Lynx Starter Dam 2019 Site Investigation Report

Myra Falls Mine
Wood Project # NX14001C1

Prepared for:

Nyrstar Myra Falls Ltd.
Campbell River, BC

30 April 2020

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1.0 Introduction

This factual data report summarizes the field program carried out for the 2019 Lynx starter dam site investigation at Nyrstar's Myra Falls Mine, located in Strathcona-Westmin Park approximately 55 km south of Campbell River on Vancouver Island, BC. The purpose of the site investigation was to collect geotechnical information for the Lynx starter dam after Wood (formerly Amec Foster Wheeler Environment & Infrastructure) identified a zone of nonconformance fill material in the southwest corner of the existing dam toe during the construction quality control activities for the 362.5 m elevation raise of Lynx TDF Dam in July 2017. The subject zone, designated as Panel 5, did not conform to the construction specifications. Wood reviewed existing information from previous site investigations completed at the Lynx TDF Dam site and record reporting from Wood and Klohn Crippen Berger (Klohn). A geotechnical site investigation was recommended to characterize the extent of the nonconformance fill materials observed during construction.

The proposed site investigation program was detailed in a letter to Nyrstar Myra Falls Mine dated August 27, 2019. The site investigation was completed in late 2019. This report contains site investigation factual information and presents a summary of the findings of the site investigation.

The primary focus of the site investigation was to identify nonconforming fill materials within the starter dam. An additional objective was to gain a better understanding of the foundation materials and the materials used during the early raises of the Lynx TDF Dam downstream shell construction prior to 2013. The data gained from the site investigation was intended to update the Lynx TDF stability model if warranted.

2.0 Scope of Work

Field activities were conducted from October 30 to November 5, and November 25 to December 3. The scope of the geotechnical site investigation included:

- Drilling paired sets of boreholes within 2 m of each other using instrumented Becker Penetration Testing (iBPT) for in situ strength testing followed by sonic drilling for sample recovery, at four locations along the dam crest at elevation 362.5 m (BH19-02/iBPT19-02, BH19-03/iBPT19-03, BH19-05/iBPT19-05&05B, and BH19-06/iBPT19-06);
- Drilling of two sonic boreholes (BH19-01 and BH19-04) along the dam centerline at elevation 365.1 m on the western side of the dam, to install slope indicators extending well below (approximately 10 m) the starter dam fill;
- Installing three vibrating wire piezometers (VWPs) in borehole BH19-02 (30.5 m depth), BH19-03 (31 m depth) and BH19-06 (35.5 m depth) at depths corresponding with the interpreted base of starter dam fill;
- Conducting two arrays of multi-channel analysis of surface waves (MASW); and
- Conducting two downhole seismic tests (DST) at two selected geotechnical boreholes.

Shallow refusal was encountered during the drilling of the iBPT holes at elevations corresponding approximately with the top of the starter dam (between about 23 and 24 m depth), so Standard Penetration Tests (SPTs) were completed below these depths in the sonic holes to provide some measure of in situ density of the starter dam fills. An additional open Becker hole was also attempted (iBPT19-05B) in an unsuccessful effort to penetrate the refusal layer.

The locations of the boreholes and geophysics lines are shown on a plan view in Figure 1, and on section views in Figure 2. The section views in Figure 2 correspond with the section lines drawn on Figure 1.

The iBPT results are presented in Appendix A and the Geophysical testing report is included in Appendix B. Amalgamated borehole logs are presented in Appendix C, and are identified as simply BH19-01 to BH19-06, except for the iBPT data from iBPT19-05B which is presented in a separate log. The RST instrument calibration documents and site investigation photographs are presented in Appendix D and Appendix E, respectively.

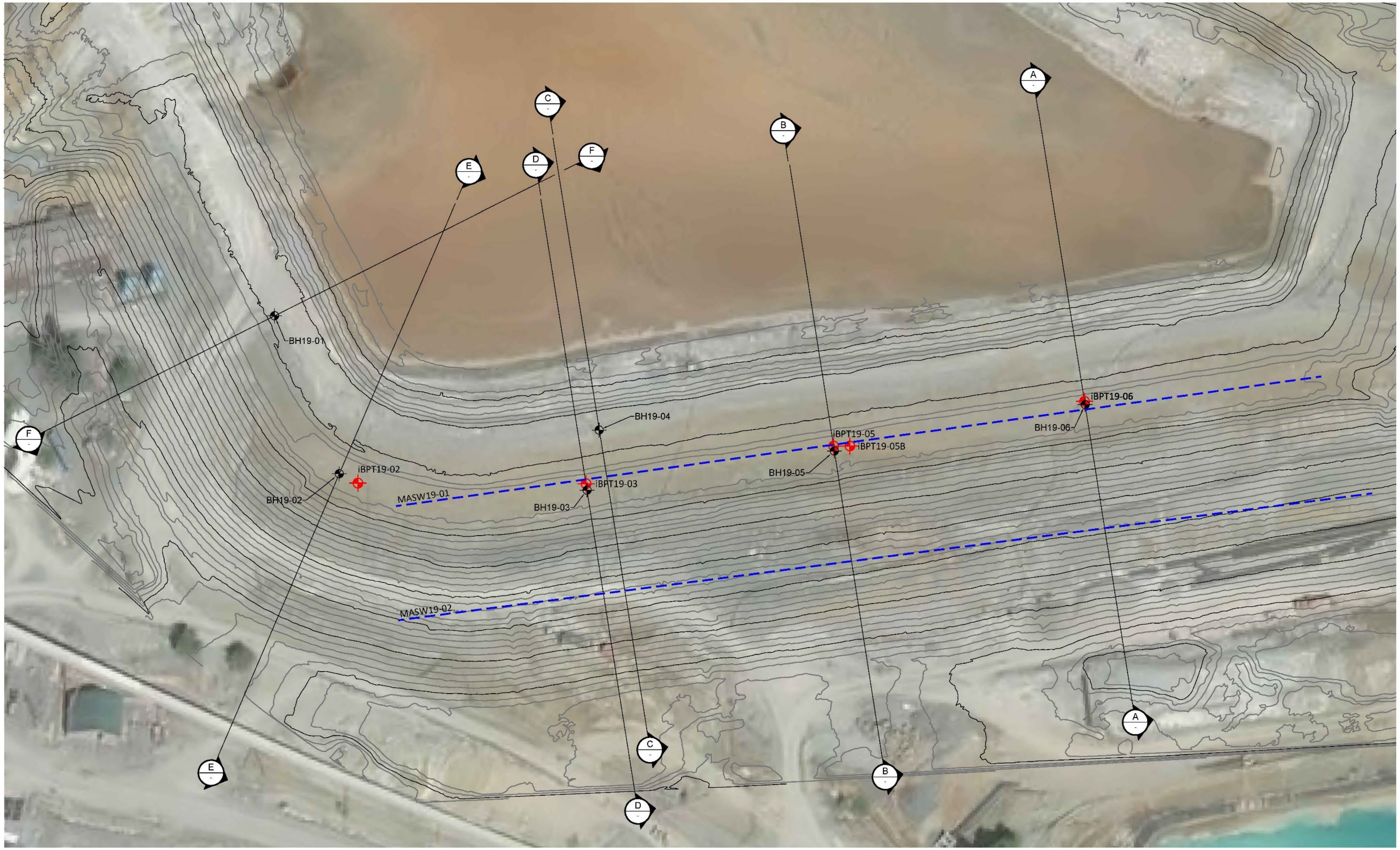
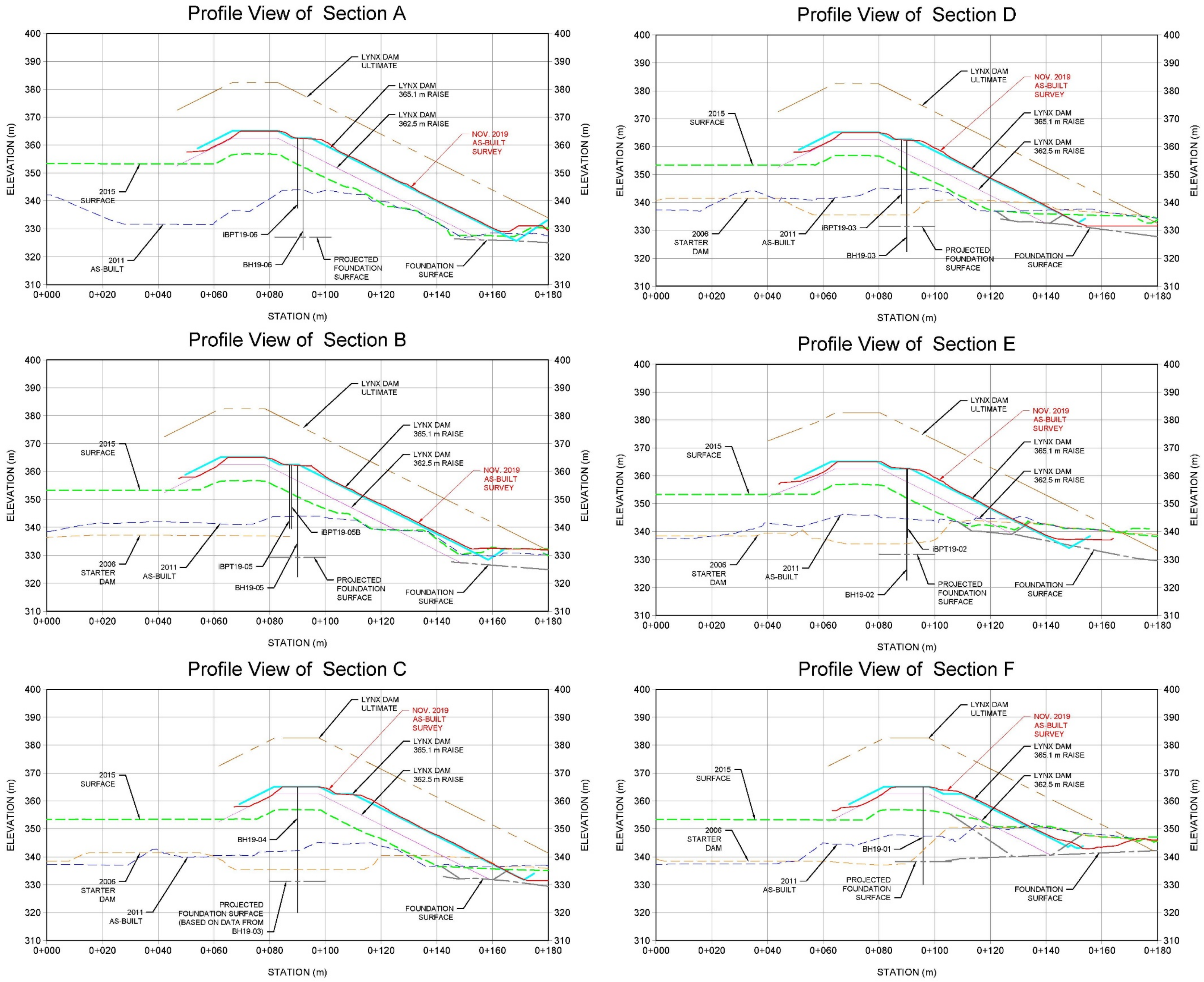


Figure 1: 2019 As-Built Borehole and MASW Plan View



Profile View of Section A

Profile View of Section B

Profile View of Section C

Profile View of Section D

Profile View of Section E

Profile View of Section F

Figure 2: 2019 As-Built Borehole Section View

3.0 Investigation Methodologies

The site investigation program was completed in two stages. The first stage consisted of completion of the iBPT boreholes conducted from October 30 to November 5, 2019. The second stage consisted of sonic drilling and instrumentation installation which was completed November 25 to December 3, 2019. Site safety orientations provided by Nyrstar, were conducted for each stage of site investigation for ConeTec, Mudbay Drilling and Wood personnel on October 30 and November 25, 2019.

3.1 iBPT Drilling

Five iBPT boreholes were completed along the 362.4 m downstream bench of the Lynx TDF from October 30 to November 5, 2019. ConeTec Investigation Ltd. was subcontracted by Nyrstar and coordinated by Wood, to conduct the iBPT profiles. The iBPT borehole drilling was completed under ConeTec's direction and supervision.

Two different drilling methods were used – closed-end and open-end. The closed-end method involves the use of the Becker rig to drive (with a hammer) closed-end casing which displaces the soil ahead of the bit. The open-end casing method is similar, except that compressed air is delivered through the annulus of the double wall casing, which forces drill cuttings to rise from the bit face through the center of the casing into a cyclone at the ground surface. With both methods the rig is instrumented to measure the resultant number of blows per foot, the number of blows per minute, and the pressure within the bounce chamber at the top of the hammer.

All holes were drilled to refusal which occurred at depths between 22.8 m (74.9 ft) and 25.2 m (82.7 ft) below the ground surface (362.4 m downstream bench). Based on estimates from record drawings, the refusal was met just below the crest of the starter dam. All holes refused at similar depths, indicating a very dense or possibly cemented layer. Refusal was met at depths much less than the target depth of 40 m. After refusal at 22.9 m, iBPT19-05 was advanced open-ended to refusal at 23.4 m depth. The hole was then re-drilled (iBPT19-05B) at an offset of 5 m, and encountered refusal at a similar depth. A copy of the iBPT report by ConeTec is presented in Appendix A. All iBPT holes were backfilled with cement-bentonite grout upon completion. A summary of the iBPT boreholes is presented below in Table 1 and the results are presented graphically in the borehole logs in Appendix C.

Table 1: iBPT Borehole Summary Table

ID	Northing	Easting	Start Date	Final Date	Ground Elevation (m)	Refusal Depth (m)
iBPT19-02	5494652.8	311735.4	04-Nov-2019	05-Nov-2019	362.4	24.7
iBPT19-03	5494652.6	311805.2	03-Nov-2019	04-Nov-2019	362.4	22.8
iBPT19-05	5494664.1	311880.9	01-Nov-2019	02-Nov-2019	362.4	22.9
iBPT19-05B	5494664.1	311875.9	02-Nov-2019	03-Nov-2019	362.4	23.0
iBPT19-06	5494676.8	311957.9	30-Oct-2019	31-Oct-2019	362.4	25.2

3.2 Sonic Drilling

The sonic drilling program started on November 25, 2019 and ended December 3, 2019. A summary of the sonic boreholes is shown in Table 2. Large Penetration Testing (LPT) was completed at 1.5 m intervals between the iBPT refusal depth and the bottom of the starter dam foundation. The LPT tests were completed to provide an indication of relative density of the materials within the starter dam below the iBPT refusal depth. A profile view of each completed borehole is presented on Figure 2, with the original ground surface projected beneath the starter dam based on interpretation of natural ground elevations from the sonic core logging.

Mudbay Drilling brought a rotary coring attachment to site to drill through the impenetrable layer in the case the sonic bit also met refusal, but the sonic bit was successful in penetrating the layer on which refusal was encountered.

Table 2: As-Built Sonic Borehole Summary Table

ID	Northing	Easting	Start Date	Completion Date	Collar Elevation (m)	Bottom Elevation (m)	Total Depth (m)	Comments
BH19-01	5494704	311709.9	25-Nov-2019	26-Nov-2019	365.1	328.5	36.6	SI casing installed
BH19-02	5494655.6	311729.7	27-Nov-2019	28-Nov-2019	362.4	322.8	39.6	VWP installed
BH19-03	5494650.7	311805.5	29-Vov-2019	30-Nov-2019	362.4	322.8	39.6	VWP installed
BH19-04	5494669	311809.2	26-Nov-2019	27-Nov-2019	365.1	319.4	45.7	SI casing installed
BH19-05	5494664.1	311880.9	1-Dec-2019	2-Dec-2019	362.5	322.9	39.6	No Instrument
BH19-06	5494677.8	311957.7	2-Dec-2019	3-Dec-2019	362.4	322.8	39.6	VWP installed

The work was executed as follows:

- A tailgate safety meeting was held daily to discuss the anticipated hazards, personal protective equipment (PPE) required and hazard mitigation procedures prior to drilling;
- All boreholes, except BH19-01, were staked in the field by Mifflin Surveys. This work was done one day after the start of the investigation program. BH19-01 was located using the plan drawings and existing features in the field. The as-built location of this borehole was about 5 m away from the proposed location. Final borehole locations were determined based on field conditions and safety requirements. In general, the boreholes were laid out within a few meters from the proposed locations. The as-built coordinates were computed upon completion and presented in Table 2;
- A Wood representative logged the soil samples from the sonic cores based on the Modified Unified Soil Classification System (MUSCS). Details of the MUSCS and the borehole logs are presented in Appendix C;
- A photo log of representative core runs and LPT samples is included in Appendix E;
- Representative soil samples were collected from the sonic cores and placed in plastic bags for further laboratory testing. The name of the borehole and depth of the sample were labelled on the bag. Samples were packaged and transferred to the Wood site office at Myra Falls Mine;

- Drilling continued until the termination depth was reached; and
- The drill holes were backfilled to the ground surface using cement bentonite grout mix.

Aerial imagery of borehole locations is provided on Figure 1; borehole cross sections are shown on Figure 2 and borehole coordinates are included in Table 1 and Table 2.

3.3 Geophysics Program

ConeTec personnel were on site to conduct the geophysical portion of the site investigation program. This geophysical program consisted of 2 two-dimensional MASW profiles and 2 DST profiles. The first MASW line, MASW19-01, was started on November 25 and completed on November 26. The second MASW line, MASW19-02, was started on November 27 and completed on November 28.

The DST19-01 and DST19-02 profiles were conducted in boreholes BH19-02 and BH19-03, respectively. The DST testing was conducted at 0.5 m intervals in the foundation soils and 1.0 m intervals in the dam fill materials. The DST profiles were started on November 29 and completed December 1. A summary table of the geophysical tests is presented in Table 3.

Table 3: Summary Table of MASW Profile Lines and DST Profiles

ID	Start Easting	Start Northing	End Easting	End Northing	Completion Date	Comments
MASW19-01	5494646	311747.1	5494685.4	312030.1	26-Nov-2019	
MASW19-02	5494610.9	311747.8	5494649.7	312045.7	28-11-2019	An excavator was used to remove large rocks & boulders along the line.
BH19-02	DST completed 29 November 2019					
BH19-03	DST completed 1 December 2019					

3.4 Laboratory Program

The planned laboratory testing program was not completed since deleterious materials were not encountered in the boreholes.

4.0 Summary of Findings and Test Results

The following is a summary of the material properties encountered by the iBPT and Sonic drill holes, and the interpreted results of the geophysical survey. The encountered materials are generally grouped in three zones defined based on physical properties and visual classification of the drilled core samples. Each zone is described in the following subsections.

4.1 Lynx TDF Dam - Downstream Shell

In general, Lynx tailings dam materials observed in the sonic cores consisted of fill materials composed of non ore-bearing rock and overburden soil produced during historical open pit and underground mining operations at the site, and removed from existing dumps on the slopes above the Lynx TDF. This material is generally coarse-grained angular gravel with some angular sand and trace of non plastic silts. The overburden material generally consists of excavated till-like materials and random mixture of gravel, sand, and fines in varying proportions. The silts within the overburden material are generally non plastic, whereas the silts/clays from the till-like materials have low plasticity. In some areas, a mixture of the mine waste and overburden fill materials may have been produced due to multiple handling during excavation and placement.

Waste rock fill materials within the downstream shell appear to have been placed with lift thicknesses ranging from 0.4 m to 0.6 m. Various lifts were easily identifiable based on moisture content, silt content, and varied coloration.

The relative density of the waste rock fill at individual boreholes was interpreted based on correlation with equivalent N_{60} values derived from the iBPT data. The relative density of the waste rock fill materials, based on correlation with the equivalent N_{60} values, ranges from 40% to 100% with average results ranging falling between 70% and 90%. Based on this data, the average density of the Lynx TDF dam waste rock fill can be generally classified as dense.

The geophysical site investigation program consisted of two MASW and two DST profiles. The program indicated that the waste rock fill materials are very dense. The waster rock fill average shear wave velocity (V_s) along the MASW19-01 ranges from 415 m/s to 657 m/s with an average of 497 m/s. The average velocity (V_s) at both DST locations ranges from 461 m/s to 751 m/s with an average of 596 m/s, which also indicates very dense soil conditions, based on Table 4.1.8.4.A in 2015 edition of the National Building Code of Canada (NBCC 2015).

4.2 Lynx TDF Dam - Starter Dam

The Lynx TDF starter dam materials consisted of waste rock fill materials, similar to those described in section 6.1. Waste rock fill materials within the starter dam appear to have been placed with lift thicknesses varying from 0.3 m to 0.6 m. Various lifts were also easily identifiable based on moisture content, silt content, and varied coloration. The relative density of the mine waste fill materials within the Lynx TDF starter dam was estimated from the LPT testing data by converting the blow counts to N_{60} values using a hammer efficiency of 85% and an LPT-SPT conversion factor of 0.6, and then correlating to relative density. The results are also plotted versus elevation for each bore hole location on the graphs included in appendix F.

The relative density of the waste rock fill materials in the starter dam, based on correlation with the equivalent N_{60} values, ranges from 90% to 100% with an average of 92%. Therefore, the Lynx TDF dam waste rock fill can be generally classified as very dense.

The geophysical site investigation program consisted of two MASW and two DST profiles. The starter dam waste rock fill shear wave average velocity (V_s) along MASW19-01 ranged from 586 m/s to 1023 m/s with an average of 710 m/s. The average velocity (V_s) at both DST locations ranges from 514 m/s to 978 m/s with an average of 746 m/s. These values of shear wave velocity are indicative of very dense soil based on Table 4.1.8.4.A in NBCC 2015.

4.3 Lynx TDF Dam – Foundation Soils

In general, the foundation soils consisted of colluvium and till-like materials, which included gravel, sand and fines. The gravel portion consist of fine to coarse grained and ranged from subrounded to angular, with the majority being subangular. Occasional cobbles were inferred from the sonic cores. The sand and fines content within the foundation soils was estimated to vary from approximately 10% to 50%. There were no iBPT or LPT testing conducted within the foundation zone. However, the geophysical results indicated that the foundation soils can be classified as very dense based on Table 4.1.8.4.A in NBCC 2015. A plot of equivalent N_{60} values obtained from iBPT and LPT tests, and shear wave velocities obtained from MASW and DST profiles are presented in Appendix F.

Wet soil conditions were observed within the dam fill below 330.1 m elevation in BH19-01, and a sample recovered between elevation 319.3 m to 322.4 m in BH19-04 was also observed to be wet. However, no groundwater accumulations were detected in these or the other boreholes during the investigation, and the apparent wet soil conditions noted in BH19-01 and BH19-04 may have been the result of: minor perching of groundwater on less permeable soil layers, derived from downward percolation of infiltrated water or residual water following a regional groundwater table fluctuation; or water introduced to the soil by the sonic drill operation (water is used to cool the bit and some excess may have been injected into the hole). Piezometers installed in BH19-02 (30.5 m depth), BH19-03 (31 m depth) and BH19-06 (35.5 m depth) all measured negative hydrostatic head several days after installation, indicating draining of the sand packs (i.e. no groundwater present). Compression wave velocity (Vp) measured by the downhole seismic surveys in BH19-02 and BH19-03 was generally greater than 1,500 m/s (Vp of water) along the entire depth of the boreholes, and therefore cannot be used as an indication of soil saturation or the presence of a water table.

5.0 Conclusions and Limitations

The boreholes did not encounter any indications of deleterious materials contained within the starter dam as have been previously observed during foundation preparation works at the site. Both the dam shell and starter dam fill materials are interpreted to be in a generally dense state, and appear to meet the project specifications for dam embankment fill. Therefore, based on the results of this investigation and assessment, no further stability analysis or re-design of the Lynx TDF dam is warranted.

The correlations of relative density based on iBPT and LPT/SPT test results can possess a high degree of uncertainty and variability as is illustrated by the relative wide scatter of the data points in Appendix F. This variability is due mainly to the variability of the size and distribution of coarse (cobble and boulder size) fragments within the shell and starter dam material, which can significantly affect the penetration test blow counts. Therefore, the overall assessment of the material density is based in part on interpretation of the testing data, and in part on the observations of drill response, sonic core returns and Wood's previous experience with and knowledge about the site.

Deleterious materials were not observed in returns from open end iBPT, the sonic cores or the material obtained from LPT; however deleterious materials could exist in unexplored areas of the starter dam. It is Wood's opinion that if deleterious materials are present, they are not present, laterally or vertically, to an extent that would adversely impact the stability of the dam.

6.0 Closure

This report has been prepared for the exclusive use of Nyrstar Myra Falls Ltd. for specific application to the area covered within this report and is subject to the Limitations in Section 8.0.

We trust that this report meets your present requirements. If you have any questions or comments, please do not hesitate to contact Bryan Woods at 604-295-6137 or by email at bryan.woods@woodplc.com.

Yours truly,

Wood Environment & Infrastructure Solutions
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7.0 References

National Building Code of Canada (NBCC, 2015).

Wood Environment & Infrastructure Solutions (2019). Letter to Keith Watson, P.Eng. Senior Tailings and Surface Engineer *"Lynx TDF Starter Dam Investigation Plan"*, August 27, 2019.

Wood Environment & Infrastructure Solutions (2019). Letter to Keith Watson, P.Eng. Senior Tailings and Surface Engineer *"Lynx TDF Starter Dam Investigation Plan Addendum – Geophysical Testing"*, November 7, 2019.

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Final sub-surface/bore/profile logs are developed by geotechnical engineers based upon their interpretation of field logs and laboratory evaluation of field samples. Customarily, only the final bore/profile logs are included in geotechnical engineering reports.

Bedrock, soil properties and groundwater conditions can be significantly altered by environmental remediation and/or construction activities such as the use of heavy equipment or machinery, excavation, blasting, pile-driving or draining or other activities conducted either directly on site or on adjacent terrain. These properties can also be indirectly affected by exposure to unfavorable natural events or weather conditions, including freezing, drought, precipitation and snowmelt.

During construction, excavation is frequently undertaken which exposes the actual subsurface and groundwater conditions between and beyond the test locations, which may differ from those encountered at the test locations. It is recommended that Wood be retained during construction to confirm that the subsurface conditions throughout the site do not deviate materially from those encountered at the test locations, that construction work has no negative impact on the geotechnical aspects of the design, to adjust recommendations in accordance with conditions as additional site information is gained, and to deal quickly with geotechnical considerations if they arise.

Interpretations and recommendations presented herein may not be valid if an adequate level of review or inspection by Wood is not provided during construction.

14. **Factors that may affect construction methods, costs and scheduling**: The performance of rock and soil materials during construction is greatly influenced by the means and methods of construction. Where comments are made relating to possible methods of construction, construction costs, construction techniques, sequencing, equipment or scheduling, they are intended only for the guidance of the project design professionals, and those responsible for construction monitoring. The number of test holes may not be sufficient to determine the local underground conditions between test locations that may affect construction costs, construction techniques, sequencing, equipment, scheduling, operational planning, etc.

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16. **Environmental and Hazardous Materials Aspects**: Unless otherwise stated, the information contained in this report in no way reflects on the environmental aspects of this project, since this aspect is beyond the Scope of Work and the Contract. Unless expressly included in the Scope of Work, this report specifically excludes the identification or interpretation of environmental conditions such as contamination, hazardous materials, wild life conditions, rare plants or archeology conditions that may affect use or design at the site. This report specifically excludes the investigation, detection, prevention or assessment of conditions that can contribute to moisture, mould or other microbial contaminant growth and/or other moisture related deterioration, such as corrosion, decay, rot in buildings or their surroundings. Any statements in this report or on the

boring logs regarding odours, colours, and unusual or suspicious items or conditions are strictly for informational purposes

17. **Sample Disposal**: Wood will dispose of all uncontaminated soil and rock samples after 30 days following the release of the final geotechnical report. Should the Client request that the samples be retained for a longer time, the Client will be billed for such storage at an agreed upon rate. Contaminated samples of soil, rock or groundwater are the property of the Client, and the Client will be responsible for the proper disposal of these samples, unless previously arranged for with Wood or a third party.

Wood Environment & Infrastructure Solutions
a Division of Wood Canada Limited

Appendix A – iBPT Report

PRESENTATION OF SITE INVESTIGATION RESULTS

Myra Falls

Prepared for:

Wood PLC

ConeTec Job No: 19-0204607

Project Start Date: 30-Oct-2019
Project End Date: 05-Nov-2019
Report Date: 13-Nov-2019

Prepared by:

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Introduction

The enclosed report presents the results of the site investigation program conducted by ConeTec Investigations Ltd. for Wood PLC at the Myra Falls mine. The program consisted of five instrumented Becker Penetration Test (iBPT) profiles.

Project Information

Project	
Client	Wood PLC
Project	Myra Falls
ConeTec project number	19-0204607

An aerial overview from Google Earth including the iBPT test locations is presented below.

Rig Description	Deployment System	Test Type
Becker hammer rig (HAV 180)	ICE 180 diesel pile driving hammer	iBPT

Coordinates		
Test Type	Collection Method	EPSG Number
iBPT	Consumer grade GPS	32610

Instrumented Becker Penetration Test (iBPT)	
Depth reference	Depths are referenced to the existing ground surface at the time of each test.
Additional information	Tabular results are provided in Excel format files in the data release package. Plots with iBPT results and Harder & Seed (1986) results are provided in the appendices.

Limitations

This report has been prepared for the exclusive use of Wood PLC (Client) for the project titled "Myra Falls". 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 instrumented Becker Penetration Test (iBPT) system was developed to obtain direct measurements of force and acceleration at the drill tip required to compute the energy delivered to the soil beneath the drill tip during penetration (DeJong et al. (2017)). Coupled with the measured blow counts, this provides an energy normalized blow count based on direct measurements. This direct measurement based method eliminates the long-standing challenge of estimating, and then correcting for, the shaft friction that develops along the drill string length which absorbs hammer energy.

The iBPT is an instrumentation and data acquisition system that provides automated measurements of force and acceleration at the tip and head of a drill string, in addition to measurements of bounce chamber pressure and drill string position. The system is comprised of two-foot-long instrumented pipe sections located at the head and tip of the drill string that contain redundant acceleration and strain measurements. The redundant instrumentation enables continued penetration even if one sensor malfunctions.

Data from the instrumented tip section is acquired by a data acquisition module located in the tip module while data from the head section is acquired in the iBPT trailer. The instrumented pipe sections are mechanically integrated within the conventional 6 5/8” outer diameter Becker drill system. Dynamic measurements are obtained during hammer impacts as the drill string is advanced into the ground. Continuous measurements of air pressure in the hammer bounce chamber and the string potentiometer position are also obtained during operation.

The dynamic measurements of strain and acceleration at the head and tip are processed to compute the energy delivered to each respective location. The acceleration records are integrated to obtain velocity, and then integrated a second time to obtain displacement. The force measurements account for both the dynamic force imparted during dynamic hammer blows as well as the residual locked-in force that develops at the tip due to shaft friction. Temperature correction is also applied to the tip force measurements.

Following conventional pile dynamic analysis (e.g. Rausche et al. (1972)) and the ASTM standard for energy measurement of dynamic penetrometers (D4633-16, (2016)), energy is calculated following:

$$\mathrm{E\ (kJ)} = \int \mathrm{FVdt}$$

The energy computed and reported is the residual energy as this measurement is representative of the total energy absorbed by the soil. This is different than the maximum energy delivered at the head as is conventionally used with SPT and Sy and Campanella’s (S&C) Becker analysis. The iBPT energy is computed as a percentage of the theoretical hammer energy as:

$$\mathrm{E\ (\%)} = \frac{\int \mathrm{FVdt}}{11.0\ \mathrm{kJ}}$$

The energy normalization of penetration resistance is consistent in form with SPT (ASTM D4633-16) and BPT (Sy and Campanella (1994)) methods.

The BPT measured blow counts, N_B, are then normalized to a reference hammer energy of 30% using:

$$N_{B30}=N_B\frac{E\ (\%)}{30}$$

The normalized to 30% hammer energy is a typical efficiency for double acting diesel hammers and is consistent with Sy and Campanella (1994).

The delivered energy ratio (DER), the ratio of the residual energy delivered to the tip of the drill string, normalized to the residual energy delivered to the head of the drill string, provides an indication of the amount of energy absorbed along the drill string due to the shaft friction. In general, the DER decreases with penetration depth and when underlying soft layers are encountered (DeJong et al. (2017)).

It is noted that DER values larger than 100% are possible as the residual energy at the tip is computed based on both the dynamic and locked-in force components. Small DER values (e.g. less than about 10%) indicate that practically all of the hammer energy (and thus penetration resistance) is being absorbed by shaft resistance along the drill string; this occurs when shaft friction is very high relative to tip resistance. This can occur in competent soils when shaft friction is high and/or in very weak soils when the soil resistance below the tip is very small. When the DER is very small (e.g. < 10%), the absolute tip measurements of force and acceleration used to compute energy can be near the performance limit, and it also produces significant reduction of N_B to compute N_{B30} because the ratio of E(%)/30 is very small.

When minimal energy is delivered to the tip a significant normalization factor is required to compute N_{B30}. For data reduction, a threshold limit of 2% is set for the tip residual energy, which corresponds to a normalization factor of 15. Due to the proportional form of the equation, a tip residual energy of 3% significantly reduces the normalization factor to 10 while a tip residual energy of 1% significantly increases the normalization factor to 30. Currently, application of the equation down to tip residual energies of 2% is reasonable though confidence increases rapidly with greater tip residual energy. Application of the equation to measurements with tip residual energies less than 2% extends the developed correlation beyond the database upon which it was developed.

The continuous bounce chamber pressure and pile head position measurements are used to compute hammer blows per foot (N_B), hammer bounce chamber pressure (BCP), and displacement and depth for each hammer blow.

The correlation developed by Ghafghazi et al. (2017a) is used to estimate equivalent SPT N_{60} values as follows:

$$N_{60}=1.8 \times N_{B30}$$

The median correlation factor of 1.8 is the best fit to the data collected and analyzed by Ghafghazi et al. (2017a), producing an estimate close to the expected 50th percentile value. This correlation value was determined based on comparisons of 364 pairs of side-by-side SPT N_{60} and iBPT N_{B30} measurements in soils that are free of gravel (Ghafghazi et al. (2017a)). More conservative estimates of SPT N_{60} values corresponding to a 33rd percentile value could be obtained using a correlation factor of about 1.6 or a 16th percentile value using a correlation factor of about 1.3. As detailed in Ghafghazi et al. (2017a), most of the scatter in the developed correlation is attributed to lateral spatial variability commonly present in fluvial depositional environments. As a result, and as evident in the published correlation plots, it is reasonable to observe penetration resistance differences between two adjacent soundings/borings performed at a spacing of 10 to 20 feet, regardless of whether it is two iBPT N_{B30} soundings, two SPT N_{60} borings, or two cone penetration test (CPTu) corrected tip resistance (q_t) soundings.

Additional analysis was performed to compute equivalent SPT N_{60} values based on the Harder and Seed (1986) method. This method requires measured blows per foot (N_B), average hammer bounce chamber pressure (BCP), and correction of the measured air pressure for project elevation. The effect of shaft friction is not explicitly accounted for; instead, the accumulation of shaft friction with depth is embedded in the correction of N_B to N_{BC} even though the accumulation of shaft friction with depth depends on stratigraphy and soil type. Further discussion of the Harder and Seed method and the differences compared to the iBPT method are discussed in Ghafghazi et al. (2017b).

A summary of the iBPT soundings along with test results and individual plots are provided in the relevant appendices.

References

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The appendices listed below are included in the report:

- Instrumented Becker Penetration Test Borehole Summary and Tabular Results
- Instrumented Becker Penetration Test Plots with Energy Results and iBPT Equivalent N_{60}
- Instrumented Becker Penetration Test Plots with Harder & Seed (1986) Results

Instrumented Becker Penetration Test Borehole Summary and Tabular Results

CONETEC

Job No: 19-0204607
Client: Wood PLC
Project: Myra Falls
Start Date: 30-Oct-2019
End Date: 05-Nov-2019

iBPT BOREHOLE SUMMARY

Borehole ID	File Name	Date From	Date To	Predrill Depth (ft)	Start Depth (ft)	Final Depth (ft)	Northing[1] (m)	Easting[1] (m)	Refer To Notation
iBPT19-02	19-0204607_iBPT02	04-Nov-2019	05-Nov-2019	0.0	0.0	81.0	5494659	311738	
iBPT19-03	19-0204607_iBPT03	03-Nov-2019	04-Nov-2019	0.0	0.0	74.9	5494655	311806	
iBPT19-05	19-0204607_iBPT05	01-Nov-2019	02-Nov-2019	0.0	0.0	75.0	5494666	311880	2
iBPT19-05B	19-0204607_iBPT05B	02-Nov-2019	03-Nov-2019	0.0	0.0	75.3	5494666	311879	
iBPT19-06	19-0204607_iBPT06	30-Oct-2019	31-Oct-2019	0.0	0.0	82.7	5494678	311958	

1. Coordinates were acquired using consumer grade GPS equipment, datum: WGS 1984 / UTM Zone 10 North.
2. Drilled out to 76.75' with an open bit.

Job No: 19-0204607
Client: Wood PLC
Project: Myra Falls
Start Date: 04-Nov-2019
End Date: 05-Nov-2019

Borehole ID: iBPT19-02
Rig: HAV 180

INSTRUMENTED BECKER PENETRATION TEST RESULTS

Start Depth (ft)	End Depth (ft)	Average Bounce Chamber Pressure (BCP) (psi)	N_{BC}[1]	N_{60}[1]	N_B (blows per foot)	Average Head Max Energy $E_{max,head}$ (%)	Average Head Residual Energy $E_{res,head}$ (%)	Average Tip Max Energy $E_{max,tip}$ (%)	Average Tip Residual Energy $E_{res,tip}$ (%)	Delivered Energy Ratio (DER)	N_{B30}	iBPT N_{60}	Refer to Notation Number
0.0	0.1	18.6	11	11	11	26.3	26.2	26.8	26.7	102.2	10	18	
0.1	1.0	13.2	14	14	34	25.3	23.7	24.7	24.0	101.2	27	49	
1.0	2.0	15.8	15	15	23	38.8	38.2	37.5	37.3	97.6	29	51	
2.0	3.0	17.9	21	20	27	36.8	36.3	36.9	36.8	101.4	33	60	
3.0	4.0	19.1	25	23	30	38.1	37.5	35.7	35.5	94.6	36	64	
4.0	5.0	17.6	19	18	25	37.4	36.9	34.8	34.6	93.8	29	52	
5.0	6.0	16.3	16	15	22	38.5	38.4	35.3	35.3	92.0	26	47	
6.0	7.5	15.8	15	15	22	35.4	35.1	30.2	30.0	85.3	22	40	
7.5	8.0	17.7	18	17	22	36.9	36.1	33.0	32.7	90.6	24	43	
8.0	9.0	18.9	25	23	31	35.2	33.9	30.0	29.7	87.4	31	55	
9.0	10.0	20.5	33	29	39	36.2	35.6	28.7	28.2	79.3	37	66	
10.0	11.0	20.9	35	30	40	34.5	33.5	28.1	27.7	82.7	37	66	
11.0	12.0	22.5	55	44	64	32.4	28.1	24.4	22.5	80.0	48	86	
12.0	13.0	22.5	69	52	86	30.2	23.5	21.7	19.4	82.4	55	100	
13.0	14.0	23.1	93	66	126	28.8	20.3	20.2	17.3	85.1	73	131	
14.0	15.0	23.4	109	76	152	27.2	17.5	19.9	16.9	96.8	86	154	
15.0	16.0	23.4	91	65	119	27.4	18.9	20.3	17.7	93.9	70	126	
16.0	17.0	21.4	78	57	117	25.6	17.8	19.8	17.2	96.4	67	121	
17.0	18.0	21.8	65	49	85	30.9	22.1	22.0	19.8	89.4	56	101	
18.0	19.0	22.2	77	56	104	31.9	22.4	22.7	20.8	93.0	72	130	
19.0	20.0	21.9	69	51	91	32.1	24.1	22.7	21.1	87.5	64	115	
20.0	21.0	22.0	71	53	94	31.3	23.7	22.8	21.2	89.6	67	120	
21.0	22.0	21.7	62	48	81	32.5	25.5	23.8	22.3	87.3	60	108	
22.0	23.0	20.6	46	38	58	32.7	28.0	23.9	22.8	81.6	44	79	
23.0	24.0	19.6	39	34	51	31.8	28.2	21.9	21.0	74.7	36	64	
24.0	25.0	19.5	30	27	38	34.4	31.8	21.9	21.4	67.3	27	49	

CONETEC

Job No:	19-0204607
Client:	Wood PLC
Project:	Myra Falls
Start Date:	04-Nov-2019
End Date:	05-Nov-2019

Borehole ID:	iBPT19-02
Rig:	HAV 180

INSTRUMENTED BECKER PENETRATION TEST RESULTS

Start Depth (ft)	End Depth (ft)	Average Bounce Chamber Pressure (BCP) (psi)	N_{BC}^{1}	N_{60}^{1}	N_B (blows per foot)	Average Head Max Energy $E_{max,head}$ (%)	Average Head Residual Energy $E_{res,head}$ (%)	Average Tip Max Energy $E_{max,tip}$ (%)	Average Tip Residual Energy $E_{res,tip}$ (%)	Delivered Energy Ratio (DER)	N_{B30}	iBPT N_{60}	Refer to Notation Number
25.0	26.0	18.5	25	23	32	34.7	34.0	22.3	22.2	65.3	24	43	
26.0	27.0	19.0	27	24	34	34.9	33.6	21.1	20.9	62.3	24	43	
27.0	27.3	18.9	30	27	39	34.1	29.0	20.9	20.2	69.7	26	47	
27.3	28.0	19.1	40	34	56	29.4	23.4	20.6	19.8	84.7	37	66	
28.0	29.0	21.3	48	39	57	33.8	26.8	23.9	22.9	85.6	44	78	
29.0	30.0	22.8	66	50	79	33.0	23.7	21.2	20.4	86.3	54	97	
30.0	31.0	23.6	96	68	126	31.0	18.1	17.5	16.2	89.4	68	122	
31.0	32.0	22.1	86	62	124	27.6	16.3	14.5	13.5	83.0	56	101	
32.0	33.0	21.1	66	50	94	26.2	18.1	12.4	11.8	65.0	37	66	
33.0	34.0	22.1	76	56	104	26.5	17.2	12.8	12.2	70.7	42	76	
34.0	35.0	20.9	51	41	65	26.6	20.0	14.7	14.2	71.1	31	55	
35.0	36.0	18.8	42	36	63	22.7	17.8	13.4	13.0	73.1	27	49	
36.0	37.0	21.2	139	94	266	22.6	11.2	11.4	9.5	84.8	84	152	
37.0	38.0	21.6	93	66	147	27.7	15.8	15.5	13.8	87.4	68	122	
38.0	39.0	22.1	92	65	136	32.0	20.1	18.7	17.8	88.2	80	145	
39.0	40.0	20.6	53	42	73	32.1	24.1	20.5	20.0	83.3	49	88	
40.0	41.0	20.6	46	38	58	32.9	25.9	19.2	18.9	73.0	36	66	
41.0	42.0	21.2	67	51	96	31.4	22.4	15.0	14.3	63.8	46	83	
42.0	43.0	20.5	63	48	95	30.0	22.3	14.3	13.7	61.6	43	78	
43.0	44.0	19.1	41	35	58	30.0	25.3	17.5	17.0	67.4	33	59	
44.0	45.0	18.4	30	27	43	30.9	27.7	18.7	18.3	66.2	26	47	
45.0	46.0	17.6	26	24	39	29.3	27.0	17.1	16.9	62.7	22	40	
46.0	47.0	19.5	38	32	49	32.9	28.7	20.2	19.8	68.9	32	58	
47.0	48.0	17.7	25	23	37	31.1	26.9	19.6	19.2	71.3	24	43	
48.0	49.0	18.0	41	34	65	31.2	24.7	18.2	17.7	71.7	38	69	
49.0	50.2	19.0	41	35	58	32.6	25.8	18.9	18.4	71.1	35	64	

CONETEC

Job No: 19-0204607
Client: Wood PLC
Project: Myra Falls
Start Date: 04-Nov-2019
End Date: 05-Nov-2019

Borehole ID: iBPT19-02
Rig: HAV 180

INSTRUMENTED BECKER PENETRATION TEST RESULTS

Start Depth (ft)	End Depth (ft)	Average Bounce Chamber Pressure (BCP) (psi)	N_{BC}^{1}	N_{60}^{1}	N_B (blows per foot)	Average Head Max Energy $E_{max,head}$ (%)	Average Head Residual Energy $E_{res,head}$ (%)	Average Tip Max Energy $E_{max,tip}$ (%)	Average Tip Residual Energy $E_{res,tip}$ (%)	Delivered Energy Ratio (DER)	N_{B30}	iBPT N_{60}	Refer to Notation Number
50.2	51.0	18.4	30	27	43	34.1	29.0	21.4	21.1	72.7	30	54	
51.0	52.0	19.8	48	39	69	33.0	24.9	19.5	19.1	76.6	44	79	
52.0	53.0	19.8	127	86	283	29.6	14.3	12.8	12.4	86.7	117	210	
53.0	54.0	21.0	166	109	342	30.8	15.6	14.9	14.6	93.2	166	299	
54.0	55.0	21.5	89	64	139	34.4	21.4	18.5	17.5	82.0	81	146	
55.0	56.0	20.9	75	55	116	31.6	20.7	15.6	13.8	66.8	53	96	
56.0	57.0	23.4	99	70	133	36.8	21.5	10.8	10.2	47.3	45	81	
57.0	58.0	22.4	89	64	126	35.1	21.1	9.7	9.1	43.0	38	68	
58.0	59.0	21.9	68	51	89	36.7	25.9	10.9	10.4	40.2	31	56	
59.0	60.0	21.7	127	86	222	35.7	20.1	10.7	9.1	45.4	68	122	
60.0	61.0	22.3	114	78	179	37.9	22.7	14.4	12.8	56.2	76	137	
61.0	62.0	22.9	134	91	210	38.5	21.3	16.2	14.8	69.7	104	187	
62.0	63.0	23.3	188	123	311	40.7	22.2	17.9	16.3	73.4	168	303	
63.0	64.0	22.6	108	75	163	40.5	25.4	20.4	19.2	75.5	104	188	
64.0	65.0	21.7	80	58	117	37.3	24.7	18.1	17.8	72.1	69	125	
65.0	66.0	23.6	106	74	143	40.1	23.6	17.2	16.4	69.5	78	140	
66.0	67.0	22.6	88	63	121	38.8	25.9	17.1	16.2	62.4	65	117	
67.0	68.0	20.5	53	42	73	37.0	27.8	16.0	15.6	56.3	38	68	
68.0	69.0	18.4	32	28	46	34.2	28.9	13.9	13.8	47.8	21	38	
69.0	70.0	18.5	29	26	40	34.2	30.0	11.6	11.6	38.7	15	28	
70.0	71.0	20.6	40	34	48	38.8	32.8	14.0	13.9	42.4	22	40	
71.0	72.0	20.1	40	34	49	38.8	33.4	14.4	14.2	42.4	23	42	
72.0	73.0	19.2	32	28	41	37.1	31.8	17.0	16.7	52.5	23	41	
73.0	74.0	20.9	80	58	127	39.0	26.9	17.1	15.9	59.1	67	121	
74.0	75.0	20.9	99	70	172	38.7	27.0	17.0	15.3	56.5	88	158	
75.0	76.0	21.7	85	61	128	39.5	28.0	18.4	17.5	62.5	75	134	

Job No:	19-0204607
Client:	Wood PLC
Project:	Myra Falls
Start Date:	04-Nov-2019
End Date:	05-Nov-2019
Borehole ID:	iBPT19-02
Rig:	HAV 180

INSTRUMENTED BECKER PENETRATION TEST RESULTS

Start Depth (ft)	End Depth (ft)	Average Bounce Chamber Pressure (BCP) (psi)	N_{BC}[1]	N_{60}[1]	N_B (blows per foot)	Average Head Max Energy $E_{max,head}$ (%)	Average Head Residual Energy $E_{res,head}$ (%)	Average Tip Max Energy $E_{max,tip}$ (%)	Average Tip Residual Energy $E_{res,tip}$ (%)	Delivered Energy Ratio (DER)	N_{B30}	iBPT N_{60}	Refer to Notation Number
76.0	77.0	21.9	62	47	78	40.3	30.1	20.4	20.2	67.3	53	95	
77.0	78.0	20.9	50	40	63	40.6	30.7	20.0	19.6	63.7	41	74	
78.0	79.0	21.6	85	61	130	41.0	27.9	17.9	16.8	60.1	73	131	
79.0	80.0	21.7	131	89	230	40.3	25.5	15.9	13.9	54.3	106	191	
80.0	81.0	21.5	147	98	275	39.6	27.8	18.1	15.1	54.1	138	248	

1. Harder & Seed, 1986.

Job No: 19-0204607
Client: Wood PLC
Project: Myra Falls
Start Date: 03-Nov-2019
End Date: 04-Nov-2019

Borehole ID: iBPT19-03
Rig: HAV 180

INSTRUMENTED BECKER PENETRATION TEST RESULTS

Start Depth (ft)	End Depth (ft)	Average Bounce Chamber Pressure (BCP) (psi)	N_{BC}^{1}	N_{60}^{1}	N_B (blows per foot)	Average Head Max Energy $E_{max,head}$ (%)	Average Head Residual Energy $E_{res,head}$ (%)	Average Tip Max Energy $E_{max,tip}$ (%)	Average Tip Residual Energy $E_{res,tip}$ (%)	Delivered Energy Ratio (DER)	N_{B30}	iBPT N_{60}	Refer to Notation Number
0.0	0.1	13.2	8	8	12	9.9	9.7	8.9	8.7	89.9	3	6	
0.1	1.0	14.7	13	13	21	33.7	33.1	33.5	33.2	100.3	23	42	
1.0	2.0	15.8	16	15	24	32.1	31.3	32.6	32.2	102.8	26	46	
2.0	3.0	18.5	23	22	30	34.4	33.8	35.6	35.6	105.4	36	64	
3.0	4.0	19.0	26	24	33	35.6	35.4	34.4	34.3	97.0	38	68	
4.0	5.0	18.7	27	25	36	32.0	31.4	29.4	29.1	92.7	35	63	
5.0	6.0	19.2	30	27	39	30.3	28.5	26.7	26.0	91.3	34	61	
6.0	7.0	19.4	32	28	41	29.2	27.2	25.0	24.0	88.1	33	59	
7.0	8.0	19.1	31	28	41	30.0	28.0	25.5	24.4	87.2	33	60	
8.0	9.0	19.1	30	27	39	32.1	30.8	28.0	27.3	88.6	35	64	
9.0	10.0	19.8	33	29	41	31.8	29.4	28.2	27.2	92.6	37	67	
10.0	11.0	20.1	34	30	41	31.8	29.4	28.3	27.2	92.6	37	67	
11.0	12.0	20.1	42	35	53	30.1	29.2	25.8	24.5	83.9	43	78	
12.0	13.0	20.2	41	35	51	29.7	28.3	26.1	25.0	88.2	42	76	
13.0	14.0	20.4	46	38	60	27.3	24.6	23.8	22.7	92.2	45	82	
14.0	15.0	21.2	52	42	66	26.6	21.8	22.6	21.1	96.8	46	84	
15.0	16.0	22.5	76	56	99	27.9	20.9	22.6	20.8	99.7	69	124	
16.0	17.0	20.7	68	51	104	25.8	19.5	21.2	19.5	99.7	67	121	
17.0	17.2	18.6	56	44	103	23.3	17.2	18.0	16.6	96.7	57	103	
17.2	18.0	22.7	63	48	74	33.2	26.8	24.5	23.2	86.5	57	103	
18.0	19.0	23.7	79	58	95	32.5	25.3	22.3	20.8	82.1	66	118	
19.0	20.0	22.7	75	55	95	31.6	24.6	21.5	20.1	81.8	64	115	
20.0	21.0	21.3	55	44	71	29.8	24.1	20.5	19.6	81.2	46	83	
21.0	22.0	21.3	56	44	72	30.4	24.1	23.3	22.0	91.2	53	95	
22.0	23.0	21.1	57	44	75	28.4	21.6	19.2	18.1	84.1	45	82	
23.0	24.0	20.7	58	45	82	26.5	19.3	18.2	17.1	88.6	47	84	

CONETEC

Job No: 19-0204607
Client: Wood PLC
Project: Myra Falls
Start Date: 03-Nov-2019
End Date: 04-Nov-2019

