GEOTECHNICAL INVESTIGATION REPORT

Proposed Rock Cut Areas, Delaware River Tinicum to Marcus Hook, Pennsylvania , New Jersey, & Delaware

US Army Corps. of Engineers
Philadelphia, Pennsylvania

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O'BRIEN & GERE
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**Proposed Rock Cut Areas, Delaware River
Tinicum to Marcus Hook, Pennsylvania, New Jersey & Delaware**

Prepared for:
US Army Corps of Engineers
Philadelphia, Pennsylvania

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1. INTRODUCTION

O'Brien & Gere conducted a geotechnical investigation of the proposed rock cut areas within the Delaware River shipping channel, Tinicum to Marcus Hook ranges. The primary purpose of this investigation is to determine the subsurface soil and bedrock conditions at the selected boring locations that were not previously investigated for the proposed Delaware River channel deepening project. As part of that project, the river which is currently dredged to a depth of 40 feet below Mean Lower Low Water (MLLW), will be deepened to a depth of 45 feet plus 2 feet of pay over-depth in the rock cut areas to assure proper clearance of the bedrock surface. The minimum required dredging depth in bedrock areas will be 47 feet below MLLW. In this section of the river, the MLLW datum is approximately 3.2 feet below North American Vertical datum (NAVD 88).

2. SITE INFORMATION

As shown in Figures 1 through 3, the project "site" includes the Tinicum to Marcus Hook Ranges of the Delaware River, which extends approximately 8.3 miles from Station 96+300 to 140 + 100. Project stationing increases from upstream (north) to downstream (south). The Delaware River shipping channel is located along the Pennsylvania, New Jersey and Delaware shoreline and is approximately 800 feet wide. As stated previously, the current maintenance dredged depth in the channel averages 40 feet below MLLW. Tidal fluctuations result in water surface elevation variances of up to 6 feet.

3. REGIONAL GEOLOGY

According to the Preliminary Bedrock Geologic Map of a Portion of the Wilmington 30- by 60- Minute Quadrangle, Southeastern Pennsylvania, Gale C. Blackmer, PhD, P.G., published by the Pennsylvania Geological Survey in 2005, the study area is situated within igneous and metamorphic rock formations of Ordovician and Sillurian age. The extent of the geologic units presented on the map does not extend into the Delaware River and is truncated by the Coastal Plain onlap. However, based on units mapped near the river and observations collected from rock core samples, the geology of the study area consists of Chester Park Gniess and the Perkins Run Gabbronorite Suite of the Arden Plutonic Supersuite.

The Perkins Run Gabbronorite Suite is a collection of mafic and minor intermediate rocks that crystallized from mantle-derived basaltic magma. Typical compositions are 50-60% labradorite, subequal amounts of orthopyroxene and clinopyroxene, hornblende and lesser olivine and biotite. Based on rock core examination, the borings in the southwestern portion of the study area (CB-287, CB-288 and CB-306) penetrated the Perkins Run Gabbronorite. (Blackmer, 2005)

The Chester Park Gneiss is a medium to coarse grained plagioclase-quartz bitoite gneiss and schist. Local aluminous domains contain muscovite, garnet, kyanite, sillimanite, or cordierite. Irregularly shaped, elongate biotite-rich enclaves range in size from a few centimeters to several meters long. (Blackmer 2005) The unit is generally massive, but layering, defined mainly by biotite abundance, is present locally. Examination of rock cores indicate that Boring CB-290 and borings upstream of CB-290 are located within the Chester Park Gneiss.

4. EXPLORATION AND TESTING PROCEDURES

4.1. DRILLING AND SAMPLING

The subsurface conditions within the project area were evaluated by drilling 22 drive sample soil borings with HQ-size rock coring to a depth of 20 feet below the mudline of the channel, designated as Borings CB-287 through CB-308. Positioning and surveying was performed by licensed surveyors, Taylor Wiseman & Taylor. A Trimble model R8 GNSS Rover utilizing Network RTK corrections was used to determine horizontal and vertical positions. Additional measurements were taken using a weighted tape and hand held measuring tapes. Initial position measurements were made when the lift boat reached the proposed boring locations to verify that the boring location was within ten feet of the proposed location. When the lift boat reached working height, RTK GPS measurements were made upon the deck of the vessel along a baseline relative to the center of the fixed aperture in the deck through which drilling tools were lowered. These measurements established the centerline of the boring and elevation of the deck. The deck elevations were analyzed for levelness and any incline detected on the deck was accounted for. After the drillers advanced casing to the bottom of the river, a weighted tape was lowered within the casing to determine the river bottom elevation. Additional depth measurements were taken to record the elevation of the top of rock using a combination of the weighted tape and careful measurements of the drill rod lengths as they were advanced down the casing. When the drillers reached boring termination depth, a temporary mark was set on the drill rod to indicate the depth of boring termination. All lengths of drill rod were measured to determine the final depth of the drill bit relative to the deck. Upon completion of each boring, RTK GPS measurements were repeated on the deck baseline to validate the initial observations, and were used to determine the final published elevations presented in the surveyor's report and on the boring logs.

The project crew and equipment were mobilized to the USACE's Ft. Mifflin facility on May 12, 2010. The drilling program began the following day on May 13, 2010 and was completed on June 8, 2010. The borings were drilled at a rate of one to two borings per day by our subcontractor, Uni-Tech Drilling Co., Inc., using a CME-750 drill rig mounted on the R/V Hayes lift boat provided by Aqua Survey, Inc. After positioning over the boring coordinates, the lift boat lowered its three hydraulically-operated spuds to raise the lift boat and drill rig above the water surface. Use of the lift boat provided a stable drilling platform above the influence of tidal fluctuations in the river and wakes from passing vessels. The drilling tools were lowered to the river bottom through an aperture in the work deck at the stern of the R/V Hayes lift boat.

The drill crew utilized 6-inch diameter flush threaded steel casing to allow the drill cuttings to be flushed to the surface using water as the drilling fluid. Where soil materials were encountered at the river bottom, the borings were advanced by rotating an inner drill rod equipped with a tri-cone roller bit. Drive sample penetration tests were conducted at continuous two-foot intervals in general accordance with ASTM D3550 - Standard Practice for Thick Wall, Ring-Lined, Split Barrel, Drive Sampling of Soils. Soil samples were obtained using a 3-inch diameter split barrel sampler driven with a 300-lb hammer, which was hoisted with a rope and pulley and allowed to free fall 30-inches. The number of hammer blows required to drive the sampler 2 feet was recorded in intervals of 6-inches. The total number of hammer blows required to drive the sampler from 6 to 18 inches represents the "N-value" provided on the logs. It should also be noted that the N-values reported on the logs do not represent the Standard Penetration Test N-value, due to the use of a 3-inch O.D. split barrel sampler and 300-lb. hammer versus a 2-inch O.D. sampler and 140-lb. hammer, as specified for the Standard Penetration Test per ASTM D1586. No standardized correlation between the SPT N-value and the blows per foot obtained using ASTM D3550 procedure has been established. The 3-inch diameter sampler was used to facilitate sampling and optimal recovery of soils containing gravel.

Sampler refusal was encountered when at least 50 blows were recorded at less than 2-inches of sampler penetration, at which point driving of the sampler was terminated for the sample interval. Where sampler refusal was encountered, the blow counts were recorded on the logs as the number of blows over the length of sampler penetration in inches (i.e. 50/2"). The casing was then advanced to just above the next sampling interval and the drilling and sampling process was repeated. After sample collection, the split-barrel sample was opened, sample recovery recorded, and the sample was photographed. Each soil sample was visually classified in accordance with ASTM D2487, visual-manual procedure for identification of soils, and recorded on the field logs. A representative portion of the samples was placed in moisture-tight glass jars, which were labeled for future reference of boring number, sample depth, blow counts, and sample date. The boring logs provided in Appendix A include a general geotechnical boring log and a detailed rock core log for borings where rock was encountered.

Upon encountering bedrock, the outer casing was seated into the rock and the drilling tools were swapped for an HQ-size diamond bit wireline core barrel. The HQ core barrel cuts a 2.5-inch diameter rock core. Rock coring was conducted in general accordance with ASTM D2113. After coring the length of the core run (typically 5 feet), the wireline tool was used to hoist the inner core barrel and rock core to the surface. The rock cores were placed in a wooden core box and the percent core recovery, rock quality designation (RQD), and visual classification of the rock were recorded on the core logs. RQD is defined as the sum of the recovered intact and sound pieces of rock core having a length of 4 inches or greater divided by the total length of the run, expressed as a percentage. In addition, the discontinuities in the rock cores were carefully examined and their depth and inclination from horizontal were sketched on the logs. After the core boxes were filled to capacity, the boxes were labeled for future reference and the cores were photographed. Photographs of the rock cores are included in Appendix C.

4.2. LABORATORY TESTING

Selected soil and rock samples were subjected to laboratory testing. In general, lab sample selection focused on materials encountered at elevations above, and approximately 5 feet below the proposed dredge depth of 47 feet below MLLW. The samples were delivered to GeoTesting Express, a USACE-validated geotechnical laboratory, in Boxborough, Massachusetts.

Soil samples were tested for moisture content and particle size distribution. Atterberg limits tests were conducted on samples with appreciable silt/clay fines. The test results were used to confirm the visual soil classifications, which were corrected on the logs as appropriate in accordance with the Unified Soil Classification System (USCS) and ASTM D2487. The USCS soil classification is not provided on some of the laboratory gradation test reports in Appendix B, which is due to the fact that Atterberg limits tests were not assigned for samples that were obviously non-plastic. The laboratory will not provide soil classifications on their report unless Atterberg limits tests are run. As such, the table below indicates the samples that were determined to be non-plastic based on visual methods and the USCS classification is presented accordingly. A summary of the laboratory testing conducted on the soil samples is provided in Table 4.1 below:

Table 4.1: Summary of Soil Laboratory Testing

Boring No. Sample No.	ELEV	% Finer # 200 Sieve	LL	PI	USCS Soil Classification	Water Content (%)
CB-289 S-1	-45.4 to -47.4	87	107	71	Fat CLAY (CH)	138.2
CB-289 S-2	-47.4 to -48.3	9	NPV	NPV	Poorly Graded GRAVEL with silt and sand (GP-GM)	5.6
CB-292 S-1	-45.7 to -47.7	7	NPV	NPV	Poorly Graded GRAVEL with silt and sand (GP-GM)	5.4
CB-292 S-2	-47.7 to -48.4	7	NPV	NPV	Poorly Graded GRAVEL with silt and sand (GP-GM)	4.8
CB-293 S-2	-50.1 to -52.1	84	70	26	Elastic SILT with sand (MH)	59.1

Boring No. Sample No.	ELEV	% Finer # 200 Sieve	LL	PI	USCS Soil Classification	Water Content (%)
CB-295 S-1	-45.3 to -47.3	6	NPV	NPV	Poorly Graded GRAVEL with silt and sand (GP-GM)	7.1
CB-296 S-1	-44.7 to -46.7	7	NPV	NPV	Poorly Graded GRAVEL with silt and sand (GP-GM)	7.1
CB-296 S-2	-46.7 to -48.7	24	21	6	Silty, Clayey SAND with gravel (SC-SM)	5.2
CB-298 S-1	-45.1 to -47.1	5	NPV	NPV	Well Graded GRAVEL with silt and sand (GW-GM)	7.0
CB-298 S-2A	-47.1 to -48.1	6	NP	NP	Well Graded GRAVEL with silt and sand (GW-GM)	5.9
CB-298 S-2B	-48.1 to -49.1	28	NP	NP	Silty SAND (SM)	14.0
CB-299 S-1	-48.0 to -50	9	NPV	NPV	Poorly Graded GRAVEL with silt and sand (GP-GM)	7.1
CB-301 S-1	-45.4 to -47.4	6	NPV	NPV	Poorly Graded GRAVEL with silt and sand (GP-GM)	6.3
CB-301 S-2	-47.4 to -49.4	7	NPV	NPV	Well Graded GRAVEL with silt and sand (GW-GM)	5.8
CB-303 S-1	-45.0 to -47.0	11	NPV	NPV	Poorly Graded SAND with silt and gravel (SP-SM)	9.8
CB-305 S-1	-42.4 to -44.4	2	NP	NP	Poorly Graded GRAVEL with sand (GP)	8.3
CB-305 S-2	-44.4 to -46.4	3	NP	NP	Poorly Graded GRAVEL with sand (GP)	10.3
CB-305 S-3	-46.4 to -48.4	4	NP	NP	Poorly Graded GRAVEL with sand (GP)	2.1
CB-306 S-1	-44.6 to -46.6	67	88	53	Sandy Fat CLAY (CH)	53.1
CB-306 S-2	-46.6 to -48.6	68	53	25	Sandy Fat CLAY (CH)	38.4
CB-308 S-1	-45.2 to -47.2	5	NP	NP	Poorly graded SAND (SP)	25.0
CB-308 S-2A	-47.2 to -49.2	3	NP	NP	Poorly graded SAND (SP)	26.0
CB-308 S-2B	-47.2 to -49.2	93	84	50	Fat CLAY (CH)	76.3

*Datum: Mean Lower Low Water (MLLW)
Notes: NPV = Non-plastic fines as determined by visual methods; NP = Non-plastic fines as determined by laboratory methods; LL = Liquid Limit; PI = Plastic Index

Rock cores were subjected to strength tests inclusive of uniaxial compressive strength (ASTM D7012 C), point load strength index (ASTM D5731), and splitting tensile strength (ASTM D3967). The results of the strength testing were used to establish the Rock Mass Rating (RMR) and to aid in the rippability evaluation. The results of the unconfined compressive strength tests and estimated compressive strengths from the point load index tests are provided on the individual core logs. A summary of all laboratory strength test results is presented in Table 4.2 below. The laboratory test reports are provided in Appendix B. The side straightness tolerances on some of the cores tested for compressive strength did not meet ASTM D4543. The condition of the core side straightness could not be corrected and the cores were tested in the as-received condition. The effect of the side straightness on the compressive strength result is unknown.

Table 4.2 – Summary of Rock Core Strength Tests

Boring No.	Run No.	ELEV*	Unconfined Compressive Strength (psi)	Point Load Index/ Est. Compressive Strength (psi)	Splitting Tensile Strength (psi)
CB-287	R-1	-47.90 to -48.0-			955
CB-287	R-1	-50.62 to -51.08	22,727		
CB-287	R-2	-52.19 to -52.30			1,870
CB-288	R-1	-42.92 to -43.37	22,624		
CB-288	R-1	-43.60 to -43.7			1,620
CB-288	R-1	-44.12 to -44.58	25,971		
CB-288	R-1	-46.82 to -46.92			1,180
CB-289	R-1	-50.98 to -51.45	15,241		
CB-289	R-2	-53.00 to -53.09			1,260
CB-289	R-2	-53.36 to -53.82	17,134		
CB-290	R-2	-46.93 to -47.38	6,643		
CB-290	R-2	-48.78 to -49.22	31,331		
CB-290	R-2	-47.70 to -47.79			1,560
CB-290	R-3	-52.3 to -52.71	8,520		
CB-291	R-1	-48.00 to -48.11			1,043
CB-291	R-2	-50.92 to -51.38	11,487		
CB-292	R-1	-49.10 to -49.21			758
CB-292	R-1	-52.04 to -52.14		591/11,200	
CB-294	R-1	-45.30 to -45.40			663
CB-294	R-2	-48.45 to -48.91	9,964		
CB-294	R-2	-49.08 to -49.46	13,137		
CB-295	R-1	-48.44 to -48.88	11,152		
CB-295	R-1	-51.02 to -51.48	5,524		
CB-297	R-1	-47.72 to -48.06	17,023		
CB-297	R-2	-51.17 to -51.27			1,510
CB-300	R-1	-42.72 to -43.18	3,348		

Boring No.	Run No.	ELEV*	Unconfined Compressive Strength (psi)	Point Load Index/ Est. Compressive Strength (psi)	Splitting Tensile Strength (psi)
CB-300	R-1	-43.98 to -44.34	5,846		
CB-300	R-2	-47.49 to -47.59			506
CB-301	R-1	-48.94 to -49.36	5,234		
CB-301	R-1	-49.94 to -50.4	13,582		
CB-302	R-1	-45.33 to -45.71	2,850		
CB-302	R-1	-46.50 to -46.61		158/2,960	
CB-302	R-2	-47.84 to -47.96		104/1,920	
CB-302	R-2	-49.29 to -49.72	6,043		
CB-303	R-1	-47.12 to -47.22		646/12,200	
CB-303	R-2	-50.03 to -50.38	14,630		
CB-304	R-1	-48.85 to -49.27	3,794		
CB-304	R-2	-51.21 to -51.29		162/3,090	
CB-307	R-2	-48.35 to -48.81	14,145		
CB-307	R-2	-49.36 to -49.45			468

*Datum: Mean Lower Low Water (MLLW)

The strength tests indicate the rock to be much weaker where shear failure occurred along well-defined foliation planes, with relative strength ranging from weak to medium strong. The strength of the rock in the absence of well-defined foliation planes was found to be strong to very strong. The photographs in the laboratory reports help to illustrate this observation.

