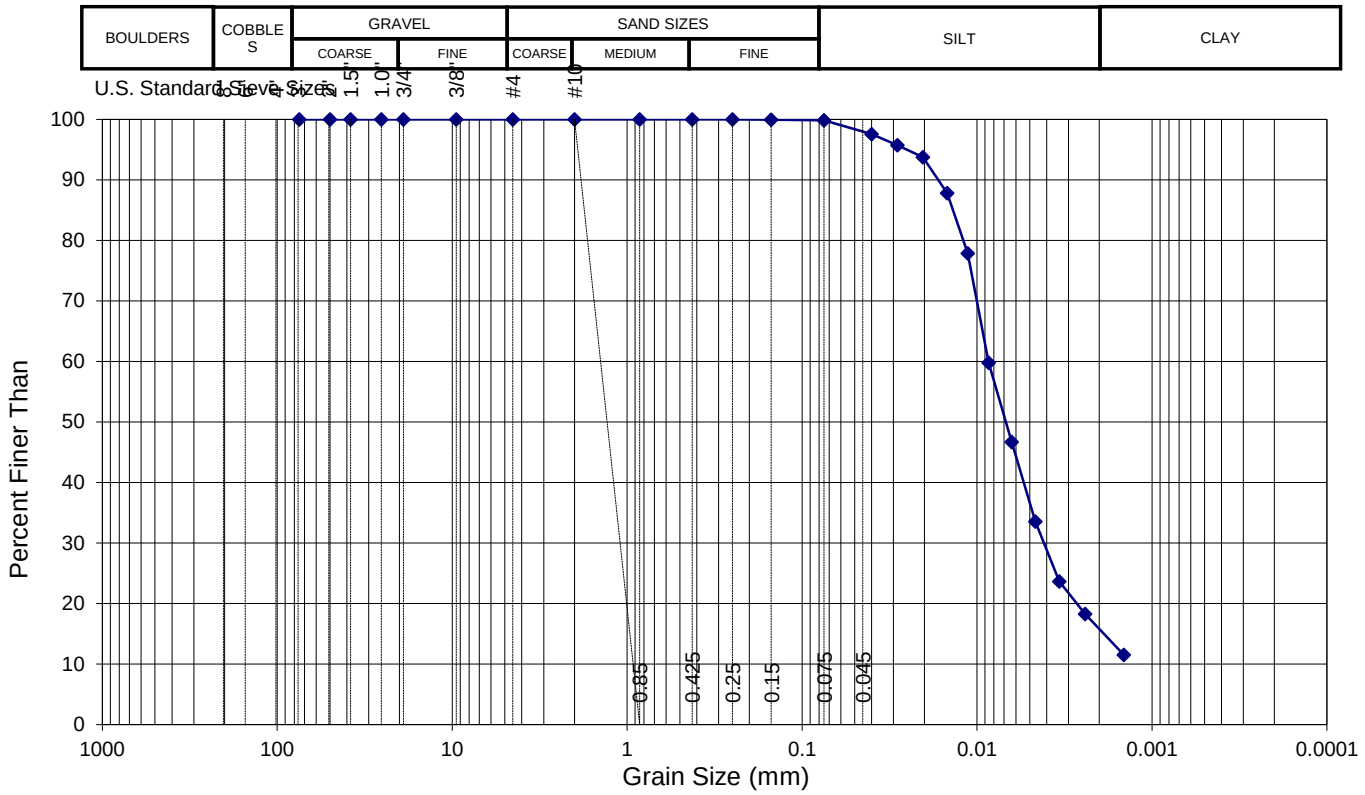
GRAIN SIZE	WT %	DIA. RANGE (mm)
% GRAVEL :	<1	> 4.75
% COARSE SAND :	<1	2.0 - 4.75
% MEDIUM SAND :	<1	0.425 - 2.0
% FINE SAND :	<1	0.075 - 0.425
% SILT :	63.22	0.075 - 0.005
% CLAY :	36.65	< 0.005

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819-58th Street, Saskatoon,SK

PARTICLE SIZE DISTRIBUTION CURVE

Client Name:	CH2M HILL, INC
Project Number:	CHM400-CHM200-VA
Client Sample ID	CH16-201-CP916_SOA
Lab Sample ID	L1746804-34
Date Sample Received	19-Mar-16
Test Completion Date:	01-Apr-16
Analyst:	HML



PARTICLE SIZE DISTRIBUTION

Particle Size range (mm)	Weight %	Passing %	Method
> 300 mm	0	100	Sieve
75 mm	0	100	Sieve
50 mm	0	100	Sieve
37.5 mm	0	100	Sieve
25 mm	0	100	Sieve
19 mm	0	100	Sieve
9.5 mm	0	100	Sieve
4.75 mm	0	100	Sieve
2 mm	0	100	Sieve
0.85 mm	0	99.998808	Sieve
0.425 mm	0	99.99265	Sieve
0.25 mm	0	99.980333	Sieve
0.106 mm	0	99.899704	Sieve
0.075 mm	0	99.868091	Hydrometer
0.045 mm	2	97.871095	Hydrometer
0.033 mm	1	96.443798	Hydrometer
0.023 mm	2	94.399609	Hydrometer
0.017 mm	4	90.130513	Hydrometer
0.012 mm	10	79.825196	Hydrometer
0.009 mm	17	62.59523	Hydrometer
0.006 mm	19	44.027271	Hydrometer
0.005 mm	8	36.295629	Hydrometer
0.0046 mm	3	33.196662	Hydrometer
0.003 mm	12	21.512506	Hydrometer
0.002 mm	6	15.981498	Hydrometer
0.0015 mm	3	13.215994	Hydrometer
0.001 mm	3	10.45049	Hydrometer

METHOD DESCRIPTION

Method Reference: ASTM D 422 - 63 (2002)

Dispersion method: Mechanical

Dispesion period: 1 minute cm/s

Soil classification system used: Unified Soil Classification

DESCRIPTION OF SAND AND GRAVEL PARTICLES

Shape: Angular

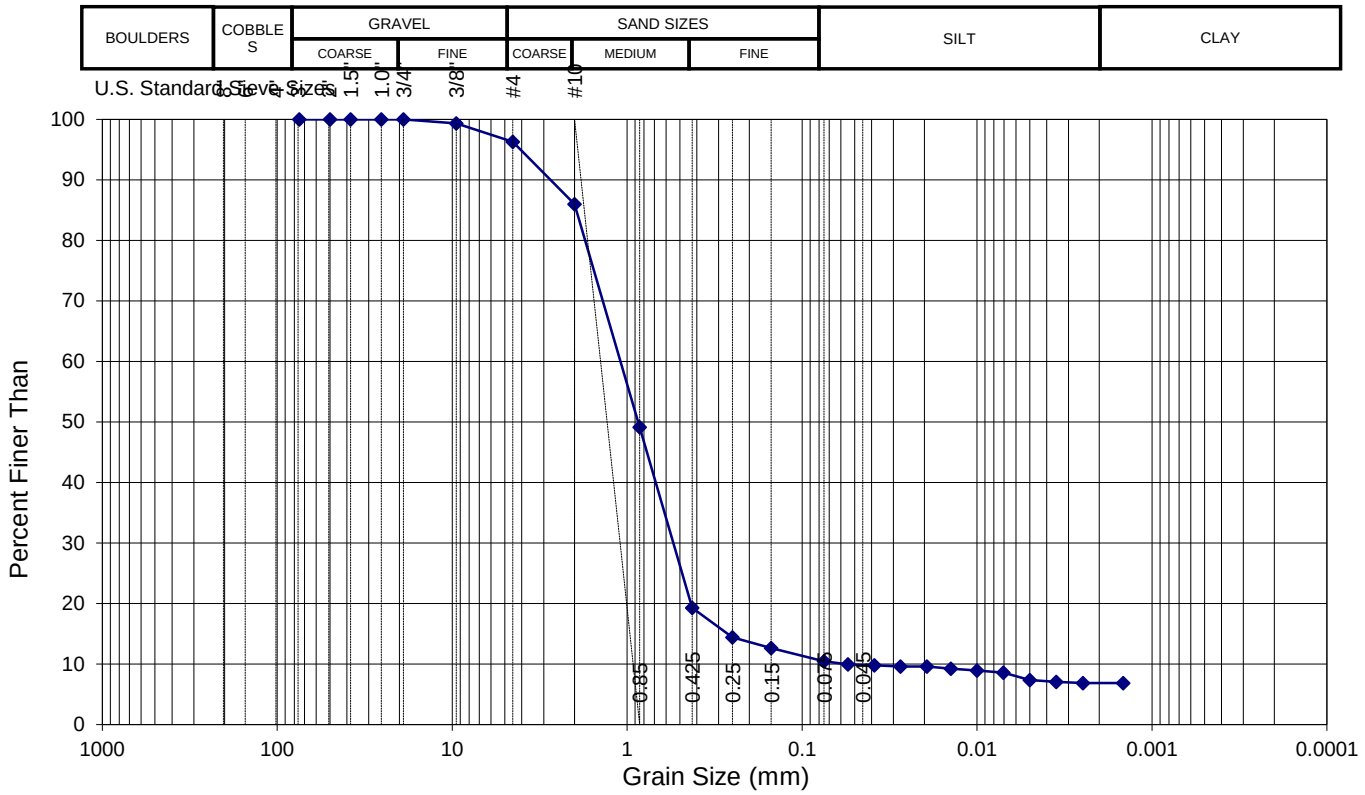
Hardness: Hard

ALS Laboratory Group

819-58th Street, Saskatoon,SK

PARTICLE SIZE DISTRIBUTION CURVE

Client Name:	CH2M HILL, INC
Project Number:	CHM400-CHM200-VA
Client Sample ID	CH16-201-BH008_SOB1
Lab Sample ID	L1746804-3
Date Sample Received	19-Mar-16
Test Completion Date:	01-Apr-16
Analyst:	HML



PARTICLE SIZE DISTRIBUTION

Particle Size range (mm)	Weight %	Passing %	Method
> 300 mm	0	100	Sieve
75 mm	0	100	Sieve
50 mm	0	100	Sieve
37.5 mm	0	100	Sieve
25 mm	0	100	Sieve
19 mm	0	100	Sieve
9.5 mm	1	99.361255	Sieve
4.75 mm	3	96.470218	Sieve
2 mm	10	85.979742	Sieve
0.85 mm	37	49.163612	Sieve
0.425 mm	30	19.30988	Sieve
0.25 mm	5	14.410847	Sieve
0.106 mm	3	11.361473	Sieve
0.075 mm	1	10.461786	Hydrometer
0.045 mm	1	9.852887	Hydrometer
0.033 mm	0	9.6988876	Hydrometer
0.023 mm	0	9.6130148	Hydrometer
0.017 mm	0	9.4590346	Hydrometer
0.012 mm	0	9.0925445	Hydrometer
0.009 mm	0	8.8089679	Hydrometer
0.006 mm	1	7.9634429	Hydrometer
0.005 mm	1	7.3870128	Hydrometer
0.0046 mm	0	7.2895108	Hydrometer
0.003 mm	0	6.9509618	Hydrometer
0.002 mm	0	6.7872865	Hydrometer
0.0015 mm	0	6.7054489	Hydrometer
0.001 mm	0	6.6236113	Hydrometer

METHOD DESCRIPTION

Method Reference: ASTM D 422 - 63 (2002)

Dispersion method: Mechanical

Dispesion period: 1 minute cm/s

Soil classification system used: Unified Soil Classification

DESCRIPTION OF SAND AND GRAVEL PARTICLES

Shape: Angular

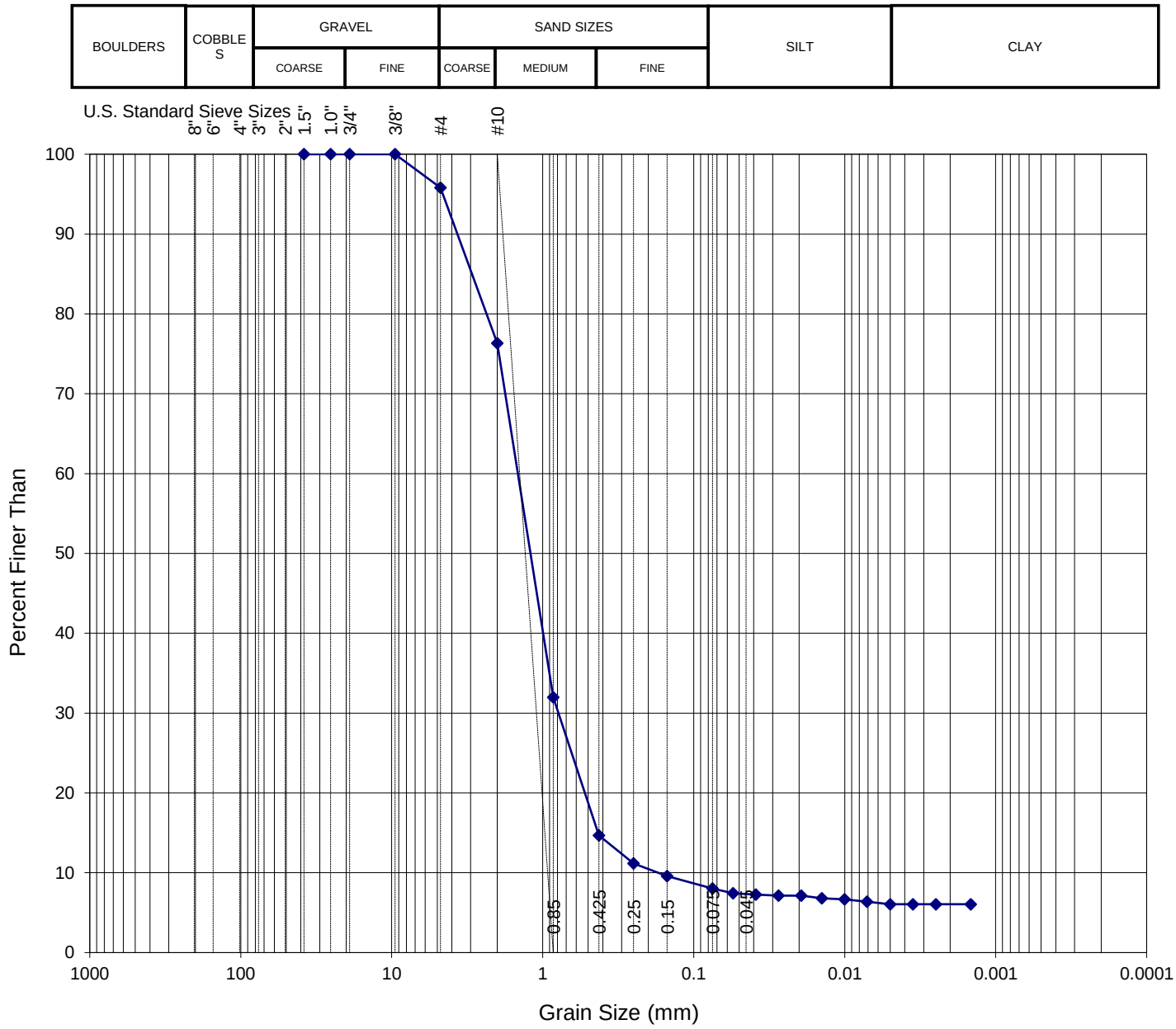
Hardness: Hard

ALS Laboratory Group

819-58th Street, Saskatoon,SK

PARTICLE SIZE DISTRIBUTION CURVE

Client Name:	CH2M HILL, INC
Project Number:	CHM400-CHM200-VA
Client Sample ID	CH16-201-BH007_SOA1
Lab Sample ID	L1746804-5
Date Sample Received	19-Mar-16
Test Completion Date:	01-Apr-16
Analyst:	HML