Borehole ID: iBPT19-03
Rig: HAV 180

INSTRUMENTED BECKER PENETRATION TEST RESULTS

Start Depth (ft)	End Depth (ft)	Average Bounce Chamber Pressure (BCP) (psi)	N_{BC}[1]	N_{60}[1]	N_B (blows per foot)	Average Head Max Energy $E_{max,head}$ (%)	Average Head Residual Energy $E_{res,head}$ (%)	Average Tip Max Energy $E_{max,tip}$ (%)	Average Tip Residual Energy $E_{res,tip}$ (%)	Delivered Energy Ratio (DER)	N_{B30}	iBPT N_{60}	Refer to Notation Number
24.0	25.0	19.1	45	37	66	24.5	19.2	17.9	17.0	88.4	37	67	
25.0	26.0	18.8	41	34	59	23.7	19.7	15.8	15.2	77.3	30	54	
26.0	27.0	19.9	59	46	92	23.2	17.2	13.3	12.5	72.9	38	69	
27.0	28.0	20.8	49	40	62	28.9	22.0	14.9	14.0	63.5	29	52	
28.0	29.0	20.4	47	39	62	31.1	24.9	17.4	16.8	67.4	35	62	
29.0	30.0	23.1	103	72	146	32.1	20.1	16.5	14.5	72.5	71	127	
30.0	31.0	22.0	67	50	87	32.2	23.6	15.0	13.9	58.7	40	72	
31.0	32.0	21.3	56	44	72	31.8	24.9	17.8	16.9	67.9	41	73	
32.0	33.0	20.9	50	41	64	30.6	25.1	17.2	16.6	66.2	35	64	
33.0	34.0	21.1	63	48	87	27.7	21.0	14.5	14.0	66.8	41	73	
34.0	35.0	21.4	56	44	72	28.4	21.4	13.6	13.1	61.3	31	57	
35.0	36.0	19.9	46	38	63	25.6	20.5	10.6	10.3	50.2	22	39	
36.0	37.0	21.0	56	44	74	26.7	20.4	9.9	9.7	47.4	24	43	
37.0	38.0	20.2	37	32	45	33.1	27.7	14.1	13.8	49.9	21	37	
38.0	39.0	20.0	41	35	52	34.1	29.3	16.0	15.6	53.3	27	49	
39.0	40.0	19.9	41	35	52	33.2	29.1	16.6	16.3	55.8	28	51	
40.0	41.0	21.0	52	41	66	35.0	28.6	17.4	16.6	58.0	36	66	
41.0	42.0	18.9	37	32	52	32.3	27.5	19.2	18.4	67.1	32	57	
42.0	43.0	18.6	26	24	34	34.3	30.8	21.8	21.3	69.0	24	43	
43.0	44.0	16.2	17	17	26	31.1	30.7	18.5	18.4	59.9	16	29	
44.0	45.0	15.6	15	15	23	29.8	29.5	16.4	16.4	55.4	13	23	
45.0	46.0	16.9	19	18	27	34.2	33.2	16.2	15.8	47.7	14	26	
46.0	47.0	16.0	16	15	23	32.4	32.1	15.4	15.4	47.8	12	21	
47.0	48.0	15.8	13	13	18	32.9	32.5	16.6	16.6	50.9	10	18	
48.0	49.0	16.0	16	16	24	32.9	32.4	21.5	21.5	66.2	17	31	
49.0	50.1	15.6	15	15	23	32.7	32.3	21.3	21.3	65.9	16	29	

CONETEC

Job No: 19-0204607
Client: Wood PLC
Project: Myra Falls
Start Date: 03-Nov-2019
End Date: 04-Nov-2019

Borehole ID: iBPT19-03
Rig: HAV 180

INSTRUMENTED BECKER PENETRATION TEST RESULTS

Start Depth (ft)	End Depth (ft)	Average Bounce Chamber Pressure (BCP) (psi)	N_{BC}[1]	N_{60}[1]	N_B (blows per foot)	Average Head Max Energy $E_{max,head}$ (%)	Average Head Residual Energy $E_{res,head}$ (%)	Average Tip Max Energy $E_{max,tip}$ (%)	Average Tip Residual Energy $E_{res,tip}$ (%)	Delivered Energy Ratio (DER)	N_{B30}	iBPT N_{60}	Refer to Notation Number
50.1	51.0	15.5	13	13	19	33.2	32.9	21.7	21.6	65.5	14	25	
51.0	52.1	14.4	11	11	17	31.0	30.6	19.5	19.3	63.1	11	20	
52.1	53.1	13.8	10	10	15	33.7	33.6	20.6	20.5	61.2	10	18	
53.1	54.0	13.6	9	9	14	31.8	31.6	18.9	18.9	59.6	9	16	
54.0	55.0	18.4	34	30	50	31.8	27.1	19.9	19.5	71.8	32	58	
55.0	56.0	18.5	34	30	49	31.2	26.3	20.0	19.5	74.2	32	57	
56.0	57.0	18.3	34	30	50	31.4	26.8	19.6	19.1	71.0	32	57	
57.0	58.0	16.6	24	22	40	31.0	28.8	18.5	18.3	63.5	24	44	
58.0	59.0	17.8	27	25	41	35.0	32.3	18.4	18.1	56.0	25	44	
59.0	60.0	16.6	20	19	31	31.7	30.3	16.2	16.0	53.0	17	30	
60.0	61.0	16.1	17	17	27	30.6	29.5	15.3	15.1	51.3	14	25	
61.0	62.0	19.8	46	38	64	35.9	30.2	18.3	17.0	56.3	36	65	
62.0	63.0	19.1	40	34	55	34.8	30.3	15.2	14.5	48.0	27	48	
63.0	64.0	17.3	23	22	35	31.2	29.0	13.2	13.1	45.1	15	27	
64.0	65.0	17.9	25	23	36	32.7	29.6	12.8	12.7	42.9	15	27	
65.0	66.0	17.6	23	22	33	33.0	30.7	9.0	9.0	29.2	10	18	
66.0	67.0	17.5	22	21	32	31.9	29.8	8.0	8.0	26.8	8	15	
67.0	68.0	16.5	15	14	19	31.4	30.2	7.9	7.9	26.0	5	9	
68.0	69.0	17.4	22	21	32	34.2	32.8	11.1	11.1	33.8	12	21	
69.0	70.0	17.5	14	14	15	34.8	34.1	11.4	11.4	33.5	6	10	
70.0	71.0	19.9	46	38	62	36.7	29.3	15.5	15.0	51.2	31	56	
71.0	72.0	20.3	57	45	84	36.1	27.4	15.9	15.2	55.5	43	77	
72.0	73.0	20.4	59	46	87	35.6	27.1	15.1	14.6	53.9	42	76	
73.0	74.0	20.7	63	48	94	35.8	27.4	13.7	13.2	48.4	42	75	
74.0	74.9	22.8	275	174	512	45.8	31.3	11.2	9.6	30.7	164	295	

1. Harder & Seed, 1986.

CONETEC

Job No: 19-0204607
Client: Wood PLC
Project: Myra Falls
Start Date: 01-Nov-2019
End Date: 02-Nov-2019

Borehole ID: iBPT19-05
Rig: HAV 180

INSTRUMENTED BECKER PENETRATION TEST RESULTS

Start Depth (ft)	End Depth (ft)	Average Bounce Chamber Pressure (BCP) (psi)	N_{BC}[1]	N_{60}[1]	N_B (blows per foot)	Average Head Max Energy $E_{max,head}$ (%)	Average Head Residual Energy $E_{res,head}$ (%)	Average Tip Max Energy $E_{max,tip}$ (%)	Average Tip Residual Energy $E_{res,tip}$ (%)	Delivered Energy Ratio (DER)	N_{B30}	iBPT N_{60}	Refer to Notation Number
0.0	0.1	18.3	10	10	10	23.3	23.1	27.2	27.1	117.1	9	16	
0.1	1.0	15.8	17	17	28	29.4	28.1	30.3	29.9	106.6	28	50	
1.0	2.0	16.7	17	16	23	38.3	37.1	37.3	36.6	98.5	28	50	
2.0	3.0	16.6	16	15	21	35.6	34.4	34.3	33.7	97.9	24	42	
3.0	4.0	17.2	17	17	23	35.3	33.9	35.8	34.7	102.5	27	48	
4.0	5.0	17.9	19	18	24	35.4	34.7	35.9	35.3	102.0	28	51	
5.0	6.0	18.6	24	22	30	32.8	32.2	29.5	29.1	90.4	29	52	
6.0	7.4	21.0	35	30	40	30.8	29.5	24.9	24.7	83.7	33	59	
7.4	8.0	18.4	31	28	45	27.6	26.4	23.5	22.8	86.4	34	61	
8.0	9.0	19.6	29	26	36	33.9	31.7	33.4	32.6	102.8	39	70	
9.0	10.0	20.9	25	23	27	30.9	28.4	27.8	26.8	94.5	24	43	
10.0	11.0	21.6	27	25	27	30.8	27.9	25.8	24.8	89.1	22	40	
11.0	12.5	21.3	31	28	35	30.6	27.8	24.9	23.9	86.1	28	50	
12.5	13.1	21.7	21	20	21	28.1	24.6	19.0	18.0	73.2	13	23	
13.1	14.1	21.2	21	20	21	29.6	27.5	21.5	20.5	74.8	14	26	
14.1	15.0	20.5	33	29	39	29.2	27.1	23.2	22.3	82.5	29	52	
15.0	16.2	20.4	36	31	43	26.4	23.7	20.4	19.4	81.6	28	50	
16.2	17.1	21.3	3	3	3	24.3	18.4	16.4	14.6	79.4	1	3	
17.1	19.2	19.9	9	9	9	27.1	19.6	18.2	17.0	86.8	5	9	
19.2	24.4	19.7	1	1	1								2
24.4	25.0	19.0	24	22	29	30.0	27.2	22.0	20.9	76.9	20	36	
25.0	26.0	17.5	25	23	38	27.9	26.5	19.8	19.4	73.1	25	44	
26.0	27.3	18.2	22	20	28	28.8	27.1	19.2	19.0	70.1	18	32	
27.3	28.0	18.4	34	30	49	31.0	27.2	19.7	18.9	69.5	31	56	
28.0	29.0	19.6	30	27	37	35.8	32.0	23.8	23.2	72.5	29	52	
29.0	30.0	20.1	32	29	39	35.7	31.7	23.0	22.4	70.5	29	52	

Job No: 19-0204607
Client: Wood PLC
Project: Myra Falls
Start Date: 01-Nov-2019
End Date: 02-Nov-2019

Borehole ID: iBPT19-05
Rig: HAV 180

INSTRUMENTED BECKER PENETRATION TEST RESULTS

Start Depth (ft)	End Depth (ft)	Average Bounce Chamber Pressure (BCP) (psi)	N_{BC}^{1}	N_{60}^{1}	N_B (blows per foot)	Average Head Max Energy $E_{max,head}$ (%)	Average Head Residual Energy $E_{res,head}$ (%)	Average Tip Max Energy $E_{max,tip}$ (%)	Average Tip Residual Energy $E_{res,tip}$ (%)	Delivered Energy Ratio (DER)	N_{B30}	iBPT N_{60}	Refer to Notation Number
30.0	31.0	19.5	34	30	43	33.4	29.5	19.4	18.9	64.1	27	49	
31.0	32.1	21.3	4	4	4								2
32.1	33.1	20.5	13	13	13	32.4	25.8	17.6	16.9	65.5	7	13	
33.1	34.0	19.9	25	23	29	32.1	26.6	18.2	17.4	65.5	17	30	
34.0	35.0	19.7	21	20	23	37.9	36.3	21.1	20.7	57.0	16	29	
35.0	36.1	19.0	26	24	32	34.3	31.5	17.7	17.4	55.3	19	33	
36.1	37.4	20.5	5	5	5	28.0	21.5	11.3	10.8	50.2	2	3	
37.4	38.1	20.6	29	26	34	37.2	26.8	18.4	17.8	66.5	20	36	
38.1	39.0	20.4	10	10	10	36.7	28.0	19.1	18.2	64.8	6	11	
39.0	40.0	19.2	37	32	49	34.0	28.3	20.8	19.8	70.0	32	58	
40.0	41.0	18.8	27	25	35	34.9	31.8	21.6	21.1	66.5	25	44	
41.0	42.0	19.2	23	21	27	37.4	35.3	20.2	19.9	56.3	18	32	
42.0	43.0	18.4	22	20	27	37.4	36.6	18.6	18.4	50.4	17	30	
43.0	44.0	16.6	16	16	22	34.1	33.6	14.7	14.6	43.5	11	19	
44.0	45.0	17.0	17	17	23	34.7	34.3	15.6	15.5	45.2	12	21	
45.0	46.0	17.4	19	18	25	36.7	36.7	15.7	15.6	42.6	13	23	
46.0	47.0	17.3	19	18	26	36.6	36.6	17.6	17.4	47.6	15	27	
47.0	48.0	18.2	16	16	18	38.1	37.9	18.1	18.0	47.5	11	19	
48.0	49.0	18.3	19	18	22	41.1	40.6	23.3	23.1	56.8	17	30	
49.0	50.0	15.5	13	13	19	34.6	34.1	22.2	22.1	64.8	14	25	
50.0	51.0	13.1	10	10	17	28.2	28.1	16.5	16.4	58.6	9	17	
51.0	52.0	15.2	12	12	16	34.4	34.3	20.8	20.7	60.4	11	20	
52.0	53.1	15.3	12	12	17	37.7	37.7	23.6	23.6	62.7	13	24	
53.1	54.0	15.5	12	12	17	36.0	35.9	23.0	23.0	64.0	13	23	
54.0	55.0	15.9	14	13	19	34.4	33.8	22.1	21.9	64.8	14	25	
55.0	56.0	16.8	19	18	27	33.9	32.6	21.8	21.6	66.2	19	35	

CONETEC

Job No: 19-0204607
Client: Wood PLC
Project: Myra Falls
Start Date: 01-Nov-2019
End Date: 02-Nov-2019

Borehole ID: iBPT19-05
Rig: HAV 180

INSTRUMENTED BECKER PENETRATION TEST RESULTS

Start Depth (ft)	End Depth (ft)	Average Bounce Chamber Pressure (BCP) (psi)	N_{BC}[1]	N_{60}[1]	N_B (blows per foot)	Average Head Max Energy $E_{max,head}$ (%)	Average Head Residual Energy $E_{res,head}$ (%)	Average Tip Max Energy $E_{max,tip}$ (%)	Average Tip Residual Energy $E_{res,tip}$ (%)	Delivered Energy Ratio (DER)	N_{B30}	iBPT N_{60}	Refer to Notation Number
56.0	57.1	19.7	38	32	48	35.6	26.6	19.9	19.7	73.8	31	57	
57.1	58.0	20.4	47	39	62	36.5	26.1	21.5	21.4	82.1	44	80	
58.0	59.0	20.2	57	45	85	36.0	26.4	19.9	19.8	75.0	56	101	
59.0	60.0	20.1	49	40	68	35.1	26.7	16.8	16.4	61.3	37	67	
60.0	61.0	19.3	52	42	82	34.8	28.1	17.7	16.8	59.7	46	82	
61.0	62.0	17.6	25	23	38	34.0	31.2	19.0	18.4	58.9	23	42	
62.0	63.0	17.5	24	22	35	32.1	30.0	19.5	19.0	63.4	22	40	
63.0	64.0	18.9	34	30	46	35.0	30.8	17.7	17.3	56.3	27	48	
64.0	65.2	19.9	41	34	52	37.3	31.2	16.7	16.4	52.4	28	51	
65.2	66.0	20.3	24	22	26	38.5	33.0	18.8	18.5	56.2	16	29	
66.0	67.0	19.9	27	25	32	37.7	33.7	14.4	14.2	42.3	15	27	
67.0	68.0	18.5	26	24	34	34.7	32.3	9.0	9.0	27.9	10	18	
68.0	69.0	17.7	27	24	40	33.0	30.7	7.6	7.6	24.6	10	18	
69.0	70.0	18.2	23	22	31	35.1	33.5	5.9	5.8	17.4	6	11	
70.0	71.0	18.4	22	20	27	35.6	33.8	3.8	3.8	11.1	3	6	
71.0	72.0	17.0	22	20	33	32.2	30.6	3.2	3.2	10.4	4	6	
72.0	73.0	17.2	19	19	27	33.5	32.3	3.9	3.9	12.0	3	6	
73.0	74.0	17.4	20	19	28	33.0	31.3	7.8	7.7	24.4	7	13	
74.0	75.0	19.1	43	36	63	37.0	30.9	12.2	11.6	37.5	24	44	

1. Harder & Seed, 1986.
2. Energy results are not presented due to equipment issues.

Job No: 19-0204607
Client: Wood PLC
Project: Myra Falls
Start Date: 02-Nov-2019
End Date: 03-Nov-2019

Borehole ID: iBPT19-05B
Rig: HAV 180

INSTRUMENTED BECKER PENETRATION TEST RESULTS

Start Depth (ft)	End Depth (ft)	Average Bounce Chamber Pressure (BCP) (psi)	N_{BC}[1]	N_{60}[1]	N_B (blows per foot)	Average Head Max Energy $E_{max,head}$ (%)	Average Head Residual Energy $E_{res,head}$ (%)	Average Tip Max Energy $E_{max,tip}$ (%)	Average Tip Residual Energy $E_{res,tip}$ (%)	Delivered Energy Ratio (DER)	N_{B30}	iBPT N_{60}	Refer to Notation Number
0.0	0.1	19.6	11	11	11	12.2	12.2	16.8	16.7	137.8	6	11	
0.1	1.0	16.7	17	16	23	34.6	33.0	34.1	33.2	100.5	25	46	
1.0	2.0	18.1	21	20	27	35.2	34.3	35.7	35.4	103.3	32	57	
2.0	3.0	17.2	18	18	25	34.8	33.5	33.0	32.3	96.4	27	48	
3.0	4.0	18.3	24	22	31	34.0	33.4	32.6	32.6	97.5	34	61	
4.0	5.0	19.5	30	27	38	32.3	31.9	29.8	29.7	93.0	38	68	
5.0	6.0	20.0	36	31	44	29.9	28.6	26.2	25.9	90.6	38	68	
6.0	7.3	19.4	29	26	36	30.2	29.4	25.3	25.0	85.1	30	54	
7.3	8.0	18.9	30	27	40	31.0	29.8	26.4	26.0	87.3	35	62	
8.0	9.0	18.4	27	25	37	31.2	29.2	26.8	26.6	90.9	33	59	
9.0	10.0	20.6	45	37	56	29.5	26.8	24.2	23.0	86.0	43	77	
10.0	11.0	19.9	45	37	61	27.9	25.1	22.1	21.0	83.4	43	77	
11.0	12.0	19.7	45	37	62	27.2	24.7	20.4	19.3	78.4	40	72	
12.0	13.0	20.0	46	38	61	28.3	25.3	19.6	18.6	73.5	38	68	
13.0	14.0	19.5	40	34	53	29.3	26.1	21.3	20.2	77.5	36	64	
14.0	15.0	19.5	40	34	52	28.3	25.4	20.5	19.5	76.7	34	61	
15.0	16.0	22.2	62	48	77	29.8	24.2	20.7	19.2	79.6	49	89	
16.0	17.0	23.2	84	60	107	31.1	21.7	21.3	19.3	89.3	69	124	
17.0	18.0	23.1	66	50	77	36.9	26.6	23.7	22.1	83.2	57	102	
18.0	19.0	23.8	87	62	107	36.0	25.4	22.1	20.3	79.6	72	130	
19.0	20.0	22.5	69	52	86	34.0	26.4	21.4	19.8	74.9	57	102	
20.0	21.0	22.1	65	49	83	33.3	24.9	18.6	17.4	69.9	48	87	
21.0	22.0	22.4	67	50	83	34.4	25.9	18.7	17.3	66.8	48	86	
22.0	23.0	23.1	69	52	83	34.0	25.9	18.0	16.6	64.1	46	83	
23.0	24.0	22.7	56	44	64	35.4	27.6	20.6	19.3	69.8	41	74	
24.0	25.0	20.3	38	33	46	32.9	27.4	21.4	20.4	74.4	31	56	

Job No: 19-0204607
Client: Wood PLC
Project: Myra Falls
Start Date: 02-Nov-2019
End Date: 03-Nov-2019

Borehole ID: iBPT19-05B
Rig: HAV 180

INSTRUMENTED BECKER PENETRATION TEST RESULTS

Start Depth (ft)	End Depth (ft)	Average Bounce Chamber Pressure (BCP) (psi)	N_{BC}[1]	N_{60}[1]	N_B (blows per foot)	Average Head Max Energy $E_{max,head}$ (%)	Average Head Residual Energy $E_{res,head}$ (%)	Average Tip Max Energy $E_{max,tip}$ (%)	Average Tip Residual Energy $E_{res,tip}$ (%)	Delivered Energy Ratio (DER)	N_{B30}	iBPT N_{60}	Refer to Notation Number
25.0	26.0	20.2	40	34	50	32.5	26.3	21.1	20.0	76.1	33	60	
26.0	27.0	20.5	39	33	46	35.0	30.0	22.6	21.6	71.9	33	59	
27.0	28.0	20.8	31	28	36	35.4	31.6	26.2	23.9	75.6	29	52	
28.0	29.0	20.6	29	26	34	36.2	32.9	26.8	26.2	79.7	30	53	
29.0	30.0	20.7	36	31	42	32.8	28.7	22.1	21.5	74.9	30	54	
30.0	31.0	20.6	32	29	38	32.8	29.3	20.9	20.5	70.0	26	47	
31.0	32.0	23.6	69	52	79	33.2	24.7	18.4	17.6	71.2	46	83	
32.0	33.0	23.2	63	48	72	32.0	24.8	17.4	16.7	67.3	40	72	
33.0	34.0	21.2	41	35	48	30.9	26.3	15.9	15.6	59.6	25	45	
34.0	35.0	21.9	42	35	47	31.1	26.2	13.0	12.9	49.2	20	36	
35.0	36.0	22.0	47	39	54	30.5	23.9	12.5	12.3	51.5	22	40	
36.0	37.0	21.2	58	45	77	27.7	20.5	11.7	11.4	55.7	29	53	
37.0	38.0	20.8	43	36	52	32.7	26.7	15.9	15.3	57.3	26	48	
38.0	39.0	21.1	41	34	47	34.7	29.6	18.6	18.1	61.0	28	51	
39.0	40.0	21.0	44	37	53	34.7	28.7	19.5	18.6	64.9	33	59	
40.0	41.0	19.2	29	26	36	33.9	30.7	20.0	19.5	63.4	23	42	
41.0	42.0	18.0	19	18	24	33.1	32.1	19.5	19.4	60.3	15	28	
42.0	43.0	18.9	24	23	30	33.8	32.3	20.6	20.2	62.7	20	36	
43.0	44.0	17.6	20	19	27	33.0	32.0	19.9	19.6	61.1	18	32	
44.0	45.0	17.7	24	23	35	28.8	25.5	17.0	16.7	65.5	19	35	
45.0	46.0	20.3	47	38	61	30.8	22.8	17.8	17.1	74.9	35	62	
46.0	47.0	20.2	52	42	74	28.4	20.7	15.5	14.8	71.3	36	66	
47.0	48.0	20.2	55	43	79	31.8	23.1	14.2	13.8	59.7	36	65	
48.0	49.0	20.7	59	46	84	35.1	26.3	16.5	16.0	61.0	45	81	
49.0	50.0	19.6	52	41	78	31.5	24.2	15.3	14.8	61.3	39	69	
50.0	51.0	18.3	32	28	46	30.4	26.2	15.9	15.3	58.5	23	42	

CONETEC

Job No: 19-0204607
Client: Wood PLC
Project: Myra Falls
Start Date: 02-Nov-2019
End Date: 03-Nov-2019

Borehole ID: iBPT19-05B
Rig: HAV 180

INSTRUMENTED BECKER PENETRATION TEST RESULTS

Start Depth (ft)	End Depth (ft)	Average Bounce Chamber Pressure (BCP) (psi)	N_{BC}[1]	N_{60}[1]	N_B (blows per foot)	Average Head Max Energy $E_{max,head}$ (%)	Average Head Residual Energy $E_{res,head}$ (%)	Average Tip Max Energy $E_{max,tip}$ (%)	Average Tip Residual Energy $E_{res,tip}$ (%)	Delivered Energy Ratio (DER)	N_{B30}	iBPT N_{60}	Refer to Notation Number
51.0	52.0	17.9	28	26	42	29.1	25.5	15.7	15.4	60.2	21	39	
52.0	53.0	18.7	31	27	42	30.9	26.9	16.0	15.6	58.1	22	39	
53.0	54.0	17.6	29	26	46	27.1	23.4	13.0	12.7	54.3	19	35	
54.0	55.0	16.2	27	25	51	23.3	20.1	11.1	10.8	53.5	18	33	
55.0	56.0	16.4	36	31	70	21.6	17.4	9.9	9.4	54.0	22	39	
56.0	57.0	19.2	63	48	111	28.4	20.2	12.8	12.0	59.7	45	80	
57.0	58.0	18.6	35	30	50	32.6	27.1	17.1	16.6	61.1	28	50	
58.0	59.0	15.9	22	21	40	29.5	27.1	17.3	16.8	62.2	22	40	
59.0	60.0	14.5	15	14	27	27.1	26.4	14.7	14.5	54.9	13	23	
60.0	61.0	14.5	14	13	24	27.8	27.0	13.0	12.9	47.9	10	19	
61.0	62.0	15.6	20	19	38	28.1	25.7	14.5	14.2	55.2	18	32	
62.0	63.0	15.9	22	20	39	27.9	25.1	15.5	15.2	60.8	20	36	
63.0	64.0	16.7	25	23	43	29.3	26.4	15.6	15.4	58.1	22	40	
64.0	65.0	18.4	28	25	39	33.5	30.4	14.5	14.2	46.8	19	33	
65.0	66.0	20.0	44	37	58	34.8	28.8	13.4	13.2	45.7	25	46	
66.0	67.0	20.4	59	46	88	34.3	26.1	12.9	12.3	47.1	36	65	
67.0	68.0	19.5	49	39	72	34.0	27.3	12.4	11.9	43.6	29	51	
68.0	69.0	19.5	38	32	49	36.0	32.0	9.2	8.8	27.5	14	26	
69.0	70.0	17.9	35	30	55	29.7	26.2	4.5	4.3	16.3	8	14	
70.0	71.0	18.8	39	33	55	30.9	27.0	3.6	3.5	12.8	6	11	
71.0	72.0	19.8	44	37	59	33.7	28.5	4.7	4.6	16.0	9	16	
72.0	73.0	18.9	38	33	53	30.3	26.0	3.9	3.8	14.6	7	12	
73.0	74.0	22.2	114	78	182	37.0	23.2	7.8	6.8	29.4	41	74	
74.0	75.0	22.0	169	112	311	37.9	23.6	8.8	7.7	32.7	80	144	
75.0	75.3	22.3	500	308	1018	41.0	23.7	9.3	8.5	36.1	290	521	

1. Harder & Seed, 1986.

Job No: 19-0204607
Client: Wood PLC
Project: Myra Falls
Start Date: 30-Oct-2019
End Date: 31-Oct-2019

Borehole ID: iBPT19-06
Rig: HAV 180

INSTRUMENTED BECKER PENETRATION TEST RESULTS

Start Depth (ft)	End Depth (ft)	Average Bounce Chamber Pressure (BCP) (psi)	N_{BC}[1]	N_{60}[1]	N_B (blows per foot)	Average Head Max Energy $E_{max,head}$ (%)	Average Head Residual Energy $E_{res,head}$ (%)	Average Tip Max Energy $E_{max,tip}$ (%)	Average Tip Residual Energy $E_{res,tip}$ (%)	Delivered Energy Ratio (DER)	N_{B30}	iBPT N_{60}	Refer to Notation Number
0.0	0.1	10.2	6	6	10	11.2	11.2	8.6	8.5	76.4	3	5	
0.1	1.0	16.0	16	15	23	34.0	33.3	33.9	33.8	101.5	26	47	
1.0	2.0	16.3	17	16	24	35.8	34.3	35.0	34.2	99.6	27	49	
2.0	3.0	18.4	22	20	27	35.1	33.9	36.4	36.3	107.3	33	59	
3.0	4.0	19.4	27	25	33	36.6	35.8	37.0	37.0	103.4	41	73	
4.0	5.0	20.6	33	29	39	32.9	31.8	29.8	29.4	92.3	38	69	
5.0	6.0	22.6	50	40	56	31.0	28.4	25.9	25.3	89.1	47	85	
6.0	7.0	23.3	57	44	63	31.1	27.3	25.9	25.5	93.4	54	96	
7.0	8.0	22.3	51	41	58	31.2	26.0	26.1	25.0	96.3	48	87	
8.0	9.0	21.6	57	45	72	29.2	24.0	23.2	21.8	91.0	52	94	
9.0	10.0	20.9	52	41	67	29.2	23.3	23.8	22.2	95.3	50	89	
10.0	11.0	20.7	48	39	61	29.1	25.1	24.3	23.2	92.3	47	85	
11.0	12.0	21.4	52	42	64	30.5	25.8	23.4	22.2	86.1	47	85	
12.0	13.0	21.6	51	41	61	31.3	26.9	23.1	21.8	81.1	44	80	
13.0	14.0	22.3	58	45	69	31.7	26.5	21.3	20.0	75.6	46	83	
14.0	15.0	23.3	71	53	84	32.0	23.8	21.6	19.6	82.2	55	99	
15.0	16.0	24.0	74	55	86	33.1	24.0	24.6	22.1	92.3	63	114	
16.0	17.0	22.3	66	50	83	30.5	23.7	22.5	20.5	86.4	57	102	
17.0	18.0	21.3	44	36	51	37.2	31.4	28.5	27.2	86.6	46	83	
18.0	19.0	21.9	42	35	47	36.7	31.3	26.9	26.1	83.5	41	74	
19.0	20.0	24.4	76	56	87	37.1	26.0	24.7	23.2	89.2	67	121	
20.0	21.0	23.1	65	49	75	35.4	25.3	24.0	22.4	88.7	56	101	
21.0	22.0	21.8	56	44	68	33.5	26.1	21.2	20.2	77.4	46	82	
22.0	23.0	21.7	51	41	60	33.6	26.5	23.5	22.4	84.6	45	81	
23.0	24.0	19.1	30	27	39	33.3	30.6	22.8	22.3	72.8	29	52	
24.0	25.0	18.4	27	24	36	32.1	29.8	23.6	23.3	78.1	28	50	

Job No: 19-0204607
Client: Wood PLC
Project: Myra Falls
Start Date: 30-Oct-2019
End Date: 31-Oct-2019

Borehole ID: iBPT19-06
Rig: HAV 180

INSTRUMENTED BECKER PENETRATION TEST RESULTS

Start Depth (ft)	End Depth (ft)	Average Bounce Chamber Pressure (BCP) (psi)	N_{BC}[1]	N_{60}[1]	N_B (blows per foot)	Average Head Max Energy $E_{max,head}$ (%)	Average Head Residual Energy $E_{res,head}$ (%)	Average Tip Max Energy $E_{max,tip}$ (%)	Average Tip Residual Energy $E_{res,tip}$ (%)	Delivered Energy Ratio (DER)	N_{B30}	iBPT N_{60}	Refer to Notation Number
25.0	26.0	20.1	35	30	42	33.0	28.7	22.2	21.7	75.6	30	55	
26.0	27.0	21.0	44	37	53	32.6	27.0	23.7	22.7	84.1	40	72	
27.0	28.0	22.2	44	37	50	38.4	29.9	27.7	26.0	86.8	43	78	
28.0	29.0	23.1	52	42	58	39.3	30.8	23.3	22.4	72.8	43	78	
29.0	30.0	22.8	55	43	62	37.1	29.2	23.3	22.5	77.0	46	84	
30.0	31.0	22.2	58	45	69	35.6	27.4	23.8	22.7	82.9	52	94	
31.0	32.0	24.2	89	63	107	36.9	24.4	21.7	20.4	83.6	73	131	
32.0	33.0	23.7	82	60	100	37.3	27.0	21.0	19.6	72.7	65	118	
33.0	34.0	22.5	59	46	69	41.9	36.8	20.9	19.8	53.9	46	82	
34.0	35.0	23.0	52	42	58	38.0	30.3	19.4	18.8	62.0	36	65	
35.0	36.0	23.1	50	41	56	38.2	31.2	20.2	19.7	63.0	37	66	
36.0	37.0	23.5	59	46	65	36.9	29.8	17.6	17.0	57.1	37	66	
37.0	37.1	22.1	58	45	70	36.2	27.7	15.7	15.0	54.3	35	63	
37.1	38.0	22.4	74	55	97	32.9	20.9	14.5	14.3	68.4	46	83	
38.0	39.0	22.8	63	48	74	35.3	25.9	17.5	17.3	66.9	43	77	
39.0	40.0	21.2	46	38	55	34.6	28.7	24.2	23.9	83.4	44	79	
40.0	41.0	20.5	38	33	45	34.1	29.8	20.8	20.5	68.9	31	55	
41.0	42.0	20.2	34	30	41	33.2	29.4	16.6	16.5	56.0	23	41	
42.0	43.0	20.4	38	33	46	32.6	28.0	17.2	17.0	60.9	26	47	
43.0	44.0	20.9	47	38	58	31.1	25.6	17.5	17.2	67.1	33	60	
44.0	45.0	20.7	37	32	44	31.9	28.0	18.8	18.5	66.2	27	49	
45.0	46.0	18.8	30	27	41	27.3	24.4	14.6	14.4	59.1	20	36	
46.0	47.2	17.3	20	19	27	26.5	25.6	12.9	12.8	49.9	12	21	
47.2	48.0	17.2	14	14	17	33.2	32.2	14.1	14.1	43.8	8	14	
48.0	49.0	15.9	12	12	15	35.6	35.4	19.1	18.9	53.4	9	17	
49.0	50.1	15.9	13	13	17	34.5	34.5	19.2	19.1	55.6	11	20	

CONETEC

Job No: 19-0204607
Client: Wood PLC
Project: Myra Falls
Start Date: 30-Oct-2019
End Date: 31-Oct-2019

Borehole ID: iBPT19-06
Rig: HAV 180

INSTRUMENTED BECKER PENETRATION TEST RESULTS

Start Depth (ft)	End Depth (ft)	Average Bounce Chamber Pressure (BCP) (psi)	N_{BC}[1]	N_{60}[1]	N_B (blows per foot)	Average Head Max Energy $E_{max,head}$ (%)	Average Head Residual Energy $E_{res,head}$ (%)	Average Tip Max Energy $E_{max,tip}$ (%)	Average Tip Residual Energy $E_{res,tip}$ (%)	Delivered Energy Ratio (DER)	N_{B30}	iBPT N_{60}	Refer to Notation Number
50.1	51.0	16.8	14	14	18	36.3	35.9	25.2	25.1	69.9	15	27	
51.0	52.0	15.7	12	12	16	36.0	35.6	26.8	26.5	74.6	14	25	
52.0	53.0	15.6	12	12	15	35.7	35.4	28.7	28.5	80.6	14	26	
53.0	54.0	15.6	12	12	16	33.6	33.2	22.1	21.9	65.9	12	21	
54.0	55.0	16.1	13	13	16	32.5	32.1	18.5	18.4	57.4	10	18	
55.0	56.0	15.1	12	12	18	30.4	30.2	17.0	16.9	56.0	10	18	
56.0	57.2	14.8	11	11	16	28.6	28.3	19.3	19.2	67.7	10	18	
57.2	58.0	16.9	15	15	19	34.6	33.8	26.5	26.2	77.3	17	30	
58.0	59.0	20.1	49	40	67	34.4	26.4	22.8	22.7	86.1	51	91	
59.0	60.0	22.9	151	101	246	35.4	20.1	16.6	16.4	81.8	135	242	
60.0	61.0	22.7	173	114	295	37.2	22.0	19.2	18.7	84.9	184	331	
61.0	62.0	20.7	106	74	196	32.2	21.4	17.9	17.2	80.6	113	203	
62.0	63.0	20.7	68	51	105	33.1	23.2	17.8	17.3	74.5	60	109	
63.0	64.0	19.2	47	39	72	31.1	25.0	18.3	17.7	71.0	43	77	
64.0	65.0	17.5	27	25	42	27.5	25.2	16.2	15.8	62.8	22	40	
65.0	66.0	16.6	19	18	29	27.2	25.6	9.8	9.7	38.0	9	17	
66.0	67.0	16.7	19	18	29	28.9	27.3	9.8	9.8	36.0	9	17	
67.0	68.0	16.5	11	11	11	34.1	33.7	17.0	17.0	50.3	6	11	
68.0	69.1	15.4	12	12	16	33.9	33.7	15.1	15.1	44.8	8	14	
69.1	70.1	15.3	12	12	16	33.0	32.6	14.4	14.4	44.2	8	14	
70.1	71.0	16.3	14	14	19	33.3	32.2	12.4	12.4	38.4	8	14	
71.0	72.1	16.1	13	13	17	34.2	33.8	12.4	12.3	36.5	7	13	
72.1	73.1	15.6	12	12	15	33.5	33.1	9.5	9.5	28.7	5	9	
73.1	74.0	15.8	12	12	15	33.1	32.7	9.8	9.8	29.9	5	9	
74.0	75.0	15.6	13	12	17	32.9	32.6	9.6	9.5	29.0	5	10	
75.0	76.0	15.5	13	13	19	29.6	29.0	8.5	8.5	29.4	5	10	

Job No: 19-0204607
Client: Wood PLC
Project: Myra Falls
Start Date: 30-Oct-2019
End Date: 31-Oct-2019

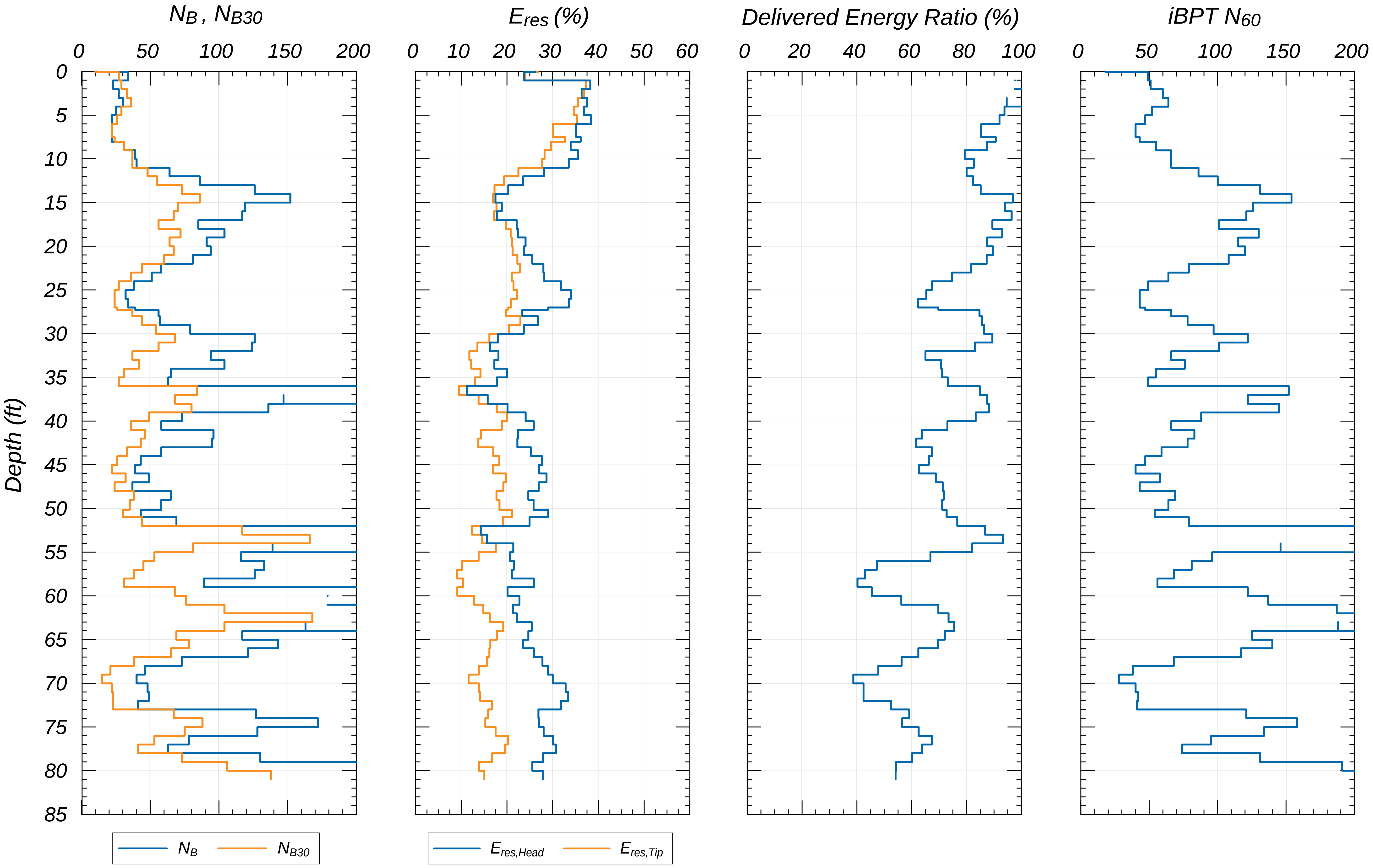
Borehole ID: iBPT19-06
Rig: HAV 180

INSTRUMENTED BECKER PENETRATION TEST RESULTS

Start Depth (ft)	End Depth (ft)	Average Bounce Chamber Pressure (BCP) (psi)	N_{BC}[1]	N_{60}[1]	N_B (blows per foot)	Average Head Max Energy $E_{max,head}$ (%)	Average Head Residual Energy $E_{res,head}$ (%)	Average Tip Max Energy $E_{max,tip}$ (%)	Average Tip Residual Energy $E_{res,tip}$ (%)	Delivered Energy Ratio (DER)	N_{B30}	iBPT N_{60}	Refer to Notation Number
76.0	77.3	15.3	13	13	19	28.7	28.3	8.2	8.2	28.9	5	9	
77.3	78.1	15.9	8	8	8	34.6	34.5	10.9	10.9	31.5	3	5	
78.1	79.0	15.0	12	12	17	29.8	29.4	10.9	10.9	37.0	6	11	
79.0	80.0	18.8	40	34	57	33.4	28.5	18.3	18.0	62.9	34	61	
80.0	81.0	18.4	44	36	69	31.4	25.8	19.4	18.7	72.4	43	77	
81.0	82.0	19.3	133	90	328	31.1	20.1	14.0	12.3	61.3	134	242	
82.0	82.7	20.9	175	115	371	34.4	19.0	12.0	9.4	49.5	116	210	

1. Harder & Seed, 1986.

Instrumented Becker Penetration Test Plots with Energy Results and iBPT Equivalent N_{60}

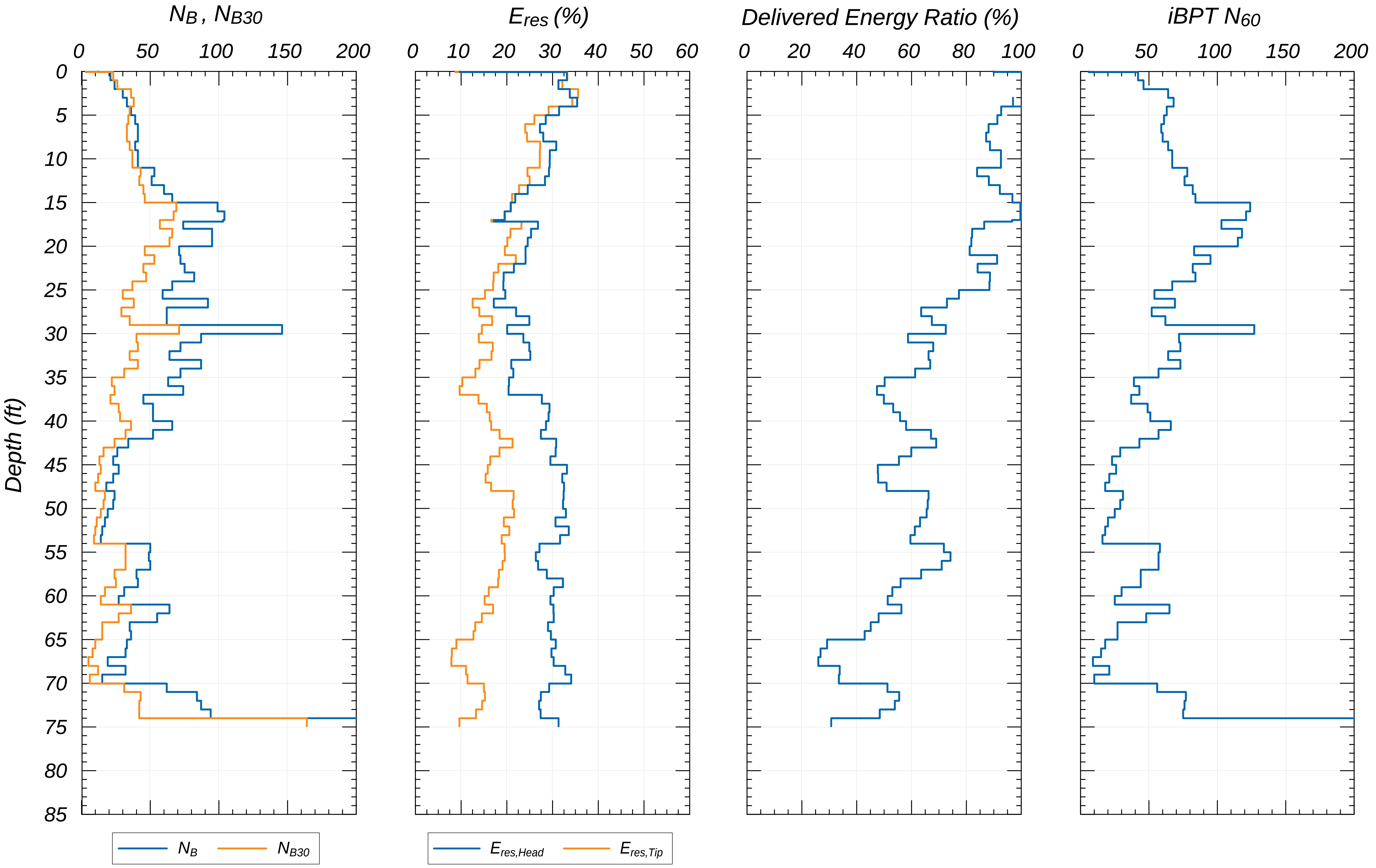


CONETEC

iBPT Results

JOB NO: 19-0204607
SITE: Myra Falls

SOUNDING: iBPT19-02
DATE: 04-Nov-2019



CONETEC

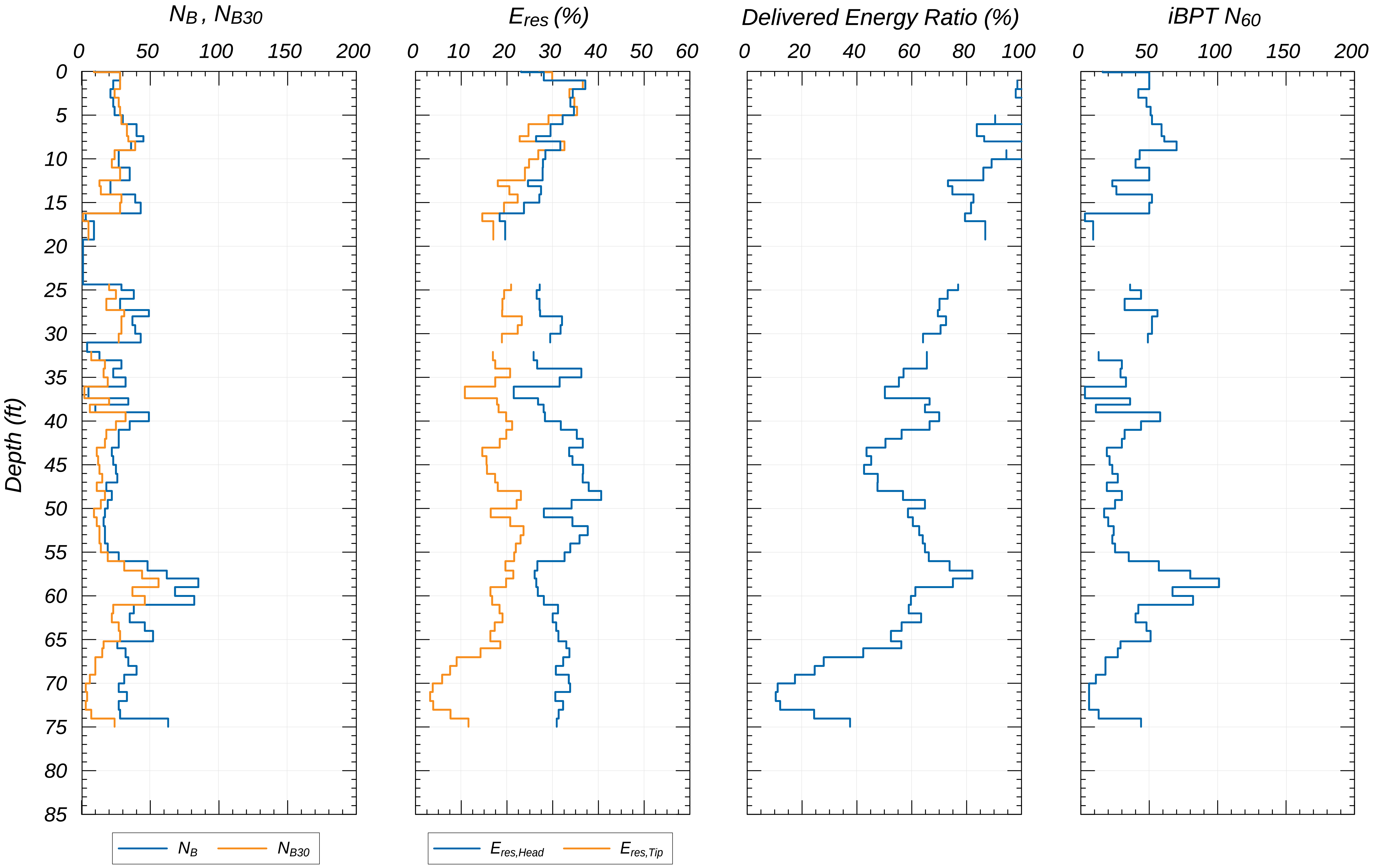
iBPT Results

JOB NO: 19-0204607

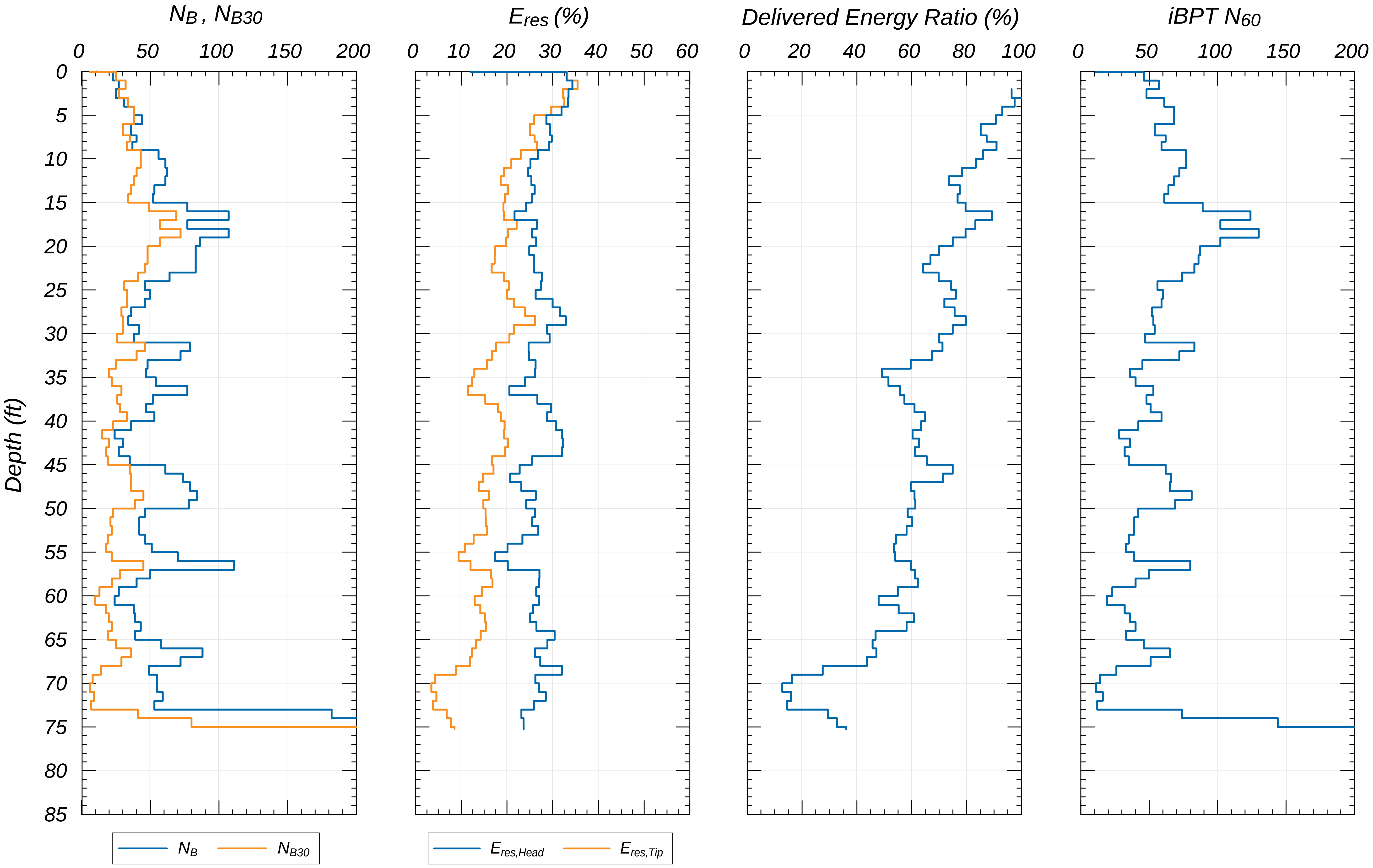
SITE: Myra Falls

SOUNDING: iBPT19-03

DATE: 03-Nov-2019



CONETEC	iBPT Results	JOB NO: 19-0204607	SOUNDING: iBPT19-05
		SITE: Myra Falls	DATE: 01-Nov-2019

