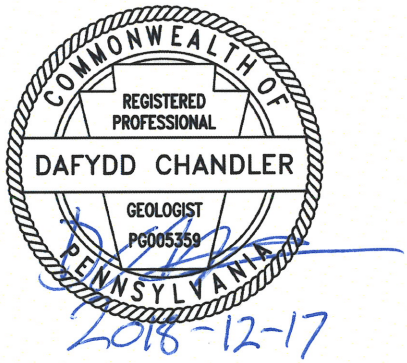
MOTT MACDONALD

Geological Data Report Interstate 81 and SR315 Crossing

PennEast Pipeline Project



December 17, 2018

Mott MacDonald
6000 Town Center Blvd
Suite 300
Canonsburg PA 15317
United States of America

T +1 (724) 514 5330
F +1 (724) 873 9116
mottmac.com

PennEast Pipeline Project
One Meridian Blvd.
Suite 2C01
Wyomissing, PA 19610

Geological Data Report Interstate 81 and SR315 Crossing

PennEast Pipeline Project

December 17, 2018

Issue and revision record

Revision	Date	Originator	Checker	Approver	Description
A	09-04-2015	A. Wachenfeld	T. Rajah	V. Shah	Interim Report
B	12-10-2015	B. Cortes	T. Rajah	V. Shah	Interim Report
C	06-09-2016	D. Heber	G. Obamije	V. Shah	Interim Report
D	08-14-2017	D. Chandler	T. Rajah	V. Shah	Final Report
E	12-17-2018			D.Chandler	PG Review

Document reference: 353754-MM-E-E-099 RevE

Information class: Standard

This document is issued for the party which commissioned it and for specific purposes connected with the above-captioned project only. It should not be relied upon by any other party or used for any other purpose.

Contents

Tables

Figures

Executive Summary

This report presents the findings of an investigation into the ground conditions present at the proposed Interstate 81 (I-81) and State Route 315 (SR315) crossing. The report summarizes the findings of a desktop study and subsurface investigation.

A subsurface drilling investigation was performed by Craig Test Boring between February 2016 and April 2017. The investigation consisted of seven (7) boreholes, drilled to depths ranging from 175ft and 225ft. Geophysical investigation utilizing multichannel analysis of surface waves (MASW) was performed in January 2017.

The rock consists of a metamorphized sequence of shale, sandstone, conglomerate, and anthracite coal. In places, the sandstone is sufficiently metamorphosed to be classified as quartzite with a UCS of up to 21,000 psi.

The crossing is located in the Wyoming Valley, within the coal mining region known as the Northern Anthracite Field. The features of the historic coal mining have a notable influence on the conditions at the crossing.

Workings of the coal seams known as the *Top Ross* and *Ross* are found at depth below the interstate. These seams were worked via room and pillar mining methods in the early 1900's, and today are present as laterally extensive layers including collapsed sections and some open un-collapsed sections. The largest void encountered during the drilling investigation was 7.6ft thick. In collapsed locations, the mine workings currently exist as thick zones of rubble. Additional bedrock fracturing does exist above the primary zone of mine collapse.

Strip mining was used on the northern side of the crossing to extract coal from the *Cooper* and *Bennet* coal seams. The backfill of this stripped area has resulted in thick fill of variable composition. In most areas, the soils have been modified by mining activities and/or by the earthworks of I-81 construction.

1 Introduction

At the request of PennEast Pipeline Company, LLC. (PennEast), Mott MacDonald conducted a subsurface investigation for the proposed 115-mile, 36-inch diameter high pressure natural gas pipeline that spans from Luzerne County, Pennsylvania to Mercer County, New Jersey. The purpose of the subsurface investigation is to gather information for the design and construction of the pipeline. This report summarizes the findings of the geotechnical exploration conducted near State Road 315 and Interstate I-81, which is to be constructed via trenchless methods. Field work was performed during the months of February 2016 through April 2017.

The objective of the report is to present factual information to be utilized in the design and construction of the methodology to cross Interstate 81 and State Road 315 at approximately project mile post 10.5. A site location map is provided as Appendix A.

This report summarizes the results from our subsurface investigation for the use in the design and construction of the proposed Interstate 81 and State Road 315 (SR 315) crossing.

The subsurface investigation consisted of a geophysical survey and seven (7) exploratory borings. A locus map depicting the as-drilled boring locations is provided as Appendix B, which also contains a conceptual crossing profile dated August 2017.

The site is located in Plains Township, PA.

2 Local Geology

2.1 Bedrock Geology

The crossing lies entirely within the Llewellyn Formation as shown on mapping published by the United States Geological Survey (USGS), provided in Appendix D. The USGS map indicates there is a known fault within the bedrock beneath the crossing. Additional details of this feature were revealed by inspecting coal mine maps and by exploratory drilling works. The USGS description of the formation is:

- The Llewellyn Formation is a Pennsylvanian age "gray, fine to coarse grained sandstone, siltstone, shale, conglomerate, and numerous anthracite coals in repetitive sequences."

Although the proposed crossing alignment falls within the approximate outlines of the Llewellyn Formation, it is possible that other formations or rock types could occur along the alignment, due to the approximate nature of USGS maps.

The large scale geological structure of the Wyoming Valley is a syncline, but faulting and folding make the local scale geological structure highly complex.

2.2 Surficial Geology

Surficial mapping from the Natural Resources Conservation Service (NRCS) Web Soil Survey, provided in Appendix D, indicates that the northwest side of the Area of Interest (AOI) consists of cut and fill material. On the southeast side of I-81, the AOI consists primarily of Wurtsboro channery loam with minor components, which consist of Wurtsboro extremely stony loam and Volusia channery silt loam.

The investigation program found much of the crossing area to have been disturbed by historic coal mining activities. On the North side of SR315, backfill material up to 50ft thick was found. The fill material likely originates from the backfill of a mine which was operated to extract the Cooper and Bennet coal seams. The proposed HDD entry location is located near the base of the old strip mine.

Within the I-81 median 10ft of fill was found, likely resultant from interstate construction. On the southern side of the interstate a glacial till was observed up to 20ft thick before bedrock was encountered.

2.3 Karst Formations

No Karst formations are anticipated to be encountered at the Interstate 81 and SR315 crossing.

2.4 Abandoned Mines

The Wyoming Valley was extensively mined for anthracite coal during the 19th and 20th century. This crossing is affected by both underground and strip mining. The remnant features of surface strip mining and underground room and pillar mining present abnormal ground conditions for trenchless pipe installation beneath I-81 and SR315. Numerous Pennsylvania Department of Environmental Protection (PADEP) bureau of abandoned mine land reclamation holds maps of numerous abandoned coal mines near the proposed crossing which were reviewed in detail. Select extracts of key historical coal mining maps are presented within the crossing profile drawings in Appendix B.

Strip mining was used on the northern side of SR315 to mine the *Cooper* and *Bennet* coal seams in the 1930s. Strip mining operations excavated the overlaying materials to expose and remove the mineral deposits, and it can be assumed that the *Cooper* and *Bennet* seams were totally removed. Some of the strip mine was backfilled in the mid-to-late 20th century. The location of the recently constructed garage is

thought to sit upon thick deposits of strip mine backfill, but the proposed HDD entry is located to the south of the major backfill zone.

The backfilling of pits was generally conducted with little regard to compaction or fill uniformity. Appendix B presents the historic outcrop lines of the *Cooper* and *Bennet* seams, which can be used as an approximate indicators for the historic strip mining extents.

Underground room and pillar mining operations were carried out under the entirety of the proposed crossing. The main phase of underground workings was during the 1930's-1940's. The coal was extracted via hand tools, blasting and mechanical excavation which progressed through the seam. Pillars of coal were left as roof supports. In many cases these pillars were later trimmed back in a secondary phase of mining which would result in less stable pillars. Access to the seams was typically gained either by following seams from outcrop in tunnels or by means of excavated shafts or slopes. No mine shafts are mapped near within the ROW of this crossing location.

The significant seams below the crossing which were mined via underground room and pillar mining are the *Top Ross, Ross,* and *Red Ash (AKA 3ft).* At the center point of I-81, the seam bases are at the following approximate elevations NAVD88:

- Top Ross: 720ft
- Ross: 690ft
- Red Ash: 540ft

Note: Seams generally dip down to the North West and thus seams are found at a higher elevation towards the southern end of the crossing. See profile drawings in Appendix B for details.

The selected alignment was chosen to avoid a direct clash with the workings of the Top Ross and Ross seams by remaining above the mapped worked elevations and above the observed primary zone of collapse. Even through a direct clash with the observed mine elevations has been avoided the presence of these worked coal seams will significantly influence the ground conditions encountered by the proposed construction. The removal of the coal from these seams and the subsequent collapse of pillars and supports has caused settlement and modification of the stress fields in the area and will influence the ground water flow. Fracturing and voiding of the bedrock above the primary mine collapse zone will exist. Due to the many decades which have passed since active mining occurred it is anticipated that the rate of deterioration has decreased notably, but some degree of ongoing settlement may still occur.

Subsurface investigation was progressed to ascertain the modern-day condition of these underground workings. Section 4 describes the results of this investigation.

Figures 1 and 2 show historical photographs of typical surface and underground coal workings. These photographs are not from the specific I-81 crossing location, but they are from the Northern Anthracite Coal field during the correct time period, and are believed to represent similar practices which resulted in the ground conditions present beneath I-81. Figure 3 presents a modern photograph from within a coal mining access tunnel in the general vicinity of the I-81 crossing.

Figure 1: Photograph of typical early 20th century strip mining in the PA Anthracite region.

(http://www.coalmininghistorypa.org/historicalpictures/pic016a.htm)

Exact location and date unknown.

Figure 2: Underground coal mine excavation from the early 1900's.

(http://www.coalmininghistorypa.org/historicalpictures/pic047.htm).

Exact location and date unknown.

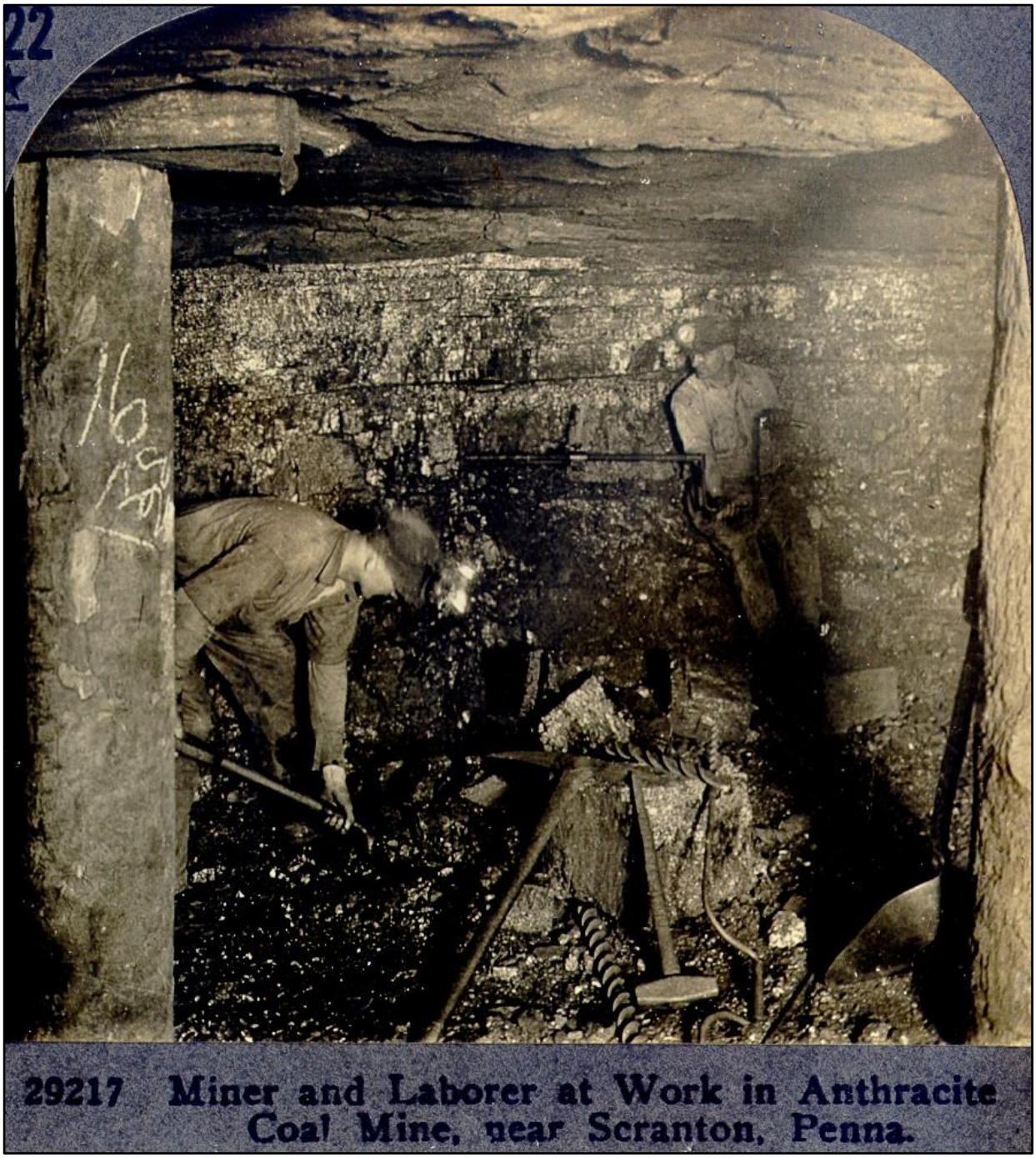


Figure 3: Modern photograph by members of the "Underground Miners Club" who investigate and document abandoned mine workings.

(http://www.undergroundminers.com/pr34tunnel21.JPG)

This photograph was claimed to have been taken along the Pine Ridge No.34 Colliery. Their photographs and descriptions demonstrate that many of the access tunnels and workings remain open. This photograph was taken during the 2002-2015 time period.

3 Subsurface Exploration Program

3.1 Boring Locations

The surface investigation consisted of seven (7) borings (B-7, B-7A, B-8, B-9, B-I81-1, B-I81-2, and B-I81-3). Borings B-I81-1, B-7 and B-7A are located northwest of State Road 315, borings B-I81-2, B-8 and B-9 are located Southeast of I-81, and B-I81-3 was drilled within the median of I-81. A locus map is provided as Appendix A. The boring locations and ground profile are provided in Appendix B.

3.2 Sampling Activities

Drilling and sampling activities were conducted by Craig Test Boring Co. Inc. of Mays Landing, New Jersey, and overseen and logged by a qualified Mott MacDonald geotechnical representative under the direction of a Professional Engineer currently licensed in the Commonwealth of Pennsylvania. Soil and rock samples were taken in accordance with the latest American Society of Testing and Materials (ASTM) D1586 and ASTM D2113 respectively. Soil samples were taken from a standard 2-inch split spoon, generally at 5 foot intervals, though this varied based on site conditions. The Standard Penetration Test was also performed at each split spoon sample to obtain an N-Value[1]. Soil was classified in the field according to ASTM D2488 classifications. Where bedrock was encountered before the boring termination depth, rock coring using a double barrel NQ series wireline setup was conducted. Rock coring was performed to the proposed boring termination depth. Rock cores were measured for recovery and RQD[2], logged for discontinuities and described based on type, color, hardness, weathering, and dip angle. Boring and coring logs, as well as core photos, are provided in Appendix C. Boring depths and approximate ground surface elevations are as follows:

Table 1: Boring Elevations and Depths

Boring Number	Approximate Ground Surface Elevation [α] (feet)	Boring Termination Depth (feet)
B-I81-1	807	180
B-7	815	100
B-7A	812	200
B-I81-3	827	175
B-I81-2	862	225
B-8	883	200
B-9	899	200

[α] Based on North American Vertical Datum of 1988

In select locations a down hole borehole camera was used to inspect the borings after termination depth was reached. The video results of the inspection were used to refine the details presented within the logs and stratum descriptions here within.

Upon completion, each borehole was grouted using a mixture of bentonite and Portland cement. Due to the large open voids grouting was performed in multiple stages. The lower portions of the holes were grouted first and then packers were used to hold the grout column above the voids and ensure grout came to surface.

[1] N-Value is the sum of the blows from the second and third 6 inches of penetration.

[2] RQD is Rock Quality Designation and is the percentage of rock core that is in pieces of larger than 4 inches.

3.3 Geophysical investigation

A MASA seismic survey was performed in January 2017 by geophysical subconsultant Hager-Richter Geosciences under the instruction of Mott MacDonald.

A 1075 ft. long survey line was performed. The objective of the investigation was to ascertain the thickness of fill material on the northern side of the crossing. The results are provided in Appendix F.

4 Subsurface Description

Based on our review of published information and project specific field data, the following is a description of the ground conditions present at this crossing. The boring profiles are shown on the alignment drawings provided in Appendix B. The logged results and core photos of the borings performed are provided in Appendix C.

4.1 North of SR315.

Boring B-I81-1 was drilled through historic strip mine backfill, the mining operation extracted the Cooper and Bennet coal seams and the location was backfilled at a later date. The fill was seen to be 50 ft. thick and is described as a Clayey Gravel. The material is highly variable and Standard Penetration Test N values fluctuated from refusal to N=3. At the base of the fill an abrupt change was encountered and the bedrock below was observed as a sequence of shales, sandstones, quartzites and coal layers. At 150ft depth, coal seams of the Top Ross and Ross seams were encountered which matched the elevations predicted from historical map inspection. Neither of the Ross coal seams were worked in the B-I81-1 boring, and it is thought the lack of working is due to this boring laying directly over the boundary between two independently operated collier operations. At the boundary between collieries, a zone of no working was enforced. These barrier zones were approximately 100 ft wide and represent an alignment with no coal extraction. No voids were encountered in B-I81-1.

It should be noted that B-I81-1 was drilled in the North-East corner of the car dealership plot (prior to the dealership being constructed). This location is topographically around 50 ft. higher than the base of the valley where the PP&L ROW is situated. The low laying areas at the base of the cliff are interpreted as areas of strip mine which were not backfilled and thus it can be estimated that bedrock will be present at relatively shallow depths.

B-7A was drilled towards the southern edge of the strip mine location. In this location, the backfill was 35 ft. thick and of a similarly heterogeneous composition to that seen in B-I81-1. B-7A was progressed into bedrock from 35 ft. Bedrock consisted of sandstone, quartzite, shale, and coal. From depths of 106-124 ft., numerous voids were encountered up to a maximum of 2 ft. thick. This zone is interpreted as the collapsed workings of the Ross coal seams. Boring B-7 was drilled in close proximity to B-7A but B-7 was terminated at 100ft depth, prior to reaching historic mine elevation.

The MASW seismic survey did not detect any mining highwall locations, and the interpreted depth to bedrock was generally as predicted by the historic mapping and drilling program (25-50 ft.).

4.2 Median of Interstate 81

Boring B-I81-3 was drilled in the median of I-81. Drilling encountered 10 ft. of granular fill. Below the fill, glacial till and weathered bedrock was penetrated until 25 ft. depth. From 25-175 ft., bedrock of sandstone, quartzite, mudstone shale and coal was cored. As predicted by the historical maps, a zone of voiding was encountered from 90-130 ft. The largest individual void was one (1) foot thick. The rock immediately above individual voids was generally high strength sandstone or conglomerate, acting as cap rock.

4.3 South of Interstate 81

Borings B-I81-2, B8 and B9 were all drilled to the south of I-81. All three boreholes encountered glacial till over bedrock. Glacial till was seen to be between 15-20ft thick and is characterized as a stiff gravely Clay. The bedrock is composed of the same lithologies as the other side of the crossing. The coal mining voids on the southern side of the crossing were generally observed to be slightly more intact and had not completely collapsed into rubble zones like the many of the northern locations.

The largest void encountered during this investigation was in B-9 and was 7.6 ft. thick at a depth of 60 ft. Inspection of the void via downhole camera showed a rubble floor and the void extending off laterally in all directions. The borehole logs and profile drawings show additional voids locations encountered in B-8 and B-9.

Boring B-MillCreek-1 was drilled 0.3 miles south of the I-81 crossing on the western crest of the Mill Creek Valley. This boring is not fully reported within this document because it pertains to a different crossing, however, it is mentioned because B-MillCreek-1 was progressed through the same stratigraphy and a void was observed 13 ft. thick at a depth of 30ft.

4.4 Current Conditions of Historic Mine Workings

The ground investigation performed was conducted with the sole objective of enabling the design of a trenchless crossing at this location. Limited commentary is made regarding the condition of the mine workings to assist with this objective; this report is not intended to be a detailed review of coal mine conditions and should not be used as such.

The modern-day condition of the historic coal workings is seen to be variable. In some locations the worked seams were observed to be relative intact, and in other locations the workings have collapsed. The largest void encountered was 7.6ft high and though to represent relative intact workings of the Top Ross coal seam (B-9). In other locations (B-8) the current conditions are thick zones of collapsed material. Based upon limited borehole information it is approximated that the zone of collapse has extended to become approximately 3.5x thicker than the original worked coal seam thickness where collapse has occurred. This is a lower multiple than is typically used to predict collapse propagation. The relatively limited propagation of collapse is possibly attributed to the high strength of the quartzite within the rock mass. Significant open fractures do exist well above the main zone of collapse due to stresses induced by mining.

4.5 Fault

A fault is indicated on the USGS mapping of this location. The elevations and notes observed on the historical mine mapping confirm the presence of a kink in the stratigraphy, which is consistent with a fold or fault zone. The feature lays beneath the southern carriageway of I-81. In this zone, the Top Ross mine map records a rapid change in elevation and stability issues encountered by the miners. The Ross mine maps also record rapid elevation changes but mining did continue through the zone implying that there is little displacement of the fault.

4.6 Groundwater Conditions

The majority of the exploratory boreholes drilled were not able to recirculate water to the surface. It is considered likely that the drilling water was lost to fractures and into the coal mine network. All boreholes were drilled with fresh water and no additional additives. A minor amount of perched ground water exists at shallow depths within cohesive materials and fill. The bedrock is well drained via the mining-induced fracturing and voids.

During drilling, the following ground water elevations were observed:

Table 2: Ground water conditions during borings

Borehole	Ground water depth	Drilling Fluid returns comment	Ground water comment
B-7	Ground water at 28 ft. depth when base of hole was at 67ft.	Good drill flush water return for full drill	Good return of drilling. Hole drilled through strip-mine backfill and bedrock but did not extend down to mine zone.
B-7A	Ground water at 130 ft. depth when base of hole was at 160 ft.	No drill flush water return below 51 ft.	Drilling water lost to mine void network
B-8	Ground water at 110 ft. depth when base of hole was at 120 ft.	No drill flush water return below 31 ft.	Drilling water lost to mine void network
B-9	Ground water at 84 ft. depth when base of hole was at 125 ft.	No drill flush water return below 26 ft.	Drilling water lost to mine void network
B-i81-1	Ground water at 30 ft. depth when base of hole was 180 ft.	Good drill flush water return for full drill	Good return of drilling water. Hole drilled through strip-mine backfill and unworked barrier pillar bedrock.
B-i81-2	Ground water at 215 ft. when hole at 225 ft.	No drill flush water return below 60 ft.	Drilling water lost to mine void network
B-i81-3	Hole dry to base at 175 ft.	No drill flush water return below 59 ft.	Drilling water lost to mine void network

Source: Field observations during drilling

5 Laboratory Testing

As directed by Mott MacDonald, soil and rock core samples were submitted to Craig Testing Laboratories, Inc. of Mays Landing, NJ.