METHOD DESCRIPTION

Method Reference: ASTM D 422 - 63 (2002)

Dispersion method: Mechanical

Dispesion period: 1 minute cm/s

Soil classification system used: ASTM D422-63 Classification

DESCRIPTION OF SAND AND GRAVEL PARTICLES

Shape: Angular

Hardness: Hard

SUMMARY OF RESULTS

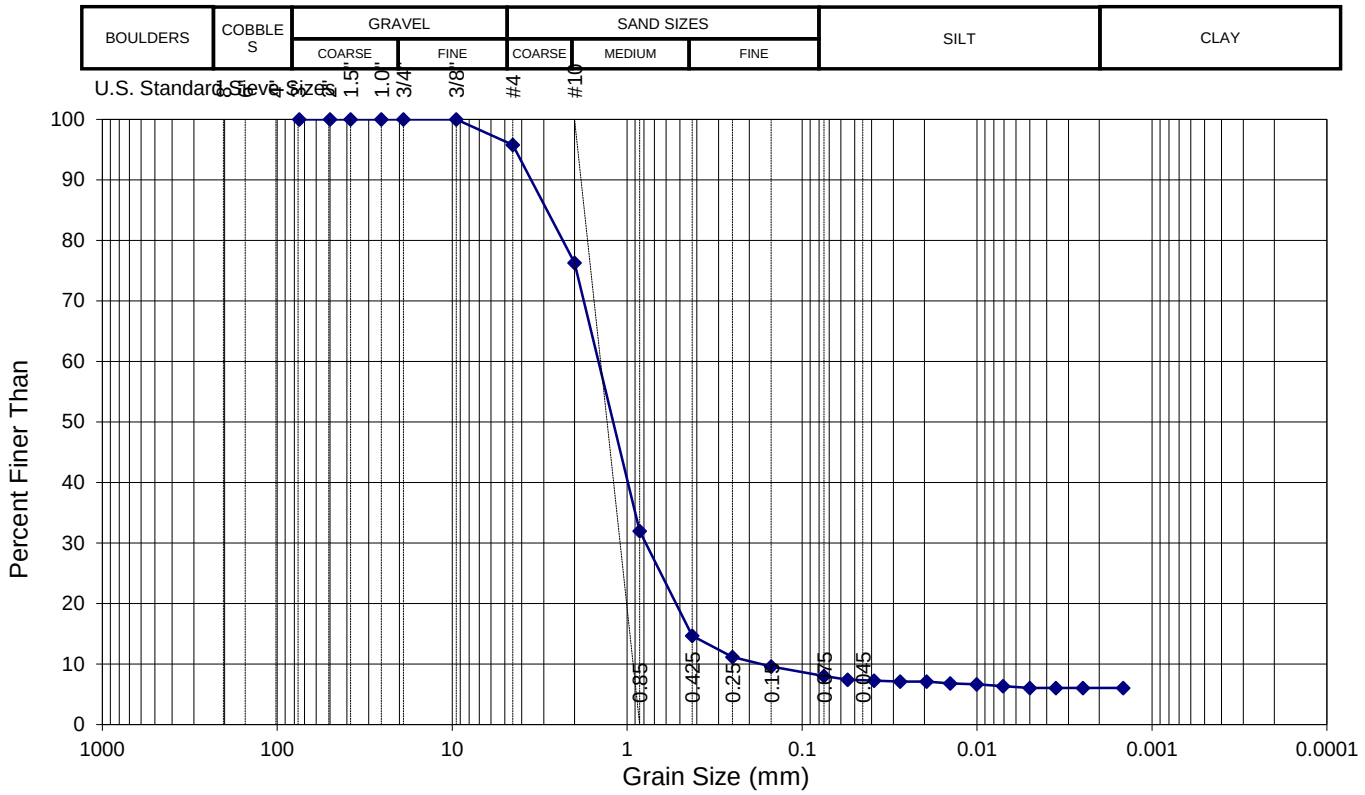
GRAIN SIZE	WT %	DIA. RANGE (mm)
% GRAVEL :	4.19	> 4.75
% COARSE SAND :	19.50	2.0 - 4.75
% MEDIUM SAND :	61.65	0.425 - 2.0
% FINE SAND :	6.63	0.075 - 0.425
% SILT :	1.97	0.075 - 0.005
% CLAY :	6.06	< 0.005

ALS Laboratory Group

819-58th Street, Saskatoon,SK

PARTICLE SIZE DISTRIBUTION CURVE

Client Name:	CH2M HILL, INC
Project Number:	CHM400-CHM200-VA
Client Sample ID	CH16-201-BH007_SOA1
Lab Sample ID	L1746804-5
Date Sample Received	19-Mar-16
Test Completion Date:	01-Apr-16
Analyst:	HML



PARTICLE SIZE DISTRIBUTION

Particle Size range (mm)	Weight %	Passing %	Method
> 300 mm	0	100	Sieve
75 mm	0	100	Sieve
50 mm	0	100	Sieve
37.5 mm	0	100	Sieve
25 mm	0	100	Sieve
19 mm	0	100	Sieve
9.5 mm	0	100	Sieve
4.75 mm	4	96.021602	Sieve
2 mm	20	76.314292	Sieve
0.85 mm	44	31.962718	Sieve
0.425 mm	17	14.660054	Sieve
0.25 mm	3	11.162388	Sieve
0.106 mm	2	8.6736817	Sieve
0.075 mm	1	8.0322673	Hydrometer
0.045 mm	1	7.3272776	Hydrometer
0.033 mm	0	7.191346	Hydrometer
0.023 mm	0	7.1176958	Hydrometer
0.017 mm	0	6.9771408	Hydrometer
0.012 mm	0	6.7346871	Hydrometer
0.009 mm	0	6.555871	Hydrometer
0.006 mm	0	6.20165	Hydrometer
0.005 mm	0	6.0578768	Hydrometer
0.0046 mm	0	6.0576134	Hydrometer
0.003 mm	0	6.0576134	Hydrometer
0.002 mm	0	6.0576134	Hydrometer
0.0015 mm	0	6.0576134	Hydrometer
0.001 mm	0	6.0576134	Hydrometer

METHOD DESCRIPTION

Method Reference: ASTM D 422 - 63 (2002)

Dispersion method: Mechanical

Dispesion period: 1 minute cm/s

Soil classification system used: Unified Soil Classification

DESCRIPTION OF SAND AND GRAVEL PARTICLES

Shape: Angular

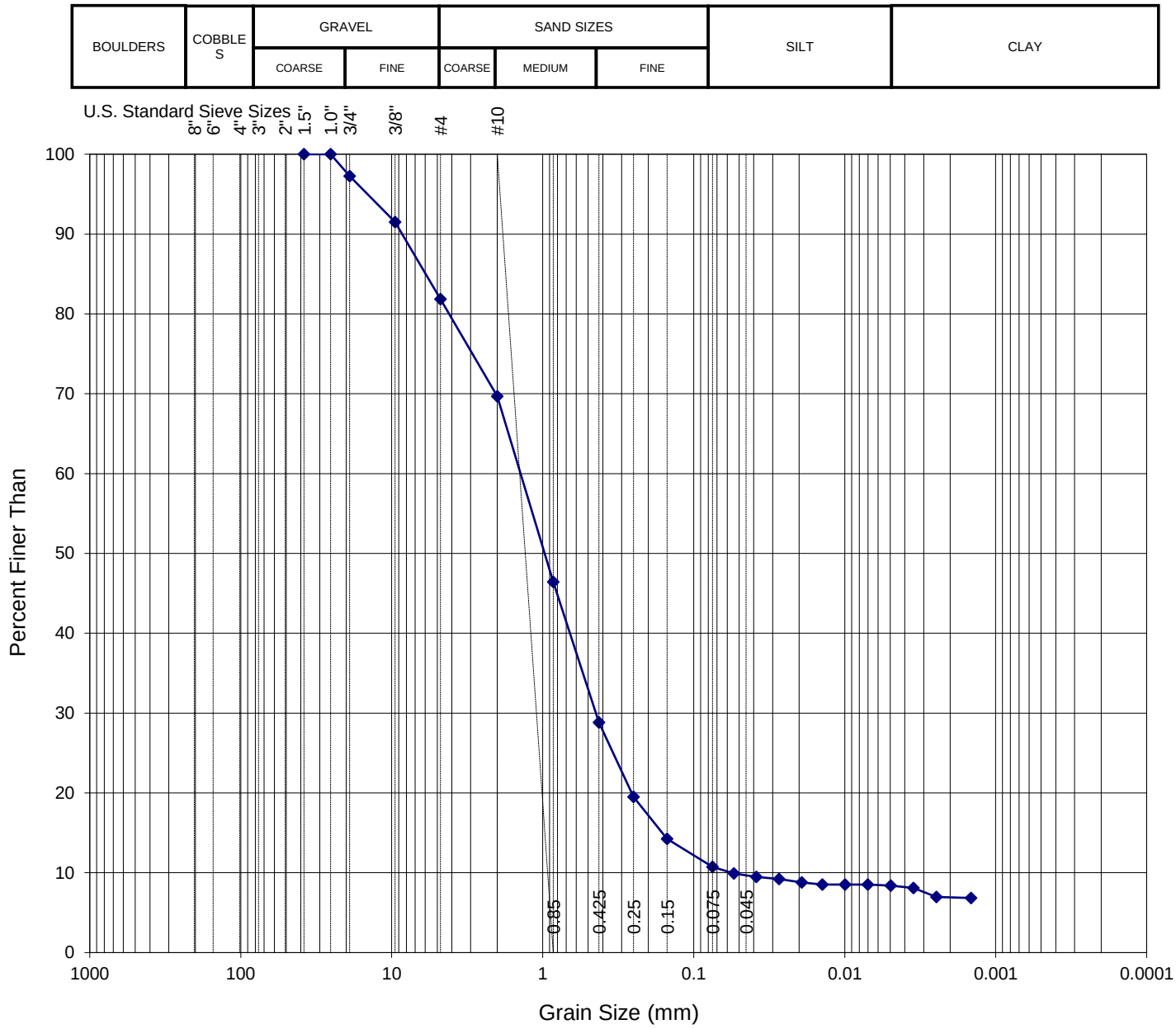
Hardness: Hard

ALS Laboratory Group

819-58th Street, Saskatoon,SK

PARTICLE SIZE DISTRIBUTION CURVE

Client Name:	CH2M HILL, INC
Project Number:	CHM400-CHM200-VA
Client Sample ID	CH16-201-BH007_SOC
Lab Sample ID	L1746804-6
Date Sample Received	19-Mar-16
Test Completion Date:	01-Apr-16
Analyst:	HML



METHOD DESCRIPTION

Method Reference: ASTM D 422 - 63 (2002)

Dispersion method: Mechanical

Dispesion period: 1 minute cm/s

Soil classification system used: ASTM D422-63 Classification

DESCRIPTION OF SAND AND GRAVEL PARTICLES

Shape: Angular

Hardness: Hard

SUMMARY OF RESULTS

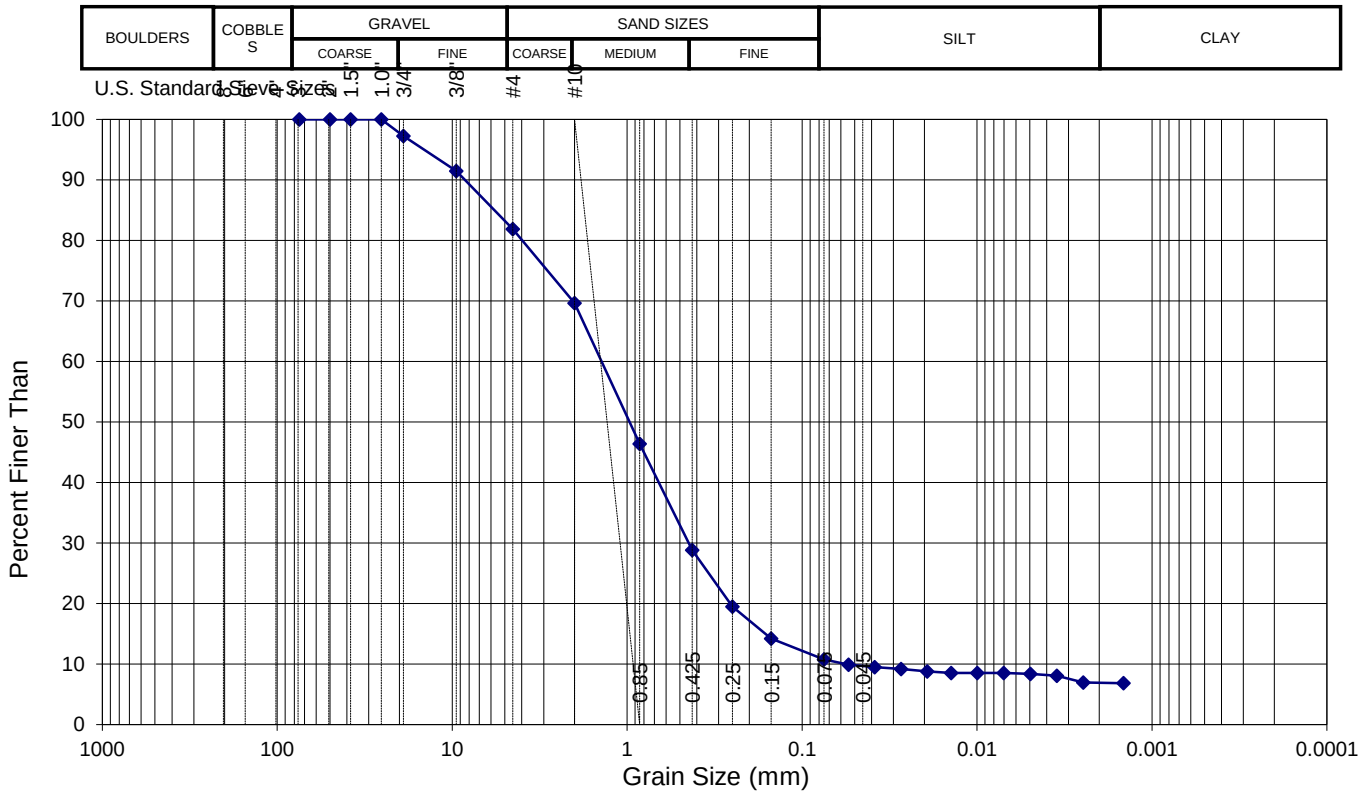
GRAIN SIZE	WT %	DIA. RANGE (mm)
% GRAVEL :	18.14	> 4.75
% COARSE SAND :	12.20	2.0 - 4.75
% MEDIUM SAND :	40.84	0.425 - 2.0
% FINE SAND :	18.08	0.075 - 0.425
% SILT :	2.37	0.075 - 0.005
% CLAY :	8.38	< 0.005