5. SUMMARY OF SUBSURFACE CONDITIONS

A generalized description of the subsurface conditions encountered in the borings is presented in the following sections:

5.1. SOIL MATERIALS

Soil materials were encountered at the river bottom at 12 of the 22 boring locations. Borings CB-305 and CB-308 were drilled to the target depth of 20 feet without encountering rock. The soil descriptions provided on the logs were established in general accordance with the visual-manual procedure for soil identification (ASTM D2488) and confirmed by laboratory soil classification testing of representative samples. In general, the predominant soil type encountered in the borings consisted of poorly to well graded gravel with silt and sand. The gravel is generally sub-rounded to sub-angular of mixed lithology and was interpreted to be representative of the Trenton Gravel Formation. Apparent densities of the gravels varied significantly, but were generally in the dense to very dense range based on the non-standard N-values obtained from driving a 3-inch O.D. split barrel sampler with a 300-lb. hammer, as discussed in Section 4.1 of this report. It should be noted that the blow counts could be somewhat amplified due to the presence of small cobbles within the gravel matrix that may have plugged or blocked the 3-inch diameter sampler opening at some locations. Some interbedded layers of very soft (weight-of-hammer) to medium stiff fat clays and elastic silts were encountered in four of the 22 borings. Localized deposits of medium dense to very dense clean to silty and clayey sands were also encountered in a few borings. The soils typically transitioned into saprolitic gneiss, which exhibited sampler penetration resistances of 30 to greater than 100 blows per foot.

5.2. ROCK MATERIALS

Bedrock was encountered at variable depths in 20 of the 22 borings. Rock was encountered at or above the proposed dredge depth in 10 of these 20 borings. All of the rock encountered in this exploration was identified as gneiss, which was observed to be predominantly fine-grained, and non-foliated to foliated at 50 to 80 degrees from the horizontal. The majority of the rock was observed to be slightly weathered to fresh, with a few instances of moderately to highly weathered rock. The Perkins Run Gabbronorite Suite bedrock core displayed only a massive character with no discernible weakness planes.

The Chester Park Gneiss constituently displayed a steeply dipping foliation plane, but the strike was not identifiable. Reconnaissance to the type section in Chester Park PA was under taken and yielded the following measurements.

Foliations:
Chester Park Type Section:

Location 1-"Bouldered" Outcrop on northeast side of Creek south of bridge
In-situ Gneiss N-S 65^{0}E
Gneiss N10^{0}E 85^{0}SE

Location 2- top of Hill due east

Schist N15^{0}E 50^{0}SE (biotite and extensive muscovite present)

Location 3-back downstream and slope (south) about half way.
Gneiss E-W 70^{0}N
Gneiss E-W 69^{0}N

Location 4 downstream at the base of slope
Gneiss N10^{0}E 80^{0}SE

Core recovery for individual runs varied from 5 to 100 percent, averaging about 92 percent for the study area as a whole. Based on rock quality designations ranging from 0 to 100 percent, the quality of the rock is highly variable from boring to boring, ranging from very poor to excellent. As shown in Table 5.1 below, RQD between individual core runs of the same boring remained variable, with no apparent trending of rock quality with depth. The average RQD of the total 83 core runs for the project is 64 percent, or "FAIR" rock quality.

Rock cores obtained from elevations at or above the proposed dredge line elevation of 47 feet below MLLW exhibited recoveries ranging from 40 to 100 percent, and RQD's ranging from 0 to 98 percent. For the cores above the proposed dredge depth, an average recovery of 86 percent and an average RQD of 43 percent (POOR) were indicated. A summary of the rock core data for each core run is provided in Table 5.1 below.

The Rock Mass Rating System (ASTM D5878) was applied to the upper core run where the required data was available. This system of rock mass characterization has been applied to engineering evaluation of rock masses in tunneling, hard rock mining, coal mining, stability of rock slopes, rock foundations, borability, rippability, dredgeability, weatherability, and rock bolting. The parameters used to classify the rock mass in accordance with the RMR system are uniaxial compressive strength, RQD, spacing of discontinuities, condition of discontinuities, ground water conditions, and orientation of discontinuities. It should be noted that the RMR system was intended to be applied to "structural regions" within the rock mass where the various parameters being evaluated are somewhat uniform. Typically, these structural regions cover greater areas and depths than those explored for this project. In addition, the parameter of joint spacing is not intended to be gathered from boreholes, but rather a joint survey. For the purpose of this report, the discontinuity spacing was based on the borehole data, since no joint survey was available. The RMR was applied to the upper core run to provide an evaluation of the rock mass on a smaller scale than would be applied in a tunneling project. The groundwater parameter was always assigned a rating of zero given that the rock is submerged. While the dip angle of the discontinuities and foliation planes identified in the rock cores was recorded, the strike orientation of the rock formation was not determined during this exploration. Therefore, the reduction values for strike and dip orientation were not applied to the raw RMR, which results in a more conservative evaluation of rippability given that a rock mass rated with a higher RMR would generally be more difficult to rip.

Based on our interpretation of the classification parameters from the rock cores, the RMR for the upper rock cores ranges from 41 (FAIR) to 70 (GOOD). The RMR for the cores indicated most of the rock to fall within Class III, FAIR rock mass class. The RMR for the rock core runs is provided in Table 5.1 below.

Table 5.1: Summary of Rock Core Data

BORING NO.	RUN NO.	ELEV*	Predominant Rock Type	Recovery (%)	RQD** (%)	RMR
CB-287	1	-47.1 to -51.43	GNEISS	65	46/POOR	50/FAIR
CB-287	2	-51.43 to -56.43	GNEISS	100	100/EXCELLENT	-
CB-287	3	-56.43 to -61.43	GNEISS	98	93/EXCELLENT	-
CB-287	4	-61.43 to -66.43	GNEISS	100	100/EXCELLENT	-
CB-287	5	-66.43 to -67.43	GNEISS	100	100/EXCELLENT	-
CB-288	1	-42.8 to -47.8	GNEISS	98	98/EXCELLENT	70/GOOD
CB-288	2	-47.8 to -52.8	GNEISS	65	35/POOR	-
CB-288	3	-52.8 to -57.8	GNEISS	51	13/VERY POOR	-
CB-288	4	-57.8 to -62.8	GNEISS	83	70/FAIR	-
CB-289	1	-49.4 to -51.65	GNEISS	66	40/POOR	51/FAIR
CB-289	2	-51.65 to -56.23	GNEISS	91	71/FAIR	-
CB-289	3	-56.23 to -61.65	GNEISS	103	66/FAIR	-
CB-289	4	-61.65 to -65.9	GNEISS	98	33/POOR	-
CB-290	1	-45.9 to -46.9	GNEISS	50	N/A	N/A
CB-290	2	-46.9 to -51.9	GNEISS	95	85/GOOD	55/FAIR

BORING NO.	RUN NO.	ELEV*	Predominant Rock Type	Recovery (%)	RQD** (%)	RMR
CB-290	3	-51.9 to -56.9	GNEISS	100	41/POOR	-
CB-290	4	-56.9 to -61.9	GNEISS	103	80/GOOD	-
CB-290	5	-61.9 to -65.9	GNEISS	94	77/GOOD	-
CB-291	1	-45.4 to -48.4	GNEISS	77	0/VERY POOR	41/FAIR
CB-291	2	-48.4 to -53.4	GNEISS	100	40/POOR	-
CB-291	3	-53.4 to -58.4	GNEISS	100	61/FAIR	-
CB-291	4	-58.4 to -63.4	GNEISS	100	100/EXCELLENT	-
CB-291	5	-63.4 to -65.4	GNEISS	100	67/FAIR	-
CB-292	1	-48.7 to -52	GNEISS	95	24/VERY POOR	42/FAIR
CB-292	2	-52 to -57.2	GNEISS	100	80/GOOD	-
CB-292	3	-57.2 to -62.2	GNEISS	90	86/GOOD	-
CB-292	4	-62.2 to -66.2	GNEISS	108	100/EXCELLENT	-
CB-293	1	-64.1 to -69.1	GNEISS	93	80/GOOD	-
CB-294	1	-44.0 to -46.17	GNEISS	100	34/POOR	49/FAIR
CB-294	2	-46.17 to -51.17	GNEISS	100	40/POOR	-
CB-294	3	-51.17 to -56.17	GNEISS	100	75/GOOD	-
CB-294	4	-56.17 to -61.17	GNEISS	100	85/GOOD	-
CB-294	5	-61.17 to -64.17	GNEISS	86	47/POOR	-
CB-295	1	-47.3 to -52.3	GNEISS	100	65/FAIR	54/FAIR
CB-295	2	-52.3 to -57.3	GNEISS	98	66/FAIR	-
CB-295	3	-57.3 to -62.3	GNEISS	100	100/EXCELLENT	-
CB-295	4	-62.3 to -65.3	GNEISS	100	86/GOOD	-
CB-296	1	-49.87 to -53.2	GNEISS	78	0/VERY POOR	-
CB-296	2	-53.2 to -58.2	GNEISS	95	35/POOR	-
CB-296	3	-58.2 to -63.2	GNEISS	100	63/FAIR	-
CB-296	4	-63.2 to -65.2	GNEISS	100	67/FAIR	-
CB-297	1	-46.1 to -48.43	GNEISS	96	18/VERY POOR	41/FAIR
CB-297	2	-48.43 to -53.43	GNEISS	50	12/VERY POOR	-
CB-297	3	-53.43 to -58.43	GNEISS	96	46/POOR	-
CB-297	4	-58.43 to -66.43	GNEISS	100	91/EXCELLENT	-
CB-298	1	-56.85 to -59.1	GNEISS	100	70/FAIR	-
CB-298	2	-59.1 to -64.1	GNEISS	55	33/POOR	-
CB-298	3	-64.1 to -66.1	GNEISS	75	75/GOOD	
CB-299	1	-58.5 to -60.5	GNEISS	62	0/VERY POOR	-
CB-299	2	-60.5 to -65.5	GNEISS	100	81/GOOD	-
CB-299	3	-65.5 to -68.5	GNEISS	100	78/GOOD	-
CB-300	1	-42.7 to -47.2	GNEISS	94	70/FAIR	50/FAIR
CB-300	2	-47.2 to -52.2	GNEISS	96	65/FAIR	-
CB-300	3	-52.2 to -57.2	GNEISS	100	100/EXCELLENT	-
CB-300	4	-57.2 to -62.2	GNEISS	100	100/EXCELLENT	-
CB-300	5	-62.2 to -63.2	GNEISS	100	100/EXCELLENT	-
CB-301	1	-48.4 to -51.9	GNEISS	93	64/FAIR	56/FAIR
CB-301	2	-51.9 to -56.9	GNEISS	100	100/EXCELLENT	-
CB-301	3	-56.9 to -61.9	GNEISS	93	66/FAIR	-
CB-301	4	-61.9 to -65.9	GNEISS	98	93/EXCELLENT	-
CB-302	1	-44.4 to -48.9	GNEISS	94	70/FAIR	49/FAIR

BORING NO.	RUN NO.	ELEV*	Predominant Rock Type	Recovery (%)	RQD** (%)	RMR
CB-302	2	-48.9 to -53.9	GNEISS	100	76/GOOD	-
CB-302	3	-53.9 to -58.9	GNEISS	100	76/GOOD	-
CB-302	4	-58.9 to -63.9	GNEISS	100	86/EXCELLENT	-
CB-302	5	-63.9 to -64.9	GNEISS	100	100/EXCELLENT	-
CB-303	1	-46.7 to -49.0	GNEISS	93	32/POOR	48/FAIR
CB-303	2	-49.0 to -54.0	GNEISS	100	33/POOR	-
CB-303	3	-54.0 to -59.0	GNEISS	100	81/GOOD	-
CB-303	4	-59.0 to -64.0	GNEISS	100	88/GOOD	-
CB-303	5	-64.0 to -66.5	GNEISS	100	86/GOOD	-
CB-304	1	-47.2 to -49.7	GNEISS	100	90/EXCELLENT	52/FAIR
CB-304	2	-49.7 to -54.7	GNEISS	83	50/FAIR	-
CB-304	3	-54.7 to -59.7	GNEISS	100	73/FAIR	-
CB-304	4	-59.7 to -64.7	GNEISS	96	48/POOR	-
CB-304	5	-64.7 to -67.7	GNEISS	100	66/FAIR	-
CB-305	NO BEDROCK ENCOUNTERED					
CB-306	1	-50.6 to -54.1	GNEISS	5	0/VERY POOR	-
CB-306	2	-54.1 to -59.1	GNEISS	96	51/FAIR	-
CB-306	3	-59.1 to -64.1	GNEISS	98	92/EXCELLENT	-
CB-306	4	-64.1 to -65.1	GNEISS	100	0/VERY POOR	-
CB-307	1	-44.4 to -46.9	GNEISS	40	0/VERY POOR	46/FAIR
CB-307	2	-47.4 to -52.4	GNEISS	100	93/EXCELLENT	-
CB-307	3	-52.4 to -57.4	GNEISS	100	90/EXCELLENT	-
CB-307	4	-57.4 to -62.4	GNEISS	100	96/EXCELLENT	-
CB-307	5	-62.4 to -64.9	GNEISS	100	100/EXCELLENT	-
CB-308	NO BEDROCK ENCOUNTERED					

*Datum: Mean Lower Low Water (MLLW)
**RQD is defined as the sum of the recovered intact and sound pieces of rock core having a length of 4 inches or greater divided by the total length of the run, expressed as a percentage.

RQD	Classification of Rock Quality
0 – 25 %	Very Poor
25 – 50 %	Poor
50 – 75 %	Fair
75 – 90 %	Good
90 – 100%	Excellent

RMR	Classification of RMR
<20	Class V – Very Poor Rock
21 – 40	Class IV – Poor Rock
41 – 60	Class III – Fair Rock
61 – 80	Class II – Good Rock
81 – 100	Class I – Very Good Rock

6. CONCLUSIONS

The dredging template for this rock removal project is anticipated to be -47 feet MLLW, meaning that all materials will be required to be 100 percent clear to this elevation based on a post-dredging survey. In addition to a variety of sediments and unconsolidated materials, rock materials will be encountered during dredging operations. Based on the bottom elevations established at the boring locations, rock was encountered at elevations up to approximately 5 feet above the proposed dredging template line, but could be present at higher elevations in unexplored areas. In order to establish the anticipated dredging template, the contractor will inherently encounter materials consisting of both soil and rock at elevations below -47 feet MLLW. Based on the results of this geotechnical exploration, the rock materials encountered above and below the proposed dredging template of 47 feet below MLLW generally consist of gneiss of highly variable rock quality ranging from very poor to excellent. As such, the rippability or mechanical dredgeability is expected to vary significantly along the reach of channel covered by this project.

6.1. COMMON ROCK DREDGING METHODS

Various equipment and methods of underwater rock excavation and mechanical pre-treatment are available. The most common methods include the barge-mounted backhoe, the dipper (power shovel), and suction cutter dredges. These direct dredging methods typically break up or cut the rock and remove it to the surface simultaneously. Other mechanical pre-treatment methods which only break the rock into manageable pieces for later removal include the backhoe bucket-mounted ripper tooth, drag picks, and crushing with a heavy chisel or punch that is dropped onto the rock surface; however, mechanical pre-treatment is rarely performed for navigation projects such as this.

6.2. RIPPABILITY EVALUATION

Mechanical dredgeability or underwater rippability of rock is defined as the ability to excavate rock underwater with respect to the characteristics of the material, type of equipment, and methods of excavation. Rippability of rock is highly dependent on contractor means and methods, and the ultimate determination of whether or not the rock will be rippable is left to the contractor. This report focuses on presenting the data gathered from the rock cores and laboratory testing and applying the data to established rating systems for use as a qualitative index of the relative difficulty of rock ripping. Given the many factors affecting the rippability of rock, it should be understood that the conclusions presented herein are not intended to dictate with any certainty what rock will be rippable. The contractor should use his own experience along with the all of the data included this report to make his own judgment regarding the rippability of the rock.

6.2.1. Rock Mass Rating Systems

As presented in Section 5 of this report, the Rock Mass Rating (RMR) system was used as one index of the rock quality and can be used to provide a qualitative index of the anticipated difficulty of rippability; however, it should be understood that the RMR system was not specifically designed for rippability evaluation. Based on the RMR data, it should be expected that ripping will be moderately difficult to difficult at the majority of the rock outcrop areas explored. The rock encountered at Borings CB-288, CB-289, CB-290, and CB-304 is anticipated to be very difficult to rip and will likely require blasting to loosen the rock prior to removal.

Weaver (1975) developed a rippability rating (RR) system based on similar weighted rock mass parameters and added seimic velocity, joint continuity, and weathering parameters. Greater weighting is applied to the joint spacing parameter given its significant influence on rippability. The Weaver RR for the upper core runs is provided in Table 6.1 below based on the available data and our interpretation of the parameters. In addition, the table includes the correlated seismic velocity. The percent recovery and RQD data is provided for comparison to the resulting RR.