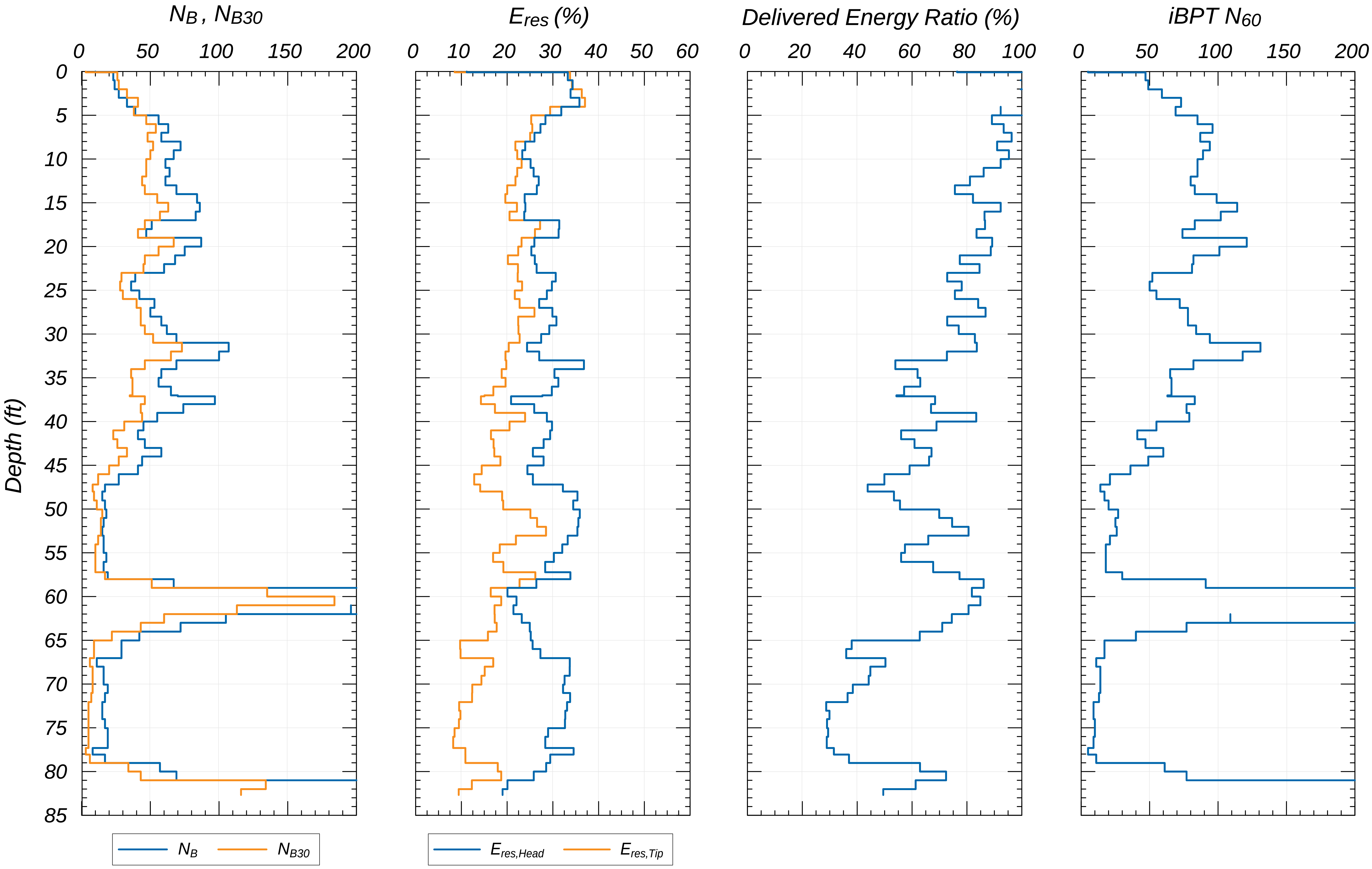


CONETEC

iBPT Results

JOB NO: 19-0204607
SITE: Myra Falls

SOUNDING: iBPT19-05B
DATE: 02-Nov-2019

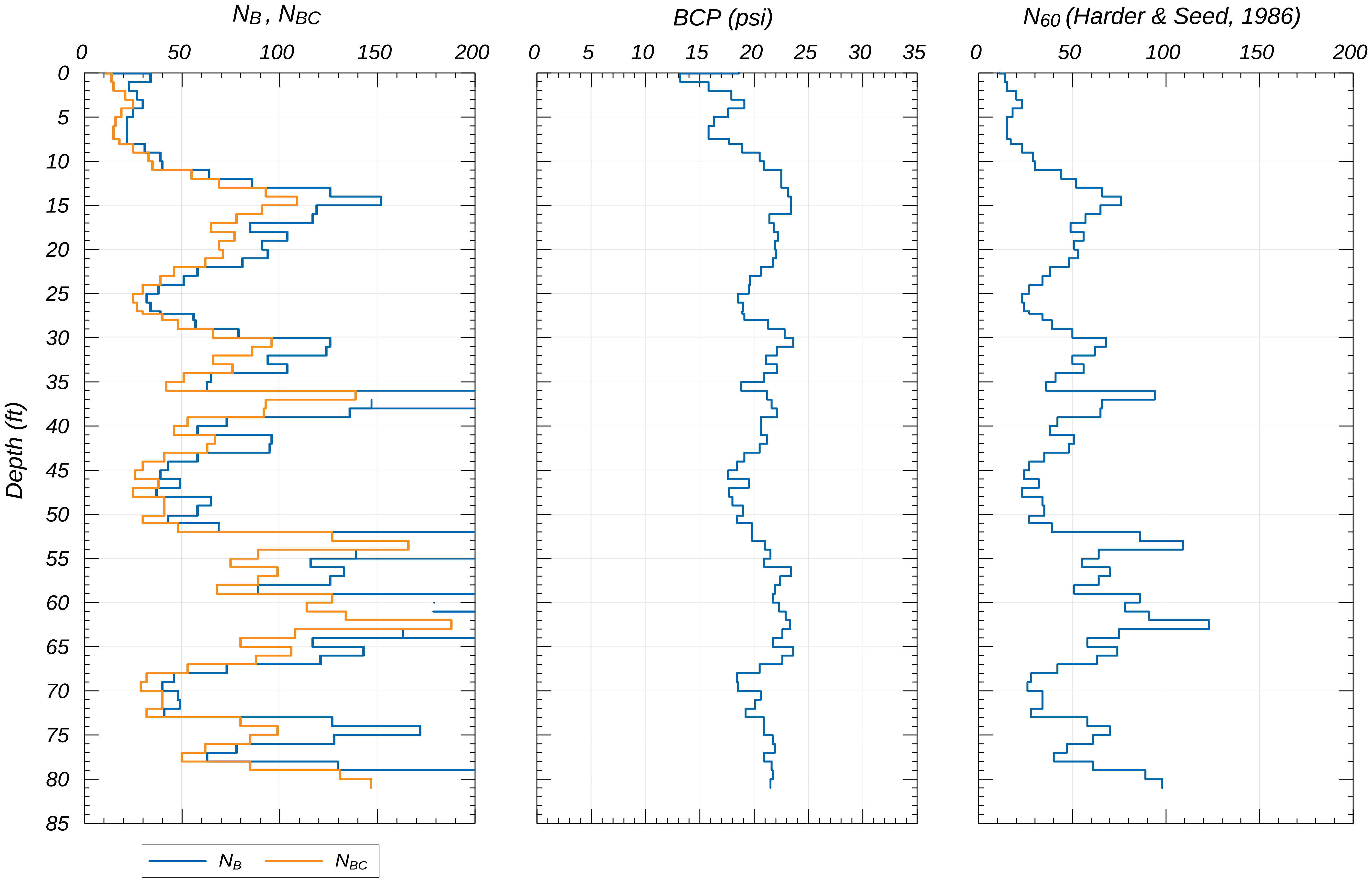


CONETEC

iBPT Results

JOB NO:	19-0204607	SOUNDING:	iBPT19-06
SITE:	Myra Falls	DATE:	30-Oct-2019

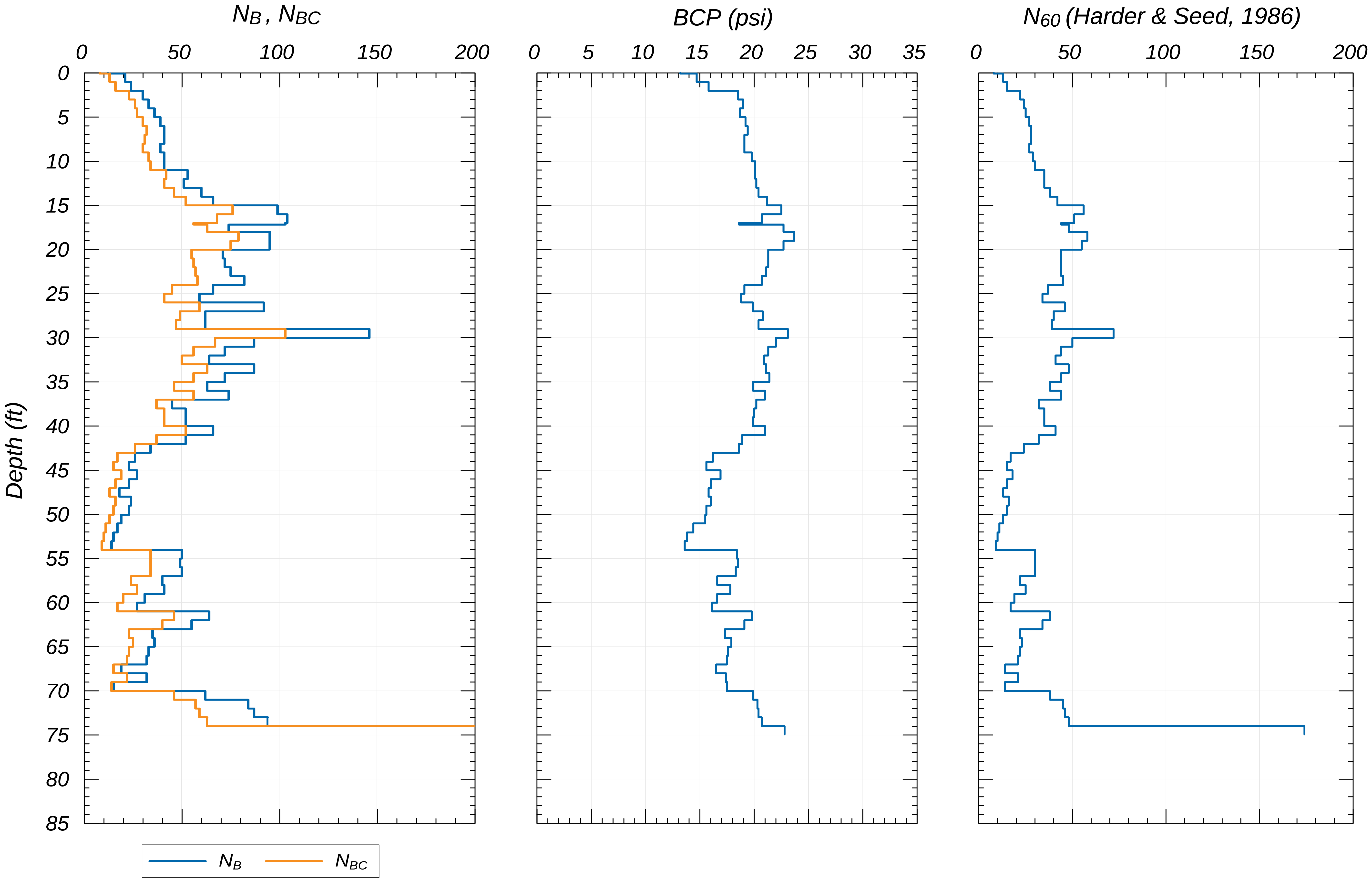
Instrumented Becker Penetration Test Plots with Harder & Seed (1986) Results



CONETEC

Harder & Seed (1986)
Results

JOB NO:	19-0204607
SITE:	Myra Falls
SOUNDING:	iBPT19-02
DATE:	04-Nov-2019

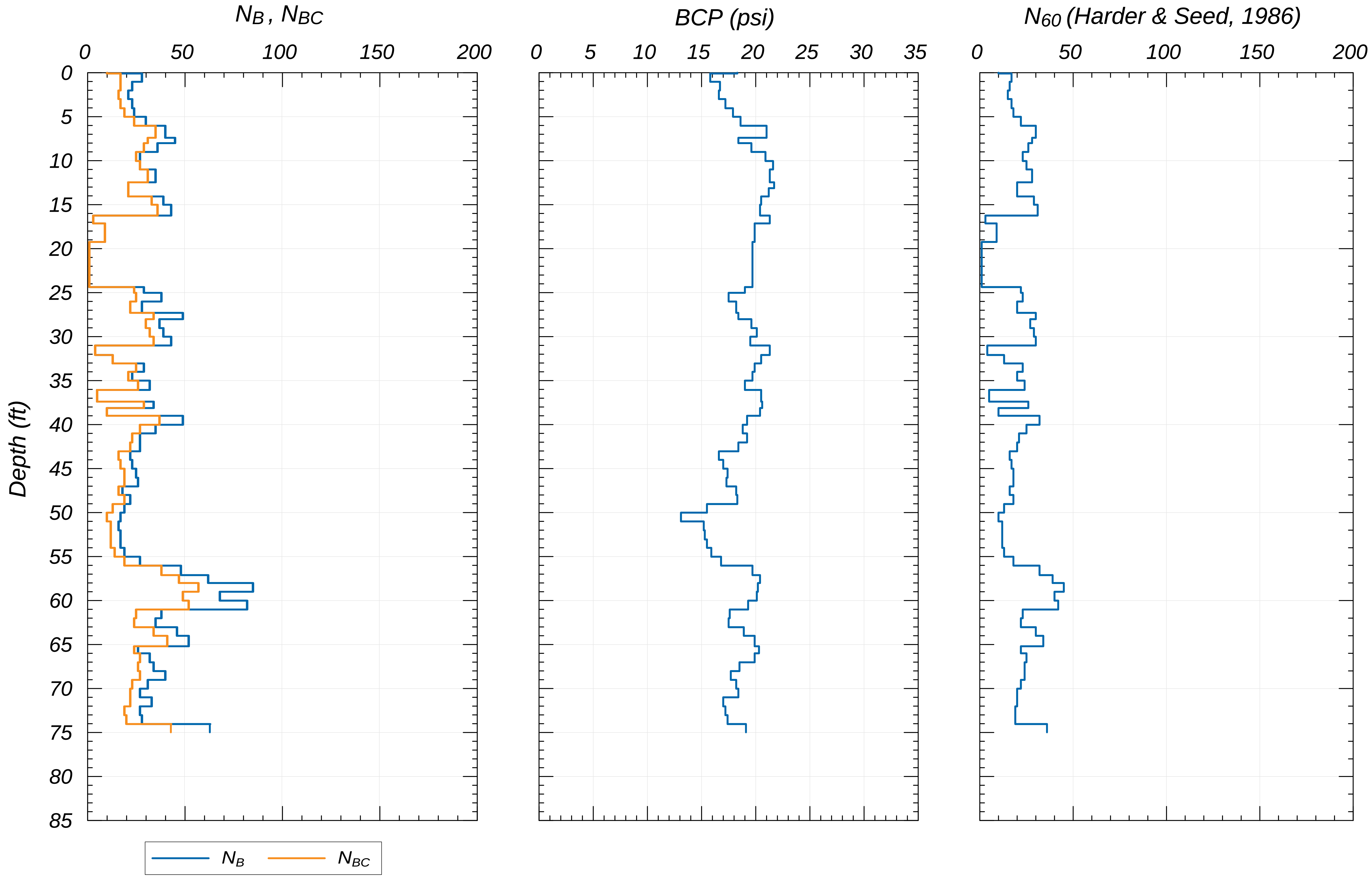


CONETEC

Harder & Seed (1986) Results

JOB NO: 19-0204607
SITE: Myra Falls

SOUNDING: iBPT19-03
DATE: 03-Nov-2019



CONETEC

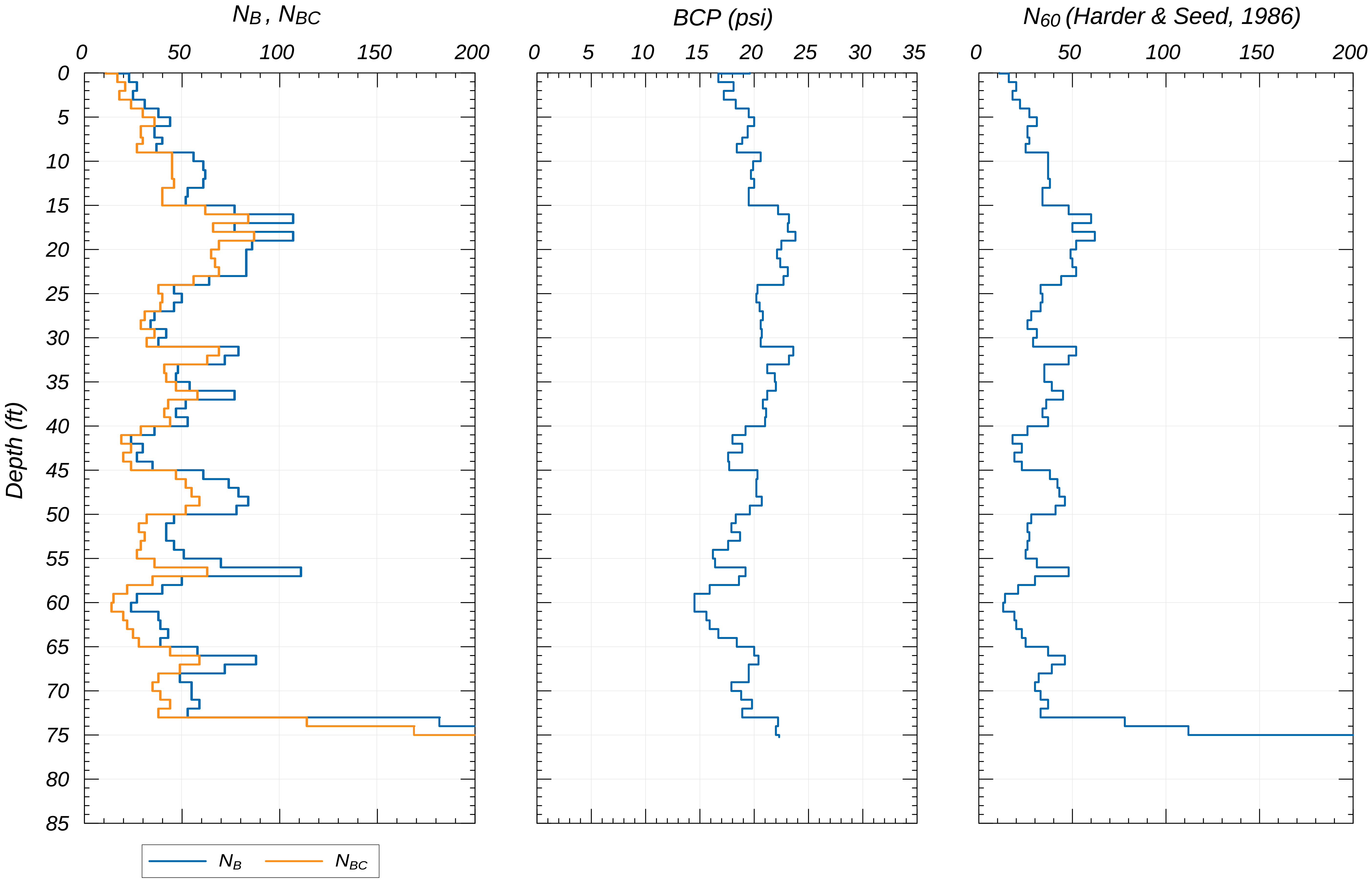
Harder & Seed (1986) Results

JOB NO: 19-0204607

SITE: Myra Falls

SOUNDING: iBPT19-05

DATE: 01-Nov-2019



CONETEC

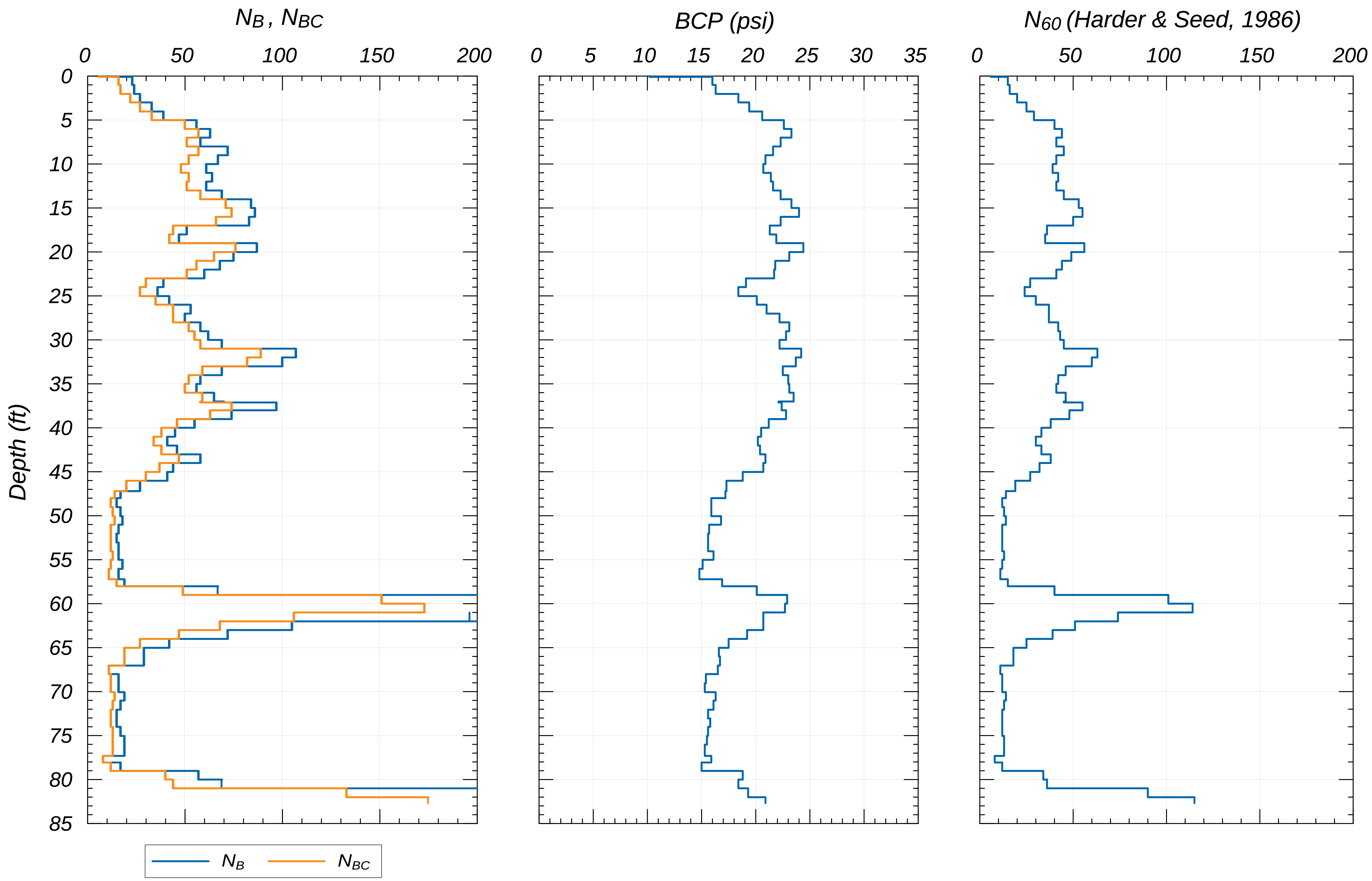
Harder & Seed (1986) Results

JOB NO: 19-0204607

SITE: Myra Falls

SOUNDING: iBPT19-05B

DATE: 02-Nov-2019



CONETEC	Harder & Seed (1986) Results	JOB NO: 19-0204607	SOUNDING: iBPT19-06
		SITE: Myra Falls	DATE: 30-Oct-2019

Appendix B – Geophysical Testing Report

PRESENTATION OF SITE INVESTIGATION RESULTS

Myra Falls Investigation

Prepared for:

Wood PLC

ConeTec Job No: 19-0204607

Project Start Date: 25-Nov-2019
Project End Date: 01-Dec-2019
Report Date: 18-Dec-2019

Prepared by:

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Introduction

The enclosed report presents the results of the geophysical site investigation program conducted by ConeTec Investigations Ltd., for Wood PLC, at the Myra Falls mine. The program consisted of two, two-dimensional Multichannel Analysis of Surface Waves (2D MASW) profiles and two Downhole Seismic Tests (DST).

Project Information

Project	
Client	Wood PLC
Project	Myra Falls Investigation
ConeTec project number	19-0204607

An aerial overview showing the MASW lines and DST locations is presented below.

Coordinates			
Test Type	Collection Method	EPSG Number	Comments
MASW, DST	GNSS	6653	Coordinates were provided by Mifflin Surveys and are referenced to NAD83 datum, UTM Zone 10 North projection. Elevations were also provided by Mifflin Surveys. Depths are referenced to the ground surface at time of testing.

MASW Acquisition Procedures

The MASW data was collected using a 72-channel static geophone array with geophones spaced at 2m. The active seismic source was a sledge hammer impacting vertically on an aluminum plate placed on the ground. At each shot location at least five strikes were recorded and added together (stacked) in the seismograph to produce a single seismic time domain trace record. The time domain records are 1 second in length with samples every 0.125 milliseconds (8 kHz). The source was then advanced 4m and the impacts were repeated, until the source reached the other side of the static array. After the shot location had advanced through the entire static array, the 24 channels furthest from the shot location were picked up and placed ahead of the current shot location. The data collection was repeated until the shot location had advanced, once again, through the static array. This procedure of advancing the shot then advancing part of the array is referred to as the roll-along method.

In addition to the active source seismic records, passive source seismic records were also collected for each array setup. The passive seismic records consisted of individual stack 30 second recordings sampled at 2 millisecond (500 Hz) intervals of ambient (background) seismic waves.

Seismograph record timing was initiated with a piezoelectric style trigger attached directly to the hammer that senses the vibration of impact with the plate. For each seismic record the field operator documented the seismic record number and location of the shot relative to the geophone station number. The equipment used for this project is outlined in the table below.

MASW Equipment Used for this Project				
Seismographs	Geophones	Coupling Mechanism	Trigger Style	Seismic Sources
3 x Geometrics Geode 24	72 x Geospace 4.5 Hz vertical	Aluminium pucks and spikes	piezoelectric	10 lb sledge hammer

MASW Data

Data quality was generally very good on both lines. To generate 2D shear wave velocity profiles with a 72-channel static geophone array each time domain record was re-sampled to a subset of 45 geophones oriented ahead of the shot location. This technique simulates a 45-channel geophone array with a 4m source offset and 4m array moves.

Overtone images of the 45-channel active source time domain records were generated and revealed coherent surface wave energy in the 10 – 60 Hz frequency band. Overtone images for the passive source time domain records were also produced and added further coherent surface wave energy in the 5 – 12

Hz band. The active and passive source Overtone images were then combined to produce an improved dataset. Examples of the 45 channel time domain traces and resulting combined (active and passive) Overtone images with picked dispersion curves are available in the appendices of this report.

Georeferencing of the shear wave velocity data was completed using the as-built survey data (start and end points) provided by Mifflin Surveys. Each geophone position was calculated by interpolating the X, Y, Z position between the surveyed end points with the help of the geophone spacing measured in the field. Each resulting Vs data point was then paired with the associated X, Y position. The Vs data was converted from Depth(m) to Elevation(m) by using the interpolated surface elevation for the corresponding X, Y position.

MASW Results

The 2D shear waves velocity profiles are shown in the appendices of this report. Each figure shows the 2D shear wave velocity profiles for that location along with an aerial image with the line placements and orientations. Included with the digital contents of this report are CSV files of the 2D shear wave velocity results containing columns of: Horizontal Distance(m), Easting(m), Northing(m), Depth(m), Vs(m/s). The results are georeferenced to NAD83 datum, UTM Zone 10 North projection (EPSG 6653). The datum of the vertical reference was not known at the time of writing.

DST Acquisition and Data Quality

The DST data was collected inside the 6” Sonic casing, instead of the more traditional method of using grouted in PVC. The testing interval was reduced from 1m to 0.5m for the bottom 11m of the borehole at the client’s request. Both shear wave (Vs) and compression wave (Vp) data was collected for each borehole. The table below outlines the survey parameters.

Downhole Seismic Test (DST)	
Depth reference	Ground surface at time of testing
Recorded depth interval	0.5 – 1m
Sampling frequency and length	48 kHz for 300 milliseconds
Seismic source	Beam (Vs) and Plate (Vp)

The data quality ranged from excellent to very poor. For BH19-02 data below 35m (below ground surface) was excellent, however above 35m the data quality degraded significantly. This can be seen in the time domain traces as significant ringing in the signal after the first wave arrival. This ringing is not seen in the bottom 4m of data in BH19-02. The ringing is likely a result of poor coupling between the Sonic casing and surrounding soils. As a result, picking a seismic arrival time at each depth was not possible. Data quality for BH19-03 was similar to the top portion of BH19-02. Data quality was particularly bad below 28m, resulting in fewer interpretable time arrivals in this section.

The DST results are presented in the appendices of this report. The results are also included in the digital release in XLSX format.

Limitations

This report has been prepared for the exclusive use of Wood PLC (Client) for the project titled "Myra Falls Investigation". 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.

Multichannel analysis of surface waves (MASW) is a non-intrusive in-situ test that uses the principles of elasticity and surface wave dispersion to determine the variation of shear wave velocity with depth at a site. The observation that surface waves (Rayleigh waves) of different wavelengths propagate at different phase velocities in non-ideal media, is called dispersion. This is a direct result of the fact that surface waves of different wavelengths propagate along the surface to varying depths, and hence, if material stiffness changes with depth (as is the case with most non-ideal materials), then an appropriately selected wavelength band will reflect such changes in the velocity of propagation.

The field methods for surface wave testing are very similar to other surface seismic data collection methods. Surface geophones are placed in a linear array along a survey line at a known separation (typically one metre). A series of recordings (shots) are collected with a known in-line source offset from the array. Each shot gather is represented in the time-offset domain and shows the amplitude of wave propagation through the array (refer to Figure MASW-1). For detailed frequency analysis, multiple records with different shot offset distances are collected to help better define the broad spectrum frequency-phase velocity response of the medium. Two-dimensional cross sections can be collected by moving the geophone array a small distance (typically two meters) along the line and repeating the shots at set offsets.

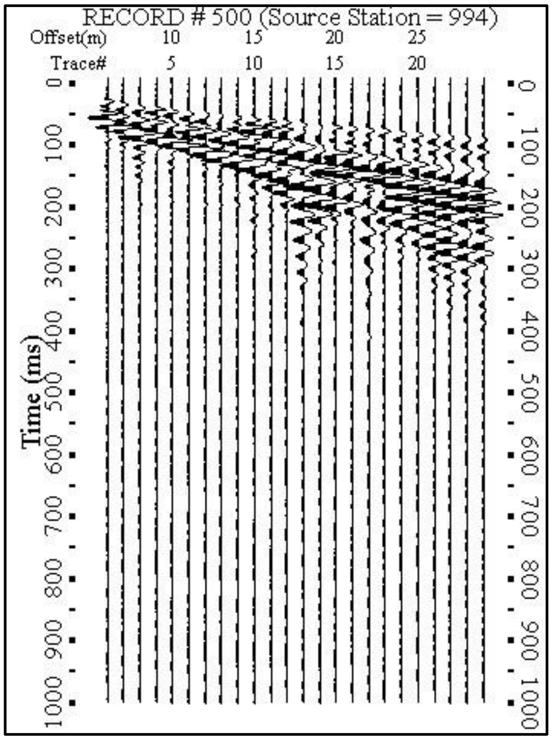


Figure MASW-1. Typical MASW time domain record (shot gather)

Given that surface wave velocity is closely related to the shear wave velocity and the wavelength related to depth, the surface wave results can be used to develop a profile of shear wave velocity versus depth through a process referred to as inversion. The program used to perform the inversion is SurfSeis 6.6, developed by the Kansas Geological Survey. In SurfSeis, the raw time domain traces are transformed to the frequency domain to create what is referred to as an overtone image as shown in Figure MASW-2. The overtone image displays the amplitude of the primary surface wave mode and any potential higher modes. A dispersion curve is fitted to the overtone image, and the inversion process is then used to determine the most appropriate shear wave velocity profile. The parameters used for the inversion of the dispersion data are provided in the data release folder in an Excel table.

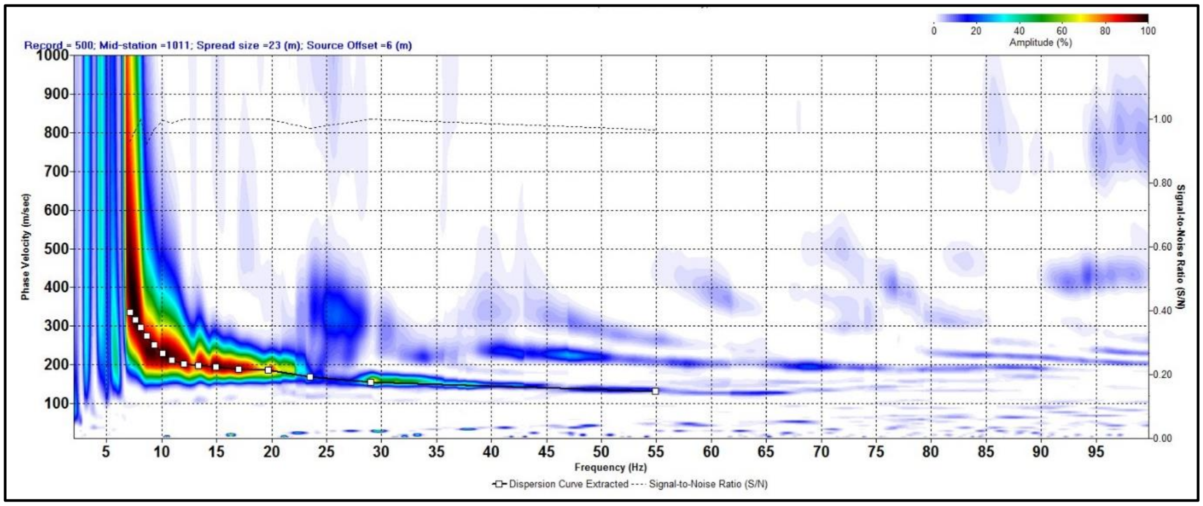


Figure MASW-2. Overtone image and a picked dispersion curve

For each test location, a 1D shear wave velocity profile comprising of a number of velocity layers of variable thickness (refer to Figure MASW-3) is provided. For 2D testing a series of 1D tests are combined to produce a shear wave velocity cross section.

The depth of investigation is related to the ground conditions and the amount of energy delivered by the surface wave source. The surface wave method uses Rayleigh waves that travel horizontally along the ground surface to a depth of about one wavelength. The actual depth of sampling of the ground is considered to be one-half to one-third of the Rayleigh (surface) wave wavelength. The wavelengths measured by the equipment will be a function of the frequency of the source and the velocity of the surface waves through the ground. As the depth of investigation increases, there will be less certainty in terms of layer boundaries and velocity values.

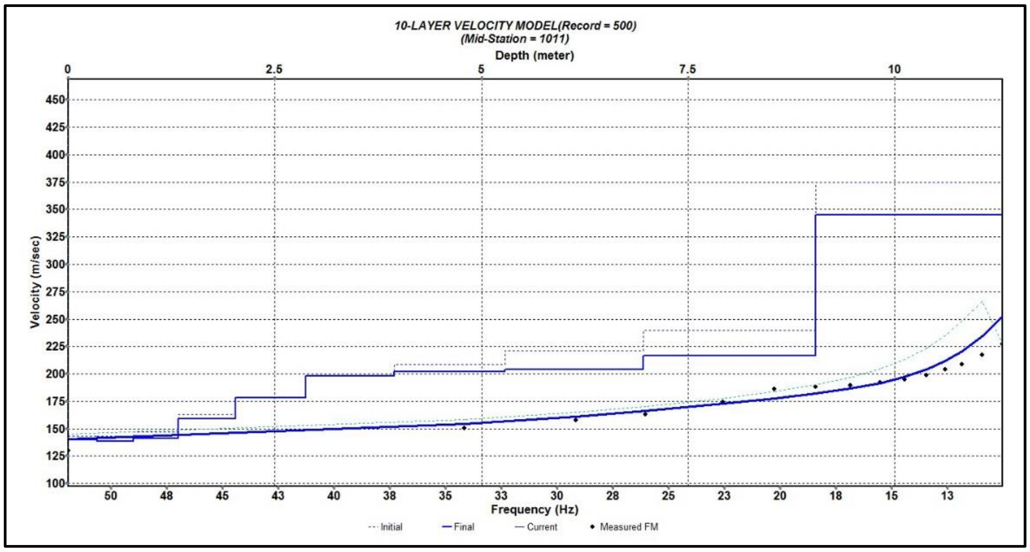


Figure MASW-3. 1D inversion result with fitted dispersion curve

The equipment, field procedures, and analysis software used by ConeTec all conform to the currently accepted best practices for MASW testing. The results of geophysical testing are always interpretative to a certain extent and should be confirmed by drilling or other intrusive testing.

References

Miller, R.D., Xia, J., Park, C.B., and Ivanov, J.M., 1999, Multichannel analysis of surface waves to map bedrock, Kansas Geological Survey, The Leading Edge, December, p. 1392-1396.

Park, C.B., Miller, R.D., and Xia, J., 1998b, Ground roll as a tool to image near-surface anomaly: 68th Ann. Internat. Mtg. Soc. Expl.Geophys., Expanded Abstracts, p. 874-877.

Park, C.B., Miller, R.D., and Xia, J., 1999, Multichannel analysis of surface waves: Geophysics, v. 64, n. 3, pp. 800-808.

Park, C.B., Miller, R.D., Xia, J., and Ivanov, J., 2007, Multichannel analysis of surface waves (MASW)-active and passive methods: The Leading Edge, January.

SurfSeis website: http://www.kgs.ku.edu/software/surfseis/index.html

Xia, J., R.D. Miller, and C.B. Park, 2000a, Advantages of calculating shear-wave velocity from surface waves with higher modes: [Exp. Abs.]: Soc. Expl. Geophys., p. 1295-1298.

Xia, J., Miller, R.D., Park, C.B., and Ivanov, J., 2000b, Construction of 2-D vertical shear-wave velocity field by the Multichannel Analysis of Surface Wave technique, Proceedings of the Symposium on the Application of Geophysics to Engineering and Environmental Problems (SAGEEP 2000), Washington D.C, February 20-24, p. 1197-1206.

Downhole seismic testing (DST) is conducted using a system comprising of a surface source, a downhole tool equipped with a triaxial geophone package, and a data acquisition system.

The downhole tool has a triaxial geophone package mounted on an internal block such that the orientation of the geophones can be maintained within the borehole through the use of the built in fluxgate compass and servo motor system. A motor driven bow spring clamp is used to couple the downhole tool with the borehole wall. The downhole seismic test equipment is in general accordance with the current ASTM D7400 standard.

Shear waves (Vs) are typically generated by using an impact hammer horizontally striking a beam that is held in place by a normal load while compression waves (Vp) are typically generated by using an impact hammer vertically striking a metal plate. The hammer and beam (or plate) act as a contract trigger that initiates the recording of the seismic wave traces. The beam is generally struck on each end to generate horizontally polarized shear waves. The traces are recorded using an uphole data acquisition system. An illustration of the downhole seismic testing configuration is presented in Figure DHS-1.

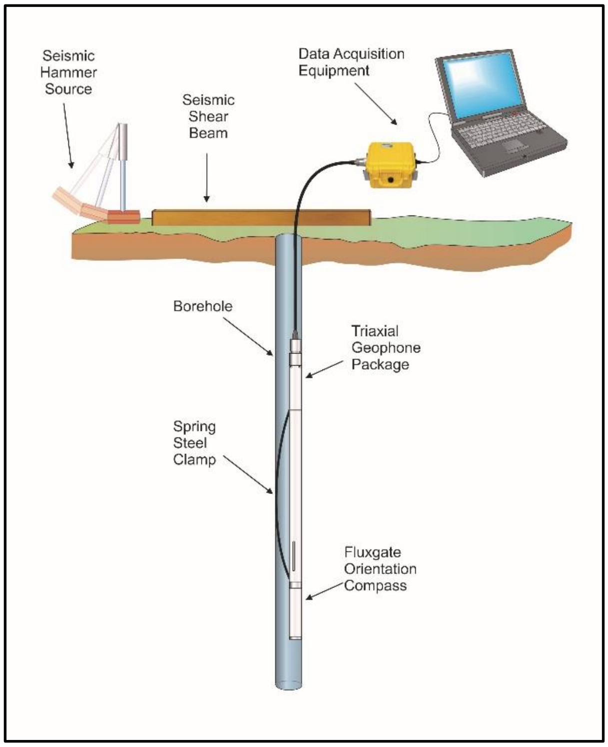


Figure DHS-1. Typical downhole seismic testing equipment

Prior to conducting downhole seismic testing, the horizontal offset between the borehole and seismic source is measured and recorded.

Testing is performed by lowering the tool into a cased borehole to the initial start depth where it is coupled to the side of the casing using the spring clamp. The two horizontal geophones are aligned parallel and perpendicular to the shear wave source. Doing so maintains the same orientation of the geophones throughout the test, which eliminates any apparent phase changes due to rotation of the tool.

Multiple wave traces are recorded and reviewed on the data acquisition computer. Once sufficient data has been recorded, the tool is lowered to the next depth by a set increment (typically one meter) and the procedures are repeated. Test procedures are in general accordance with the current ASTM D7400 standard.

Determination of interval travel times are performed by visually picking a common feature (e.g. the first characteristic peak, trough, or crossover) on all of the recorded wave sets. The velocity can then be determined by taking the difference in ray path divided by the interval travel time. The ray path is defined as the straight line distance from the seismic source to the geophone; accounting for the source offset and source depth. Alternatively, the velocity can be determined by calculating the slope of the accumulated travel time – ray path data. This is normally done on a 3 or 5 point basis using linear least squares regression (Arsenault et al. (2012)). Doing so also allows for the calculation of the standard error which provides a qualitative indication of the velocity uncertainty determined from linear least squares regression.

A summary of the testing performed and the seismic wave velocity data, presented in tabular and graphical format is provided in the relevant appendix. Images of the time domain traces used for the shear wave and compression wave picks are presented for reference in an additional appendix. The traces provide a visual representation of the seismic data and an indication of the data quality.

References

ASTM D7400/D7400M-19, 2019, "Standard Test Methods for Downhole Seismic Testing", ASTM International, West Conshohocken, PA. DOI: 10.1520/D7400_D7400M-19.

Arsenault, J.-L., Hunter, J.A. and Crow, H.L., 2012. Shear Wave Velocity Logs From Vertical Seismic Profiles; *in* Shear Wave Velocity Measurement Guidelines for Canadian Seismic Site Characterization in Soil and Rock, (ed.) J.A. Hunter and H.L. Crow; Geological Survey of Canada, Open File 7078, p.123-138.

The appendices listed below are included in the report:

- 2D MASW Test Summary and Profiles
- MASW Time Domain Traces and Overtone Images
- DST Summary and Results
- DST Time Domain Traces

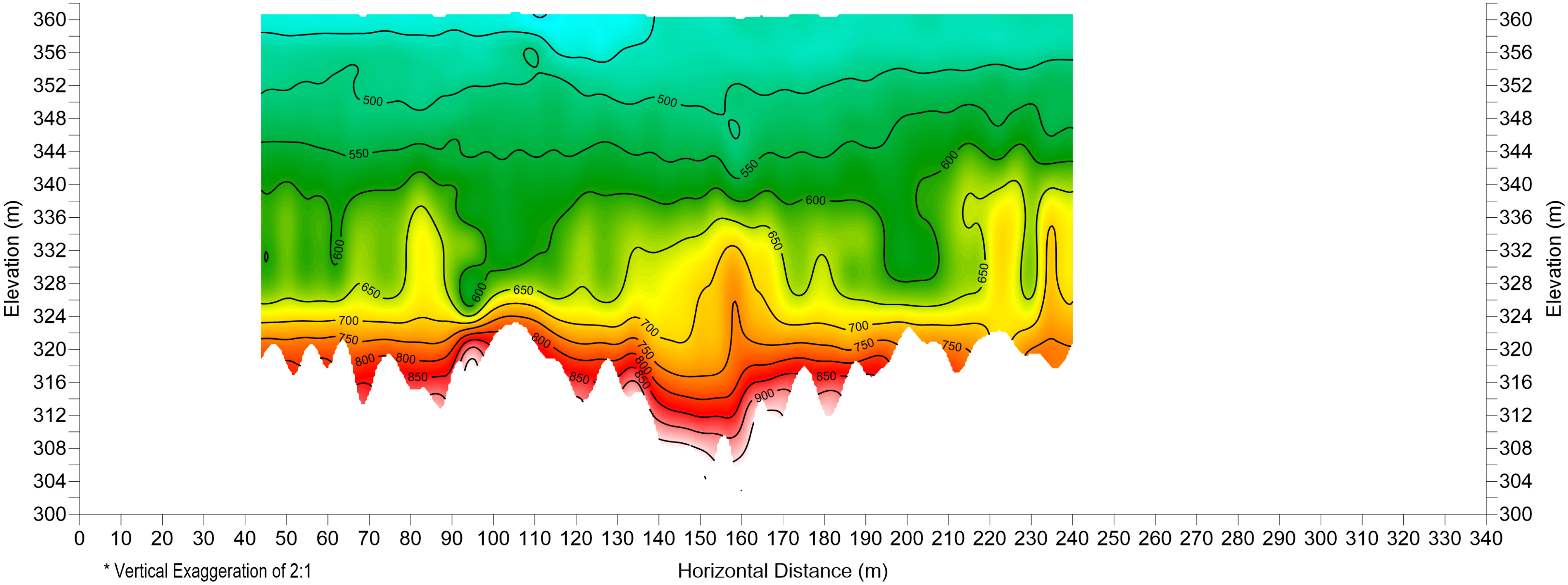
2D MASW Test Summary and Profiles

Job No: 19-0204607
Client: Wood PLC
Project: Myra Falls Investigation
Start Date: 25-Nov-2019
End Date: 01-Dec-2019

2D MASW TEST SUMMARY

Section ID	Location	Date(s)	Geophone Spacing (m)	Line Length (m)	Start of Section Northing[1] (m)	Start of Section Easting (m)	End of Section Northing (m)	End of Section Easting (m)	Refer to Notation Number
MASW19-01	Drill Bench	25-Nov-2019, 26-Nov-2019	2	286	5494646	311747	5494685	312030	2
MASW19-02	Dam Face	27-Nov-2019, 28-Nov-2019	2	334	5494611	311748	5494650	312046	2

1. Coordinates were provided by Mifflin Surveys and are referenced to NAD83 datum, UTM Zone 10 North projection.
2. Elevations were provided by Mifflin Surveys.



* Vertical Exaggeration of 2:1

wood.

Myra Falls Investigation

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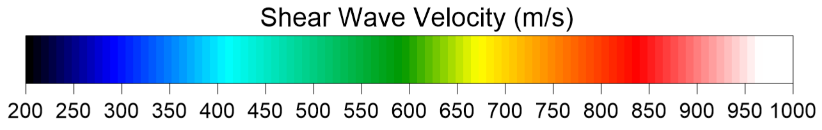
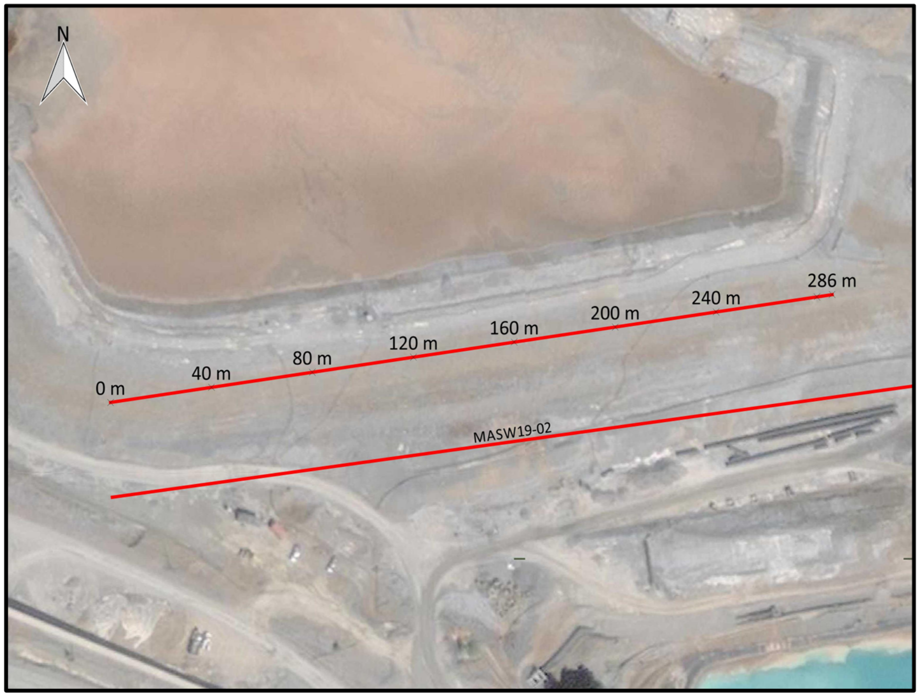
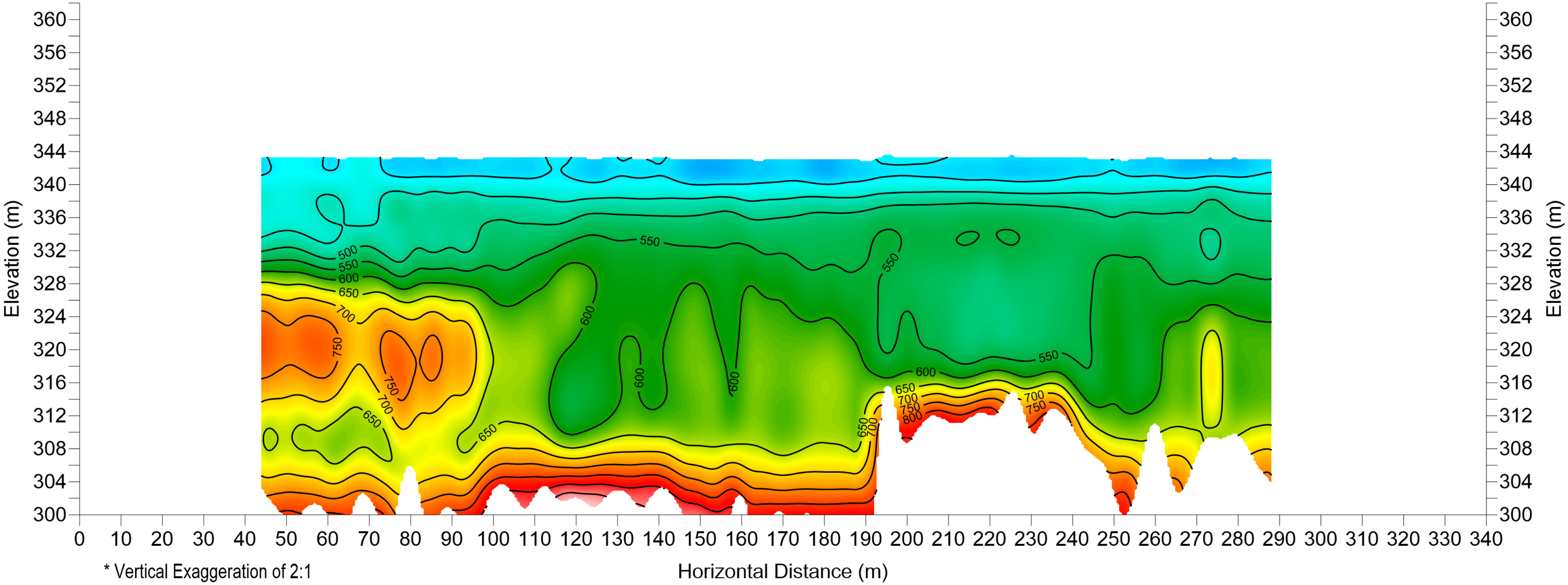
FIGURE 1
MASW19-01: 44 to 240 m

INFORMATION TABLE	
HORIZONTAL DATUM	NAD 83
PROJECTION	UTM Zone 10 North
VERTICAL REFERENCE	Client Provided Elevation
DATE(S) ISSUED / REVISED	16-DEC-2019
SURVEY DATE(S)	25-NOV-2019 to 26-NOV-2019
CONETEC JOB NUMBER	19-0204607







* Vertical Exaggeration of 2:1

wood.