ALS Laboratory Group

819-58th Street, Saskatoon,SK

PARTICLE SIZE DISTRIBUTION CURVE

Client Name:	CH2M HILL, INC
Project Number:	CHM400-CHM200-VA
Client Sample ID	CH16-201-BH007_SOC
Lab Sample ID	L1746804-6
Date Sample Received	19-Mar-16
Test Completion Date:	01-Apr-16
Analyst:	HML



PARTICLE SIZE DISTRIBUTION

Particle Size range (mm)	Weight %	Passing %	Method
> 300 mm	0	100	Sieve
75 mm	0	100	Sieve
50 mm	0	100	Sieve
37.5 mm	0	100	Sieve
25 mm	0	99.829293	Sieve
19 mm	3	97.268692	Sieve
9.5 mm	6	91.494009	Sieve
4.75 mm	9	82.344317	Sieve
2 mm	13	69.661383	Sieve
0.85 mm	23	46.42553	Sieve
0.425 mm	18	28.82451	Sieve
0.25 mm	9	19.514172	Sieve
0.106 mm	7	12.188564	Sieve
0.075 mm	1	10.748628	Hydrometer
0.045 mm	1	9.6656829	Hydrometer
0.033 mm	0	9.3567905	Hydrometer
0.023 mm	0	8.9910208	Hydrometer
0.017 mm	0	8.6719561	Hydrometer
0.012 mm	0	8.5145739	Hydrometer
0.009 mm	0	8.5145739	Hydrometer
0.006 mm	0	8.4454829	Hydrometer
0.005 mm	0	8.3786349	Hydrometer
0.0046 mm	0	8.3082333	Hydrometer
0.003 mm	1	7.5530618	Hydrometer
0.002 mm	1	6.4691193	Hydrometer
0.0015 mm	1	5.927148	Hydrometer
0.001 mm	1	5.3851767	Hydrometer

METHOD DESCRIPTION

Method Reference: ASTM D 422 - 63 (2002)

Dispersion method: Mechanical

Dispesion period: 1 minute cm/s

Soil classification system used: Unified Soil Classification

DESCRIPTION OF SAND AND GRAVEL PARTICLES

Shape: Angular

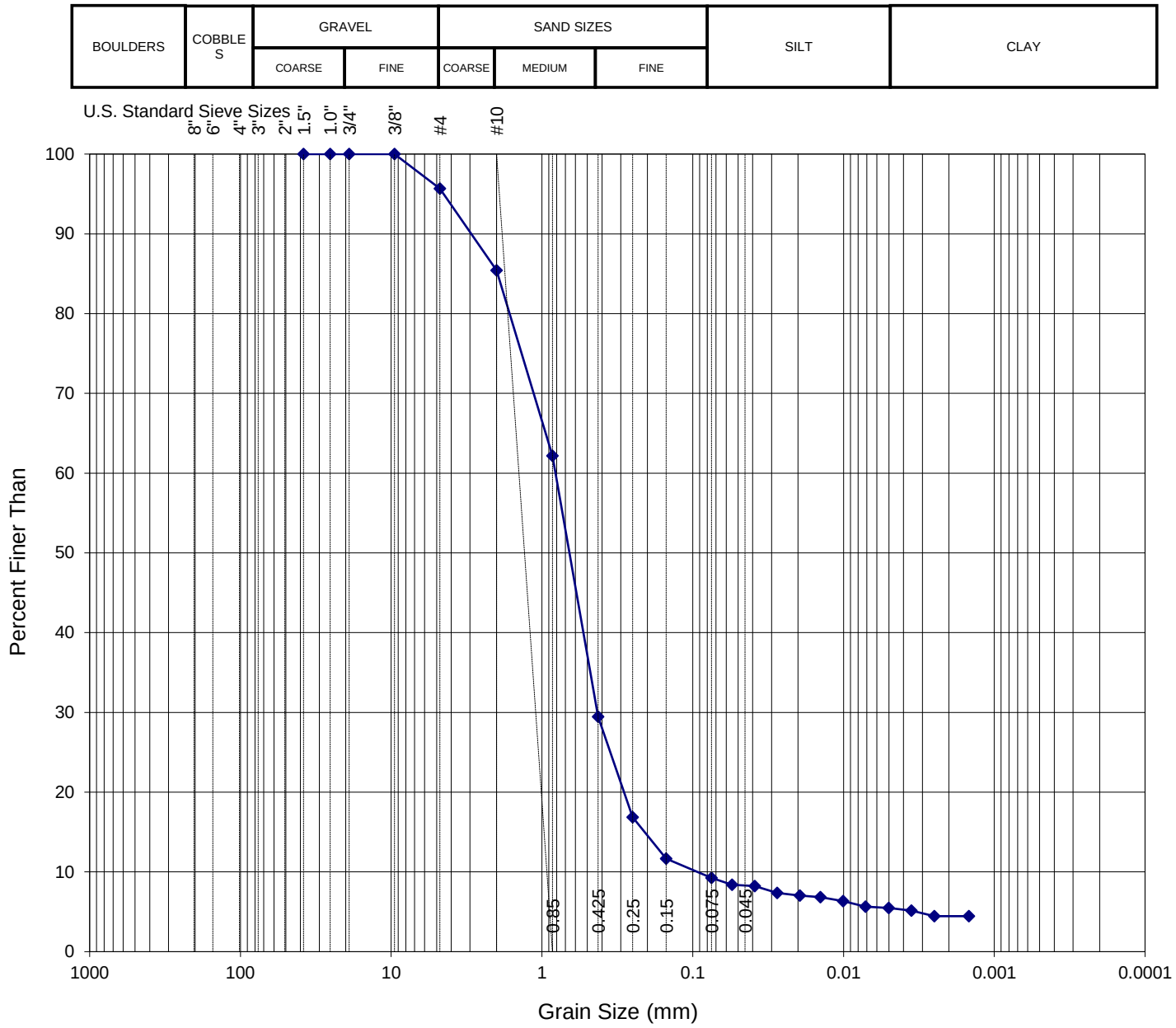
Hardness: Hard

ALS Laboratory Group

819-58th Street, Saskatoon,SK

PARTICLE SIZE DISTRIBUTION CURVE

Client Name:	CH2M HILL, INC
Project Number:	CHM400-CHM200-VA
Client Sample ID	CH16-201-BH007_SOE1
Lab Sample ID	L1746804-7
Date Sample Received	19-Mar-16
Test Completion Date:	01-Apr-16
Analyst:	HML



METHOD DESCRIPTION

Method Reference: ASTM D 422 - 63 (2002)

Dispersion method: Mechanical

Dispesion period: 1 minute cm/s

Soil classification system used: ASTM D422-63 Classification

DESCRIPTION OF SAND AND GRAVEL PARTICLES

Shape: Angular

Hardness: Hard

SUMMARY OF RESULTS

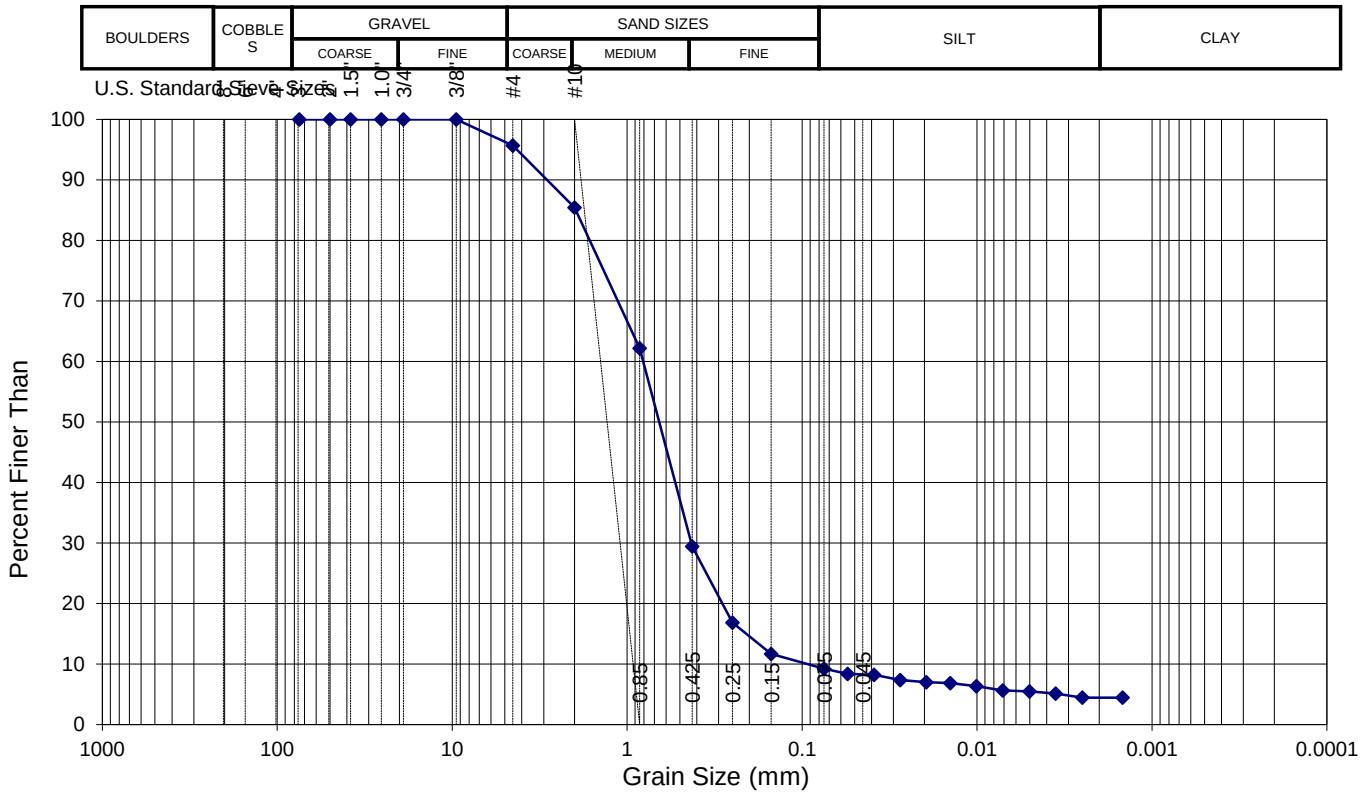
GRAIN SIZE	WT %	DIA. RANGE (mm)
% GRAVEL :	4.33	> 4.75
% COARSE SAND :	10.25	2.0 - 4.75
% MEDIUM SAND :	55.95	0.425 - 2.0
% FINE SAND :	20.22	0.075 - 0.425
% SILT :	3.77	0.075 - 0.005
% CLAY :	5.48	< 0.005

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819-58th Street, Saskatoon,SK

PARTICLE SIZE DISTRIBUTION CURVE

Client Name:	CH2M HILL, INC
Project Number:	CHM400-CHM200-VA
Client Sample ID	CH16-201-BH007_SOE1
Lab Sample ID	L1746804-7
Date Sample Received	19-Mar-16
Test Completion Date:	01-Apr-16
Analyst:	HML



PARTICLE SIZE DISTRIBUTION

Particle Size range (mm)	Weight %	Passing %	Method
> 300 mm	0	100	Sieve
75 mm	0	100	Sieve
50 mm	0	100	Sieve
37.5 mm	0	100	Sieve
25 mm	0	100	Sieve
19 mm	0	100	Sieve
9.5 mm	0	100	Sieve
4.75 mm	4	95.889303	Sieve
2 mm	10	85.419834	Sieve
0.85 mm	23	62.170815	Sieve
0.425 mm	33	29.471869	Sieve
0.25 mm	13	16.84931	Sieve
0.106 mm	7	10.248889	Sieve
0.075 mm	1	9.250813	Hydrometer
0.045 mm	1	8.2836536	Hydrometer
0.033 mm	1	7.7759503	Hydrometer
0.023 mm	1	7.1689832	Hydrometer
0.017 mm	0	6.9383864	Hydrometer
0.012 mm	0	6.5719208	Hydrometer
0.009 mm	0	6.0832611	Hydrometer
0.006 mm	1	5.5578601	Hydrometer
0.005 mm	0	5.4741589	Hydrometer
0.0046 mm	0	5.3807544	Hydrometer
0.003 mm	1	4.7760404	Hydrometer
0.002 mm	1	4.1244207	Hydrometer
0.0015 mm	0	3.7986108	Hydrometer
0.001 mm	0	3.472801	Hydrometer

METHOD DESCRIPTION

Method Reference: ASTM D 422 - 63 (2002)

Dispersion method: Mechanical

Dispesion period: 1 minute cm/s

Soil classification system used: Unified Soil Classification

DESCRIPTION OF SAND AND GRAVEL PARTICLES

Shape: Angular

Hardness: Hard

April 20, 2016 Service Request No:T1600478

Ms. Amber Springer
ALS Environmental - Canada
8081 Lougheed Hwy
Burnaby, BC V5A 1W9

Laboratory Results for:

Dear Ms.Springer,

Enclosed are the results of the sample(s) submitted to our laboratory April 01, 2016
For your reference, these analyses have been assigned our service request number **T1600478.**

All analyses were performed according to our laboratory's quality assurance program. All results are intended to be considered in their entirety, and ALS Environmental is not responsible for use of less than the complete report. Results
apply only to the items submitted to the laboratory for analysis and individual items (samples) analyzed, as listed in the report.

Please contact me if you have any questions. My extension is 7102. You may also contact me via email at Wendy.Hyatt@alsglobal.com.