5.1 Soil Testing Program

The following tests were performed by Craig Testing Laboratories, Inc.:

- **ASTM D422 – Sieve Grain Size Analysis**
- **ASTM D422 – Hydrometer Grain Size Analysis**
- **ASTM D2216 – Water Content**
- **ASTM D4318 – Liquid Limit, Plastic Limit, and Plasticity Index of Soils**

5.2 Soil Testing Results

The results below are a summary of the laboratory testing performed for the initial investigation. Complete testing results are provided in Appendix E.

Table 3: Soil Testing Results

Boring No.	Sample	Depth	% Passing No. 4	% Passing No. 10	% Passing No. 40	% Passing No. 200	% Clay	% Silt	% Water Content
B-7	S-2	5’ – 7’	79.1	60.1	45.0	31.2	16.9	14.3	13.6
	S-3	10’ – 12’	74.3	60.1	47.0	28.6	16.5	12.1	13.0
	S-4	15’ – 17’	79.9	63.3	48.0	26.1	22.3	3.8	8.4
	S-5	20’ – 22’	42.7	32.8	23.0	12.0	10.4	1.6	N/A
	S-6	25’ – 27’	38.5	29.0	22.0	11.2	6.9	4.3	N/A
	S-7	30’ – 32’	46.1	37.2	25.0	11.8	7.6	4.2	11.3
	S-8	35’ – 37’	44.8	35.3	22.5	10.1	6.3	3.8	11.9
	S-9	40’ – 42’	26.4	22.6	15.5	7.2	6.4	0.8	13.0
	S-10	45’ – 47’	29.0	21.5	17.5	8.6	6.0	2.6	N/A
	S-11	50’ – 52’	59.0	46.7	38.0	14.4	9.9	4.5	11.5
	S-12	55’ – 57’	65.1	58.0	44.0	18.4	18.4	11.0	N/A
B-I81-1	S-9	40’ – 42’	75.2	54.3	44.0	29.6	8.7	20.9	16.3
	S-10	45’ – 47’	N/A	N/A	N/A	N/A	N/A	N/A	18.0
	S-11	50’ – 52’	75.9	52.4	42.0	27.6	8.7	18.9	11.6
	S-12	55’ – 57’	N/A	N/A	N/A	N/A	N/A	N/A	11.7

Boring No.	Sample	Depth	Liquid Limit	Plastic Limit	Plasticity Index	Water Content (%)
B-7	S-2	5’ – 7’	25	14	11	13.6
	S-3	10’ – 12’	24	13	11	13.0

Boring No.	Sample	Depth	Liquid Limit	Plastic Limit	Plasticity Index	Water Content (%)
	S-4	15’ – 17’	21	11	10	8.4
	S-11	50’ – 52’	No-Value	Non-Plastic	Non-Plastic	11.5
B-I81-1	S-9	40’ – 42’	25	13	12	16.3
	S-10	45’ – 47’	26	12	14	18.0
	S-11	50’ – 52’	25	13	12	11.6
	S-12	55’ – 57’	25	12	13	11.7

N/A: Test not performed

5.3 Rock Testing Program

The following tests were performed by Craig Testing Laboratories, Inc.:

- **ASTM D5731- Point Load Unconfined Compressive Strength of Rock**
- **ASTM D7012 Method D- Uniaxial Compressive Strength of Rock**
- **Unit Weight of Oven Dried Rock on**

The following tests were performed by Terrasense, LLC:

- **ASTM D3967 – Splitting Tensile Strength422**

5.4 Rock Testing Results

The results below are a summary of the lab testing performed for the initial investigation. Complete testing results are provided in Appendix E.

Table 4: Rock Testing Results

Boring No.	Run No.	Depth (feet)	Point Load Unconfined Compressive Strength of Rock – Diametral* (psi)	Point Load Unconfined Compressive Strength of Rock – Axial (psi)	Uniaxial Compressive Strength of Rock (psi)	Unit Weight of Oven Dried Rock (pcf)	Splitting Tensile Strength (psi)
B-7	R-1	71.2’ – 71.9’	19,859	19,496	N/A	N/A	N/A
	R-1	72.9’ – 74.0’	N/A	N/A	16,547	N/A	N/A
	R-2	75.6’ – 76.3’	N/A	N/A	11,676	N/A	N/A
	R-2	76.9’ – 77.6’	10,366	19,589	N/A	N/A	N/A
	R-2	77.6’ – 76.2’	N/A	N/A	N/A	164.5	N/A
B-7A	R-18	130.5’ – 131.6’	3237	16750	N/A	N/A	N/A
	R-18	132.9’ – 132.95’	N/A	N/A	N/A	166	1627
	R-18	132.95’ – 133’	N/A	N/A	N/A	166	1401
	R-19	138.8’ – 139.9’	7229	15801	N/A	N/A	N/A
B-I81-2	R-1	26’ – 26.64’	N/A	N/A	20,116	N/A	N/A
	R-3	36.97’ – 37.56’	N/A	N/A	12,726	N/A	N/A
	R-5	47.1’ – 47.6’	N/A	N/A	N/A	164.9	N/A
	R-7	56.55’ – 57.34’	N/A	N/A	14,597	N/A	N/A
	R-10	70.95’ – 71.47’	N/A	N/A	2,340	N/A	N/A
	R-12	80.3’ – 80.9’	N/A	N/A	1,590	N/A	N/A
	R-14	92.25’ – 93.03’	N/A	N/A	11,759	N/A	N/A
	R-16	103.27’ – 104.07’	N/A	N/A	21,177	N/A	N/A
	R-18	110.25’ – 111.03’	N/A	N/A	15,682	N/A	N/A
	R-20	123.57’ – 124.38’	N/A	N/A	20,852	N/A	N/A
	R-22	131.67’ – 132.45’	N/A	N/A	17,765	N/A	N/A
B-I81-3	R-1	25.78’ – 27.35’	N/A	N/A	11,143	N/A	N/A
	R-2	32.83’ – 33.5’	N/A	N/A	9,819	N/A	N/A
	R-2	33.52’ – 34.14’	N/A	N/A	N/A	165	N/A
	R-4	43.05’ – 43.7’	N/A	N/A	5,979	N/A	N/A
	R-4	44.38’ – 44.8’	N/A	N/A	N/A	167.1	N/A

Boring No.	Run No.	Depth (feet)	Point Load Unconfined Compressive Strength of Rock – Diametral* (psi)	Point Load Unconfined Compressive Strength of Rock – Axial (psi)	Uniaxial Compressive Strength of Rock (psi)	Unit Weight of Oven Dried Rock (pcf)	Splitting Tensile Strength (psi)
	R-8	63.3’ – 65’	N/A	N/A	11,903	N/A	N/A
	R-18	113.78’ – 114.4’	N/A	N/A	12,001	N/A	N/A
	R-18	114.42’ – 114.6’	N/A	N/A	N/A	165.1	N/A

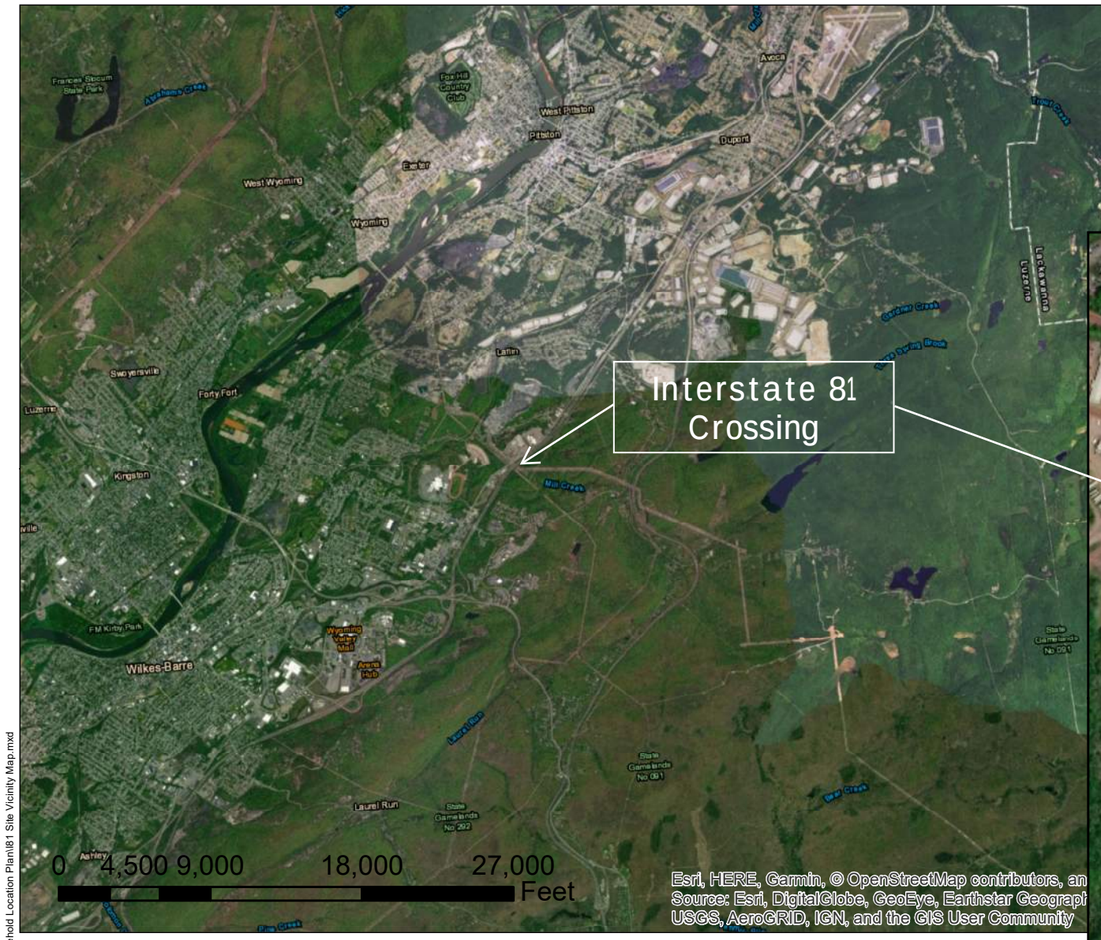
N/A: Test not performed
***If two results were given for the diametral point load test or splitting tensile strength test, an average of the two was taken.**

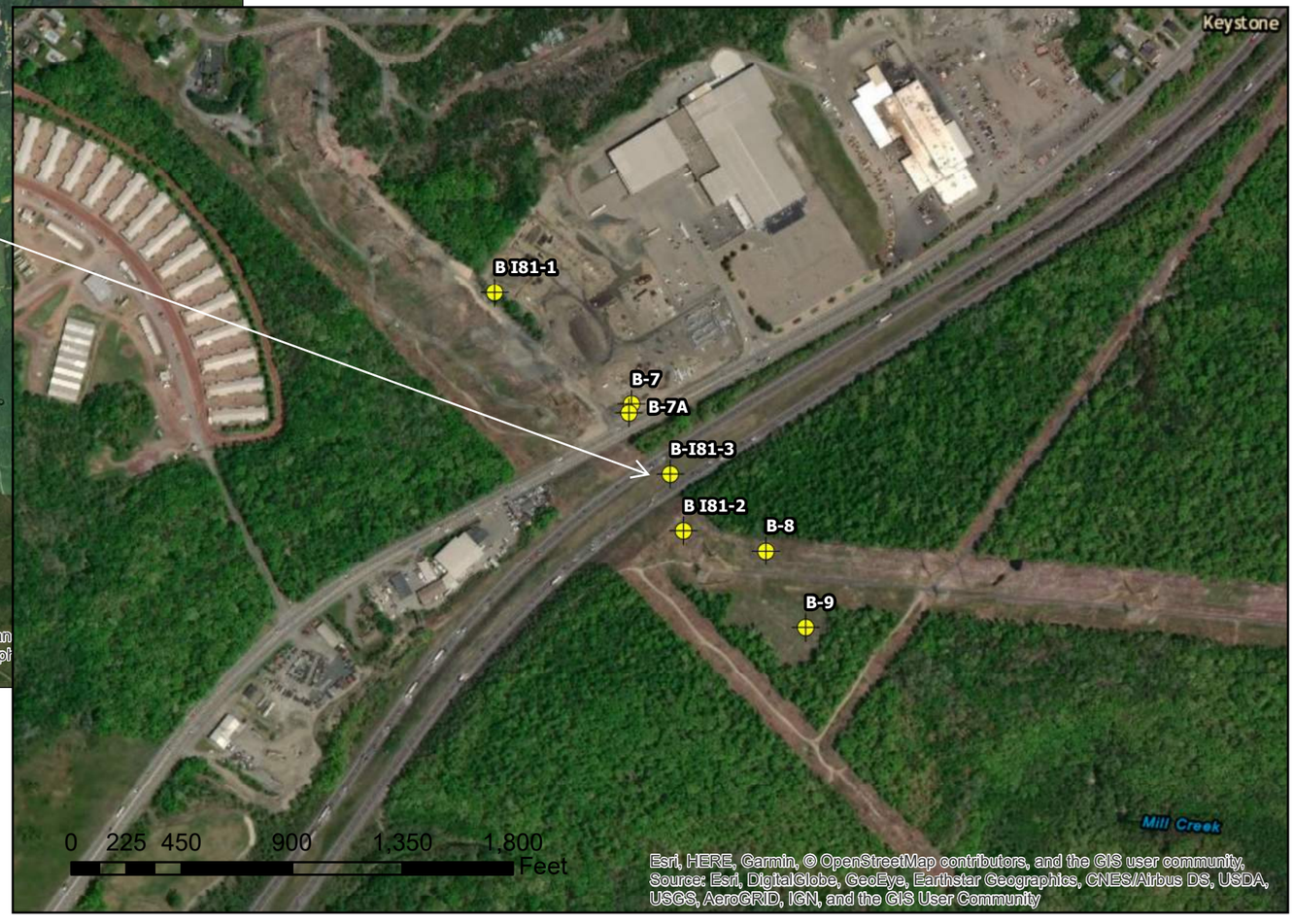
6 Limitations

The results and recommendations presented in this report are largely based on subsurface information from the borings performed during the February 2016 through April 2017 subsurface investigation, and our use of generally accepted analytical procedures. If further investigation or laboratory testing reveals significant differences in the subsurface conditions, Mott MacDonald should be given the opportunity to review and modify our recommendations, if appropriate.

Appendices

A. Site Vicinity Map





MOTT MACDONALD
Mott MacDonald
111 Wood Avenue South
Iselin, NJ 08830-4112
United States of America
T +1 973 379 3400
F +1 973 912 2400
mottmac.com
Certificate No. 24GA28016600

Client

PENNEAST PIPELINE

Rev	Date	Drawn	Description	Ch'k'd	App'd
0	12/15/2018				

LOCUS MAP

Designed	JWN		Eng check		
Drawn	JWN		Coordination		
Dwg Check	DC		Approved	VAS	

Project Number	B/O	Total
353754	1	1

Scale at 11" x 17"	Status	Rev	Security
AS SHOWN			

Drawing Number: 353754-I81-GT-LOC

Title

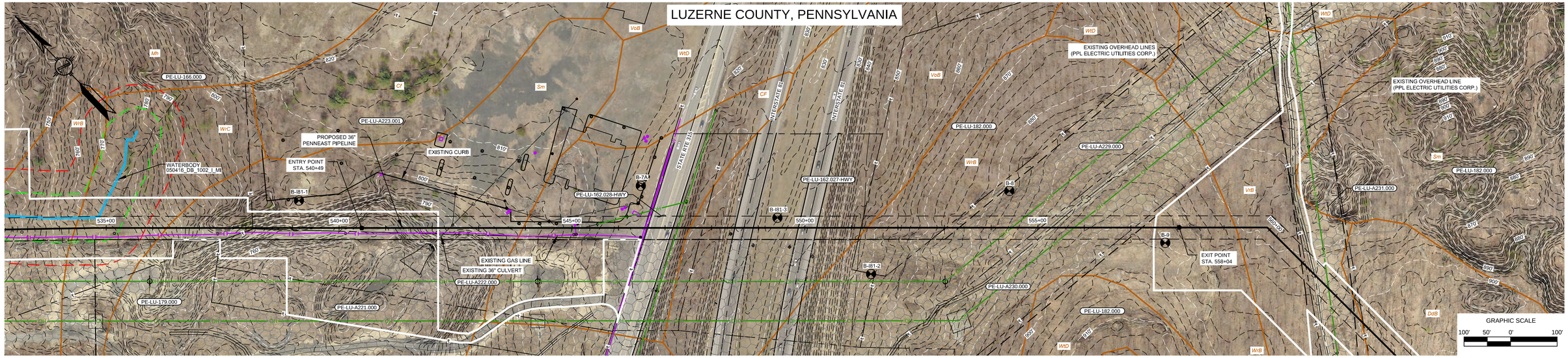
PENNEAST PIPELINE PROJECT

INTERSTATE 81 CROSSING
LUZERNE COUNTY, PENNSYLVANIA

P:\353754 PennEast\Geotechnical\008-HDD\01 - Interstate 81 Crossing (MP 10.0)-Route Change June 2015\I-Drawings\Borehold Location Plan\I81 Site Vicinity Map.mxd

IMAGE SOURCE: OGRIP

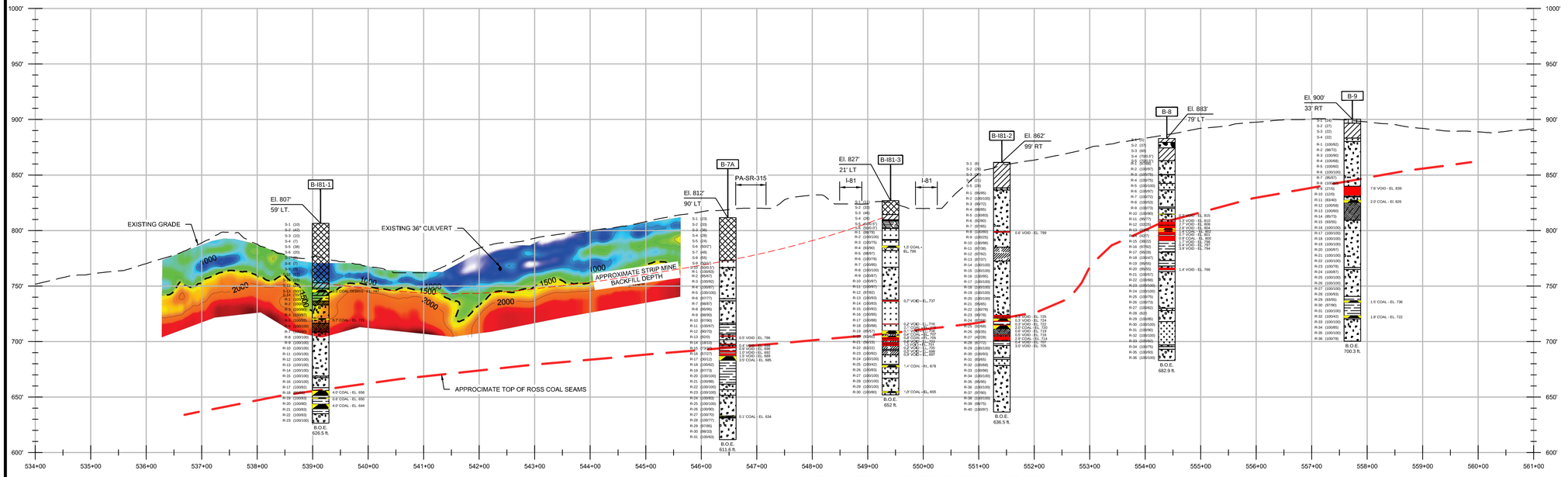
B. Alignment Drawings



NOTES:

1. PROFILE PRESENTS SUMMARY BOREHOLE LOG GRAPHICS, SEE FULL BOREHOLE LOG FOR DETAILS.
2. ROSS COAL SEAMS WERE WORKED VIA ROOM AND PILLAR MINING METHODS IN THE 1930'S AND 1940'S. DASHED RED LINE INDICATES APPROXIMATE LOCATION OF TOP OF WORKINGS. FRACTURING DUE TO MINING DISTURBANCE WILL EXIST ABOVE THIS ELEVATION. ADDITIONAL WORKED COAL SEAMS EXIST BELLOW THE ROSS COAL SEAMS.
3. SUMMARY GEOPHYSICAL PROFILE DISPLAYED, SEE FULL REPORT FOR DETAILS.

PA ST. ROUTE 315 / INTERSTATE 81 HDD PLAN VIEW
SCALE: 1" = 100'

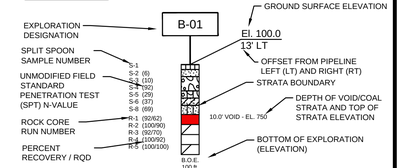


PA ST. ROUTE 315 / INTERSTATE 81 HDD PROFILE
SCALE: 1" = 100'

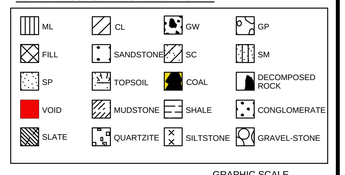
GEOTECHNICAL NOTE: MASW GEOPHYSICS CONDUCTED OFF CENTERLINE.

Resistivity (Ohm-m)

BORING LEGEND



SOIL AND ROCK STRATAGRAPHIC LEGEND:



GRAPHIC SCALE

HORIZ SCALE: 100' 50' 0' 100'

VERT SCALE: 50' 25' 0' 50'

NOTES:

1. THE CONTOURS AND IMAGERY SHOWN WERE PROVIDED BY PICTOMETRY, 2015. ADDITIONAL CONTOURS AND IMAGERY SUPPLEMENTED FROM PASDA.
2. EXISTING FEATURE SURVEYED PERFORMED BY MOTT MACDONALD 2015 THRU 2018. ADDITIONAL FEATURES DIGITIZED FROM IMAGERY. ALL LOCATIONS ARE APPROXIMATE AND SHALL BE VERIFIED BY CONTRACTOR.
3. PROPERTY LINES DEPICTED ON THIS PLAN ARE BASED ON GIS TAX MAP DATA AND RECTIFIED PROPERTY LINES AND ARE NOT THE RESULT OF A BOUNDARY SURVEY.
4. WATERBODY INFORMATION PROVIDED BY AECOM 2015 THRU 2018.