Table 6.1: Weaver Rippability Rating Summary

BORING NO.	RUN NO.	ELEV*	Recovery (%)	RQD (%)	RR	CORRELATED SEISMIC VELOCITY (fps)
CB-287	1	-47.1 to -51.43	65	46/POOR	43	5,400
CB-288	1	-42.8 to -47.8	98	98/EXCELLENT	46	6,000
CB-289	1	-49.4 to -51.6	66	40/POOR	45	6,000
CB-290	2	-46.9 to -51.9	95	85/GOOD	45	6,000
CB-291	1	-45.4 to -48.4	77	0/VERY POOR	40	5,300
CB-294	1	-44.0 to -46.17	100	34/POOR	40	5,300
CB-295	1	-47.3 to -52.3	100	65/FAIR	40	5,300
CB-297	1	-46.1 to -48.43	96	18/VERY POOR	40	5,300
CB-300	1	-42.7 to -47.2	94	70/FAIR	35	5,100
CB-301	1	-48.4 to -51.9	93	64/FAIR	36	5,100
CB-302	1	-44.4 to -48.9	94	70/FAIR	35	5,100
CB-303	1	-46.7 to -49.0	93	32/POOR	40	5,300
CB-304	1	-47.2 to -49.7	100	90/EXCELLENT	36	5,100
CB-307	1	-44.4 to -46.9	40	0/VERY POOR	46	6,000

*Datum: Mean Lower Low Water (MLLW)

RR	**Descriptive Classification**
<21	Very Poor Rock
22 – 43	Poor Rock
44 – 59	Fair Rock
60 – 74	Good Rock
75 – 100	Very Good Rock

Based on Weaver's RR, the correlated seismic velocity, and the Caterpillar Tractor bulldozer ripping charts, the upper rock is shown to be rippable by a Caterpillar D8 bulldozer or larger, equipped with a hydraulic ripping shank. Based on correspondence from consultants working in the metamorphic rocks of the Atlantic Piedmont Province, which was published in an ASCE Geotechnical Special Publication entitled *Foundations and Excavations in Decomposed Rock of the Piedmont Province* (1987), a seismic velocity of 6000 fps is considered the typical transition point from ripping to blasting for land based applications using tractor drawn ripping shanks. The above table is not intended to state whether or not the rock will be rippable, but provides a qualitative index of rock mass conditions for use along with the other data presented in this report and correlation to the contractor's own experience working in materials of similar properties.

6.2.2. Summary of Rippability

In our evaluation of rippability, several rock mass rating systems were applied as detailed above. Each of the rating systems incorporates the conditions observed in the rock cores and lab test data such as fracture spacing, compressive strength, weathering, and fracture orientation. Based on the laboratory strength tests, the majority of the rock tested is strong to very strong, which will make mechanical breaking of intact rock very difficult. For this reason, joint spacing becomes a very important parameter in evaluation of rippability, as more closely spaced joints in the rock will make ripping easier. Examination of the cores at the 10 boring locations where rock lies above the proposed dredge line elevation of -47 feet MLLW indicates that fracture spacing ranges from very slightly fractured as observed in CB-288 and CB-304, moderately fractured in CB-290, CB-294, CB-300, CB-302, and CB-303, and intensely fractured in CB-291, CB-297, and CB-307.

7. REFERENCES

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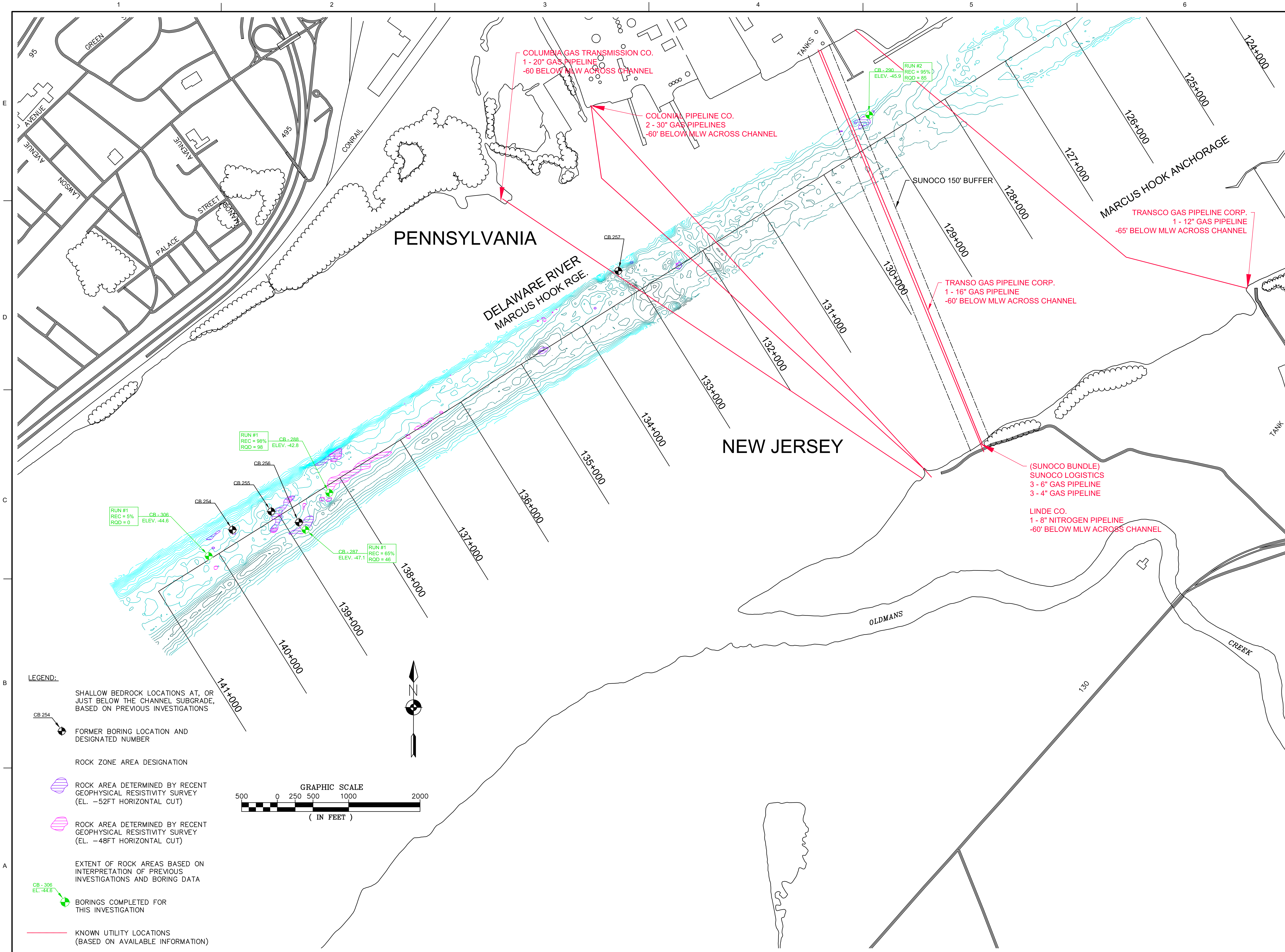
Figures



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0	DRAFT FINAL SUBMISSION	07/09/10					

DESIGNED BY:		DATE: 07/09/2010
DWN BY: RGB	CKD BY: DDW	SOLICITATION NO.:
SUBMITTED BY: THOMAS NOWLAN		CONTRACT NO.: W912BU-10-D-0001
PLOT SCALE: 1=1	PLOT DATE: 08/09/10	FILE NUMBER:
SIZE: ANSI F	FILE NAME: 46126-F001.DWG	

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DELAWARE RIVER DEEPENING

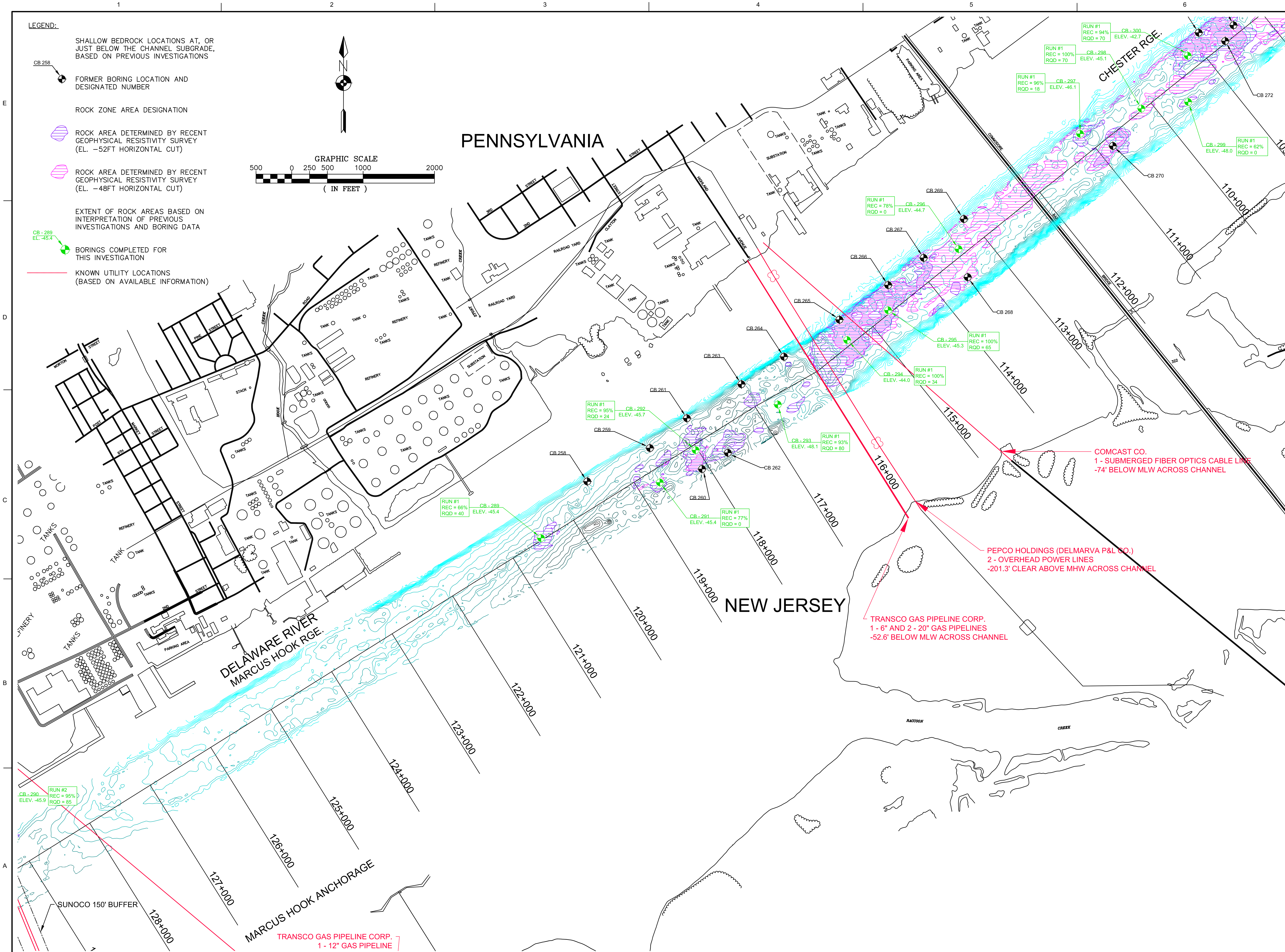
BORING LOCATION PLAN

STA. 141+000 TO STA. 128+000

SHEET IDENTIFICATION

FIGURE-1

SHEET 1 OF 7



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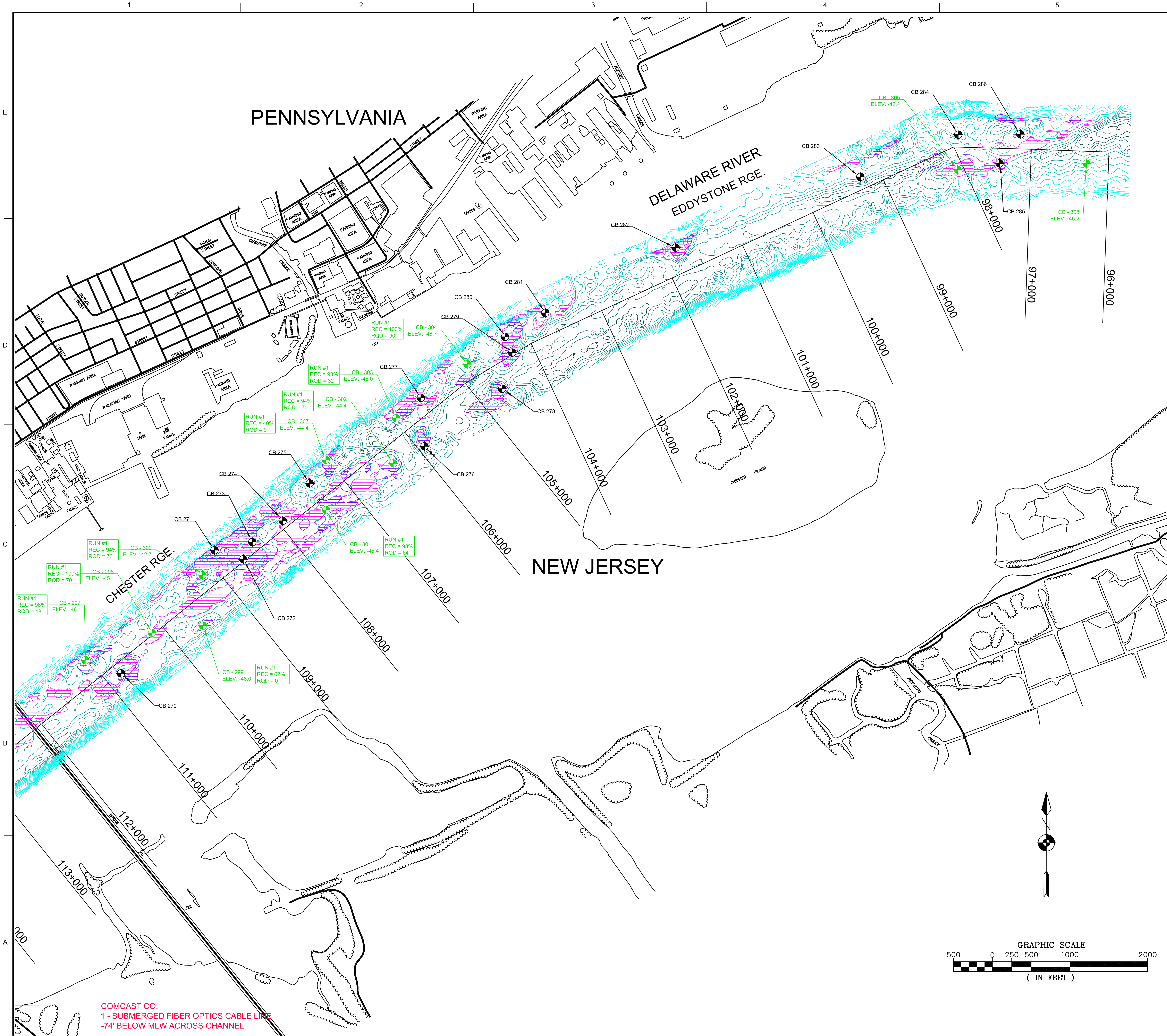
DELAWARE RIVER DEEPENING

BORING LOCATION PLAN

STA. 128+000 TO STA. 112+000

SHEET IDENTIFICATION
FIGURE-2
SHEET 2 OF 7



LEGEND:

SHALLOW BEDROCK LOCATIONS AT, OR JUST BELOW THE CHANNEL SUBGRADE, BASED ON PREVIOUS INVESTIGATIONS

CB 286 — FORMER BORING LOCATION AND DESIGNATED NUMBER

ROCK ZONE AREA DESIGNATION

ROCK AREA DETERMINED BY RECENT GEOPHYSICAL RESISTIVITY SURVEY (EL. −52FT HORIZONTAL CUT)

ROCK AREA DETERMINED BY RECENT GEOPHYSICAL RESISTIVITY SURVEY (EL. −48FT HORIZONTAL CUT)

EXTENT OF ROCK AREAS BASED ON INTERPRETATION OF PREVIOUS INVESTIGATIONS AND BORING DATA

CB - 308 EL. -45.2 — BORINGS COMPLETED FOR THIS INVESTIGATION

KNOWN UTILITY LOCATIONS (BASED ON AVAILABLE INFORMATION)

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SUBMITTED BY: THOMAS NOWLAN		CONTRACT NO.: W912BU-10-D-0001
PLOT SCALE: 1=1	PLOT DATE: 08/09/2010	FILE NUMBER:
SIZE: ANSI F	FILE NAME: 46126-F001.DWG	

DELAWARE RIVER DEEPENING

BORING LOCATION PLAN

STA. 112+000 TO STA. 96+000

SHEET IDENTIFICATION
FIGURE-3
SHEET 3 OF 7

Appendices

Appendix A

Boring and Rock Core Logs

UNIFIED SOIL CLASSIFICATION SYSTEM - ASTM D2488

MAJOR DIVISION			GROUP SYMBOL	LETTER SYMBOL	GROUP NAME
COARSE GRAINED SOILS CONTAINS MORE THAN 50% FINES	**GRAVEL AND GRAVELLY SOILS** MORE THAN 50% OF COARSE FRACTION RETAINED ON NO. 4 SIEVE	GRAVEL WITH * 5% FINES		GW	Well-graded GRAVEL
				GP	Poorly graded GRAVEL
		GRAVEL WITH BETWEEN 5% AND 15% FINES		GW-GM	Well-graded GRAVEL with silt
				GW-GC	Well-graded GRAVEL with clay
				GP-GM	Poorly graded GRAVEL with silt
				GP-GC	Poorly graded GRAVEL with clay
		GRAVEL WITH ≥ 15% FINES		GM	Silty GRAVEL
				GC	Clayey GRAVEL
	SAND AND SANDY SOILS MORE THAN 50% OF COARSE FRACTION PASSING ON NO. 4 SIEVE	SAND WITH * 5% FINES		SW	Well-graded SAND
				SP	Poorly graded SAND
		SAND WITH BETWEEN 5% AND 15% FINES		SW-SM	Well-graded SAND with silt
				SW-SC	Well-graded SAND with clay
				SP-SM	Poorly graded SAND with silt
				SP-SC	Poorly graded SAND with clay
		SAND WITH ≥ 15% FINES		SM	Silty SAND
				SC	Clayey SAND
FINE GRAINED SOILS CONTAINS MORE THAN 50% FINES	SILT AND CLAY	LIQUID LIMIT LESS THAN 50		ML	Inorganic SILT with low plasticity
				CL	Lean inorganic CLAY with low plasticity
				OL	Organic SILT with low plasticity
		LIQUID LIMIT GREATER THAN 50		MH	Elastic inorganic SILT with moderate to high plasticity
				CH	Fat inorganic CLAY with moderate to high plasticity
				OH	Organic SILT or CLAY with moderate to high plasticity
HIGHLY ORGANIC SOILS				PT	PEAT soils with high organic contents

NOTES:

1) Sample descriptions are based on visual field and laboratory observations using classification methods of ASTM D2488. Where laboratory data are available, classifications are in accordance with ASTM D2487.