Respectfully submitted,

ALS Group USA, Corp. dba ALS Environmental



Wendy Hyatt
Client Services
Manager

ADDRESS 3860 S. Palo Verde Road, Suite 302, Tucson, AZ 85714
PHONE +1 520 573 1061 | FAX +1 520 573 1063
ALS Group USA, Corp.
dba ALS Environmental

Client: ALS Environmental - Canada **Service Request:**T1600478
Project:

SAMPLE CROSS-REFERENCE

SAMPLE #	CLIENT SAMPLE ID	DATE	TIME
T1600478-001	L1746804-1	3/10/2016	0000
T1600478-002	L1746804-2	3/10/2016	0000
T1600478-003	L1746804-4	3/10/2016	0000
T1600478-004	L1746804-5	3/8/2016	0000
T1600478-005	L1746804-8	3/8/2016	0000
T1600478-006	L1746804-9	3/8/2016	0000
T1600478-007	L1746804-11	3/9/2016	0000
T1600478-008	L1746804-12	3/9/2016	0000
T1600478-009	L1746804-13	3/10/2016	0000
T1600478-010	L1746804-14	3/11/2016	0000
T1600478-011	L1746804-15	3/11/2016	0000
T1600478-012	L1746804-16	3/11/2016	0000
T1600478-013	L1746804-18	3/11/2016	0000
T1600478-014	L1746804-19	3/10/2016	0000
T1600478-015	L1746804-22	3/11/2016	0000
T1600478-016	L1746804-23	3/11/2016	0000
T1600478-017	L1746804-24	3/12/2016	0000
T1600478-018	L1746804-25	3/12/2016	0000
T1600478-019	L1746804-26	3/12/2016	0000
T1600478-020	L1746804-27	3/12/2016	0000
T1600478-021	L1746804-28	3/12/2016	0000
T1600478-022	L1746804-29	3/12/2016	0000
T1600478-023	L1746804-31	3/13/2016	0000
T1600478-024	L1746804-32	3/14/2016	0000
T1600478-025	L1746804-33	3/15/2016	0000
T1600478-026	L1746804-34	3/15/2016	0000

Subcontract Request Form

Subcontract To:

ALS ENVIRONMENTAL - TUCSON, ARIZONA, USA
3860 S PALO VERDE ROAD
SUITE 302
TUCSON,ARIZONA 85714

NOTES: Please reference on final report and invoice: PO# *L1746804*
ALS requires QC data to be provided with your final results.

Please see enclosed 28 sample(s) in 28 Container(s)

SAMPLE NUMBER	ANALYTICAL REQUIRED	DATE SAMPLED / DUE DATE	Priority Flag
L1746804-1 CH16-201-BH008_SOA1	Neutralization Potential (NP) (NP-TU 2)	**3/10/2016** 4/4/2016	
L1746804-2 CH16-201-BH008_SOA2	Neutralization Potential (NP) (NP-TU 2)	**3/10/2016** 4/4/2016	
L1746804-4 CH16-201-BH908_SOA2	Neutralization Potential (NP) (NP-TU 2)	**3/10/2016** 4/4/2016	
L1746804-5 CH16-201-BH007_SOA1	Neutralization Potential (NP) (NP-TU 2)	**3/8/2016** 4/4/2016	
L1746804-8 CH16-201-BH007_SOE2	Neutralization Potential (NP) (NP-TU 2)	**3/8/2016** 4/4/2016	
L1746804-9 CH16-201-BH907_SOE2	Neutralization Potential (NP) (NP-TU 2)	**3/8/2016** 4/4/2016	
L1746804-11 CH16-201-BH009_SOA2	Neutralization Potential (NP) (NP-TU 2)	**3/9/2016** 4/4/2016	
L1746804-12 CH16-201-BH009_SOB2	Neutralization Potential (NP) (NP-TU 2)	**3/9/2016** 4/4/2016	
L1746804-13 CH16-201-BH006A_SOA1	Neutralization Potential (NP) (NP-TU 2)	**3/10/2016** 4/4/2016	

Monday, March 21, 2016 1:18 PM

Subcontract Request Form

Subcontract To:

ALS ENVIRONMENTAL - TUCSON, ARIZONA, USA
3860 S PALO VERDE ROAD
SUITE 302
TUCSON,ARIZONA 85714

SAMPLE NUMBER	ANALYTICAL REQUIRED	DATE SAMPLED / DUE DATE	Priority Flag
L1746804-14 CH16-201-BH006A_SOA3		**3/10/2016**	
	Neutralization Potential (NP) (NP-TU 2)	4/4/2016	
L1746804-15 CH16-201-BH008_SOA3		**3/10/2016**	
	Neutralization Potential (NP) (NP-TU 2)	4/4/2016	
L1746804-16 CH16-201-BH010A_SOA1		**3/10/2016**	
	Neutralization Potential (NP) (NP-TU 2)	4/4/2016	
L1746804-18 CH16-201-BH010A_SOA2		**3/10/2016**	
	Neutralization Potential (NP) (NP-TU 2)	4/4/2016	
L1746804-19 CH16-201-BH010A_SOB2		**3/10/2016**	
	Neutralization Potential (NP) (NP-TU 2)	4/4/2016	
L1746804-21 CH16-201-BH011_SOA1		**3/11/2016**	See attached Email
missing - AB	Neutralization Potential (NP) (NP-TU 2)	4/4/2016	TVB
L1746804-22 CH16-201-BH011_SOA2		**3/11/2016**	
	Neutralization Potential (NP) (NP-TU 2)	4/4/2016	
L1746804-23 CH16-201-BH012_SOB		**3/11/2016**	
	Neutralization Potential (NP) (NP-TU 2)	4/4/2016	
L1746804-24 CH16-201-BH005B_SOA1		**3/12/2016**	
	Neutralization Potential (NP) (NP-TU 2)	4/4/2016	
L1746804-25 CH16-201-BH011A_SOA		**3/12/2016**	
	Neutralization Potential (NP) (NP-TU 2)	4/4/2016	
L1746804-26 CH16-201-BH011A_SOB		**3/12/2016**	
	Neutralization Potential (NP) (NP-TU 2)	4/4/2016	

ALS Environmental

Subcontract Request Form

Subcontract To:

ALS ENVIRONMENTAL - TUCSON, ARIZONA, USA
3860 S PALO VERDE ROAD
SUITE 302
TUCSON,ARIZONA 85714

SAMPLE NUMBER	ANALYTICAL REQUIRED	DATE SAMPLED / DUE DATE	Priority Flag
L1746804-27 CH16-201-BH012A_SOA1		**3/12/2016**	
	Neutralization Potential (NP) (NP-TU 2)	4/4/2016	
L1746804-28 CH16-201-BH012A_SOA2		**3/12/2016**	
	Neutralization Potential (NP) (NP-TU 2)	4/4/2016	
L1746804-29 CH16-201-BH012A_SOA4		**3/12/2016**	
	Neutralization Potential (NP) (NP-TU 2)	4/4/2016	
L1746804-30 CH16-201-CP018_SOA		**3/13/2016**	
	Neutralization Potential (NP) (NP-TU 2)	4/4/2016	
L1746804-31 CH16-201-GS001_SOA		**3/13/2016**	
	Neutralization Potential (NP) (NP-TU 2)	4/4/2016	
L1746804-32 CH16-201-CP017_SOA		**3/14/2016**	
	Neutralization Potential (NP) (NP-TU 2)	4/4/2016	
L1746804-33 CH16-201-CP016_SOA		**3/15/2016**	
	Neutralization Potential (NP) (NP-TU 2)	4/4/2016	
L1746804-34 CH16-201-CP916_SOA		**3/15/2016**	
	Neutralization Potential (NP) (NP-TU 2)	4/4/2016	

See attached email
missing -AVB
AVB

Monday, March 21, 2016 1:18 PM

T1600478 5
ALS Environmental - Canada

L1746804
VANCOUVER

Subcontract Request Form

Subcontract To:

ALS ENVIRONMENTAL - TUCSON, ARIZONA, USA
3860 S PALO VERDE ROAD
SUITE 302
TUCSON,ARIZONA 85714

Subcontract Info Contact: Walter Lin (604) 253-4188

Analysis and reporting info contact: Amber Springer, B.Sc
8081 LOUGHEED HWY
SUITE 100
BURNABY,BC V5A 1W9
Phone: (604) 253-4188 Email: amber.springer@alsglobal.com

Please email confirmation of receipt to: **amber.springer@alsglobal.com**

Shipped By: _____ Date Shipped: Mar 30, 2016

Received By: Andi Barton Date Received: 4/1/16 0955

Verified By: _____ Date Verified: _____

Temperature: _____

Sample Integrity Issues: _____

Monday, March 21, 2016 1:18 PM

3860 S. Palo Verde Road, Suite 302
Tucson, AZ 85714
T: +1 520 573 1061
F: +1 520 573 1063
www.alsglobal.com

Sample Receipt Form

T1600478 5
ALS Environmental - Canada

Client/Project: **ALS Canada** Work Order Number:

Received by: Andi Barton Date & Time: 4/1/16 0955 Matrix: Aqueous + solid

Samples were received via?: FedEx Samples were received in: Cooler

Were custody seals on containers? ○ Yes ◉ No ○ NA If yes, how many and where?

If present were custody seals intact? ○ Yes ○ No If present, were they signed and dated? ○ Yes ○ No

Cooler Temp C	Temp Blank C	Tracking Number
16.4	N/A	6116 7669 9831

Packing material used? Bubble Wrap | Gel Packs | Bags | Box

Did all the bottles arrive in good condition (unbroken)? ◉ Yes ○ No ○ NA If No, record comments below

Did all sample labels and tags agree with COC? ◉ Yes ○ No ○ NA If No, record discrepancies below

Were all the appropriate containers and volumes received for the tests indicated? ◉ Yes ○ No ○ NA

Are samples received deemed acceptable? ◉ Yes ○ No

Comments:
26 - 4oz Glass Jars; 2 - 8oz Glass Jars

Notes, discrepancies, & resolutions:
Missing samples -21 and -30 are on SubCOC in error
Fridge A MB

As a part of ISO 17025 protocols, ALS must notify clients that the quoted analytical methods performed by ALS may have minor modifications from the methods as published. These modifications are written into our Standard Operating Procedures and do not impact the quality of the data. Receipt of this document will be considered an acceptance of the procedures used by the laboratory for analysis unless notified by the client.
Modifications may include, but are not limited to:

- The analysis of a sample matrix that differs from that stated in the published method (example - ASTM D5865 Standard Test Method for Gross Calorific Value of Coal and Coke is used for other matrices such as biomass, Tire Derived Fuel, etc.).
- Analyzing a sample mass that differs from those in the published method (example - to accommodate samples with high concentrations of analyte, samples of limited volume, or to comply with the instrument manufacturer's operating guidelines).
- Instruments used for the analysis may differ from those listed in the published method (example - using ICP-OES when the method references flame Atomic Absorption Spectroscopy)

Client: ALS Environmental - Canada
8081 Lougheed Hwy
Burnaby, BC V5A 1W9

Attn: Amber Springer
Project: L1746804 Date Received: 4/ 1/16

Certificate of Analysis

Client ID:	Sample Date:	Lab #:		Moisture, Total D3173 wt%	Neutralization Potential Sobek 3.2.3, MOD $CaCO_3$/1,000t
Reporting Limits				0.01	1
L1746804-1	3/10/16	T1600478-001		35.79	30
L1746804-2	3/10/16	T1600478-002		27.69	36
L1746804-4	3/10/16	T1600478-003		15.96	27
L1746804-5	3/8/16	T1600478-004		11.47	64
L1746804-8	3/8/16	T1600478-005		11.43	13
L1746804-9	3/8/16	T1600478-006		14.17	11
L1746804-11	3/9/16	T1600478-007		16.34	13
L1746804-12	3/9/16	T1600478-008		11.11	20
L1746804-13	3/10/16	T1600478-009		27.20	17
L1746804-14	3/11/16	T1600478-010		43.21	12
L1746804-15	3/11/16	T1600478-011		26.36	17
L1746804-16	3/11/16	T1600478-012		38.34	15
L1746804-18	3/11/16	T1600478-013		28.94	10
L1746804-19	3/10/16	T1600478-014		34.05	437
L1746804-22	3/11/16	T1600478-015		15.07	35

Client: ALS Environmental - Canada
8081 Lougheed Hwy
Burnaby, BC V5A 1W9

Attn: Amber Springer
Project: L1746804 Date Received: 4/ 1/16

Certificate of Analysis

Client ID:	Sample Date:	Lab #:		Moisture, Total D3173 wt%	Neutralization Potential Sobek 3.2.3, MOD $CaCO_3$/1,000t
Reporting Limits				0.01	1
L1746804-23	3/11/16	T1600478-016		36.76	22
L1746804-24	3/12/16	T1600478-017		14.74	74
L1746804-25	3/12/16	T1600478-018		98.72	511
L1746804-26	3/12/16	T1600478-019		98.88	623
L1746804-27	3/12/16	T1600478-020		28.06	24
L1746804-28	3/12/16	T1600478-021		17.32	16
L1746804-29	3/12/16	T1600478-022		16.00	24
L1746804-31	3/13/16	T1600478-023		95.54	435
L1746804-32	3/14/16	T1600478-024		18.56	71
L1746804-33	3/15/16	T1600478-025		27.43	32
L1746804-34	3/15/16	T1600478-026		28.47	30

Notes:
Samples were ground to < 60 mesh prior to analysis.