Myra Falls Investigation

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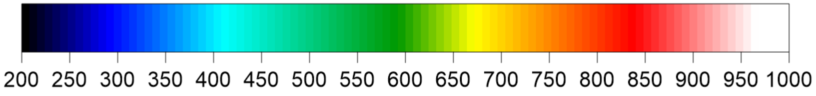
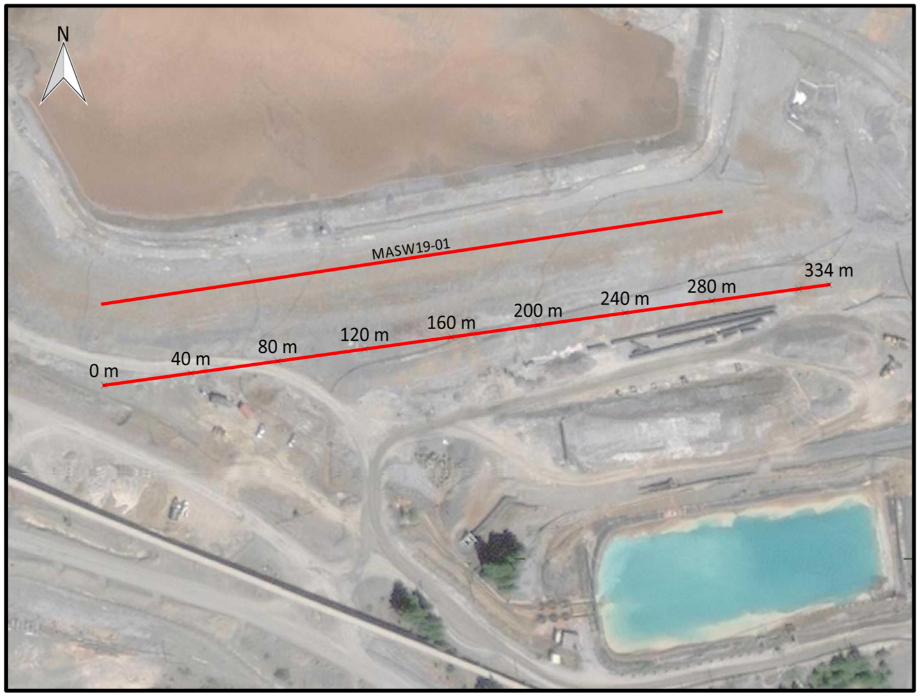
FIGURE 2

MASW19-02: 44 to 288 m

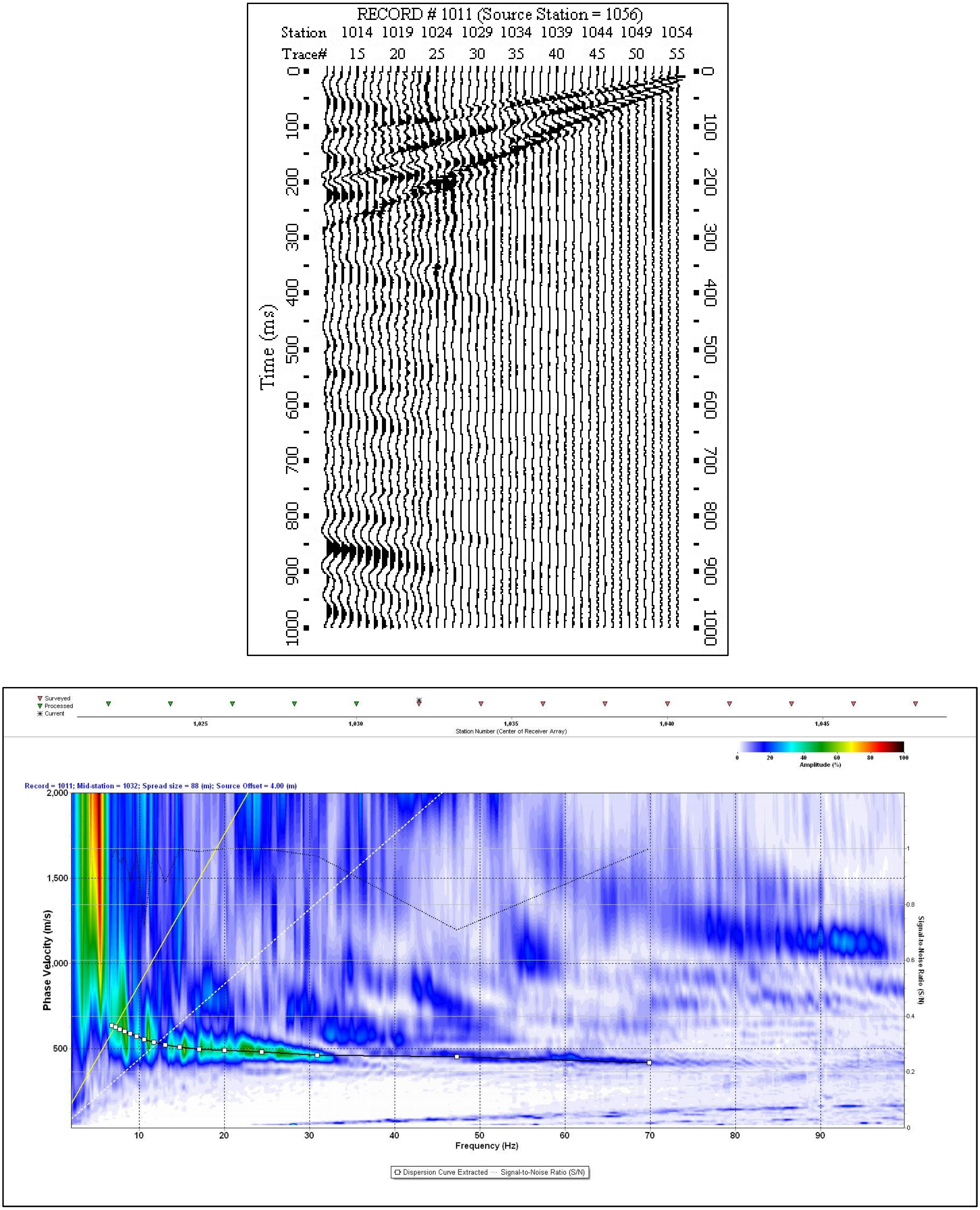
INFORMATION TABLE	
HORIZONTAL DATUM	NAD 83
PROJECTION	UTM Zone 10 North
VERTICAL REFERENCE	Client Provided Elevation
DATE(S) ISSUED / REVISED	16-DEC-2019
SURVEY DATE(S)	27-NOV-2019 to 28-NOV-2019
CONETEC JOB NUMBER	19-0204607

Shear Wave Velocity (m/s)

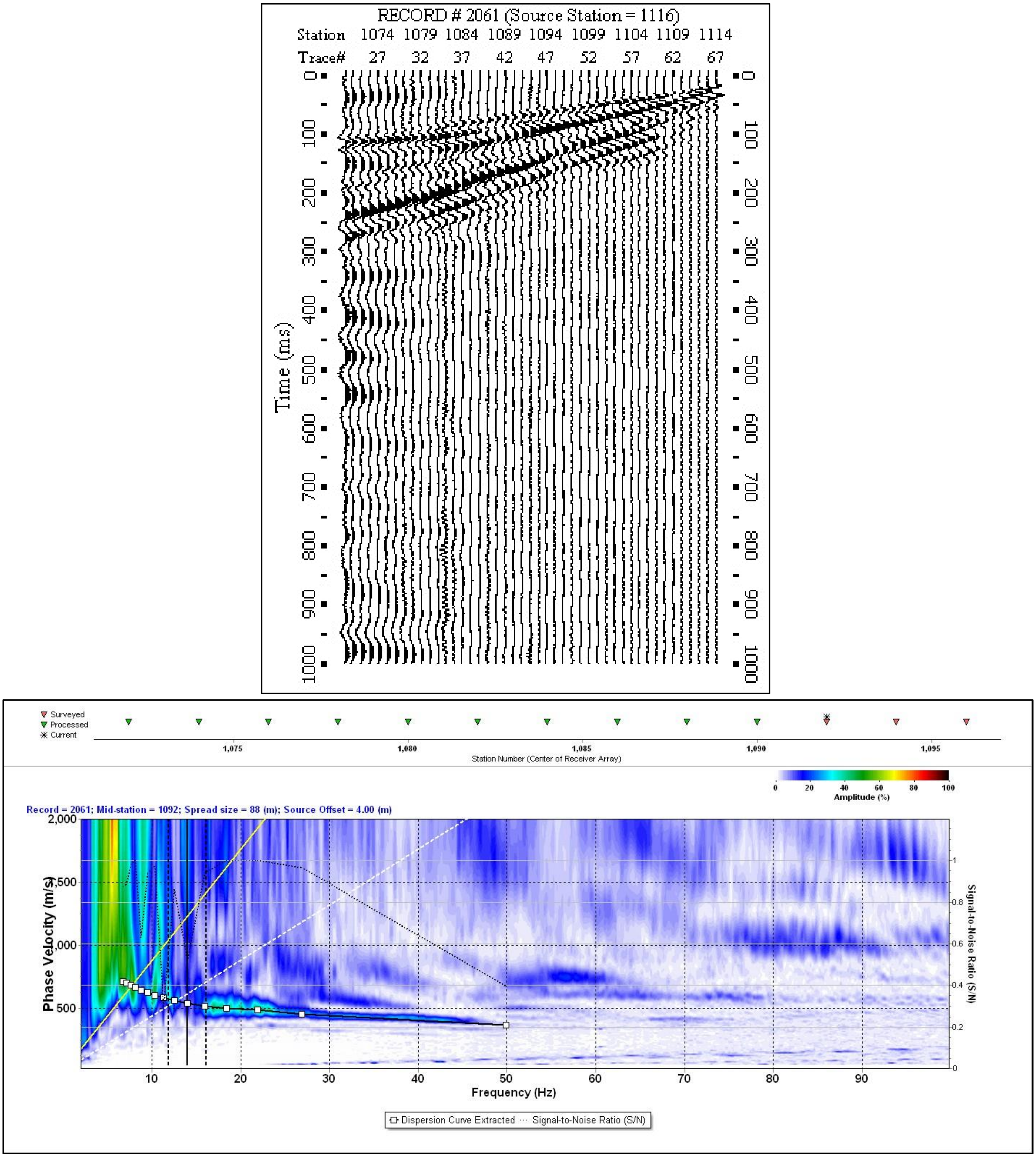




MASW Time Domain Traces and Overtone Images



MASW19-01: example time domain trace (top) and overtone image with picked dispersion curve (bottom).



MASW19-02: example time domain trace (top) and overtone image with picked dispersion curve (bottom).

DST Summary and Results

Job No: 19-0204607
Client: Wood PLC
Project: Myra Falls Investigation
Start Date: 25-Nov-2019
End Date: 01-Dec-2019

DOWNHOLE SEISMIC SUMMARY

Sounding ID	Location	Date	Final Depth (m)	Northing[1] (m)	Easting[1] (m)	Elevation[2] (m)	Refer to Notation Number
DST19-01	BH19-02	29-Nov-2019	38.25	5494655.6	311729.7	362.4	
DST19-02	BH19-03	01-Dec-2019	38.30	5494650.7	311805.5	362.4	

1. Coordinates were provided by Mifflin Surveys and are referenced to NAD83 datum, UTM Zone 10 North projection.
2. Elevations were provided by Mifflin Surveys and are referenced to the existing ground surface at the time of testing.

Job No: 19-0204607
Client: Wood PLC
Project: Myra Falls Investigation
Sounding ID: BH19-02
Date: 29-Nov-2019

Receivers: Geostuff BHG-3 - Triaxial 15 Hz geophones
Seismograph: Geometrics Geode
Seismic Source: Beam
Source Offset (m): 0.70
Source Depth (m): 0.00
Geophone Offset (m): 0.00

DOWNHOLE SEISMIC SHEAR WAVE VELOCITY TEST RESULTS - Vs

Geophone Depth (m)	Ray Path (m)	Ray Path Difference (m)	Travel Time Interval (ms)	Interval Velocity (m/s)	Average Interval Depth (m)
2.75	2.84				
3.68	3.75	0.91	1.78	511	3.2
4.75	4.80	1.06	2.28	464	4.2
6.75	6.79	1.98	3.99	498	5.8
7.75	7.78	1.00	2.05	486	7.3
8.75	8.78	1.00	2.20	454	8.3
10.75	10.77	1.99	3.64	548	9.8
11.75	11.77	1.00	1.71	584	11.3
13.75	13.77	2.00	3.38	592	12.8
14.75	14.77	1.00	1.91	522	14.3
15.75	15.77	1.00	1.84	543	15.3
16.25	16.27	0.50	0.86	578	16.0
16.75	16.76	0.50	0.65	774	16.5
17.25	17.26	0.50	0.62	799	17.0
18.25	18.26	1.00	1.35	740	17.8
18.75	18.76	0.50	0.67	743	18.5
19.25	19.26	0.50	0.64	784	19.0
19.75	19.76	0.50	0.60	831	19.5
20.25	20.26	0.50	0.63	799	20.0
20.75	20.76	0.50	0.71	706	20.5
21.25	21.26	0.50	0.73	686	21.0
21.75	21.76	0.50	0.73	686	21.5
22.25	22.26	0.50	0.73	680	22.0
23.25	23.26	1.00	1.35	739	22.8
24.75	24.76	1.50	2.41	621	24.0

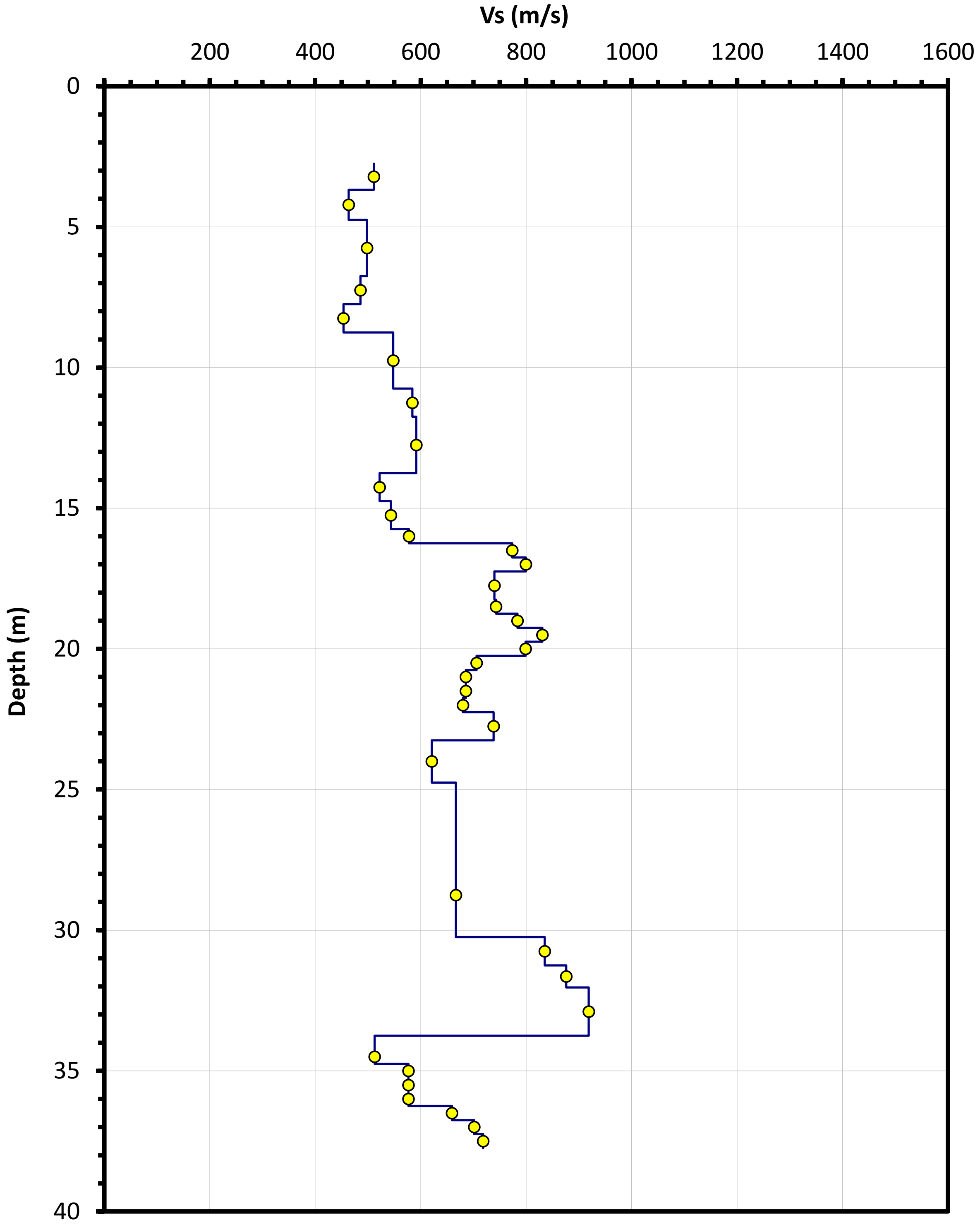
Job No:	19-0204607
Client:	Wood PLC
Project:	Myra Falls Investigation
Sounding ID:	BH19-02
Date:	29-Nov-2019

Receivers:	Geostuff BHG-3 - Triaxial 15 Hz geophones
Seismograph:	Geometrics Geode
Seismic Source:	Beam
Source Offset (m):	0.70
Source Depth (m):	0.00
Geophone Offset (m):	0.00

DOWNHOLE SEISMIC SHEAR WAVE VELOCITY TEST RESULTS - Vs

Geophone Depth (m)	Ray Path (m)	Ray Path Difference (m)	Travel Time Interval (ms)	Interval Velocity (m/s)	Average Interval Depth (m)
30.25	30.26	3.00	4.50	667	28.8
31.25	31.26	1.00	1.20	836	30.8
32.04	32.05	0.79	0.90	876	31.6
33.75	33.76	1.71	1.86	919	32.9
34.75	34.76	0.50	0.98	513	34.5
35.25	35.26	0.50	0.87	577	35.0
35.75	35.76	0.50	0.87	577	35.5
36.25	36.26	0.50	0.87	577	36.0
36.75	36.76	0.50	0.76	659	36.5
37.25	37.26	0.50	0.71	702	37.0
37.75	37.76	0.50	0.70	718	37.5

Job No: 19-0204607
Client: Wood PLC
Project: Myra Falls Investigation
Sounding ID: BH19-02
Date: 29-Nov-2019



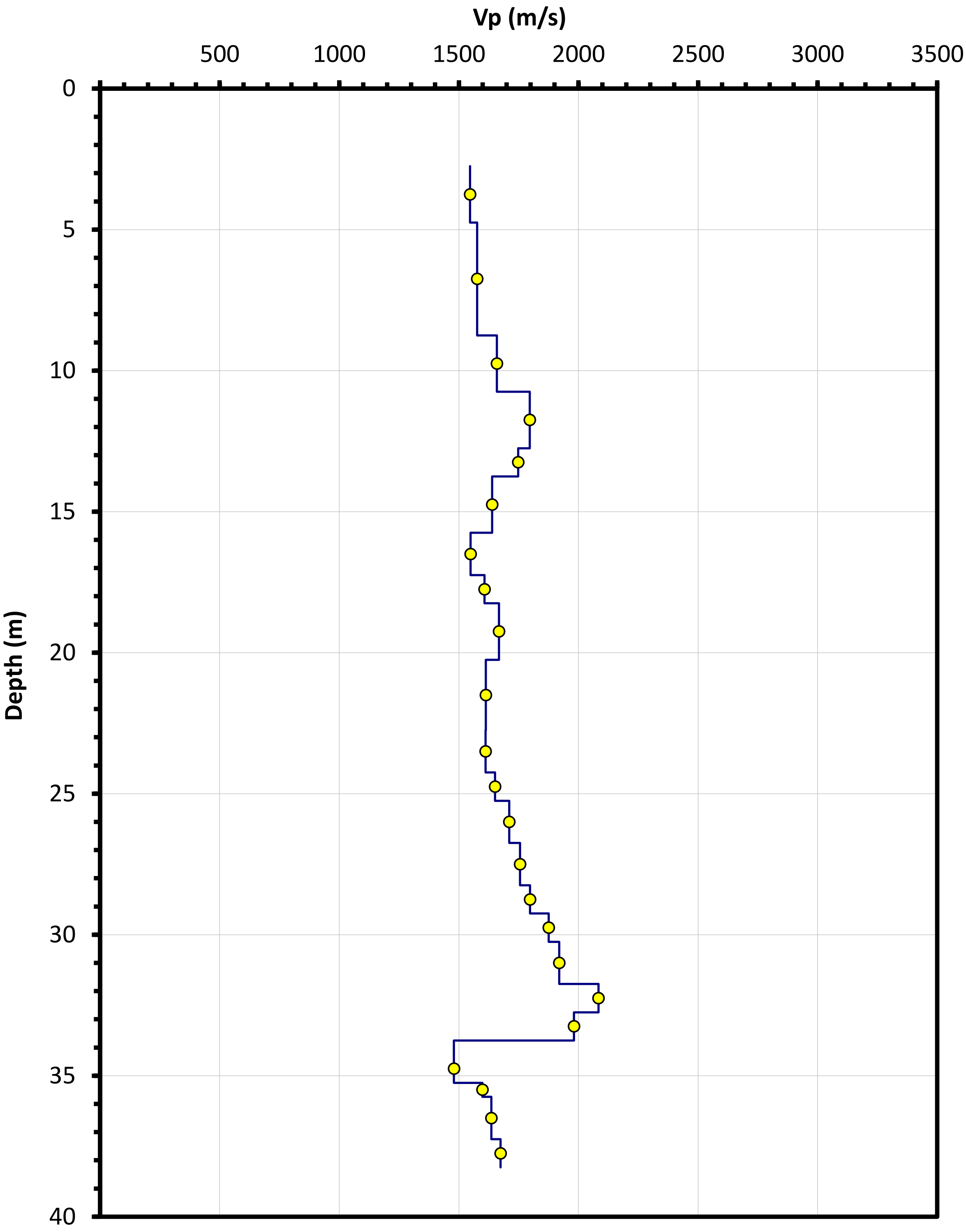
Job No: 19-0204607
Client: Wood PLC
Project: Myra Falls Investigation
Sounding ID: BH19-02
Date: 29-Nov-2019

Receivers: Geostuff BHG-3 - Triaxial 15 Hz geophones
Seismograph: Geometrics Geode
Seismic Source: Plate
Source Offset (m): 1.85
Source Depth (m): 0.00
Geophone Offset (m): 0.00

DOWNHOLE SEISMIC COMPRESSION WAVE VELOCITY TEST RESULTS - Vp

Geophone Depth (m)	Ray Path (m)	Ray Path Difference (m)	Travel Time Interval (ms)	Interval Velocity (m/s)	Average Interval Depth (m)
2.75	3.31				
4.75	5.10	1.78	1.15	1546	3.8
8.75	8.94	3.85	2.44	1577	6.8
10.75	10.91	1.96	1.18	1659	9.8
12.75	12.88	1.98	1.10	1796	11.8
13.75	13.87	0.99	0.57	1748	13.3
15.75	15.86	1.98	1.21	1639	14.8
17.25	17.35	1.49	0.96	1549	16.5
18.25	18.34	0.99	0.62	1607	17.8
20.25	20.33	1.99	1.19	1668	19.3
22.75	22.83	2.49	1.54	1612	21.5
24.25	24.32	1.50	0.93	1612	23.5
25.25	25.32	1.00	0.60	1651	24.8
26.75	26.81	1.50	0.87	1710	26.0
28.25	28.31	1.50	0.85	1756	27.5
29.25	29.31	1.00	0.56	1797	28.8
30.25	30.31	1.00	0.53	1876	29.8
31.75	31.80	1.50	0.78	1919	31.0
32.75	32.80	1.00	0.48	2084	32.3
33.75	33.80	1.00	0.50	1981	33.3
35.25	35.30	1.00	0.68	1479	34.8
35.75	35.80	0.50	0.31	1598	35.5
37.25	37.30	1.50	0.92	1636	36.5
38.25	38.29	1.00	0.60	1674	37.8

Job No: 19-0204607
Client: Wood PLC
Project: Myra Falls Investigation
Sounding ID: BH19-02
Date: 29-Nov-2019



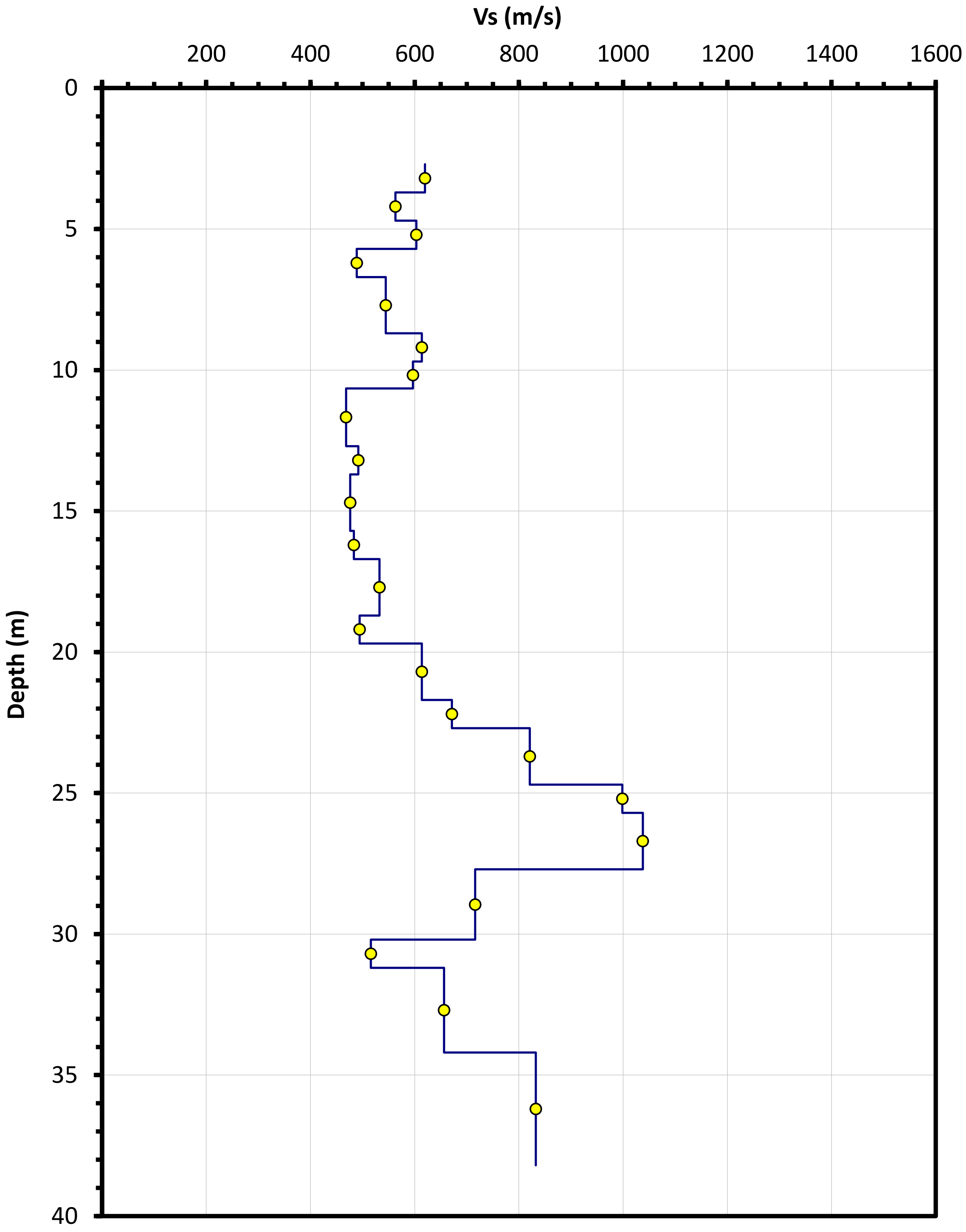
Job No: 19-0204607
Client: Wood PLC
Project: Myra Falls Investigation
Sounding ID: BH19-03
Date: 01-Dec-2019

Receivers: Geostuff BHG-3 - Triaxial 15 Hz geophones
Seismograph: Geometrics Geode
Seismic Source: Beam
Source Offset (m): 0.80
Source Depth (m): 0.00
Geophone Offset (m): 0.00

DOWNHOLE SEISMIC SHEAR WAVE VELOCITY TEST RESULTS - Vs

Geophone Depth (m)	Ray Path (m)	Ray Path Difference (m)	Travel Time Interval (ms)	Interval Velocity (m/s)	Average Interval Depth (m)
2.70	2.82				
3.70	3.79	0.97	1.56	620	3.2
4.70	4.77	0.98	1.74	563	4.2
5.70	5.76	0.99	1.64	603	5.2
6.70	6.75	0.99	2.03	489	6.2
8.70	8.74	1.99	3.65	544	7.7
9.70	9.73	1.00	1.62	613	9.2
10.65	10.68	0.95	1.59	597	10.2
12.70	12.73	2.05	4.37	468	11.7
13.70	13.72	1.00	2.03	492	13.2
15.70	15.72	2.00	4.20	476	14.7
16.70	16.72	1.00	2.07	483	16.2
18.70	18.72	2.00	3.75	532	17.7
19.70	19.72	1.00	2.02	494	19.2
21.70	21.71	2.00	3.26	614	20.7
22.70	22.71	1.00	1.49	671	22.2
24.70	24.71	2.00	2.43	821	23.7
25.70	25.71	1.00	1.00	998	25.2
27.70	27.71	2.00	1.93	1038	26.7
30.20	30.21	2.50	3.49	716	29.0
31.20	31.21	1.00	1.94	516	30.7
34.20	34.21	3.00	4.57	657	32.7
38.20	38.21	4.00	4.81	832	36.2

Job No:	19-0204607
Client:	Wood PLC
Project:	Myra Falls Investigation
Sounding ID:	BH19-03
Date:	1-Dec-2019



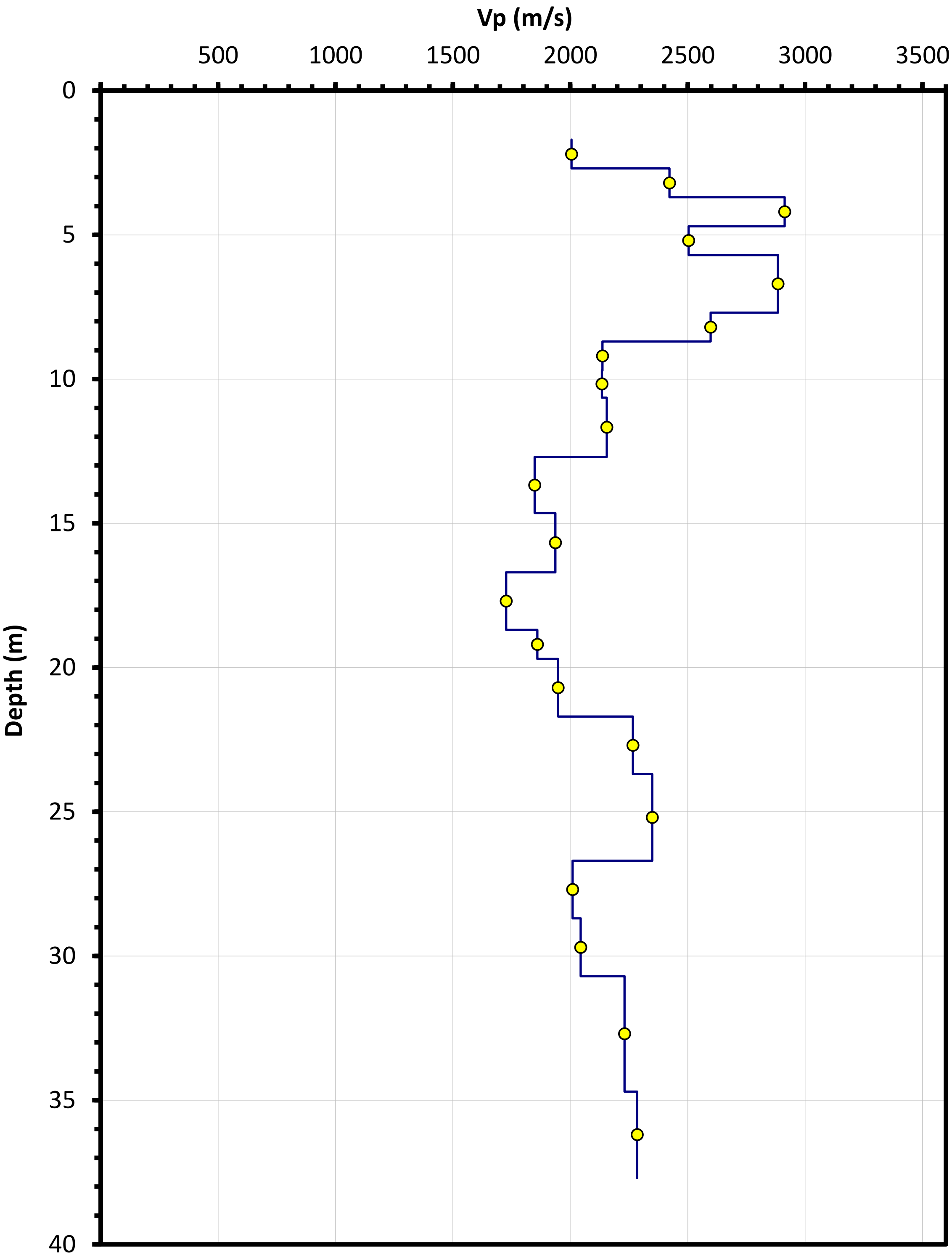
Job No: 19-0204607
Client: Wood PLC
Project: Myra Falls Investigation
Sounding ID: BH19-03
Date: 01-Dec-2019

Receivers: Geostuff BHG-3 - Triaxial 15 Hz geophones
Seismograph: Geometrics Geode
Seismic Source: Plate
Source Offset (m): 1.90
Source Depth (m): 0.00
Geophone Offset (m): 0.00

DOWNHOLE SEISMIC COMPRESSION WAVE VELOCITY TEST RESULTS - Vp

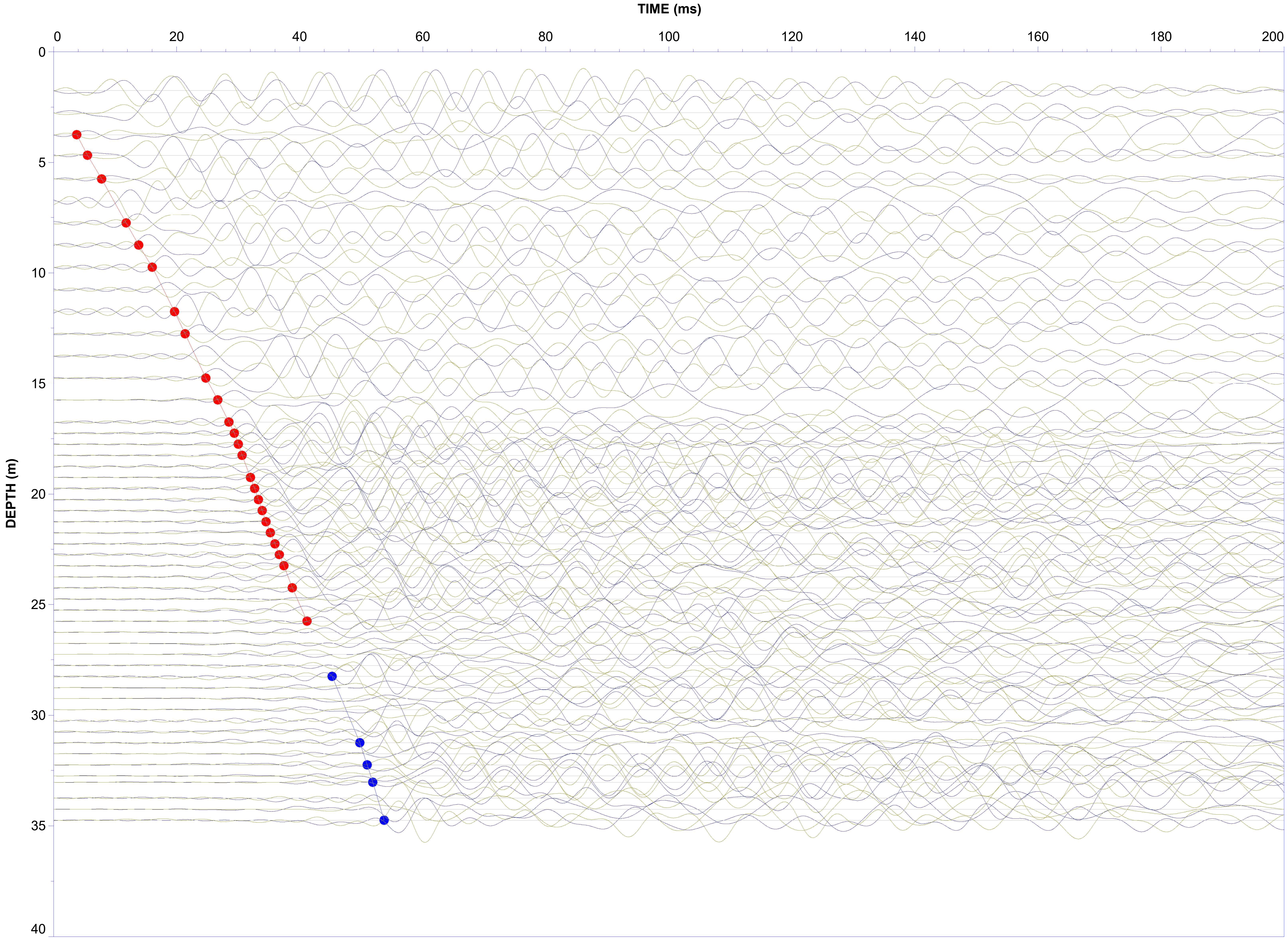
Geophone Depth (m)	Ray Path (m)	Ray Path Difference (m)	Travel Time Interval (ms)	Interval Velocity (m/s)	Average Interval Depth (m)
1.70	2.55				
2.70	3.30	0.75	0.37	2006	2.2
3.70	4.16	0.86	0.35	2422	3.2
4.70	5.07	0.91	0.31	2913	4.2
5.70	6.01	0.94	0.37	2504	5.2
7.70	7.93	1.92	0.67	2884	6.7
8.70	8.91	0.97	0.37	2598	8.2
9.70	9.88	0.98	0.46	2137	9.2
10.65	10.82	0.93	0.44	2135	10.2
12.70	12.84	2.02	0.94	2156	11.7
14.65	14.77	1.93	1.05	1848	13.7
16.70	16.81	2.04	1.05	1936	15.7
18.70	18.80	1.99	1.15	1727	17.7
19.70	19.79	1.00	0.54	1860	19.2
21.70	21.78	1.99	1.02	1948	20.7
23.70	23.78	1.99	0.88	2267	22.7
26.70	26.77	2.99	1.27	2349	25.2
28.70	28.76	2.00	0.99	2009	27.7
30.70	30.76	2.00	0.98	2044	29.7
34.70	34.75	3.99	1.79	2231	32.7
37.70	37.75	3.00	1.31	2284	36.2

Job No: 19-0204607
Client: Wood PLC
Project: Myra Falls Investigation
Sounding ID: BH19-03
Date: 1-Dec-2019

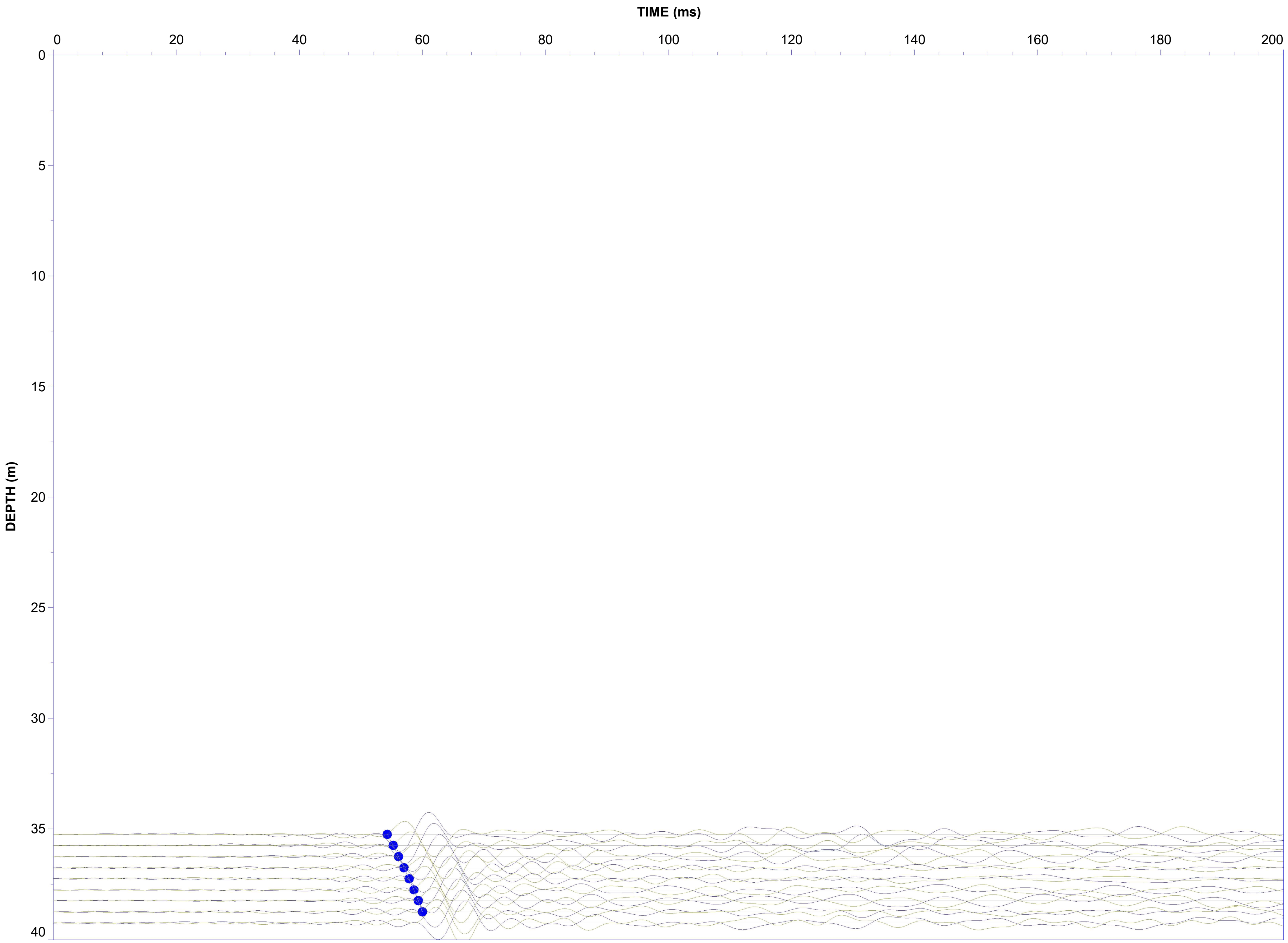


DST Time Domain Traces

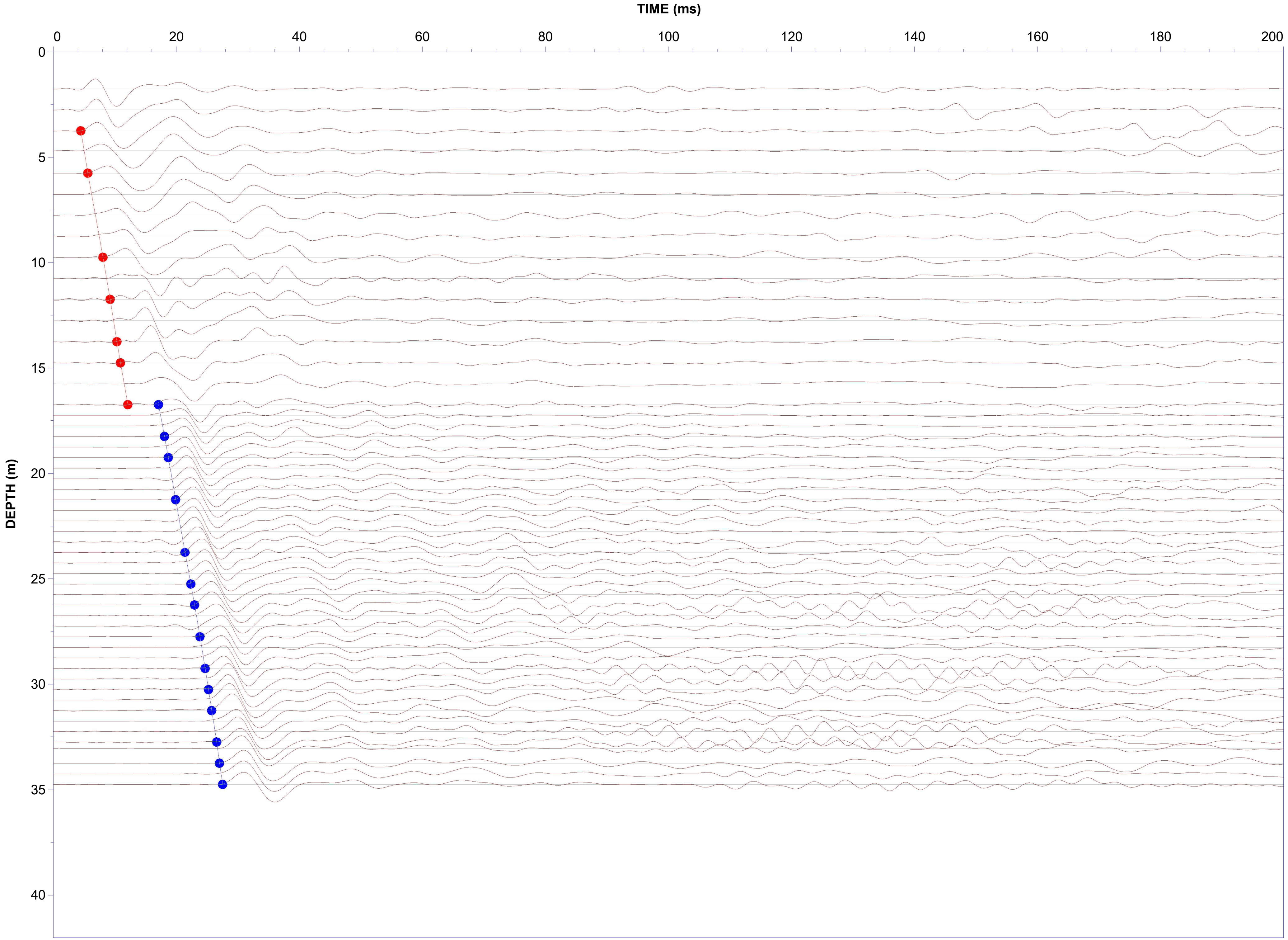
Job No: 19-0204607 | Client: Wood PLC | Project: Myra Falls | Geo Y Filter: 0 - 160 Hz Bandpass | Hole: BH19-02 | Date: 2019-11-29



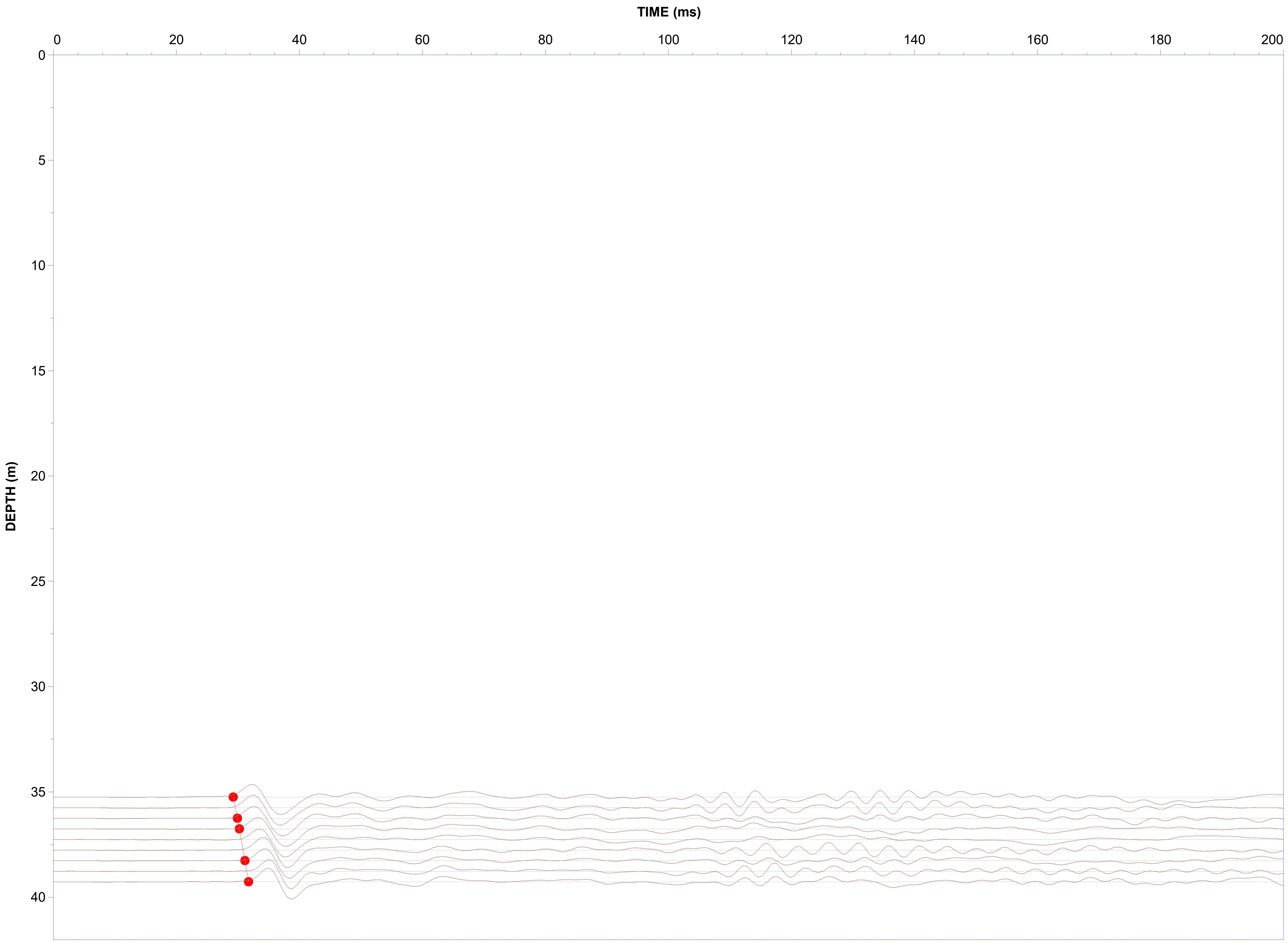
Job No: 19-0204607 Client: Wood PLC Project: Myra Falls Geo Y Filter: 0 - 160 Hz Bandpass Hole: BH19-02 Date: 2019-11-29



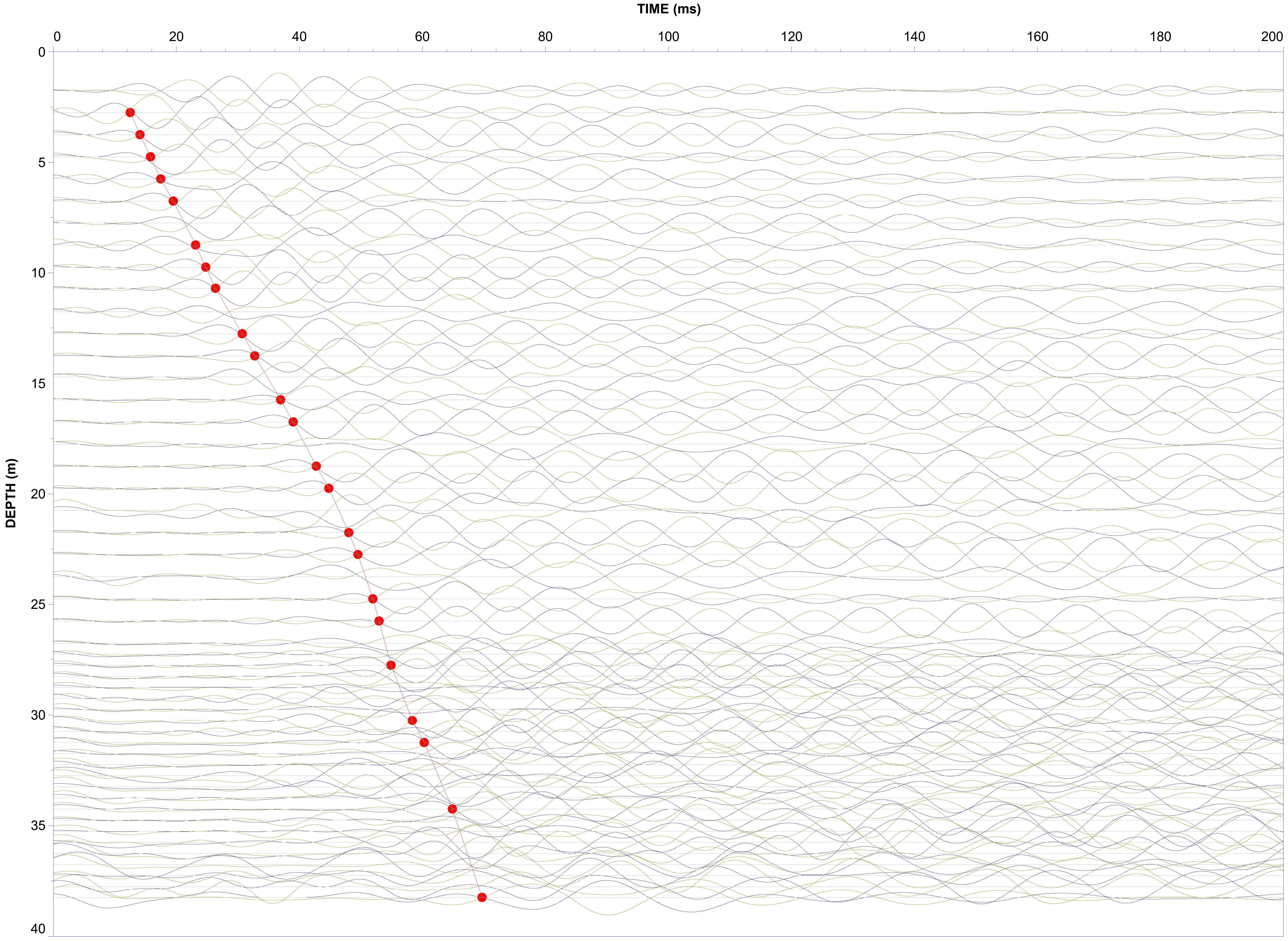
Job No: 19-0204607 | Client: Wood PLC | Project: Myra Falls | Geo Z Filter: 0 - 250 Hz Bandpass | Hole: BH19-02 | Date: 2019-11-29



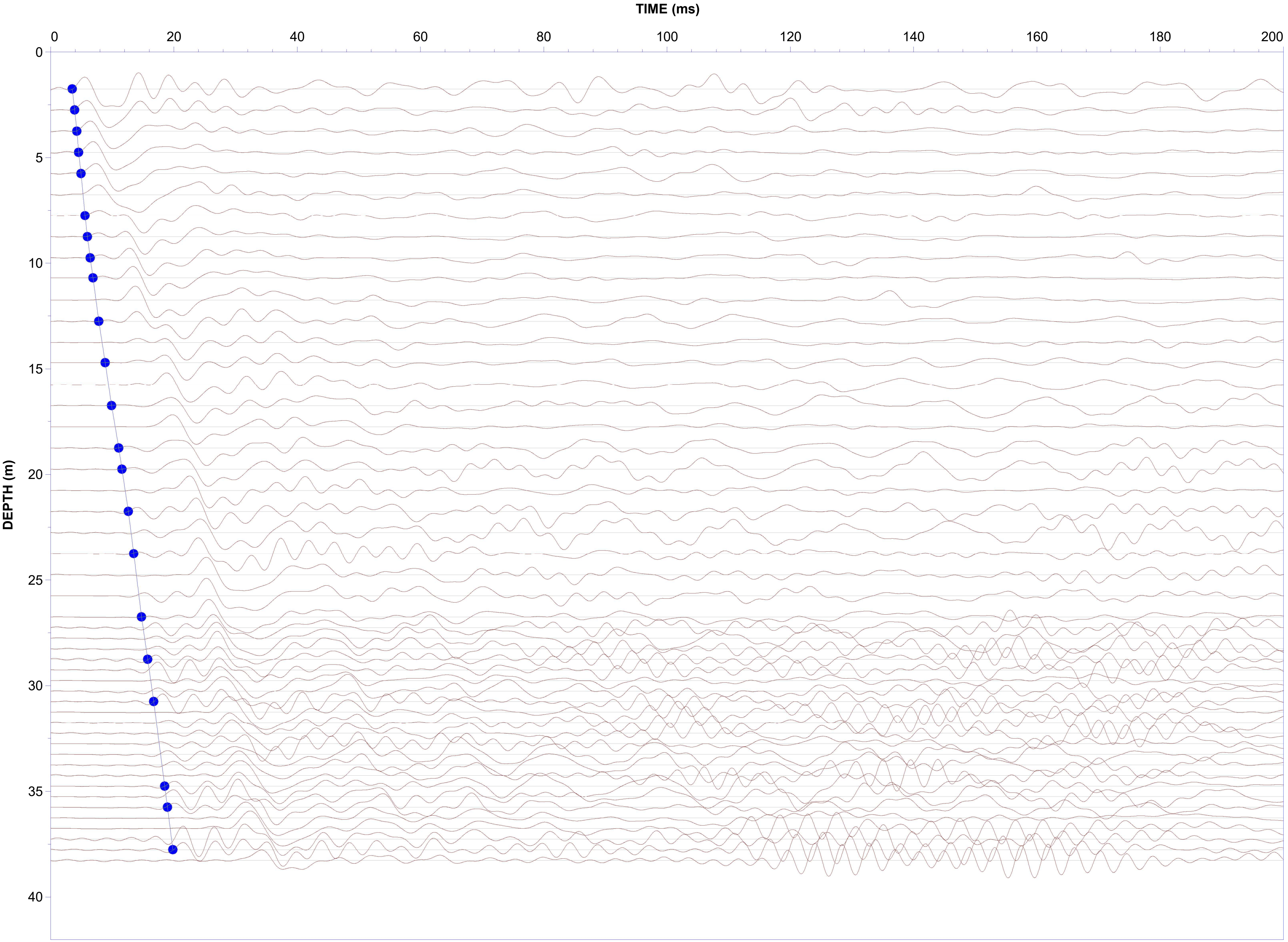
Job No: 19-0204607 Client: Wood PLC Project: Myra Falls Geo Z Filter: 0 - 250 Hz Bandpass Hole: BH19-02 Date: 2019-11-29



Job No: 19-0204607 Client: Wood Project: Myra Falls Geo X Filter: 0 - 90 Hz Bandpass Hole: BH19-03 Date: 2019-12-01



CONETEC Job No: 19-0204607 Client: Wood PLC Project: Myra Falls Geo Z Filter: 0 - 250 Hz Bandpass Hole: BH19-03 Date: 2019-12-01



Appendix C – Borehole Logs

EXPLANATION OF TERMS AND SYMBOLS

The terms and symbols used on the borehole logs to summarize the results of field investigation and subsequent laboratory testing are described in these pages.