2) Solid lines between soil descriptions indicate change in interpreted geologic unit. Dashed lines indicate stratigraphic change within the unit.

3) Fines are material passing the U.S. Std. #200 Sieve.

Hole No. CB-287

DRILLING LOG	DIVISION North Atlantic	INSTALLATION Philadelphia District	SHEET 1 OF 1 SHEETS

1. PROJECT Geotechnical Inv. of Rock Cut Areas	10. SIZE AND TYPE OF BIT HQ Diamond Bit
2. LOCATION (Coordinates or Station) STA. 138 + 800 N 348,466.7 E 223,737.2	11. DATUM FOR ELEVATION SHOWN *(TBM or MSL)* MLLW
3. DRILLING AGENCY Uni-Tech Drilling Co., Inc	12. MANUFACTURER'S DESIGNATION OF DRILL CME-750
4. HOLE NO. *(As shown on drawing title and file number)* CB-287	13. TOTAL NO. OF OVERBURDEN SAMPLES TAKEN: DISTURBED 0; UNDISTURBED 0
5. NAME OF DRILLER Jim Evans	14. TOTAL NUMBER CORE BOXES 3
6. DIRECTION OF HOLE ☒ VERTICAL ☐ INCLINED --- DEG. FROM VERT.	15. ELEVATION GROUND WATER 0.0
	16. DATE HOLE: STARTED 6/3/2010; COMPLETED 6/3/2010
7. THICKNESS OF OVERBURDEN 0.0	17. ELEVATION TOP OF HOLE -47.1
8. DEPTH DRILLED INTO ROCK 20.3	18. TOTAL CORE RECOVERY FOR BORING 92 %
9. TOTAL DEPTH OF HOLE 20.3	19. GEOLOGIST Steve Scott

ELEVATION a	DEPTH b	LEGEND c	CLASSIFICATION OF MATERIALS (Description) d	% CORE RECOVERY e	BOX OR SAMPLE NO. f	REMARKS *(Drilling time, water loss, depth weathering, etc., if significant)* g
-47.1	0.0		BEDROCK - See Core Log CB-287			
-67.4	20.3					
			Boring Terminated at 20.33 ft. below river bottom.			

O'BRIEN & GERE

ROCK CORE LOG

TEST HOLE No. **CB-287**

Project **Geotechnical Inv. of Rock Cut Areas**

Location **N348,835.000/E225,092.300**

Elevation **-47.10ft**

Driller **Jim Evans**

Method **HQ Diamond Drill**

Dates **6/3/10**

Hole Orientation **Vertical**

Logged By **SRS**

Date **6/3/10**

Drilling Details: HQ Diamond Impregnated; HQ

Coring Started at 0ft

Depth (ft)	Core Recovery (%)	Core Condition	Discontinuity Spacing	R.Q.D. (%)	Intact Rock Strength (psi)	Weathering	Structural Discontinuity Description	Unconf. Comp. Strength (ksi)	Rock Mass Description	Tests
0–4.3	65	Intensely Fractured - Moderately Fractured	Multiple	46	R5	MW - SW	Intensely fractured to 1.3 ft.; MB, 45°; MB, 15°; MB, 5 °	22.7	RUN #1: GNEISS, fine grained, occaissional coarse grained, no foliation, gray, black, white, green, phaneritic, intensely fractured to 1.3 ft then moderately to slightly weathered, moderately hard	
4.3–9.3	100	Slightly Fractured	2	100		F	MB, horiz.; MB, 45°; MB, 15°		RUN #2: GNEISS, fine grained, occaissional coarse grained, no foliation, gray, black, white, green, phaneritic, fresh, hard, slightly fractured	
9.3–14.3	98	Slightly Fractured	0	93		F	MB, 15°; MB, 5°; MB, 5°; MB, horiz.		RUN #3: Same as RUN #2	
14.3–	100	Slightly Fractured	0	100		F			RUN #4: Same as RUN #2	

CORE RECOVERY

$\frac{\text{Length of core}}{\text{core run}} \times 100$

R.Q.D.

$\frac{\text{Sum core lengths > 4 in.}}{\text{length of core run}} \times 100$

DISCONTINUITY SPACING
No. of fractures/Run

ROCK STRENGTH (ksi)	
R0 Extremely weak	<0.15
R1 Very weak	0.15 - 0.7
R2 Weak	0.7 - 3.5
R3 Medium strong	3.5 - 7.0
R4 Strong	7.0 -14.5
R5 Very strong	14.5 - 30.0
R6 Extremely strong	>30.0

WEATHERING	
F	Fresh
SW	Slightly
MW	Moderately
HW	Highly
CW	Completely
RS	Residual Soil

FILE No. **46126**

PREPARED By: **DDW**

O'BRIEN & GERE

ROCK CORE LOG

TEST HOLE No. **CB-287**

Project **Geotechnical Inv. of Rock Cut Areas**
Location **N348,835.000/E225,092.300** Elevation **-47.10ft**
Driller **Jim Evans** Method **HQ Diamond Drill** Dates **6/3/10**
Hole Orientation **Vertical** Logged By **SRS** Date **6/3/10**

Drilling Details	Depth (ft)	Core Recovery (%)	Core Condition	Discontinuity Spacing	R.Q.D. (%)	Intact Rock Strength (psi)	Weathering	Structural Discontinuity Description	Unconf. Comp. Strength (ksi)	Rock Mass Description	Tests
HQ	19							MB, horiz.		RUN #4: Same as RUN #2 *(continued)*	
	20	100	Unfractured	0	100		F	MB, horiz.		RUN #5: Same as RUN # 2	
										Boring Terminated at 20.3 ft.	
	21										
	22										
	23										
	24										
	25										
	26										
	27										
	28										
	29										
	30										
	31										
	32										
	33										
	34										
	35										

CORE RECOVERY

$\frac{\text{Length of core}}{\text{core run}} \times 100$

R.Q.D.

$\frac{\text{Sum core lengths > 4 in.}}{\text{length of core run}} \times 100$

DISCONTINUITY SPACING
No. of fractures/Run

ROCK STRENGTH (ksi)
R0 Extremely weak <0.15
R1 Very weak 0.15 - 0.7
R2 Weak 0.7 - 3.5
R3 Medium strong 3.5 - 7.0
R4 Strong 7.0 -14.5
R5 Very strong 14.5 - 30.0
R6 Extremely strong >30.0

WEATHERING
F Fresh
SW Slightly
MW Moderately
HW Highly
CW Completely
RS Residual Soil

FILE No. **46126**
PREPARED By: **DDW**

Hole No. CB-288

DRILLING LOG	DIVISION North Atlantic	INSTALLATION Philadelphia District	SHEET 1 OF 1 SHEETS

1. PROJECT Geotechnical Inv. of Rock Cut Areas	10. SIZE AND TYPE OF BIT HQ Diamond Bit
2. LOCATION (Coordinates or Station) STA. 138 + 200 N 349,351.7 E 225,426.5	11. DATUM FOR ELEVATION SHOWN *(TBM or MSL)* MLLW
3. DRILLING AGENCY Uni-Tech Drilling Co., Inc	12. MANUFACTURER'S DESIGNATION OF DRILL CME-750
4. HOLE NO. *(As shown on drawing title and file number)* CB-288	13. TOTAL NO. OF OVERBURDEN SAMPLES TAKEN — DISTURBED 0 — UNDISTURBED 0
5. NAME OF DRILLER Jim Evans	14. TOTAL NUMBER CORE BOXES 2
6. DIRECTION OF HOLE ☒ VERTICAL ☐ INCLINED --- DEG. FROM VERT.	15. ELEVATION GROUND WATER 0.0
	16. DATE HOLE — STARTED 6/3/2010 — COMPLETED 6/3/2010
7. THICKNESS OF OVERBURDEN 0.0	17. ELEVATION TOP OF HOLE -42.8
8. DEPTH DRILLED INTO ROCK 20.0	18. TOTAL CORE RECOVERY FOR BORING 70 %
9. TOTAL DEPTH OF HOLE 20.0	19. GEOLOGIST Steve Scott

ELEVATION a	DEPTH b	LEGEND c	CLASSIFICATION OF MATERIALS (Description) d	% CORE RECOVERY e	BOX OR SAMPLE NO. f	REMARKS *(Drilling time, water loss, depth weathering, etc., if significant)* g
-42.8	0.0		BEDROCK - See Core Log CB-288			
-47.0	4.2					
-62.8	20.0					
			Boring Terminated at 20 ft. below river bottom.			

ENG FORM 1836 MAR 71 PREVIOUS EDITIONS ARE OBSOLETE. PROJECT Geotechnical Inv. of Rock Cut Areas HOLE NO. CB-288

O'BRIEN & GERE

ROCK CORE LOG

TEST HOLE No. **CB-288**

Project **Geotechnical Inv. of Rock Cut Areas**
Location **N349,351.700/E225,426.500**
Elevation **-42.80ft**
Driller **Jim Evans**
Method **HQ Diamond Drill**
Dates **6/3/10**
Hole Orientation **Vertical**
Logged By **SRS**
Date **6/3/10**

Drilling Details	Depth (ft)	Core Recovery (%)	Core Condition	Discontinuity Spacing	R.Q.D. (%)	Intact Rock Strength (psi)	Weathering	Structural Discontinuity Description	Unconf. Comp. Strength (ksi)	Rock Mass Description (Coring Started at 0ft)	Tests
HQ Diamond Impregnated; HQ	0-5	98	V. Slightly Fractured	1	98	R5; R5	F	MB; Joint, 15°	22.6,25.9	RUN #1: GNEISS, mafic, fine grained, foliation absent, gray, blue, black, green, white, phaneritic, fresh, hard, v. sl. fractured, iron staining	
	5-10	65	Slightly Fractured; Intensely Fractured	2	35		MW - HW	Joint, horiz.; Intensely Fractured		RUN #2: Same as RUN #1 except (5-6.75') slightly fractured and (6.75-10') mod. weathered, hard to mod. hard, intensely fractured Driller reports drill string drop from 8.5' to 9.5'	
	10-15	51	Slightly Fractured; Decomposed	3	13		MW - CW	Broken Joint, 45°; MB, horiz.; MB, horiz.; MB, horiz.; Intensely Fractured; Joint, 45°		RUN #3: (10-11.5') GNEISS, fine-grained, foliation absent, gray, blue, black, green, white, phaneritic, mod. weathered, mod. soft, sl. to mod. fractured (11.5-14.75') becomes decomposed Saprolitic GNEISS to 14.8', very soft (14.75-15') becomes moderately weathered, moderately soft	
	15-	83	Slightly Fractured	4	70		SW			RUN #4: GNEISS, fine-grained, foliation is absent, gray, blue, black, green, white, phaneritic, mod. weathered, mod. soft, sl. fractured	

CORE RECOVERY
$\frac{\text{Length of core}}{\text{core run}} \times 100$

R.Q.D.
$\frac{\text{Sum core lengths > 4 in.}}{\text{length of core run}} \times 100$

DISCONTINUITY SPACING
No. of fractures/Run

ROCK STRENGTH (ksi)
R0 Extremely weak <0.15
R1 Very weak 0.15 - 0.7
R2 Weak 0.7 - 3.5
R3 Medium strong 3.5 - 7.0
R4 Strong 7.0 -14.5
R5 Very strong 14.5 - 30.0
R6 Extremely strong >30.0

WEATHERING
F Fresh
SW Slightly
MW Moderately
HW Highly
CW Completely
RS Residual Soil

FILE No. **46126**
PREPARED By: **DDW**

O'BRIEN & GERE

ROCK CORE LOG

TEST HOLE No. **CB-288**

Project **Geotechnical Inv. of Rock Cut Areas**
Location **N349,351.700/E225,426.500** Elevation **-42.80ft**
Driller **Jim Evans** Method **HQ Diamond Drill** Dates **6/3/10**
Hole Orientation **Vertical** Logged By **SRS** Date **6/3/10**

Drilling Details	Depth (ft)	Core Recovery (%)	Core Condition	Discontinuity Spacing	R.Q.D. (%)	Intact Rock Strength (psi)	Weathering	Structural Discontinuity Description	Unconf. Comp. Strength (ksi)	Rock Mass Description	Tests
HQ	19										
	20									Boring Terminated at 20 ft.	
	21										
	22										
	23										
	24										
	25										
	26										
	27										
	28										
	29										
	30										
	31										
	32										
	33										
	34										
	35										

CORE RECOVERY

$\frac{\text{Length of core}}{\text{core run}} \times 100$

R.Q.D.

$\frac{\text{Sum core lengths > 4 in.}}{\text{length of core run}} \times 100$

DISCONTINUITY SPACING
No. of fractures/Run

ROCK STRENGTH (ksi)

R0 Extremely weak	<0.15
R1 Very weak	0.15 - 0.7
R2 Weak	0.7 - 3.5
R3 Medium strong	3.5 - 7.0
R4 Strong	7.0 -14.5
R5 Very strong	14.5 - 30.0
R6 Extremely strong	>30.0

WEATHERING

F	Fresh
SW	Slightly
MW	Moderately
HW	Highly
CW	Completely
RS	Residual Soil

FILE No. **46126**

PREPARED By: **DDW**

DRILLING LOG	DIVISION North Atlantic	INSTALLATION Philadelphia District	SHEET 1 OF 1 SHEETS

1. PROJECT Geotechnical Inv. of Rock Cut Areas	10. SIZE AND TYPE OF BIT 6" Tri-Cone / HQ Diamond Bit
2. LOCATION (Coordinates or Station) STA. N/A N 358,865.1 E 240,375.4	11. DATUM FOR ELEVATION SHOWN *(TBM or MSL)* MLLW
3. DRILLING AGENCY Uni-Tech Drilling Co., Inc	12. MANUFACTURER'S DESIGNATION OF DRILL CME-750
4. HOLE NO. *(As shown on drawing title and file number)* CB-289	13. TOTAL NO. OF OVERBURDEN SAMPLES TAKEN: DISTURBED 2; UNDISTURBED 0
5. NAME OF DRILLER Jim Evans	14. TOTAL NUMBER CORE BOXES 2
6. DIRECTION OF HOLE ☒ VERTICAL ☐ INCLINED --- DEG. FROM VERT.	15. ELEVATION GROUND WATER 0.0
	16. DATE HOLE: STARTED 6/7/2010; COMPLETED 6/7/2010
7. THICKNESS OF OVERBURDEN 4.0	17. ELEVATION TOP OF HOLE -45.4
8. DEPTH DRILLED INTO ROCK 16.5	18. TOTAL CORE RECOVERY FOR BORING 93 %
9. TOTAL DEPTH OF HOLE 20.5	19. GEOLOGIST Steve Scott

ELEVATION a	DEPTH b	LEGEND c	CLASSIFICATION OF MATERIALS (Description) d	% CORE RECOV-ERY e	BOX OR SAMPLE NO. f	REMARKS *(Drilling time, water loss, depth weathering, etc., if significant)* g
-45.4	0.0		FAT CLAY (CH), wet, very soft, dark gray silt, organic odor	50	S-1 0.0 2.0	WOH/24"
-47.0	1.6					
-47.9	2.5			100	S-2 2.0 2.9	17-100/5"
-49.4	4.0		Poorly-graded GRAVEL with silt and coarse sand (GP-GM), wet, very dense, dark gray, quartz and quartzite gravel			
			BEDROCK - See Core Log CB-289			NOTE: DRIVE SAMPLING OF SOILS WAS COMPLETED PER ASTM D3550 USING A 300-LB. HAMMER AND 30-INCH FALL TO DRIVE A 3-IN. O.D. SPLIT BARREL SAMPLER. THE N-VALUE REPORTED ON THE LOGS IS NOT EQUIVALENT TO THE STANDARD PENETRATION TEST N-VALUE PER ASTM D1586.
-65.9	20.5					
			Boring Terminated at 20.5 ft. below river bottom.			