Client: ALS Environmental - Canada
8081 Lougheed Hwy
Burnaby, BC V5A 1W9

Attn: Amber Springer
Project: L1746804 Date Received: 4/ 1/16

Quality Control

				Moisture, Total D3173 wt%	Neutralization Potential Sobek 3.2.3, MOD $CaCO_3$/1,000t
Prep Blank 1				<0.01	<1
Prep Blank 2				0.04	n/a
Laboratory Control Sample (LCS) - Sand/Nano CN 2941			Observed Value	12.31	n/a
			True Value	12.41	
			%R	99.2	
Laboratory Control Sample (LCS) 2 - Sand/Nano CN 2941			Observed Value	9.88	n/a
			True Value	9.89	
			%R	100	
Laboratory Control Sample (LCS) - CaCO3 CN 4480			Observed Value	n/a	975
			True Value		1,000
			%R		97.5
Laboratory Control Sample (LCS) 2 - CaCO3 CN 4480			Observed Value	n/a	1,000
			True Value		1,000
			%R		100
				T1600478-001	T1600478-001
Duplicate Results 1				35.79	30
			Duplicate	35.80	30
			%RPD	0.0	0.0
				T1600478-017	T1600478-011
Duplicate Results 2				14.74	17
			Duplicate	14.74	16
			%RPD	0.1	6.1

CH2MHILL

CHAIN OF CUSTODY RECORD

L1746804-COFC

Project Name Faro Mine
Location Faro Mine Complex - Faro YK
Project Number 660403.07.01.01.02.03.FW
Project Manager Chuck Shewen
Sample Manager Travis Gouveia
(530) 229-3268
Task Order 201
Project CVP AND IDP DRILLING 2016
Turnaround Time 10 Days
Shipping Date: 3/18/2016
COC Number: ALS999_1

	DATE	TIME	Matrix	DI Leach Acidity	DI Leach Alkalinity	DI Leach Conductivity	DI Leach Metals	DI Leach ORP	DI Leach Sulfate	Neut. Potential	Organic Content	Paste PH	ASTM 2216 Gradation	ASTM 2216 Moisture	ASTM D422-63 Gradation Hydrometer	ASTM D4318 Atterberg	ISO 15178-2000 Total Sulfur	SW6010B/6020A Total Metals	Number of Containers	COMMENTS
Container:				1 Gallon Ziploc	1 Gallon Ziploc	1 Gallon Ziploc	1 Gallon Ziploc	1 Gallon Ziploc	1 Gallon Ziploc	1 Gallon Ziploc	5 Gallon Bucket	1 Gallon Ziploc	1 Gallon Ziploc	Ziploc	Ziploc	Ziploc	Ziploc	Ziploc	Ziploc	
Preservatives:				4°C	4°C	4°C	4°C	4°C	4°C	4°C	4°C	4°C	4°C	4°C	4°C	4°C	4°C	4°C	4°C	
Filtered:				NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	
Holding Time:				30	30	30	180/28	30	30	None	NA	30	NA	NA	NA	NA	NA	30	180/28	
CH16-201-BH008_SOa1	3/10/2016		Soil	X	X	X	X	X	X	X		X			X	X	X	X	4	
CH16-201-BH008_SOa2	3/10/2016		Soil	X	X	X	X	X	X	X		X			X	X	X	X	4	
CH16-201-BH008_SOb1	3/10/2016		Soil												X				1	
CH16-201-BH908_SOa2	3/10/2016		Soil	X	X	X	X	X	X	X		X					X	X	3	
CH16-201-BH007_SOa1	3/8/2016		Soil	X	X	X	X	X	X	X		X			X		X	X	4	
CH16-201-BH007_SOc	3/8/2016		Soil												X				1	
CH16-201-BH007_SOe1	3/8/2016		Soil												X				1	
CH16-201-BH007_SOe2	3/8/2016		Soil	X	X	X	X	X	X	X		X					X	X	3	
CH16-201-BH907_SOe2	3/8/2016		Soil	X	X	X	X	X	X	X		X					X	X	3	
CH16-201-BH009_SOa1	3/9/2016		Soil												X				1	
CH16-201-BH009_SOa2	3/9/2016		Soil	X	X	X	X	X	X	X		X					X	X	3	
CH16-201-BH009_SOb2	3/9/2016		Soil	X	X	X	X	X	X	X	X	X			X	X	X	X	5	
CH16-201-BH006A_SOa1	3/10/2016		Soil	X	X	X	X	X	X	X		X					X	X	3	
CH16-201-BH006A_SOa3	3/10/2016		Soil	X	X	X	X	X	X	X		X					X	X	3	

Signatures	Date/Time
Approved by	
Sampled by	
Relinquished by	3/19/16
Received by	19/Mar/16 1.0/0.5/1.1
Relinquished by	8pm
Received by	Lady Mar. 22 2:30pm

7/8/8/8/6.0

Shipping Details
Method of Shipment: ~~FedEx~~
On Ice: yes / no
Airbill No:
Lab Name: ALS Vancouver
Lab Phone: (604) 253-4188

ATTN:
Sample Custody
and
Amber Springer

Special Instructions:

Report Copy to
Mark Cichy
(530) 229-3274



L1746804-COFC

CH2MHILL

CHAIN OF CUSTODY RECORD

Project Name Faro Mine
Location Faro Mine Complex - Faro YK
Project Number 660403.07.01.01.02.03.FW
Project Manager Chuck Shewen
Sample Manager Travis Gouveia
(530) 229-3268
Task Order 201
Project CVP AND IDP DRILLING 2016
Turnaround Time 10 Days
Shipping Date: 3/18/2016
COC Number: ALS999_1

	DATE	TIME	Matrix	DI Leach Acidity	DI Leach Alkalinity	DI Leach Conductivity	DI Leach Metals	DI Leach ORP	DI Leach Sulfate	Neut. Potential	Organic Content	Paste PH	ASTM 2216 Gradation	ASTM 2216 Moisture	ASTM D422-63 Gradation Hydrometer	ASTM D4318 Atterberg	ISO 15178-2000 Total Sulfur	SW6010B/6020A Total Metals	Number of Containers	COMMENTS
Container:				1 Gallon Ziploc	1 Gallon Ziploc	1 Gallon Ziploc	1 Gallon Ziploc	1 Gallon Ziploc	1 Gallon Ziploc	1 Gallon Ziploc	5 Gallon Bucket	1 Gallon Ziploc	1 Gallon Ziploc	1 Ziploc	Ziploc	Ziploc	Ziploc	Ziploc	Ziploc	
Preservatives:				4°C	4°C	4°C	4°C	4°C	4°C	4°C	4°C	4°C	4°C	4°C	4°C	4°C	4°C	4°C	4°C	
Filtered:				NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	
Holding Time:				30	30	30	180/28	30	30	None	NA	30	NA	NA	NA	NA	30	180/28		
CH16-201-BH008_SOa3	3/10/2016		Soil	X	X	X	X	X	X	X		X					X	X	3	
CH16-201-BH010A_SOa1	3/10/2016		Soil	X	X	X	X	X	X	X		X					X	X	5	
CH16-201-BH010A_SOa1	3/10/2016		Soil								X				X	X			5	
CH16-201-BH010A_SOa2	3/10/2016		Soil	X	X	X	X	X	X	X		X					X	X	3	
CH16-201-BH010A_SOb2	3/10/2016		Soil	X	X	X	X	X	X	X		X					X	X	3	
CH16-201-BH010A_SOb4	3/10/2016		Soil								X				X	X			2	
CH16-201-BH011_SOa1	3/11/2016		Soil	X	X	X	X	X	X	X		X			X	X	X	X	4	
CH16-201-BH011_SOa2	3/11/2016		Soil	X	X	X	X	X	X	X		X					X	X	3	
CH16-201-BH012_SOb	3/11/2016		Soil	X	X	X	X	X	X	X	X	X			X	X	X	X	5	
CH16-201-BH005B_SOa1	3/12/2016		Soil	X	X	X	X	X	X	X		X					X	X	3	
CH16-201-BH011A_SOa	3/12/2016		Soil	X	X	X	X	X	X	X		X			X	X	X	X	4	
CH16-201-BH011A_SOb	3/12/2016		Soil	X	X	X	X	X	X	X		X					X	X	3	
CH16-201-BH012A_SOa1	3/12/2016		Soil	X	X	X	X	X	X	X	X	X			X	X	X	X	5	
CH16-201-BH012A_SOa2	3/12/2016		Soil	X	X	X	X	X	X	X	X	X	X			X	X	X	5	

	Signatures	Date/Time
Approved by		
Sampled by		
Relinquished by		3/19/16
Received by		
Relinquished by		
Received by	lady Mar27 2:30Pm	

7/8/8/8/6·C

Shipping Details
Method of Shipment: FedEx
On Ice: yes / no
Airbill No:
Lab Name: ALS Vancouver
Lab Phone: (604) 253-4188

ATTN:
Sample Custody
and
Amber Springer

Special Instructions:

Report Copy to
Mark Cichy
(530) 229-3274

L1746804-COFC

CH2MHILL

CHAIN OF CUSTODY RECORD

3/

Project Name Faro Mine
Location Faro Mine Complex - Faro YK
Project Number 660403.07.01.01.02.03.FW
Project Manager Chuck Shewen
Sample Manager Travis Gouveia
(530) 229-3268
Task Order 201
Project CVP AND IDP DRILLING 2016
Turnaround Time 10 Days
Shipping Date: 3/18/2016
COC Number: ALS999_1

	DATE	TIME	Matrix	DI Leach Acidity	DI Leach Alkalinity	DI Leach Conductivity	DI Leach Metals	DI Leach ORP	DI Leach Sulfate	Neut. Potential	Organic Content	Paste PH	ASTM 2216 Gradation	ASTM 2216 Moisture	ASTM D422-63 Gradation Hydrometer	ASTM D4318 Atterberg	ISO 15178-2000 Total Sulfur	SW6010B/6020A Total Metals	Number of Containers	COMMENTS
Container:				1 Gallon Ziploc	1 Gallon Ziploc	1 Gallon Ziploc	1 Gallon Ziploc	1 Gallon Ziploc	1 Gallon Ziploc	1 Gallon Ziploc	5 Gallon Bucket	1 Gallon Ziploc	1 Gallon Ziploc	1 Gallon Ziploc	Ziploc	Ziploc	Ziploc	Ziploc		
Preservatives:				4°C	4°C	4°C	4°C	4°C	4°C	4°C	4°C	4°C	4°C	4°C	4°C	4°C	4°C	4°C		
Filtered:				NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA		
Holding Time:				30	30	30	180/28	30	30	None	NA	30	NA	NA	NA	NA	30	180/28		
CH16-201-BH012A_SOa4	3/12/2016		Soil	X	X	X	X	X	X	X		X			X		X	X	4	
CH16-201-CP018_SOa	3/13/2016		Soil	X	X	X	X	X	X	X		X			X		X	X	4	
CH16-201-GS001_SOa	3/13/2016		Soil	X	X	X	X	X	X	X		X		X	X	X	X	X	4	
CH16-201-CP017_SOa	3/14/2016		Soil	X	X	X	X	X	X	X		X			X		X	X	4	
CH16-201-CP016_SOa	3/15/2016		Soil	X	X	X	X	X	X	X		X			X		X	X	4	
CH16-201-CP916_SOa	3/15/2016		Soil	X	X	X	X	X	X	X		X			X		X	X	4	
																		TOTAL NUMBER OF CONTAINERS	116	

	Signatures	Date/Time
Approved by		
Sampled by		
Relinquished by		3/19/16
Received by		
Relinquished by		
Received by	Lady Mar. 22	2:30pm

7/8/8/8/6 v

Shipping Details
Method of Shipment: FedEx
On Ice: yes / no
Airbill No:
Lab Name: ALS Vancouver
Lab Phone: (604) 253-4188

ATTN:
Sample Custody
and
Amber Springer

Special Instructions:

Report Copy to
Mark Cichy
(530) 229-3274

Attachment 7
Data Quality Evaluation Report

ATTACHMENT 7

2016 Faro Mine CVD and ID Ponds Drilling Investigation Data Quality Evaluation Report

Soil samples were collected and analyzed during the March 2016 Cross Valley Dam Pond and Intermediate Dam Pond Drilling Investigation in support of the Faro Mine Remediation Project. All analytical data were evaluated as described in the *Quality Assurance Project Plan, Faro Mine Remediation Project* (QAPP) (CH2M HILL, 2015a). This data quality evaluation (DQE) report summarizes the results of the quality assurance and quality control activities prescribed in the QAPP and provides a data usability assessment. The QAPP identifies the method-specific QC requirements for each analytical parameter and matrix and defines a plan to test that the correct sampling, analytical, and data reduction procedures are followed by using audits and data validation.

This report is a general data quality assessment designed to summarize data issues.

Analytical Data

Between March 8th and 15th 2016, 30 native environmental soil samples, 3 soil field duplicates (FD) and 1 equipment blank (EB) were collected. Samples were analyzed by ALS Canada, Ltd. (ALS), in Burnaby, British Columbia. The laboratory placed the samples into two sample delivery groups (SDG). Summaries of the samples collected are presented in Tables 1 and 2. A total of 12 methods were used to analyze the environmental samples. The samples were collected and couriered to ALS in Whitehorse and shipped by overnight carrier to ALS in Burnaby for analysis. Selected samples were analyzed for one or more of the following analytes/methods:

- Material finer than 75-µm by Method ASTM D1140
- Particle Size with hydrometer by Method ASTM D422
- Atterberg Limits by Method ASTM D4318
- Organic Matter by Method CSSS (1978) P 160
- Paste pH and pH(1:2 soil: water) by Method CSSS/APHA 4500H
- Mercury, total and dissolved by Method E1631E
- Sulfur by Method ISO 15178:2000
- Neutralization Potential (as CaCO3 Equivalents) by Method MOD-SOBEK-3.2.3
- Hardness by Method SM2340B_CALC
- Sulfate by Method SM4110B
- Metals, total and dissolved by Method SW6010B
- Metals, dissolved by Method SW6020A

The SDGs were evaluated by CH2M HILL chemists for data quality. Analytical performance was initially assessed on an SDG basis or an analytical batch basis. The association of laboratory QC samples and environmental samples from the same analytical batch is determined by the laboratory lot control number. Data were assessed using Level II validation as indicated below:

- Review data set narrative to identify issues that the laboratory reported in the data deliverable
- Check sample integrity (e.g., sample collection, preservation, and holding times)
- Evaluate basic QC measurements used to assess the accuracy, precision, and representativeness of data, including QC blanks, laboratory control samples, matrix spike samples, surrogate recovery (when applicable), and field or laboratory duplicate results
- Review sample results, target compound lists, and detection limits to verify that project analytical requirements are met
- Initiate corrective actions, as necessary, based on the data review findings

- Verify that hardcopy results match electronic deliverable results
- Qualify data by using appropriate qualifier flags, as necessary, to indicate data usability limitations

Field samples were also reviewed to ascertain field compliance and data quality issues. This included a review of the EB and FDs.

Data flags were assigned in accordance with the QC acceptance limits defined in the QAPP. The data validation flags for the SDG are summarized in each data quality validation report. The flags, and the reason for each flag, are recorded in the electronic validation database. Multiple flags can be applied to specific sample method/matrix/analyte combinations, but there is only one final flag. The final flag is applied on the basis of the flags entered into the database and is the most conservative of the applied validation flags. The final flag also includes matrix and blank sample impacts.

Data flags can be separated into two categories to be used in estimating both contractor and analytical completeness:

1. Flags applied because of laboratory deviations from requirements in the QAPP
2. Flags applied because of the nature of the sample matrix or method limitations

The database tracks the type of protocol violation and the contractual and analytical completeness during data validation.

The data flags are defined in the QAPP as follows:

J = Analyte was present but the reported value may not be accurate or precise.

UJ = Analyte was not detected above the detection limit objective. However, the reported detection limit is approximate and may or may not represent the actual limit of quantitation necessary to accurately and precisely measure the analyte in the sample.

R = Result has been rejected for use.

U = Analyte was analyzed for but not detected at the specified detection limit.

None = A database flag with no QC implications. A flag is not applied. This is a placeholder for calculating QC criteria issues that do not require flagging.

Exclude = A database flag with no QC implications. When multiple data points have been reported, such as dilutions or re-extractions, the data that best match QAPP QC requirements are presented to the data users and the remainders are marked with this flag.

= = A database flag with no QC implications. A place holder for the DQE reporting purposes noting that the reported result is a detected concentration greater than the RL.