REFERENCE DRAWINGS

DWG. NO.	TITLE
000-03-01-021	ALIGNMENT SHEET
000-03-01-022	ALIGNMENT SHEET
000-03-01-023	ALIGNMENT SHEET
000-03-03-012.1	ACCESS ROAD DETAIL
000-03-07-001	HDD EXHIBIT PLAN AND PROFILE

REVISIONS

	REVISIONS	DATE	DRAWN	CK	APPR
A	ISSUED FOR PADEP	10/2018	JL (MM)	AJD (MM)	MJD (MM)

APPROVALS

	DATE
DRAWN BY	
RJP (MM)	10/15/2018
CHECKED BY	DATE
CAF (MM)	10/15/2018
ENG. APPROVAL	DATE
MDN (MM)	10/15/2018
P.M. APPROVAL	DATE
MAW (MM)	10/15/2018

CLIENT APPROVAL

DATE

PREPARED FOR

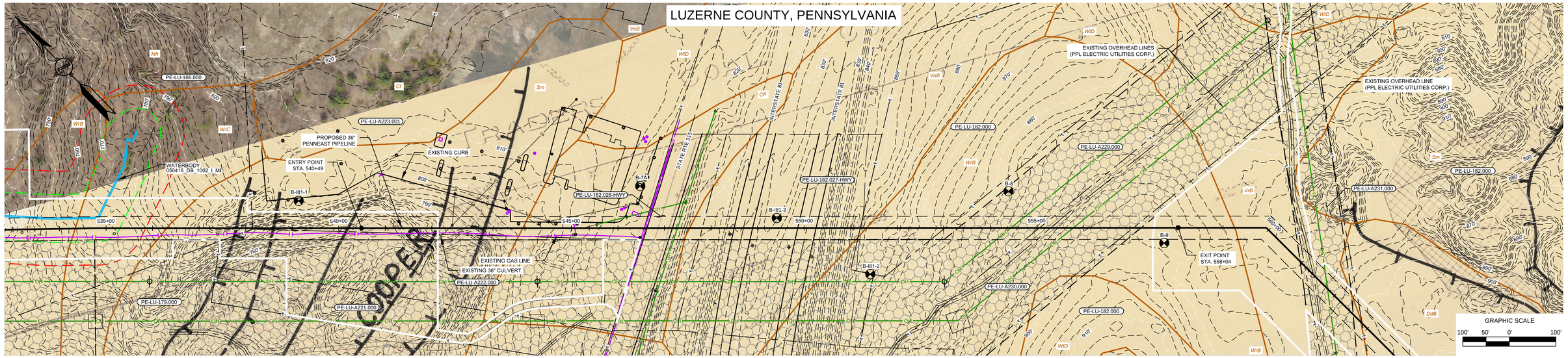
PennEast PIPELINE

PENNEAST PIPELINE PROJECT

GEOLOGICAL INVESTIGATION PROFILE DRAWING
PROPOSED 36" PIPELINE
HDD EXHIBIT PLAN AND PROFILE
PA ST. ROUTE 315 / INTERSTATE 81 HDD
LUZERNE COUNTY, PENNSYLVANIA

SCALE	DRAWING NO.	REVISION
AS SHOWN	000-03-07-001-GT	A

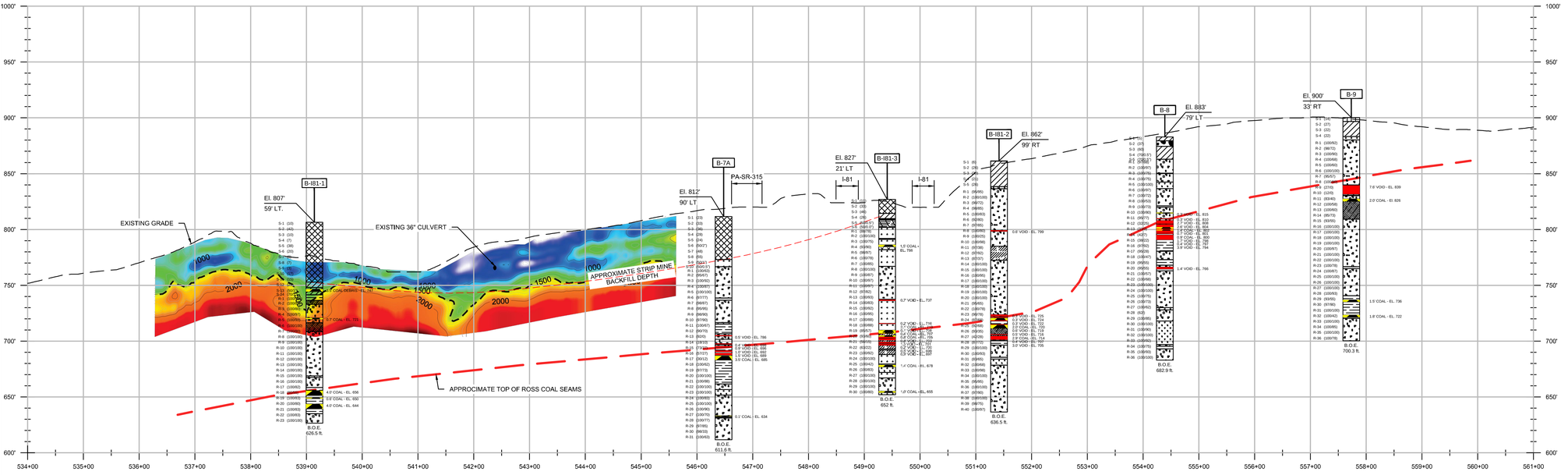
G:\PENNEAST\353754_PENNEAST_PIPELINE_EPC\MDA\TAPROOT_STATE_PERMIT\WORK\PAIDRAFTING\EROSION_SEDIMENT_CONTROL_PLAN\HDD_DETAILS\GEOTECH_SPECIFIC_HDDS\000-03-07-001-GT.DWG DUM64749



NOTES:

1. PROFILE PRESENTS SUMMARY BOREHOLE LOG GRAPHICS, SEE FULL BOREHOLE LOG FOR DETAILS.
2. ROSS COAL SEAMS WERE WORKED VIA ROOM AND PILLAR MINING METHODS IN THE 1930'S AND 1940'S. DASHED RED LINE INDICATES APPROXIMATE LOCATION OF TOP OF WORKINGS. FRACTURING DUE TO MINING DISTURBANCE WILL EXIST ABOVE THIS ELEVATION. ADDITIONAL WORKED COAL SEAMS EXIST BELLOW THE ROSS COAL SEAMS.
3. SUMMARY GEOPHYSICAL PROFILE DISPLAYED, SEE FULL REPORT FOR DETAILS.

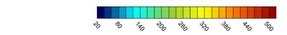
PA ST. ROUTE 315 / INTERSTATE 81 HDD PLAN VIEW
SCALE: 1" = 100'



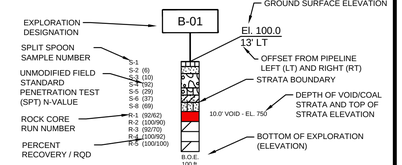
PA ST. ROUTE 315 / INTERSTATE 81 HDD PROFILE
SCALE: 1" = 100'

GEOTECHNICAL NOTE: MASW GEOPHYSICS CONDUCTED OFF CENTERLINE.

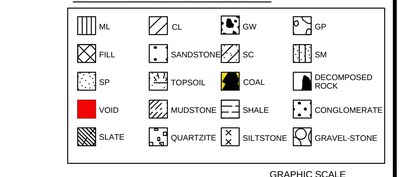
Resistivity (Ohm-m)



BORING LEGEND



SOIL AND ROCK STRATAGRAPHIC LEGEND:



GRAPHIC SCALE

HORIZ SCALE: 100' 50' 0' 100'

VERT SCALE: 50' 25' 0' 50'

NOTES:

1. THE CONTOURS AND IMAGERY SHOWN WERE PROVIDED BY PICTOMETRY, 2015. ADDITIONAL CONTOURS AND IMAGERY SUPPLEMENTED FROM PASDA.
2. EXISTING FEATURE SURVEYED PERFORMED BY MOTT MACDONALD 2015 THRU 2018. ADDITIONAL FEATURES DIGITIZED FROM IMAGERY. ALL LOCATIONS ARE APPROXIMATE AND SHALL BE VERIFIED BY CONTRACTOR.
3. PROPERTY LINES DEPICTED ON THIS PLAN ARE BASED ON GIS TAX MAP DATA AND RECTIFIED PROPERTY LINES AND ARE NOT THE RESULT OF A BOUNDARY SURVEY.
4. WATERBODY INFORMATION PROVIDED BY AECOM 2015 THRU 2018.
5. HISTORIC MINE MAPS ARE OBTAINED FROM PADEP MINE MAP ATLAS. REFERENCE BMSA 4943-001B

REFERENCE DRAWINGS

DWG. NO.	TITLE
000-03-01-021	ALIGNMENT SHEET
000-03-01-022	ALIGNMENT SHEET
000-03-01-023	ALIGNMENT SHEET
000-03-03-012.1	ACCESS ROAD DETAIL
000-03-07-001	HDD EXHIBIT PLAN AND PROFILE

REVISIONS

	REVISIONS	DATE	DRAWN	CK	APPR
A	ISSUED FOR PADEP	10/2018	JL (MM)	AJD (MM)	MJD (MM)

APPROVALS

	DATE
DRAWN BY	
RJP (MM)	10/15/2018
CHECKED BY	DATE
CAF (MM)	10/15/2018
ENG. APPROVAL	DATE
MDN (MM)	10/15/2018
P.M. APPROVAL	DATE
MAW (MM)	10/15/2018

CLIENT APPROVAL

DATE

PREPARED FOR

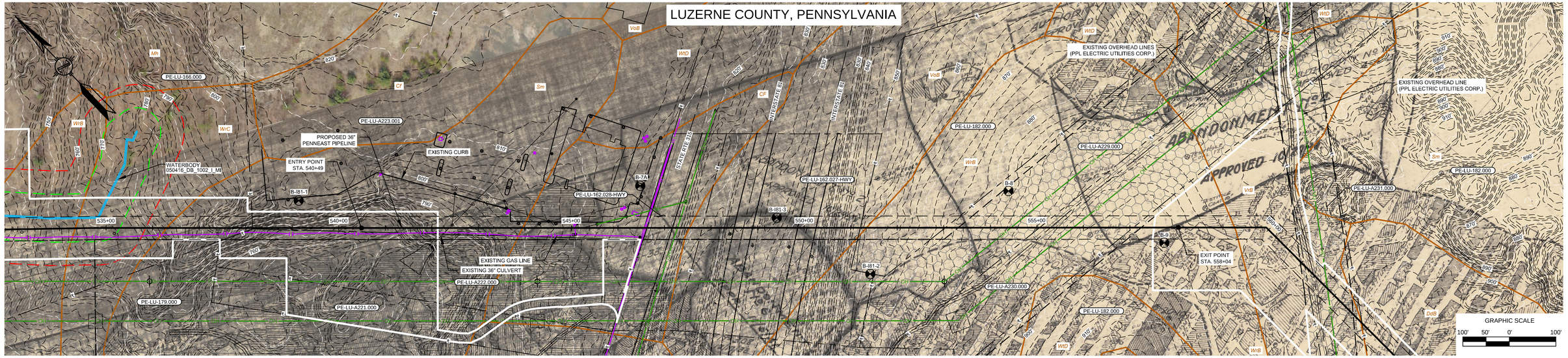
PennEast PIPELINE

PENNEAST PIPELINE PROJECT

GEOLOGICAL INVESTIGATION PROFILE DRAWING
PROPOSED 36" PIPELINE
HDD EXHIBIT PLAN AND PROFILE
PA ST. ROUTE 315 / INTERSTATE 81 HDD
LUZERNE COUNTY, PENNSYLVANIA

SCALE	DRAWING NO.	REVISION
AS SHOWN	000-03-07-001-GT (COOPER MAPPING)	A

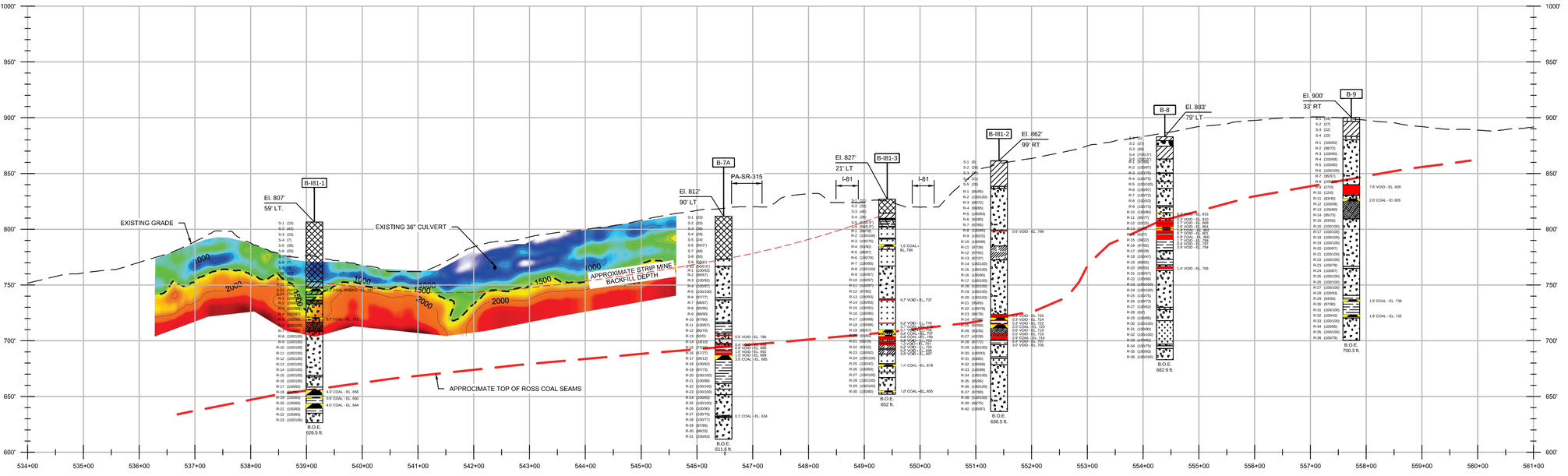
G:\PENNEAST\353754_PENNEAST_PIPELINE_EPC\MDATA\PROD_STATE_PERMIT\WORK\PAIDRAFTING\EROSION_SEDIMENT_CONTROL_PLAN\HDD_DETAILS\GEOTECH_SPECIFIC_HDDS\000-03-07-001-GT (COOPER MAPPING).DWG DUN64749



NOTES:

1. PROFILE PRESENTS SUMMARY BOREHOLE LOG GRAPHICS, SEE FULL BOREHOLE LOG FOR DETAILS.
2. ROSS COAL SEAMS WERE WORKED VIA ROOM AND PILLAR MINING METHODS IN THE 1930'S AND 1940'S. DASHED RED LINE INDICATES APPROXIMATE LOCATION OF TOP OF WORKINGS. FRACTURING DUE TO MINING DISTURBANCE WILL EXIST ABOVE THIS ELEVATION. ADDITIONAL WORKED COAL SEAMS EXIST BELLOW THE ROSS COAL SEAMS.
3. SUMMARY GEOPHYSICAL PROFILE DISPLAYED, SEE FULL REPORT FOR DETAILS.

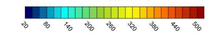
PA ST. ROUTE 315 / INTERSTATE 81 HDD PLAN VIEW
SCALE: 1" = 100'



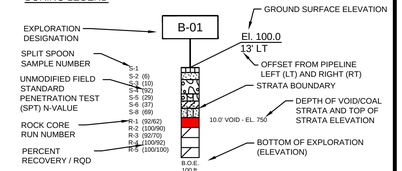
PA ST. ROUTE 315 / INTERSTATE 81 HDD PROFILE
SCALE: 1" = 100'

GEOTECHNICAL NOTE: MASW GEOPHYSICS CONDUCTED OFF CENTERLINE.

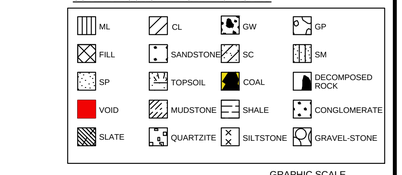
Resistivity (Ohm-m)



BORING LEGEND



SOIL AND ROCK STRATAGRAPHIC LEGEND:



GRAPHIC SCALE

HORIZ SCALE: 100' 50' 0' 100'

VERT SCALE: 50' 25' 0' 50'

NOTES:

1. THE CONTOURS AND IMAGERY SHOWN WERE PROVIDED BY PICTOMETRY, 2015. ADDITIONAL CONTOURS AND IMAGERY SUPPLEMENTED FROM PASDA.
2. EXISTING FEATURE SURVEYED PERFORMED BY MOTT MACDONALD 2015 THRU 2018. ADDITIONAL FEATURES DIGITIZED FROM IMAGERY. ALL LOCATIONS ARE APPROXIMATE AND SHALL BE VERIFIED BY CONTRACTOR.
3. PROPERTY LINES DEPICTED ON THIS PLAN ARE BASED ON GIS TAX MAP DATA AND RECTIFIED PROPERTY LINES AND ARE NOT THE RESULT OF A BOUNDARY SURVEY.
4. WATERBODY INFORMATION PROVIDED BY AECOM 2015 THRU 2018.
5. HISTORIC MINE MAPS ARE OBTAINED FROM PADEP MINE MAP ATLAS. REFERENCE BMSA 4947-005

REFERENCE DRAWINGS

DWG. NO.	TITLE
000-03-01-021	ALIGNMENT SHEET
000-03-01-022	ALIGNMENT SHEET
000-03-01-023	ALIGNMENT SHEET
000-03-03-012.1	ACCESS ROAD DETAIL
000-03-07-001	HDD EXHIBIT PLAN AND PROFILE

REVISIONS

	REVISIONS	DATE	DRAWN	CK	APPR
A	ISSUED FOR PADEP	10/2018	JL (MM)	AJD (MM)	MJD (MM)

APPROVALS

	DATE
DRAWN BY	
RJP (MM)	10/15/2018
CHECKED BY	DATE
CAF (MM)	10/15/2018
ENG. APPROVAL	DATE
MDN (MM)	10/15/2018
P.M. APPROVAL	DATE
MAW (MM)	10/15/2018

CLIENT APPROVAL

DATE

PREPARED FOR

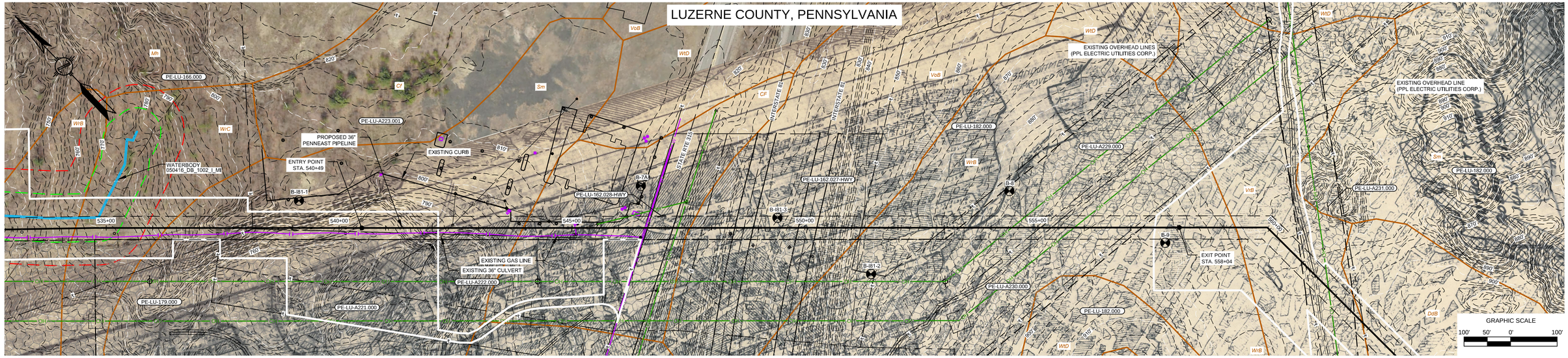
PennEast PIPELINE

PENNEAST PIPELINE PROJECT

GEOLOGICAL INVESTIGATION PROFILE DRAWING
PROPOSED 36" PIPELINE
HDD EXHIBIT PLAN AND PROFILE
PA ST. ROUTE 315 / INTERSTATE 81 HDD
LUZERNE COUNTY, PENNSYLVANIA

SCALE	DRAWING NO.	REVISION
AS SHOWN	000-03-07-001-GT (TOP ROSS SEAM MAPPING)	A

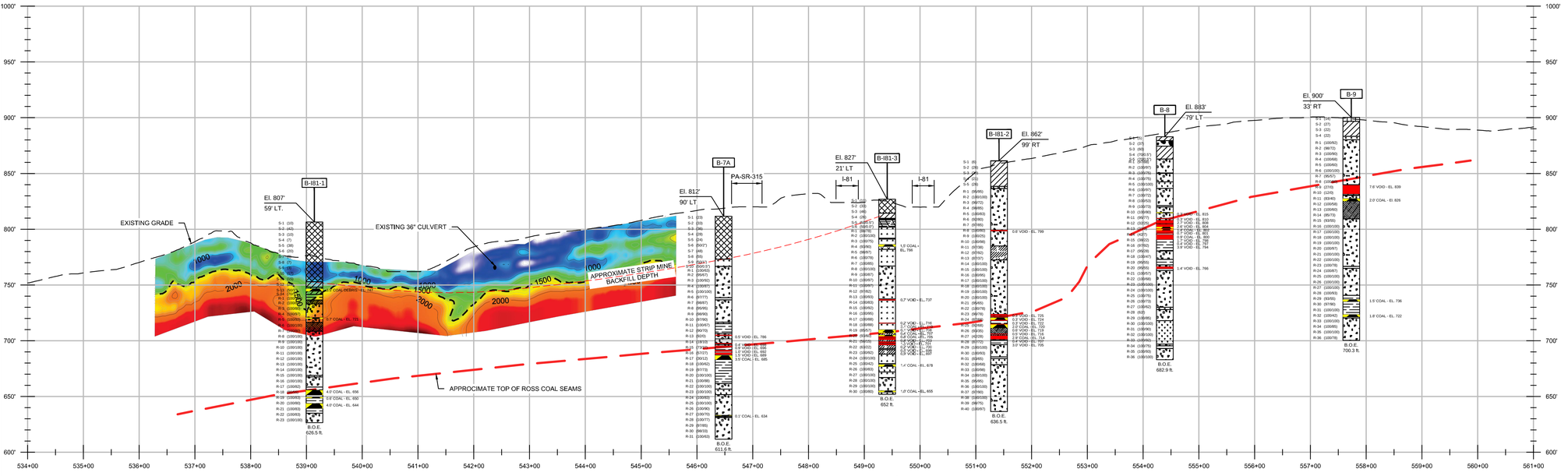
G:\PENNEAST\353754_PENNEAST_PIPELINE_EPC\MDA\TAPROOT_STATE_PERMIT\WORK\PAIDRAFTING\EROSION_SEDIMENT_CONTROL_PLAN\HDD_DETAILS\GEOTECH_SPECIFIC_HDDS\000-03-07-001-GT (TOP ROSS SEAM MAPPING).DWG DJM64749



NOTES:

1. PROFILE PRESENTS SUMMARY BOREHOLE LOG GRAPHICS, SEE FULL BOREHOLE LOG FOR DETAILS.
2. ROSS COAL SEAMS WERE WORKED VIA ROOM AND PILLAR MINING METHODS IN THE 1930'S AND 1940'S. DASHED RED LINE INDICATES APPROXIMATE LOCATION OF TOP OF WORKINGS. FRACTURING DUE TO MINING DISTURBANCE WILL EXIST ABOVE THIS ELEVATION. ADDITIONAL WORKED COAL SEAMS EXIST BELLOW THE ROSS COAL SEAMS.
3. SUMMARY GEOPHYSICAL PROFILE DISPLAYED, SEE FULL REPORT FOR DETAILS.

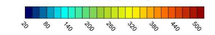
PA ST. ROUTE 315 / INTERSTATE 81 HDD PLAN VIEW
SCALE: 1" = 100'



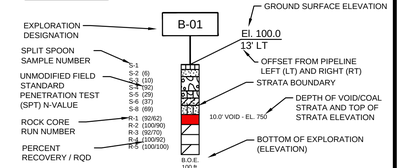
PA ST. ROUTE 315 / INTERSTATE 81 HDD PROFILE
SCALE: 1" = 100'

GEOTECHNICAL NOTE: MASW GEOPHYSICS CONDUCTED OFF CENTERLINE.