O'BRIEN & GERE

ROCK CORE LOG

TEST HOLE No.
CB-289

Project	**Geotechnical Inv. of Rock Cut Areas**				
Location	**N358,865.100/E240,375.400**			Elevation	**-45.40ft**
Driller	**Jim Evans**	Method	**HQ Diamond Drill**	Dates	**6/7/10**
Hole Orientation	**Vertical**	Logged By	**SRS**	Date	**6/7/10**

Drilling Details	Depth (ft)	Core Recovery (%)	Core Condition	Discontinuity Spacing	R.Q.D. (%)	Intact Rock Strength (psi)	Weathering	Structural Discontinuity Description	Unconf. Comp. Strength (ksi)	Rock Mass Description	Tests
HQ Diamond Impregnated HQ	5 6	66	Moderately Fractured	2	40	R5	F	Joint, 15° Joint, 15° MB, 15° MB, 10°	15.2	Coring Started at 4ft RUN #1: GNEISS, fine-grained, foliation absent, white, black, gray, phaneritic, fresh, hard, moderately fractured; quartz, biotite, trace garnet; fracture surfaces have sl. weathering and secondary mineralization	
	7 8 9 10 11	91	Moderately Fractured	6	71	R5	F	Joint, horiz. MB, 20 ° Joint, 5 ° Joint, 15° Joint, 10 ° Joint, 10°, with 75° fracture to 11.25'	17.1	RUN #2: Same as RUN #1	
	12 13 14 15 16	103	Moderately Fractured	4	66		F	MB, horiz. MB, 60° to horiz. MB, 5° MB, 15° Joint, 15° with connected vertical fracture to 15' Joint, horiz. Joint, 10°		RUN #3: Same as RUN #1	
	17 18 19 20	98	Moderately Fractured - Intensely Fractured	8	33		F - MW	Joint, 75° to 16.5' MB, horiz.; near vert. fracture extends to 17.6' MB, horiz. MB, horiz. MB, horiz. Joint, horiz. Joint, 65 ° Joints and MB's at 1 inch spacing to 20.5 ft.		RUN #4: Same as RUN #1, except moderately to intensely fractured	
	21									Boring Terminated at 20.5 ft.	

CORE RECOVERY

$$\frac{\text{Length of core}}{\text{core run}} \times 100$$

R.Q.D.

$$\frac{\text{Sum core lengths > 4 in.}}{\text{length of core run}} \times 100$$

DISCONTINUITY SPACING
No. of fractures/Run

ROCK STRENGTH (ksi)	
R0 Extremely weak	<0.15
R1 Very weak	0.15 - 0.7
R2 Weak	0.7 - 3.5
R3 Medium strong	3.5 - 7.0
R4 Strong	7.0 -14.5
R5 Very strong	14.5 - 30.0
R6 Extremely strong	>30.0

WEATHERING	
F	Fresh
SW	Slightly
MW	Moderately
HW	Highly
CW	Completely
RS	Residual Soil

FILE No. **46126**

PREPARED By: **DDW**

Hole No. CB-290

DRILLING LOG	DIVISION North Atlantic	INSTALLATION Philadelphia District	SHEET 1 OF 1 SHEETS

1. PROJECT Geotechnical Inv. of Rock Cut Areas	10. SIZE AND TYPE OF BIT HQ Diamond Bit
2. LOCATION (Coordinates or Station) STA. N 354,645.7 E 232,933.0	11. DATUM FOR ELEVATION SHOWN *(TBM or MSL)* MLLW
3. DRILLING AGENCY Uni-Tech Drilling Co., Inc	12. MANUFACTURER'S DESIGNATION OF DRILL CME-750
4. HOLE NO. *(As shown on drawing title and file number)* CB-290	13. TOTAL NO. OF OVERBURDEN SAMPLES TAKEN: DISTURBED 0; UNDISTURBED 0
5. NAME OF DRILLER Jim Evans	14. TOTAL NUMBER CORE BOXES 2
6. DIRECTION OF HOLE ☒ VERTICAL ☐ INCLINED --- DEG. FROM VERT.	15. ELEVATION GROUND WATER 0.0
	16. DATE HOLE: STARTED 6/8/2010; COMPLETED 6/8/2010
7. THICKNESS OF OVERBURDEN 1.0	17. ELEVATION TOP OF HOLE -45.9
8. DEPTH DRILLED INTO ROCK 19.0	18. TOTAL CORE RECOVERY FOR BORING 98 %
9. TOTAL DEPTH OF HOLE 20.0	19. GEOLOGIST Steve Scott

ELEVATION a	DEPTH b	LEGEND c	CLASSIFICATION OF MATERIALS (Description) d	% CORE RECOVERY e	BOX OR SAMPLE NO. f	REMARKS *(Drilling time, water loss, depth weathering, etc., if significant)* g
-45.9	0.0		BEDROCK - See Core Log CB-290			
-47.0	1.1					
-65.9	20.0					
			Boring terminated at 20 ft. below river bottom.			

O'BRIEN & GERE

ROCK CORE LOG

TEST HOLE No. **CB-290**

Project **Geotechnical Inv. of Rock Cut Areas**
Location **N345,645.700/E232,993.000** Elevation **-45.90ft**
Driller **Jim Evans** Method **HQ Diamond Drill** Dates **6/8/10**
Hole Orientation **Vertical** Logged By **SRS** Date **6/8/10**

Drilling Details	Depth (ft)	Core Recovery (%)	Core Condition	Discontinuity Spacing	R.Q.D. (%)	Intact Rock Strength (psi)	Weathering	Structural Discontinuity Description	Unconf. Comp. Strength (ksi)	Rock Mass Description	Tests
										Coring Started at 0ft	
HQ Diamond Impregnated / HQ	0–1	50	Cobbles		0		F - SW	Multiple joints, 70°		RUN #1: Mixed lithology, cobbles overlying bedrock	
	1–6	95	Moderately Fractured	8	85	R3 R6	F - SW	Joint, 60° Joint, 70° Joint, 60° Joints, 45° and 70°; MB, 45°	6.6 to 31.3	RUN #2: GNEISS, fine grained, black, white, gray, phaneritic, f. to sl. weathered, hard, mod. fractured; fracture surfaces are sl. to mod. weathered and contain secondary mineralization; closed fractures contain secondary mineralization	
	6–11	100	Moderately Fractured - Intensely Fractured	10	41	R4	F - SW	Joint, 30° Joint, 5° Joint, 20° Joint, 30° MB, 20° limbs Joint, 45° Joint, 75° Joint, 60° Multiple intersecting joints, 70° and 75° Joint, 5° Joint, 5°	8.5	RUN #3: Same as Run #2, except pegmatitic from 5 to 7 ft and intensely fractured from 8 to 11.5 ft	
	11–16	103	Intensely Fractured - Moderately Fractured	4	80		F - SW	Broken bedrock to 11.4', 75° Joint, 60° MB, 60° Joint, 35° MB, 15° MB, 5° Joint, 30° MB, 5°		RUN #4: Same as Run #2, except aphanitic	
	16–		Moderately					MB, 15°		RUN #5: Same as Run #2, except aphanitic	

CORE RECOVERY

$\frac{\text{Length of core}}{\text{core run}} \times 100$

R.Q.D.

$\frac{\text{Sum core lengths > 4 in.}}{\text{length of core run}} \times 100$

DISCONTINUITY SPACING
No. of fractures/Run

ROCK STRENGTH (ksi)

R0	Extremely weak	<0.15
R1	Very weak	0.15 - 0.7
R2	Weak	0.7 - 3.5
R3	Medium strong	3.5 - 7.0
R4	Strong	7.0 -14.5
R5	Very strong	14.5 - 30.0
R6	Extremely strong	>30.0

WEATHERING

F	Fresh
SW	Slightly
MW	Moderately
HW	Highly
CW	Completely
RS	Residual Soil

FILE No. **46126**

PREPARED By: **DDW**

O'BRIEN & GERE

ROCK CORE LOG

TEST HOLE No. **CB-290**

Project **Geotechnical Inv. of Rock Cut Areas**
Location **N345,645.700/E232,993.000** Elevation **-45.90ft**
Driller **Jim Evans** Method **HQ Diamond Drill** Dates **6/8/10**
Hole Orientation **Vertical** Logged By **SRS** Date **6/8/10**

Drilling Details	Depth (ft)	Core Recovery (%)	Core Condition	Discontinuity Spacing	R.Q.D. (%)	Intact Rock Strength (psi)	Weathering	Structural Discontinuity Description	Unconf. Comp. Strength (ksi)	Rock Mass Description	Tests
HQ	19	94	Fractured	3	77		F - SW	Joint, 65° MB, 5° Joint, 75° MB, 5°		RUN #5: Same as Run #2, except aphanitic *(continued)*	
	20									Boring Terminated at 20 ft.	
	21										
	22										
	23										
	24										
	25										
	26										
	27										
	28										
	29										
	30										
	31										
	32										
	33										
	34										
	35										

CORE RECOVERY

$\frac{\text{Length of core}}{\text{core run}} \times 100$

DISCONTINUITY SPACING
No. of fractures/Run

R.Q.D.

$\frac{\text{Sum core lengths > 4 in.}}{\text{length of core run}} \times 100$

ROCK STRENGTH (ksi)
R0 Extremely weak <0.15
R1 Very weak 0.15 - 0.7
R2 Weak 0.7 - 3.5
R3 Medium strong 3.5 - 7.0
R4 Strong 7.0 -14.5
R5 Very strong 14.5 - 30.0
R6 Extremely strong >30.0

WEATHERING
F Fresh
SW Slightly
MW Moderately
HW Highly
CW Completely
RS Residual Soil

FILE No. **46126**
PREPARED By: **DDW**

Hole No. CB-291

DRILLING LOG	DIVISION North Atlantic	INSTALLATION Philadelphia District	SHEET 1 OF 1 SHEETS

1. PROJECT Geotechnical Inv. of Rock Cut Areas	10. SIZE AND TYPE OF BIT HQ Diamond Bit
2. LOCATION (Coordinates or Station) STA. 118 + 800 N 359,644.3 E 242,040.5	11. DATUM FOR ELEVATION SHOWN *(TBM or MSL)* MLLW
3. DRILLING AGENCY Uni-Tech Drilling Co., Inc	12. MANUFACTURER'S DESIGNATION OF DRILL CME-750
4. HOLE NO. *(As shown on drawing title and file number)* CB-291	13. TOTAL NO. OF OVERBURDEN SAMPLES TAKEN — DISTURBED 0 — UNDISTURBED 0
5. NAME OF DRILLER Jim Evans	14. TOTAL NUMBER CORE BOXES 2
6. DIRECTION OF HOLE ☒ VERTICAL ☐ INCLINED --- DEG. FROM VERT.	15. ELEVATION GROUND WATER 0.0
	16. DATE HOLE — STARTED 6/2/2010 — COMPLETED 6/2/2010
7. THICKNESS OF OVERBURDEN 0.0	17. ELEVATION TOP OF HOLE -45.4
8. DEPTH DRILLED INTO ROCK 20.0	18. TOTAL CORE RECOVERY FOR BORING 96 %
9. TOTAL DEPTH OF HOLE 20.0	19. GEOLOGIST Steve Scott

ELEVATION a	DEPTH b	LEGEND c	CLASSIFICATION OF MATERIALS (Description) d	% CORE RECOVERY e	BOX OR SAMPLE NO. f	REMARKS *(Drilling time, water loss, depth weathering, etc., if significant)* g
-45.4	0.0		BEDROCK - See Core Log CB-291			
-47.0	1.6					
-65.4	20.0					
			Boring Terminated at 20 ft. below river bottom.			

ENG FORM 1836 MAR 71 PREVIOUS EDITIONS ARE OBSOLETE. PROJECT Geotechnical Inv. of Rock Cut Areas HOLE NO. CB-291

O'BRIEN & GERE

ROCK CORE LOG

TEST HOLE No. **CB-291**

Project **Geotechnical Inv. of Rock Cut Areas**
Location **N359,644.300/E242,040.500**
Elevation **-45.40ft**
Driller **Jim Evans**
Method **HQ Diamond Drill**
Dates **6/2/10**
Hole Orientation **Vertical**
Logged By **SRS**
Date **6/2/10**

Drilling Details	Depth (ft)	Core Recovery (%)	Core Condition	Discontinuity Spacing	R.Q.D. (%)	Intact Rock Strength (psi)	Weathering	Structural Discontinuity Description	Unconf. Comp. Strength (ksi)	Rock Mass Description	Tests
HQ Diamond Impregnated; HQ	0–3	77	Intensely Fractured	4	0		SW	Intensely fractured zone to 3'; Joint, 75°; Joint, 75°; Joint, 75°; Joint, 15°; MB, 75°		Coring Started at 0ft. RUN #1: GNEISS, fine grained, 75° foliation, white, black, gray, phaneritic, sl. weathered, mod. hard, intensely fractured; fractured surfaces sl. to mod. weathering	
	3–8	100	Moderately Fractured - Intensely Fractured	6	40	R4	SW	Joint, 75°; Multiple joints to 4.5', 60°; MB, 60°; Joint, 75°; Joint, 75°; Joint, 75°; Joint, 75°	11.5	RUN #2: Same as Run #1, except mod. to intensely fractured with pegmatite (plagioclase, muscovite, biotite, quartz) on 60° angle, sub-orthoganol to foliation from 6.17 to 6.5	
	8–13	100	Slightly Fractured	5	61		SW	Joint, 60°; MB, 55°; Joint, 55°; Multiple joints to 11.5', 75°; MB, 60°		RUN #3: Same as Run #2, except slightly fractured	
	13–18	100	Unfractured	0	100		SW			RUN #4: Same as Run #2, except unfractured	

CORE RECOVERY: $\frac{\text{Length of core}}{\text{core run}} \times 100$

R.Q.D.: $\frac{\text{Sum core lengths} > 4\text{ in.}}{\text{length of core run}} \times 100$

DISCONTINUITY SPACING
No. of fractures/Run

ROCK STRENGTH (ksi)
R0 Extremely weak <0.15
R1 Very weak 0.15 - 0.7
R2 Weak 0.7 - 3.5
R3 Medium strong 3.5 - 7.0
R4 Strong 7.0 -14.5
R5 Very strong 14.5 - 30.0
R6 Extremely strong >30.0

WEATHERING
F Fresh
SW Slightly
MW Moderately
HW Highly
CW Completely
RS Residual Soil

FILE No. **46126**
PREPARED By: **DDW**

O'BRIEN & GERE

ROCK CORE LOG

TEST HOLE No. **CB-291**

Project **Geotechnical Inv. of Rock Cut Areas**

Location **N359,644.300/E242,040.500**

Elevation **-45.40ft**

Driller **Jim Evans** Method **HQ Diamond Drill** Dates **6/2/10**

Hole Orientation **Vertical** Logged By **SRS** Date **6/2/10**

Drilling Details	Depth (ft)	Core Recovery (%)	Core Condition	Discontinuity Spacing	R.Q.D. (%)	Intact Rock Strength (psi)	Weathering	Structural Discontinuity Description	Unconf. Comp. Strength (ksi)	Rock Mass Description	Tests
HQ	19	100	Slightly Fractured	1	67		SW	MB, 20° MB, 45° MB, 45° Joint, horiz.		RUN #5: Same as Run #2, except slightly fractured	
	20									Boring Terminated at 20 ft.	
	21										
	22										
	23										
	24										
	25										
	26										
	27										
	28										
	29										
	30										
	31										
	32										
	33										
	34										
	35										

CORE RECOVERY

$\frac{\text{Length of core}}{\text{core run}} \times 100$

R.Q.D.