Findings

The overall summaries of the data validation findings are contained in Tables 1 through 5 and summarized in the method sections that follow:

- **Table 1**: Sample Summary by Chain of Custody – Data Summary. Presents the sample identifiers, sampling dates, and SDG sorted by chain-of-custody (COC) number.
- **Table 2**: Sample Chronology – Data Summary. Presents the sample identifiers, methods, sampling dates, received dates, extraction dates, and analysis dates sorted by SDG number.
- **Table 3**: Overall Flagging Summary. Presents the number of occurrences for each data validation reason by method.

- **Table 4:** Field Duplicate Precision – Qualified Data. Presents the data qualified because of FD precision exceedances.
- **Table 5**: Site Completeness by Analyte – Qualified Data. Presents the percent completeness by method, analyte, and matrix.

Overall Flagging Summary

The frequency of field and laboratory QC samples and the associated control criteria are specified in the QAPP. The control criteria were used to evaluate laboratory data. In the following method-specific discussions, only the criteria exceedances that affect data qualification are discussed.

Method E1631E (Mercury)

Field Duplicate

Table 4 lists the specific field sample and its associated laboratory duplicate relative percent difference (RPD) criteria exceedance. There was a criteria exceedance in one sample. The associated detected concentrations were flagged "J."

Method ISO 15178:2000 (Sulfur)

Field Duplicate

Table 4 lists the specific field sample and its associated laboratory duplicate relative percent difference (RPD) criteria exceedance. There was a criteria exceedance in one sample. The associated detected concentrations were flagged "J."

Method SW6010B (Metals)

Field Duplicate

Table 4 lists the specific field samples and their associated laboratory duplicate relative percent difference (RPD) criteria exceedances. There was a criteria exceedance in two samples. The associated detected concentrations were flagged "J."

Overall Assessment

Completeness is calculated and reported for each method, matrix, and analyte combination as outlined in the QAPP. The number of valid (i.e., not qualified with an "R" flag) results divided by the number of possible individual analyte results, expressed as a percentage, determines the completeness of the data set. A summary of the completeness percentages is provided in Table 5.

The QAPP completeness goal is 90 percent, and the overall data completeness is 100 percent.

Of 1155 normal and FD data points, 32 detected results (approximately 2.8 percent) were qualified as estimated concentrations because of QC exceedances.

Evaluation of 100 percent of the chemical data was performed by using QAPP guidelines for this DQE.

Data Management

Faro Mine Remediation Project (FMRP) sampling activity logs and laboratory analytical data are maintained in a project database or in project files, where appropriate. Data were collected and stored in a manner consistent with the requirements of the QAPP.

All raw data will be maintained on file in the laboratory and will be available upon request. Complete documentation of sample preparation and analysis and associated QC information will be maintained in a manner that allows easy retrieval if that information is needed. The following minimum documentation was kept for this project:

- Original work order, COC forms, and other pertinent documents received with the samples
- Records of communications between the laboratory, field personnel, and the client
- Corrective action reports
- Laboratory data reports
- Laboratory logbooks and all raw sample preparation and analytical data
- Electronic data and all pertinent standard operating procedures

The minimum field records retained for this project included correspondence, COC forms, field notes, field equipment performance records, maintenance logs, field procedures, corrective action reports, field personnel files, and project-related reports.

The receipt of electronic and portable document format (PDF) laboratory data were logged into the sample tracking program to determine completeness and contractor turnaround time compliance. CH2M HILL chemists uploaded this data into the validation program. All data validation was performed by a semi-automated data validation program that uses laboratory PDF report and electronic data simultaneously. All validation flags and discoveries were entered into the validation database and linked directly to each individual data point. All DQE reports were generated from the validation database. Final validation flags and data points were uploaded to the FMRP EQuIS site.

The data management system is designed to maintain the usability and integrity of the data through a series of procedures and QC checks that began at the field site and carried through to the generation of data for the user. These data include chemical data and field operation information. Both the chemical data and the field operations information were handled in accordance with the guidelines established in the QAPP and the *Faro Mine Data Management Plan* (CH2M HILL, 2015b).

The laboratory PDF reports are stored in the project files and project local area network hard drive areas in the CH2M HILL office in Redding, California. The original field data forms are stored on the FMRP SharePoint site. Laboratories are required to archive the analytical data as outlined in the QAPP.

Works Cited

CH2M Canada Limited (CH2M). 2015a. *Quality Assurance Project Plan.* Final. Prepared for Government of Canada as represented by Aboriginal Affairs and Northern Development Canada and the Government of Yukon. September.

CH2M Canada Limited (CH2M). 2015b. *Faro Mine Complex Data Management Plan.* Final. Prepared for Government of Canada as represented by Aboriginal Affairs and Northern Development Canada and the Government of Yukon. December 1.

TABLE 1

Sample Summary by COC - Data Summary

CoC Number	Sample Date	Matrix	Sample ID / QAQC Type	SDG	Laboratory
ALS15031602					
	09-Mar-16	WATER	E_201_16_001 / EB	L1745598	ALS
			E_201_16_001MS / MS	L1745598	ALS
ALS999_1					
	12-Mar-16	SOIL	CH16-201-BH005B_SOA1 / N	L1746804	ALS
	10-Mar-16		CH16-201-BH006A_SOA1 / N	L1746804	ALS
			CH16-201-BH006A_SOA3 / N	L1746804	ALS
	08-Mar-16		CH16-201-BH007_SOA1 / N	L1746804	ALS
			CH16-201-BH007_SOC / N	L1746804	ALS
			CH16-201-BH007_SOE1 / N	L1746804	ALS
			CH16-201-BH007_SOE2 / N	L1746804	ALS
	10-Mar-16		CH16-201-BH008_SOA1 / N	L1746804	ALS
			CH16-201-BH008_SOA1MS / MS	L1746804	ALS
			CH16-201-BH008_SOA2 / N	L1746804	ALS
			CH16-201-BH008_SOA3 / N	L1746804	ALS
			CH16-201-BH008_SOB1 / N	L1746804	ALS
	09-Mar-16		CH16-201-BH009_SOA1 / N	L1746804	ALS
			CH16-201-BH009_SOA2 / N	L1746804	ALS
			CH16-201-BH009_SOB2 / N	L1746804	ALS
	10-Mar-16		CH16-201-BH010A_SOA1 / N	L1746804	ALS
			CH16-201-BH010A_SOA2 / N	L1746804	ALS
			CH16-201-BH010A_SOB2 / N	L1746804	ALS
			CH16-201-BH010A_SOB4 / N	L1746804	ALS
	11-Mar-16		CH16-201-BH011_SOA1 / N	L1746804	ALS
			CH16-201-BH011_SOA2 / N	L1746804	ALS
	12-Mar-16		CH16-201-BH011A_SOA / N	L1746804	ALS
			CH16-201-BH011A_SOB / N	L1746804	ALS
	11-Mar-16		CH16-201-BH012_SOB / N	L1746804	ALS
	12-Mar-16		CH16-201-BH012A_SOA1 / N	L1746804	ALS
			CH16-201-BH012A_SOA2 / N	L1746804	ALS
			CH16-201-BH012A_SOA4 / N	L1746804	ALS
			CH16-201-BH012A_SOA4MS / MS	L1746804	ALS
	08-Mar-16		CH16-201-BH907_SOE2 / FD	L1746804	ALS
	10-Mar-16		CH16-201-BH908_SOA2 / FD	L1746804	ALS

TABLE 1

Sample Summary by COC - Data Summary

CoC Number	Sample Date	Matrix	Sample ID / QAQC Type	SDG	Laboratory
ALS999_1					
	15-Mar-16	SOIL	CH16-201-CP016_SOA / N	L1746804	ALS
	14-Mar-16		CH16-201-CP017_SOA / N	L1746804	ALS
	13-Mar-16		CH16-201-CP018_SOA / N	L1746804	ALS
			CH16-201-CP018_SOAMS / MS	L1746804	ALS
	15-Mar-16		CH16-201-CP916_SOA / FD	L1746804	ALS
	13-Mar-16		CH16-201-GS001_SOA / N	L1746804	ALS

QAQC Type

N = normal environmental sample
FD = field duplicate
MS = matrix spike
EB = equipment blank

TABLE 2

Sample Chronology - Data Summary

Laboratory	SDG	Sample ID	Method	Sample Date	Receive Date	Extract Date	Analysis Date
ALS	L1745598	E_201_16_001	E1631E	3/9/2016	3/16/2016		3/20/2016
		E_201_16_001	E1631E	3/9/2016	3/16/2016	3/18/2016	3/20/2016
		E_201_16_001	SM2340B_CALC	3/9/2016	3/16/2016		3/29/2016
		E_201_16_001	SM4110B	3/9/2016	3/16/2016		3/18/2016
		E_201_16_001	SW6010B	3/9/2016	3/16/2016		3/27/2016
		E_201_16_001	SW6010B	3/9/2016	3/16/2016		3/28/2016
		E_201_16_001	SW6010B	3/9/2016	3/16/2016		3/29/2016
		E_201_16_001	SW6010B	3/9/2016	3/16/2016	3/18/2016	3/27/2016
		E_201_16_001	SW6020A	3/9/2016	3/16/2016	3/18/2016	3/29/2016
		E_201_16_001MS	E1631E	3/9/2016	3/18/2016	3/18/2016	3/20/2016
		E_201_16_001MS	E1631E	3/9/2016	3/20/2016		3/20/2016
	L1746804	CH16-201-BH005B_SOA1	CSSS/APHA 4500H	3/12/2016	3/19/2016		4/1/2016
		CH16-201-BH005B_SOA1	CSSS/APHA 4500H	3/12/2016	3/19/2016		4/4/2016
		CH16-201-BH005B_SOA1	E1631E	3/12/2016	3/19/2016	3/30/2016	4/2/2016
		CH16-201-BH005B_SOA1	ISO 15178:2000	3/12/2016	3/19/2016	4/5/2016	4/5/2016
		CH16-201-BH005B_SOA1	MOD-SOBEK-3.2.3	3/12/2016	3/19/2016	4/15/2016	4/15/2016
		CH16-201-BH005B_SOA1	SW6010B	3/12/2016	3/19/2016	3/30/2016	4/1/2016
		CH16-201-BH006A_SOA1	CSSS/APHA 4500H	3/10/2016	3/19/2016		4/1/2016
		CH16-201-BH006A_SOA1	CSSS/APHA 4500H	3/10/2016	3/19/2016		4/4/2016
		CH16-201-BH006A_SOA1	E1631E	3/10/2016	3/19/2016	3/30/2016	4/2/2016
		CH16-201-BH006A_SOA1	ISO 15178:2000	3/10/2016	3/19/2016	4/5/2016	4/5/2016
		CH16-201-BH006A_SOA1	MOD-SOBEK-3.2.3	3/10/2016	3/19/2016	4/15/2016	4/15/2016
		CH16-201-BH006A_SOA1	SW6010B	3/10/2016	3/19/2016	3/30/2016	4/1/2016
		CH16-201-BH006A_SOA3	CSSS/APHA 4500H	3/10/2016	3/19/2016		4/1/2016
		CH16-201-BH006A_SOA3	E1631E	3/10/2016	3/19/2016	3/30/2016	4/2/2016
		CH16-201-BH006A_SOA3	ISO 15178:2000	3/10/2016	3/19/2016	4/5/2016	4/5/2016
		CH16-201-BH006A_SOA3	MOD-SOBEK-3.2.3	3/10/2016	3/19/2016	4/15/2016	4/15/2016
		CH16-201-BH006A_SOA3	SW6010B	3/10/2016	3/19/2016	3/30/2016	4/1/2016
		CH16-201-BH007_SOA1	ASTM D422-63	3/8/2016	3/19/2016	4/8/2016	4/8/2016
		CH16-201-BH007_SOA1	CSSS/APHA 4500H	3/8/2016	3/19/2016		4/1/2016
		CH16-201-BH007_SOA1	CSSS/APHA 4500H	3/8/2016	3/19/2016		4/4/2016
		CH16-201-BH007_SOA1	E1631E	3/8/2016	3/19/2016	3/30/2016	4/2/2016
		CH16-201-BH007_SOA1	ISO 15178:2000	3/8/2016	3/19/2016	4/5/2016	4/5/2016
		CH16-201-BH007_SOA1	MOD-SOBEK-3.2.3	3/8/2016	3/19/2016	4/15/2016	4/15/2016
		CH16-201-BH007_SOA1	SW6010B	3/8/2016	3/19/2016	3/30/2016	4/1/2016

TABLE 2

Sample Chronology - Data Summary

Laboratory	SDG	Sample ID	Method	Sample Date	Receive Date	Extract Date	Analysis Date
ALS	L1746804	CH16-201-BH007_SOC	ASTM D422-63	3/8/2016	3/19/2016	4/8/2016	4/8/2016
		CH16-201-BH007_SOE1	ASTM D422-63	3/8/2016	3/19/2016	4/8/2016	4/8/2016
		CH16-201-BH007_SOE2	CSSS/APHA 4500H	3/8/2016	3/19/2016		4/1/2016
		CH16-201-BH007_SOE2	CSSS/APHA 4500H	3/8/2016	3/19/2016		4/4/2016
		CH16-201-BH007_SOE2	E1631E	3/8/2016	3/19/2016	3/30/2016	4/2/2016
		CH16-201-BH007_SOE2	ISO 15178:2000	3/8/2016	3/19/2016	4/5/2016	4/5/2016
		CH16-201-BH007_SOE2	MOD-SOBEK-3.2.3	3/8/2016	3/19/2016	4/15/2016	4/15/2016
		CH16-201-BH007_SOE2	SW6010B	3/8/2016	3/19/2016	3/30/2016	4/1/2016
		CH16-201-BH008_SOA1	ASTM D422-63	3/10/2016	3/19/2016	4/8/2016	4/8/2016
		CH16-201-BH008_SOA1	ASTM D4318	3/10/2016	3/19/2016	4/7/2016	4/7/2016
		CH16-201-BH008_SOA1	CSSS/APHA 4500H	3/10/2016	3/19/2016		4/1/2016
		CH16-201-BH008_SOA1	CSSS/APHA 4500H	3/10/2016	3/19/2016		4/4/2016
		CH16-201-BH008_SOA1	E1631E	3/10/2016	3/19/2016	3/30/2016	4/2/2016
		CH16-201-BH008_SOA1	ISO 15178:2000	3/10/2016	3/19/2016	4/5/2016	4/5/2016
		CH16-201-BH008_SOA1	MOD-SOBEK-3.2.3	3/10/2016	3/19/2016	4/15/2016	4/15/2016
		CH16-201-BH008_SOA1	SW6010B	3/10/2016	3/19/2016	3/30/2016	4/1/2016
		CH16-201-BH008_SOA1MS	E1631E	3/10/2016	3/30/2016	3/30/2016	4/2/2016
		CH16-201-BH008_SOA1MS	SW6010B	3/10/2016	3/30/2016	3/30/2016	4/1/2016
		CH16-201-BH008_SOA2	ASTM D422-63	3/10/2016	3/19/2016	4/8/2016	4/8/2016
		CH16-201-BH008_SOA2	ASTM D4318	3/10/2016	3/19/2016	4/7/2016	4/7/2016
		CH16-201-BH008_SOA2	CSSS/APHA 4500H	3/10/2016	3/19/2016		4/1/2016
		CH16-201-BH008_SOA2	CSSS/APHA 4500H	3/10/2016	3/19/2016		4/4/2016
		CH16-201-BH008_SOA2	E1631E	3/10/2016	3/19/2016	3/30/2016	4/2/2016
		CH16-201-BH008_SOA2	ISO 15178:2000	3/10/2016	3/19/2016	4/5/2016	4/5/2016
		CH16-201-BH008_SOA2	MOD-SOBEK-3.2.3	3/10/2016	3/19/2016	4/15/2016	4/15/2016
		CH16-201-BH008_SOA2	SW6010B	3/10/2016	3/19/2016	3/30/2016	4/1/2016
		CH16-201-BH008_SOA3	CSSS/APHA 4500H	3/10/2016	3/19/2016		4/1/2016
		CH16-201-BH008_SOA3	CSSS/APHA 4500H	3/10/2016	3/19/2016		4/4/2016
		CH16-201-BH008_SOA3	E1631E	3/10/2016	3/19/2016	3/30/2016	4/2/2016
		CH16-201-BH008_SOA3	ISO 15178:2000	3/10/2016	3/19/2016	4/5/2016	4/5/2016
		CH16-201-BH008_SOA3	MOD-SOBEK-3.2.3	3/10/2016	3/19/2016	4/15/2016	4/15/2016
		CH16-201-BH008_SOA3	SW6010B	3/10/2016	3/19/2016	3/30/2016	4/1/2016
		CH16-201-BH008_SOB1	ASTM D422-63	3/10/2016	3/19/2016	4/8/2016	4/8/2016
		CH16-201-BH009_SOA1	ASTM D422-63	3/9/2016	3/19/2016	4/8/2016	4/8/2016
		CH16-201-BH009_SOA2	CSSS/APHA 4500H	3/9/2016	3/19/2016		4/1/2016