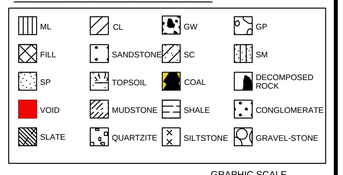
Resistivity (Ohm-m)



BORING LEGEND



SOIL AND ROCK STRATAGRAPHIC LEGEND:



GRAPHIC SCALE

HORIZ SCALE: 100' 50' 0' 100'

VERT SCALE: 50' 25' 0' 50'

NOTES:

1. THE CONTOURS AND IMAGERY SHOWN WERE PROVIDED BY PICTOMETRY, 2015. ADDITIONAL CONTOURS AND IMAGERY SUPPLEMENTED FROM PASDA.
2. EXISTING FEATURE SURVEYED PERFORMED BY MOTT MACDONALD 2015 THRU 2018. ADDITIONAL FEATURES DIGITIZED FROM IMAGERY. ALL LOCATIONS ARE APPROXIMATE AND SHALL BE VERIFIED BY CONTRACTOR.
3. PROPERTY LINES DEPICTED ON THIS PLAN ARE BASED ON GIS TAX MAP DATA AND RECTIFIED PROPERTY LINES AND ARE NOT THE RESULT OF A BOUNDARY SURVEY.
4. WATERBODY INFORMATION PROVIDED BY AECOM 2015 THRU 2018.
5. HISTORIC MINE MAPS ARE OBTAINED FROM PADEP MINE MAP ATLAS. REFERENCE BMSA 4947-004.

REFERENCE DRAWINGS

DWG. NO.	TITLE
000-03-01-021	ALIGNMENT SHEET
000-03-01-022	ALIGNMENT SHEET
000-03-01-023	ALIGNMENT SHEET
000-03-03-012.1	ACCESS ROAD DETAIL
000-03-07-001	HDD EXHIBIT PLAN AND PROFILE

REVISIONS

	REVISIONS	DATE	DRAWN	CK	APPR
A	ISSUED FOR PADEP	10/2018	JL (MM)	AJD (MM)	MJD (MM)

APPROVALS

	DATE
DRAWN BY	
RJP (MM)	10/15/2018
CHECKED BY	DATE
CAF (MM)	10/15/2018
ENG. APPROVAL	DATE
MDN (MM)	10/15/2018
P.M. APPROVAL	DATE
MAW (MM)	10/15/2018

CLIENT APPROVAL

DATE

PREPARED FOR

PennEast PIPELINE

PENNEAST PIPELINE PROJECT

GEOLOGICAL INVESTIGATION PROFILE DRAWING
PROPOSED 36" PIPELINE
HDD EXHIBIT PLAN AND PROFILE
PA ST. ROUTE 315 / INTERSTATE 81 HDD
LUZERNE COUNTY, PENNSYLVANIA

SCALE	DRAWING NO.	REVISION
AS SHOWN	000-03-07-001-GT (ROSS SEAM MAPPING)	A

G:\PENNEAST\353754_PENNEAST_PIPELINE_EPC\MDA\TAPROOT_STATE_PERMIT\WORK\PAIDRAFTING\EROSION_SEDIMENT_CONTROL_PLAN\HDD_DETAILS\GEOTECH_SPECIFIC_HDDS\000-03-07-001-GT (ROSS SEAM MAPPING).DWG DUM64749

C. Boring Logs and Core Photographs

MOTT MACDONALD

SOIL/ROCK BORING LOG LEGEND

USCS Group Symbol

UNIFIED SOIL CLASSIFICATION SYSTEM AND SYMBOL CHART

COARSE-GRAINED SOILS (more than 50% of material is larger than No. 200 sieve size.)			FINE-GRAINED SOILS (more than 50% of material is smaller than No. 200 sieve size.)		
Gravels More than 50% of coarse fraction larger than N.4 sieve size	Clean Gravels (Less than 5% fines)		**SILTS AND CLAYS** Liquid limit less than 50%	ML	Inorganic silts and very fine sands, rock flour, silty of clayey of clayey fine sands or clayey silts with slight plasticity
	GW	Well-graded gravels, gravel-sand mixtures, little or no fines		CL	Inorganic clays of low to medium plasticity, gravelly clays, sandy clays, silty clays, lean clays
	GP	Poorly-graded gravels, gravel-sand mixtures, little or no fines		OL	Organic silts and organic silty clays of low plasticity
	Gravels with fines (more than 12% fines)		**SILTS AND CLAYS** Liquid limit 50% or greater	MH	Inorganic silts, micaceous or diatomaceous fine sandy or silty soils, elastic silts
	GM	Silty gravels, gravel-sand-silt mixtures		CH	Inorganic clays of high plasticity, fats clays
	GC	Clayey gravels, gravel-sand-clay mixtures		OH	Organic clays of medium to high plasticity, organic silts
Sands More than 50% of coarse fraction larger than N.4 sieve size	Clean Sands (Less than 5% fines)		**HIGHLY ORGANIC SOILS**	PT	Peat and other highly organic soils
	SW	Well-graded sands, gravelly sands, little or no fines	Determine percentages of sand and Gravel from grain-size curve. Depending on percentage of fines (fraction smaller than No. 200 sieve size), coarse-grained soils are classified as follows: Less than 5 percent ……GW, GP, SW, SP More than 12 percent ……GM, GC, SM, SC 5 to 12 percent ……Borderline cases requiring dual symbols		
	SP	Poorly-graded sands, gravelly sands, little or no fines			
	Sands with fines (More than 12% fines)				
	SM	Silty sands, sand-silt mixtures			
	SC	Clayey sands, sand-clay mixtures			

Minor Components

Description	Criteria
20 – 30%	some
10 – 20%	little
1 – 10%	trace

Infilling

Description	Symbol
Clay	CL
Silt	ML
Sand	SD
Calcite	CA
Carbonate	C
Dolomite	DO
Gypsum/Tale	GY
Hematite	HE
Limonite	L
Quartz	QZ
Chlorite	CH
Pyrite	PY
Iron Oxide Staining	FE
Stylolite	ST
Not Determined	X
None	N
Healed	H

Weathering of Rock Mass

Description	Symbol	Criteria	Grade
Fresh (Unweathered)	FR	No visible sign of rock material weathering, except slight discoloration on major discontinuity surfaces.	I
Slightly Weathered	SL	Discoloration indicates weathering of rock material and discontinuity surfaces. All rock material may be discolored by weathering and may be somewhat weaker than externally than in its fresh condition.	II
Moderately Weathered	M	Less than half of the rock material is decomposed and/or disintegrated to soil. Fresh or discolored rock is present either as a continuous framework or as corestones.	III
Highly Weathered	H	More than half of the rock material is decomposed and/or disintegrated to a soil. Fresh or discolored rock is present either as a discontinuous framework or as corestones.	IV
Completely Weathered	C	All rock material is decomposed and/or disintegrated to soil. The original mass structure remains largely intact.	V
Residual Soil	RS	All rock material is converted to soil. The mass structure and material fabric are destroyed. There is a large change in volume, but the soil has not been significantly transported.	VI

Discontinuity Spacing

Description	Symbol	Spacing (in.)
Extremely Close	EC	< 0.75
Very Close	VC	0.75 – 2.5
Close	C	2.5 – 8.0
Moderate	M	8 – 24
Wide	W	24 – 80
Very Wide	VW	80 – 240
Extremely Wide	EW	> 240

Spacing Type

Description	Symbol	Spacing (in.)
Joint	J	A natural fracture along which no displacement has occurred. May occur in parallel groups called sets.
Shear	S	A natural fracture along which differential movement has occurred. May be slickensided or striated.
Fault	F	A natural fracture along which displacement has occurred. Usually lined with gouge and slickensides.
Vein	V	A thin, sheet-like igneous intrusion into a fissure.
Bedding Joint	B	Joints that occur along bedding planes.
Foliation Joint	FJ	Joints that occur parallel to the foliation of a rock mass.
Shear Zone	SZ	Zone of fractured rock and gouge bordering the displacement plane.

Field Strength*

Description	Criteria	Grade	Approx. Range of Uniaxial Compressive Strength (psi)
Extremely Weak	Indented by thumbnail.	R0	40 – 150
Very Weak	Crumbles under firm blows with point of geological hammer, can be peeled by a pocket knife.	R1	150 – 700
Weak	Can be peeled by a pocket knife with difficulty, shallow indentations made by firm blow with point of geological hammer.	R2	700 – 4,000
Medium Strong	Cannot be scraped or peeled with a pocket knife, specimen can be fractured with single firm blow of geological hammer.	R3	4,000 – 7,000
Strong	Specimen requires more than one blow of geological hammer to fracture it.	R4	7,000 – 15,000
Very Strong	Specimen requires many blows of geological hammer to fracture it.	R5	15,000 – 36,000
Extremely Strong	Specimen can only be chipped with geological hammer.	R6	>36,000

Roughness

Intermediate Scale	Symbol	Small Scale	Symbol
Stepped	S	Rough	R
Undulating	U	Smooth	Sm
Planar	P	Slickensided	K
Not Determined	X	Wavy	Wa
		Not Determined	X

Weathering/Alteration of Discontinuity Surfaces

Description	Symbol	Criteria
Fresh	FR	No visible sign of weathering on the rock discontinuity surfaces.
Discolored	DS	Discoloration of rock material discontinuity surfaces. Degree of discoloration and specific discolored mineral constituents (if applicable) indicated.
Disintegrated	DG	Discontinuity surface rock material is weathered to a soil with the rock material fabric intact. Rock material is friable, but the mineral grains are not decomposed.
Decomposed	DE	Discontinuity surface rock material is weathered to a soil with the rock material fabric intact and with some or all mineral grains decomposed.

Aperture

Description	Symbol	Aperture (in.)	
Very Tight	VT	< 0.004	"Closed" Features
Tight*	T	0.004 – 0.010	
Partly Open	PO	0.01 – 0.02	
Open**	O	0.02 – 0.10	"Gapped" Features
Moderately Wide	MW	0.1 – 0.4	
Wide	W	> 0.4	
Very Wide	VW	0.4 – 4.0	"Open" Features
Extremely Wide	EW	4.0 – 40.0	
Cavernous	CA	> 40	

*__Note__: The Uniaxial Compressive Strength ranges are approximate; therefore, a geotechnical engineer should be consulted for verification of rock strength.

MOTT MACDONALD M M

BOREHOLE LOG GRAPHIC LEGEND

Project:	PennEast Pipeline Project	**Project No.:**	353754
Location:	Interstate - 81 Crossing, Wilkes - Barre, PA	**Project Manager:**	Vatsal Shah
Client:	PennEast Pipeline	**Project Director:**	Michael Wilcox

Soil Log Graphic Legend


CL: USCS Low Plasticity Clay


COAL: Coal


FILL: Miscellaneous and Manmade Fill


GP: USCS Poorly-graded Gravel


GW: USCS Well-graded Gravel


ML: USCS Silt


SANDSTONE: Sandstone


SC: USCS Sandy Clay to Clayey Sand


SM: USCS Silty Sand


SP: USCS Poorly-graded Sand


TOPSOIL: Topsoil


WEATHERED SANDSTONE: Highly or Severely Weathered Sandstone


WEATHERED SHALE: Highly or Severely Weathered Shale

Rock Log Graphic Legend


CL - USCS Low Plasticity Clay


COAL - Coal


CONGLOMERATE - Conglomerate


GRAVEL-STONE - Gravel or Crushed Stone


MUDSTONE - Mudstone


QUARTZITE - Quartz and Quartzite


SANDSTONE - Sandstone


SHALE - Shale


SILTSTONE - Siltstone


SLATE - Slate


VOID - Underground Void

▽ Ground Water Level
(Note that due to drilling process disturbance the ground water levels obtained during drilling are not as representative as those obtained from monitoring wells)

This legend reports all soil and rock graphics which have been used in the logs of this project only.

MOTT MACDONALD M M

SOIL BORING LOG

BORING NO.: **B-I81-1**
Page **1** of **3**

Project:	PennEast Pipeline Project	**Project No.:**	353754
Location:	Interstate - 81 Crossing, Wilkes - Barre, PA	**Project Mgr:**	Vatsal Shah
Client:	PennEast Pipeline	**Field Eng. Staff:**	Dafydd Chandler
Drilling Co.:	Craig Test Boring Co., Inc.	**Date/Time Started:**	August 4, 2016 at 2:15 pm
Driller/Helper:	Paul Mullins /Nick Beehler	**Date/Time Finished:**	August 8, 2016 at 3:02 pm

Elevation: 807 ft. **Vertical Datum:** NAVD 1988 **Boring Location:** Northwest corner of construction site. **Coord.:** **N:** 14991695.36 **E:** 1418643.024 **Horizontal Datum:** UTM Zone 18 T

Item	Casing	Sampler	Core Barrel
Type	HW	SS	NQ2
Length (ft)	30	2	5
Inside Dia. (in.)	4	1.375	2.0
Hammer Wt. (lb.)	140	140	-
Hammer Fall (in.)	30	30	-

Rig Make & Model: CME-750X

☐ Truck ☐ Tripod ☐ Cat-Head
☑ ATV ☐ Geoprobe ☑ Winch
☐ Track ☐ Air Track ☑ Roller Bit
☐ Skid ☐ _____ ☐ Cutting Head

Hammer Type: ☐ Safety ☐ Doughnut ☑ Automatic ☐ _____

Drilling Fluid: ☐ Bentonite ☐ Polymer ☑ Water ☐ None

Drill Rod Size:

Casing Advance: Mud Rotary

Depth/ Elev. (ft)	Sample No. / Interval (ft)	Rec. (in)	Sample Blows per 6"	Stratum Graphic	USCS Group Symbol	Visual - Manual Identification & Description (Density/consistency, color, Group Name, constituents, particle size, structure, moisture, optional descriptions, geologic interpretation, Symbol)	Field Tests: Dilatancy	Toughness	Plasticity	Dry Strength	Remarks
	S-1 0.0'- 2.0'	20	8 4 6 4		FILL	Stiff, Black and brown Gravelly SILT with Sand and Clay, dry (FILL)	N	-	NP	-	
5	S-2 5.0'- 7.0'	11	7 9 33 67		FILL	Very dense, Brown to gray SAND with Gravel, trace Clay and Silt, wet (FILL)	N	-	NP	-	
800											
10	S-3 10.0'- 12.0'	16	4 4 6 5		FILL	Stiff, Brown to black Lean CLAY with Gravel and Sand, wet (FILL)	N	-	M	-	Gravel is Sandstone and Coal.
15	S-4 15.0'- 17.0'	16	3 3 4 3		FILL	Medium stiff, Black Lean CLAY with Gravel, moist (FILL)	S	M	M	M	
790											

Water Level Data

Date	Time	Elapsed Time (hr)	Depth in feet to: Bot. of Casing	Bottom of Hole	Water
8/8/16	6:10	-	30.0	110.0	50
8/9/16	6:10	-	30.0	180.0	30

Sample Type

O Open End Rod
T Thin-Wall Tube
U Undisturbed Sample
S Split Spoon Sample
G Grab Sample

Notes:

PP = Pocket Penetrometer
TV = Torvane

Boring No.: **B-I81-1**

Field Test Legend: Dilatancy: N - None S - Slow R - Rapid; Toughness: L - Low M - Medium H - High; Plasticity: NP - Non-Plastic L - Low M - Medium H - High; Dry Strength: N - None L - Low M - Medium H - High VH - Very High

NOTES: 1.) "ppd" denotes soil sample average diametral pocket penetrometer reading. 2.) "ppa" denotes soil sample average axial pocket penetrometer reading.
3.) Maximum Particle Size is determined by direct observation within limitations of sampler size. 4.) Soil identifications and field tests based on visual-manual methods per ASTM D2488.

SOIL BORING LOG
(continued)

Depth/ Elev. (ft)	Sample No. / Interval (ft)	Rec. (in)	Sample Blows per 6"	Stratum Graphic	USCS Symbol Group	Visual - Manual Identification & Description (Density/consistency, color, Group Name, constituents, particle size, structure, moisture, optional descriptions, geologic interpretation, Symbol)	Field Tests: Dilatancy	Toughness	Plasticity	Dry Strength	Remarks
	S-5 20.0'-22.0'	8	10 20 18 9		FILL	Hard, Black Lean CLAY with Gravel, moist (FILL)	N	M	M	L	Gravel is Coal, Shale, and Sandstone.
25	S-6 25.0'-27.0'	8	5 7 13 5		FILL	Very stiff, Black Gravelly Lean CLAY, moist (FILL)	N	M	M	L	Gravel is Quartzite, Coal, and Shale.
780											
30 ▽	S-7 30.0'-32.0'	10	3 4 4 6		FILL	Stiff, Dark gray Gravelly Lean CLAY, moist (FILL)	N	M	L	L	
35	S-8 35.0'-37.0'	13	3 3 4 6		FILL	Medium stiff, Dark gray Gravelly Lean CLAY with Silt, moist (FILL)	N	M	M	M	
770											
40	S-9 40.0'-42.0'	10	2 2 1 2		FILL	Soft, Dark gray Gravelly Lean CLAY, moist (FILL)	N	M	M	-	
45	S-10 45.0'-47.0'	17	6 6 11 10		FILL	Very stiff, Dark gray Gravelly Lean CLAY, moist (FILL)	N	M	M	M	

NOTES: PP = Pocket Penetrometer
TV = Torvane

PROJECT NO.: **353754**

BORING NO.: **B-I81-1**

NOTES: 1.) "ppd" denotes soil sample average diametral pocket penetrometer reading. 2.) "ppa" denotes soil sample average axial pocket penetrometer reading.
3.) Maximum Particle Size is determined by direct observation within limitations of sampler size. 4.) Soil identifications and field tests based on visual-manual methods per ASTM D2488.

Depth/ Elev. (ft)	Sample No. / Interval (ft)	Rec. (in)	Sample Blows per 6"	Stratum Graphic	USCS Symbol Group	Visual - Manual Identification & Description (Density/consistency, color, Group Name, constituents, particle size, structure, moisture, optional descriptions, geologic interpretation, Symbol)	Field Tests: Dilatancy	Toughness	Plasticity	Dry Strength	Remarks
760											
50	S-11 50.0'-52.0'	11	6 7 8 12		FILL	Stiff, Dark gray Gravelly Lean CLAY, moist (FILL)	-	-	-	-	
						53.5					
55	S-12 55.0'-57.0'	20	5 9 12 12		CL	Very stiff, Dark gray Gravelly Lean CLAY, moist (CL)	N	M	M	M	Possible Fill.
750						58.5					
60	S-13 60.0'-62.0'	1	50/1"			Poor Recovery of Anthracite COAL fragments. [Base of strip mine debris?]	-	-	-	-	Possible base of Strip mine.
						62.0					
65	S-14 65.0'-65.1'	1	70/1"			Top of Rock at 65 feet BGS. See Rock Coring Log.	-	-	-	-	Small fragments of Shale recovered.
740						65.0					
70											

NOTES: PP = Pocket Penetrometer
TV = Torvane

PROJECT NO.: 353754

BORING NO.: B-I81-1

NOTES: 1.) "ppd" denotes soil sample average diametral pocket penetrometer reading. 2.) "ppa" denotes soil sample average axial pocket penetrometer reading.
3.) Maximum Particle Size is determined by direct observation within limitations of sampler size. 4.) Soil identifications and field tests based on visual-manual methods per ASTM D2488.

MOTT MACDONALD M M

CORE BORING LOG

BORING NO.: **B-I81-1**

Project:	PennEast Pipeline Project	**Project No.:**	353754
Location:	Interstate - 81 Crossing, Wilkes - Barre, PA	**Project Mgr:**	Vatsal Shah
Client:	PennEast Pipeline	**Field Eng. Staff:**	Dafydd Chandler
Drilling Co.:	Craig Test Boring Co., Inc.	**Date/Time Started:**	August 4, 2016 at 2:15 pm
Driller/Helper:	Paul Mullins /Nick Beehler	**Date/Time Finished:**	August 8, 2016 at 3:02 pm

Elevation: 807 ft. **Vertical Datum:** NAVD 1988 **Boring Location:** Northwest corner of construction site. **Coord.: N:** 14991695.36 **E:** 1418643.024

Item	Casing	Core Barrel	Core Bit
Type	HW	NQ2	Imp. Diamond
Length (ft)	30	5	3.25
Inside Dia. (in.)	4	2.0	2.0

Horizontal Datum: UTM Zone 18 T
Rig Make & Model: CME-750X
Drilling Method: Wireline

Depth/ Elev. (ft)	Avg Core Rate (min /ft)	Depth (ft)	Run/ (Box) No.	Rec (in. / %)	RQD (in / %)	Rock Core Hard.	Rock Core Weath	Stratum Graphic	Visual Identification, Description and Remarks (Rock type, colour, texture, weathering, field strength, discontinuity spacing, optional additional geological observations)	Depth (ft.)	Discontinuities Type	Dip	Rgh	Wea	Aper	Infill	Remarks
									SEE TEST BORING LOG FOR OVERBURDEN DETAILS								
	3.50	65.0							SHALE, Dark gray, fine to very fine grained, fresh, strong, wide spaced discontinuities								Good water return.
	4.00																
740	4.00		R-1	60 100%	60 100%	R4	FR										
	4.00																
	6.00	70.0								69.30	B	5	P,Sm	DS	T	N	
70									70.0								
	4.00	70.0							SLATE, Dark gray, very fine to fine grained, fresh, strong, very close to wide spaced discontinuities 70' - 70.5' Highly Fractured zone								Good water return.
	3.00									71.30	B	5	U,R	FR	VT	N	
										71.80	B	10	U,R	FR	VT	N	
	4.00		R-2	60 100%	49 82%	R4	FR		72.4' - 72.7' Highly Fractured zone								
	4.00								73.5								
	4.00	75.0							QUARTZITE, Gray, medium grained, fresh, strong, wide spaced discontinuities	73.50	J	10	U,R	FR	VT	N	Quartzite is MetaSandstone.
75		75.0															
	9.00								QUARTZITE, Gray, fine to medium grained, fresh, strong, close to moderately spaced discontinuities Fine to medium grained laminations 75.5' - 76.4' Highly Fractured zone								Good water return.
	9.00																
730										76.80	B	15	U,R	FR	VT	N	
	9.00		R-3	60 100%	48 80%	R4	FR			77.50	J	10	P,R	FR	VT	N	
	10.00																
	12.00	80.0															Breif loss of water at 79 feet BGS.
80		80.0							QUARTZITE, Gray, fine to medium grained, fresh, strong, close to moderately spaced discontinuities Fine to medium grained laminations								Good water return all the way to 150ft depth.
	5.00									80.80	J	15	U,R	FR	PO	N	
	4.00																
	4.00		R-4	60 100%	58 97%	R4	FR		QUARTZITE, Gray, fine to coarse grained, fresh, very strong, moderate to wide spaced discontinuities 82' - 82.1' Anthracite COAL, highly fractured zone Occasional fine Slate layer	82.00	B	15	P,Sm	FR	T	N	
	5.00									83.50	J	10	P,R	FR	T	N	
	5.00	85.0								84.40	J	20	U,Sm	FR	T	Coal	

(See Legend for Rock Description System)

Water Level Data

Date	Time	Elapsed Time (hr)	Depth in feet to: Bot. of Casing	Bottom of Hole	Water
8/8/16	6:10	-	30.0	110.0	50.0
8/9/16	6:10	-	30.0	180.0	30.0

Notes:

Coal seam encountered. Strip mined.