It should be noted that materials, boundaries and conditions have been established only at the borehole locations at the time of investigation and are not necessarily representative of subsurface conditions elsewhere across the site.

TEST DATA

Data obtained during the field investigation and from laboratory testing are shown at the appropriate depth interval.

Abbreviations, graphic symbols, and relevant test method designations are as follows:

*C	Consolidation Test	TV	Torvane shear strength
D_R	Relative Density	VS	Vane shear strength
*k	Permeability coefficient	w	Natural Moisture Content (ASTM D2216)
*MA	Mechanical grain size analysis and hydrometer test	wl	Liquid Limit (ASTM D 423)
		w_p	Plastic Limit (ASTM D 424)
N	Standard Penetration Test (CSA A119.1-60)	Ef	Unit strain at failure
		γ	Unit weight of soil or rock
N_d	Dynamic cone penetration test	γd	Dry unit weight of soil or rock
NP	Non plastic soil	ρ	Density of soil or rock
Pp	Pocket penetrometer strength	ρd	Dry Density of soil or rock
*q	Triaxial compression test	C_u	Undrained shear strength
q_u	Unconfined compressive strength	→	Seepage
*SB	Shearbox test	▼	Observed water level
SO_4	Concentration of water-soluble sulphate	▽	Water level at completion of drilling

* The results of these tests are usually reported separately

Soils are classified and described according to their engineering properties and behaviour.

The soil of each stratum is described using the Unified Soil Classification System[1] modified slightly so that an inorganic clay of "medium plasticity" is recognized.

The modifying adjectives used to define the actual or estimated percentage range by weight of minor components are consistent with the Canadian Foundation Engineering Manual[2].

Relative Density and Consistency:

Cohensionless Soils		**Cohesive Soils**		
Relative Density	SPT (N) Value	Consistency	Undrained Shear Strength c_u (kPa)	**Approximate SPT (N) Value**
Very Loose	0-4	Very Soft	0-12	**0-2**
Loose	4-10	Soft	12-25	**2-4**
Compact	10-30	Firm	25-50	**4-8**
Dense	30-50	Stiff	50-100	**8-15**
Very Dense	>50	Very Stiff	100-200	**15-30**
		Hard	**>200**	**>30**

Standard Penetration Resistance ("N" value)
The number of blows by a 63.6kg hammer dropped 760mm to drive a 50 mm diameter open sampler attached to "A" drill rods for a distance of 300 mm after an initial penetration of 150 mm.

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[1] "Unified Soil Classification System", Technical Memorandum 36-357 prepared by Waterways Experiment Station, Vicksburg, Mississippi, Corps Engineers of U.S. Army. Vol. 1 March 1953

[2] "Canadian Foundation Engineering Manual", 4th Edition, Canadian Geotechnical Society, 2006.

MODIFIED UNIFIED SOIL CLASSIFICATION SYSTEM INCLUDING IDENTIFICATION AND DESCRIPTIONS

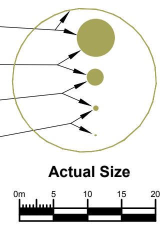
MAJOR DIVISION			TYPICAL DESCRIPTION	LABORATORY CLASSIFICATION CRITERIA	GROUP SYMBOL	GRAPH SYMBOL
COARSE GRAINED SOILS (MORE THAN HALF BY WEIGHT LARGER THAN 75µm)	GRAVELS MORE THAN HALF THE COARSE FRACTION LARGER THAN 4.75mm	CLEAN GRAVEL (TRACE OR NO FINES)	WELL GRADED GRAVEL, GRAVELS - SAND MIXTURES, LITTLE OR NO FINES $C_U = \left(\frac{D_{60}}{D_{10}}\right)$; $C_C = \left(\frac{(D_{30})^2}{D_{10} \times D_{60}}\right)$	$C_U \ge 4$ and $1 \le C_C \le 3$	GW	▨
			POORLY GRADED GRAVELS, GRAVEL- SAND MIXTURES, LITTLE OR NO FINES	NOT MEETING ABOVE REQUIREMENTS	GP	▨
		DIRTY GRAVEL (WITH SOME OR MORE FINES)	SILTY GRAVELS, GRAVEL-SAND-SILT MIXTURES	ATTERBERG LIMITS BELOW "A" LINE OR P.I. LESS THAN 4	GM	▨
			CLAYEY GRAVELS, GRAVEL-SAND- CLAY MIXTURES	ATTERBERG LIMITS ABOVE "A" LINE P.I. MORE THAN 7	GC	▨
	SANDS MORE THAN HALF THE COARSE FRACTION SMALLER THAN 4.75mm	CLEAN SANDS (TRACE OR NO FINES)	WELL GRADED SANDS, GRAVELLY SANDS, LITTLE OR NO FINES	$C_U \ge 4$ and $1 \le C_C \le 3$	SW	▨
			POORLY GRADED SANDS, GRAVELLY SANDS, LITTLE OR NO FINES	NOT MEETING ABOVE REQUIREMENTS	SP	▨
		DIRTY SANDS (WITH SOME OR MORE FINES)	SILTY SANDS, SAND-SILT MIXTURES	ATTERBERG LIMITS BELOW "A" LINE OR P.I. LESS THAN 4	SM	▨
			CLAYEY SANDS, SAND-CLAY MIXTURES	ATTERBERG LIMITS ABOVE "A" LINE P.I. MORE THAN 7	SC	▨
FINE-GRAINED SOILS (MORE THAN HALF BY WEIGHT SMALLER THAN 75µm)		LIQUID LIMIT W_L(%)	HUMAN PLACED MATERIALS (FILL) SHOULD BE DESCRIBED FOR THEIR ENGINEERING PROPERTIES IN ACCORDANCE WITH THE MODIFIED USCS STANDARDS AS IF THEY WERE NATURALLY OCCURRING SOILS		FILL	▨
	SILTS BELOW "A" LINE NEGLIGIBLE ORGANIC CONTENT	W_L< 50%	INORGANIC SILTS AND VERY FINE SANDS, ROCK FLOUR, SILTY SANDS OF SLIGHT PLASTICITY	1. CLASSIFICATION IS BASED UPON PLASTICITY CHART (SEE BELOW). 2. ALL SIEVE SIZES ON THIS SHEET ARE U.S. STANDARD (ASTM E11). 3. IF THE NATURE OF THE FINES HAS NOT BEEN DETERMINED, IT IS DESIGNATED BY THE LETTER "F",(e.g. SF IS A MIXTURE OF SAND WITH SILT OR CLAY). 4. COARSE GRAIN SOILS WITH 5% TO 10% FINES GIVEN COMBINED GROUP SYMBOLS, E.G. GW-GP IS A WELL GRADED OR POORLY GRADED GRAVEL SAND MIXTURE WITH CLAY BINDER BETWEEN 5% AND 10% FINES.	ML	▨
		W_L> 50%	INORGANIC SILTS, MICACEOUS OR DIATOMACEOUS, FINE SANDS OR SILTY SOILS		MH	▨
	CLAYS ABOVE "A" LINE NEGLIGIBLE ORGANIC CONTENT	W_L< 30%	INORGANIC CLAYS OF LOW PLASTICITY, GRAVELLY, SANDY OR SILTY CLAYS, LEAN CLAYS		CL	▨
		30% <W_L< 50%	INORGANIC CLAYS OF MEDIUM PLASTICITY, SILTY CLAYS		CI	▨
		W_L> 50%	INORGANIC CLAYS OF HIGH PLASTICITY, FAT CLAYS		CH	▨
	ORGANIC SILTS & CLAYS BELOW "A" LINE	W_L< 50%	ORGANIC SILTS AND ORGANIC SILTY CLAYS OF LOW PLASTICITY		OL	▨
		W_L> 50%	ORGANIC CLAYS OF HIGH PLASTICITY		OH	▨
HIGHLY ORGANIC SOILS			PEAT AND OTHER HIGHLY ORGANIC SOILS	STRONG COLOUR OR ODOR, AND OFTEN FIBROUS TEXTURE	Pt	▨

SOIL GRAIN SIZE RANGE AND DISTRIBUTION

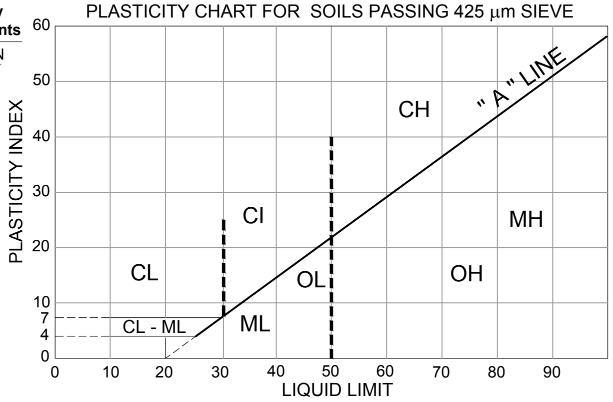
Material	Fraction	Sieve size (grain size)	Approx. Scale Size
Boulders		>(200-mm)	Larger than a soccer ball
Cobbles		Retained on 3-in (75-mm) sieve & < (200-mm)	Fist-size to Soccer ball
Gravel	Coarse	Passes 3-in (75-mm) sieve & retained on ¾ -in (19-mm) sieve	Thumb-sized to fist-sized
	Fine	Passes ¾ -in (19-mm) sieve & retained on No.4 (4.75-mm) sieve	Pea-sized to Thumb-sized
Sand	Coarse	Passes No.4 (4.75-mm) sieve & retained on No.10 (2.00-mm) sieve	Rock Salt to Pea-sized
	Medium	Passes No.10 (2.00-mm) sieve & retained on No.40 (425-µm) sieve	Sugar-sized to Rock Salt
	Fine	Passes No.40 (425-µm) sieve & retained on No.200 (75-µm) sieve	Flour sized to Sugar-sized
Fines (Silt/Clay)		Passes No. 200 (75-µm) sieve < 0.075mm	Flour-sized and smaller

Defining Ranges of % by Weight of Minor Components

PERCENT	DESCRIPTION
35 - 50	AND
20 - 35	Y / EY
10 - 20	SOME
1 - 10	TRACE



PLASTICITY CHART FOR SOILS PASSING 425 µm SIEVE



wood.

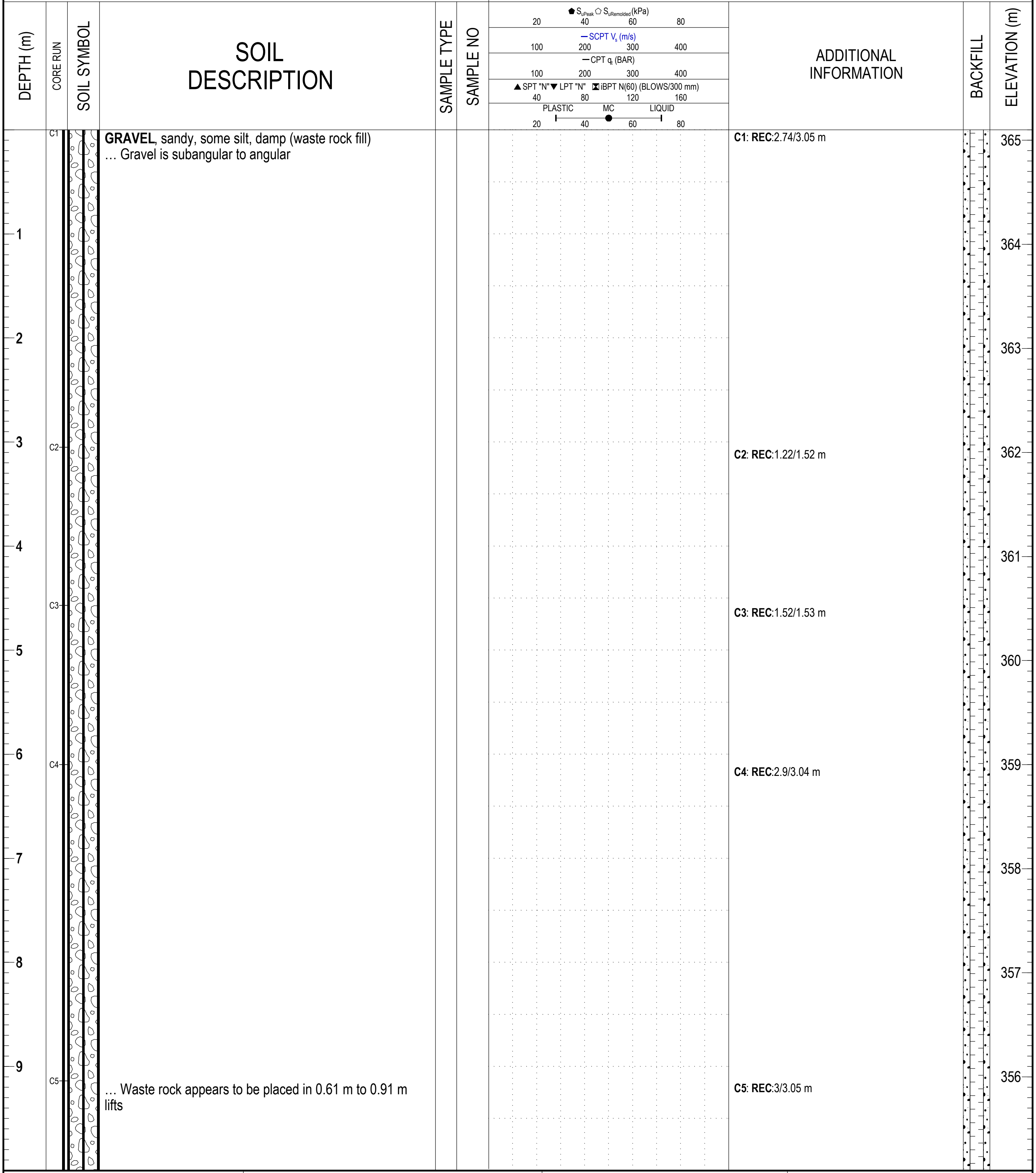
ENVIRONMENT & INFRASTRUCTURE SOLUTIONS
A DIVISION OF WOOD CANADA LIMITED
#600 - 4445 LOUGHEED HIGHWAY
BURNABY, BC V5C 0E4
TEL. 604-294-3811 FAX 604-294-4664

TITLE:
MODIFIED UNIFIED SOIL CLASSIFICATION SYSTEM

DWN BY: HY	DATUM: N/A	DATE: DECEMBER 2019
CHK'D BY: TM	REV. NO.: N/A	PROJECT NO: NX14001C1.3
PROJECTION: N/A	SCALE: AS SHOWN	REFERENCE NO.: GEO - 1110

CLIENT: Nyrstar Myra Falls Ltd.	PROJECT: Myra Falls	BOREHOLE NO: **BH19-01**
DRILLER/DRILL: Mudbay Drilling/Sonic/Becker	British Columbia, BC	PROJECT NO: NX14001C1.3
METHOD: Sonic Drilling	NORTHING: 5494704 EASTING: 311709.9	ELEVATION: 365.1 m

SAMPLE TYPE	■ TUBE	▨ NO RECOVERY	☒ SPT	☰ GRAB	⬚ LPT	▌ CORE
BACKFILL TYPE	▩ BENTONITE	▤ BENTONITE CHIPS	🟥 BENTONITE PELLETS	⬚ GROUT	▮ PIEZOMETER HEAD	⬚ SAND



SOIL DESCRIPTION

GRAVEL, sandy, some silt, damp (waste rock fill)
… Gravel is subangular to angular

… Waste rock appears to be placed in 0.61 m to 0.91 m lifts

ADDITIONAL INFORMATION

C1: **REC**:2.74/3.05 m

C2: **REC**:1.22/1.52 m

C3: **REC**:1.52/1.53 m

C4: **REC**:2.9/3.04 m

C5: **REC**:3/3.05 m

Environment & Infrastructure Solutions **600 - 4445 Lougheed Highway** **Burnaby, BC V5C 0E4**	LOGGED BY: HY	COMPLETION DEPTH: 36.6 m
	ENTERED BY: HY	COMPLETION DATE: 11/26/2019
	REVIEWED BY: BW	Page 1 of 4

CLIENT: Nyrstar Myra Falls Ltd.	PROJECT: Myra Falls	BOREHOLE NO: **BH19-01**
DRILLER/DRILL: Mudbay Drilling/Sonic/Becker	British Columbia, BC	PROJECT NO: NX14001C1.3
METHOD: Sonic Drilling	NORTHING: 5494704 EASTING: 311709.9	ELEVATION: 365.1 m

SAMPLE TYPE ■ TUBE ⧄ NO RECOVERY ☒ SPT ☰ GRAB ▨ LPT ▮ CORE

BACKFILL TYPE ▨ BENTONITE ▨ BENTONITE CHIPS ▨ BENTONITE PELLETS ▨ GROUT ▮ PIEZOMETER HEAD ▨ SAND

DEPTH (m)	CORE RUN	SOIL SYMBOL	SOIL DESCRIPTION	SAMPLE TYPE	SAMPLE NO	● S_{uPeak} ○ $S_{uRemolded}$ (kPa) 20 40 60 80 — SCPT V_s (m/s) 100 200 300 400 — CPT q_t (BAR) 100 200 300 400 ▲ SPT "N" ▼ LPT "N" ⧗ iBPT N(60) (BLOWS/300 mm) 40 80 120 160 PLASTIC MC LIQUID 20 40 60 80	ADDITIONAL INFORMATION	BACKFILL	ELEVATION (m)
									355
11									354
12									353
	C6						**C6**: **REC**:2.74/3.05 m		
13									352
14									351
15									350
	C7						**C7**: **REC**:2.44/3.05 m		
16									349
17									348
18									347
	C8						**C8**: **REC**:2.44/3.05 m		
19									346

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LOGGED BY: HY	COMPLETION DEPTH: 36.6 m
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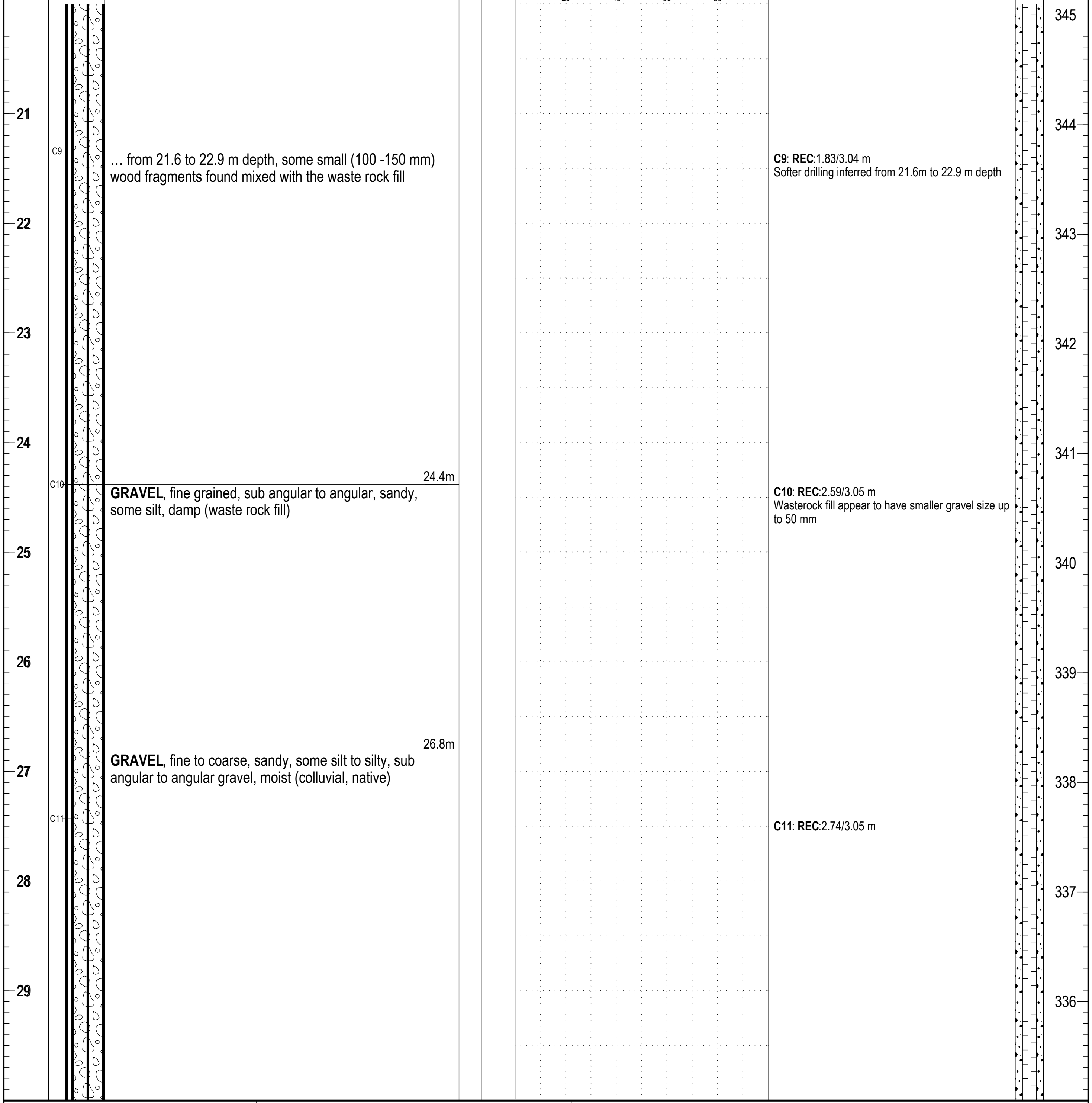
CLIENT: Nyrstar Myra Falls Ltd.	PROJECT: Myra Falls	BOREHOLE NO: **BH19-01**
DRILLER/DRILL: Mudbay Drilling/Sonic/Becker	British Columbia, BC	PROJECT NO: NX14001C1.3
METHOD: Sonic Drilling	NORTHING: 5494704 EASTING: 311709.9	ELEVATION: 365.1 m

SAMPLE TYPE ■ TUBE ◸ NO RECOVERY ☒ SPT ☰ GRAB ⁘ LPT ▮ CORE

BACKFILL TYPE ▨ BENTONITE ▨ BENTONITE CHIPS 🟥 BENTONITE PELLETS ⁘ GROUT ▮ PIEZOMETER HEAD ⁘ SAND

DEPTH (m)	CORE RUN	SOIL SYMBOL	SOIL DESCRIPTION	SAMPLE TYPE	SAMPLE NO	● S_{uPeak} ○ $S_{uRemolded}$ (kPa) 20 40 60 80 — SCPT V_s (m/s) 100 200 300 400 — CPT q_t (BAR) 100 200 300 400 ▲ SPT "N" ▼ LPT "N" ⧗ iBPT N(60) (BLOWS/300 mm) 40 80 120 160 PLASTIC MC LIQUID 20 40 60 80	ADDITIONAL INFORMATION	BACKFILL	ELEVATION (m)



… from 21.6 to 22.9 m depth, some small (100 -150 mm) wood fragments found mixed with the waste rock fill

24.4m

GRAVEL, fine grained, sub angular to angular, sandy, some silt, damp (waste rock fill)

26.8m

GRAVEL, fine to coarse, sandy, some silt to silty, sub angular to angular gravel, moist (colluvial, native)

C9: **REC**:1.83/3.04 m
Softer drilling inferred from 21.6m to 22.9 m depth

C10: **REC**:2.59/3.05 m
Wasterock fill appear to have smaller gravel size up to 50 mm

C11: **REC**:2.74/3.05 m

CLIENT: Nyrstar Myra Falls Ltd.	PROJECT: Myra Falls	BOREHOLE NO: **BH19-01**
DRILLER/DRILL: Mudbay Drilling/Sonic/Becker	British Columbia, BC	PROJECT NO: NX14001C1.3
METHOD: Sonic Drilling	NORTHING: 5494704 EASTING: 311709.9	ELEVATION: 365.1 m

SAMPLE TYPE ■ TUBE ◿ NO RECOVERY ☒ SPT ☰ GRAB ⬚ LPT ▌ CORE

BACKFILL TYPE ▩ BENTONITE ▨ BENTONITE CHIPS 🟥 BENTONITE PELLETS ⁘ GROUT ▮ PIEZOMETER HEAD ⬚ SAND

DEPTH (m) | CORE RUN | SOIL SYMBOL | SOIL DESCRIPTION | SAMPLE TYPE | SAMPLE NO | ⬟ S_{uPeak} ⬠ $S_{uRemolded}$ (kPa) 20 40 60 80 / — SCPT V_s (m/s) 100 200 300 400 / — CPT q_t (BAR) 100 200 300 400 / ▲ SPT "N" ▼ LPT "N" ☒ iBPT N(60) (BLOWS/300 mm) 40 80 120 160 / PLASTIC MC LIQUID 20 40 60 80 | ADDITIONAL INFORMATION | BACKFILL | ELEVATION (m)

DEPTH (m)	CORE RUN	SOIL DESCRIPTION	ADDITIONAL INFORMATION	ELEVATION (m)
30.0m		**SAND**, fine to coarse grained, some fine gravel, trace silt, damp to moist (colluvial, native)	Softer drilling inferred from 27 m to 30 m depth Landslide type materials or random backfill	335
30.2m	C12	**GRAVEL**, fine to coarse, sandy, some silt to silty, moist, brown (colluvial, native)	**C12**: **REC**:1.68/3.05 m	
30.5m		**GRAVEL**, fine to coarse, some sand to sandy, some silt, sub angular to angular, moist, brown (colluvial, native)		
31				334
32				333
33				332
33.2m	C13	**GRAVEL**, angular to subangular, some sand, some silt, moist, grey (colluvial, native) ...Occasional subrounded gravel observed below 33 m depth	about 50 mm of brown staining observed at 36.0 m depth **C13**: **REC**:2.74/3.05 m	
34				331
35				330
36				329
36.6m		END OF BOREHOLE AT 36.6 m No groudwater encountered, Higher moisture content (wet) at 35.0 m depth Borehole grouted from 36.6 m to ground surface with cement bentonite grout Installed 85 mm Slope Inclinometer casing (3.34 inch OD) Installed protective stick-up cover using bentonite chips for easy removal for next raise	- Slope Inclinometer casing, 3.34 inch (85 mm) installed in cement-bentonite grout mix. - Installed well cover protection (Stick-Up type) which was backfilled with bentonite chips only instead of concrete for easy removal. - The protective cover must be removed carefully preventing damge to the casings prior or during the next dam raise.	
37				328
38				327
39				326

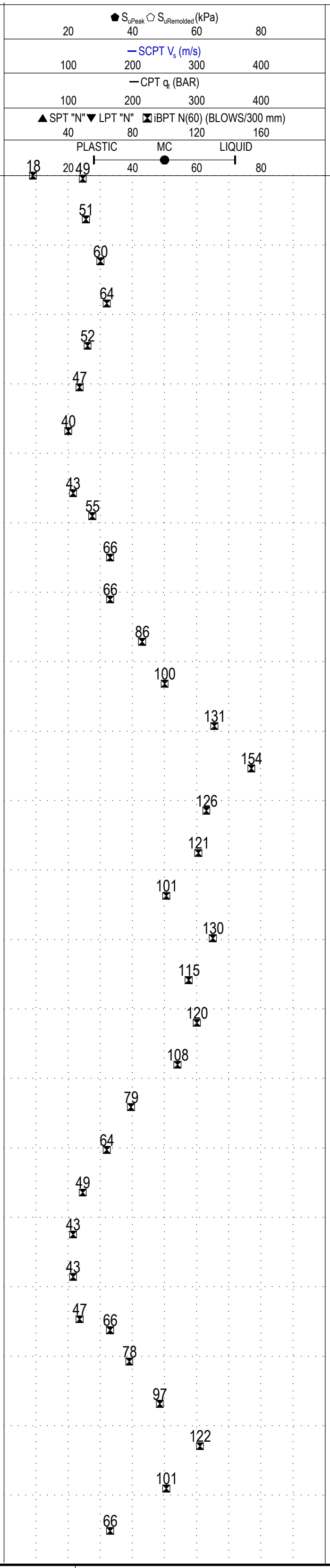
LOGGED BY: HY	COMPLETION DEPTH: 36.6 m
ENTERED BY: HY	COMPLETION DATE: 11/26/2019
REVIEWED BY: BW	

CLIENT: Nyrstar Myra Falls Ltd.	PROJECT: Myra Falls	BOREHOLE NO: **BH19-02**
DRILLER/DRILL: Mudbay Drilling/Sonic/Becker	British Columbia, BC	PROJECT NO: NX14001C1.3
METHOD: Sonic/iBPT Drilling	NORTHING: 5494655.6 EASTING: 311729.7	ELEVATION: 362.4 m

SAMPLE TYPE ■ TUBE ◩ NO RECOVERY ☒ SPT ☰ GRAB ⬚ LPT ▐ CORE

BACKFILL TYPE ▩ BENTONITE ▤ BENTONITE CHIPS 🟥 BENTONITE PELLETS ⁘ GROUT ▮ PIEZOMETER HEAD ⬚ SAND

DEPTH (m)	CORE RUN	SOIL SYMBOL	SOIL DESCRIPTION	SAMPLE TYPE	SAMPLE NO	ADDITIONAL INFORMATION	BACKFILL	ELEVATION (m)
	C1		**GRAVEL**, fine to coarse, angular to subangular, sandy, trace to some silt, dry to damp, grey (waste rock fill)			**C1**: **REC**:3.05/3.05 m - Proposed surveyed borehole location had to be relocated in order to be within 2.0 m from the iBPT as-built location. - BH19-02 located at 1.5 m from iBPT19-02.		
3	C2		...damp below 3.0 m depth			**C2**: **REC**:3.05/3.05 m		
			... Cored two large rocks at 3.4 m and 4.0 m depths					
6	C3					**C3**: **REC**:2.44/3.04 m		
8			... Increase silt content from 8 m to 10.4 m depth					
9	C4					**C4**: **REC**:2.74/3.05 m		



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LOGGED BY: HY	COMPLETION DEPTH: 39.6 m
ENTERED BY: HY	COMPLETION DATE: 11/29/2019
REVIEWED BY: BW	

CLIENT: Nyrstar Myra Falls Ltd.	PROJECT: Myra Falls	BOREHOLE NO: **BH19-02**
DRILLER/DRILL: Mudbay Drilling/Sonic/Becker	British Columbia, BC	PROJECT NO: NX14001C1.3
METHOD: Sonic/iBPT Drilling	NORTHING: 5494655.6 EASTING: 311729.7	ELEVATION: 362.4 m

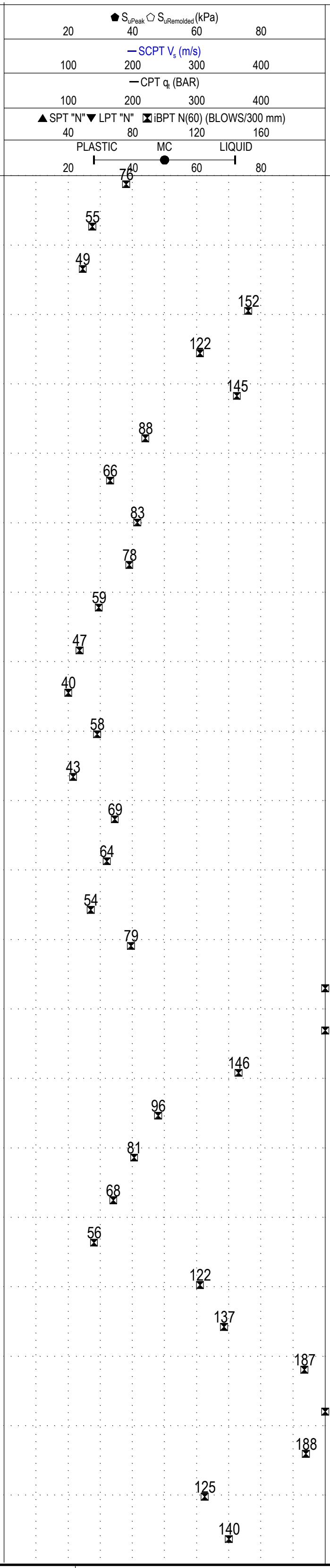
SAMPLE TYPE ■ TUBE ╱ NO RECOVERY ☒ SPT ☰ GRAB ░ LPT ▌ CORE

BACKFILL TYPE ▨ BENTONITE ▨ BENTONITE CHIPS ▨ BENTONITE PELLETS ░ GROUT ▌ PIEZOMETER HEAD ░ SAND

DEPTH (m)	CORE RUN	SOIL SYMBOL	SOIL DESCRIPTION	SAMPLE TYPE	SAMPLE NO	ADDITIONAL INFORMATION	BACKFILL	ELEVATION (m)
13.1m			**SAND**, fine to coarse grained, gravelly, silty, moist, brown (fill)					
15.2m	C6		**GRAVEL**, angular to subangular, fine to coarse grained, sandy, trace to some silt, moist to damp, various colour per each lift (waste rock fill) … Gravel is fine to coarse grained … Increase silt content to "some silt to silty" from 16.5 to 18.3 m depth			C6: **REC**:2.59/3.05 m		
	C5					C5: **REC**:2.59/3.05 m		
	C7					C7: **REC**:2.59/3.05 m		

Depth (m): 11, 12, 13, 14, 15, 16, 17, 18, 19

Elevation (m): 352, 351, 350, 349, 348, 347, 346, 345, 344, 343



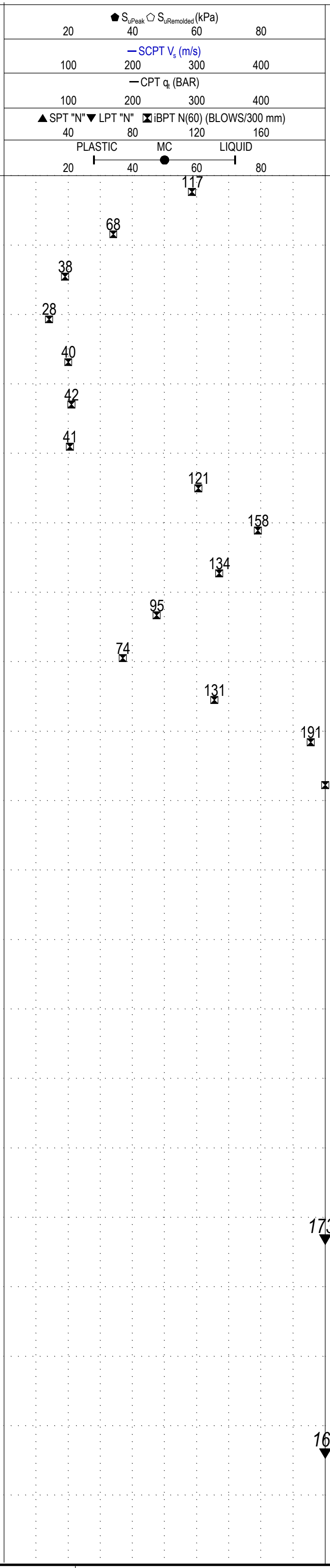
LOGGED BY: HY	COMPLETION DEPTH: 39.6 m
ENTERED BY: HY	COMPLETION DATE: 11/29/2019
REVIEWED BY: BW	Page 2 of 4

CLIENT: Nyrstar Myra Falls Ltd.	PROJECT: Myra Falls	BOREHOLE NO: **BH19-02**
DRILLER/DRILL: Mudbay Drilling/Sonic/Becker	British Columbia, BC	PROJECT NO: NX14001C1.3
METHOD: Sonic/iBPT Drilling	NORTHING: 5494655.6 EASTING: 311729.7	ELEVATION: 362.4 m

SAMPLE TYPE ■ TUBE ◿ NO RECOVERY ☒ SPT ☰ GRAB ▒ LPT ▌ CORE

BACKFILL TYPE ▩ BENTONITE ▨ BENTONITE CHIPS ▦ BENTONITE PELLETS ▧ GROUT ▮ PIEZOMETER HEAD ░ SAND

DEPTH (m)	CORE RUN	SOIL SYMBOL	SOIL DESCRIPTION	SAMPLE TYPE	SAMPLE NO	ADDITIONAL INFORMATION	BACKFILL	ELEVATION (m)
								342
21	C8					**C8**: **REC**:2.9/3.04 m		341
22								340
23								339
24	C9		...Hard drilling from 23.8 to 24.4 m depth			**C9**: **REC**:2.9/3.05 m		338
25								337
26								336
27	C10		... One piece of organic fiber (wood) at 27.7 m depth	▒	LPT1	**LPT1**: **Blow Count**37-53-30/1.5" **REC**:0.38/0.46 m **C10**: **REC**:1.52/1.52 m		335
28								334
29	C11		29.0m **GRAVEL**, fine to medium, rounded to subrounded, sandy, fine to coarse grained, some to silty, moist, grey (waste rock fill) 29.6m **GRAVEL**, fine to medium, subangular to angular, sandy, trace to some silt, damp, grey (waste rock fill)	▒	LPT2	**C11**: **REC**:1.52/1.52 m **LPT2**: **Blow Count**62-81-88 **REC**:0.46/0.46 m		333



wood.

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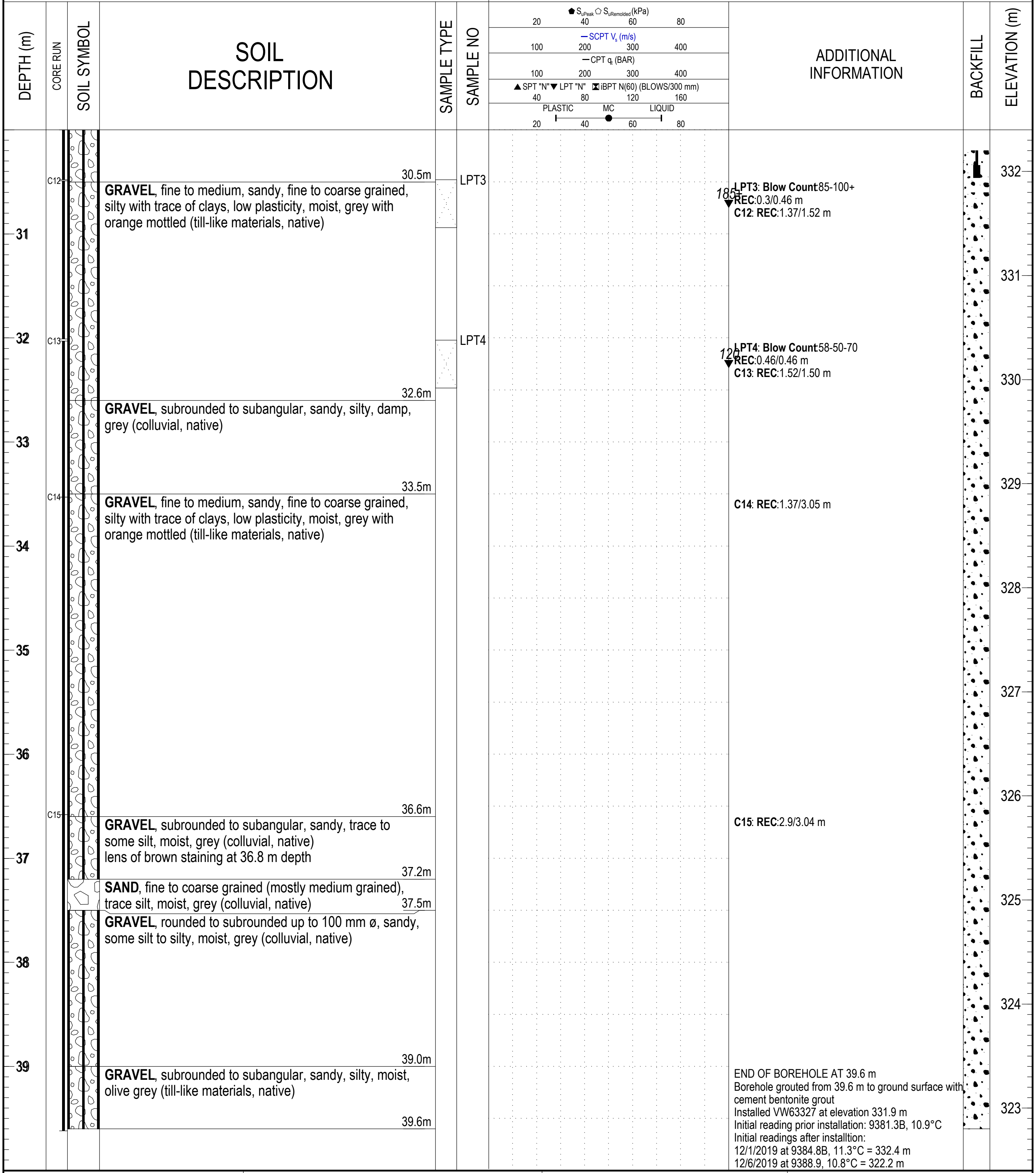
600 - 4445 Lougheed Highway
Burnaby, BC V5C 0E4

LOGGED BY: HY	COMPLETION DEPTH: 39.6 m
ENTERED BY: HY	COMPLETION DATE: 11/29/2019
REVIEWED BY: BW	

CLIENT: Nyrstar Myra Falls Ltd.	PROJECT: Myra Falls	BOREHOLE NO: **BH19-02**
DRILLER/DRILL: Mudbay Drilling/Sonic/Becker	British Columbia, BC	PROJECT NO: NX14001C1.3
METHOD: Sonic/iBPT Drilling	NORTHING: 5494655.6 EASTING: 311729.7	ELEVATION: 362.4 m

SAMPLE TYPE	■ TUBE	◪ NO RECOVERY	☒ SPT	☰ GRAB	⬚ LPT	▮ CORE
BACKFILL TYPE	▩ BENTONITE	▨ BENTONITE CHIPS	🟥 BENTONITE PELLETS	⁘ GROUT	▮ PIEZOMETER HEAD	⬚ SAND



SOIL DESCRIPTION

30.5m

GRAVEL, fine to medium, sandy, fine to coarse grained, silty with trace of clays, low plasticity, moist, grey with orange mottled (till-like materials, native)

32.6m

GRAVEL, subrounded to subangular, sandy, silty, damp, grey (colluvial, native)

33.5m

GRAVEL, fine to medium, sandy, fine to coarse grained, silty with trace of clays, low plasticity, moist, grey with orange mottled (till-like materials, native)

36.6m

GRAVEL, subrounded to subangular, sandy, trace to some silt, moist, grey (colluvial, native)
lens of brown staining at 36.8 m depth

37.2m

SAND, fine to coarse grained (mostly medium grained), trace silt, moist, grey (colluvial, native)

37.5m

GRAVEL, rounded to subrounded up to 100 mm ø, sandy, some silt to silty, moist, grey (colluvial, native)

39.0m

GRAVEL, subrounded to subangular, sandy, silty, moist, olive grey (till-like materials, native)

39.6m

ADDITIONAL INFORMATION

LPT3: **Blow Count**:85-100+
REC:0.3/0.46 m
C12: **REC**:1.37/1.52 m

LPT4: **Blow Count**:58-50-70
REC:0.46/0.46 m
C13: **REC**:1.52/1.50 m

C14: **REC**:1.37/3.05 m

C15: **REC**:2.9/3.04 m

END OF BOREHOLE AT 39.6 m
Borehole grouted from 39.6 m to ground surface with cement bentonite grout
Installed VW63327 at elevation 331.9 m
Initial reading prior installation: 9381.3B, 10.9°C
Initial readings after installtion:
12/1/2019 at 9384.8B, 11.3°C = 332.4 m
12/6/2019 at 9388.9, 10.8°C = 322.2 m

wood.	**Environment & Infrastructure Solutions** **600 - 4445 Lougheed Highway** **Burnaby, BC V5C 0E4**	LOGGED BY: HY ENTERED BY: HY REVIEWED BY: BW
		COMPLETION DEPTH: 39.6 m COMPLETION DATE: 11/29/2019

CLIENT: Nyrstar Myra Falls Ltd.	PROJECT: Myra Falls	BOREHOLE NO: **BH19-03**
DRILLER/DRILL: Mudbay Drilling/Sonic/Becker	British Columbia, BC	PROJECT NO: NX14001C1.3
METHOD: Sonic/iBPT Drilling	NORTHING: 5494650.7 EASTING: 311805.5	ELEVATION: 362.4 m

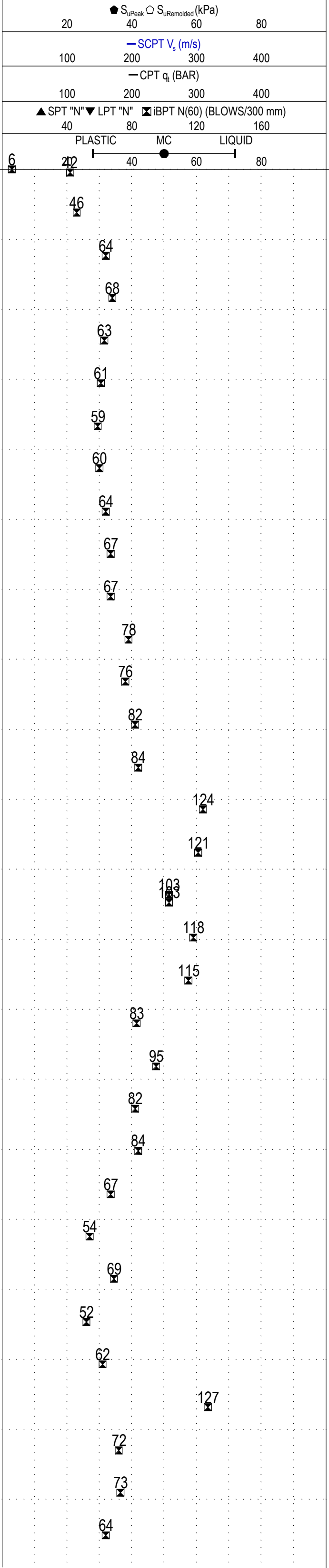
SAMPLE TYPE ■ TUBE ▨ NO RECOVERY ☒ SPT ☰ GRAB ░ LPT ▮ CORE

BACKFILL TYPE ▩ BENTONITE ▤ BENTONITE CHIPS 🟥 BENTONITE PELLETS ░ GROUT ▮ PIEZOMETER HEAD ░ SAND

DEPTH (m)	CORE RUN	SOIL SYMBOL	SOIL DESCRIPTION	SAMPLE TYPE	SAMPLE NO	ADDITIONAL INFORMATION	ELEVATION (m)
0	C1		**GRAVEL**, fine to coarse, angular to subangular, sandy, fine to coarse grained, some silt to silty, dry to damp, grey/brown (waste rock fill)			**C1**: **REC**:2.74/3.05 m - BH19-03 located at 1.9 m from iBPT19-03.	362
3	C2					**C2**: **REC**:3.05/3.05 m	359
6.1	C3		6.1m **GRAVEL**, fine to coarse, angular to subangular, occasional cobbles, some sand, trace to some silt, brown/orange/grey (waste rock fill)			**C3**: **REC**:2.44/3.04 m	356
9.1	C4					**C4**: **REC**:2.44/3.05 m	353

Depth (m): 1, 2, 3, 4, 5, 6, 7, 8, 9

Elevation (m): 362, 361, 360, 359, 358, 357, 356, 355, 354, 353



wood. Environment & Infrastructure Solutions 600 - 4445 Lougheed Highway Burnaby, BC V5C 0E4	LOGGED BY: HY	COMPLETION DEPTH: 36.9 m
	ENTERED BY: HY	COMPLETION DATE: 12/1/2019
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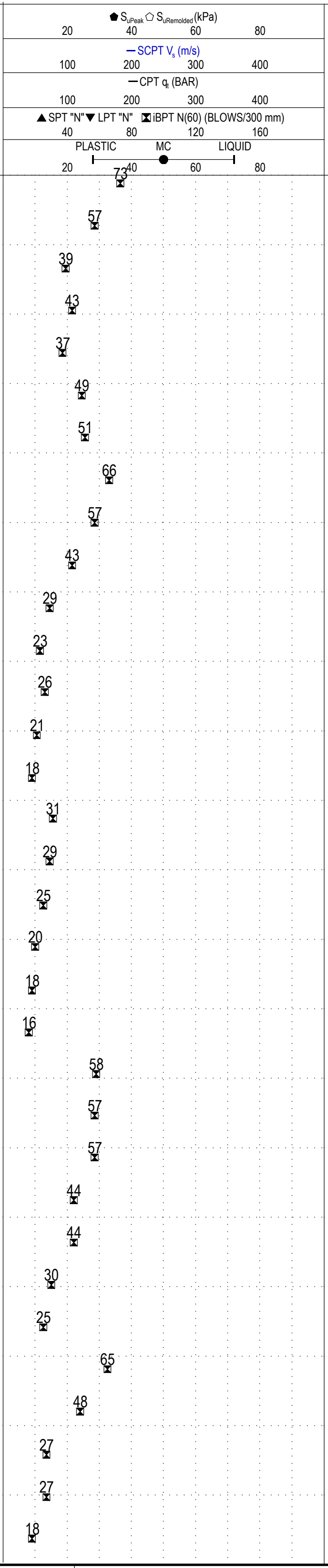
CLIENT: Nyrstar Myra Falls Ltd.	PROJECT: Myra Falls	BOREHOLE NO: **BH19-03**
DRILLER/DRILL: Mudbay Drilling/Sonic/Becker	British Columbia, BC	PROJECT NO: NX14001C1.3
METHOD: Sonic/iBPT Drilling	NORTHING: 5494650.7 EASTING: 311805.5	ELEVATION: 362.4 m

SAMPLE TYPE	■ TUBE	◿ NO RECOVERY	☒ SPT	☰ GRAB	⬚ LPT	▮ CORE
BACKFILL TYPE	▨ BENTONITE	▨ BENTONITE CHIPS	🟥 BENTONITE PELLETS	⁘ GROUT	▮ PIEZOMETER HEAD	⬚ SAND

DEPTH (m)	CORE RUN	SOIL SYMBOL	SOIL DESCRIPTION	SAMPLE TYPE	SAMPLE NO	ADDITIONAL INFORMATION	BACKFILL	ELEVATION (m)
								352
11								351
12	C5		12.2m **SAND**, fine to coarse, silty, trace gravelbrown/orange/grey (waste rock fill) 12.5m			**C5**: **REC**:2.44/3.05 m		350
			GRAVEL, fine to coarse, angular to subangular, occasional cobbles, sandy, some silt to silty, brown/orange/grey (waste rock fill)					
13								349
14								348
15	C6		15.2m **SAND**, fine to coarse grained, gravelly, silty, moist, brown/grey (waste rock fill)			**C6**: **REC**:3.05/3.05 m		347
16								346
			16.8m **GRAVEL**, fine to coarse, angular to subangular, occasional cobbles, some sand, trace to some silt, brown/orange/grey (waste rock fill)					
17								345
18	C7		18.3m **GRAVEL**, fine to coarse grained, angular to subangular, sandy, fine to coarse grained, some silt, moist, brown (waste rock fill)			**C7**: **REC**:3.05/3.05 m ... small wood fragments found here		344
19			19.4m **GRAVEL**, fine to coarse grained, angular to subangular, silty, some fine sand, moist, grey (waste rock fill)					343



wood.