TABLE 2

Sample Chronology - Data Summary

Laboratory	SDG	Sample ID	Method	Sample Date	Receive Date	Extract Date	Analysis Date
ALS	L1746804	CH16-201-BH009_SOA2	CSSS/APHA 4500H	3/9/2016	3/19/2016		4/4/2016
		CH16-201-BH009_SOA2	E1631E	3/9/2016	3/19/2016	3/30/2016	4/2/2016
		CH16-201-BH009_SOA2	ISO 15178:2000	3/9/2016	3/19/2016	4/5/2016	4/5/2016
		CH16-201-BH009_SOA2	MOD-SOBEK-3.2.3	3/9/2016	3/19/2016	4/15/2016	4/15/2016
		CH16-201-BH009_SOA2	SW6010B	3/9/2016	3/19/2016	3/30/2016	4/1/2016
		CH16-201-BH009_SOB2	ASTM D422-63	3/9/2016	3/19/2016	4/8/2016	4/8/2016
		CH16-201-BH009_SOB2	ASTM D4318	3/9/2016	3/19/2016	4/7/2016	4/7/2016
		CH16-201-BH009_SOB2	CSSS 1978_P160	3/9/2016	3/19/2016	4/8/2016	4/9/2016
		CH16-201-BH009_SOB2	CSSS/APHA 4500H	3/9/2016	3/19/2016		4/1/2016
		CH16-201-BH009_SOB2	CSSS/APHA 4500H	3/9/2016	3/19/2016		4/4/2016
		CH16-201-BH009_SOB2	E1631E	3/9/2016	3/19/2016	3/30/2016	4/2/2016
		CH16-201-BH009_SOB2	ISO 15178:2000	3/9/2016	3/19/2016	4/5/2016	4/5/2016
		CH16-201-BH009_SOB2	MOD-SOBEK-3.2.3	3/9/2016	3/19/2016	4/15/2016	4/15/2016
		CH16-201-BH009_SOB2	SW6010B	3/9/2016	3/19/2016	3/30/2016	4/1/2016
		CH16-201-BH010A_SOA1	ASTM D422-63	3/10/2016	3/19/2016	4/8/2016	4/8/2016
		CH16-201-BH010A_SOA1	ASTM D4318	3/10/2016	3/19/2016	4/7/2016	4/7/2016
		CH16-201-BH010A_SOA1	CSSS 1978_P160	3/10/2016	3/19/2016	4/8/2016	4/9/2016
		CH16-201-BH010A_SOA1	CSSS/APHA 4500H	3/10/2016	3/19/2016		4/1/2016
		CH16-201-BH010A_SOA1	CSSS/APHA 4500H	3/10/2016	3/19/2016		4/4/2016
		CH16-201-BH010A_SOA1	E1631E	3/10/2016	3/19/2016	3/30/2016	4/2/2016
		CH16-201-BH010A_SOA1	ISO 15178:2000	3/10/2016	3/19/2016	4/5/2016	4/5/2016
		CH16-201-BH010A_SOA1	MOD-SOBEK-3.2.3	3/10/2016	3/19/2016	4/15/2016	4/15/2016
		CH16-201-BH010A_SOA1	SW6010B	3/10/2016	3/19/2016	3/30/2016	4/1/2016
		CH16-201-BH010A_SOA2	CSSS/APHA 4500H	3/10/2016	3/19/2016		4/1/2016
		CH16-201-BH010A_SOA2	CSSS/APHA 4500H	3/10/2016	3/19/2016		4/4/2016
		CH16-201-BH010A_SOA2	E1631E	3/10/2016	3/19/2016	3/30/2016	4/2/2016
		CH16-201-BH010A_SOA2	ISO 15178:2000	3/10/2016	3/19/2016	4/5/2016	4/5/2016
		CH16-201-BH010A_SOA2	MOD-SOBEK-3.2.3	3/10/2016	3/19/2016	4/15/2016	4/15/2016
		CH16-201-BH010A_SOA2	SW6010B	3/10/2016	3/19/2016	3/30/2016	4/1/2016
		CH16-201-BH010A_SOB2	CSSS/APHA 4500H	3/10/2016	3/19/2016		4/1/2016
		CH16-201-BH010A_SOB2	CSSS/APHA 4500H	3/10/2016	3/19/2016		4/4/2016
		CH16-201-BH010A_SOB2	E1631E	3/10/2016	3/19/2016	3/30/2016	4/2/2016
		CH16-201-BH010A_SOB2	ISO 15178:2000	3/10/2016	3/19/2016	4/5/2016	4/5/2016
		CH16-201-BH010A_SOB2	MOD-SOBEK-3.2.3	3/10/2016	3/19/2016	4/15/2016	4/15/2016
		CH16-201-BH010A_SOB2	SW6010B	3/10/2016	3/19/2016	3/30/2016	4/1/2016

TABLE 2

Sample Chronology - Data Summary

Laboratory	SDG	Sample ID	Method	Sample Date	Receive Date	Extract Date	Analysis Date
ALS	L1746804	CH16-201-BH010A_SOB4	ASTM D422-63	3/10/2016	3/19/2016	4/8/2016	4/8/2016
		CH16-201-BH010A_SOB4	ASTM D4318	3/10/2016	3/19/2016	4/7/2016	4/7/2016
		CH16-201-BH010A_SOB4	CSSS 1978_P160	3/10/2016	3/19/2016	4/8/2016	4/9/2016
		CH16-201-BH011_SOA1	CSSS/APHA 4500H	3/11/2016	3/19/2016		4/1/2016
		CH16-201-BH011_SOA1	E1631E	3/11/2016	3/19/2016	3/30/2016	4/2/2016
		CH16-201-BH011_SOA1	ISO 15178:2000	3/11/2016	3/19/2016	4/5/2016	4/5/2016
		CH16-201-BH011_SOA1	SW6010B	3/11/2016	3/19/2016	3/30/2016	4/1/2016
		CH16-201-BH011_SOA2	CSSS/APHA 4500H	3/11/2016	3/19/2016		4/1/2016
		CH16-201-BH011_SOA2	CSSS/APHA 4500H	3/11/2016	3/19/2016		4/4/2016
		CH16-201-BH011_SOA2	E1631E	3/11/2016	3/19/2016	3/30/2016	4/2/2016
		CH16-201-BH011_SOA2	ISO 15178:2000	3/11/2016	3/19/2016	4/5/2016	4/5/2016
		CH16-201-BH011_SOA2	MOD-SOBEK-3.2.3	3/11/2016	3/19/2016	4/15/2016	4/15/2016
		CH16-201-BH011_SOA2	SW6010B	3/11/2016	3/19/2016	3/30/2016	4/3/2016
		CH16-201-BH011A_SOA	CSSS/APHA 4500H	3/12/2016	3/19/2016		3/31/2016
		CH16-201-BH011A_SOA	E1631E	3/12/2016	3/19/2016	3/30/2016	4/2/2016
		CH16-201-BH011A_SOA	ISO 15178:2000	3/12/2016	3/19/2016	4/5/2016	4/5/2016
		CH16-201-BH011A_SOA	MOD-SOBEK-3.2.3	3/12/2016	3/19/2016	4/15/2016	4/15/2016
		CH16-201-BH011A_SOA	SW6010B	3/12/2016	3/19/2016	3/30/2016	4/1/2016
		CH16-201-BH011A_SOB	CSSS/APHA 4500H	3/12/2016	3/19/2016		3/31/2016
		CH16-201-BH011A_SOB	E1631E	3/12/2016	3/19/2016	3/30/2016	4/2/2016
		CH16-201-BH011A_SOB	ISO 15178:2000	3/12/2016	3/19/2016	4/5/2016	4/5/2016
		CH16-201-BH011A_SOB	MOD-SOBEK-3.2.3	3/12/2016	3/19/2016	4/15/2016	4/15/2016
		CH16-201-BH011A_SOB	SW6010B	3/12/2016	3/19/2016	3/30/2016	4/1/2016
		CH16-201-BH012_SOB	ASTM D1140	3/11/2016	3/19/2016	4/7/2016	4/8/2016
		CH16-201-BH012_SOB	ASTM D4318	3/11/2016	3/19/2016	4/7/2016	4/7/2016
		CH16-201-BH012_SOB	CSSS 1978_P160	3/11/2016	3/19/2016	4/8/2016	4/9/2016
		CH16-201-BH012_SOB	CSSS/APHA 4500H	3/11/2016	3/19/2016		4/1/2016
		CH16-201-BH012_SOB	CSSS/APHA 4500H	3/11/2016	3/19/2016		4/4/2016
		CH16-201-BH012_SOB	E1631E	3/11/2016	3/19/2016	3/30/2016	4/2/2016
		CH16-201-BH012_SOB	ISO 15178:2000	3/11/2016	3/19/2016	4/5/2016	4/5/2016
		CH16-201-BH012_SOB	MOD-SOBEK-3.2.3	3/11/2016	3/19/2016	4/15/2016	4/15/2016
		CH16-201-BH012_SOB	SW6010B	3/11/2016	3/19/2016	3/30/2016	4/1/2016
		CH16-201-BH012A_SOA1	ASTM D422-63	3/12/2016	3/19/2016	4/8/2016	4/8/2016
		CH16-201-BH012A_SOA1	ASTM D4318	3/12/2016	3/19/2016	4/7/2016	4/7/2016
		CH16-201-BH012A_SOA1	CSSS 1978_P160	3/12/2016	3/19/2016	4/8/2016	4/9/2016

TABLE 2

Sample Chronology - Data Summary

Laboratory	SDG	Sample ID	Method	Sample Date	Receive Date	Extract Date	Analysis Date
ALS	L1746804	CH16-201-BH012A_SOA1	CSSS/APHA 4500H	3/12/2016	3/19/2016		4/1/2016
		CH16-201-BH012A_SOA1	CSSS/APHA 4500H	3/12/2016	3/19/2016		4/4/2016
		CH16-201-BH012A_SOA1	E1631E	3/12/2016	3/19/2016	3/30/2016	4/2/2016
		CH16-201-BH012A_SOA1	ISO 15178:2000	3/12/2016	3/19/2016	4/5/2016	4/5/2016
		CH16-201-BH012A_SOA1	MOD-SOBEK-3.2.3	3/12/2016	3/19/2016	4/15/2016	4/15/2016
		CH16-201-BH012A_SOA1	SW6010B	3/12/2016	3/19/2016	3/30/2016	4/1/2016
		CH16-201-BH012A_SOA2	ASTM D422-63	3/12/2016	3/19/2016	4/8/2016	4/8/2016
		CH16-201-BH012A_SOA2	ASTM D4318	3/12/2016	3/19/2016	4/7/2016	4/7/2016
		CH16-201-BH012A_SOA2	CSSS 1978_P160	3/12/2016	3/19/2016	4/8/2016	4/9/2016
		CH16-201-BH012A_SOA2	CSSS/APHA 4500H	3/12/2016	3/19/2016		4/1/2016
		CH16-201-BH012A_SOA2	CSSS/APHA 4500H	3/12/2016	3/19/2016		4/4/2016
		CH16-201-BH012A_SOA2	E1631E	3/12/2016	3/19/2016	3/30/2016	4/2/2016
		CH16-201-BH012A_SOA2	ISO 15178:2000	3/12/2016	3/19/2016	4/5/2016	4/5/2016
		CH16-201-BH012A_SOA2	MOD-SOBEK-3.2.3	3/12/2016	3/19/2016	4/15/2016	4/15/2016
		CH16-201-BH012A_SOA2	SW6010B	3/12/2016	3/19/2016	3/30/2016	4/1/2016
		CH16-201-BH012A_SOA4	ASTM D422-63	3/12/2016	3/19/2016	4/8/2016	4/8/2016
		CH16-201-BH012A_SOA4	CSSS/APHA 4500H	3/12/2016	3/19/2016		4/1/2016
		CH16-201-BH012A_SOA4	CSSS/APHA 4500H	3/12/2016	3/19/2016		4/4/2016
		CH16-201-BH012A_SOA4	E1631E	3/12/2016	3/19/2016	3/30/2016	4/2/2016
		CH16-201-BH012A_SOA4	ISO 15178:2000	3/12/2016	3/19/2016	4/5/2016	4/5/2016
		CH16-201-BH012A_SOA4	MOD-SOBEK-3.2.3	3/12/2016	3/19/2016	4/15/2016	4/15/2016
		CH16-201-BH012A_SOA4	SW6010B	3/12/2016	3/19/2016	3/30/2016	4/4/2016
		CH16-201-BH012A_SOA4MS	E1631E	3/12/2016	3/30/2016	3/30/2016	4/2/2016
		CH16-201-BH012A_SOA4MS	SW6010B	3/12/2016	3/30/2016	3/30/2016	4/4/2016
		CH16-201-BH907_SOE2	CSSS/APHA 4500H	3/8/2016	3/19/2016		4/1/2016
		CH16-201-BH907_SOE2	CSSS/APHA 4500H	3/8/2016	3/19/2016		4/4/2016
		CH16-201-BH907_SOE2	E1631E	3/8/2016	3/19/2016	3/30/2016	4/2/2016
		CH16-201-BH907_SOE2	ISO 15178:2000	3/8/2016	3/19/2016	4/5/2016	4/5/2016
		CH16-201-BH907_SOE2	MOD-SOBEK-3.2.3	3/8/2016	3/19/2016	4/15/2016	4/15/2016
		CH16-201-BH907_SOE2	SW6010B	3/8/2016	3/19/2016	3/30/2016	4/1/2016
		CH16-201-BH908_SOA2	CSSS/APHA 4500H	3/10/2016	3/19/2016		4/1/2016
		CH16-201-BH908_SOA2	CSSS/APHA 4500H	3/10/2016	3/19/2016		4/4/2016
		CH16-201-BH908_SOA2	E1631E	3/10/2016	3/19/2016	3/30/2016	4/2/2016
		CH16-201-BH908_SOA2	ISO 15178:2000	3/10/2016	3/19/2016	4/5/2016	4/5/2016
		CH16-201-BH908_SOA2	MOD-SOBEK-3.2.3	3/10/2016	3/19/2016	4/15/2016	4/15/2016