CORE BORING LOG
(continued)

Depth/ Elev. (ft)	Avg Core Rate (min /ft)	Depth (ft)	Run/ (Box) No.	Rec. (in. / %)	RQD (in. / %)	Rock Core Hard.	Rock Core Weath	Stratum Graphic	Visual Identification, Description and Remarks (Rock type, colour, texture, weathering, field strength, discontinuity spacing, optional additional geological observations)	Depth (ft.)	Discontinuities Type	Dip	Rgh	Wea	Aper	Infill	Remarks
	3.00	85.0							85.8								
	3.00								Anthracite COAL, Black, very fine grained, fresh, medium strong, close spaced discontinuities	85.80	B	0	U,Sm	FR	T	N	
720	3.00		R-5	60 100%	55 92%	R4	FR		86.3 86.5 86.7 QUARTZITE, Dark gray, fine to medium grained, fresh, strong to very strong, wide spaced discontinuities 86.5' - 86.7' Highly Fractured Coal								
	3.00									88.10	J	10	P,R	FR	VT	N	
	3.00									88.50	J	35	P,R	FR	VT	N	
	4.00	90.0							90.0								
90	3.00	90.0							SLATE, Gray, very fine to fine grained, fresh, very strong, wide spaced discontinuities	90.40	J	40	P,R	FR	T	N	
	3.00																
	3.00		R-6	60 100%	60 100%	R5	FR										
	4.00									93.10	B	10	P,R	FR	T	N	
	4.00	95.0															
95	4.00	95.0							SLATE, Gray, very fine to fine grained, fresh, medium strong, close spaced discontinuities Laminated horizontal fracturing								
	4.00																
710	4.00		R-7	60 100%	48 80%	R3	FR			97.00	J	5	U,R	FR	VT	N	
	4.00								98.0								
	4.00								QUARTZITE, Gray, fine grained, fresh, very strong, wide spaced discontinuities	98.00	B	10	U,R	FR	T	N	
	4.50	100.0															
100	3.00	100.0							QUARTZITE, Gray, very fine to fine grained, fresh, very strong, wide spaced discontinuities Occasional Shale interbedding								
	3.00									101.30	J	70	S,R	FR	T	N	
	3.50		R-8	60 100%	60 100%	R5	FR										
	3.50																
	3.50	105.0															
105	2.50	105.0							QUARTZITE, Gray, fine to medium grained, fresh, very strong, wide spaced discontinuities								
	2.50																
700	2.50		R-9	60 100%	60 100%	R5	FR										
	3.00																
	3.50	110.0								109.10	J	10	U,R	FR	VT	N	

NOTES: Coal seam encountered. Strip mined.

PROJECT NO.: **353754**

Boring No.: **B-I81-1**

Depth/ Elev. (ft)	Avg Core Rate (min /ft)	Depth (ft)	Run/ (Box) No.	Rec. (in. / %)	RQD (in. / %)	Rock Core Hard.	Rock Core Weath	Stratum Graphic	Visual Identification, Description and Remarks (Rock type, colour, texture, weathering, field strength, discontinuity spacing, optional additional geological observations)	Depth (ft.)	Discontinuities Type	Dip	Rgh	Wea	Aper	Infill	Remarks
	3.00	110.0															
	3.00								QUARTZITE, Gray, medium grained, fresh, very strong, wide spaced discontinuities								
	3.00		R-10	60 100%	60 100%	R5	FR										
	3.00																
	3.00	115.0															
115	3.00	115.0							QUARTZITE, Gray, fine to coarse grained, fresh, extremely strong, wide spaced discontinuities								
	3.50																
690	4.00		R-11	60 100%	60 100%	R6	FR										
	4.00																
	4.00	120.0								118.90	J	5	U,R	FR	VT	N	
120	3.50	120.0							QUARTZITE, Gray, fine to coarse grained, fresh, extremely strong, wide spaced discontinuities								
	4.00																
	4.00		R-12	60 100%	60 100%	R6	FR			122.50	J	15	U,R	FR	T	N	
	4.00																
	5.00	125.0															
125	4.00	125.0							QUARTZITE, Gray, medium to coarse grained, fresh, very strong, moderately spaced discontinuities								
	4.00									126.10	J	0	U,R	FR	T	N	
680	4.00		R-13	60 100%	60 100%	R5	FR			127.40	J	15	U,R	FR	T	N	
	4.00									128.70	J	30	P,R	FR	T	N	
	5.00	130.0															
130	3.00	130.0							QUARTZITE, Gray, fine to coarse grained, fresh, very strong, wide spaced discontinuities								
	4.00									130.70	J	24	U,R	FR	T	N	
	4.50		R-14	60 100%	60 100%	R5	FR										
	4.50																
	4.50	135.0															

NOTES: Coal seam encountered. Strip mined.

CORE BORING LOG
(continued)

Depth/ Elev. (ft)	Avg Core Rate (min /ft)	Depth (ft)	Run/ (Box) No.	Rec. (in. / %)	RQD (in. / %)	Rock Core Hard.	Rock Core Weath	Stratum Graphic	Visual Identification, Description and Remarks (Rock type, colour, texture, weathering, field strength, discontinuity spacing, optional additional geological observations)	Depth (ft.)	Discontinuities Type	Dip	Rgh	Wea	Aper	Infill	Remarks
	6.00	135.0							QUARTZITE, Gray, fine to coarse grained, fresh, extremely strong, wide spaced discontinuities								
	6.00									135.90	J	40	U,R	FR	T	N	
670	6.00		R-15	60 100%	60 100%	R6	FR										
									137.7								
	6.50								CONGLOMERATE, Gray and white, coarse grained, fresh, extremely strong, wide spaced discontinuities Conglomerate is of coarse angular grains predominantly quartz.								
									139.0	138.60	J	30	U,R	FR	T	N	
	7.00	140.0							QUARTZITE, Gray, fine to coarse grained, fresh, extremely strong, wide spaced discontinuities								
140		140.0															
	6.00									140.40	J	60	U,R	FR	PO	N	
	6.00																
	6.00		R-16	60 100%	60 100%	R6	FR										
	6.00																
	6.00	145.0															
145		145.0							QUARTZITE, Gray, medium to coarse grained, fresh, very strong, wide spaced discontinuities								
	6.00																
	6.00																
660	6.00		R-17	60 100%	49 82%	R5	FR										
									148.0								
	5.50								SHALE, Black, very fine grained, fresh, strong, close to very close spaced discontinuities Coal beds with Pyrite layers encountered 148.5' - 150' Highly Fractured zone with Pyrite	148.10	J	5	U,R	FR	T	N	
	6.00	150.0															
150		150.0							150' - 152' Highly Fractured zone								Loss of water.
	4.00																
									151.0								
	4.00								Anthracite COAL, Black, very fine grained, fresh, weak, close spaced discontinuities. Brittle.								
	1.00		R-18	48 80%	33 55%	R2	FR			152.20 152.40	J J	10 20	P,R S,R	FR FR	T T	N N	
	1.00																
										153.80	J	10	U,R	FR	T	N	
	1.50									154.20 154.50	J J	10 40	S,R S,R	FR FR	T T	N N	
155		155.0							155.0								
	4.00	155.0							SHALE, Dark gray, fine grained, fresh, strong, moderately spaced discontinuities								Loss of water.
	4.00																
650									157.2								
	2.00		R-19	60 100%	50 83%	R4	FR		157.2' - 157.8' Anthracite COAL, very fine grained, fresh								
									157.8 Highly Fractured zone								
	4.00								158.2' - 158.4' Highly Fractured zone								
	4.00	160.0															

NOTES: Coal seam encountered. Strip mined.

PROJECT NO.: **353754**

Boring No.: **B-I81-1**

Depth/ Elev. (ft)	Avg Core Rate (min /ft)	Depth (ft)	Run/ (Box) No.	Rec. (in. / %)	RQD (in. / %)	Rock Core Hard.	Rock Core Weath	Stratum Graphic	Visual Identification, Description and Remarks (Rock type, colour, texture, weathering, field strength, discontinuity spacing, optional additional geological observations)	Depth (ft.)	Discontinuities (See Legend for Rock Description System) Type	Dip	Rgh	Wea	Aper	Infill	Remarks
	4.00	160.0							SHALE, Dark gray, fine grained, fresh, strong, close spaced discontinuities	160.50	J	0	P,Sm	FR	VT	N	
										160.90	J	0	P,Sm	FR	T	N	
	4.00									161.50	J	0	P,Sm	FR	T	N	
										161.90	J	0	P,Sm	FR	VT	N	
	3.00		R-20	60 100%	48 80%	R4	FR			162.30	J	0	P,Sm	FR	T	N	
									163.0								
	3.00								Anthracite COAL, Black, very fine grained, fresh, weak, close to moderately spaced discontinuities 163.4' - 165' Highly Fractured zone								
	3.00	165.0															
165	3.00	165.0							165' - 165.7' Highly Fractured zone								
	3.00																
									167.0								
640	3.00		R-21	60 100%	50 83%	R4	FR		SHALE, Dark gray, fine grained, fresh, strong, moderately spaced discontinuities	167.30	B	20	P,R	FR	VT	N	
										167.70	B	5	P,R	FR	VT	N	
	3.00									168.00	J	0	P,R	FR	T	N	
	3.00	170.0															
170		170.0							SHALE, Dark gray, fine grained, fresh, strong, moderately spaced discontinuities								
	4.00									170.70	J	10	P,R	FR	T	N	
										171.00	B	20	P,Sm	FR	T	N	
	4.00								171.5								
	3.00		R-22	60 100%	50 83%	R5	FR		QUARTZITE, Dark gray, fine to medium grained, fresh, very strong, wide spaced discontinuities	171.60	J	10	P,R	FR	T	N	
	3.00																
	4.00	175.0															
175	3.00	175.0							QUARTZITE, Dark gray, fine to medium grained, fresh, extremely strong, wide spaced discontinuities								
	2.00									176.40	J	15	P,R	FR	T	N	
630	2.00		R-23	60 100%	60 100%	R6	FR										
	2.00																
	2.00	180.0															
180									180.0								
									End of Boring at 180 feet BGS. Borehole grouted with cement and bentonite hole plug.								

NOTES: Coal seam encountered. Strip mined.

Figure B-I81-1.1
B-I81-1 Box 1 Runs 1-4 Dry

Figure B-I81-1.2
B-I81-1 Box 1 Runs 1-4 Wet

MOTT MACDONALD M M	**PennEast Pipeline Project** **Rock Core Photographs**	**BORING NO.:** B-I81-1

Figure B-I81-1.3
B-I81-1 Box 2 Runs 5-8 Dry

Figure B-I81-1.4
B-I81-1 Box 2 Runs 5-8 Wet

MOTT MACDONALD	PennEast Pipeline Project Rock Core Photographs	BORING NO.: B-I81-1

Figure B-I81-1.5
B-I81-1 Box 3 Runs 9-12 Dry

Figure B-I81-1.6
B-I81-1 Box 3 Runs 9-12 Wet

MOTT MACDONALD M M	**PennEast Pipeline Project** **Rock Core Photographs**	**BORING NO.:** B-I81-1

Figure B-I81-1.7
B-I81-1 Box 4 Runs 13-16 Dry

Figure B-I81-1.8
B-I81-1 Box 4 Runs 13-16 Wet

MOTT MACDONALD M M	PennEast Pipeline Project Rock Core Photographs	BORING NO.: B-I81-1

Figure B-I81-1.9
B-I81-1 Box 5 Runs 17-20 Dry

Figure B-I81-1.10
B-I81-1 Box 5 Runs 17-20 Wet

MOTT MACDONALD M M	**PennEast Pipeline Project** **Rock Core Photographs**	**BORING NO.:** B-I81-1

Figure B-I81-1.11
B-I81-1 Box 6 Runs 21-23 Dry

Figure B-I81-1.12
B-I81-1 Box 6 Runs 21-23 Dry

MOTT MACDONALD M M	PennEast Pipeline Project Rock Core Photographs	BORING NO.: B-I81-1

MOTT MACDONALD M M

SOIL BORING LOG

BORING NO.: **B-I81-2**
Page **1** of **2**

Project:	PennEast Pipeline Project	**Project No.:**	353754
Location:	Interstate - 81 Crossing, Wilkes - Barre, PA	**Project Mgr:**	Vatsal Shah
Client:	PennEast Pipeline	**Field Eng. Staff:**	Dafydd Chandler
Drilling Co.:	Craig Test Boring Co., Inc.	**Date/Time Started:**	August 17, 2016 at 11:10 am
Driller/Helper:	Nick Beehler /Miles Neipert	**Date/Time Finished:**	August 19, 2016 at 12:05 pm

Elevation: 862 ft. **Vertical Datum:** NAVD 1988 **Boring Location:** South of I81, top of I81 cutting **Coord.:** **N:** 14990729.45 **E:** 1419417.27

Horizontal Datum: UTM Zone 18 T

Item	Casing	Sampler	Core Barrel
Type	HW	SS	NQ2
Length (ft)	5	2	5
Inside Dia. (in.)	4	1.375	2.0
Hammer Wt. (lb.)	140	140	-
Hammer Fall (in.)	30	30	-

Rig Make & Model: CME-750X

☐ Truck ☐ Tripod ☐ Cat-Head
☑ ATV ☐ Geoprobe ☑ Winch
☐ Track ☐ Air Track ☑ Roller Bit
☐ Skid ☐ _____ ☐ Cutting Head

Hammer Type: ☐ Safety ☐ Doughnut ☑ Automatic ☐ _____

Drilling Fluid: ☐ Bentonite ☐ Polymer ☑ Water ☐ None

Drill Rod Size:

Casing Advance: Mud Rotary

Depth/ Elev. (ft)	Sample No. / Interval (ft)	Rec. (in)	Sample Blows per 6"	Stratum Graphic	USCS Group Symbol	Visual - Manual Identification & Description (Density/consistency, color, Group Name, constituents, particle size, structure, moisture, optional descriptions, geologic interpretation, Symbol)	Field Tests: Dilatancy	Toughness	Plasticity	Dry Strength	Remarks
	S-1 0.0'- 2.0'	22	1 2 4 12		CL	0.2 Top (2") TOPSOIL Bottom (20") Medium stiff, Light brown, Sandy Lean CLAY with Gravel, moist. (CL)	N	L	M	-	Installed 4-inch casing to 5 feet BGS.
860											
5	S-2 5.0'- 7.0'	22	9 13 13 12		CL	Very stiff, Black, Gravelly Lean CLAY, moist. (CL)	N	H	-	-	Gravel consists of angular Coal, Sandstone, and Quartz.
10	S-3 10.0'- 12.0'	22	9 15 15 14		CL	Very stiff, Black, Gravelly Lean CLAY, moist. (CL)	N	M	L	M	Gravel consists of angular Coal, Sandstone, and Quartz.
850											
15	S-4 15.0'- 17.0'	20	10 9 12 39		CL	Very stiff, Black, Gravelly Lean CLAY, moist. (CL) 17' - 17.5' Cobble encountered	N	H	L	M	Gravel consists of angular Coal, Sandstone, and Quartz.

Water Level Data

Date	Time	Elapsed Time (hr)	Depth in feet to: Bot. of Casing	Bottom of Hole	Water

Sample Type

O Open End Rod
T Thin-Wall Tube
U Undisturbed Sample
S Split Spoon Sample
G Grab Sample

Notes:

PP = Pocket Penetrometer
TV = Torvane

Boring No.: **B-I81-2**

Field Test Legend:
Dilatancy: N - None S - Slow R - Rapid
Toughness: L - Low M - Medium H - High
Plasticity: NP - Non-Plastic L - Low M - Medium H - High
Dry Strength: N - None L - Low M - Medium H - High VH - Very High

NOTES: 1.) "ppd" denotes soil sample average diametral pocket penetrometer reading. 2.) "ppa" denotes soil sample average axial pocket penetrometer reading.
3.) Maximum Particle Size is determined by direct observation within limitations of sampler size. 4.) Soil identifications and field tests based on visual-manual methods per ASTM D2488.

MOTT MACDONALD M M

SOIL BORING LOG
(continued)

BORING NO.: **B-I81-2**
Page **2** of **2**

Depth/ Elev. (ft)	Sample No. / Interval (ft)	Rec. (in)	Sample Blows per 6"	Stratum Graphic	USCS Symbol Group	Visual - Manual Identification & Description (Density/consistency, color, Group Name, constituents, particle size, structure, moisture, optional descriptions, geologic interpretation, Symbol)	Field Tests: Dilatancy	Field Tests: Toughness	Field Tests: Plasticity	Field Tests: Dry Strength	Remarks
	S-5 20.0'-22.0'	18	6 11 15 12		CL	Very stiff, Black, Gravelly Lean CLAY, moist. (CL)	N	H	-	-	Installed 4-inch casing to 20 feet BGS. Gravel consists of coarse to fine Coal, Sandstone, and Quartz. Rock chips present in water return.
840						23.0					
	23.0'-25.0'					23' - 25' Weathered Rock Top of Rock at 23 feet BGS. See Rock Coring Log.	-	-	-	-	Advanced to 25 feet BGS to begin 5 foot runs.
25						25.0					
30											
830											
35											
40											
820											
45											

NOTES: PP = Pocket Penetrometer
TV = Torvane

PROJECT NO.: **353754**

BORING NO.: **B-I81-2**

NOTES: 1.) "ppd" denotes soil sample average diametral pocket penetrometer reading. 2.) "ppa" denotes soil sample average axial pocket penetrometer reading.
3.) Maximum Particle Size is determined by direct observation within limitations of sampler size. 4.) Soil identifications and field tests based on visual-manual methods per ASTM D2488.

MOTT MACDONALD M M

CORE BORING LOG

BORING NO.: **B-I81-2**

Project:	PennEast Pipeline Project	**Project No.:**	353754
Location:	Interstate - 81 Crossing, Wilkes - Barre, PA	**Project Mgr:**	Vatsal Shah
Client:	PennEast Pipeline	**Field Eng. Staff:**	Dafydd Chandler
Drilling Co.:	Craig Test Boring Co., Inc.	**Date/Time Started:**	August 17, 2016 at 11:10 am
Driller/Helper:	Nick Beehler /Miles Neipert	**Date/Time Finished:**	August 19, 2016 at 12:05 pm

Elevation: 862 ft. **Vertical Datum:** NAVD 1988 **Boring Location:** South of I81, top of I81 cutting **Coord.: N:** 14990729.45 **E:** 1419417.27

Item	Casing	Core Barrel	Core Bit
Type	HW	NQ2	Imp. Diamond
Length (ft)	5	5	3.25
Inside Dia. (in.)	4	2.0	2.0

Horizontal Datum: UTM Zone 18 T
Rig Make & Model: CME-750X
Drilling Method: Wireline

Depth/ Elev. (ft)	Avg Core Rate (min /ft)	Depth (ft)	Run/ (Box) No.	Rec (in. / %)	RQD (in / %)	Rock Core Hard.	Rock Core Weath	Stratum Graphic	Visual Identification, Description and Remarks (Rock type, colour, texture, weathering, field strength, discontinuity spacing, optional additional geological observations)	Depth (ft.)	Discontinuities Type	Dip	Rgh	Wea	Aper	Infill	Remarks
									SEE TEST BORING LOG FOR OVERBURDEN DETAILS		(See Legend for Rock Description System)						
	2.00	25.0							QUARTZITE, Light gray, fine to medium grained, fresh, very strong, wide spaced discontinuities (Quartzite is MetaSandstone)								Good water return 25 to 40ft depth
	2.00									26.00	J	0	S,R	FR	T	N	
	1.50		R-1	57 95%	57 95%	R5	FR										
	1.50									27.90	J	5	U,R	FR	T	N	
	1.50	30.0								29.60	J	0	S,R	FR	T	N	
30	1.00	30.0							QUARTZITE, Light gray, fine to medium grained, fresh, very strong, wide spaced discontinuities. Occasional thin shale bed.								Fractures occure at fine grained laminations of shale not within quartzite
	1.00																
830	1.50		R-2	60 100%	60 100%	R5	FR			32.70	J	5	P,Sm	FR	VT	N	
	1.50									33.20	J	15	P,R	FR	T	N	
	1.50	35.0															
35	1.50	35.0							QUARTZITE, Light gray, fine to coarse grained, fresh, very strong, close to wide spaced discontinuities 38.6' - 40' Highly Fractured zone								
	1.50																
	1.50		R-3	54 90%	43 72%	R5	FR			37.60	J	5	P,R	FR	T	N	
	1.50																
	1.50	40.0															
40	1.00	40.0							QUARTZITE, Light gray, fine to coarse grained, fresh, very strong, moderate to close spaced discontinuities Occasional fine, dark gray layer 44' - 45' Highly Fractured zone								Some water return
	1.00																
820	1.00		R-4	59 98%	51 85%	R5	FR			41.60	J	10	U,R	DS	T	N	
	1.00									42.40	J	10	U,R	FR	T	N	
	1.00									42.90	J	5	S,R	FR	VT	N	
	1.00									43.50	B	10	P,Sm	FR	T	N	
	1.00	45.0															

Water Level Data

Date	Time	Elapsed Time (hr)	Depth in feet to: Bot. of Casing	Bottom of Hole	Water
		-			

Notes:

Coal seam encountered

Depth/ Elev. (ft)	Avg Core Rate (min /ft)	Depth (ft)	Run/ (Box) No.	Rec. (in. / %)	RQD (in. / %)	Rock Core Hard.	Rock Core Weath	Stratum Graphic	Visual Identification, Description and Remarks (Rock type, colour, texture, weathering, field strength, discontinuity spacing, optional additional geological observations)	Depth (ft.)	Discontinuities (See Legend for Rock Description System) Type	Dip	Rgh	Wea	Aper	Infill	Remarks
	1.50	45.0							Interbedded QUARTZITE and SHALE, fine to coarse grained, slightly weathered, strong, close spaced discontinuities	45.50	B	35	P,Sm	DG	O	CL	
	1.50									46.30	J	25	P,R	FR	T	Fe	
	1.50		R-5	60 100%	50 83%	R4	SL			47.10	B	10	P,R	DG	O	CL	
	1.50									47.80	B	25	P,R	FR	T	QZ	
	1.50	50.0															
50	1.00	50.0							QUARTZITE, Gray, fine to medium grained, fresh, very strong, wide spaced discontinuities								
	1.00																
810	1.00		R-6	55 92%	48 80%	R5	FR										
	1.00																
	2.00	55.0								54.20	J	0	S,R	FR	T	N	
										54.60	J	5	S,R	FR	PO	N	
55	1.00	55.0							QUARTZITE, Gray, fine to medium grained, fresh, very strong, moderately spaced discontinuities								
	1.50									56.50	J	20	P,R	FR	T	N	
	1.50		R-7	58 97%	51 85%	R5	FR			57.40	J	0	P,R	FR	O	QZ	
										57.80	J	20	S,R	FR	T	QZ	
	1.50									58.20	J	15	S,R	FR	W	QZ	
										58.90	J	0	P,Sm	FR	T	N	
	1.50	60.0								59.50	J	20	P,Sm	FR	T	N	
60	1.50	60.0							QUARTZITE, Gray, fine to medium grained, fresh, very strong, moderately spaced discontinuities 63.7' - 63.9' Major joint encountered 64.5' - 65' Highly Fractured zone								Loss of water at 61 feet BGS. Rod dropped 3 inches at 64 feet BGS.
	1.50																
800	1.50		R-8	60 100%	48 80%	R5	FR		62.4 62.4' - 63' Video confirmed VOID - field logged as: 63.0 (63.7' - 63.9' Major joint encountered) (64.5' - 65' Highly Fractured zone)								
	1.00									63.70	J	0	P,R	DG	VW	QZ	
	1.00	65.0															
65	1.00	65.0							QUARTZITE, Gray and orange, medium to coarse grained, slightly weathered, medium strong, moderately spaced discontinuities 65' - 70' Highly Fractured zone with Quartz veins and Iron infilling								Intense Fracturing with Quartzite veins and Iron staining. Potential fault zone.
	1.00																
	1.50		R-9	60 100%	15 25%	R3	SL										
	1.50																
	2.00	70.0															