Environment & Infrastructure Solutions **600 - 4445 Lougheed Highway** **Burnaby, BC V5C 0E4**	LOGGED BY: HY	COMPLETION DEPTH: 36.9 m
	ENTERED BY: HY	COMPLETION DATE: 12/1/2019
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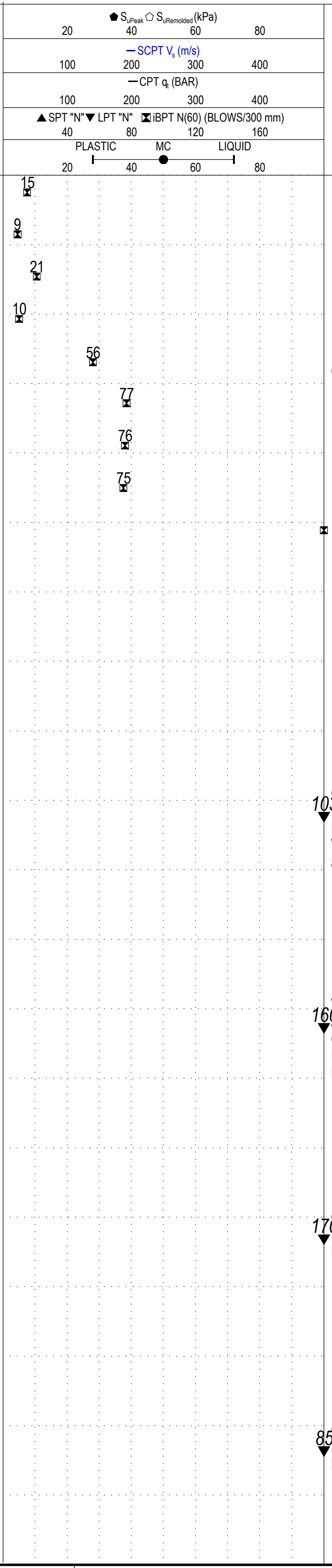
CLIENT: Nyrstar Myra Falls Ltd.	PROJECT: Myra Falls	BOREHOLE NO: **BH19-03**
DRILLER/DRILL: Mudbay Drilling/Sonic/Becker	British Columbia, BC	PROJECT NO: NX14001C1.3
METHOD: Sonic/iBPT Drilling	NORTHING: 5494650.7 EASTING: 311805.5	ELEVATION: 362.4 m

SAMPLE TYPE ■ TUBE ╱ NO RECOVERY ☒ SPT ☰ GRAB ▨ LPT ▮ CORE

BACKFILL TYPE ▨ BENTONITE ▨ BENTONITE CHIPS ▨ BENTONITE PELLETS ▨ GROUT ▮ PIEZOMETER HEAD ▨ SAND

DEPTH (m)	CORE RUN	SOIL SYMBOL	SOIL DESCRIPTION	SAMPLE TYPE	SAMPLE NO		ADDITIONAL INFORMATION	BACKFILL	ELEVATION (m)
21	C8						**C8**: **REC**:3.05/3.04 m		342 341
22			21.9m **GRAVEL**, fine to coarse grained, angular to subangular, some sand to sandy, trace to some silt, damp to dry, grey/brown (waste rock fill)						340
23									339
24	C9			▨	LPT1		**C9**: **REC**:1.52/1.53 m **LPT1**: **Blow Count**39-50-53 **REC**:0.43/0.46 m Wasterock lifts appear to be placed <0.3 m thickness as various layers can be seen clearly (6 lifts/1.5m)		338
25									337
26	C10			▨	LPT2		Wasterock lifts appear to be placed > 0.3 m thickness as various layers can be seen clearly (4 lifts/ 1.5 m) **C10**: **REC**:1.52/1.52 m **LPT2**: **Blow Count**85-60-100 **REC**:0/0.46 m		336
27	C11			▨	LPT3		**C11**: **REC**:1.52/1.53 m **LPT3**: **Blow Count**170/1.5" **REC**:0.04/0.46 m		335 334
28									
29	C12		29.0m **GRAVEL**, fine to coarse grained, angular to subangular, sandy, trace to some silt, damp to dry, grey/brown (waste rock fill)	▨	LPT4		**C12**: **REC**:1.52/1.52 m **LPT4**: **Blow Count**45-35-50 **REC**:0.25/0.45 m		333



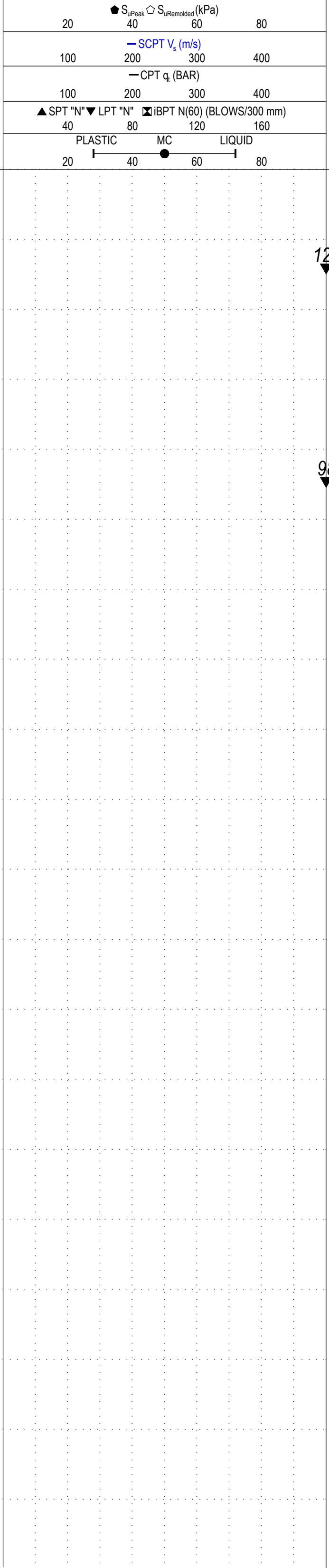
wood.	**Environment & Infrastructure Solutions** **600 - 4445 Lougheed Highway** **Burnaby, BC V5C 0E4**	LOGGED BY: HY ENTERED BY: HY REVIEWED BY: BW

COMPLETION DEPTH: 36.9 m
COMPLETION DATE: 12/1/2019

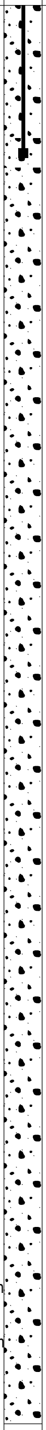
CLIENT: Nyrstar Myra Falls Ltd.	PROJECT: Myra Falls	BOREHOLE NO: **BH19-03**
DRILLER/DRILL: Mudbay Drilling/Sonic/Becker	British Columbia, BC	PROJECT NO: NX14001C1.3
METHOD: Sonic/iBPT Drilling	NORTHING: 5494650.7 EASTING: 311805.5	ELEVATION: 362.4 m

SAMPLE TYPE ■ TUBE ◿ NO RECOVERY ☒ SPT ☰ GRAB ⬚ LPT ▌ CORE

BACKFILL TYPE ▨ BENTONITE ▨ BENTONITE CHIPS 🟥 BENTONITE PELLETS ⬚ GROUT ▌ PIEZOMETER HEAD ⬚ SAND



DEPTH (m)	CORE RUN	SOIL DESCRIPTION	SAMPLE TYPE	SAMPLE NO	ADDITIONAL INFORMATION	ELEVATION (m)
	C13	… one piece of wood, finger size, at 30.2 m depth … becomes moist below 30.3 m depth 31.1m	☒	LPT5	black staining at 34 m depth, no apparent organic matter. Fines appeared dark grey, but turns black when added water **C13**: **REC**:1.52/1.52 m **LPT5**: **Blow Count**55-60/3" **REC**:0.23/0.46 m	332
31		**GRAVEL**, fine to medium, rounded to subrounded, silty, trace to some sand, dry to damp, grey (colluvial, native) 32.0m				331
32	C14	**GRAVEL**, sandy (fine to coarse grained), some silt to silty, moist, grey/brown (colluvial, native) 32.6m	☒	LPT6	**C14**: **REC**:1.52/1.53 m **LPT6**: **Blow Count**45-43-55 **REC**:0.61/0.45 m	330
33		**GRAVEL**, fine to medium, sandy, fine to coarse grained, silty with trace of clays, low plasticity, moist, grey with orange mottled (till-like materials, native) 33.2m				
	C15	**GRAVEL**, silty, trace to some sand, dry to damp, grey (colluvial, native) 33.5m			**C15**: **REC**:1.52/3.05 m	329
34		**GRAVEL**, subangular, occasional cobbles, some sand, trace silt to some silt, damp to moist, grey (till-like materials, native) 34.1m				
35 36		**GRAVEL**, subrounded to subangular, occasional cobbles, silty, some sand, dry to damp, grey (colluvial, native) … hard drilling from 34.1 m to 35.7 m depth 36.3m				328 327
37 38	C16	**GRAVEL**, fine to coarse grained, rounded to subrounded, occasional cobbles, sandy, trace silt to some silt, moist, grey (colluvial, native) 39.0m			**C16**: **REC**:3.05/3.04 m	326 325 324
39		**GRAVEL**, fine to medium grained, rounded, occasional cobbles, some sand, some silt to silty, moist, grey (colluvial, native) 39.6m			END OF BOREHOLE AT 39.6 m Borehole grouted from 39.6 m to ground surface with cement bentonite grout Installed VW63326 at elevation 331.3 m Initial reading prior installation: 9620.8B, 33°C (warm water used) Initial readings after installtion: 12/3/2019 at 9662.1B, 11.7°C => 329.7 m 12/6/2019 at 9664.3B, 11.3°C => 329.6 m	323



Environment & Infrastructure Solutions
600 - 4445 Lougheed Highway
Burnaby, BC V5C 0E4

LOGGED BY: HY	COMPLETION DEPTH: 36.9 m
ENTERED BY: HY	COMPLETION DATE: 12/1/2019
REVIEWED BY: BW	Page 4 of 4

CLIENT: Nyrstar Myra Falls Ltd.	PROJECT: Myra Falls	BOREHOLE NO: **BH19-04**
DRILLER/DRILL: Mudbay Drilling/Sonic/Becker	British Columbia, BC	PROJECT NO: NX14001C1.3
METHOD: Sonic Drilling	NORTHING: 5494669 EASTING: 311809.2	ELEVATION: 365.1 m

SAMPLE TYPE ■ TUBE ▨ NO RECOVERY ☒ SPT ☰ GRAB ⬚ LPT ▌ CORE

BACKFILL TYPE ▩ BENTONITE ▨ BENTONITE CHIPS 🟥 BENTONITE PELLETS ⁘ GROUT ▮ PIEZOMETER HEAD ⬚ SAND

DEPTH (m) | CORE RUN | SOIL SYMBOL | SOIL DESCRIPTION | SAMPLE TYPE | SAMPLE NO | ADDITIONAL INFORMATION | BACKFILL | ELEVATION (m)

● S_{uPeak} ○ $S_{uRemolded}$ (kPa) 20 40 60 80

— SCPT V_s (m/s) 100 200 300 400

— CPT q_t (BAR) 100 200 300 400

▲ SPT "N" ▼ LPT "N" ⧗ iBPT N(60) (BLOWS/300 mm) 40 80 120 160

PLASTIC MC LIQUID 20 40 60 80

NO SAMPLING

42.7m

GRAVEL & SAND, silty, occasional cobble, moist to wet, grey/Olive green (colluvium, native)
... Gravel is fine to coarse grained, subangular to subrounded and sand is fine to coarse grained

45.7m

No sonic sampling was required, and sonic casing was advanced without recovery.

END OF BOREHOLE AT 45.7m
No groundwater encountered.
Borehole grouted from 45.7 m to ground surface with cement bentonite grout.
Installed 85 mm Slope Inclinometer Casing (3.34 inch OD).
Installed protective stick-up cover using bentonite chips for easy removal for neext raise.
Slope Inclinometer casing, 3.34 inch (85 mm) installed in cement-bentonite grout mix.
Installed well cover protection (Stick-Up type) which was backfilled with bentonite chips only instead of concrete for easy removal.
The protective cover must be removed carefully preventing damge to the casings prior or during the next dam raise.

DEPTH (m)	ELEVATION (m)
1	364
2	363
3	362
4	361
5	360
6	359
7	358
8	357
9	356
10	355
11	354
12	353
13	352
14	351
15	350
16	349
17	348
18	347
19	346
20	345
21	344
22	343
23	342
24	341
25	340
26	339
27	338
28	337
29	336
30	335
31	334
32	333
33	332
34	331
35	330
36	329
37	328
38	327
39	326
40	325
41	324
42	323
43	322
44	321
45	320
46	319
47	318
48	317
49	316

wood.

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Burnaby, BC V5C 0E4

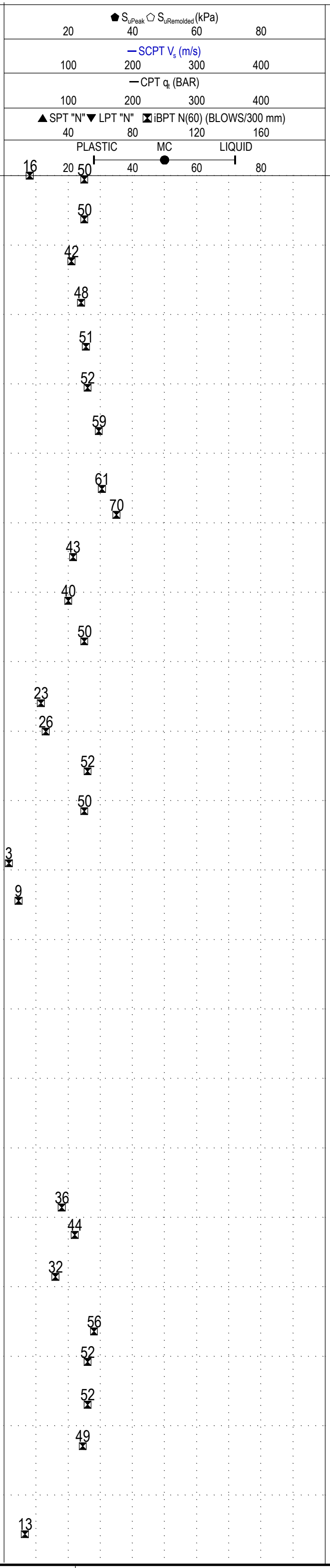
LOGGED BY: HY	COMPLETION DEPTH: 45.7 m
ENTERED BY: HY	COMPLETION DATE: 11/27/2019
REVIEWED BY: BW	Page 1 of 1

CLIENT: Nyrstar Myra Falls Ltd.	PROJECT: Myra Falls	BOREHOLE NO: **BH19-05**
DRILLER/DRILL: Mudbay Drilling/Sonic/Becker	British Columbia, BC	PROJECT NO: NX14001C1.3
METHOD: Sonic/iBPT Drilling	NORTHING: 5494664.1 EASTING: 311880.9	ELEVATION: 362.5 m

SAMPLE TYPE ■ TUBE ▨ NO RECOVERY ☒ SPT ☰ GRAB ⬚ LPT ▮ CORE

BACKFILL TYPE ▩ BENTONITE ▤ BENTONITE CHIPS ▦ BENTONITE PELLETS ⬚ GROUT ▮ PIEZOMETER HEAD ⬚ SAND

DEPTH (m)	CORE RUN	SOIL SYMBOL	SOIL DESCRIPTION	SAMPLE TYPE	SAMPLE NO		ADDITIONAL INFORMATION	BACKFILL	ELEVATION (m)
	C1		**GRAVEL**, fine to coarse, angular to subangular, occasional cobbles, some sand to sandy, fine to coarse grained, trace to some silt, damp to moist, grey/brown (waste rock fill)				**C1**: **REC**:3.05/3.05 m		362
1							- iBPT19-05B was completed 5 m east from iBPT19-05, which located 2.8 m north of proposed BH19-05. - BH19-05 was relocated to be at 1.5 m from iBPT19-05.		361
2									360
3	C2						**C2**: **REC**:3.05/3.05 m		359
4									358
5									357
6	C3		… less gravel, more silt from 5.8 m to 6.1 m depth				**C3**: **REC**:2.44/3.04 m		356
7									355
8			… occasional subrounded gravel from 7.6 m to 7.9 m depth						354
9	C4						**C4**: **REC**:3.05/3.05 m		353



wood.

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600 - 4445 Lougheed Highway
Burnaby, BC V5C 0E4

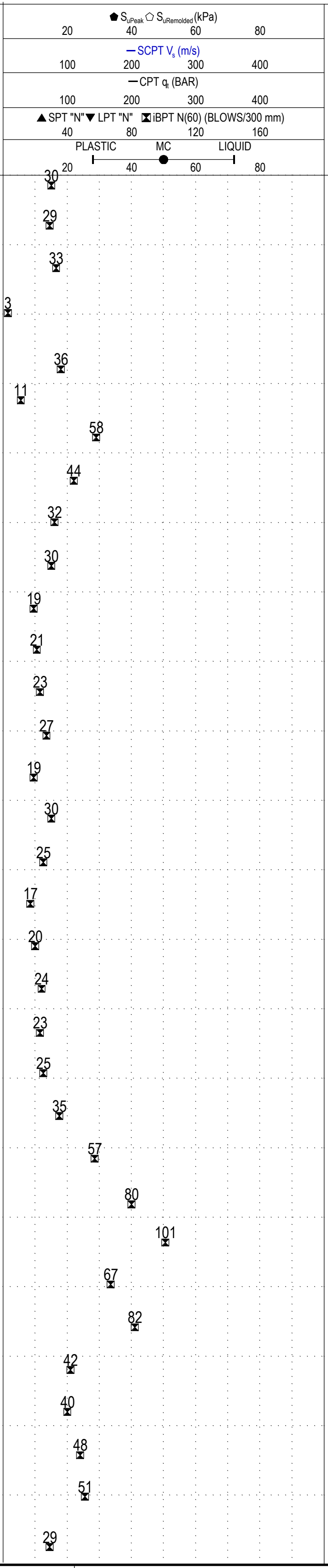
LOGGED BY: HY	COMPLETION DEPTH: 39.6 m
ENTERED BY: HY	COMPLETION DATE: 12/2/2019
REVIEWED BY: BW	

CLIENT: Nyrstar Myra Falls Ltd.	PROJECT: Myra Falls	BOREHOLE NO: **BH19-05**
DRILLER/DRILL: Mudbay Drilling/Sonic/Becker	British Columbia, BC	PROJECT NO: NX14001C1.3
METHOD: Sonic/iBPT Drilling	NORTHING: 5494664.1 EASTING: 311880.9	ELEVATION: 362.5 m

SAMPLE TYPE ■ TUBE ◪ NO RECOVERY ☒ SPT ☰ GRAB ▨ LPT ▌ CORE

BACKFILL TYPE ▩ BENTONITE ▤ BENTONITE CHIPS 🟥 BENTONITE PELLETS ▦ GROUT ▮ PIEZOMETER HEAD ▨ SAND

DEPTH (m)	CORE RUN	SOIL SYMBOL	SOIL DESCRIPTION	SAMPLE TYPE	SAMPLE NO		ADDITIONAL INFORMATION	BACKFILL	ELEVATION (m)
11									352
12	C5		... increase in silt content (silty) and moisture content (moist) from 12.2 m to 15.2 m depth				**C5**: **REC**:2.29/3.05 m		351
13									350
14									349
15	C6		... denser layer inferred from drilling from 15.5 m to 16.8 m and from 17.3 to 17.7 m depths				**C6**: **REC**:2.44/3.05 m		348
16									347
17			... Dry to damp below 16.8 m depth						346
18	C7						**C7**: **REC**:2.74/3.05 m		345
19									344
									343



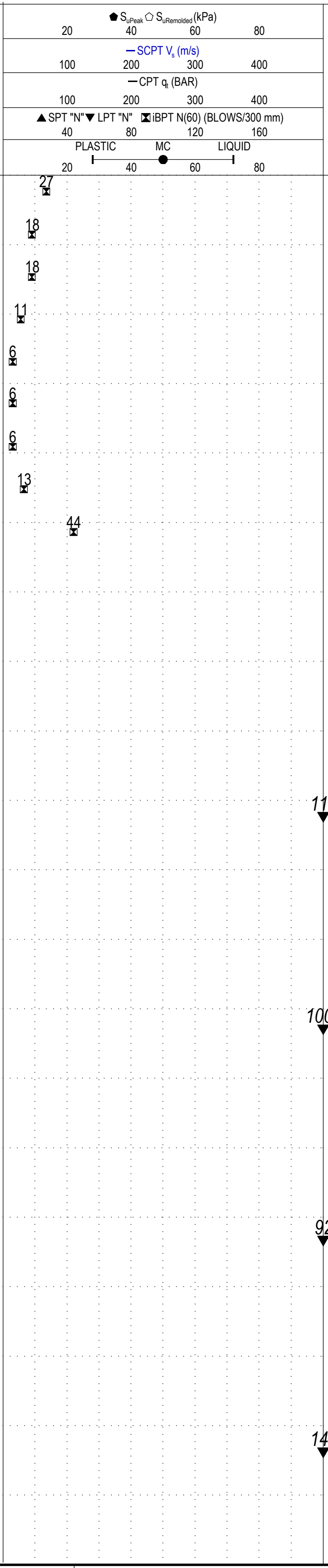
wood.	**Environment & Infrastructure Solutions** **600 - 4445 Lougheed Highway** **Burnaby, BC V5C 0E4**	LOGGED BY: HY ENTERED BY: HY REVIEWED BY: BW
		COMPLETION DEPTH: 39.6 m COMPLETION DATE: 12/2/2019

CLIENT: Nyrstar Myra Falls Ltd.	PROJECT: Myra Falls	BOREHOLE NO: **BH19-05**
DRILLER/DRILL: Mudbay Drilling/Sonic/Becker	British Columbia, BC	PROJECT NO: NX14001C1.3
METHOD: Sonic/iBPT Drilling	NORTHING: 5494664.1 EASTING: 311880.9	ELEVATION: 362.5 m

SAMPLE TYPE ■ TUBE ◩ NO RECOVERY ☒ SPT ☰ GRAB ⬚ LPT ▌ CORE

BACKFILL TYPE ▩ BENTONITE ▨ BENTONITE CHIPS 🟥 BENTONITE PELLETS ⬚ GROUT ▮ PIEZOMETER HEAD ⬚ SAND

DEPTH (m) | CORE RUN | SOIL SYMBOL | SOIL DESCRIPTION | SAMPLE TYPE | SAMPLE NO | ADDITIONAL INFORMATION | BACKFILL | ELEVATION (m)



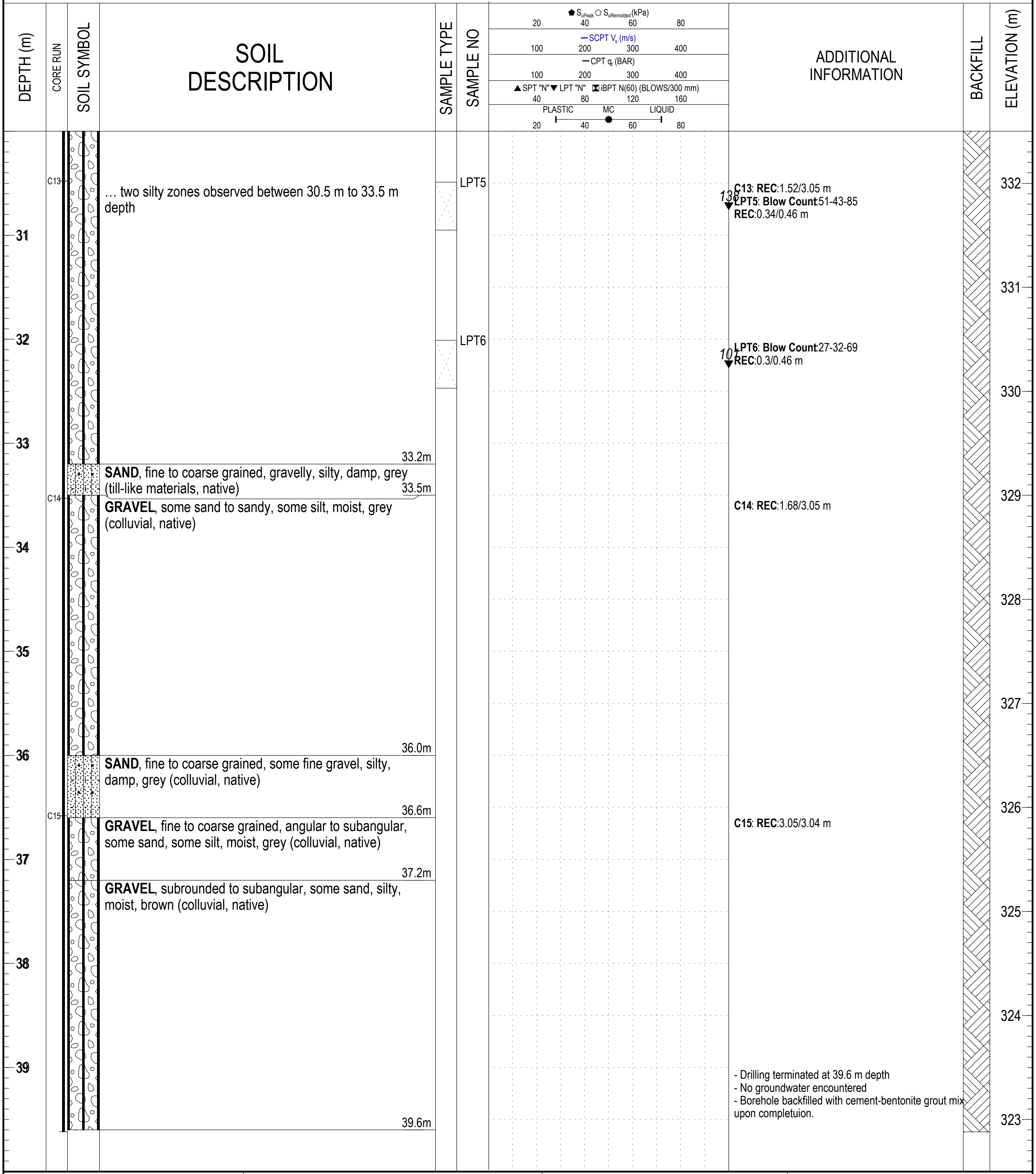
DEPTH (m)	CORE RUN	SOIL DESCRIPTION	SAMPLE NO	ADDITIONAL INFORMATION	ELEVATION (m)
					342
21	C8			**C8**: **REC**:3.05/3.04 m	341
22					340
23		... Very hard drilling from 22.9 to 24.1 m depth			339
24	C9		LPT1	**C9**: **REC**:1.52/1.53 m **LPT1**: **Blow Count**:55-46-68 **REC**:0.36/0.46 m	338
25					337
26	C10	26.4m	LPT2	**C10**: **REC**:1.52/1.52 m **LPT2**: **Blow Count**:31-25/0.25" **REC**:0.16/0.46 m	336
		GRAVEL, fine to medium, angular to subangular, some sand to sandy, some silt, moist, brown/orange/grey (waste rock fill)			
27	C11	27.4m	LPT3	**C11**: **REC**:1.52/1.53 m **LPT3**: **Blow Count**:32-42-50 **REC**:0.08/0.46 m	335
		GRAVEL, fine to coarse grained, angular to subangular, some sand to sandy, trace to some silt, damp to dry, brown/grey (waste rock fill)			
28					334
29	C12	29.0m	LPT4	**C12**: **REC**:1.52/1.52 m **LPT4**: **Blow Count**:38-85-53 **REC**:0.46/0.45 m	333
		GRAVEL, fine to medium, angular to subangular, some sand to sandy, trace to some silt, moist, brown/orange/grey (waste rock fill)			

Environment & Infrastructure Solutions **600 - 4445 Lougheed Highway** **Burnaby, BC V5C 0E4**	LOGGED BY: HY	COMPLETION DEPTH: 39.6 m
	ENTERED BY: HY	COMPLETION DATE: 12/2/2019
	REVIEWED BY: BW	Page 3 of 4

CLIENT: Nyrstar Myra Falls Ltd.	PROJECT: Myra Falls	BOREHOLE NO: **BH19-05**
DRILLER/DRILL: Mudbay Drilling/Sonic/Becker	British Columbia, BC	PROJECT NO: NX14001C1.3
METHOD: Sonic/iBPT Drilling	NORTHING: 5494664.1 EASTING: 311880.9	ELEVATION: 362.5 m

SAMPLE TYPE ■ TUBE ◿ NO RECOVERY ☒ SPT ☰ GRAB ▨ LPT ▮ CORE

BACKFILL TYPE ▨ BENTONITE ▨ BENTONITE CHIPS ▨ BENTONITE PELLETS ▨ GROUT ▮ PIEZOMETER HEAD ▨ SAND



... two silty zones observed between 30.5 m to 33.5 m depth

33.2m

SAND, fine to coarse grained, gravelly, silty, damp, grey (till-like materials, native)

33.5m

GRAVEL, some sand to sandy, some silt, moist, grey (colluvial, native)

36.0m

SAND, fine to coarse grained, some fine gravel, silty, damp, grey (colluvial, native)

36.6m

GRAVEL, fine to coarse grained, angular to subangular, some sand, some silt, moist, grey (colluvial, native)

37.2m

GRAVEL, subrounded to subangular, some sand, silty, moist, brown (colluvial, native)

39.6m

C13: **REC**:1.52/3.05 m
LPT5: **Blow Count**:51-43-85
REC:0.34/0.46 m

LPT6: **Blow Count**:27-32-69
REC:0.3/0.46 m

C14: **REC**:1.68/3.05 m

C15: **REC**:3.05/3.04 m

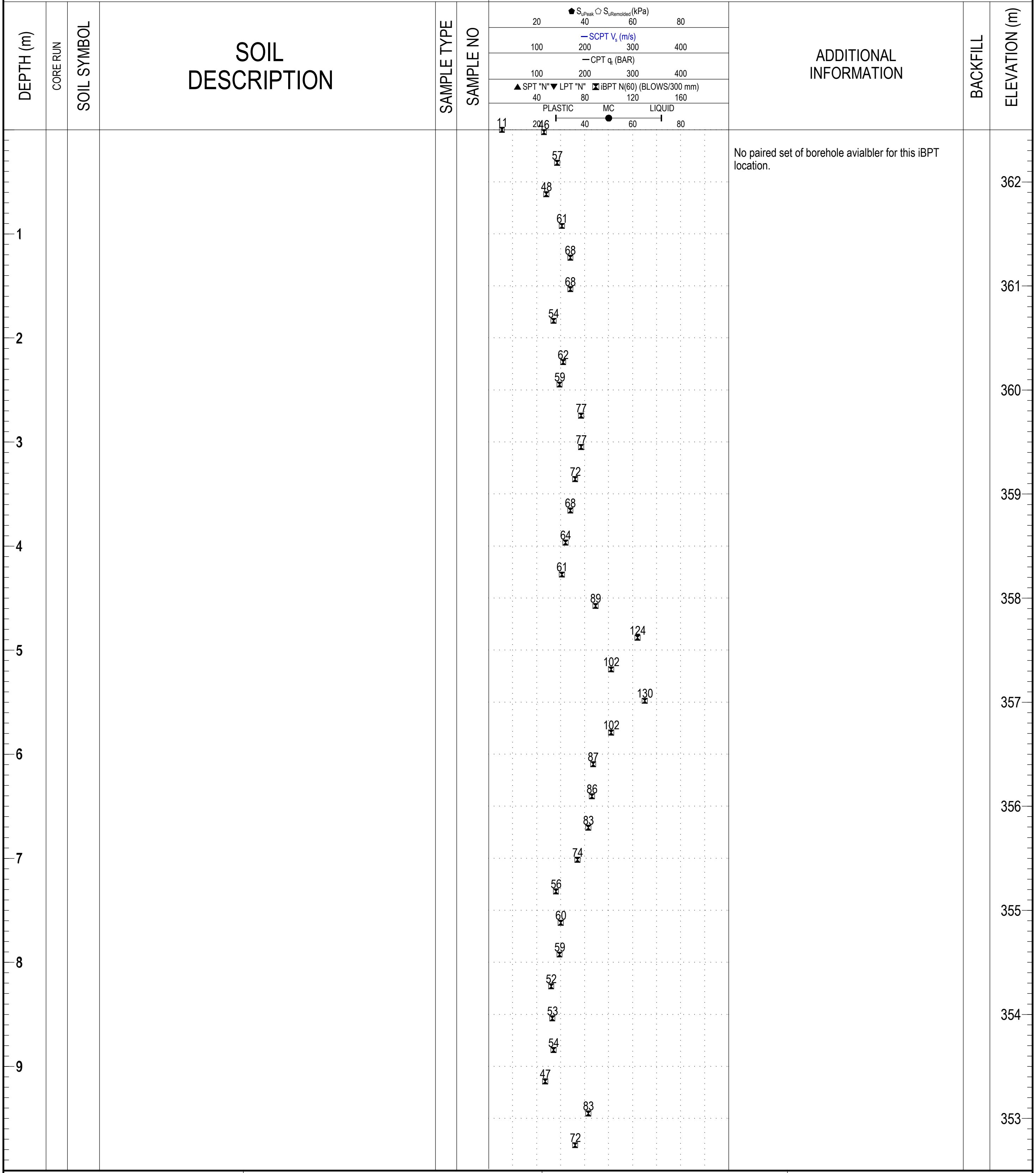
- Drilling terminated at 39.6 m depth
- No groundwater encountered
- Borehole backfilled with cement-bentonite grout mix upon completuion.

Environment & Infrastructure Solutions **600 - 4445 Lougheed Highway** **Burnaby, BC V5C 0E4**	LOGGED BY: HY	COMPLETION DEPTH: 39.6 m
	ENTERED BY: HY	COMPLETION DATE: 12/2/2019
	REVIEWED BY: BW	Page 4 of 4

CLIENT: Nyrstar Myra Falls Ltd.	PROJECT: Myra Falls	BOREHOLE NO: **BH1905B**
DRILLER/DRILL: ConeTec/Becker	British Columbia, BC	PROJECT NO: NX14001C1.3
METHOD: iBPT	NORTHING: 5494664.1 EASTING: 311875.9	ELEVATION: 362.5 m

SAMPLE TYPE ■ TUBE ▱ NO RECOVERY ☒ SPT ☰ GRAB ⬚ LPT ▮ CORE

BACKFILL TYPE ▨ BENTONITE ▨ BENTONITE CHIPS 🟥 BENTONITE PELLETS ⬚ GROUT ▮ PIEZOMETER HEAD ⬚ SAND

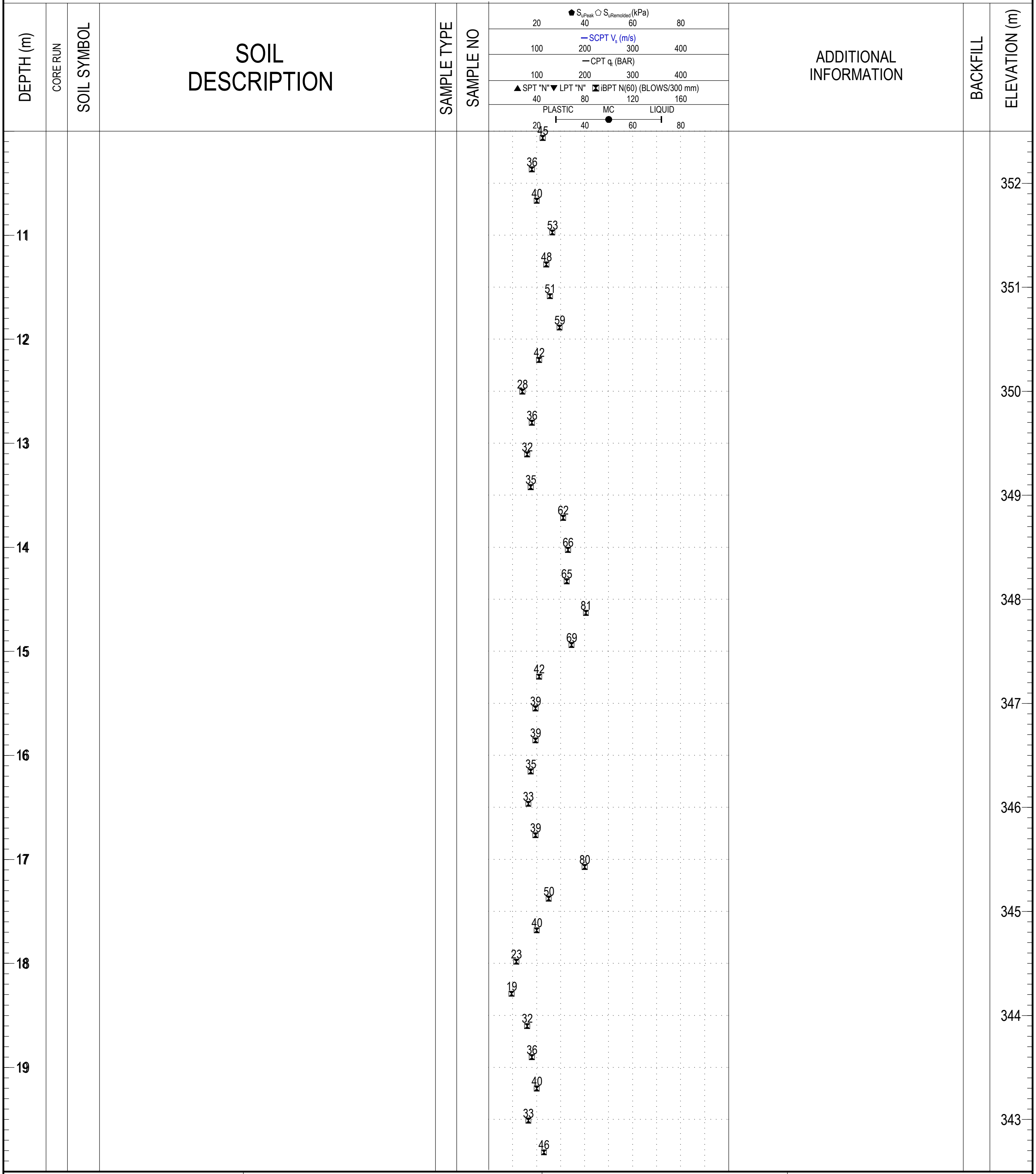


No paired set of borehole avialbler for this iBPT location.

Environment & Infrastructure Solutions 600 - 4445 Lougheed Highway Burnaby, BC V5C 0E4	LOGGED BY: HY	COMPLETION DEPTH: 22.9 m
	ENTERED BY: HY	COMPLETION DATE: 11/2/2019
	REVIEWED BY: BW	Page 1 of 3

CLIENT: Nyrstar Myra Falls Ltd.	PROJECT: Myra Falls	BOREHOLE NO: **BH1905B**
DRILLER/DRILL: ConeTec/Becker	British Columbia, BC	PROJECT NO: NX14001C1.3
METHOD: iBPT	NORTHING: 5494664.1 EASTING: 311875.9	ELEVATION: 362.5 m

SAMPLE TYPE	■ TUBE	◿ NO RECOVERY	☒ SPT	☰ GRAB	⬚ LPT	▐ CORE
BACKFILL TYPE	▨ BENTONITE	▨ BENTONITE CHIPS	🟥 BENTONITE PELLETS	⬚ GROUT	▮ PIEZOMETER HEAD	⬚ SAND

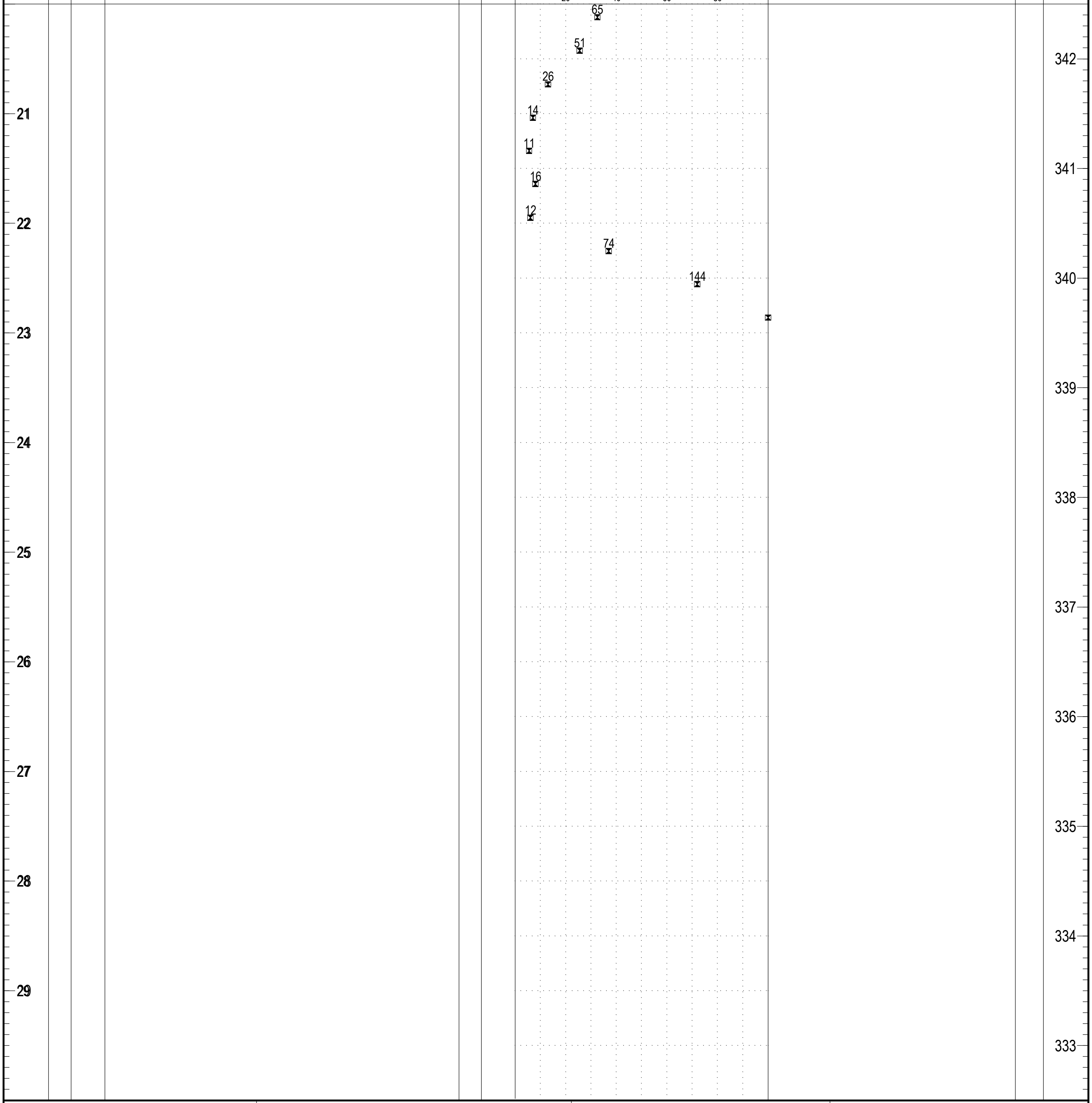


wood.	LOGGED BY: HY	COMPLETION DEPTH: 22.9 m
Environment & Infrastructure Solutions **600 - 4445 Lougheed Highway** **Burnaby, BC V5C 0E4**	ENTERED BY: HY	COMPLETION DATE: 11/2/2019
	REVIEWED BY: BW	Page 2 of 3

CLIENT: Nyrstar Myra Falls Ltd.	PROJECT: Myra Falls	BOREHOLE NO: **BH1905B**
DRILLER/DRILL: ConeTec/Becker	British Columbia, BC	PROJECT NO: NX14001C1.3
METHOD: iBPT	NORTHING: 5494664.1 EASTING: 311875.9	ELEVATION: 362.5 m

SAMPLE TYPE	■ TUBE	◿ NO RECOVERY	☒ SPT	☰ GRAB	⬚ LPT	▮ CORE
BACKFILL TYPE	▩ BENTONITE	▨ BENTONITE CHIPS	🟥 BENTONITE PELLETS	⬚ GROUT	▮ PIEZOMETER HEAD	⬚ SAND

DEPTH (m)	CORE RUN	SOIL SYMBOL	SOIL DESCRIPTION	SAMPLE TYPE	SAMPLE NO	● S_{uPeak} ○ $S_{uRemolded}$ (kPa) 20 40 60 80 — SCPT V_s (m/s) 100 200 300 400 — CPT q_t (BAR) 100 200 300 400 ▲ SPT "N" ▼ LPT "N" ☒ iBPT N(60) (BLOWS/300 mm) 40 80 120 160 PLASTIC MC LIQUID 20 40 60 80	ADDITIONAL INFORMATION	BACKFILL	ELEVATION (m)

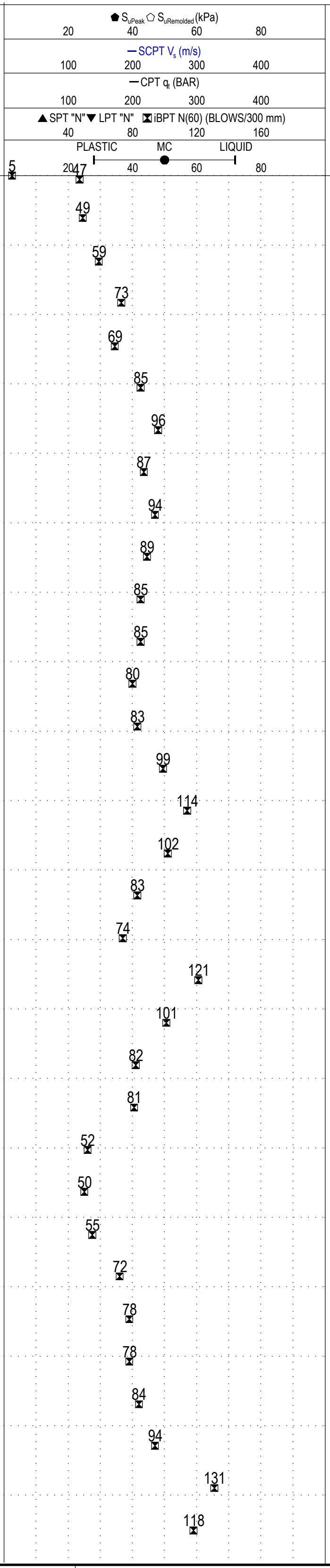


Environment & Infrastructure Solutions **600 - 4445 Lougheed Highway** **Burnaby, BC V5C 0E4**	LOGGED BY: HY	COMPLETION DEPTH: 22.9 m
	ENTERED BY: HY	COMPLETION DATE: 11/2/2019
	REVIEWED BY: BW	Page 3 of 3

CLIENT: Nyrstar Myra Falls Ltd.	PROJECT: Myra Falls	BOREHOLE NO: **BH19-06**
DRILLER/DRILL: Mudbay Drilling/Sonic/Becker	British Columbia, BC	PROJECT NO: NX14001C1.3
METHOD: Sonic/iBPT Drilling	NORTHING: 5494677.8 EASTING: 311957.7	ELEVATION: 362.4 m

SAMPLE TYPE	■ TUBE	◺ NO RECOVERY	☒ SPT	☰ GRAB	▨ LPT	▌ CORE
BACKFILL TYPE	▩ BENTONITE	▤ BENTONITE CHIPS	▦ BENTONITE PELLETS	▨ GROUT	▮ PIEZOMETER HEAD	▨ SAND

DEPTH (m)	CORE RUN	SOIL SYMBOL	SOIL DESCRIPTION	SAMPLE TYPE	SAMPLE NO		ADDITIONAL INFORMATION	BACKFILL	ELEVATION (m)
0	C1		**GRAVEL**, fine to coarse, angular to subangular, sandy, fine to coarse grained, some silt to silty, dry to damp, grey/brown (waste rock fill)				**C1**: **REC**:3.05/3.05 m - BH19-06 located at 1.0 m from iBPT19-06.		362
3	C2						**C2**: **REC**:3.05/3.05 m		359
6	C3						**C3**: **REC**:2.13/3.04 m		356
9.1m	C4		**GRAVEL**, fine to medium, angular to subangular, sandy, silty, brown/orange/grey (waste rock fill)				**C4**: **REC**:3.05/3.05 m		353



Depth (m): 1 2 3 4 5 6 7 8 9

Elevation (m): 362 361 360 359 358 357 356 355 354 353

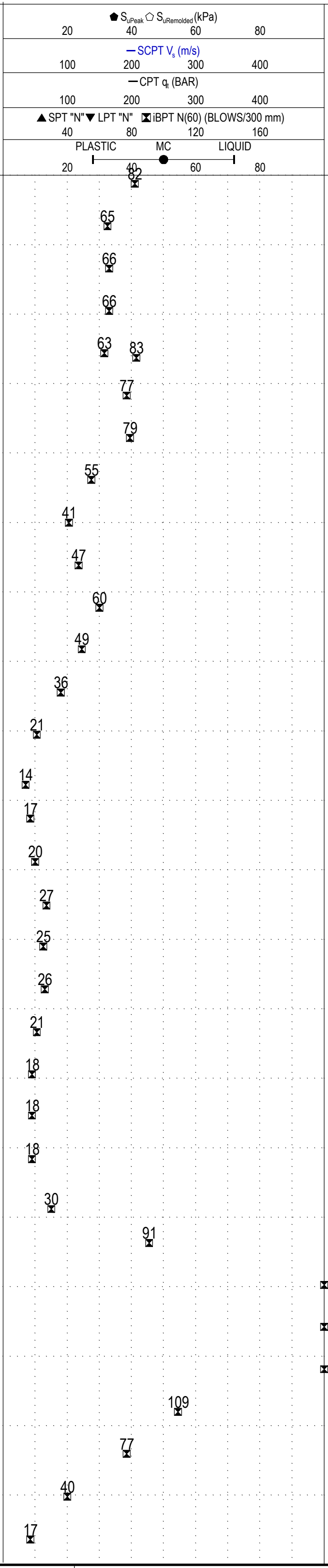
wood.	**Environment & Infrastructure Solutions** **600 - 4445 Lougheed Highway** **Burnaby, BC V5C 0E4**	LOGGED BY: HY ENTERED BY: HY REVIEWED BY: BW	COMPLETION DEPTH: 39.6 m COMPLETION DATE: 12/3/2019 Page 1 of 4

CLIENT: Nyrstar Myra Falls Ltd.	PROJECT: Myra Falls	BOREHOLE NO: **BH19-06**
DRILLER/DRILL: Mudbay Drilling/Sonic/Becker	British Columbia, BC	PROJECT NO: NX14001C1.3
METHOD: Sonic/iBPT Drilling	NORTHING: 5494677.8 EASTING: 311957.7	ELEVATION: 362.4 m

SAMPLE TYPE ■ TUBE ◿ NO RECOVERY ☒ SPT ☰ GRAB ⬚ LPT ▌ CORE

BACKFILL TYPE ▨ BENTONITE ▨ BENTONITE CHIPS 🟥 BENTONITE PELLETS ⁘ GROUT ▮ PIEZOMETER HEAD ⬚ SAND

DEPTH (m)	CORE RUN	SOIL SYMBOL	SOIL DESCRIPTION	SAMPLE TYPE	SAMPLE NO		ADDITIONAL INFORMATION	BACKFILL	ELEVATION (m)
									352
11									351
12	C5						**C5**: **REC**:2.44/3.05 m		350
13									349
14			… finer gravel from 14 m to 14.9 m depth						348
15	C6						**C6**: **REC**:2.13/3.05 m		347
16									346
17									345
18	C7						**C7**: **REC**:2.74/3.05 m		344
19			19.8m						343
			GRAVEL, fine to coarse, subrounded to subangular, some						