TABLE 2

Sample Chronology - Data Summary

Laboratory	SDG	Sample ID	Method	Sample Date	Receive Date	Extract Date	Analysis Date
ALS	L1746804	CH16-201-BH908_SOA2	SW6010B	3/10/2016	3/19/2016	3/30/2016	4/1/2016
		CH16-201-CP016_SOA	ASTM D422-63	3/15/2016	3/19/2016	4/8/2016	4/8/2016
		CH16-201-CP016_SOA	CSSS/APHA 4500H	3/15/2016	3/19/2016		4/1/2016
		CH16-201-CP016_SOA	CSSS/APHA 4500H	3/15/2016	3/19/2016		4/4/2016
		CH16-201-CP016_SOA	E1631E	3/15/2016	3/19/2016	3/30/2016	4/2/2016
		CH16-201-CP016_SOA	ISO 15178:2000	3/15/2016	3/19/2016	4/5/2016	4/5/2016
		CH16-201-CP016_SOA	MOD-SOBEK-3.2.3	3/15/2016	3/19/2016	4/15/2016	4/15/2016
		CH16-201-CP016_SOA	SW6010B	3/15/2016	3/19/2016	3/30/2016	4/1/2016
		CH16-201-CP017_SOA	ASTM D422-63	3/14/2016	3/19/2016	4/8/2016	4/8/2016
		CH16-201-CP017_SOA	CSSS/APHA 4500H	3/14/2016	3/19/2016		4/1/2016
		CH16-201-CP017_SOA	CSSS/APHA 4500H	3/14/2016	3/19/2016		4/4/2016
		CH16-201-CP017_SOA	E1631E	3/14/2016	3/19/2016	3/30/2016	4/2/2016
		CH16-201-CP017_SOA	ISO 15178:2000	3/14/2016	3/19/2016	4/5/2016	4/5/2016
		CH16-201-CP017_SOA	MOD-SOBEK-3.2.3	3/14/2016	3/19/2016	4/15/2016	4/15/2016
		CH16-201-CP017_SOA	SW6010B	3/14/2016	3/19/2016	3/30/2016	4/1/2016
		CH16-201-CP018_SOA	CSSS/APHA 4500H	3/13/2016	3/19/2016		3/31/2016
		CH16-201-CP018_SOA	CSSS/APHA 4500H	3/13/2016	3/19/2016		4/5/2016
		CH16-201-CP018_SOA	E1631E	3/13/2016	3/19/2016	3/30/2016	4/1/2016
		CH16-201-CP018_SOA	ISO 15178:2000	3/13/2016	3/19/2016	4/5/2016	4/5/2016
		CH16-201-CP018_SOA	SW6010B	3/13/2016	3/19/2016	3/30/2016	4/1/2016
		CH16-201-CP018_SOAMS	E1631E	3/13/2016	3/30/2016	3/30/2016	4/1/2016
		CH16-201-CP018_SOAMS	SW6010B	3/13/2016	3/30/2016	3/30/2016	4/1/2016
		CH16-201-CP916_SOA	ASTM D422-63	3/15/2016	3/19/2016	4/8/2016	4/8/2016
		CH16-201-CP916_SOA	CSSS/APHA 4500H	3/15/2016	3/19/2016		4/1/2016
		CH16-201-CP916_SOA	CSSS/APHA 4500H	3/15/2016	3/19/2016		4/4/2016
		CH16-201-CP916_SOA	E1631E	3/15/2016	3/19/2016	3/30/2016	4/2/2016
		CH16-201-CP916_SOA	ISO 15178:2000	3/15/2016	3/19/2016	4/5/2016	4/5/2016
		CH16-201-CP916_SOA	MOD-SOBEK-3.2.3	3/15/2016	3/19/2016	4/15/2016	4/15/2016
		CH16-201-CP916_SOA	SW6010B	3/15/2016	3/19/2016	3/30/2016	4/1/2016
		CH16-201-GS001_SOA	ASTM D1140	3/13/2016	3/19/2016	4/7/2016	4/8/2016
		CH16-201-GS001_SOA	CSSS/APHA 4500H	3/13/2016	3/19/2016		3/31/2016
		CH16-201-GS001_SOA	E1631E	3/13/2016	3/19/2016	3/30/2016	4/2/2016
		CH16-201-GS001_SOA	ISO 15178:2000	3/13/2016	3/19/2016	4/5/2016	4/5/2016
		CH16-201-GS001_SOA	MOD-SOBEK-3.2.3	3/13/2016	3/19/2016	4/15/2016	4/15/2016
		CH16-201-GS001_SOA	SW6010B	3/13/2016	3/19/2016	3/30/2016	4/1/2016

TABLE 3

Overall Flagging Summary

Method	Matrix	Validation Reason	Qualifier*	Qualifier Type	Number of Affected Analytes
E1631E	SOIL				
Category = FieldDuplicate		Field duplicate exceeds RPD criteria			
			J	Other	2
ISO 15178:2000	SOIL				
Category = FieldDuplicate		Field duplicate exceeds RPD criteria			
			J	Other	2
SW6010B	SOIL				
Category = FieldDuplicate		Field duplicate exceeds RPD criteria			
			J	Other	28

* The most severe flag for each analyte becomes the final validation flag.

Qualifier Description:

J = Analyte was present but the reported value may not be accurate or precise.

Qualifier Type:

Protocol = Flagging due to contractor/laboratory protocol violations.
Other = Flagging due to sample, matrix, or field issues not related to Quality Assurance Project Plan (QAPP) or Sampling and Analysis Plan (SAP) protocol.

TABLE 4

Field Duplicate Precision - Qualified Data

Method	Matrix	Sample ID	Analyte	Result	Field Duplicate Qualifier*	Criteria
E1631E	SOIL		**Mercury**			
		CH16-201-BH008_SOA2		0.0935 mg/kg	J	FD>RPD
		CH16-201-BH908_SOA2		0.0537 mg/kg	J	FD>RPD
ISO 15178:2000	SOIL		**Sulfur**			
		CH16-201-BH008_SOA2		3600 mg/kg	J	FD>RPD
		CH16-201-BH908_SOA2		2000 mg/kg	J	FD>RPD
SW6010B	SOIL		**Arsenic**			
		CH16-201-BH007_SOE2		15.5 mg/kg	J	FD>RPD
		CH16-201-BH907_SOE2		7.87 mg/kg	J	FD>RPD
SW6010B	SOIL		**Cadmium**			
		CH16-201-BH007_SOE2		0.313 mg/kg	J	FD>RPD
		CH16-201-BH907_SOE2		0.167 mg/kg	J	FD>RPD
SW6010B	SOIL		**Calcium**			
		CH16-201-BH008_SOA2		13000 mg/kg	J	FD>RPD
		CH16-201-BH908_SOA2		7630 mg/kg	J	FD>RPD
SW6010B	SOIL		**Chromium**			
		CH16-201-BH007_SOE2		95.9 mg/kg	J	FD>RPD
		CH16-201-BH907_SOE2		39.3 mg/kg	J	FD>RPD
SW6010B	SOIL		**Cobalt**			
		CH16-201-BH007_SOE2		13.3 mg/kg	J	FD>RPD
		CH16-201-BH907_SOE2		7.96 mg/kg	J	FD>RPD
SW6010B	SOIL		**Copper**			
		CH16-201-BH007_SOE2		34.9 mg/kg	J	FD>RPD
		CH16-201-BH907_SOE2		19.7 mg/kg	J	FD>RPD
SW6010B	SOIL		**Lead**			
		CH16-201-BH007_SOE2		15.3 mg/kg	J	FD>RPD
		CH16-201-BH008_SOA2		84.7 mg/kg	J	FD>RPD
		CH16-201-BH907_SOE2		8.75 mg/kg	J	FD>RPD
		CH16-201-BH908_SOA2		48.3 mg/kg	J	FD>RPD
SW6010B	SOIL		**Manganese**			

TABLE 4

Field Duplicate Precision - Qualified Data

Method	Matrix	Sample ID	Analyte	Result	Field Duplicate Qualifier*	Criteria
		CH16-201-BH007_SOE2		458 mg/kg	J	FD>RPD
		CH16-201-BH907_SOE2		272 mg/kg	J	FD>RPD
SW6010B	SOIL		**Nickel**			
		CH16-201-BH007_SOE2		58.2 mg/kg	J	FD>RPD
		CH16-201-BH907_SOE2		28.2 mg/kg	J	FD>RPD
SW6010B	SOIL		**Phosphorus**			
		CH16-201-BH007_SOE2		701 mg/kg	J	FD>RPD
		CH16-201-BH907_SOE2		420 mg/kg	J	FD>RPD
SW6010B	SOIL		**Sodium**			
		CH16-201-BH007_SOE2		562 mg/kg	J	FD>RPD
		CH16-201-BH907_SOE2		317 mg/kg	J	FD>RPD
SW6010B	SOIL		**Titanium**			
		CH16-201-BH008_SOA2		388 mg/kg	J	FD>RPD
		CH16-201-BH908_SOA2		179 mg/kg	J	FD>RPD
SW6010B	SOIL		**Uranium**			
		CH16-201-BH008_SOA2		3.28 mg/kg	J	FD>RPD
		CH16-201-BH908_SOA2		1.49 mg/kg	J	FD>RPD

* The most severe flag for each analyte becomes the final validation flag.

Qualifier Description:

J = Analyte was present but the reported value may not be accurate or precise.

Criteria:

FD>RPD **=** Field duplicate exceeds RPD criteria

TABLE 5

Site Completeness by Analyte - Qualified Data

Method	Analyte	Units	Number of Occurrences						Completeness (%)	
			Analyses	Detects	Non-detects	Blank Flags	J-Flags	Contractor Total R-Flags	Contractor	Overall
ASTM D1140	PSA % < 75UM	%	2	2					100	100
ASTM D422-63	% Clay	%	16	16					100	100
ASTM D422-63	% Coarse Sand	%	16	10	6				100	100
ASTM D422-63	% Fine Sand	%	16	14	2				100	100
ASTM D422-63	% Gravel	%	16	10	6				100	100
ASTM D422-63	% Medium Sand	%	16	13	3				100	100
ASTM D422-63	% Silt	%	16	16					100	100
ASTM D4318	MOISTURE AT LIQUID LIMIT	%	8	8					100	100
ASTM D4318	PLASTICITY INDEX	%	8	7	1				100	100
CSSS 1978_P160	Organic Matter	%	6	4	2				100	100
CSSS 1978_P160	Organic Matter_LOI	%	6	4	2				100	100
CSSS/APHA 4500H	Paste pH	PH	26	26					100	100
CSSS/APHA 4500H	pH (1:2 soil:water)	PH	25	25					100	100
E1631E	Mercury	MG/KG	28	28			2		100	100
ISO 15178:2000	Sulfur	MG/KG	28	28			2		100	100
MOD-SOBEK-3.2.3	Neutralization Potential (as CaCO3 Eq.)	TCACO3/1KT	26	26					100	100
SW6010B	Aluminum	MG/KG	28	28					100	100
SW6010B	Antimony	MG/KG	28	28					100	100
SW6010B	Arsenic	MG/KG	28	28			2		100	100
SW6010B	Barium	MG/KG	28	28					100	100
SW6010B	Beryllium	MG/KG	28	28					100	100
SW6010B	Bismuth	MG/KG	28	24	4				100	100
SW6010B	Boron	MG/KG	28		28				100	100
SW6010B	Cadmium	MG/KG	28	28			2		100	100
SW6010B	Calcium	MG/KG	28	28			2		100	100
SW6010B	Chromium	MG/KG	28	28			2		100	100
SW6010B	Cobalt	MG/KG	28	28			2		100	100
SW6010B	Copper	MG/KG	28	28			2		100	100
SW6010B	Iron	MG/KG	28	28					100	100
SW6010B	Lead	MG/KG	28	28			4		100	100

TABLE 5

Site Completeness by Analyte - Qualified Data

Method	Analyte	Units	Number of Occurrences						Contractor Completeness (%)	Overall Completeness (%)
			Analyses	Detects	Non-detects	Blank Flags	J-Flags	Contractor Total R-Flags		
SW6010B	Lithium	MG/KG	28	28					100	100
SW6010B	Magnesium	MG/KG	28	28					100	100
SW6010B	Manganese	MG/KG	28	28			2		100	100
SW6010B	Molybdenum	MG/KG	28	28					100	100
SW6010B	Nickel	MG/KG	28	28			2		100	100
SW6010B	Phosphorus	MG/KG	28	28			2		100	100
SW6010B	Potassium	MG/KG	28	28					100	100
SW6010B	Selenium	MG/KG	28	22	6				100	100
SW6010B	Silver	MG/KG	28	24	4				100	100
SW6010B	Sodium	MG/KG	28	27	1		2		100	100
SW6010B	Strontium	MG/KG	28	28					100	100
SW6010B	Thallium	MG/KG	28	28					100	100
SW6010B	Tin	MG/KG	28	4	24				100	100
SW6010B	Titanium	MG/KG	28	28			2		100	100
SW6010B	Uranium	MG/KG	28	28			2		100	100
SW6010B	Vanadium	MG/KG	28	28					100	100
SW6010B	Zinc	MG/KG	28	28					100	100
SW6010B	Zirconium	MG/KG	28	24	4				100	100

% = Percent

MG/KG = Milligrams per Kilogram

TCACO3/1KT = Tons of Calcium Carbonate per One Thousand Tons of Material