$\frac{\text{Sum core lengths > 4 in.}}{\text{length of core run}} \times 100$

DISCONTINUITY SPACING
No. of fractures/Run

ROCK STRENGTH (ksi)

R0 Extremely weak	<0.15
R1 Very weak	0.15 - 0.7
R2 Weak	0.7 - 3.5
R3 Medium strong	3.5 - 7.0
R4 Strong	7.0 -14.5
R5 Very strong	14.5 - 30.0
R6 Extremely strong	>30.0

WEATHERING

F	Fresh
SW	Slightly
MW	Moderately
HW	Highly
CW	Completely
RS	Residual Soil

FILE No. **46126**

PREPARED By: **DDW**

Hole No. CB-292

DRILLING LOG	DIVISION North Atlantic	INSTALLATION Philadelphia District	SHEET 1 OF 1 SHEETS

1. PROJECT Geotechnical Inv. of Rock Cut Areas	10. SIZE AND TYPE OF BIT 6" Tri-Cone / HQ Diamond Bit
2. LOCATION (Coordinates or Station) STA. 118 + 000 N 360,097.6 E 242,541.6	11. DATUM FOR ELEVATION SHOWN *(TBM or MSL)* MLLW
3. DRILLING AGENCY Uni-Tech Drilling Co., Inc	12. MANUFACTURER'S DESIGNATION OF DRILL CME-750
4. HOLE NO. *(As shown on drawing title and file number)* CB-292	13. TOTAL NO. OF OVERBURDEN SAMPLES TAKEN: DISTURBED 2; UNDISTURBED 0
5. NAME OF DRILLER Jim Evans	14. TOTAL NUMBER CORE BOXES 2
6. DIRECTION OF HOLE ☒ VERTICAL ☐ INCLINED --- DEG. FROM VERT.	15. ELEVATION GROUND WATER 0.0
7. THICKNESS OF OVERBURDEN 3.0	16. DATE HOLE STARTED 6/2/2010 COMPLETED 6/2/2010
8. DEPTH DRILLED INTO ROCK 17.5	17. ELEVATION TOP OF HOLE -45.7
9. TOTAL DEPTH OF HOLE 20.5	18. TOTAL CORE RECOVERY FOR BORING 98 %
	19. GEOLOGIST Steve Scott

ELEVATION a	DEPTH b	LEGEND c	CLASSIFICATION OF MATERIALS (Description) d	% CORE RECOVERY e	BOX OR SAMPLE NO. f	REMARKS *(Drilling time, water loss, depth weathering, etc., if significant)* g
-45.7	0.0		Poor-graded GRAVEL with silt and sand (GP-GM), wet, very dense, dark gray, fine to coarse grained gravel, some fine to coarse sand	67	S-1 0.0 2.0	26-32-19-38 N = 51
-47.0	1.3					
				100	S-2 2.0 2.8	18-100/4"
-48.5	2.8		BEDROCK - See Core Log CB-292			NOTE: DRIVE SAMPLING OF SOILS WAS COMPLETED PER ASTM D3550 USING A 300-LB. HAMMER AND 30-INCH FALL TO DRIVE A 3-IN. O.D. SPLIT BARREL SAMPLER. THE N-VALUE REPORTED ON THE LOGS IS NOT EQUIVALENT TO THE STANDARD PENETRATION TEST N-VALUE PER ASTM D1586.
-66.2	20.5		Boring Terminated at 20.5 ft. below river bottom.			

O'BRIEN & GERE

ROCK CORE LOG

TEST HOLE No. **CB-292**

Project	**Geotechnical Inv. of Rock Cut Areas**		
Location	**N360,097.600/E242,541.600**	Elevation	**-45.70ft**
Driller	**Jim Evans**	Method	**HQ Diamond Drill**
Dates	**6/2/10**		
Hole Orientation	**Vertical**	Logged By	**SRS**
Date	**6/2/10**		

Drilling Details: HQ Diamond Impregnated — HQ

Coring Started at 3ft

Depth (ft)	Core Recovery (%)	Core Condition	Discontinuity Spacing	R.Q.D. (%)	Intact Rock Strength (psi)	Weathering	Unconf. Comp. Strength (ksi)	Tests
3 – 6.5	95	Moderately Fractured - Intensely Fractured	10	24		SW		
6.5 – 11.5	100	Moderately Fractured - Intensely Fractured; Unfractured	6	80		SW - F		
11.5 – 16.5	90	Unfractured	0	86		F		
16.5 – 20.5	108	Unfractured	0	100		F		

Structural Discontinuity Description

- Broken to 3.25'
- Joint, 10°
- Joint, 30°
- MB, 45°
- Joint, 5°
- Joint, 5°
- MB, horiz.
- Multiple joints to 4.92', 30°
- Joint, 30°
- MB, 75° with connected MB, 80° to 6'
- MB, 5° to 6.17'
- Joint, 10°
- 15°
- Joint, 30°
- Joint, 45°
- MB, 30°
- Joint, 60° with connected joint, horiz. to 9.083'
- MB, horiz.
- Multiple MB to 11.67', horiz. and 90°
- MB, 15°
- MB, 5°
- MB, 45°
- MB, horiz.
- MB, 25° with connected MB, horiz. to 16.25
- MB, horiz.
- MB, horiz.
- MB, 10°

Rock Mass Description

RUN #1: GNEISS, fine grained, 40° foliation, white, black, gray, phaneritic, sl. weathering, mod. hard, mod. to intensely fractured; fractured surfaces are sl. weathered, iron staining present

RUN #2: Same as RUN #1, except high angle foliation, fresh, hard, unfractured

Boring Terminated at 20.5 ft.

CORE RECOVERY

$\frac{\text{Length of core}}{\text{core run}} \times 100$

R.Q.D.

$\frac{\text{Sum core lengths > 4 in.}}{\text{length of core run}} \times 100$

DISCONTINUITY SPACING
No. of fractures/Run

ROCK STRENGTH (ksi)		
R0	Extremely weak	<0.15
R1	Very weak	0.15 - 0.7
R2	Weak	0.7 - 3.5
R3	Medium strong	3.5 - 7.0
R4	Strong	7.0 -14.5
R5	Very strong	14.5 - 30.0
R6	Extremely strong	>30.0

WEATHERING	
F	Fresh
SW	Slightly
MW	Moderately
HW	Highly
CW	Completely
RS	Residual Soil

FILE No. **46126**

PREPARED By: **DDW**

DRILLING LOG	DIVISION North Atlantic	INSTALLATION Philadelphia District	SHEET 1 OF 1 SHEETS

1. PROJECT Geotechnical Inv. of Rock Cut Areas	10. SIZE AND TYPE OF BIT 6" Tri-Cone / HQ Diamond Bit
2. LOCATION (Coordinates or Station) STA. 116 + 700 N 360,735.4 E 243,693.6	11. DATUM FOR ELEVATION SHOWN *(TBM or MSL)* MLLW
3. DRILLING AGENCY Uni-Tech Drilling Co., Inc	12. MANUFACTURER'S DESIGNATION OF DRILL CME-750
4. HOLE NO. *(As shown on drawing title and file number)* CB-293	13. TOTAL NO. OF OVERBURDEN SAMPLES TAKEN: DISTURBED 8; UNDISTURBED 0
5. NAME OF DRILLER Jim Evans	14. TOTAL NUMBER CORE BOXES 1
6. DIRECTION OF HOLE ☒ VERTICAL ☐ INCLINED --- DEG. FROM VERT.	15. ELEVATION GROUND WATER 0.0
7. THICKNESS OF OVERBURDEN 16.0	16. DATE HOLE: STARTED 5/27/2010; COMPLETED 5/27/2010
8. DEPTH DRILLED INTO ROCK 5.0	17. ELEVATION TOP OF HOLE -48.1
9. TOTAL DEPTH OF HOLE 21.0	18. TOTAL CORE RECOVERY FOR BORING 93 %
	19. GEOLOGIST Steve Scott

ELEVATION a	DEPTH b	LEGEND c	CLASSIFICATION OF MATERIALS (Description) d	% CORE RECOV-ERY e	BOX OR SAMPLE NO. f	REMARKS *(Drilling time, water loss, depth weathering, etc., if significant)* g
-48.1	0.0		Elastic SILT with sand (MH), wet, very soft, very dark brown (10YR 2/1) silt with little peat varving, little fine sand increasing percentages with depth	100	S-1 0.0 2.0	WOH/24" N = WOH
				100	S-2 2.0 4.0	WOH/18" - 17 N = WOH
-52.1	4.0					
			Well-graded GRAVEL with silt and sand (GW-GM), wet, medium dense, dark gray (10YR 4/1) gravel (fine to coarse sub-rounded, sub-angular, mixed lithology) with some fine to coarse, sub-rounded sand and little silt	75	S-3 4.0 6.0	20-15-14-15 N = 29
			with cobbles	71	S-4 6.0 8.0	12-13-14-11 N = 27
				92	S-5 8.0 10.0	12-8-9-11 N = 17
-58.1	10.0					
			Well-graded GRAVEL with sand (GW), wet, medium dense, dark gray (10YR 4/1) gravel (fine to coarse, sub-rounded, sub-angular, mixed lithology) with some fine to coarse, sub-rounded sand and trace silt	46	S-6 10.0 12.0	5-7-8-6 N = 15
				33	S-7 12.0 14.0	4-5-5-8 N = 10
			with cobbles	100	S-8 14.0 15.6	4-6-38-50/1" N = 44
-63.7	15.6					
			BEDROCK - See Core Log CB-293			NOTE: DRIVE SAMPLING OF SOILS WAS COMPLETED PER ASTM D3550 USING A 300-LB. HAMMER AND 30-INCH FALL TO DRIVE A 3-IN. O.D. SPLIT BARREL SAMPLER. THE N-VALUE REPORTED ON THE LOGS IS NOT EQUIVALENT TO THE STANDARD PENETRATION TEST N-VALUE PER ASTM D1586.
-69.1	21.0					
			Boring Terminated at 21 ft. below river bottom.			

O'BRIEN & GERE

ROCK CORE LOG

TEST HOLE No. **CB-293**

Project **Geotechnical Inv. of Rock Cut Areas**
Location **N360,736.400/E243,693.600** Elevation **-48.10ft**
Driller **Jim Evans** Method **HQ Diamond Drill** Dates **5/27/10**
Hole Orientation **Vertical** Logged By **SRS** Date **5/27/10**

Drilling Details	Depth (ft)	Core Recovery (%)	Core Condition	Discontinuity Spacing	R.Q.D. (%)	Intact Rock Strength (psi)	Weathering	Structural Discontinuity Description	Unconf. Comp. Strength (ksi)	Rock Mass Description	Tests
										Coring Started at 16ft	
HQ Diamond Impregnated; HQ	17							Joint, 60° with horiz. MB at 17.4' and horiz. joint at 17.7'		RUN #1: GNEISS, fine grained, 62° foliation, black, white, gray, phaneritic, fresh, hard, sl. fractured; biotite, quartz, muscovite; fracture surfaces are sl. weathered	
	18	93	Slightly Fractured	3	80		F				
	19							MB, horiz. Joint, horiz.			
	20										
	21									Boring terminated at 21 ft.	
	22										
	23										
	24										
	25										
	26										
	27										
	28										
	29										
	30										
	31										
	32										
	33										

CORE RECOVERY

$\frac{\text{Length of core}}{\text{core run}} \times 100$

R.Q.D.

$\frac{\text{Sum core lengths > 4 in.}}{\text{length of core run}} \times 100$

DISCONTINUITY SPACING
No. of fractures/Run

ROCK STRENGTH (ksi)

R0 Extremely weak	<0.15
R1 Very weak	0.15 - 0.7
R2 Weak	0.7 - 3.5
R3 Medium strong	3.5 - 7.0
R4 Strong	7.0 -14.5
R5 Very strong	14.5 - 30.0
R6 Extremely strong	>30.0

WEATHERING

F	Fresh
SW	Slightly
MW	Moderately
HW	Highly
CW	Completely
RS	Residual Soil

FILE No. **46126**

PREPARED By: **DDW**

Hole No. CB-294

DRILLING LOG	DIVISION North Atlantic	INSTALLATION Philadelphia District	SHEET 1 OF 1 SHEETS

1. PROJECT Geotechnical Inv. of Rock Cut Areas	10. SIZE AND TYPE OF BIT HQ Diamond Bit
2. LOCATION (Coordinates or Station) STA. 115 + 400 N 361,639.5 E 244,665.5	11. DATUM FOR ELEVATION SHOWN *(TBM or MSL)* MLLW
3. DRILLING AGENCY Uni-Tech Drilling Co., Inc	12. MANUFACTURER'S DESIGNATION OF DRILL CME-750
4. HOLE NO. *(As shown on drawing title and file number)* CB-294	13. TOTAL NO. OF OVERBURDEN SAMPLES TAKEN: DISTURBED 0; UNDISTURBED 0
5. NAME OF DRILLER Jim Evans	14. TOTAL NUMBER CORE BOXES 3
6. DIRECTION OF HOLE ☒ VERTICAL ☐ INCLINED --- DEG. FROM VERT.	15. ELEVATION GROUND WATER 0.0
7. THICKNESS OF OVERBURDEN 0.0	16. DATE HOLE: STARTED 5/27/2010; COMPLETED 5/27/2010
8. DEPTH DRILLED INTO ROCK 20.2	17. ELEVATION TOP OF HOLE -44.0
9. TOTAL DEPTH OF HOLE 20.2	18. TOTAL CORE RECOVERY FOR BORING 98 %
	19. GEOLOGIST Steve Scott

ELEVATION a	DEPTH b	LEGEND c	CLASSIFICATION OF MATERIALS (Description) d	% CORE RECOVERY e	BOX OR SAMPLE NO. f	REMARKS *(Drilling time, water loss, depth weathering, etc., if significant)* g
-44.0	0.0		BEDROCK - See Core Log CB-294			
-47.0	3.0					
-64.2	20.2					
			Boring Terminated at 20.17 ft. below river bottom.			

O'BRIEN & GERE

ROCK CORE LOG

TEST HOLE No.
CB-294

Project	Geotechnical Inv. of Rock Cut Areas				
Location	N361,639.500/E244,665.500			Elevation	-44.00ft
Driller	Jim Evans	Method	HQ Diamond Drill	Dates	5/27/10
Hole Orientation	Vertical	Logged By	SRS	Date	5/27/10

Drilling Details: HQ Diamond Impregnated; HQ

Coring Started at 0ft

Depth (ft)	Core Recovery (%)	Core Condition	Discontinuity Spacing	R.Q.D. (%)	Intact Rock Strength (psi)	Weathering	Structural Discontinuity Description	Unconf. Comp. Strength (ksi)	Rock Mass Description	Tests
0 – 2	100	Moderately Fractured	3	34		F - SW	Joint, horiz. with 55°, joint to 0.6' MB, 55° MB, 55° Joint, horiz. MB, 35° Joint, 40°		RUN #1: GNEISS, fine grained, 60° foliation, black, white, fresh to sl. weathered, mod. hard, mod. fractured; fracture surfaces are sl. to mod. weathered	
2 – 7	100	Moderately Fractured	6	40	R4 R4	F - SW	MB, 75° MB, 40° MB, 20° MB, 60° Multiple MB's to 4, 60° to 35° MB, 45° Joint, 45° Joint, 5° MB, 75° MB, 45° MB, horiz. Joint, 35°	10.0,13.1	RUN #2: GNEISS, Same as Run #1; fracture surface at 5' is intensely weathered	
7 – 12	100	Slightly Fractured	2	75		F - SW	MB, 25° Joint, horiz. MB, 50° MB, 50° MB, 35° MB, 35° MB, 50° Joint, 58° MB, 5 °		RUN #3: GNEISS, Same as Run #1, except slightly fractured	
12 – 17	100	Slightly Fractured	3	85		F - SW	MB, 5° MB, 45° Joint, 60° Joint, 45° Joint, horiz. MB, horiz.		RUN #4: GNEISS, Same as Run #3	
17 –							Multiple MBs to 17.9', horiz. to 5°		RUN #5: GNEISS, Same as Run #3, except	

CORE RECOVERY

$$\frac{\text{Length of core}}{\text{core run}} \times 100$$

R.Q.D.

$$\frac{\text{Sum core lengths > 4 in.}}{\text{length of core run}} \times 100$$

DISCONTINUITY SPACING
No. of fractures/Run

ROCK STRENGTH (ksi)	
R0 Extremely weak	<0.15
R1 Very weak	0.15 - 0.7
R2 Weak	0.7 - 3.5
R3 Medium strong	3.5 - 7.0
R4 Strong	7.0 -14.5
R5 Very strong	14.5 - 30.0
R6 Extremely strong	>30.0

WEATHERING	
F	Fresh
SW	Slightly
MW	Moderately
HW	Highly
CW	Completely
RS	Residual Soil

FILE No. 46126

PREPARED By: DDW

O'BRIEN & GERE

ROCK CORE LOG

TEST HOLE No. **CB-294**

Project **Geotechnical Inv. of Rock Cut Areas**
Location **N361,639.500/E244,665.500** Elevation **-44.00ft**
Driller **Jim Evans** Method **HQ Diamond Drill** Dates **5/27/10**
Hole Orientation **Vertical** Logged By **SRS** Date **5/27/10**