CORE BORING LOG
(continued)

Depth/ Elev. (ft)	Avg Core Rate (min /ft)	Depth (ft)	Run/ (Box) No.	Rec. (in. / %)	RQD (in. / %)	Rock Core Hard.	Rock Core Weath	Stratum Graphic	Visual Identification, Description and Remarks (Rock type, colour, texture, weathering, field strength, discontinuity spacing, optional additional geological observations)	Depth (ft.)	Discontinuities (See Legend for Rock Description System) Type	Dip	Rgh	Wea	Aper	Infill	Remarks
	1.20	70.0							QUARTZITE, Gray, medium to coarse grained, fresh, very strong, close to moderately spaced discontinuities	70.40	J	40	S,R	FR	T	N	Displacement of Quartz veins indicates multiple deformation phases.
	1.20									70.90	J	40	P,R	FR	T	N	
790	1.20		R-10	60 100%	59 98%	R5	FR										
	1.20									72.70	J	50	S,R	FR	T	QZ	
	1.20									74.00	J	45	S,R	FR	T	N	
		75.0								74.60	J	0	S,R	FR	PO	N	
75		75.0							QUARTZITE, Gray, medium to coarse grained, fresh, very strong, close to moderately spaced discontinuities								
	2.00																
	2.00								76.6								
	3.00		R-11	58 97%	23 38%	R2	SL		MUDSTONE, Dark gray, very fine grained, slightly weathered, weak, very close spaced discontinuities 76.6' - 80' Highly Fractured zone								
	3.00																
	3.00	80.0															
80		80.0							MUDSTONE, Dark gray, very fine grained, fresh, weak, wide spaced discontinuities Occasional high angle fracture with Clay.								
	2.00																
	2.00																
780	2.00		R-12	58 97%	55 92%	R2	FR			82.00	B	60	P,Sm	FR	T	N	
	2.00																
	2.00									84.10	B	40	P,Sm	FR	O	CL	
	2.00	85.0															
85		85.0							MUDSTONE/SHALE, Dark gray, very fine grained, fresh, weak, extremely close to close spaced discontinuities Thin Clay laminations present 85' - 86' Highly Fractured zone								
	1.50																
	1.50		R-13	52 87%	22 37%	R2	FR		87' - 89' Highly Fractured zone								
	1.50																
	1.50								89.0								
	1.50	90.0															
90		90.0							QUARTZITE, Gray, fine to coarse grained, fresh, very strong, wide spaced discontinuities								
	1.50																
	1.50																
770	1.50		R-14	60 100%	60 100%	R5	FR										
	1.50																
	1.50																
		95.0															

NOTES: Coal seam encountered

PROJECT NO.: **353754**

Boring No.: **B-I81-2**

CORE BORING LOG
(continued)

Depth/ Elev. (ft)	Avg Core Rate (min /ft)	Depth (ft)	Run/ (Box) No.	Rec. (in. / %)	RQD (in. / %)	Rock Core Hard.	Rock Core Weath	Stratum Graphic	Visual Identification, Description and Remarks (Rock type, colour, texture, weathering, field strength, discontinuity spacing, optional additional geological observations)	Depth (ft.)	Discontinuities (See Legend for Rock Description System) Type	Dip	Rgh	Wea	Aper	Infill	Remarks
	2.00	95.0							QUARTZITE, Gray, medium grained, fresh, very strong, close to wide spaced discontinuities 95' - 96.2' Highly Fractured zone								
	2.00																
	2.00		R-15	60 100%	60 100%	R5	FR										
	2.00																
	2.00	100.0															
100	1.50	100.0							QUARTZITE, Gray, medium grained, fresh, very strong, close to wide spaced discontinuities								
	1.50																
760	1.50		R-16	60 100%	57 95%	R5	FR										
	1.50																
	1.50	105.0								104.10 104.30	J J	0 60	U,R P,R	FR FR	PO PO	N N	
105	1.50	105.0							QUARTZITE, Gray, medium grained, fresh, extremely strong, moderate to wide spaced discontinuities								
	1.50									105.80 106.40	B B	5 45	S,R P,R	FR FR	VT T	N N	
	1.50		R-17	60 100%	60 100%	R6	FR										
	1.50																
	1.50	110.0															
110	1.50	110.0							QUARTZITE, Gray, medium grained, fresh, extremely strong, wide spaced discontinuities								
	1.50																
750	1.00		R-18	60 100%	60 100%	R6	FR										
	1.00									113.10	B	20	S,R	FR	VT	N	
	1.00	115.0															
115	2.00	115.0							QUARTZITE, Gray, medium to coarse grained, fresh, extremely strong, wide spaced discontinuities	115.30	J	20	S,R	FR	T	Fe	
	2.00																
	2.00		R-19	60 100%	60 100%	R6	FR										
	2.00																
	2.00	120.0															

NOTES: Coal seam encountered

PROJECT NO.: **353754**

Boring No.: **B-I81-2**

CORE BORING LOG
(continued)

Depth/ Elev. (ft)	Avg Core Rate (min /ft)	Depth (ft)	Run/ (Box) No.	Rec. (in. / %)	RQD (in. / %)	Rock Core Hard.	Rock Core Weath	Stratum Graphic	Visual Identification, Description and Remarks (Rock type, colour, texture, weathering, field strength, discontinuity spacing, optional additional geological observations)	Depth (ft.)	Discontinuities Type	Dip	Rgh	Wea	Aper	Infill	Remarks
	1.20	120.0							QUARTZITE, Gray, fine to medium grained, fresh, extremely strong, wide spaced discontinuities	120.70	J	5	U,R	DG	PO	N	
	1.20									121.60	J	30	P,R	FR	T	N	
740	1.20		R-20	60 100%	60 100%	R6	FR										
	1.20																
	1.00	125.0															
125	2.00	125.0							QUARTZITE, Gray, medium grained, fresh, very strong, very close to moderately spaced discontinuities 127.2' - 127.7' Highly Fractured zone	125.50	J	0	S,R	FR	T	N	
	2.00									126.00	J	75	U,R	FR	PO	CL	
	2.00		R-21	57 95%	39 65%	R5	FR										
	2.00																
	2.00	130.0								129.30	J	0	P,R	FR	PO	N	
130	2.00	130.0							QUARTZITE, Gray, medium grained, fresh, very strong, very close to moderately spaced discontinuities 134.3' - 135' Highly Fractured zone	131.30	J	10	S,R	FR	VT	N	
	2.00									131.60	B	15	U,R	FR	PO	N	
730	2.00		R-22	60 100%	47 78%	R5	FR										
	2.00									133.40	J	10	S,R	FR	T	N	
	2.00	135.0															
135	2.00	135.0							QUARTZITE, Gray, medium grained, fresh, very strong, very close to moderately spaced discontinuities	135.90	J	20	P,Sm	DS	VT	Fe	
	2.00																
	2.00		R-23	54 90%	47 78%	R5	FR		137.9								
									138.2137.9' - 138.2' Video confirmed VOID [V-23.1]								
	0.50								138.6	138.50	J	20	S,R	FR	T	N	
									138.9138.6' -138.9' Video confirmed VOID [V-23.2]								
	0.50								139.7								
140		140.0							140.0139.7' -140' Video confirmed VOID [V-23.3]								Rod dropped 4 inches at 139 feet BGS.
	1.50	140.0							SHALE/COAL, Black, very fine grained, fresh, medium strong, close spaced discontinuities 139' - 141.4' Highly Fractured zone								
									141.0								
	1.50								COAL, Black, fine grained, fresh, weak								
720	1.50		R-24	52 87%	41 68%	R2	FR			142.10	J	0	S,R	FR	VT	N	
									143.0	142.60	J	0	S,R	FR	VT	N	
									143.4 143' - 143.4' Video confirmed VOID [V-24]								Rod dropped 5 inches at 143 feet BGS.
	1.50								SHALE, Black, very fine grained, fresh, medium strong, close spaced discontinuities 144' - 145' Highly Fractured zone								
	1.00	145.0															

NOTES: Coal seam encountered

PROJECT NO.: **353754**

Boring No.: **B-I81-2**

CORE BORING LOG
(continued)

Depth/ Elev. (ft)	Avg Core Rate (min /ft)	Depth (ft)	Run/ (Box) No.	Rec. (in. / %)	RQD (in. / %)	Rock Core Hard.	Rock Core Weath	Stratum Graphic	Visual Identification, Description and Remarks (Rock type, colour, texture, weathering, field strength, discontinuity spacing, optional additional geological observations)	Depth (ft.)	Discontinuities Type	Dip	Rgh	Wea	Aper	Infill	Remarks
	1.50	145.0							SHALE, Dark gray, fine grained, medium strong, fresh, moderately spaced discontinuities	145.50	J	0	S,R	FR	VT	N	
	1.50								146.6								
									146.6' - 147.1' Video confirmed VOID [V-25]								
									147.1								
	1.50		R-25	55 92%	41 68%	R3	FR		COAL 148' - 150' Highly Fractured zone with Iron staining	147.20	J	10	S,R	FR	VT	N	
	1.00																
	1.00	150.0							150.0								
150																	
	0.50	150.0							SLATE, Gray, fine grained, slightly weathered, medium strong, close to moderately spaced discontinuities 150' - 155' Highly Fractured zone with some decomposed joints and Iron staining								
	0.50																
710																	
	0.50		R-26	56 93%	21 35%	R3	SL										
	1.00																
	0.50	155.0															
155																	
	1.00	155.0							155.3 SLATE, Gray, fine grained, fresh, strong, close spaced discontinuities								
									155.7 155' - 157' Highly Fractured zone								
									155.3' - 155.7' Video confirmed VOID [27.1]								
	1.00								157.0								
	0.00		R-27	25 42%	17 28%				157' - 160' Video confirmed VOID [V-27.2]								Rod dropped 3 feet at 157 feet BGS.
	0.00																
	0.00	160.0							160.0								
160																	
	3.00	160.0							GRAVEL Debris with Iron staining 160' - 161.2' Highly Fractured zone								
									161.0								
	2.00								SHALE Sands, Gray, fine grained, fresh, strong, wide spaced discontinuities fine grained laminations								
700																	
	2.00		R-28	52 87%	43 72%	R4	FR										
	2.00																
	2.00	165.0							165.0								
165										164.80	B	0	P,Sm	DE	PO	N	
	1.50	165.0							QUARTZITE, Gray, fine to medium grained, fresh, very strong, wide spaced discontinuities								
	1.50																
	1.50		R-29	60 100%	60 100%	R5	FR										
	2.00									168.60	J	0	S,R	FR	T	N	
	2.00	170.0															

NOTES: Coal seam encountered

PROJECT NO.: **353754**

CORE BORING LOG
(continued)

Depth/ Elev. (ft)	Avg Core Rate (min /ft)	Depth (ft)	Run/ (Box) No.	Rec. (in. / %)	RQD (in. / %)	Rock Core Hard.	Rock Core Weath	Stratum Graphic	Visual Identification, Description and Remarks (Rock type, colour, texture, weathering, field strength, discontinuity spacing, optional additional geological observations)	Depth (ft.)	Discontinuities Type	Dip	Rgh	Wea	Aper	Infill	Remarks
	1.50	170.0							QUARTZITE, Gray, fine to medium grained, fresh, very strong, wide spaced discontinuities								
	1.50																
690	1.50		R-30	60 100%	56 93%	R5	FR			172.80	J	20	P,R	FR	PO	N	
	1.50																
	1.50	175.0															
175	1.50	175.0							QUARTZITE, Gray, fine to medium grained, fresh, very strong, wide spaced discontinuities								
									176.0								
	1.00								SHALE/COAL 176' - 177.5' Highly Fractured zone with Clay infilling								
	1.00		R-31	50 83%	39 65%	R5	FR		177.5								
	1.00								CONGLOMERATE, White and gray, coarse grained, fresh, very strong, close spaced discontinuities								
	1.00									178.40	J	0	S,R	FR	VT	N	
	1.00	180.0								179.60	J	0	S,R	FR	T	N	
180		180.0							CONGLOMERATE, White and gray, coarse grained, fresh, very strong, close to moderately spaced discontinuities 180' - 180.6' Highly Fractured zone								Conglomerate contains clasts of angular Quartz.
	1.50									181.30	B	20	S,R	DG	PO	N	
680										182.00	J	10	S,R	FR	T	N	
	1.50		R-32	60 100%	41 68%	R5	FR			182.70	B	5	U,R	FR	T	N	
									183.0								
	1.50								QUARTZITE, Gray, fine to medium grained, fresh, very strong, wide spaced discontinuities								
	1.50	185.0															
185		185.0							QUARTZITE, Dark gray, fine to medium grained, fresh, very strong, wide spaced discontinuities Mica laminations present								
	1.50									185.80	J	50	P,Sm	FR	T	N	
	1.50																
	1.00		R-33	60 100%	59 98%	R5	FR										
	1.00																
	1.00	190.0															
190		190.0							QUARTZITE, Gray, medium to coarse grained, fresh, extremely strong, wide spaced discontinuities								
	1.50																
	1.50																
670																	
	1.50		R-34	60 100%	60 100%	R6	FR										
	1.50																
	1.50	195.0															

NOTES: Coal seam encountered

PROJECT NO.: **353754**

Depth/ Elev. (ft)	Avg Core Rate (min /ft)	Depth (ft)	Run/ (Box) No.	Rec. (in. / %)	RQD (in. / %)	Rock Core Hard.	Rock Core Weath	Stratum Graphic	Visual Identification, Description and Remarks (Rock type, colour, texture, weathering, field strength, discontinuity spacing, optional additional geological observations)	Depth (ft.)	Discontinuities (See Legend for Rock Description System) Type	Dip	Rgh	Wea	Aper	Infill	Remarks
	1.50	195.0							QUARTZITE, Gray, fine to coarse grained, fresh, extremely strong, wide spaced discontinuities 198' - 198.5' COAL								
	1.50																
	1.00		R-35	57 95%	57 95%	R6	FR			197.00	J	0	U,R	DG	VW	-	
	1.50																
	1.50	200.0															
200																	
	1.00	200.0							QUARTZITE, Gray, fine to medium grained, fresh, extremely strong, wide spaced discontinuities Mica laminations present	200.30	J	50	S,R	DS	PO	Fe	
	1.50																
660																	
	1.50		R-36	60 100%	60 100%	R6	FR										
	1.50																
	1.00	205.0															
205																	
	1.00	205.0							QUARTZITE, Gray, fine to medium grained, fresh, extremely strong, wide spaced discontinuities 209.5' - 210' Highly Fractured zone								
	1.00																
	1.00		R-37	58 97%	54 90%	R6	FR										
										207.90	J	10	P,R	FR	VT	N	
	1.00									208.10	J	30	P,R	FR	VT	N	
										208.70	J	10	P,R	FR	T	N	
	1.00	210.0															
210																	
	2.00	210.0							QUARTZITE, Light gray, medium grained, fresh, extremely strong, moderate to wide spaced discontinuities								
	2.00																
650																	
	2.00		R-38	60 100%	60 100%	R6	FR										
	2.00									213.30	J	15	P,R	FR	VT	N	
	1.50	215.0															
215																	
	2.00	215.0							QUARTZITE, Light gray, fine to coarse grained, fresh, very strong, close to moderate spaced discontinuities Occasional fine COAL laminations with Quartz veins 219' - 220' Highly Fractured zone	215.80	J	10	P,R	FR	VT	QZ	
	2.00									216.20	J	20	S,R	FR	VT	N	
	2.00		R-39	59 98%	45 75%	R5	FR			217.30	J	0	U,R	FR	O	N	
	2.00									218.30	J	20	U,R	FR	VT	N	
	2.00	220.0															

CORE BORING LOG
(continued)

Depth/ Elev. (ft)	Avg Core Rate (min /ft)	Depth (ft)	Run/ (Box) No.	Rec. (in. / %)	RQD (in. / %)	Rock Core Hard.	Rock Core Weath	Stratum Graphic	Visual Identification, Description and Remarks (Rock type, colour, texture, weathering, field strength, discontinuity spacing, optional additional geological observations)	Depth (ft.)	Discontinuities (See Legend for Rock Description System) Type	Dip	Rgh	Wea	Aper	Infill	Remarks
	1.50	220.0							QUARTZITE, Gray, medium grained, fresh, extremely strong, close spaced discontinuities								
	1.50									220.80	J	20	P,R	FR	VT	N	
										220.90	J	20	P,R	DG	PO	N	
640	1.50		R-40	60 100%	58 97%	R6	FR										
	2.00									223.00	J	30	U,R	FR	VT	N	
	2.00	225.0							225.0								
225									End of Boring at 225 feet BGS. Borehole grouted with cement and bentonite hole plug.								
230																	
630																	
235																	
240																	
620																	

NOTES: Coal seam encountered

PROJECT NO.: **353754**

Boring No.: **B-I81-2**

Figure B-I81-2.1
B-I81-2 Box 1 Runs 1-4 Dry

Figure B-I81-2.2
B-I81-2 Box 1 Runs 1-4 Wet

MOTT MACDONALD M M	**PennEast Pipeline Project** **Rock Core Photographs**	**BORING NO.:** B-I81-2

Figure B-I81-2.3
B-I81-2 Box 2 Runs 5-8 Dry

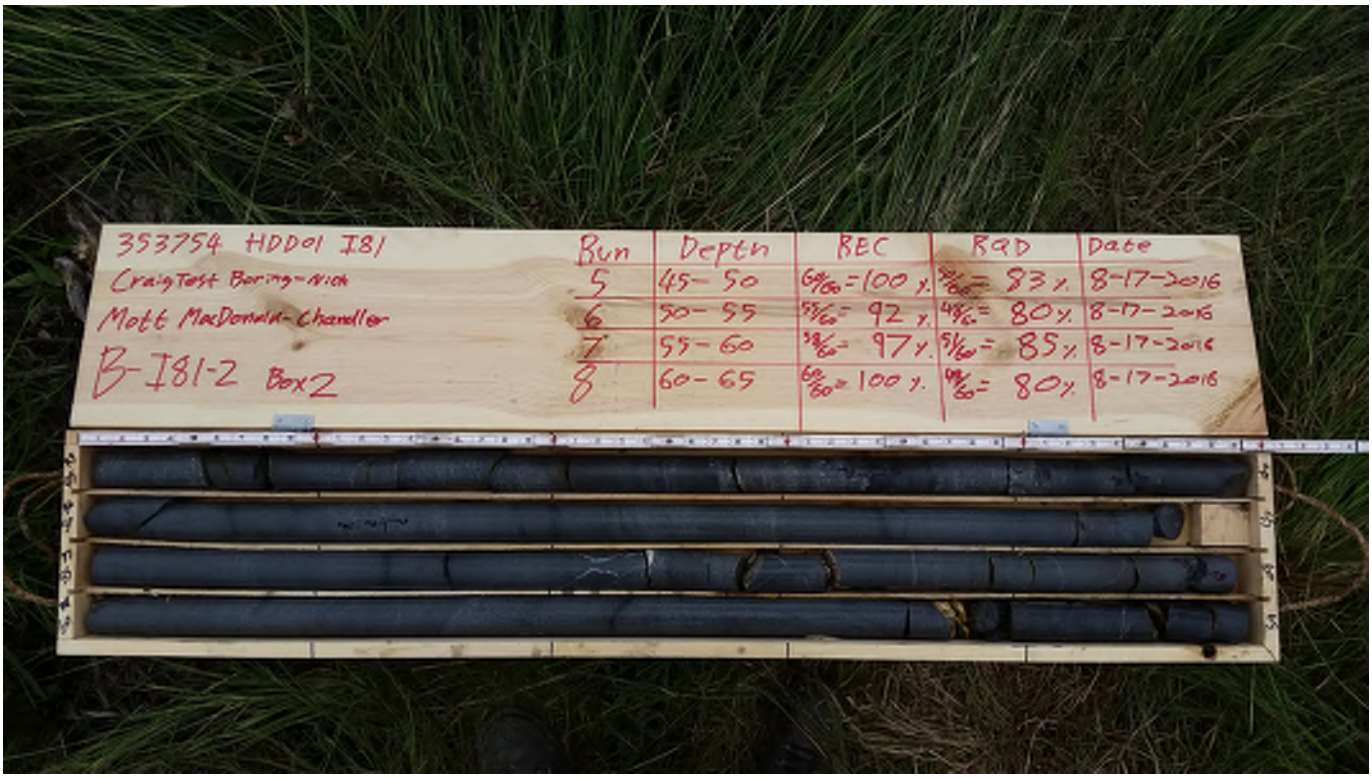


Figure B-I81-2.4
B-I81-2 Box 2 Runs 5-8 Wet

MOTT MACDONALD	PennEast Pipeline Project Rock Core Photographs	BORING NO.: B-I81-2

Figure B-I81-2.5
B-I81-2 Box 3 Runs 9-12 Dry

Figure B-I81-2.6
B-I81-2 Box 3 Runs 9-12 Wet

MOTT MACDONALD M M	**PennEast Pipeline Project** **Rock Core Photographs**	**BORING NO.:** B-I81-2

Figure B-I81-2.7
B-I81-2 Box 4 Runs 13-16 Dry

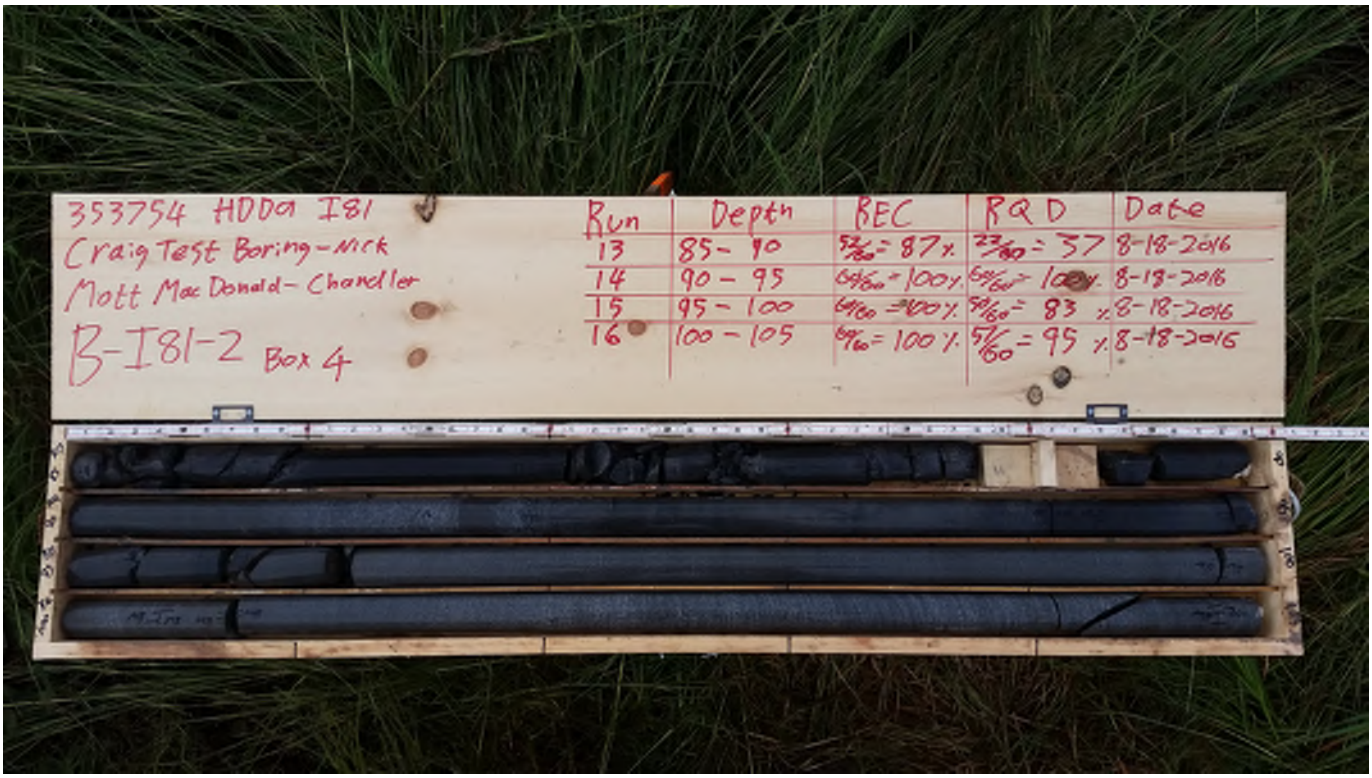


Figure B-I81-2.8
B-I81-2 Box 4 Runs 13-16 Wet

MOTT MACDONALD M M	PennEast Pipeline Project Rock Core Photographs	BORING NO.: B-I81-2