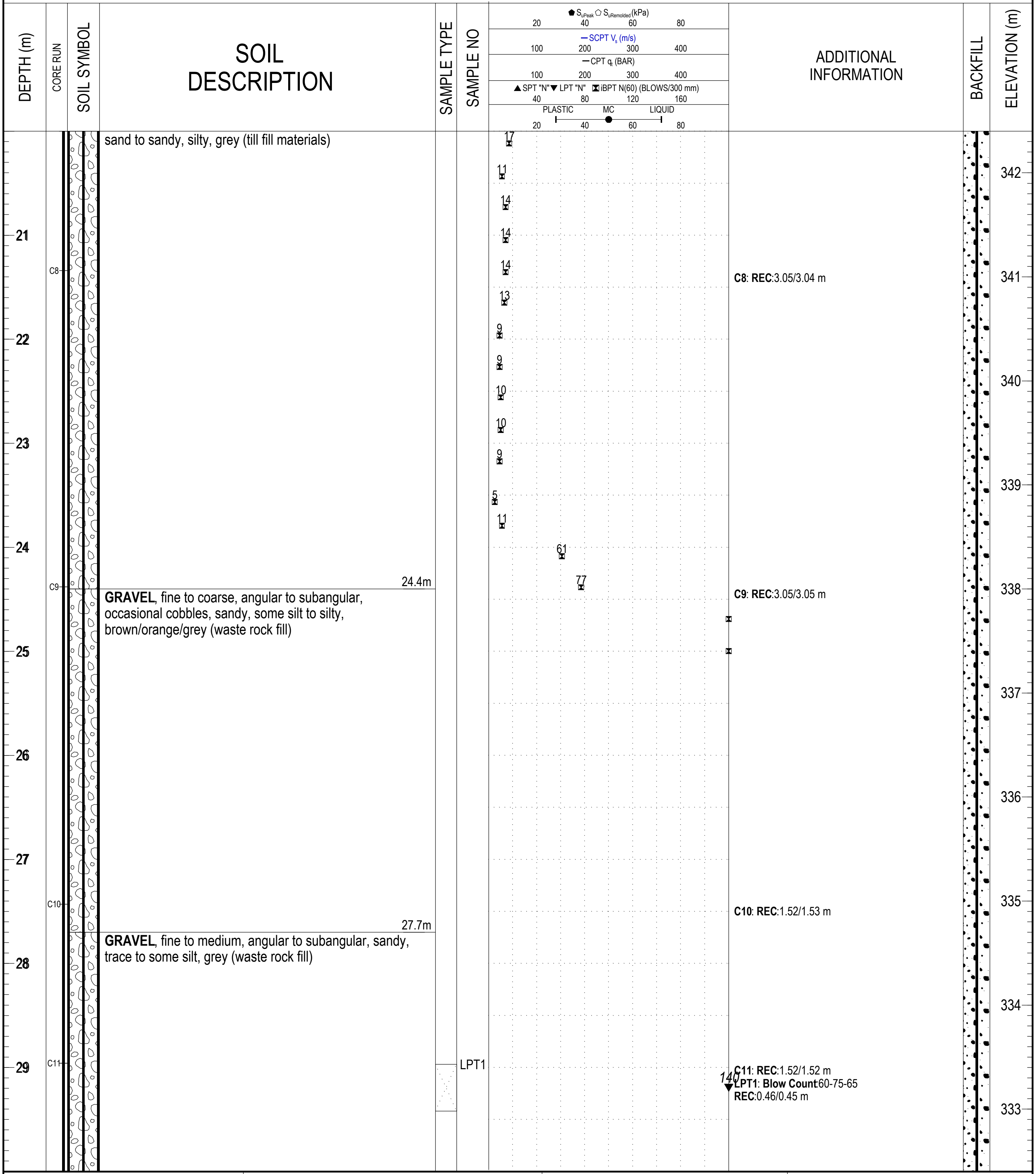


Environment & Infrastructure Solutions **600 - 4445 Lougheed Highway** **Burnaby, BC V5C 0E4**	LOGGED BY: HY	COMPLETION DEPTH: 39.6 m
	ENTERED BY: HY	COMPLETION DATE: 12/3/2019
	REVIEWED BY: BW	Page 2 of 4

CLIENT: Nyrstar Myra Falls Ltd.	PROJECT: Myra Falls	BOREHOLE NO: **BH19-06**
DRILLER/DRILL: Mudbay Drilling/Sonic/Becker	British Columbia, BC	PROJECT NO: NX14001C1.3
METHOD: Sonic/iBPT Drilling	NORTHING: 5494677.8 EASTING: 311957.7	ELEVATION: 362.4 m

SAMPLE TYPE ■ TUBE ▨ NO RECOVERY ☒ SPT ☰ GRAB ▨ LPT ▌ CORE

BACKFILL TYPE ▨ BENTONITE ▨ BENTONITE CHIPS 🟥 BENTONITE PELLETS ▨ GROUT ▌ PIEZOMETER HEAD ▨ SAND



sand to sandy, silty, grey (till fill materials)

24.4m

GRAVEL, fine to coarse, angular to subangular, occasional cobbles, sandy, some silt to silty, brown/orange/grey (waste rock fill)

27.7m

GRAVEL, fine to medium, angular to subangular, sandy, trace to some silt, grey (waste rock fill)

C8: **REC**:3.05/3.04 m

C9: **REC**:3.05/3.05 m

C10: **REC**:1.52/1.53 m

C11: **REC**:1.52/1.52 m
LPT1: **Blow Count**60-75-65
REC:0.46/0.45 m

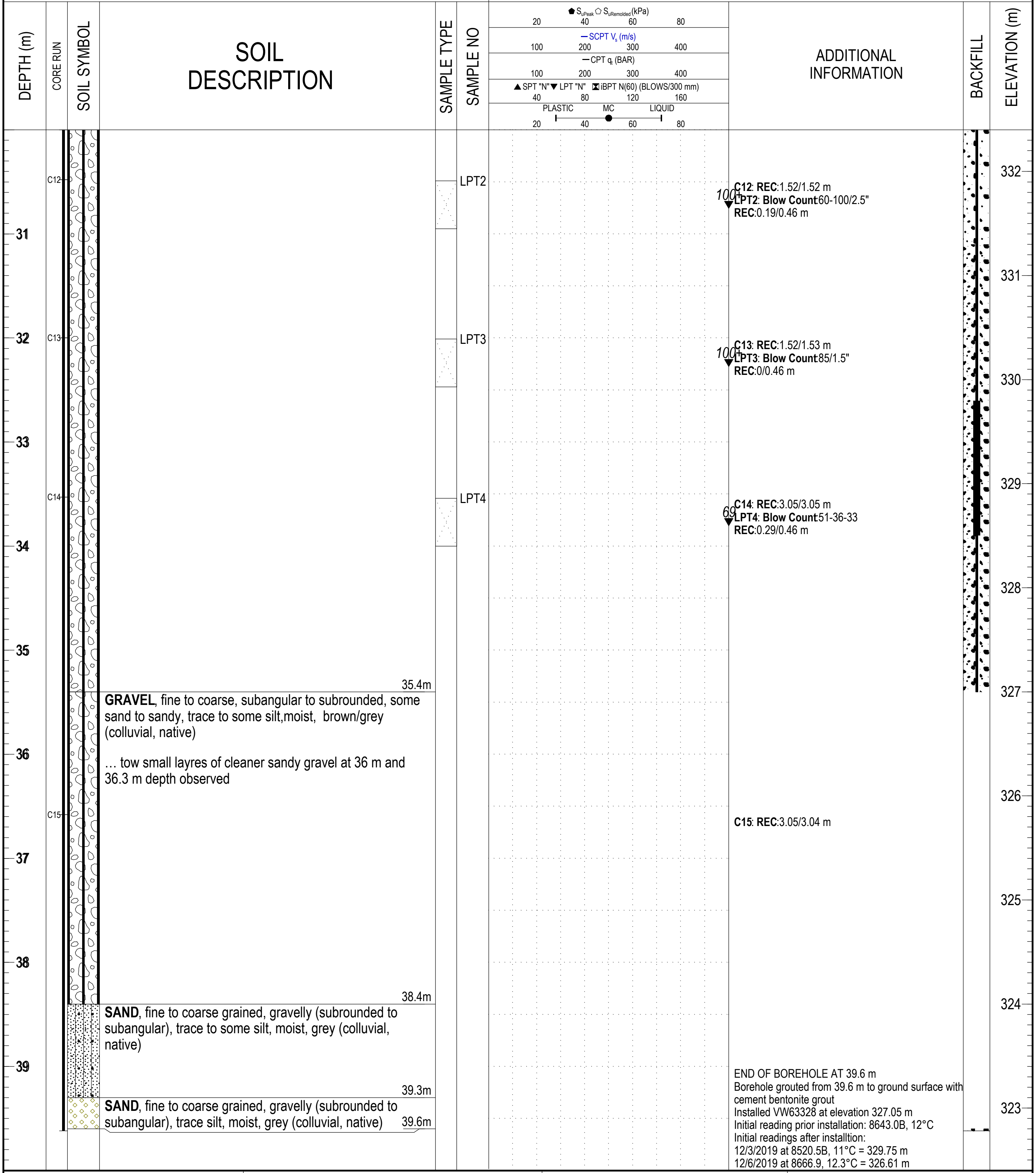
COARSE SOILS MYRA BH-2019.GPJ 1/31/20

wood.	**Environment & Infrastructure Solutions** **600 - 4445 Lougheed Highway** **Burnaby, BC V5C 0E4**	LOGGED BY: HY ENTERED BY: HY REVIEWED BY: BW
		COMPLETION DEPTH: 39.6 m COMPLETION DATE: 12/3/2019

CLIENT: Nyrstar Myra Falls Ltd.	PROJECT: Myra Falls	BOREHOLE NO: **BH19-06**
DRILLER/DRILL: Mudbay Drilling/Sonic/Becker	British Columbia, BC	PROJECT NO: NX14001C1.3
METHOD: Sonic/iBPT Drilling	NORTHING: 5494677.8 EASTING: 311957.7	ELEVATION: 362.4 m

SAMPLE TYPE ■ TUBE ◺ NO RECOVERY ☒ SPT ☰ GRAB ⬚ LPT ▌ CORE

BACKFILL TYPE ▨ BENTONITE ▨ BENTONITE CHIPS ▩ BENTONITE PELLETS ⁘ GROUT ▮ PIEZOMETER HEAD ⬚ SAND



35.4m

GRAVEL, fine to coarse, subangular to subrounded, some sand to sandy, trace to some silt,moist, brown/grey (colluvial, native)

... tow small layres of cleaner sandy gravel at 36 m and 36.3 m depth observed

38.4m

SAND, fine to coarse grained, gravelly (subrounded to subangular), trace to some silt, moist, grey (colluvial, native)

39.3m

SAND, fine to coarse grained, gravelly (subrounded to subangular), trace silt, moist, grey (colluvial, native) 39.6m

C12: **REC**:1.52/1.52 m
LPT2: **Blow Count**60-100/2.5"
REC:0.19/0.46 m

C13: **REC**:1.52/1.53 m
LPT3: **Blow Count**85/1.5"
REC:0/0.46 m

C14: **REC**:3.05/3.05 m
LPT4: **Blow Count**51-36-33
REC:0.29/0.46 m

C15: **REC**:3.05/3.04 m

END OF BOREHOLE AT 39.6 m
Borehole grouted from 39.6 m to ground surface with cement bentonite grout
Installed VW63328 at elevation 327.05 m
Initial reading prior installation: 8643.0B, 12°C
Initial readings after installtion:
12/3/2019 at 8520.5B, 11°C = 329.75 m
12/6/2019 at 8666.9, 12.3°C = 326.61 m

wood.	LOGGED BY: HY	COMPLETION DEPTH: 39.6 m
Environment & Infrastructure Solutions **600 - 4445 Lougheed Highway** **Burnaby, BC V5C 0E4**	ENTERED BY: HY	COMPLETION DATE: 12/3/2019
	REVIEWED BY: BW	Page 4 of 4

Appendix D – RST Calibration Documents

Monitor
with
Confidence

Calibration Record

RST Instruments Ltd., 11545 Kingston St., Maple Ridge, British Columbia, Canada V2X 0Z5
Tel: 604 540 1100 • Fax: 604 540 1005 • Toll Free: 1 800 665 5599 (North America only)
e-mail: info@rstinstruments.com • Website: www.rstinstruments.com

Vibrating Wire Piezometer

Customer:			Nyrstar Myra Falls Ltd	
Model:			VW2100-0.7	
Serial Number:			**VW63328**	
Mfg Number:			P116287	
Range:			700.0	kPa
Temperature:			23.0	°C
Barometric Pressure:			1022.9	millibars
Work Order Number:			222975	
Cable Length:			168	meters
Cable Markings:	264399 m	to	264567	m
Cable Colour Code:	Red / Black (Coil)		Green / White	(Thermistor)
Cable Type:			EL380004	
Thermistor Type:			3	kΩ

Applied Pressure (kPa)	First Reading (B units)	Second Reading (B units)	Average Reading (B units)	Calculated Linear (kPa)	Linearity Error (% FS)	Calculated Polynomial (kPa)	Polynomial Error (% FS)
0.0	8613	8614	8613	0.5	0.08	0.4	0.05
140.0	7956	7957	7956	139.5	-0.07	139.5	-0.06
280.0	7295	7295	7295	279.4	-0.09	279.6	-0.06
420.0	6628	6629	6628	420.3	0.05	420.5	0.07
560.0	5966	5966	5966	560.4	0.06	560.4	0.06
700.0	5307	5307	5307	699.8	-0.02	699.6	-0.05
				Max. Error (%):	0.09		0.07

Linear Calibration Factor: CF = **2.1149E-01 kPa/B unit**
Temperature Correction Factor: Tk = **9.0413E-02 kPa/°C rise**

Polynomial Gage Factors:

A = -1.2838E-07 kPa/(B unit)² **B = -2.0970E-01 kPa/B unit** **C = ____________ kPa**

Pressure is calculated with the following equations:
Linear: $P = CF(L_0 - L) - Tk(T_0 - T) + (S_0 - S)$
Polynomial: $P = A(L^2) + B(L) + C - Tk(T_0 - T) + (S_0 - S)$

Users must establish site zero readings for calculation purposes
Polynomial $C = -[A(L_0^2) + B(L_0)]$

L_0, L = initial (installation) and current readings, in B units
T_0, T = initial (installation) and current temperature, in °C
S_0, S = initial (installation) and current barometric pressure readings, in kPa
B units = B scale output of VW 2102, VW 2104, VW 2106 and DT 2011 readouts
B units = $Hz^2/1000$ ie: 1700 Hz = 2890 B units

	Date (dd/mm/yy)	VW Reading (B units)	Temperature (°C)	Baro (mbar)
Shipped Zero Readings:	26-Nov-19	8631	20.1	1012.0

This instrument has been calibrated using standards traceable to the NIST in compliance with ANSI Z540-1

Technician: O. Nygren Date: 26-Nov-19

rst INSTRUMENTS

Monitor
with
Confidence

Calibration Record

RST Instruments Ltd., 11545 Kingston St., Maple Ridge, British Columbia, Canada V2X 0Z5
Tel: 604 540 1100 • Fax: 604 540 1005 • Toll Free: 1 800 665 5599 (North America only)
e-mail: info@rstinstruments.com • Website: www.rstinstruments.com

Vibrating Wire Piezometer

Customer:			Nyrstar Myra Falls Ltd	
Model:			VW2100-0.7	
Serial Number:			**VW63327**	
Mfg Number:			P116288	
Range:			700.0	kPa
Temperature:			23.0	°C
Barometric Pressure:			1022.9	millibars
Work Order Number:			222975	
Cable Length:			147	meters
Cable Markings:	264249 m	to	264397	m
Cable Colour Code:	Red / Black (Coil)		Green / White	(Thermistor)
Cable Type:			EL380004	
Thermistor Type:			3	kΩ

Applied Pressure (kPa)	First Reading (B units)	Second Reading (B units)	Average Reading (B units)	Calculated Linear (kPa)	Linearity Error (% FS)	Calculated Polynomial (kPa)	Polynomial Error (% FS)
0.0	9346	9345	9345	0.9	0.13	0.1	0.02
140.0	8695	8695	8695	139.8	-0.03	139.9	-0.01
280.0	8042	8043	8042	279.0	-0.14	279.6	-0.05
420.0	7383	7384	7384	419.7	-0.05	420.3	0.04
560.0	6726	6726	6726	560.0	0.00	560.2	0.03
700.0	6067	6068	6068	700.6	0.09	699.8	-0.02
				Max. Error (%):	0.14		0.05

Linear Calibration Factor: **CF = 2.1347E-01 kPa/B unit**
Temperature Correction Factor: **Tk = 2.2868E-01 kPa/°C rise**

Polynomial Gage Factors:

A = -5.2957E-07 kPa/(B unit)² **B = -2.0531E-01 kPa/B unit** **C = ________ kPa**

Pressure is calculated with the following equations:
Linear: $P = CF(L_0 - L) - Tk(T_0 - T) + (S_0 - S)$
Polynomial: $P = A(L^2) + B(L) + C - Tk(T_0 - T) + (S_0 - S)$

Users must establish site zero readings for calculation purposes
Polynomial $C = -[A(L_0^2) + B(L_0)]$

L_0, L = initial (installation) and current readings, in B units
T_0, T = initial (installation) and current temperature, in °C
S_0, S = initial (installation) and current barometric pressure readings, in kPa
B units = B scale output of VW 2102, VW 2104, VW 2106 and DT 2011 readouts
B units = Hz²/1000 ie: 1700 Hz = 2890 B units

	Date (dd/mm/yy)	VW Reading (B units)	Temperature (°C)	Baro (mbar)
Shipped Zero Readings:	26-Nov-19	9363	19.9	1012.0

This instrument has been calibrated using standards traceable to the NIST in compliance with ANSI Z540-1

Technician: O. Nygren Date: 26-Nov-19

Monitor
with
Confidence

Calibration Record

RST Instruments Ltd., 11545 Kingston St., Maple Ridge, British Columbia, Canada V2X 0Z5
Tel: 604 540 1100 • Fax: 604 540 1005 • Toll Free: 1 800 665 5599 (North America only)
e-mail: info@rstinstruments.com • Website: www.rstinstruments.com

Vibrating Wire Piezometer

Customer: Nyrstar Myra Falls Ltd
Model: VW2100-0.7
Serial Number: **VW63326**
Mfg Number: P116261
Range: 700.0 kPa
Temperature: 23.0 °C
Barometric Pressure: 1023.0 millibars
Work Order Number: 222975
Cable Length: 85 meters
Cable Markings: 802326 m to 802411 m
Cable Colour Code: Red / Black (Coil) Green / White (Thermistor)
Cable Type: EL380004
Thermistor Type: 3 kΩ

Applied Pressure (kPa)	First Reading (B units)	Second Reading (B units)	Average Reading (B units)	Calculated Linear (kPa)	Linearity Error (% FS)	Calculated Polynomial (kPa)	Polynomial Error (% FS)
0.0	9596	9598	9597	1.3	0.18	0.2	0.03
140.0	8937	8938	8937	139.6	-0.06	139.8	-0.03
280.0	8273	8274	8273	278.8	-0.17	279.7	-0.05
420.0	7602	7603	7603	419.4	-0.08	420.3	0.05
560.0	6932	6933	6932	560.0	-0.01	560.2	0.03
700.0	6260	6260	6260	700.9	0.13	699.8	-0.03
				Max. Error (%):	0.18		0.05

Linear Calibration Factor: **CF = 2.0966E-01 kPa/B unit**
Temperature Correction Factor: **Tk = 2.0914E-01 kPa/°C rise**

Polynomial Gage Factors:

A = -7.3890E-07 kPa/(B unit)² **B = -1.9794E-01 kPa/B unit** **C = ____________ kPa**

Pressure is calculated with the following equations:
Linear: $P = CF(L_0 - L) - Tk(T_0 - T) + (S_0 - S)$
Polynomial: $P = A(L^2) + B(L) + C - Tk(T_0 - T) + (S_0 - S)$

Users must establish site zero readings for calculation purposes
Polynomial $C = -[A(L_0^2) + B(L_0)]$

L_0, L = initial (installation) and current readings, in B units
T_0, T = initial (installation) and current temperature, in °C
S_0, S = initial (installation) and current barometric pressure readings, in kPa
B units = B scale output of VW 2102, VW 2104, VW 2106 and DT 2011 readouts
B units = $Hz^2/1000$ ie: 1700 Hz = 2890 B units

	Date (dd/mm/yy)	VW Reading (B units)	Temperature (°C)	Baro (mbar)
Shipped Zero Readings:	26-Nov-19	9631	20.0	1012.0

This instrument has been calibrated using standards traceable to the NIST in compliance with ANSI Z540-1

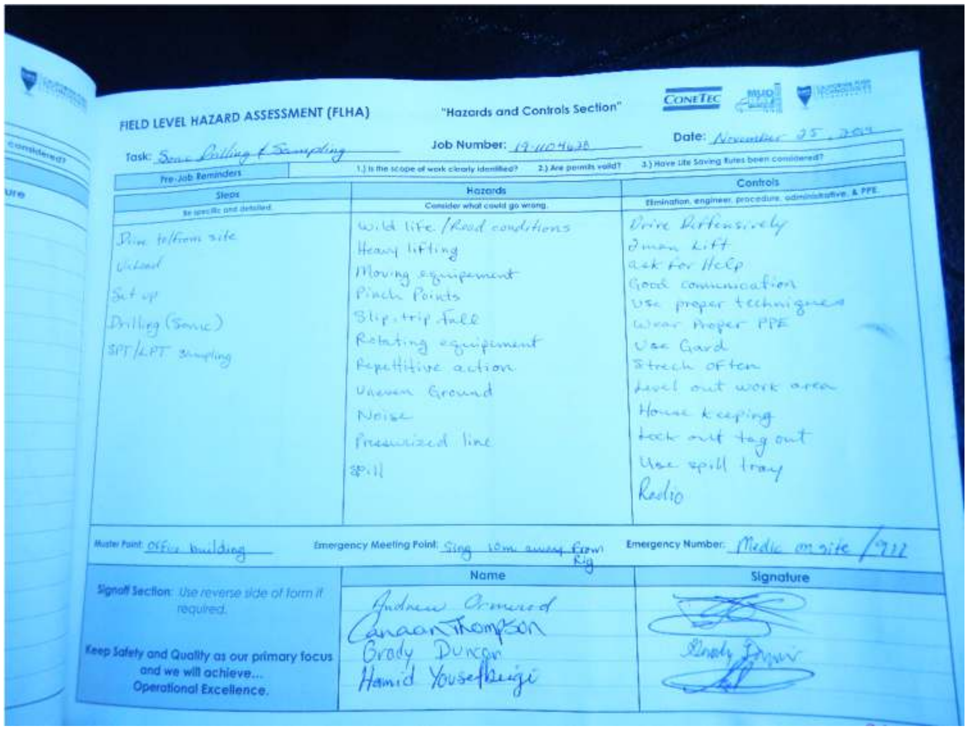
Technician: O. Nygren Date: 26-Nov-19

Appendix E – SI Program Photographs

LIST OF PHOTOS

LIST OF PHOTOS

BH19_01 DRILLING AND SEISMIC INVESTIGATION



FIELD LEVEL HAZARD ASSESSMENT (FLHA) "Hazards and Controls Section" CONETEC

Task: Sonic Drilling & Sampling Job Number: 19-1104638 Date: November 25, 2019

Pre-Job Reminders 1.) Is the scope of work clearly identified? 2.) Are permits valid? 3.) Have Life Saving Rules been considered?

Steps Be specific and detailed	Hazards Consider what could go wrong	Controls Elimination, engineer, procedure, administrative, & PPE
Drive to/from site	Wild life /Road conditions	Drive Deffensively
Unload	Heavy lifting	2 man Lift
Set up	Moving equipement	ask for Help
Drilling (Sonic)	Pinch Points	Good communication
SPT/LPT Sampling	Slip, trip fall	Use proper techniques
	Rotating equipement	Wear Proper PPE
	Repetitive action	Use Gard
	Uneven Ground	Strech often
	Noise	Level out work area
	Pressurized line	House keeping
	Spill	Lock out tag out
		Use spill tray
		Radio

Muster Point: Office building Emergency Meeting Point: Sing 10m away from Rig Emergency Number: Medic on site / 911

Signoff Section: Use reverse side of form if required. Keep Safety and Quality as our primary focus and we will achieve... Operational Excellence.	Name	Signature
	Andrew Ormerod	
	Canaan Thompson	
	Grady Duncan	Grady Duncan
	Hamid Yousefbeigi	

PHOTO 1: Signed ConeTec/Mud Bay Drilling Field Level Hazard Assessment Form (November 25, 2019)

PHOTO 2: BH19_01 Drilling Location on Lynx Dam (November 25, 2019)

2019 Site Investigation Photographs

Drawn: N/A | Scale: N/A | Date: Nov. 2019 | Project: NX14001C1.3 | Figure 1

PHOTO 3: BH19_01 Representative Sample Depth 15'-20' (November 25, 2019)

PHOTO 4: MASW19-02 Seismic Investigation (November 25, 2019)

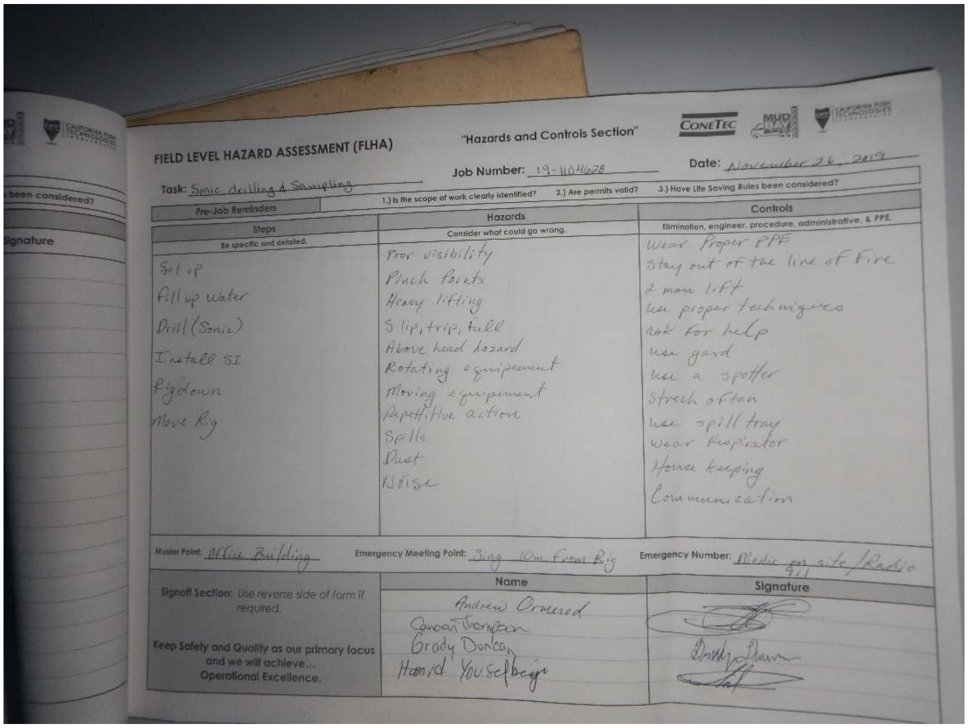
wood.

nyrstar

2019 Site Investigation Photographs

Drawn: N/A	Scale: N/A	Date: Nov. 2019	Project: NX14001C1.3	Figure 2

BH19_01 DRILLING CONT' AND SI INSTALLATION, BH19_04 LOCATION, SEISMIC INVESTIGATION



FIELD LEVEL HAZARD ASSESSMENT (FLHA) "Hazards and Controls Section"

Task: Sonic drilling & Sampling

Job Number: 19-1104628

Date: November 26, 2019

Pre-Job Reminders 1.) Is the scope of work clearly identified? 2.) Are permits valid? 3.) Have Life Saving Rules been considered?

Steps Be specific and detailed.	Hazards Consider what could go wrong.	Controls Elimination, engineer, procedure, administrative, & PPE.
Set up	Poor visibility	Wear Proper PPE
fill up water	Pinch Points	Stay out of the line of Fire
Drill (Sonic)	Heavy lifting	2 man lift
Install SI	Slip, trip, fall	use proper techniques
Rigdown	Above head hazard	ask for help
Move Rig	Rotating equipement	use gard
	Moving equipment	use a spotter
	Repetitive action	Strech often
	Spills	use spill tray
	Dust	wear Respirator
	Noise	House keeping
		Communication

Muster Point: Office Building

Emergency Meeting Point: Sing 10m From Rig

Emergency Number: Medic on site/Radio 911

Signoff Section: Use reverse side of form if required.	Name	Signature
	Andrew Ormerod	
	Cameron Thompson	
Keep Safety and Quality as our primary focus and we will achieve... Operational Excellence.	Grady Duncan	
	Hamid Yousefbeygi	

PHOTO 5: Signed ConeTec/Mud Bay Drilling Field Level Hazard Assessment Form (November 26, 2019)

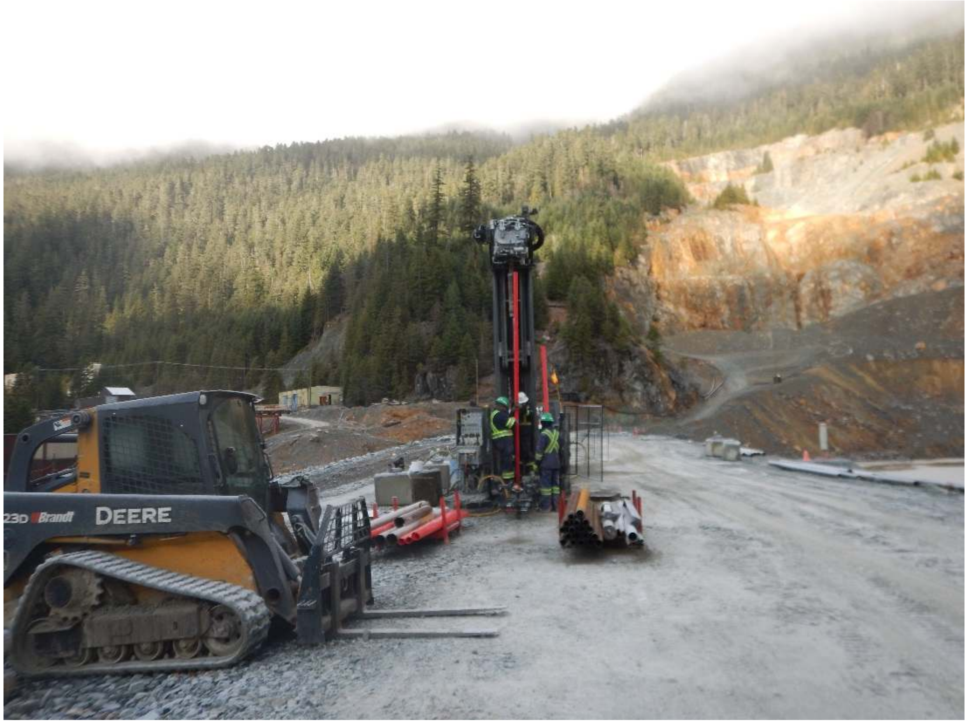


PHOTO 6: BH19_01 Drilling Location on Lynx Dam (November 26, 2019)

wood.

nyrstar

2019 Site Investigation Photographs

Drawn: N/A	Scale: N/A	Date: Nov. 2019	Project: NX14001C1.3	Figure 3

PHOTO 7: BH19_01 Representative Sample Depth 80'-90' (November 26, 2019)

PHOTO 8: BH19_01 Representative Sample Depth 90'-100' (November 26, 2019)

wood.

nyrstar

2019 Site Investigation Photographs

Drawn: N/A	Scale: N/A	Date: Nov. 2019	Project: NX14001C1.3	Figure 4

PHOTO 9: Mifflin Surveys on Site (November 26, 2019)

PHOTO 10: BH19_01 SI Installation (November 26, 2019)

wood.		2019 Site Investigation Photographs		
nyrstar				
Drawn: N/A	Scale: N/A	Date: Nov. 2019	Project: NX14001C1.3	Figure 5

PHOTO 11: Excavator Creating Path for MASW19-02 Seismic Investigation (November 26, 2019)

PHOTO 12: Excavator removing large rocks along Path for MASW19-02 Seismic Investigation (November 26, 2019)

2019 Site Investigation Photographs

Drawn: N/A	Scale: N/A	Date: Nov. 2019	Project: NX14001C1.3	Figure 6

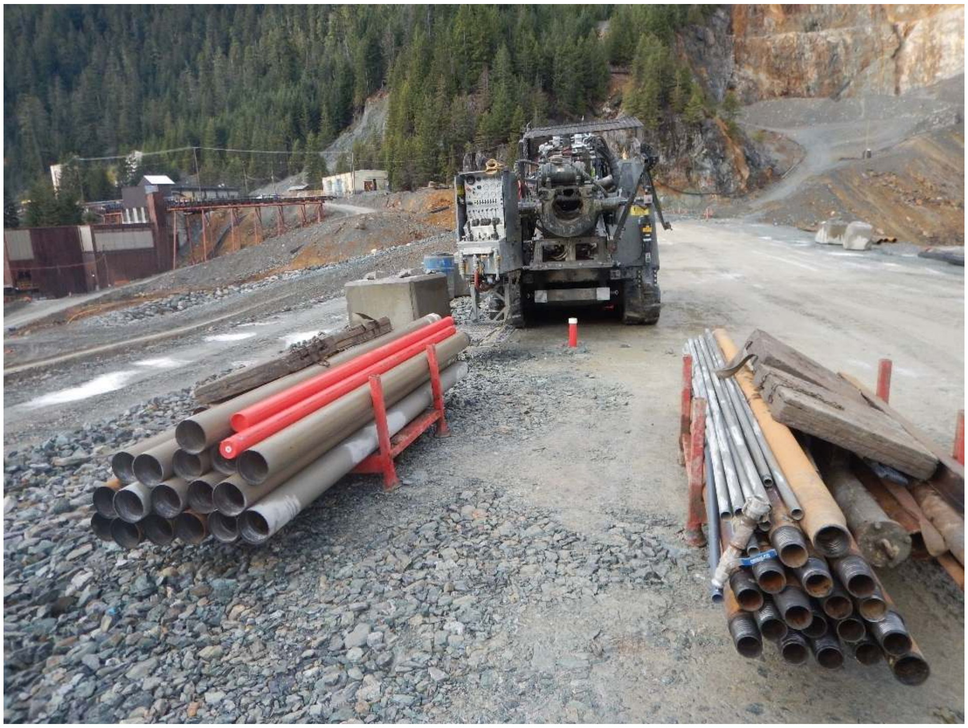


PHOTO 13: BH19_01 SI Installation upon completion (November 26, 2019)

PHOTO 14: BH19_01 SI Installation upon completion (November 26, 2019)

wood.

nyrstar

2019 Site Investigation Photographs

Drawn: N/A	Scale: N/A	Date: Nov. 2019	Project: NX14001C1.3	Figure 7

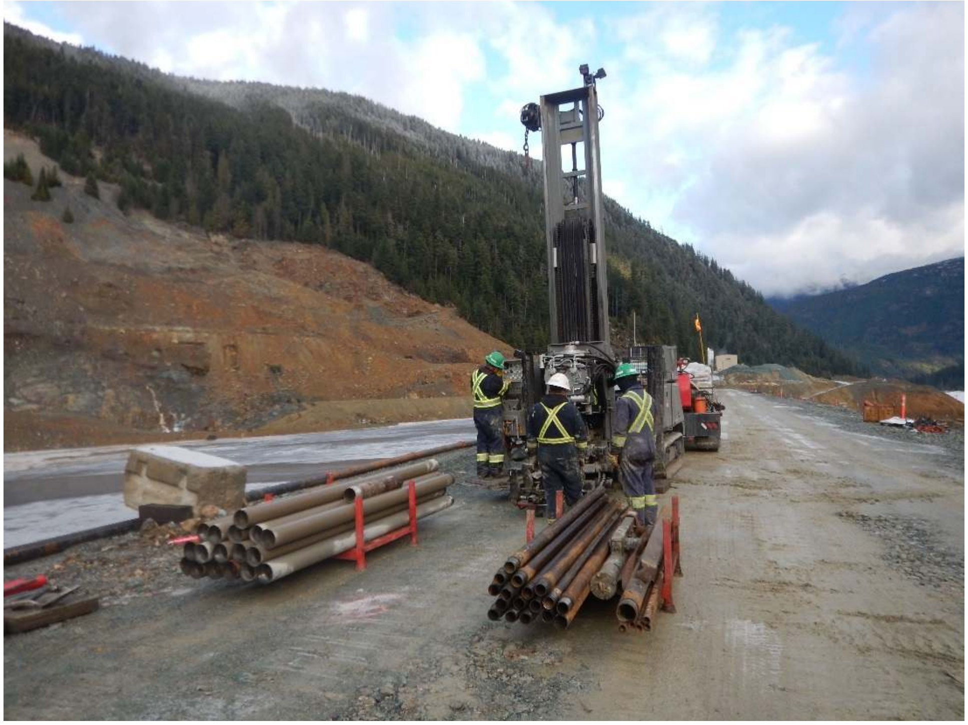


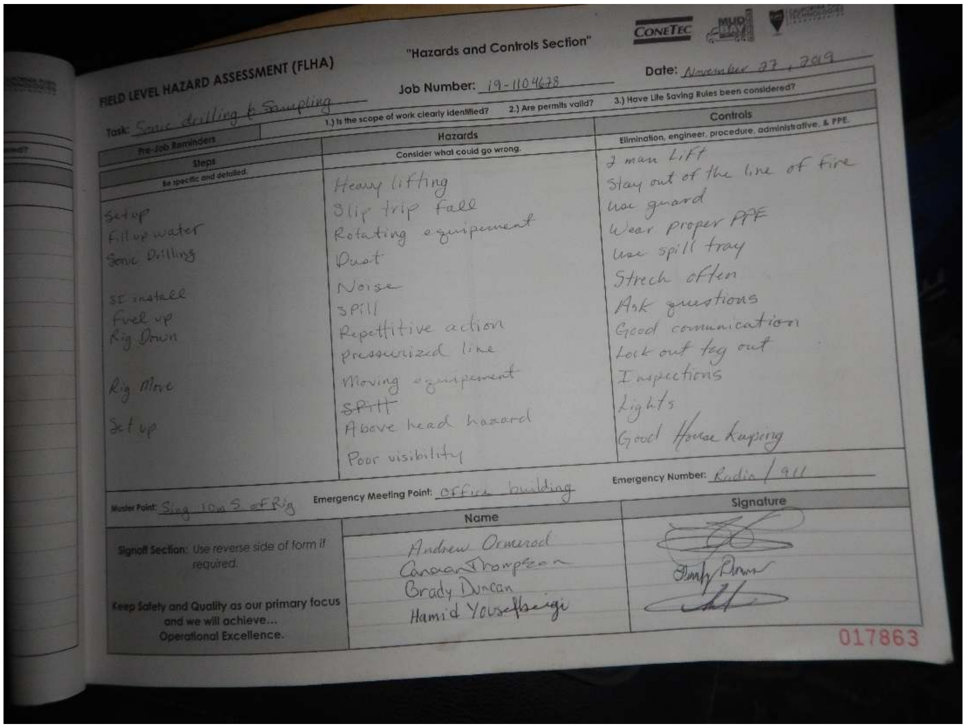
PHOTO 15: BH19_04 Location (November 26, 2019)

PHOTO 16: BH19_01 Safety Barriers (November 26, 2019)

2019 Site Investigation Photographs

Drawn: N/A	Scale: N/A	Date: Nov. 2019	Project: NX14001C1.3	Figure 8

BH19_04 AND BH19_02 DRILLING



FIELD LEVEL HAZARD ASSESSMENT (FLHA)

"Hazards and Controls Section"

Task: Sonic drilling & Sampling

Job Number: 19-1104678

Date: November 27, 2019

Pre-Job Reminders

1.) Is the scope of work clearly identified? 2.) Are permits valid? 3.) Have Life Saving Rules been considered?

Steps Be specific and detailed.	Hazards Consider what could go wrong.	Controls Elimination, engineer, procedure, administrative, & PPE.
	Heavy lifting	2 man Lift
Setup	Slip trip fall	Stay out of the line of fire
Fill up water	Rotating equipement	use guard
Sonic Drilling	Dust	Wear proper PPE
SI install	Noise	use spill tray
Fuel up	Spill	Strech often
Rig Down	Repettitive action	Ask questions
	pressurized line	Good communication
Rig Move	Moving equipement	Lock out tag out
	~~Spill~~	Inspections
Set up	Above head hazard	Lights
	Poor visibility	Good House keeping

Muster Point: Sign 10m S of Rig

Emergency Meeting Point: office building

Emergency Number: Radio / 911

Signoff Section: Use reverse side of form if required. Keep Safety and Quality as our primary focus and we will achieve... Operational Excellence.	Name	Signature
	Andrew Ormerod	
	Canaan Thompson	
	Brady Duncan	
	Hamid Yousefbeigi	

017863

PHOTO 17: Signed ConeTec/Mud Bay Drilling Field Level Hazard Assessment Form (November 27, 2019)

PHOTO 18: BH19_04 Drilling Location on Lynx Dam (November 27, 2019)

wood.

nyrstar

2019 Site Investigation Photographs

Drawn: N/A	Scale: N/A	Date: Nov. 2019	Project: NX14001C1.3	Figure 9

PHOTO 19: BH19_04 Drilling Location on Lynx Dam (November 27, 2019)

PHOTO 20: BH19_04 Typical SI Casing Anchor (November 27, 2019)

2019 Site Investigation Photographs

Drawn: N/A	Scale: N/A	Date: Nov. 2019	Project: NX14001C1.3	Figure 10

PHOTO 21: BH19_04 Representative Sample Depth 140'-150' (November 27, 2019)

PHOTO 22: BH19_04 Safety Barrier placed upon completion (November 27, 2019)

2019 Site Investigation Photographs

Drawn: N/A	Scale: N/A	Date: Nov. 2019	Project: NX14001C1.3	Figure 11

PHOTO 23: BH19_02 Drilling Location (November 27, 2019)

PHOTO 24: BH19_02 Representative Sample Depth 20'-30' (November 27, 2019)

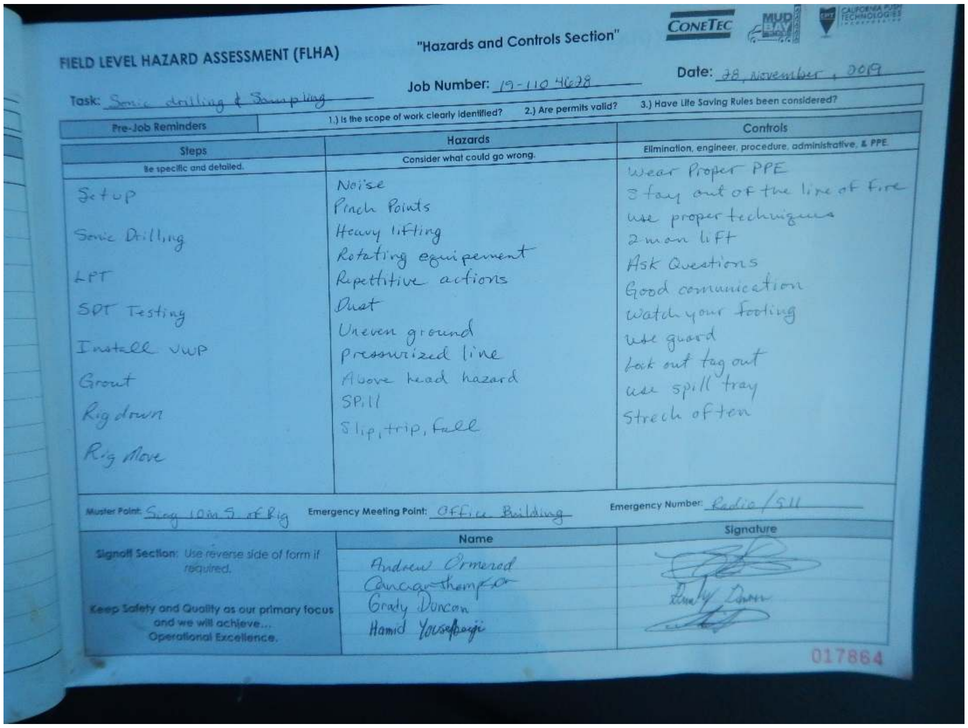
wood.

nyrstar

2019 Site Investigation Photographs

Drawn: N/A	Scale: N/A	Date: Nov. 2019	Project: NX14001C1.3	Figure 12

BH19_02 DRILLING



CONETEC MUD BAY CALIFORNIA PUSH TECHNOLOGIES

FIELD LEVEL HAZARD ASSESSMENT (FLHA) "Hazards and Controls Section"

Task: Sonic drilling & Sampling

Job Number: 19-110 4628

Date: 28, November, 2019

Pre-Job Reminders: 1.) Is the scope of work clearly identified? 2.) Are permits valid? 3.) Have Life Saving Rules been considered?

Steps Be specific and detailed.	Hazards Consider what could go wrong.	Controls Elimination, engineer, procedure, administrative, & PPE
Setup	Noise	Wear Proper PPE
Sonic Drilling	Pinch Points	Stay out of the line of fire
LPT	Heavy lifting	use proper techniques
SPT Testing	Rotating equipement	2 man lift
Install VWP	Repettitive actions	Ask Questions
Grout	Dust	Good comunication
Rig down	Uneven ground	Watch your footing
Rig Move	pressurized line	use guard
	Above head hazard	Lock out tag out
	SPill	use spill tray
	Slip, trip, fall	Strech often

Muster Point: Sing 10m S of Rig

Emergency Meeting Point: Office Building

Emergency Number: Radio/911

Signoff Section: Use reverse side of form if required.

Keep Safety and Quality as our primary focus and we will achieve... Operational Excellence.

Name	Signature
Andrew Ormerod	
Conagan thompson	
Grady Duncan	Grady Duncan
Hamid Yousefbeigi	

017864

PHOTO 25: Signed ConeTec/Mud Bay Drilling Field Level Hazard Assessment Form (November 28, 2019)

PHOTO 26: BH19_02 Representative Sample (November 28, 2019)

wood.

nyrstar

2019 Site Investigation Photographs

Drawn: N/A	Scale: N/A	Date: Nov. 2019	Project: NX14001C1.3	Figure 13

PHOTO 27: BH19_02 Soil Core Logs (November 28, 2019)

PHOTO 28: BH19_02 iBPT Refusal at 78' - 80' (November 28, 2019)

2019 Site Investigation Photographs

Drawn: N/A	Scale: N/A	Date: Nov. 2019	Project: NX14001C1.3	Figure 14

PHOTO 29: BH19_02 LPT Depth 95' - 95.5' (November 28, 2019)

PHOTO 30: BH19_02 LPT Depth 95' - 95.5' (November 28, 2019)

2019 Site Investigation Photographs

Drawn: N/A	Scale: N/A	Date: Nov. 2019	Project: NX14001C1.3	Figure 15

PHOTO 31: BH19_02 LPT Depth 105' - 106.5' (November 28, 2019)

PHOTO 32: BH19_02 LPT Depth 105' - 106.5' (November 28, 2019)

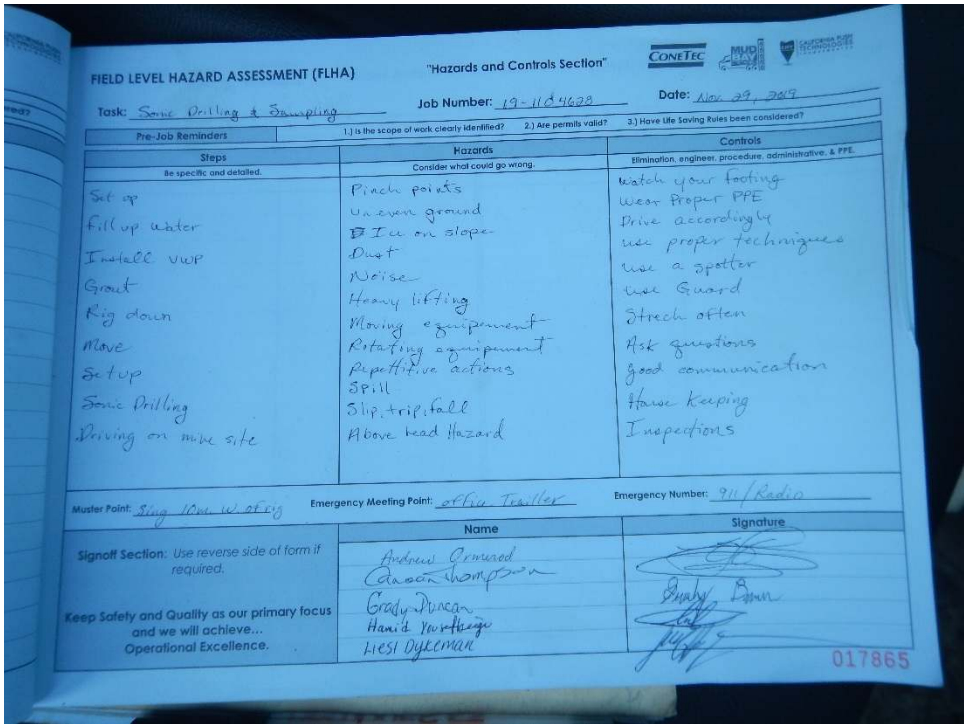
wood.

nyrstar

2019 Site Investigation Photographs

Drawn: N/A	Scale: N/A	Date: Nov. 2019	Project: NX14001C1.3	Figure 16

BH19_02 DRILLING AND VWP INSTALLATION



FIELD LEVEL HAZARD ASSESSMENT (FLHA) "Hazards and Controls Section"

CONETEC MUD BAY

Task: Sonic Drilling & Sampling
Job Number: 19-1104628
Date: Nov. 29, 2019

Pre-Job Reminders: 1.) Is the scope of work clearly identified? 2.) Are permits valid? 3.) Have Life Saving Rules been considered?