Drilling Details	Depth (ft)	Core Recovery (%)	Core Condition	Discontinuity Spacing	R.Q.D. (%)	Intact Rock Strength (psi)	Weathering	Structural Discontinuity Description	Unconf. Comp. Strength (ksi)	Rock Mass Description	Tests
HQ	19	86	Ufractured	0	47		F - SW	MB, 60°		unfractured RUN #5: GNEISS, Same as Run #3, except unfractured *(continued)*	
	20									Boring Terminated at 20.1 ft	
	21										
	22										
	23										
	24										
	25										
	26										
	27										
	28										
	29										
	30										
	31										
	32										
	33										
	34										
	35										

CORE RECOVERY
$\frac{\text{Length of core}}{\text{core run}} \times 100$

R.Q.D.
$\frac{\text{Sum core lengths > 4 in.}}{\text{length of core run}} \times 100$

DISCONTINUITY SPACING
No. of fractures/Run

ROCK STRENGTH (ksi)	
R0 Extremely weak	<0.15
R1 Very weak	0.15 - 0.7
R2 Weak	0.7 - 3.5
R3 Medium strong	3.5 - 7.0
R4 Strong	7.0 -14.5
R5 Very strong	14.5 - 30.0
R6 Extremely strong	>30.0

WEATHERING	
F	Fresh
SW	Slightly
MW	Moderately
HW	Highly
CW	Completely
RS	Residual Soil

FILE No. **46126**
PREPARED By: **DDW**

DRILLING LOG	DIVISION North Atlantic	INSTALLATION Philadelphia District	SHEET 1 OF 1 SHEETS

1. PROJECT Geotechnical Inv. of Rock Cut Areas	10. SIZE AND TYPE OF BIT 6" Tri-Cone / HQ Diamond Bit
2. LOCATION (Coordinates or Station) STA. 114 + 700 N 362,057.4 E 245,239.0	11. DATUM FOR ELEVATION SHOWN (TBM or MSL) MLLW
3. DRILLING AGENCY Uni-Tech Drilling Co., Inc	12. MANUFACTURER'S DESIGNATION OF DRILL CME-750
4. HOLE NO. (As shown on drawing title and file number) CB-295	13. TOTAL NO. OF OVERBURDEN SAMPLES TAKEN: DISTURBED 1; UNDISTURBED 0
5. NAME OF DRILLER Jim Evans	14. TOTAL NUMBER CORE BOXES 2
6. DIRECTION OF HOLE ☒ VERTICAL ☐ INCLINED --- DEG. FROM VERT.	15. ELEVATION GROUND WATER 0.0
7. THICKNESS OF OVERBURDEN 2.0	16. DATE HOLE STARTED 5/28/2010 COMPLETED 5/28/2010
8. DEPTH DRILLED INTO ROCK 18.0	17. ELEVATION TOP OF HOLE -45.3
9. TOTAL DEPTH OF HOLE 20.0	18. TOTAL CORE RECOVERY FOR BORING 99 %
	19. GEOLOGIST Steve Scott

ELEVATION a	DEPTH b	LEGEND c	CLASSIFICATION OF MATERIALS (Description) d	% CORE RECOVERY e	BOX OR SAMPLE NO. f	REMARKS (Drilling time, water loss, depth weathering, etc., if significant) g
-45.3	0.0		Poor-graded GRAVEL with silt and sand (GP-GM), wet, medium dense, light brown gravel (fine to coarse, sub-rounded) with some fine to coarse sub-rounded sand	67	S-1 0.0 2.0	7-8-44-80 N = 52
-46.3	1.0					
-47.0	1.7		Saprolitic GNEISS, wet, very dense, black, white, gray/green, crumbles to coarse sand sized particles			
-47.3	2.0		BEDROCK - See Core Log CB-295			NOTE: DRIVE SAMPLING OF SOILS WAS COMPLETED PER ASTM D3550 USING A 300-LB. HAMMER AND 30-INCH FALL TO DRIVE A 3-IN. O.D. SPLIT BARREL SAMPLER. THE N-VALUE REPORTED ON THE LOGS IS NOT EQUIVALENT TO THE STANDARD PENETRATION TEST N-VALUE PER ASTM D1586.
-65.3	20.0					
			Boring terminated at 20 ft. below river bottom.			

O'BRIEN & GERE

ROCK CORE LOG

TEST HOLE No. **CB-295**

Project **Geotechnical Inv. of Rock Cut Areas**
Location **N362,057.400/E245,239.000**
Elevation **-45.30ft**
Driller **Jim Evans**
Method **HQ Diamond Drill**
Dates **5/28/10**
Hole Orientation **Vertical**
Logged By **SRS**
Date **5/28/10**

Drilling Details: HQ Diamond Impregnated; HQ

Coring Started at 2ft

Depth (ft)	Core Recovery (%)	Core Condition	Discontinuity Spacing	R.Q.D. (%)	Intact Rock Strength (psi)	Weathering	Structural Discontinuity Description	Unconf. Comp. Strength (ksi)	Rock Mass Description	Tests
2–7	100	Slightly Fractured	4	65	R4; R3	F	Joint, 55° MB, 60° MB, 25° MB, horiz. Joint, 5° Joint, 5° MB, 5° Joint, 60° with 30° MB to 4.7' Joint, horiz. with 20° joint to 5.2' MB, 20° MB, 5°	11.1,5.5	RUN #1: GNEISS, fine grained, 50-60° foliation, white, black, gray, phaneritic, fresh, hard, sl. fractured; primarily quartz, lesser amounts of biotite and muscovite, trace garnet; mylonitic 9-11'.	
7–12	98	Slightly Fractured	2	66		F	MB, 5° MB, 5° MB, 12° MB, 35° MB, horiz.; MB 30° MB, horiz. MB, horiz. Joint, horiz. Joint, 5°		RUN #2: Same as RUN #1	
12–17	100	Unfractured	0	100		F	MB, horiz. MB, 55° MB, 10°		RUN #3: Same as RUN #1 except unfractured	
17–20	100	Unfractured	0	86		F	MB, 50° MB, horiz. MB, 55° MB, 55° MB, 45° MB, 60° limbs		RUN #4: Same as RUN #1 except unfractured Boring Terminated at 20 ft.	

CORE RECOVERY: $\frac{\text{Length of core}}{\text{core run}} \times 100$

R.Q.D.: $\frac{\text{Sum core lengths > 4 in.}}{\text{length of core run}} \times 100$

DISCONTINUITY SPACING
No. of fractures/Run

ROCK STRENGTH (ksi)
R0 Extremely weak <0.15
R1 Very weak 0.15 - 0.7
R2 Weak 0.7 - 3.5
R3 Medium strong 3.5 - 7.0
R4 Strong 7.0 -14.5
R5 Very strong 14.5 - 30.0
R6 Extremely strong >30.0

WEATHERING
F Fresh
SW Slightly
MW Moderately
HW Highly
CW Completely
RS Residual Soil

FILE No. **46126**
PREPARED By: **DDW**

Hole No. CB-296

DRILLING LOG	DIVISION North Atlantic	INSTALLATION Philadelphia District	SHEET 1 OF 1 SHEETS

1. PROJECT Geotechnical Inv. of Rock Cut Areas	10. SIZE AND TYPE OF BIT 6" Tri-Cone / HQ Diamond Bit
2. LOCATION (Coordinates or Station) STA. 113 + 400 N 362,915.4 E 246,227.0	11. DATUM FOR ELEVATION SHOWN *(TBM or MSL)* MLLW
3. DRILLING AGENCY Uni-Tech Drilling Co., Inc	12. MANUFACTURER'S DESIGNATION OF DRILL CME-750
4. HOLE NO. *(As shown on drawing title and file number)* CB-296	13. TOTAL NO. OF OVERBURDEN SAMPLES TAKEN: DISTURBED 3; UNDISTURBED 0
5. NAME OF DRILLER Jim Evans	14. TOTAL NUMBER CORE BOXES 2
6. DIRECTION OF HOLE ☒ VERTICAL ☐ INCLINED --- DEG. FROM VERT.	15. ELEVATION GROUND WATER 0.0
	16. DATE HOLE: STARTED 5/26/2010; COMPLETED 5/26/2010
7. THICKNESS OF OVERBURDEN 5.2	17. ELEVATION TOP OF HOLE -44.7
8. DEPTH DRILLED INTO ROCK 15.3	18. TOTAL CORE RECOVERY FOR BORING 93 %
9. TOTAL DEPTH OF HOLE 20.5	19. GEOLOGIST Steve Scott

ELEVATION a	DEPTH b	LEGEND c	CLASSIFICATION OF MATERIALS (Description) d	% CORE RECOV-ERY e	BOX OR SAMPLE NO. f	REMARKS *(Drilling time, water loss, depth weathering, etc., if significant)* g
-44.7 -46.7	0.0 2.0		Poorly-graded GRAVEL with silt and sand (GP-GM), wet, very dense, medium brown gravel (fine grained to cobbles, sub-rounded, sub-angular mixed lithology), some fine to coarse sub-rounded sand, trace silt	50	S-1 0.0 2.0	12-32-70-50/1" N = 102
-47.0 -48.7	2.3 4.0		Silty, clayey SAND with gravel (SC-SM), wet, dense, medium brown gravel (fine to coarse, sub-rounded, sub-angular, mixed lithology), some silty clay	54	S-2 2.0 4.0	23-24-20-26 N = 44
-49.9	5.2		Saprolitic, mafic GNEISS, wet, very dense, black, saprolitic bedrock	100	S-3 4.0 5.2	11-70-50/2"
-65.2	20.5		BEDROCK - See Core Log CB-296			NOTE: DRIVE SAMPLING OF SOILS WAS COMPLETED PER ASTM D3550 USING A 300-LB. HAMMER AND 30-INCH FALL TO DRIVE A 3-IN. O.D. SPLIT BARREL SAMPLER. THE N-VALUE REPORTED ON THE LOGS IS NOT EQUIVALENT TO THE STANDARD PENETRATION TEST N-VALUE PER ASTM D1586.
			Boring Terminated at 20.5 ft. below river bottom.			

O'BRIEN & GERE

ROCK CORE LOG

TEST HOLE No. **CB-296**

Project **Geotechnical Inv. of Rock Cut Areas**
Location **N362,915.400/E246,227.000**
Elevation **-44.70ft**
Driller **Jim Evans**
Method **HQ Diamond Drill**
Dates **5/26/10**
Hole Orientation **Vertical**
Logged By **SRS**
Date **5/26/10**

Drilling Details	Depth (ft)	Core Recovery (%)	Core Condition	Discontinuity Spacing	R.Q.D. (%)	Intact Rock Strength (psi)	Weathering	Structural Discontinuity Description	Unconf. Comp. Strength (ksi)	Rock Mass Description	Tests
HQ Diamond Impregnated; HQ	6–8	78	Moderately Fractured	Multiple	0		SW - MW	MBs, spaced at 1-3.5" to 8.5'		Coring Started at 5.17ft RUN #1: GNEISS, fine grained, foliation absent, black, trace white, sl. to mod. weathered, mod. hard, mod. fractured, extensively mechanically broken; primarily consists of biotite - mafic gneiss; fracture surfaces are mod. weathered & contain secondary mineralization	
	9–13	95	Moderately Fractured	7	35		SW - F	MB, horiz. MB, horiz. MB, horiz. Joint, 80° MB, horiz. MB, horiz. Joint, 20° MB, horiz. Joint, 5°; joint, 60° MB, horiz. MB, 40° Joint, 30° Joint, 30° MB, horiz. MB, 15° Joint, 75°		RUN #2: Same as RUN #1, except phaneritic, 70° foliation, sl. weathered to fresh; fracture surfaces are sl. weathered and contain secondary mineralization.	
	14–18	100	Intensely Fractured Moderately Fractured	10	63		SW - F	Joint, 30° MB, 20° Multiple joints, 5° and 45° Joint, horiz. Joint, 10° Joint, 5° Joint, 5° Joint, 5° Joint, 5°		RUN #3: Same as RUN #2, except intensely fractured between 13.5-15'	
	19–20	100		2	67		SW - F	Joint, 30° MB, 10° MB, horiz. Joint, 80°		RUN #4: Same as RUN #2.	
	21–22									Boring Terminated at 20.5 ft.	

CORE RECOVERY

$\frac{\text{Length of core}}{\text{core run}} \times 100$

R.Q.D.

$\frac{\text{Sum core lengths > 4 in.}}{\text{length of core run}} \times 100$

DISCONTINUITY SPACING
No. of fractures/Run

ROCK STRENGTH (ksi)

R0	Extremely weak	<0.15
R1	Very weak	0.15 - 0.7
R2	Weak	0.7 - 3.5
R3	Medium strong	3.5 - 7.0
R4	Strong	7.0 -14.5
R5	Very strong	14.5 - 30.0
R6	Extremely strong	>30.0

WEATHERING

F	Fresh
SW	Slightly
MW	Moderately
HW	Highly
CW	Completely
RS	Residual Soil

FILE No. **46126**
PREPARED By: **DDW**

Hole No. CB-297

DRILLING LOG	DIVISION: North Atlantic	INSTALLATION: Philadelphia District	SHEET 1 OF 1 SHEETS

1. PROJECT: Geotechnical Inv. of Rock Cut Areas	10. SIZE AND TYPE OF BIT: HQ Diamond Bit
2. LOCATION (Coordinates or Station): STA. 111 + 100 N 364,530.3 E 247,929.5	11. DATUM FOR ELEVATION SHOWN (TBM or MSL): MLLW
3. DRILLING AGENCY: Uni-Tech Drilling Co., Inc	12. MANUFACTURER'S DESIGNATION OF DRILL: CME-750
4. HOLE NO. (As shown on drawing title and file number): CB-297	13. TOTAL NO. OF OVERBURDEN SAMPLES TAKEN: DISTURBED 0; UNDISTURBED 0
5. NAME OF DRILLER: Jim Evans	14. TOTAL NUMBER CORE BOXES: 2
6. DIRECTION OF HOLE: ☒ VERTICAL ☐ INCLINED --- DEG. FROM VERT.	15. ELEVATION GROUND WATER: 0.0
	16. DATE HOLE: STARTED 5/25/2010; COMPLETED 5/25/2010
7. THICKNESS OF OVERBURDEN: 0.0	17. ELEVATION TOP OF HOLE: -46.1
8. DEPTH DRILLED INTO ROCK: 20.3	18. TOTAL CORE RECOVERY FOR BORING: 86 %
9. TOTAL DEPTH OF HOLE: 20.3	19. GEOLOGIST: Steve Scott

ELEVATION a	DEPTH b	LEGEND c	CLASSIFICATION OF MATERIALS (Description) d	% CORE RECOVERY e	BOX OR SAMPLE NO. f	REMARKS (Drilling time, water loss, depth weathering, etc., if significant) g
-46.1	0.0		BEDROCK - See Core Log CB-297			
-47.0	0.9					
-66.4	20.3					
			Boring Terminated at 20.33 ft. below river bottom.			

ENG FORM 1836 MAR 71 PREVIOUS EDITIONS ARE OBSOLETE.

PROJECT: Geotechnical Inv. of Rock Cut Areas | HOLE NO. CB-297

O'BRIEN & GERE

ROCK CORE LOG

TEST HOLE No. **CB-297**

Project **Geotechnical Inv. of Rock Cut Areas**
Location **N364,530.300/E247,929.500** Elevation **-46.10ft**
Driller **Jim Evans** Method **HQ Diamond Drill** Dates **5/25/10**
Hole Orientation **Vertical** Logged By **SRS** Date **5/25/10**

Drilling Details	Depth (ft)	Core Recovery (%)	Core Condition	Discontinuity Spacing	R.Q.D. (%)	Intact Rock Strength (psi)	Weathering	Structural Discontinuity Description	Unconf. Comp. Strength (ksi)	Rock Mass Description	Tests
HQ Diamond Impregnated; HQ	0–2.33 (1, 2)	96	Intensely Fractured - Moderately Fractured	8	18	R5	F	MB, 45°; Joint, horiz.; joint, 80°; Multiple joints to 1', horiz. and 90°; Joint, 45°; Joint, 30°; Joint, horiz.	17.0	Coring Started at 0ft RUN #1: GNEISS, fine grained, foliation absent, black, whitish gray, phaneritic, fresh, hard to very hard, intensely to mod. fractured; mafic GNEISS, very little to no quartz observed, biotite, muscovite, trace garnet, pyrite present as secondary mineral	
	2.33–7.33 (3, 4, 5, 6, 7)	50	Intensely Fractured	Multiple	12		SW - MW	Intensely fractured at various spacing and angles to 7.33'		RUN #2: Same as RUN #1, except sl. to mod. weathered, mod. hard, intensely fractured throughout RUN #2; 0.5-3" fracture spacing, various angles ranging from 0-90°, mod. weathering & secondary mineralization present on fracture surfaces; biotite, muscovite, quartz	
	7.33–12.33 (8, 9, 10, 11, 12)	96	Slightly Fractured - Moderately Fractured	12	46		SW - MW	Joint, horiz.; Joint, horiz.; Joint, horiz.; MB, horiz.; MB, 40°; MB, horiz.; Joint, 5°; Joint, 30°; Multiple joints to 9.7', 25°; Joint, 5°; Joint, 30°; Joint, 20°; MB, horiz.; MB, 5°; MB, 40°; Joint, horiz.; Joint, horiz.; MB, 10°		RUN #3: Same as RUN #2, except sl. to mod. fractured & sl. weathered; (7.33-8') is mod. weathered; quartz zone on 70° orientation from 10.5-11.5'	
	12.33–17.33 (13, 14, 15, 16, 17)	100	Unfractured	0	91		F	Joint, horiz. with connected 40° MB to 13.6'; MB, 5°; MB, 30°; MB, 60°; MB, 15°		RUN #4: GNEISS, fine grained, foliation absent, black, white, gray, fresh, hard, unfractured; biotite, muscovite, quartz (1" thick quartz seams throughout RUN #3 on 70° angle)	
	17.33–									RUN #5: Same as RUN #4.	