Figure B-I81-2.9
B-I81-2 Box 5 Runs 17-20 Dry

Figure B-I81-2.10
B-I81-2 Box 5 Runs 17-20 Wet

MOTT MACDONALD M M	**PennEast Pipeline Project** **Rock Core Photographs**	**BORING NO.:** B-I81-2

Figure B-I81-2.11
B-I81-2 Box 6 Runs 21-24 Dry

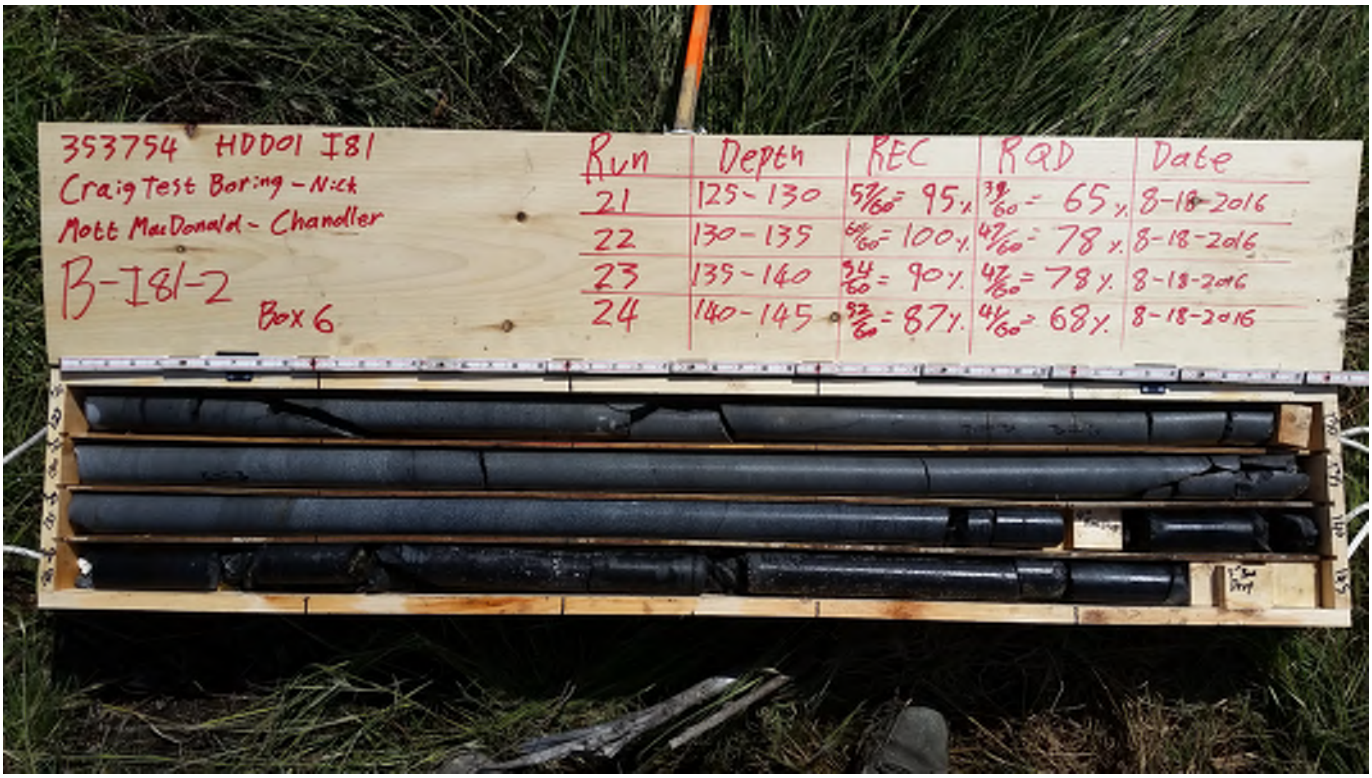


Figure B-I81-2.12
B-I81-2 Box 6 Runs 21-24 Wet

Figure B-I81-2.13
B-I81-2 Box 7 Runs 25-28 Dry

Figure B-I81-2.14
B-I81-2 Box 7 Runs 25-28 Wet

MOTT MACDONALD M M	**PennEast Pipeline Project** **Rock Core Photographs**	**BORING NO.:** B-I81-2

Figure B-I81-2.15
B-I81-2 Box 8 Runs 29-32 Dry

Figure B-I81-2.16
B-I81-2 Box 8 Runs 29-32 Wet

MOTT MACDONALD M M	**PennEast Pipeline Project** **Rock Core Photographs**	**BORING NO.:** B-I81-2

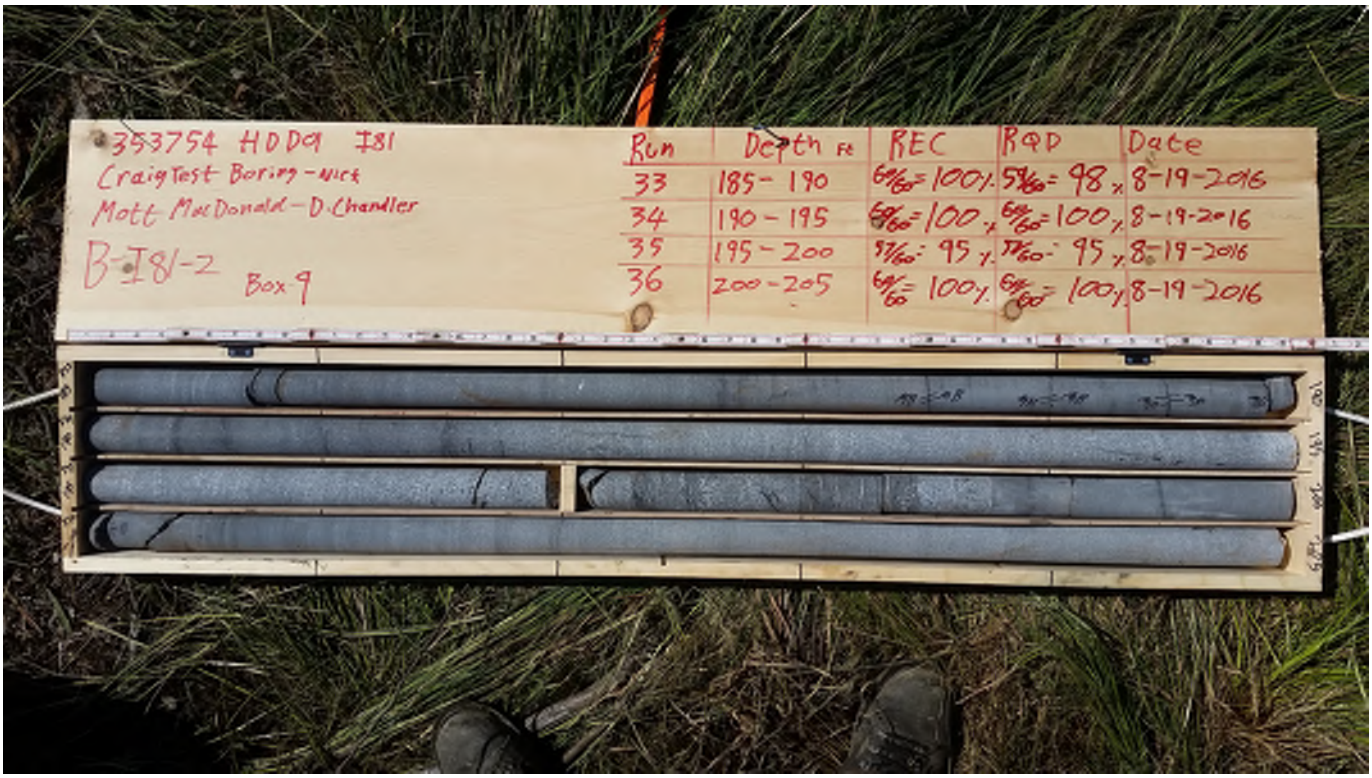


Figure B-I81-2.17
B-I81-2 Box 9 Runs 33-36 Dry

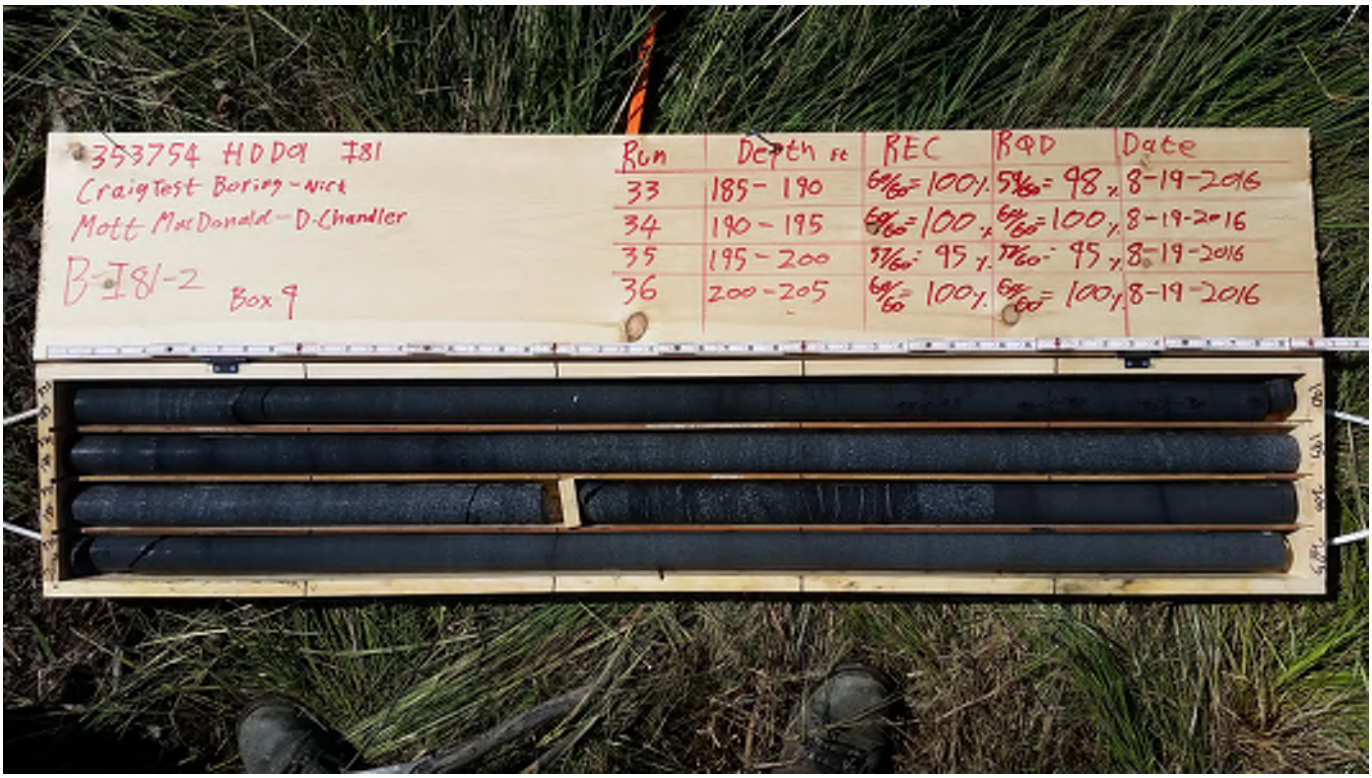


Figure B-I81-2.18
B-I81-2 Box 9 Runs 33-36 Wet

MOTT MACDONALD M M	**PennEast Pipeline Project** **Rock Core Photographs**	**BORING NO.:** B-I81-2

Figure B-I81-2.19
B-I81-2 Box 10 Runs 37-40 Dry

Figure B-I81-2.20
B-I81-2 Box 10 Runs 37-40 Wet

MOTT MACDONALD M M	PennEast Pipeline Project Rock Core Photographs	BORING NO.: B-I81-2

MOTT MACDONALD M M

SOIL BORING LOG

BORING NO.: **B-I81-3**
Page **1** of **2**

Project:	PennEast Pipeline Project	**Project No.:**	353754
Location:	Interstate - 81 Crossing, Wilkes - Barre, PA	**Project Mgr:**	Vatsal Shah
Client:	PennEast Pipeline	**Field Eng. Staff:**	Dafydd Chandler
Drilling Co.:	Craig Test Boring Co., Inc.	**Date/Time Started:**	April 17, 2017 at 8:55 pm
Driller/Helper:	Paul Mullins /Dalton Lentes	**Date/Time Finished:**	April 19, 2017 at 11:00 pm

Elevation: 827 ft. **Vertical Datum:** NAVD 1988 **Boring Location:** Median of Interstate 81 in Wilkes-Barre, PA **Coord.:** **N:** 14990960.58 **E:** 1419357.591 **Horizontal Datum:** UTM Zone 18 T

Item	Casing	Sampler	Core Barrel
Type	HW	SS	NQ2
Length (ft)	10	2	5
Inside Dia. (in.)	4	1.375	2.0
Hammer Wt. (lb.)	140	140	-
Hammer Fall (in.)	30	30	-

Rig Make & Model: CME 750x

☐ Truck ☐ Tripod ☐ Cat-Head
☑ ATV ☐ Geoprobe ☐ Winch
☐ Track ☐ Air Track ☑ Roller Bit
☐ Skid ☐ _____ ☐ Cutting Head

Hammer Type: ☐ Safety ☐ Doughnut ☑ Automatic ☐ _____

Drilling Fluid: ☐ Bentonite ☐ Polymer ☑ Water ☐ None

Drill Rod Size:

Casing Advance: Mud Rotary

Depth/ Elev. (ft)	Sample No. / Interval (ft)	Rec. (in)	Sample Blows per 6"	Stratum Graphic	USCS Group Symbol	Visual - Manual Identification & Description (Density/consistency, color, Group Name, constituents, particle size, structure, moisture, optional descriptions, geologic interpretation, Symbol)	Field Tests: Dilatancy	Toughness	Plasticity	Dry Strength	Remarks
	S-1 0.0'- 2.0'	20	5 6 5 5		FILL	Medium dense, Black and gray Clayey SAND with Gravel and Cobbles, dry (FILL)	N	H	NP	-	
5 820	S-2 5.0'- 7.0'	7	16 16 17 15		FILL	Dense, Gray Clayey medium to coarse GRAVEL, dry (FILL)	N	-	NP	-	Gravel is Sandstone, Siltstone and Coal fragments.
10	S-3 10.0'- 12.0'	19	12 20 26 25		FILL	Dense, Gray Gravelly SILT with Clay and occasional Cobble, dry (FILL)	-	-	NP	-	Gravel is Coal and Sandstone fragments.
						12.5					
15	S-4 15.0'- 17.0'	18	14 12 14 12		CL	Very Stiff, Dark gray Gravelly CLAY, moist (CL)	-	-	NP	-	Glacial Till.
810						17.2					
						Boulder of Sandstone					
						17.9					
	17.9'-'				CL	Gravelly CLAY (CL)	-	-	-	-	Glacial Till.
	18.5'-'					18.5 Top of weathered rock at 18.5 feet BGS	-	-	-	-	Weathered rock is Shale.

Water Level Data

Date	Time	Elapsed Time (hr)	Depth in feet to: Bot. of Casing	Bottom of Hole	Water
4/18/17	20:00	0:00	10.0	75.0	Dry
4/19/17	19:45	0:00	10.0	175.0	Dry

Sample Type

O Open End Rod
T Thin-Wall Tube
U Undisturbed Sample
S Split Spoon Sample
G Grab Sample

Notes:

PP = Pocket Penetrometer
TV = Torvane
Night work

Boring No.: **B-I81-3**

Field Test Legend:
Dilatancy: N - None S - Slow R - Rapid
Toughness: L - Low M - Medium H - High
Plasticity: NP - Non-Plastic L - Low M - Medium H - High
Dry Strength: N - None L - Low M - Medium H - High VH - Very High

NOTES: 1.) "ppd" denotes soil sample average diametral pocket penetrometer reading. 2.) "ppa" denotes soil sample average axial pocket penetrometer reading.
3.) Maximum Particle Size is determined by direct observation within limitations of sampler size. 4.) Soil identifications and field tests based on visual-manual methods per ASTM D2488.

MOTT MACDONALD M M

SOIL BORING LOG
(continued)

BORING NO.: **B-I81-3**
Page **2** of **2**

Depth/ Elev. (ft)	Sample No. / Interval (ft)	Rec. (in)	Sample Blows per 6"	Stratum Graphic	USCS Symbol Group	Visual - Manual Identification & Description (Density/consistency, color, Group Name, constituents, particle size, structure, moisture, optional descriptions, geologic interpretation, Symbol)	Field Tests: Dilatancy	Field Tests: Toughness	Field Tests: Plasticity	Field Tests: Dry Strength	Remarks
	S-5 20.0'-22.0'	0.5	50/0.5"		GP	Very dense, dark gray WEATHERED ROCK fragments, dry	-	-	-	-	Weathered rock is Shale. Smooth slow roller bit drilling cuttings recovered as dark gray Gravel.
25						25.0					
	S-6 25.0'-27.0'	0	50/0.0"			Top of Rock at 25 feet BGS. See Rock Coring Log.	-	-	-	-	
800											
30											
35											
790											
40											
45											

NOTES: PP = Pocket Penetrometer
TV = Torvane
Night work

PROJECT NO.: **353754**

BORING NO.: **B-I81-3**

NOTES: 1.) "ppd" denotes soil sample average diametral pocket penetrometer reading. 2.) "ppa" denotes soil sample average axial pocket penetrometer reading.
3.) Maximum Particle Size is determined by direct observation within limitations of sampler size. 4.) Soil identifications and field tests based on visual-manual methods per ASTM D2488.

MOTT MACDONALD M M

CORE BORING LOG

BORING NO.: **B-I81-3**

Project:	PennEast Pipeline Project	**Project No.:**	353754
Location:	Interstate - 81 Crossing, Wilkes - Barre, PA	**Project Mgr:**	Vatsal Shah
Client:	PennEast Pipeline	**Field Eng. Staff:**	Dafydd Chandler
Drilling Co.:	Craig Test Boring Co., Inc.	**Date/Time Started:**	April 17, 2017 at 8:55 pm
Driller/Helper:	Paul Mullins /Dalton Lentes	**Date/Time Finished:**	April 19, 2017 at 11:00 pm

Elevation: 827 ft. **Vertical Datum:** NAVD 1988 **Boring Location:** Median of Interstate 81 in Wilkes-Barre, PA **Coord.: N:** 14990960.58 **E:** 1419357.591

Item	Casing	Core Barrel	Core Bit
Type	HW	NQ2	Imp. Diamond
Length (ft)	10	5	3.25
Inside Dia. (in.)	4	2.0	2.0

Horizontal Datum: UTM Zone 18 T **Drilling Method:** Wireline

Rig Make & Model: CME 750x

Depth/ Elev. (ft)	Avg Core Rate (min /ft)	Depth (ft)	Run/ (Box) No.	Rec (in. / %)	RQD (in / %)	Rock Core Hard.	Rock Core Weath	Stratum Graphic	Visual Identification, Description and Remarks (Rock type, colour, texture, weathering, field strength, discontinuity spacing, optional additional geological observations)	Depth (ft.)	Discontinuities Type	Dip	Rgh	Wea	Aper	Infill	Remarks
									SEE TEST BORING LOG FOR OVERBURDEN DETAILS		(See Legend for Rock Description System)						
	2.40	25.0							SANDSTONE, Gray, fine to medium grained, fresh, strong, wide spaced discontinuities								Good water return from 25 to 59 feet BGS.
										25.80	B	10	P,R	FR	VT	N	
	2.60																
800	2.70		R-1	53 88%	47 78%	R4	FR			27.50	MB	15	S,R	FR	T	N	
	3.60																
	3.60	30.0								29.80	B	5	P,R	FR	T	N	
30	3.00	30.0							SANDSTONE, Gray, fine grained, fresh, very strong, wide spaced discontinuities								
	3.10																
	3.00		R-2	60 100%	60 100%	R5	FR			32.80	B	10	P,R	FR	T	N	
	3.10									33.50	B	15	S,R	FR	VT	N	
	3.20	35.0															
35	3.00	35.0							SILTSTONE, Dark gray, very fine grained, fresh, medium strong, very close spaced discontinuities	35.0							
									35' - 36' Highly Fractured zone	35.8							
	3.00								SANDSTONE, Gray, fine to medium grained, fresh, very strong, close to moderately spaced discontinuities Occasional Siltstone inclusion	36.50	B	20	P,R	FR	PO	N	
790										37.00	B	15	P,R	FR	VT	N	
	2.90		R-3	60 100%	45 75%	R5	FR			37.30	B	5	P,R	FR	VT	N	
										37.60	B	0	P,R	FR	VT	N	
	3.00									38.00	B	5	P,R	FR	VT	N	
	2.90	40.0								39.60	J	15	U,R	FR	T	Fe	
40	3.00	40.0								40.40	MB	15	P,R	FR	PO	Fe	
										40.9							
	2.00								COAL, Black anthracite Coal, medium strong, fresh	41.20	B	15	P,Sm	FR	T	N	
										41.90	B	5	P,Sm	FR	O	N	
	2.00		R-4	56 93%	54 90%	R4	FR			42.4							
									SILTSTONE, Gray, very fine grained, strong, wide spaced discontinuities	42.40	B	10	P,R	FR	O	Fe	
	3.00									43.00	J	10	S,R	DE	T	Fe	
	3.00	45.0								44.30	J	15	S,R	DE	PO	N	
										45.0							

Water Level Data

Date	Time	Elapsed Time (hr)	Depth in feet to: Bot. of Casing	Bottom of Hole	Water
4/18/17	20:00	0:00	10.0	75.0	
4/19/17	19:45	0:00	10.0	175.0	

Notes:

Coal seam encountered

CORE BORING LOG
(continued)