Steps Be specific and detailed.	Hazards Consider what could go wrong.	Controls Elimination, engineer, procedure, administrative, & PPE.
Set up	Pinch points	Watch your footing
Fill up water	Uneven ground	Wear Proper PPE
Install VWP	Ice on slope	Drive accordingly
Grout	Dust	use proper techniques
Rig down	Noise	use a spotter
Move	Heavy lifting	use Guard
Setup	Moving equipment	Strech often
Sonic Drilling	Rotating equipment	Ask questions
Driving on mine site	Repettitive actions	good communication
	Spill	House keeping
	Slip, trip, fall	Inspections
	Above head Hazard	

Muster Point: Sling 10m W. of rig
Emergency Meeting Point: office Trailer
Emergency Number: 911/Radio

Signoff Section: Use reverse side of form if required. Keep Safety and Quality as our primary focus and we will achieve... Operational Excellence.	Name	Signature
	Andrew Ormrod	
	Aaron Thompson	
	Grady Duncan	Grady Duncan
	Hamid Yousefbeigi	
	Liesl Dykeman	

017865

PHOTO 33: Signed ConeTec/Mud Bay Drilling Field Level Hazard Assessment Form (November 29, 2019)

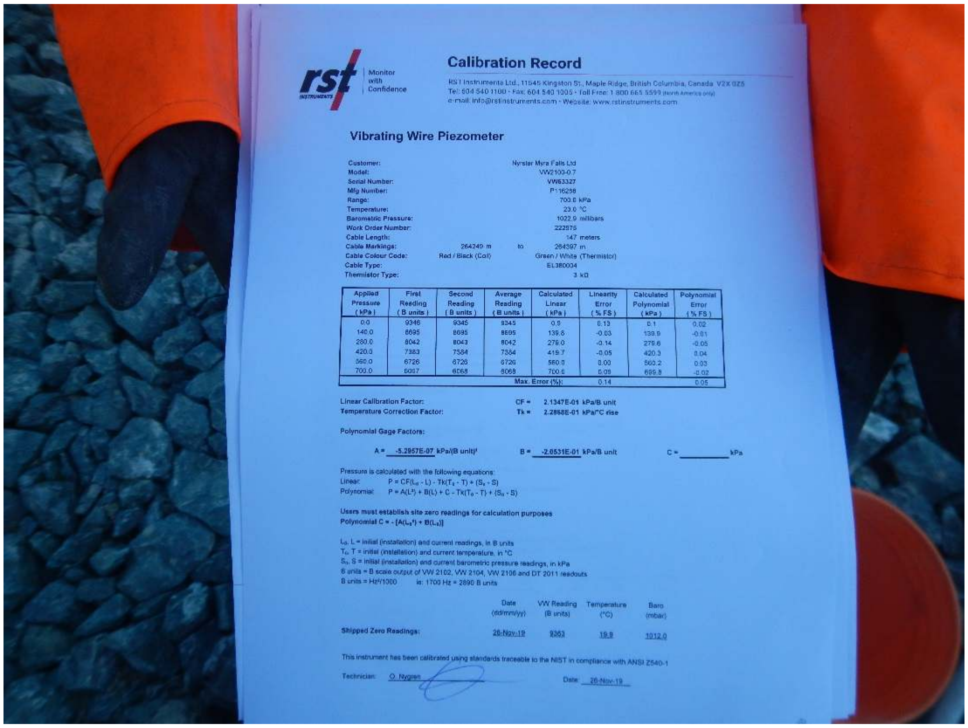
PHOTO 34: BH19_02 VWP Installation (November 29, 2019)

wood.

nyrstar

2019 Site Investigation Photographs

Drawn: N/A | Scale: N/A | Date: Nov. 2019 | Project: NX14001C1.3 | Figure 17



rst INSTRUMENTS | Monitor with Confidence

Calibration Record

RST Instruments Ltd., 11545 Kingston St., Maple Ridge, British Columbia, Canada V2X 0Z5
Tel: 604 540 1100 · Fax: 604 540 1005 · Toll Free: 1 800 665 5599 (North America only)
e-mail: info@rstinstruments.com · Website: www.rstinstruments.com

Vibrating Wire Piezometer

Customer:		Nyrstar Myra Falls Ltd	
Model:		VW2100-0.7	
Serial Number:		VW63327	
Mfg Number:		P116258	
Range:		700.0	kPa
Temperature:		23.0	°C
Barometric Pressure:		1022.9	millibars
Work Order Number:		222576	
Cable Length:		147	meters
Cable Markings:	264249 m to	264397	m
Cable Colour Code:	Red / Black (Coil)	Green / White	(Thermistor)
Cable Type:		EL380004	
Thermistor Type:		3	kΩ

Applied Pressure (kPa)	First Reading (B units)	Second Reading (B units)	Average Reading (B units)	Calculated Linear (kPa)	Linearity Error (% FS)	Calculated Polynomial (kPa)	Polynomial Error (% FS)
0.0	9346	9345	9345	0.9	0.13	0.1	0.02
140.0	8695	8695	8695	139.8	-0.03	139.9	-0.01
280.0	8042	8043	8042	279.0	-0.14	279.6	-0.05
420.0	7383	7384	7384	419.7	-0.05	420.3	0.04
560.0	6726	6726	6726	560.0	0.00	560.2	0.03
700.0	6067	6068	6068	700.6	0.09	699.8	-0.02
				Max. Error (%):	0.14		0.05

Linear Calibration Factor: CF = 2.1347E-01 kPa/B unit
Temperature Correction Factor: Tk = 2.2868E-01 kPa/°C rise

Polynomial Gage Factors:

A = -5.2957E-07 kPa/(B unit)² B = -2.0531E-01 kPa/B unit C = ________ kPa

Pressure is calculated with the following equations:
Linear: $P = CF(L_0 - L) - Tk(T_1 - T) + (S_0 - S)$
Polynomial: $P = A(L^2) + B(L) + C - Tk(T_0 - T) + (S_0 - S)$

Users must establish site zero readings for calculation purposes
Polynomial $C = -[A(L_0^2) + B(L_0)]$

L_0, L = initial (installation) and current readings, in B units
T_0, T = initial (installation) and current temperature, in °C
S_0, S = initial (installation) and current barometric pressure readings, in kPa
B units = B scale output of VW 2102, VW 2104, VW 2106 and DT 2011 readouts
B units = Hz²/1000 ie: 1700 Hz = 2890 B units

	Date (dd/mm/yy)	VW Reading (B units)	Temperature (°C)	Baro (mbar)
Shipped Zero Readings:	26-Nov-19	9363	19.9	1012.0

This instrument has been calibrated using standards traceable to the NIST in compliance with ANSI Z540-1

Technician: O. Nygren Date: 26-Nov-19

PHOTO 35: BH19_02 VWP Calibration Document (November 29, 2019)

PHOTO 36: BH19_02 VWP preparation (November 29, 2019)

wood.

nyrstar

2019 Site Investigation Photographs

Drawn: N/A	Scale: N/A	Date: Nov. 2019	Project: NX14001C1.3	Figure 18

PHOTO 37: BH19_02 VWP Installation (November 29, 2019)

PHOTO 38: BH19_02 Representative Sample Depth 10' - 20' (November 29, 2019)

wood.

nyrstar

2019 Site Investigation Photographs

Drawn: N/A	Scale: N/A	Date: Nov. 2019	Project: NX14001C1.3	Figure 19

PHOTO 39: BH19_02 Representative Sample Depth 40' - 50' (November 29, 2019)

PHOTO 40: BH19_02 Representative Sample Depth 50' - 60' (November 29, 2019)

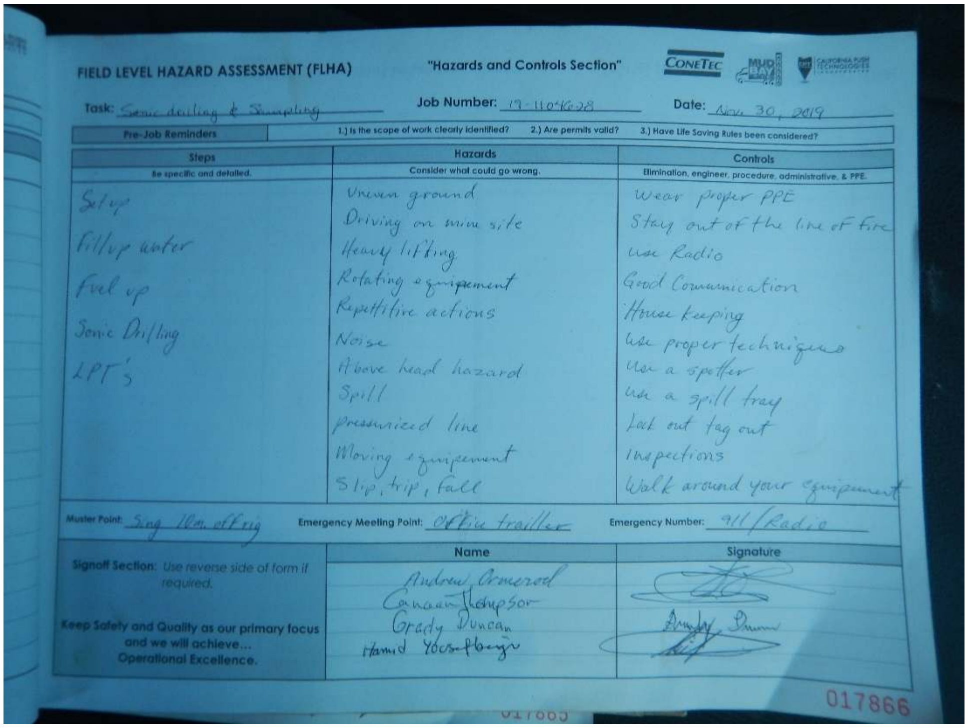
wood.

nyrstar

2019 Site Investigation Photographs

Drawn: N/A	Scale: N/A	Date: Nov. 2019	Project: NX14001C1.3	Figure 20

BH19_03 DRILLING



FIELD LEVEL HAZARD ASSESSMENT (FLHA) "Hazards and Controls Section" CONETEC MUD BAY CALIFORNIA PUSH TECHNOLOGIES

Task: Sonic drilling & Sampling Job Number: 19-1104628 Date: Nov. 30, 2019

Pre-Job Reminders	1.) Is the scope of work clearly identified?	2.) Are permits valid?	3.) Have Life Saving Rules been considered?

Steps Be specific and detailed.	Hazards Consider what could go wrong.	Controls Elimination, engineer, procedure, administrative, & PPE.
Setup	Uneven ground	Wear proper PPE
Fillup water	Driving on mine site	Stay out of the line of fire
Fuel up	Heavy lifting	use Radio
Sonic Drilling	Rotating equipement	Good Communication
LPT's	Repetitive actions	House keeping
	Noise	use proper techniques
	Above head hazard	Use a spotter
	Spill	use a spill tray
	pressurized line	Lock out tag out
	Moving equipement	inspections
	Slip, trip, fall	Walk around your equipment

Muster Point: Sing 10m. of rig Emergency Meeting Point: Office trailler Emergency Number: 911/Radio

Signoff Section: Use reverse side of form if required. Keep Safety and Quality as our primary focus and we will achieve... Operational Excellence.	Name	Signature
	Andrew Ormerod Canaan Thompson Grady Duncan Hamid Yousefbeygi	

017866

PHOTO 41: Signed ConeTec/Mud Bay Drilling Field Level Hazard Assessment Form (November 30, 2019)

PHOTO 42: BH19_03 Representative Sample Depth 60' - 70' (November 30, 2019)

wood.

nyrstar

2019 Site Investigation Photographs

Drawn: N/A	Scale: N/A	Date: Nov. 2019	Project: NX14001C1.3	Figure 21

PHOTO 43: BH19_03 Representative Sample Depth 70' - 80' (November 30, 2019)

PHOTO 44: BH19_03 LPT Sample Depth 80' - 81.5' (November 30, 2019)

2019 Site Investigation Photographs

Drawn: N/A
Scale: N/A
Date: Nov. 2019
Project: NX14001C1.3
Figure 22

PHOTO 45: BH19_03 LPT Sample Depth 80' - 81.5' (November 30, 2019)

PHOTO 46: BH19_03 Representative Sample Depth 85' - 90' (November 30, 2019)

wood.

nyrstar

2019 Site Investigation Photographs

Drawn: N/A	Scale: N/A	Date: Nov. 2019	Project: NX14001C1.3	Figure 23

PHOTO 47: BH19_03 LPT Sample Depth 100' - 100.9' (November 30, 2019)

PHOTO 48: BH19_03 Representative Sample Depth 100' - 105' (November 30, 2019)

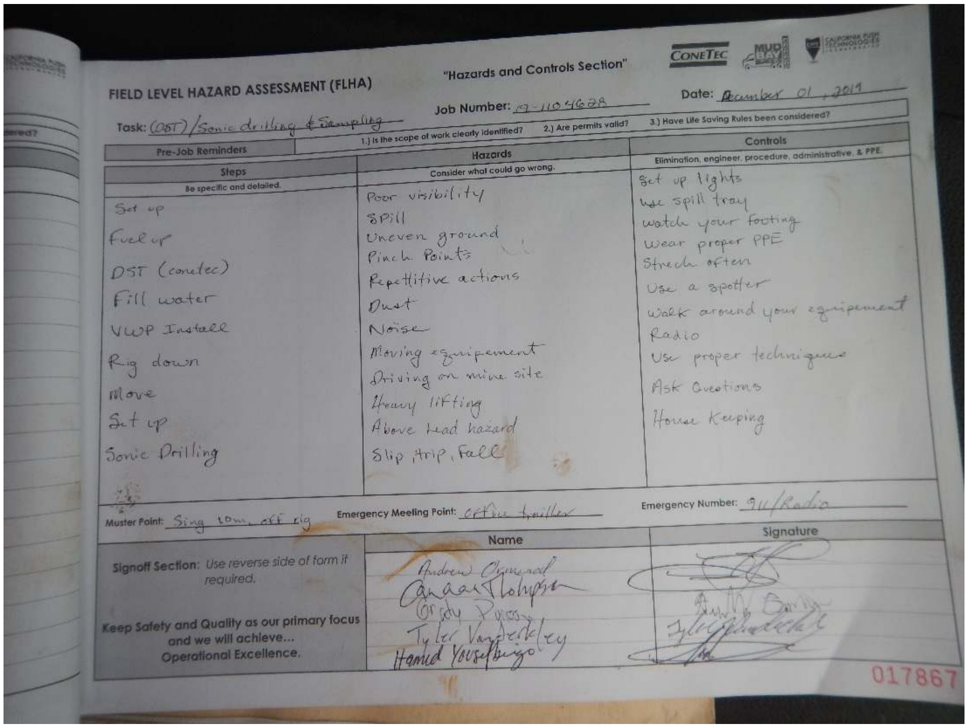
wood.

nyrstar

2019 Site Investigation Photographs

Drawn: N/A	Scale: N/A	Date: Nov. 2019	Project: NX14001C1.3	Figure 24

BH19_05 DRILLING, BH19_01 AND BH19_04 WELL INSTALLATION, BH19_03 VWP INSTALLATION



CONETEC · MUD BAY · CALIFORNIA PUSH TECHNOLOGIES

FIELD LEVEL HAZARD ASSESSMENT (FLHA)

"Hazards and Controls Section"

Job Number: 19-1104628

Date: December 01, 2019

Task: (DST)/Sonic drilling & Sampling

Pre-Job Reminders: 1.) Is the scope of work clearly identified? 2.) Are permits valid? 3.) Have Life Saving Rules been considered?

Steps Be specific and detailed.	Hazards Consider what could go wrong.	Controls Elimination, engineer, procedure, administrative, & PPE.
Set up	Poor visibility	Set up lights
Fuel up	Spill	use spill tray
DST (conetec)	Uneven ground	watch your footing
Fill water	Pinch Points	Wear proper PPE
VWP Install	Repettitive actions	Strech often
Rig down	Dust	Use a spotter
Move	Noise	Walk around your equipement
Set up	Moving equipement	Radio
Sonic Drilling	Driving on mine site	Use proper techniques
	Heavy lifting	Ask Questions
	Above head hazard	House Keeping
	Slip, trip, Fall	

Muster Point: Sing 10m. off rig

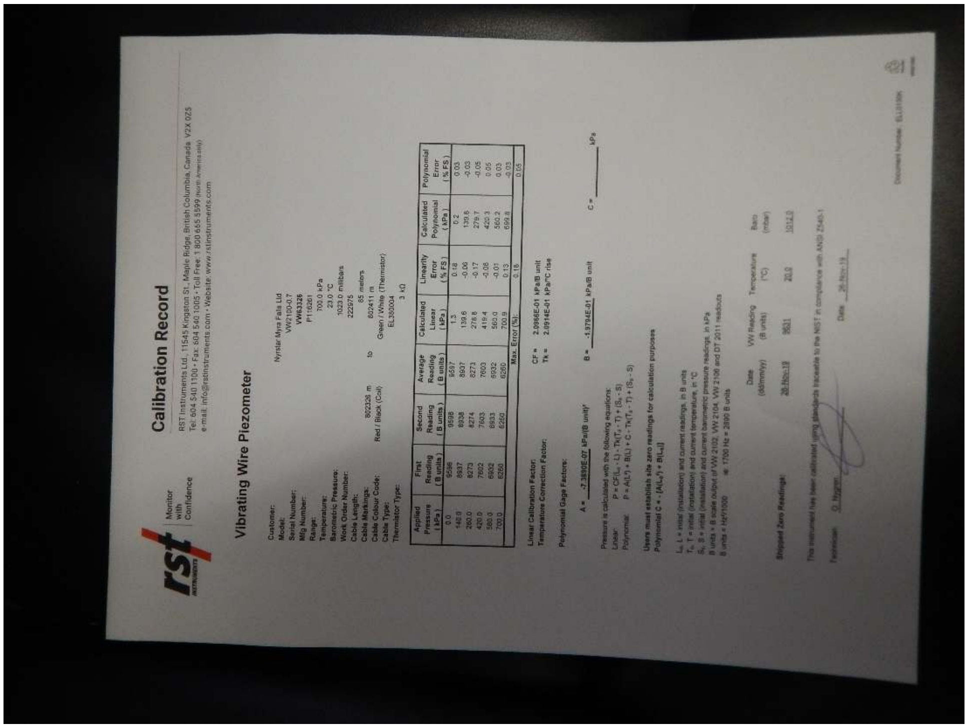
Emergency Meeting Point: office trailer

Emergency Number: 911/Radio

Signoff Section: *Use reverse side of form if required.* **Keep Safety and Quality as our primary focus and we will achieve... Operational Excellence.**	Name	Signature
	Andrew Ormond Canaan Thompson Brody Pyess Tyler Vanderkley Hamid Yousefbeigo	

017867

PHOTO 49: Signed ConeTec/Mud Bay Drilling Field Level Hazard Assessment Form (December 1, 2019)



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Calibration Record

RST Instruments Ltd., 11545 Kingston St., Maple Ridge, British Columbia, Canada V2X 0Z5
Tel: 604 540 1100 • Fax: 604 540 1005 • Toll Free: 1 800 655 5599 (North America only)
e-mail: info@rstinstruments.com • Website: www.rstinstruments.com

Vibrating Wire Piezometer

Customer: Nyrstar Myra Falls Ltd
Model: VW2100-0.7
Serial Number: VW63326
Mfg Number: P116261
Range: 700.0 kPa
Temperature: 23.0 °C
Barometric Pressure: 1023.0 millibars
Work Order Number: 222975
Cable Length: 65 meters
Cable Markings: 802326 m to 802411 m
Cable Colour Code: Red / Black (Coil) Green / White (Thermistor)
Cable Type: EL380004
Thermistor Type: 3 kΩ

Applied Pressure (kPa)	First Reading (B units)	Second Reading (B units)	Average Reading (B units)	Calculated Linear (kPa)	Linearity Error (% FS)	Calculated Polynomial (kPa)	Polynomial Error (% FS)
0.0	9596	9598	9597	1.3	0.18	0.2	0.03
140.0	8937	8938	8937	139.6	-0.06	139.6	-0.03
280.0	8273	8274	8273	278.8	-0.17	279.7	-0.05
420.0	7602	7603	7603	419.4	-0.08	420.3	0.05
560.0	6932	6933	6932	560.0	-0.01	560.2	0.03
700.0	6260	6260	6260	700.9	0.13	699.8	-0.03
				Max. Error (%):	0.18		0.05

Linear Calibration Factor: CF = 2.0966E-01 kPa/B unit
Temperature Correction Factor: Tk = 2.0914E-01 kPa/°C rise

Polynomial Gage Factors:

A = -7.3890E-07 kPa/(B unit)² B = -1.9794E-01 kPa/B unit C = ______ kPa

Pressure is calculated with the following equations:
Linear: $P = CF(L_0 - L) - Tk(T_0 - T) + (S_0 - S)$
Polynomial: $P = A(L^2) + B(L) + C - Tk(T_0 - T) + (S_0 - S)$

Users must establish site zero readings for calculation purposes
Polynomial $C = -[A(L_0^2) + B(L_0)]$

L_0, L = initial (installation) and current readings, in B units
T_0, T = initial (installation) and current temperature, in °C
S_0, S = initial (installation) and current barometric pressure readings, in kPa
B units = B scale output of VW 2102, VW 2104, VW 2106 and DT 2011 readouts
B units = Hz²/1000 ie: 1700 Hz = 2890 B units

	Date (dd/mm/yy)	VW Reading (B units)	Temperature (°C)	Baro (mbar)
Shipped Zero Readings:	26-Nov-19	9631	20.0	1012.0

This instrument has been calibrated using standards traceable to the NIST in compliance with ANSI Z540-1

Technician: O. Nygren Date: 26-Nov-19

Document Number: ELL0130K

PHOTO 50: BH19_03 VWP Calibration Document (December 1, 2019)

wood.

nyrstar

2019 Site Investigation Photographs

Drawn: N/A	Scale: N/A	Date: Dec. 2019	Project: NX14001C1.3	Figure 25

PHOTO 51: BH19_03 VWP Initial readings prior to Installation (December 1, 2019)

PHOTO 52: BH19_04 Protective cover installation using bentonite chips (December 1, 2019)

wood.

nyrstar

2019 Site Investigation Photographs

Drawn: N/A	Scale: N/A	Date: Dec. 2019	Project: NX14001C1.3	Figure 26

PHOTO 53: BH19_04 Protective cover installation using bentonite chips (December 30, 2019)

PHOTO 54: BH19_05 Representative Sample Depth 10' - 20' (December 1, 2019)

wood.

nyrstar

2019 Site Investigation Photographs

Drawn: N/A	Scale: N/A	Date: Dec. 2019	Project: NX14001C1.3	Figure 27

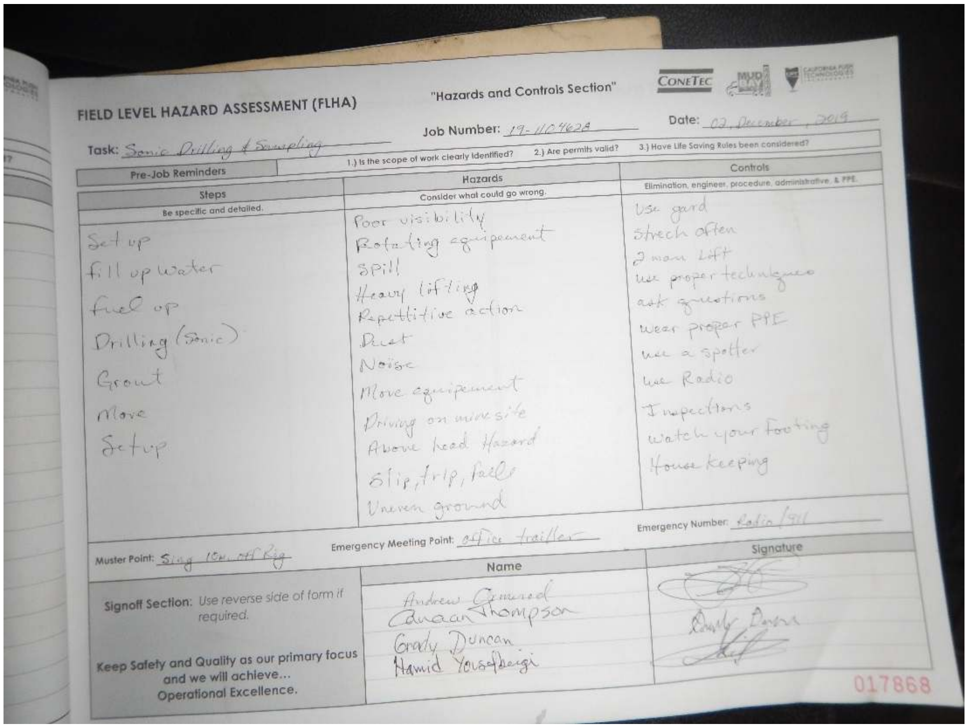
PHOTO 55: BH19_01 Protective cover installation using bentonite chips (December 30, 2019)

PHOTO 56: BH19_05 Representative Sample Depth 90' - 91.5' (December 1, 2019)

2019 Site Investigation Photographs

Drawn: N/A | Scale: N/A | Date: Dec. 2019 | Project: NX14001C1.3 | Figure 28

BH19_05 AND BH19_06 DRILLING



FIELD LEVEL HAZARD ASSESSMENT (FLHA)

"Hazards and Controls Section"

CONETEC

Job Number: 19-1104628

Date: 02, December, 2019

Task: Sonic Drilling & Sampling

Pre-Job Reminders: 1.) Is the scope of work clearly identified? 2.) Are permits valid? 3.) Have Life Saving Rules been considered?

Steps Be specific and detailed.	Hazards Consider what could go wrong.	Controls Elimination, engineer, procedure, administrative, & PPE
Set up	Poor visibility	Use guard
fill up water	Rotating equipment	strech often
fuel up	Spill	2 man Lift
Drilling (Sonic)	Heavy lifting	use proper techniques
Grout	Repetitive action	ask questions
Move	Dust	wear proper PPE
Setup	Noise	use a spotter
	Move equipment	use Radio
	Driving on mine site	Inspections
	Above head Hazard	watch your footing
	Slip, trip, falls	House keeping
	Uneven ground	

Emergency Number: Radio/911

Muster Point: Sing 10m off Rig

Emergency Meeting Point: office trailer

Signoff Section: *Use reverse side of form if required.*

Name	Signature
Andrew Gemmed	
Cavaan Thompson	
Grady Duncan	
Hamid Yousefbeigi	

Keep Safety and Quality as our primary focus and we will achieve... Operational Excellence.

017868

PHOTO 57: Signed ConeTec/Mud Bay Drilling Field Level Hazard Assessment Form (December 2, 2019)

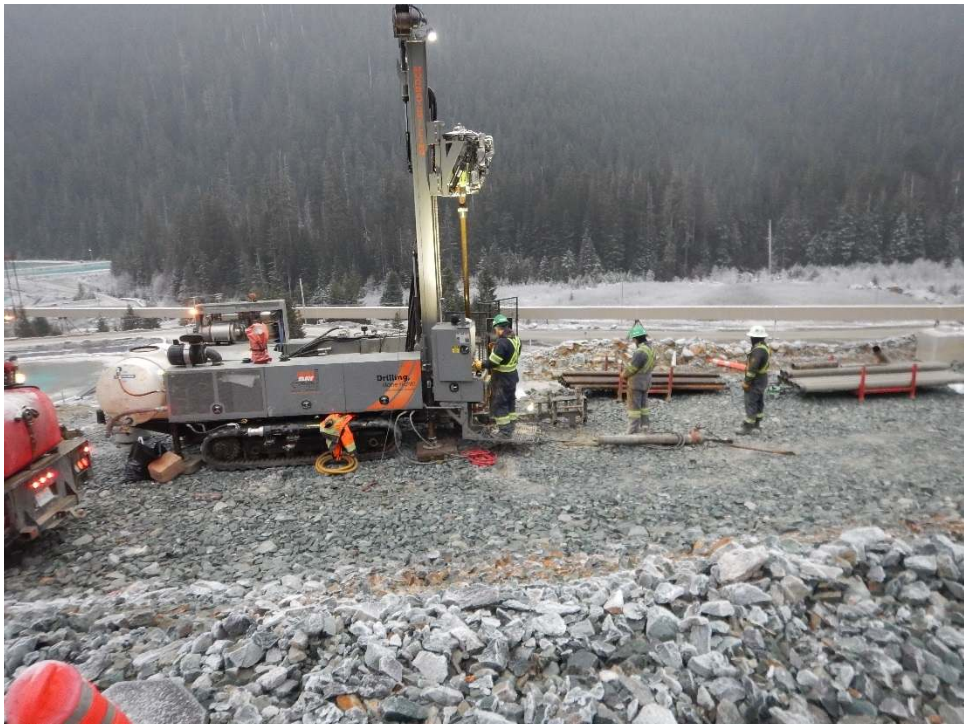


PHOTO 58: BH19_05 Drilling Location (December 2, 2019)

2019 Site Investigation Photographs

Drawn: N/A | Scale: N/A | Date: Dec. 2019 | Project: NX14001C1.3 | Figure 29

PHOTO 59: BH19_05 LPT Sample Depth 95' - 96.5' (December 2, 2019)

PHOTO 60: BH19_05 Representative Sample Depth 100' - 110' (December 2, 2019)

wood.

nyrstar

2019 Site Investigation Photographs

Drawn: N/A

Scale: N/A

Date: Dec. 2019

Project: NX14001C1.3

Figure 30

PHOTO 61: BH19_06 Representative Sample Depth 100' - 110' (December 2, 2019)

PHOTO 62: BH19_06 Representative Sample Depth 100' - 110' (December 2, 2019)

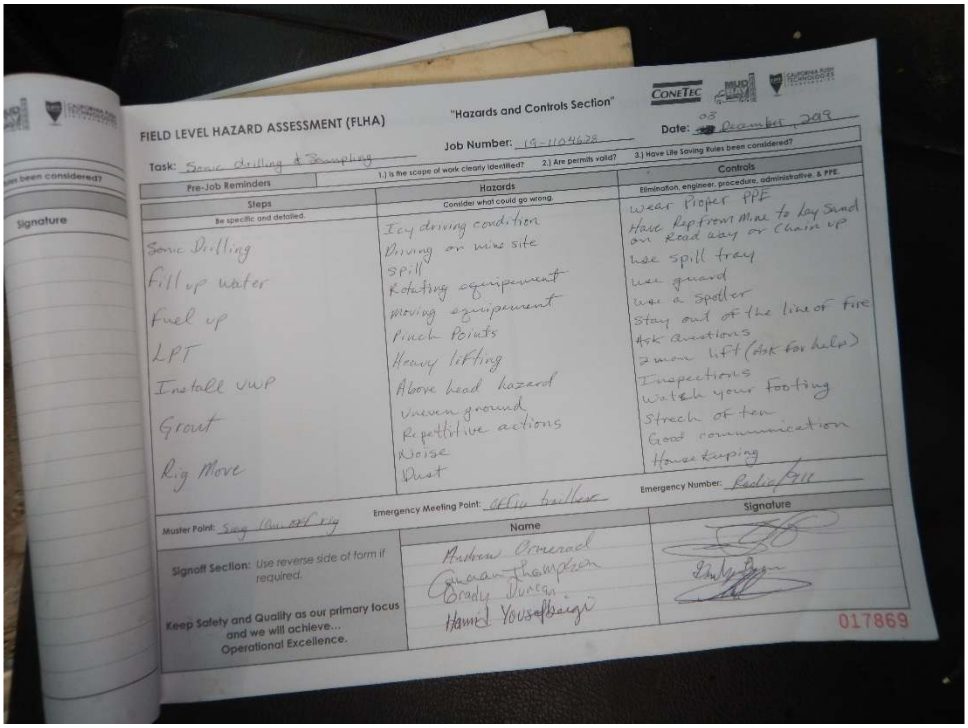
wood.

nyrstar

2019 Site Investigation Photographs

Drawn: N/A	Scale: N/A	Date: Dec. 2019	Project: NX14001C1.3	Figure 31

BH19_06 DRILLING AND VWP INSTALLATION



CONETEC

FIELD LEVEL HAZARD ASSESSMENT (FLHA)

"Hazards and Controls Section"

Date: 03 December, 2019

Job Number: 19-1104628

Task: Sonic drilling & Sampling

Pre-Job Reminders: 1.) Is the scope of work clearly identified? 2.) Are permits valid? 3.) Have Life Saving Rules been considered?

Steps Be specific and detailed.	Hazards Consider what could go wrong.	Controls Elimination, engineer, procedure, administrative, & PPE.
Sonic Drilling Fill up water Fuel up LPT Install VWP Grout Rig Move	Icy driving condition Driving on mine site spill Rotating equipement moving equipement Pinch Points Heavy lifting Above head hazard uneven ground Repetitive actions Noise Dust	wear Proper PPE Have Rep from Mine to lay Sand on Road way or Chain up use spill tray use guard use a Spotter Stay out of the line of fire Ask Questions 2 man lift (Ask for help) Inspections Watch your footing Strech often Good communication House keeping

Emergency Number: Radio/911

Emergency Meeting Point: Office trailer

Muster Point: Sing Clear off rig

Signoff Section: Use reverse side of form if required.

Keep Safety and Quality as our primary focus and we will achieve... Operational Excellence.

Name	Signature
Andrew Ormerod	
Cameron Thompson	
Brady Duncan	
Hamid Yousefbeigi	

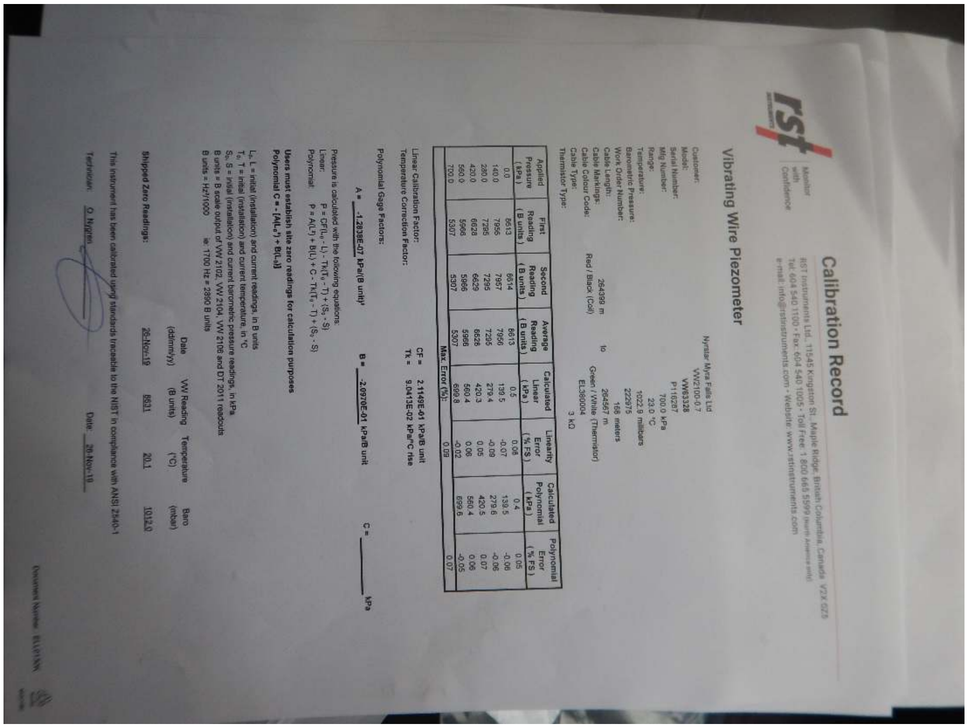
017869

PHOTO 63: Signed ConeTec/Mud Bay Drilling Field Level Hazard Assessment Form (December 3, 2019)

PHOTO 64: BH19_06 VWP Installation (December 3, 2019)

2019 Site Investigation Photographs

Drawn: N/A	Scale: N/A	Date: Dec. 2019	Project: NX14001C1.3	Figure 32



Calibration Record

RST Instruments Ltd., 11545 Kingston St., Maple Ridge, British Columbia, Canada V2X 0Z5
Tel: 604 540 1100 • Fax: 604 540 1005 • Toll Free: 1 800 665 5599 (North America only)
e-mail: info@rstinstruments.com • Website: www.rstinstruments.com

Vibrating Wire Piezometer

Customer:			Nyrstar Myra Falls Ltd
Model:			VW2100-0.7
Serial Number:			VW63328
Mfg Number:			P116287
Range:			700.0 kPa
Temperature:			23.0 °C
Barometric Pressure:			1022.9 millibars
Work Order Number:			222975
Cable Length:			158 meters
Cable Markings:	264399 m	to	264567 m
Cable Colour Code:	Red / Black (Coil)		Green / White (Thermistor)
Cable Type:			EL380004
Thermistor Type:			3 kΩ

Applied Pressure (kPa)	First Reading (B units)	Second Reading (B units)	Average Reading (B units)	Calculated Linear (kPa)	Linearity Error (% FS)	Calculated Polynomial (kPa)	Polynomial Error (% FS)
0.0	8613	8614	8613	0.5	0.08	0.4	0.05
140.0	7956	7957	7956	139.5	-0.07	139.5	-0.06
280.0	7295	7295	7295	279.4	-0.09	279.6	-0.06
420.0	6628	6629	6628	420.3	0.05	420.5	0.07
560.0	5966	5966	5966	560.4	0.06	560.4	0.06
700.0	5307	5307	5307	699.8	-0.02	699.6	-0.05
				Max. Error (%):	0.09		0.07

Linear Calibration Factor: CF = 2.1149E-01 kPa/B unit
Temperature Correction Factor: Tk = 9.0413E-02 kPa/°C rise

Polynomial Gage Factors:

A = -1.2838E-07 kPa/(B unit)² B = -2.0970E-01 kPa/B unit C = ______ kPa

Pressure is calculated with the following equations:
Linear: $P = CF(L_0 - L) - Tk(T_0 - T) + (S_0 - S)$
Polynomial: $P = A(L^2) + B(L) + C - Tk(T_0 - T) + (S_0 - S)$

Users must establish site zero readings for calculation purposes
Polynomial $C = -[A(L_0^2) + B(L_0)]$

L_0, L = initial (installation) and current readings, in B units
T_0, T = initial (installation) and current temperature, in °C
S_0, S = initial (installation) and current barometric pressure readings, in kPa
B units = B scale output of VW 2102, VW 2104, VW 2106 and DT 2011 readouts
B units = Hz²/1000 ie: 1700 Hz = 2890 B units

	Date (dd/mm/yy)	VW Reading (B units)	Temperature (°C)	Baro (mbar)
Shipped Zero Readings:	26-Nov-19	8631	20.1	1012.0

This instrument has been calibrated using standards traceable to the NIST in compliance with ANSI Z540-1

Technician: O. Nygren Date: 26-Nov-19

Document Number: [illegible]

PHOTO 65: BH19_06 VWP Calibration Document (December 3, 2019)

PHOTO 66: BH19_06 LPT Sample Depth 95' - 96.5' (December 3, 2019)

2019 Site Investigation Photographs

Drawn: N/A	Scale: N/A	Date: Dec. 2019	Project: NX14001C1.3	Figure 33

PHOTO 67: BH19_06 LPT Sample Depth 95' - 96.5' (December 3, 2019)

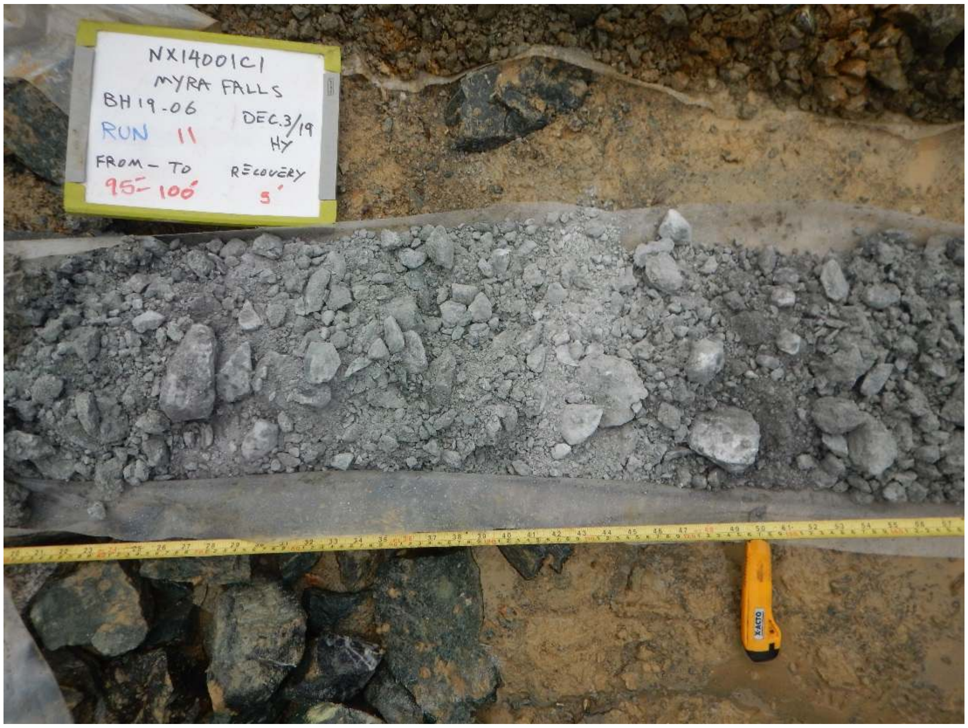


PHOTO 68: BH19_06 Representative Sample Depth 95' - 100' (December 3, 2019)

wood.

nyrstar

2019 Site Investigation Photographs

Drawn: N/A	Scale: N/A	Date: Dec. 2019	Project: NX14001C1.3	Figure 34

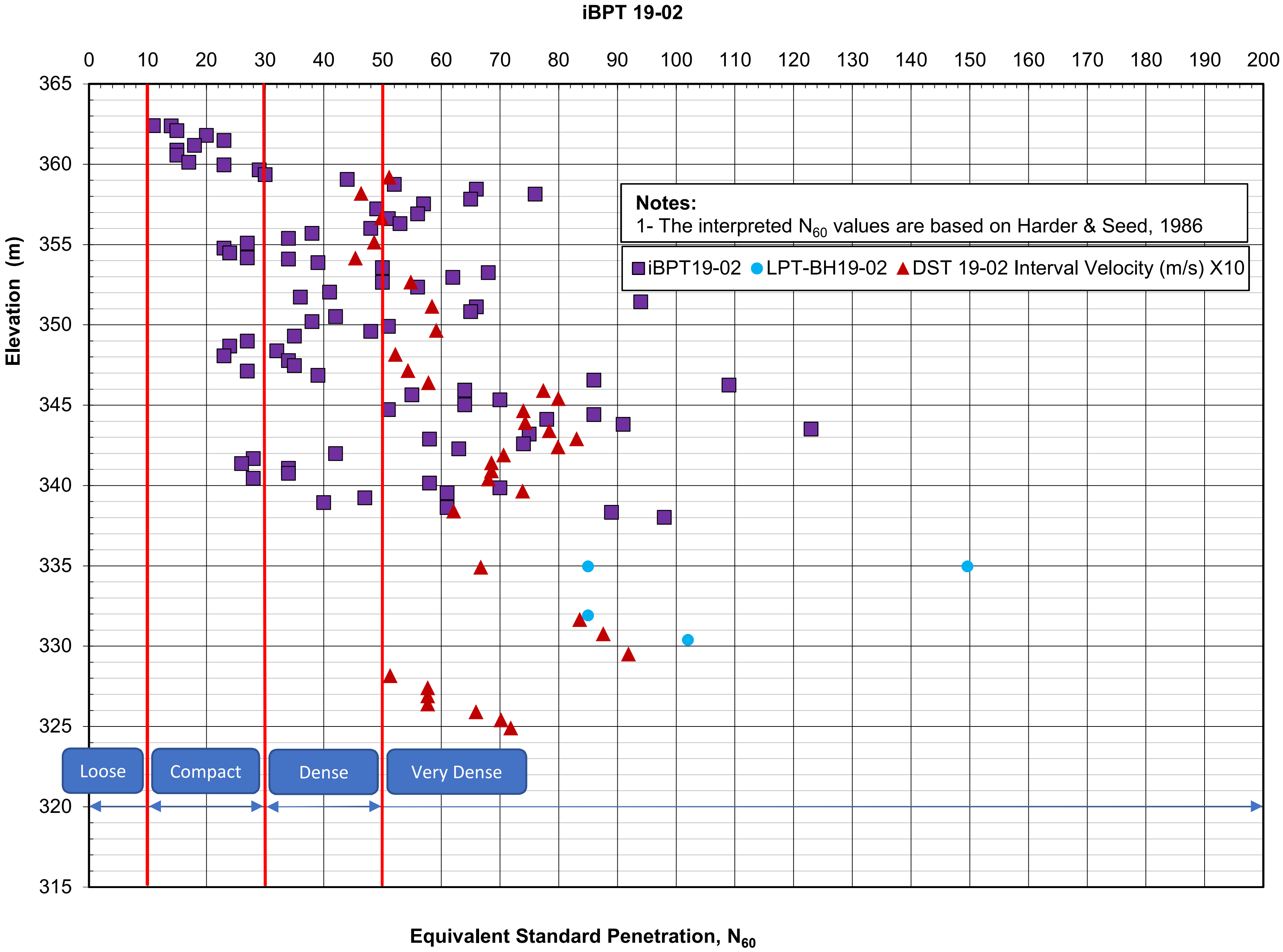
PHOTO 69: BH19_06 Representative Sample Depth 120' - 130' (December 3, 2019)

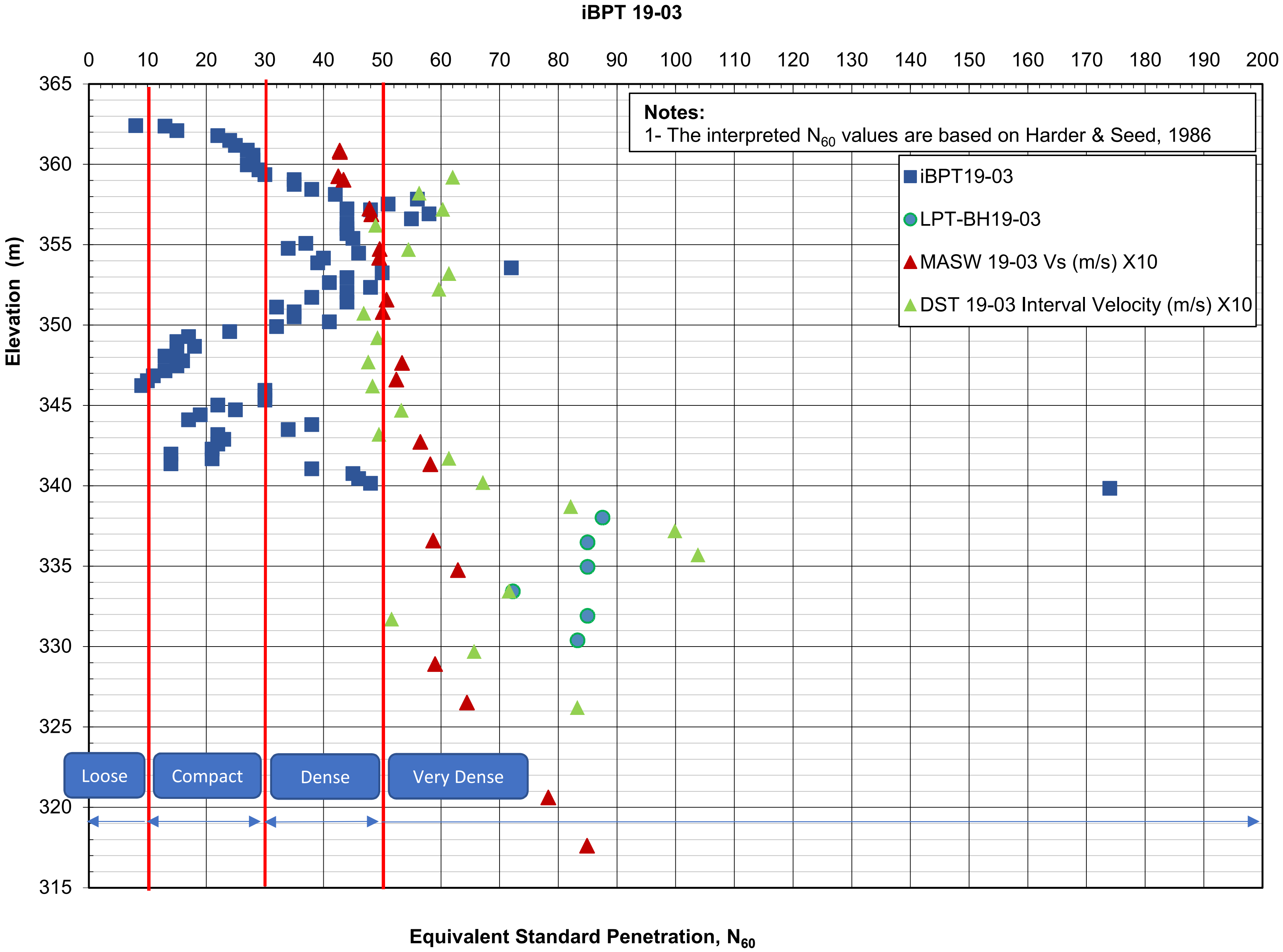
PHOTO 70: BH19_06 Drilling Location (December 3, 2019)

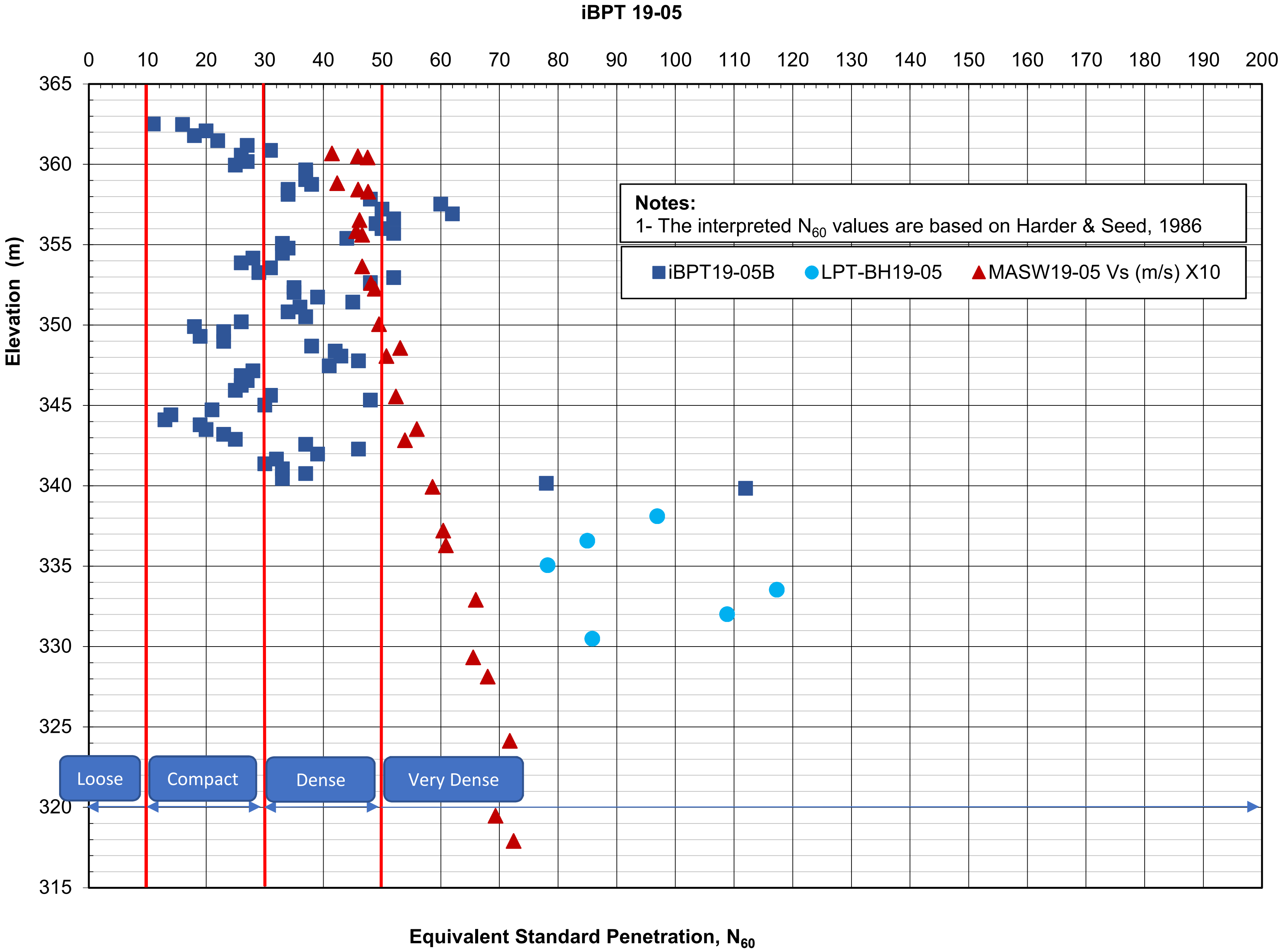
2019 Site Investigation Photographs

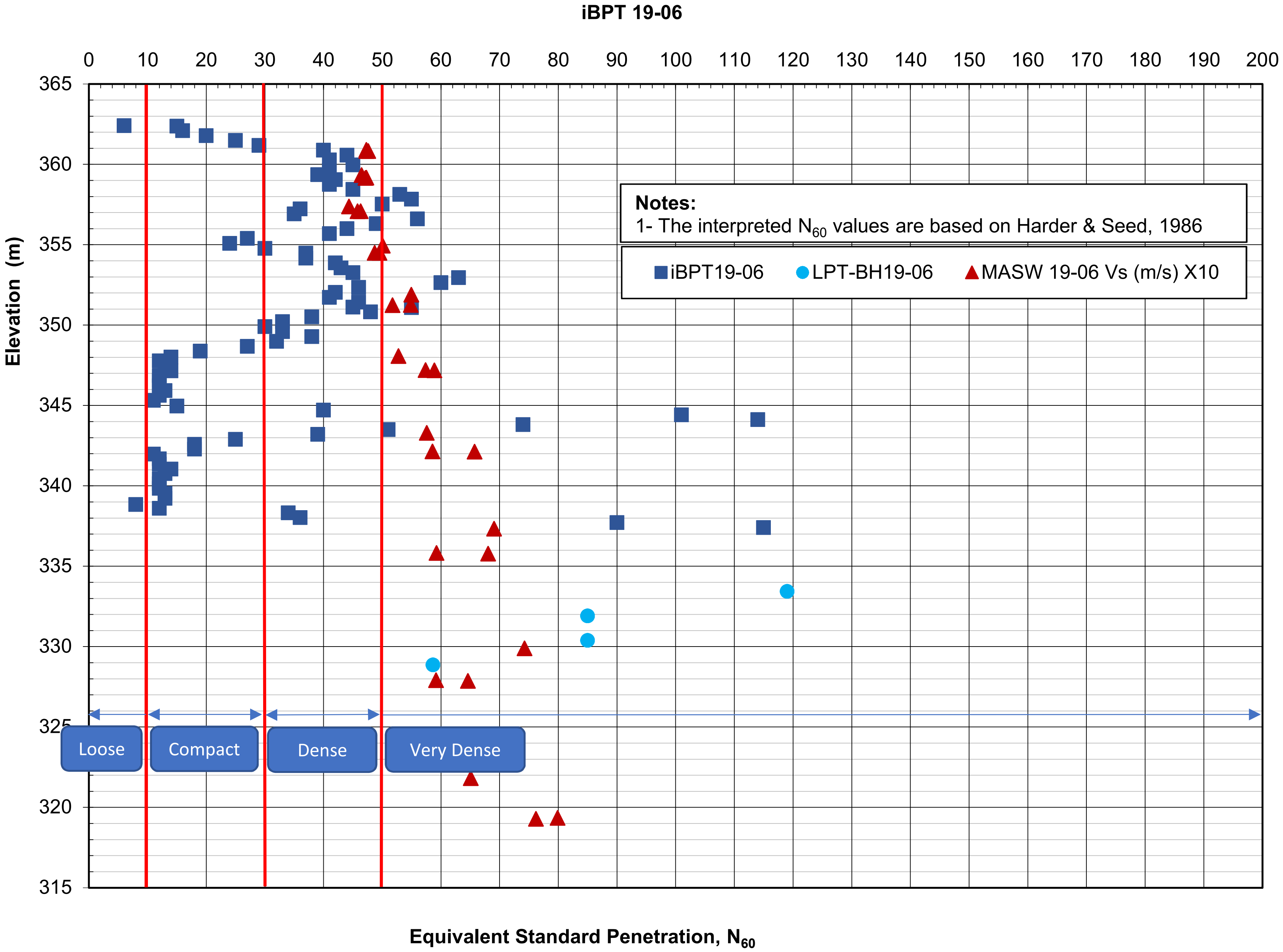
Drawn: N/A	Scale: N/A	Date: Dec. 2019	Project: NX14001C1.3	Figure 35

Appendix F – N_{60} Vs. Elevation Plots


iBPT 19-02
0
10
20
30
40
50
60
70
80
90
100
110
120
130
140
150
160
170
180
190
200
365
360
355
350
345
340
335
330
325
320
315
Elevation (m)
Notes:
1- The interpreted N_{60} values are based on Harder & Seed, 1986
iBPT19-02
LPT-BH19-02
DST 19-02 Interval Velocity (m/s) X10
Loose
Compact
Dense
Very Dense
Equivalent Standard Penetration, N_{60}


iBPT 19-03
0
10
20
30
40
50
60
70
80
90
100
110
120
130
140
150
160
170
180
190
200
365
360
355
350
345
340
335
330
325
320
315
Elevation (m)
Notes:
1- The interpreted N_{60} values are based on Harder & Seed, 1986
iBPT19-03
LPT-BH19-03
MASW 19-03 Vs (m/s) X10
DST 19-03 Interval Velocity (m/s) X10
Loose
Compact
Dense
Very Dense
Equivalent Standard Penetration, N_{60}


iBPT 19-05
0
10
20
30
40
50
60
70
80
90
100
110
120
130
140
150
160
170
180
190
200
365
360
355
350
345
340
335
330
325
320
315
Elevation (m)
Notes:
1- The interpreted N_{60} values are based on Harder & Seed, 1986
■ iBPT19-05B
● LPT-BH19-05
▲ MASW19-05 Vs (m/s) X10
Loose
Compact
Dense
Very Dense
Equivalent Standard Penetration, N_{60}


iBPT 19-06
Elevation (m)
Equivalent Standard Penetration, N_{60}
0
10
20
30
40
50
60
70
80
90
100
110
120
130
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Notes:
1- The interpreted N_{60} values are based on Harder & Seed, 1986
■ iBPT19-06
● LPT-BH19-06
▲ MASW 19-06 Vs (m/s) X10
Loose
Compact
Dense
Very Dense