Depth/ Elev. (ft)	Avg Core Rate (min /ft)	Depth (ft)	Run/ (Box) No.	Rec. (in. / %)	RQD (in. / %)	Rock Core Hard.	Rock Core Weath	Stratum Graphic	Visual Identification, Description and Remarks (Rock type, colour, texture, weathering, field strength, discontinuity spacing, optional additional geological observations)	Depth (ft.)	Discontinuities (See Legend for Rock Description System) Type	Dip	Rgh	Wea	Aper	Infill	Remarks
	2.80	45.0							SANDSTONE, Gray, fine grained, fresh, strong, wide spaced discontinuities								
										45.70	MB	5	S,R	FR	VT	N	
	2.80																
										46.70	B	0	S,R	FR	VT	N	
780	2.80		R-5	59 98%	58 97%	R4	FR			47.50	J	15	P,R	FR	VT	N	
	2.80																
	2.80	50.0															
50	2.50	50.0							SANDSTONE, Gray, fine grained, fresh, strong, moderately spaced discontinuities	50.20	B	0	P,R	DE	T	N	
										50.70	J	15	P,R	DE	PO	N	
	2.70																
	2.80		R-6	60 100%	47 78%	R4	FR			52.10	B	0	P,R	FR	T	N	
										53.00	B	15	P,R	FR	T	N	
	2.70									53.50	B	0	P,R	FR	T	N	
	2.80	55.0															
55	2.60	55.0							SANDSTONE, Gray, fine grained, fresh, strong, moderately spaced discontinuities								Loss of water from 59 to 175 feet BGS.
	2.60									56.50	B	15	P,R	FR	VT	N	
770	2.60		R-7	60 100%	51 85%	R4	FR										
	2.60																
	2.60	60.0								59.00	B	10	P,R	FR	PO	N	
60	2.20	60.0							60.0 QUARTZITE, Light gray, medium grained, fresh, extremely strong, wide spaced discontinuities								5 foot solid run.
	2.30																
	2.30		R-8	60 100%	60 100%	R6	FR										
	2.40																
	2.40	65.0															
65	1.90	65.0							QUARTZITE, Light gray, medium grained, fresh, extremely strong, wide spaced discontinuities								
	2.00																
760	2.00		R-9	60 100%	52 87%	R6	FR										
	2.00									68.50	J	40	S,R	FR	PO	N	
	1.90	70.0								68.80	B	10	P,R	FR	PO	N	

NOTES: Coal seam encountered

PROJECT NO.: **353754**

Boring No.: **B-I81-3**

CORE BORING LOG
(continued)

Depth/ Elev. (ft)	Avg Core Rate (min /ft)	Depth (ft)	Run/ (Box) No.	Rec. (in. / %)	RQD (in. / %)	Rock Core Hard.	Rock Core Weath	Stratum Graphic	Visual Identification, Description and Remarks (Rock type, colour, texture, weathering, field strength, discontinuity spacing, optional additional geological observations)	Depth (ft.)	Discontinuities Type	Dip	Rgh	Wea	Aper	Infill	Remarks
	2.10	70.0															
	2.10								QUARTZITE, Light gray, medium grained, fresh, extremely strong, wide spaced discontinuities								
	2.10		R-10	60 100%	58 97%	R6	FR										
	2.20																
	2.10	75.0								74.20	J	50	P,R	FR	PO	N	
75	1.80	75.0							QUARTZITE, Light gray, medium grained, fresh, extremely strong, wide spaced discontinuities								
	1.90									76.30	J	20	P,R	FR	T	N	
750										76.80	J	25	P,R	FR	T	N	
	1.90		R-11	60 100%	58 97%	R6	FR										
	2.00									78.40	J	25	P,R	FR	T	N	
	2.00	80.0								79.50	J	0	P,R	FR	T	N	
80	1.80	80.0							QUARTZITE, Light gray, medium grained, fresh, extremely strong, wide spaced discontinuities								
	1.90																
	1.90		R-12	58 97%	49 82%	R6	FR										
	1.80									83.40	J	15	P,R	FR	PO	N	
	1.90	85.0															
85	1.90	85.0							QUARTZITE, Light gray, medium grained, light gray, fresh, extremely strong, wide spaced discontinuities								
	1.90									86.30	J	5	P,R	FR	VT	N	
740																	
	1.90		R-13	60 100%	56 93%	R6	FR										
	2.00									88.20	B	60	P,R	FR	PO	N	
	2.20								89.5								
90		90.0							90.0 SANDSTONE, Dark gray, fine grained, fresh, very strong, close spaced discontinuities 89.6' - 90' Highly Fractured zone								
	1.50	90.0							90.7 90' - 90.7' VOID	90.40	J	0	P,R	FR	T	N	
	1.50								SANDSTONE, Dark gray, fine grained, fresh, strong, moderately spaced discontinuities Minor Shale interbedding	91.30	B	30	S,R	FR	T	N	
										91.70	J	20	S,R	FR	PO	N	
	1.40		R-14	60 100%	50 83%	R4	FR			92.10	J	25	S,R	FR	PO	N	
	1.60									92.80	B	30	S,R	FR	T	N	
	1.50	95.0															

NOTES: Coal seam encountered

PROJECT NO.: **353754**

CORE BORING LOG
(continued)

Depth/ Elev. (ft)	Avg Core Rate (min /ft)	Depth (ft)	Run/ (Box) No.	Rec. (in. / %)	RQD (in. / %)	Rock Core Hard.	Rock Core Weath	Stratum Graphic	Visual Identification, Description and Remarks (Rock type, colour, texture, weathering, field strength, discontinuity spacing, optional additional geological observations)	Depth (ft.)	Discontinuities (See Legend for Rock Description System) Type	Dip	Rgh	Wea	Aper	Infill	Remarks
	1.50	95.0															
	1.50								SANDSTONE, Dark gray, fine grained, fresh, strong, moderately spaced discontinuities Minor shale interbedding	96.60	B	20	P,R	FR	T	N	
730										96.90	B	10	P,R	DE	PO	SL	
	1.50		R-15	60 100%	55 92%	R4	FR			98.00	J	10	P,R	DE	T	Fe	
	1.50									99.30	J	15	S,R	FR	T	Py	
	1.50	100.0															
100		100.0							SANDSTONE, Dark gray, fine grained, fresh, very strong, moderately spaced discontinuities Iron staining on some joints								
	1.40									101.30	B	1	P,R	DE	W	Fe	
	1.40									102.20	J	15	P,R	FR	W	N	
	1.50		R-16	60 100%	57 95%	R5	FR			102.80	J	40	P,R	DS	PO	Fe	
	1.40									104.00	J	25	P,R	DS	O	Fe	
	1.40	105.0															
105		105.0							SANDSTONE, Light gray, medium grained, fresh, very strong, moderately spaced discontinuities Occasional fine Shale and Coal interbedding	105.60	J	50	S,R	FR	T	N	
	1.40									105.90	B	45	S,R	FR	T	N	
	1.50																
720																	
	1.60		R-17	60 100%	53 88%	R5	FR			108.00	J	5	P,R	FR	T	Fe	
	1.70									108.60	J	10	S,R	DS	T	Ca	
	1.70	110.0								109.50	J	15	P,R	FR	T	N	
110		110.0							SANDSTONE, Light gray, medium grained, fresh, extremely strong, moderately spaced discontinuities Occasional fine Shale and Coal interbedding								
	1.50								111.2	111.00	J	20	P,R	FR	T	N	
	1.50								111.4 111.2' - 111.4' VOID								
	1.60		R-18	60 100%	53 88%	R6	FR			112.50	J	10	P,R	FR	T	N	
	1.60									112.80	J	10	P,R	FR	T	N	
	1.50	115.0								113.70	B	10	P,R	DS	PO	Fe	
115		115.0							SANDSTONE, Gray, fine grained, fresh, very strong, moderately spaced discontinuities	115.00	J	20	P,R	DS	O	N	
	1.50									116.30	J	15	P,R	DS	PO	Fe	
	1.60									117.00	J	10	P,R	FR	T	N	
710																	
	1.20		R-19	51 85%	34 57%	R5	FR		117.4 Black Anthracite COAL								
	1.20								118' - 120' Highly Fractured zone								
	1.30	120.0							119.5 119.6 119.5' - 119.6' VOID 120.0								

NOTES: Coal seam encountered

PROJECT NO.: **353754**

CORE BORING LOG
(continued)

Depth/ Elev. (ft)	Avg Core Rate (min /ft)	Depth (ft)	Run/ (Box) No.	Rec. (in. / %)	RQD (in. / %)	Rock Core Hard.	Rock Core Weath	Stratum Graphic	Visual Identification, Description and Remarks (Rock type, colour, texture, weathering, field strength, discontinuity spacing, optional additional geological observations)	Depth (ft.)	Discontinuities Type	Dip	Rgh	Wea	Aper	Infill	Remarks
	1.30	120.0							MUDSTONE, Dark gray, very fine grained, fresh, strong, close spaced discontinuities								
	1.40								122.0								
	1.20		R-20	56 93%	36 60%	R4	FR		Black Anthracite COAL								Yellow staining on Coal.
	1.10								122.8 SLATE, Black, very fine grained, fresh, strong								
	1.20	125.0							123.4 123.4' - 124.2' VOID 124.2 SLATE, Black, very fine grained, fresh, strong 124.8								
125	1.30	125.0							124.8' - 126.1' 1-Foot VOID 125' - 130' Highly Fractured zone								
	1.10								126.1 MUDSTONE, Dark gray, very fine grained, fresh, medium strong Poor recovery, unrecovered material possibly CLAY								
700	1.10		R-21	35 58%	9 15%	R3	FR		127.8 128.0 127.8' - 128' VOID								
	1.20								128.5 128.5' - 129' VOID								
	1.20	130.0							129.0 129.8								
130	1.20	130.0							129.8' - 130.7' VOID 130.7								
	1.10								MUDSTONE, Dark gray, very fine grained, fresh, medium strong 130.7' - 135' Highly Fractured zone Poor recovery, unrecovered material possibly CLAY Some Iron staining								
	1.10		R-22	38 63%	13 22%	R3	FR										
	1.10																
	1.20	135.0							134.0 SANDSTONE, Gray, fine grained, fresh, strong. 135.0								
135	1.60	135.0							MUDSTONE, Gray, very fine grained, fresh, medium strong, moderately spaced discontinuities Iron staining on fractures.	135.50 135.70	J J	0 0	P,R S,R	FR FR	VT VT	N N	
	1.60																
690	1.60		R-23	60 100%	55 92%	R3	FR			137.20 137.90	J J	40 15	P,R P,R	FR DE	T PO	N Fe	
	1.60								139.0								
	1.70	140.0							SANDSTONE, Gray, fine grained, fresh, strong								5 foot solid run.
140	1.80	140.0							SANDSTONE, Dark gray, fine grained, fresh, very strong, wide spaced discontinuities Some Shale interbedding								
	1.80																
	1.80		R-24	60 100%	60 100%	R5	FR										
	1.80																
	1.80	145.0															

NOTES: Coal seam encountered

PROJECT NO.: **353754**

CORE BORING LOG
(continued)

Depth/ Elev. (ft)	Avg Core Rate (min /ft)	Depth (ft)	Run/ (Box) No.	Rec. (in. / %)	RQD (in. / %)	Rock Core Hard.	Rock Core Weath	Stratum Graphic	Visual Identification, Description and Remarks (Rock type, colour, texture, weathering, field strength, discontinuity spacing, optional additional geological observations)	Depth (ft.)	Discontinuities Type	Dip	Rgh	Wea	Aper	Infill	Remarks
	1.90	145.0							SANDSTONE, Dark gray, fine grained, fresh, strong, moderately spaced discontinuities	145.70	B	0	U,R	FR	T	N	
										146.00	J	80	P,R	FR	PO	N	
	1.90																
680										146.80	J	45	U,R	FR	T	N	
	2.00		R-25	60 100%	25 42%	R4	FR		147.5								
									CONGLOMARATE, White and gray, coarse grained, fresh, extremely strong	147.60	J	40	S,R	FR	T	N	
										147.90	J	40	S,R	FR	T	N	
	1.90								148.6								
									Black Anthracite COAL, weak, with pyrite seams 148.6' - 150' Highly Fractured zone								
	1.80	150.0							150.0								
150		150.0							CONGLOMERATE, Gray and white, coarse grained, fresh, very strong, moderately spaced discontinuities	150.20	J	0	P,R	FR	VT	N	
	2.00																
										150.80	J	20	U,R	FR	T	N	
	2.10																
										151.70	B	15	P,R	DE	T	N	
	2.20		R-26	60 100%	50 83%	R5	FR										
										153.00	J	15	S,R	FR	VT	N	
	2.20																
										154.00	B	15	S,R	FR	VT	N	
	2.20	155.0								154.30	B	10	P,R	FR	VT	N	
155									155.0	154.70	J	15	U,R	FR	VT	QZ	
	2.10	155.0							SANDSTONE, Gray, coarse grained, fresh, very strong, wide spaced discontinuities Occasional Quartz veins								
										155.90	J	15	S,R	FR	VT	N	
	2.10																
670																	
	2.00		R-27	60 100%	60 100%	R5	FR										
	1.70																
	1.90	160.0							160.0								
160		160.0							QUARTZITE, Gray, medium grained, fresh, extremely strong, wide spaced discontinuities								5 foot solid run.
	2.00																
	2.00																
			R-28	60 100%	60 100%	R6	FR										
	2.00																
	2.00	165.0															
165		165.0							QUARTZITE, Gray, medium grained, fresh, extremely strong, wide spaced discontinuities								
	1.80																
	1.90																
660																	
	1.90		R-29	60 100%	60 100%	R6	FR			168.10	J	55	U,R	FR	PO	N	
											J	25	P,R	FR	PO	N	
	1.90																
										169.00	J	50	U,R	FR	PO	N	
	1.90	170.0									J	35	P,R	FR	T	N	

NOTES: Coal seam encountered

PROJECT NO.: **353754**

Boring No.: **B-I81-3**

CORE BORING LOG
(continued)

Depth/ Elev. (ft)	Avg Core Rate (min /ft)	Depth (ft)	Run/ (Box) No.	Rec. (in. / %)	RQD (in. / %)	Rock Core Hard.	Rock Core Weath	Stratum Graphic	Visual Identification, Description and Remarks (Rock type, colour, texture, weathering, field strength, discontinuity spacing, optional additional geological observations)	Depth (ft.)	Discontinuities (See Legend for Rock Description System) Type	Dip	Rgh	Wea	Aper	Infill	Remarks
	2.00	170.0							QUARTZITE, Gray, medium grained, fresh, extremely strong, wide spaced discontinuities								
	2.00																
									172.0								
	1.10		R-30	60 100%	48 80%	R6	FR		Black Anthracite COAL 172' - 173' Highly Fractured zone								
									173.0								
	2.00								SANDSTONE, Gray, medium to coarse grained, fresh, extremely strong	173.40	J	20	P,R	FR	T	N	
	2.00	175.0															
175									175.0								
									End of Boring at 175 feet BGS. Borehole grouted with cement and bentonite hole plug.								
650																	
180																	
185																	
640																	
190																	

NOTES: Coal seam encountered

PROJECT NO.: **353754**

Boring No.: **B-I81-3**

Figure B-I81-3.1
B-I81-3 Box 1 Runs 1-4 Dry

Figure B-I81-3.2
B-I81-3 Box 1 Runs 1-4 Wet

MOTT MACDONALD	PennEast Pipeline Project Rock Core Photographs	BORING NO.: B-I81-3

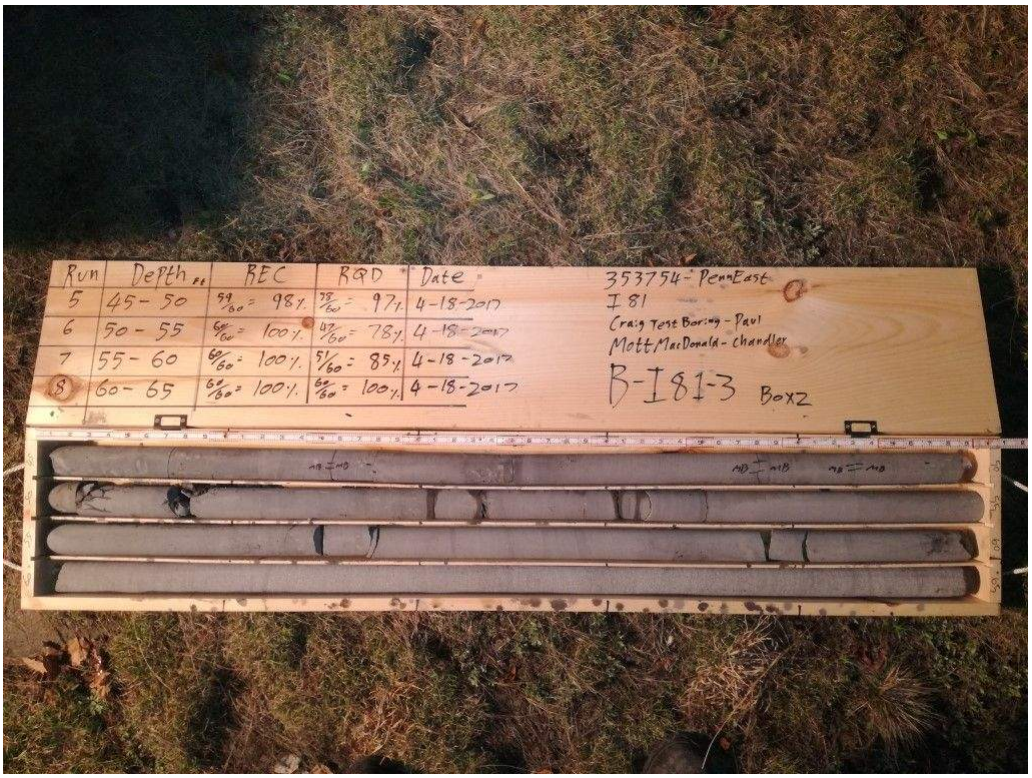


Figure B-I81-3.3
B-I81-3 Box 2 Runs 5-8 Dry

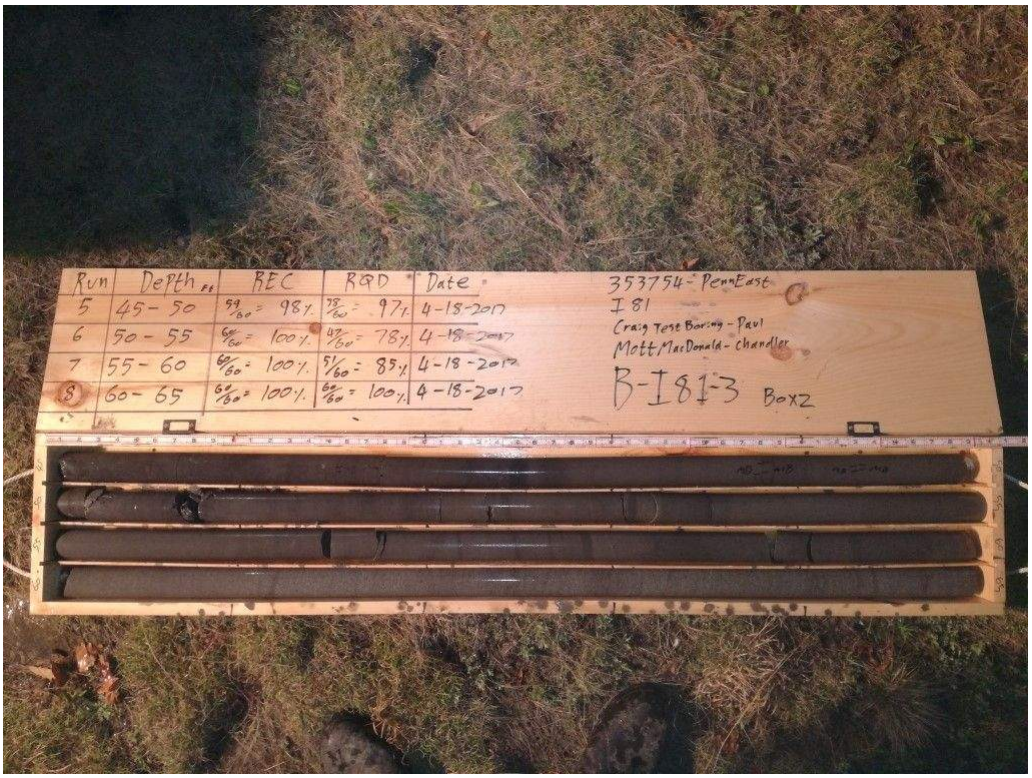


Figure B-I81-3.4
B-I81-3 Box 2 Runs 5-8 Wet

MOTT MACDONALD	PennEast Pipeline Project Rock Core Photographs	BORING NO.: B-I81-3

Figure B-I81-3.5
B-I81-3 Box 3 Runs 9-12 Dry

Figure B-I81-3.6
B-I81-3 Box 3 Runs 9-12 Wet

MOTT MACDONALD M M	PennEast Pipeline Project Rock Core Photographs	BORING NO.: B-I81-3

Figure B-I81-3.7
B-I81-3 Box 4 Runs 13-16 Dry

Figure B-I81-3.8
B-I81-3 Box 4 Runs 13-16 Wet

MOTT MACDONALD M M	PennEast Pipeline Project Rock Core Photographs	BORING NO.: B-I81-3

Figure B-I81-3.9
B-I81-3 Box 5 Runs 17-20 Dry

Figure B-I81-3.10
B-I81-3 Box 5 Runs 17-20 Wet

MOTT MACDONALD M M	PennEast Pipeline Project Rock Core Photographs	BORING NO.: B-I81-3

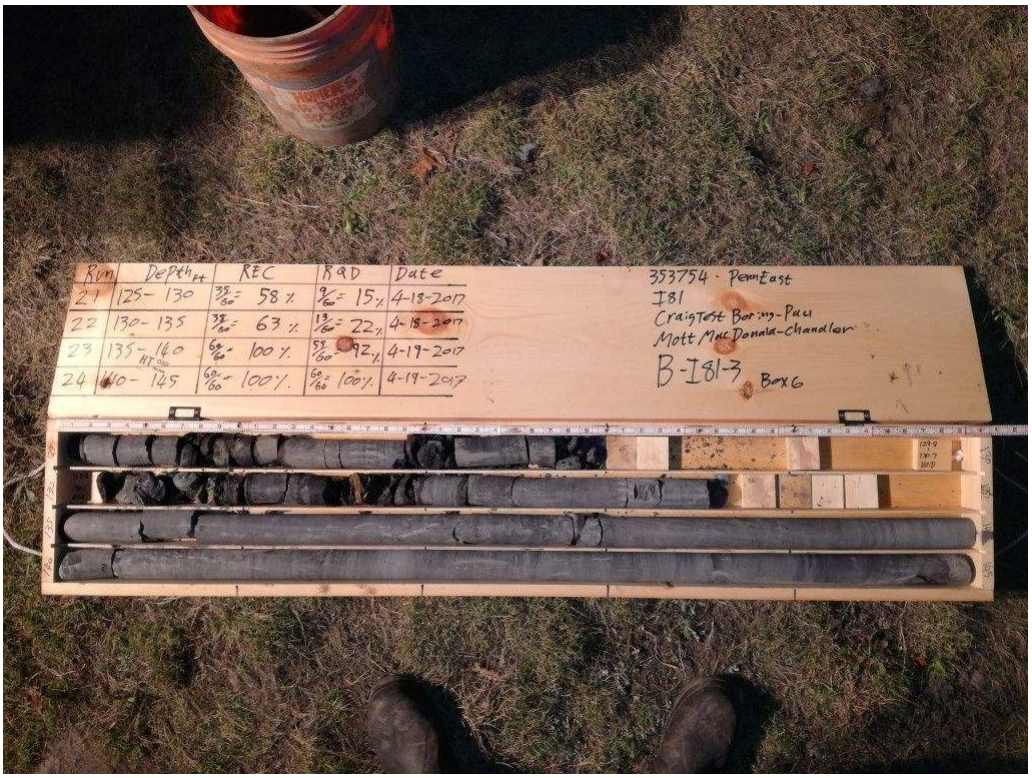


Figure B-I81-3.11
B-I81-3 Box 6 Runs 21-24 Dry

Figure B-I81-3.12
B-I81-3 Box 6 Runs 21-24 Wet