CORE RECOVERY

$\frac{\text{Length of core}}{\text{core run}} \times 100$

R.Q.D.

$\frac{\text{Sum core lengths > 4 in.}}{\text{length of core run}} \times 100$

DISCONTINUITY SPACING
No. of fractures/Run

ROCK STRENGTH (ksi)	
R0 Extremely weak	<0.15
R1 Very weak	0.15 - 0.7
R2 Weak	0.7 - 3.5
R3 Medium strong	3.5 - 7.0
R4 Strong	7.0 -14.5
R5 Very strong	14.5 - 30.0
R6 Extremely strong	>30.0

WEATHERING	
F	Fresh
SW	Slightly
MW	Moderately
HW	Highly
CW	Completely
RS	Residual Soil

FILE No. **46126**
PREPARED By: **DDW**

O'BRIEN & GERE

ROCK CORE LOG

TEST HOLE No. **CB-297**

Project **Geotechnical Inv. of Rock Cut Areas**
Location **N364,530.300/E247,929.500**
Elevation **-46.10ft**
Driller **Jim Evans**
Method **HQ Diamond Drill**
Dates **5/25/10**
Hole Orientation **Vertical**
Logged By **SRS**
Date **5/25/10**

Drilling Details	Depth (ft)	Core Recovery (%)	Core Condition	Discontinuity Spacing	R.Q.D. (%)	Intact Rock Strength (psi)	Weathering	Structural Discontinuity Description	Unconf. Comp. Strength (ksi)	Rock Mass Description	Tests
HQ	19	100	Unfractured	0	91		F	MB, 45° MB, 45°		RUN #5: Same as RUN #4. *(continued)*	
	20							Joint, 40° Multiple joints to 20.4', horiz. and 90°			
	21									Boring Terminated at 20.4 ft.	
	22										
	23										
	24										
	25										
	26										
	27										
	28										
	29										
	30										
	31										
	32										
	33										
	34										
	35										

CORE RECOVERY

$\frac{\text{Length of core}}{\text{core run}} \times 100$

R.Q.D.

$\frac{\text{Sum core lengths > 4 in.}}{\text{length of core run}} \times 100$

DISCONTINUITY SPACING
No. of fractures/Run

ROCK STRENGTH (ksi)

R0	Extremely weak	<0.15
R1	Very weak	0.15 - 0.7
R2	Weak	0.7 - 3.5
R3	Medium strong	3.5 - 7.0
R4	Strong	7.0 -14.5
R5	Very strong	14.5 - 30.0
R6	Extremely strong	>30.0

WEATHERING

F	Fresh
SW	Slightly
MW	Moderately
HW	Highly
CW	Completely
RS	Residual Soil

FILE No. **46126**
PREPARED By: **DDW**

Hole No. CB-298

DRILLING LOG	DIVISION North Atlantic	INSTALLATION Philadelphia District	SHEET 1 OF 1 SHEETS

1. PROJECT Geotechnical Inv. of Rock Cut Areas	10. SIZE AND TYPE OF BIT 6" Tri-Cone / HQ Diamond Bit
2. LOCATION (Coordinates or Station) STA. 110 + 100 N 364,883.1 E 248,788.1	11. DATUM FOR ELEVATION SHOWN *(TBM or MSL)* MLLW
3. DRILLING AGENCY Uni-Tech Drilling Co., Inc	12. MANUFACTURER'S DESIGNATION OF DRILL CME-750
4. HOLE NO. *(As shown on drawing title and file number)* CB-298	13. TOTAL NO. OF OVERBURDEN SAMPLES TAKEN: DISTURBED 6; UNDISTURBED 0
5. NAME OF DRILLER Jim Evans	14. TOTAL NUMBER CORE BOXES 1
6. DIRECTION OF HOLE ☒ VERTICAL ☐ INCLINED --- DEG. FROM VERT.	15. ELEVATION GROUND WATER 0.0
	16. DATE HOLE STARTED 5/25/2010 COMPLETED 5/25/2010
7. THICKNESS OF OVERBURDEN 11.8	17. ELEVATION TOP OF HOLE -45.1
8. DEPTH DRILLED INTO ROCK 9.3	18. TOTAL CORE RECOVERY FOR BORING 70 %
9. TOTAL DEPTH OF HOLE 21.0	19. GEOLOGIST Steve Scott

ELEVATION a	DEPTH b	LEGEND c	CLASSIFICATION OF MATERIALS (Description) d	% CORE RECOV-ERY e	BOX OR SAMPLE NO. f	REMARKS *(Drilling time, water loss, depth weathering, etc., if significant)* g
-45.1	0.0		Well-graded GRAVEL with silt and sand (GW-GM), wet, very dense, brownish light gray gravel (fine to coarse, sub-rounded, mixed lithology) with some fine to coarse sub-rounded sand	58	S-1 0.0 2.0	8-23-38-26 N = 61
-47.0	1.9					
				100	S-2 2.0 4.0	8-19-16-28 N = 35
-48.1	3.0		Silty SAND (SM), wet, dense to very dense, medium dark gray, micaceous silty sand with trace fine to coarse sub-rounded gravel			
				100	S-3 4.0 6.0	23-24-33-11 N = 57
-51.1	6.0		Elastic SILT (MH), wet, medium dense, dark gray (10YR 4/1), clayey silt with micaceous, trace peat and fine sand varving and trace fine to coarse sub-rounded gravel of mixed lithology	50	S-4 6.0 8.0	4-5-8-8 N = 13
				42	S-5 8.0 10.0	5-7-6-8 N = 13
				76	S-6 10.0 11.8	7-11-20-50/3" N = 31
-56.1	11.0		Saprolitic GNEISS, wet, dense, quartz, biotite, muscovite, garnet, white, black, greenish gray, fine to coarse sand sized particles when crushed between fingers			
-56.9	11.8		BEDROCK - See Core Log CB-298			NOTE: DRIVE SAMPLING OF SOILS WAS COMPLETED PER ASTM D3550 USING A 300-LB. HAMMER AND 30-INCH FALL TO DRIVE A 3-IN. O.D. SPLIT BARREL SAMPLER. THE N-VALUE REPORTED ON THE LOGS IS NOT EQUIVALENT TO THE STANDARD PENETRATION TEST N-VALUE PER ASTM D1586.
-66.1	21.0		Boring Terminated at 21 ft. below river bottom.			

O'BRIEN & GERE

ROCK CORE LOG

TEST HOLE No. **CB-298**

Project **Geotechnical Inv. of Rock Cut Areas**

Location **N364,883.100/E248,788.100** Elevation **-45.10ft**

Driller **Jim Evans** Method **HQ Diamond Drill** Dates **5/25/10**

Hole Orientation **Vertical** Logged By **SRS** Date **5/25/10**

Drilling Details	Depth (ft)	Core Recovery (%)	Core Condition	Discontinuity Spacing	R.Q.D. (%)	Intact Rock Strength (psi)	Weathering	Structural Discontinuity Description	Unconf. Comp. Strength (ksi)	Rock Mass Description	Tests
										Coring Started at 11.75ft	
HQ Diamond Impregnated; HQ	12–14	100	Moderately Fractured	6	70		MW - SW	Joint, horiz.; Joint, horiz.; Joint, horiz.; Joint, 30° limbs; Joint, horiz.; Joint, 40°; MB, horiz.		RUN #1: GNEISS, fine grained, 70° foliation, white, black greenish-gray, phaneritic, mod. to sl. weathered, mod. hard, mod. fractured; quartz, biotite, muscovite, trace garnet (note smoky quartz pegmatite 11.75-11.83'); fracture surfaces are sl. to mod. weathered with secondary mineralization	
	14–19	55	Moderately Fractured - Slightly Fractured	4	33		SW	Joint, 40°; Joint, horiz.; MB, horiz.; MB, horiz.; MB, 15°; Joint, 45°; Joint, horiz.		RUN #2: GNEISS, fine grained, 80° foliation, white, black, gray, phaneritic, sl. weathered, mod. hard, mod. to sl. fractured; quartz, biotite, muscovite, trace garnet; (17-19') soft zone, not recovered in core	
	19–21	75	Unfractured	0	75		SW			RUN #3: Same as RUN #2, except unfractured.	
	21									Boring Terminated at 21 ft.	

Depth scale: 12, 13, 14, 15, 16, 17, 18, 19, 20, 21, 22, 23, 24, 25, 26, 27, 28

CORE RECOVERY

$\frac{\text{Length of core}}{\text{core run}} \times 100$

R.Q.D.

$\frac{\text{Sum core lengths > 4 in.}}{\text{length of core run}} \times 100$

DISCONTINUITY SPACING
No. of fractures/Run

ROCK STRENGTH (ksi)		
R0	Extremely weak	<0.15
R1	Very weak	0.15 - 0.7
R2	Weak	0.7 - 3.5
R3	Medium strong	3.5 - 7.0
R4	Strong	7.0 -14.5
R5	Very strong	14.5 - 30.0
R6	Extremely strong	>30.0

WEATHERING	
F	Fresh
SW	Slightly
MW	Moderately
HW	Highly
CW	Completely
RS	Residual Soil

FILE No. **46126**

PREPARED By: **DDW**

Hole No. CB-299

DRILLING LOG	DIVISION North Atlantic	INSTALLATION Philadelphia District	SHEET 1 OF 1 SHEETS

1. PROJECT Geotechnical Inv. of Rock Cut Areas	10. SIZE AND TYPE OF BIT 6" Tri-Cone / HQ Diamond Bit
2. LOCATION (Coordinates or Station) STA. 109 + 600 N 364,975.9 E 249,443.4	11. DATUM FOR ELEVATION SHOWN *(TBM or MSL)* MLLW
3. DRILLING AGENCY Uni-Tech Drilling Co., Inc	12. MANUFACTURER'S DESIGNATION OF DRILL CME-750
4. HOLE NO. *(As shown on drawing title and file number)* CB-299	13. TOTAL NO. OF OVERBURDEN SAMPLES TAKEN: DISTURBED 6; UNDISTURBED 0
5. NAME OF DRILLER Jim Evans	14. TOTAL NUMBER CORE BOXES 2
6. DIRECTION OF HOLE ☒ VERTICAL ☐ INCLINED --- DEG. FROM VERT.	15. ELEVATION GROUND WATER 0.0
	16. DATE HOLE: STARTED 5/24/2010; COMPLETED 5/24/2010
7. THICKNESS OF OVERBURDEN 10.3	17. ELEVATION TOP OF HOLE -48.0
8. DEPTH DRILLED INTO ROCK 10.2	18. TOTAL CORE RECOVERY FOR BORING 92 %
9. TOTAL DEPTH OF HOLE 20.5	19. GEOLOGIST Steve Scott

ELEVATION a	DEPTH b	LEGEND c	CLASSIFICATION OF MATERIALS (Description) d	% CORE RECOV-ERY e	BOX OR SAMPLE NO. f	REMARKS *(Drilling time, water loss, depth weathering, etc., if significant)* g
-48.0	0.0		Poorly-graded GRAVEL with silt and sand (GP-GM), wet, very dense, grayish brown gravel (fine to coarse, sub-rounded, sub-angular, mixed lithology) with some fine to coarse, sub-rounded sand and little silt Quartzite cobble in spoon tip	71	S-1 0.0 2.0	8-23-49-80 N = 72
				71	S-2 2.0 4.0	23-41-49-53 N = 90
				63	S-3 4.0 6.0	30-33-38-32 N = 71
-54.3	6.3		Well-graded SAND with gravel (SW), wet, dense, greenish dark gray, micaceous, fine to coarse sand with some sub-rounded gravel consisting of quartz and some angular gravel consiting of weathered greenish schistic gneiss	58	S-4 6.0 8.0	13-17-28-21 N = 45
-56.0	8.0		Saprolitic, foliated GNEISS, wet, medium dense, quartz, biotite, muscovite, chlorite, white, black, green, fine to coarse grained sand sized particals when crushed between fingers	67	S-5 8.0 10.0	13-9-17-28 N = 26
-58.3	10.3		BEDROCK - See Core Log CB-299	101	S-6 10.0 10.3	100/4" NOTE: DRIVE SAMPLING OF SOILS WAS COMPLETED PER ASTM D3550 USING A 300-LB. HAMMER AND 30-INCH FALL TO DRIVE A 3-IN. O.D. SPLIT BARREL SAMPLER. THE N-VALUE REPORTED ON THE LOGS IS NOT EQUIVALENT TO THE STANDARD PENETRATION TEST N-VALUE PER ASTM D1586.
-68.5	20.5		Boring Terminated at 20.5 ft. below river bottom.			

O'BRIEN & GERE

ROCK CORE LOG

TEST HOLE No. **CB-299**

Project **Geotechnical Inv. of Rock Cut Areas**
Location **N364,975.900/E249,443.400** Elevation **-48.00ft**
Driller **Jim Evans** Method **HQ Diamond Drill** Dates **5/24/10**
Hole Orientation **Vertical** Logged By **SRS** Date **5/24/10**

Drilling Details	Depth (ft)	Core Recovery (%)	Core Condition	Discontinuity Spacing	R.Q.D. (%)	Intact Rock Strength (psi)	Weathering	Structural Discontinuity Description	Unconf. Comp. Strength (ksi)	Rock Mass Description	Tests
										Coring Started at 10.5ft	
HQ Diamond Impregnated; HQ (10.5–20.5 ft)	11–12.5	62	Ufractured	0			HW - CW	MB, horiz.; MB, horiz.; MB, horiz.		RUN #1: GNEISS, fine grained, est. 70° foliation, white, black, green, phaneritic, intensely weathered to decomposed, very soft, unfractured, multiple MBs; quartz, biotite, muscovite & green mineral present	
	12.5–17.5	100	Ufractured - Slightly Fractured	2	81		SW	MB, horiz.; Joint, 15°; MB, horiz.; MB, 15°; MB, horiz.; MB, 10°; MB, 30°; Joint, horiz.; MB, horiz.		RUN #2: (12.5-13') Same as RUN #1; (13-17.5') GNEISS, fine grained, foliation not discernable, white, black, gray, light green, phaneritic, sl. weathered, mod. hard to hard, sl. Fractured; quartz, biotite, muscovite, green mineral, pyrite	
	17.5–20.5	100	Slightly Fractured	0	78		SW	MB, 20°; MB, horiz.; MB, horiz.; MB, horiz.; MB, 5°; MB, 5°; MB, 5°; MB, horiz.		RUN #3: Same as RUN #2	
	20.5									Boring Terminated at 20.5 ft.	

Depth scale: 11, 12, 13, 14, 15, 16, 17, 18, 19, 20, 21, 22, 23, 24, 25, 26, 27

CORE RECOVERY

$$\frac{\text{Length of core}}{\text{core run}} \times 100$$

R.Q.D.

$$\frac{\text{Sum core lengths > 4 in.}}{\text{length of core run}} \times 100$$

DISCONTINUITY SPACING
No. of fractures/Run

ROCK STRENGTH (ksi)	
R0 Extremely weak	<0.15
R1 Very weak	0.15 - 0.7
R2 Weak	0.7 - 3.5
R3 Medium strong	3.5 - 7.0
R4 Strong	7.0 -14.5
R5 Very strong	14.5 - 30.0
R6 Extremely strong	>30.0

WEATHERING	
F	Fresh
SW	Slightly
MW	Moderately
HW	Highly
CW	Completely
RS	Residual Soil

FILE No. **46126**
PREPARED By: **DDW**

DRILLING LOG	DIVISION North Atlantic	INSTALLATION Philadelphia District	SHEET 1 OF 1 SHEETS

1. PROJECT Geotechnical Inv. of Rock Cut Areas	10. SIZE AND TYPE OF BIT HQ Diamond Bit
2. LOCATION (Coordinates or Station) STA. 109 + 200 N 365,624.6 E 249,437.7	11. DATUM FOR ELEVATION SHOWN *(TBM or MSL)* MLLW
3. DRILLING AGENCY Uni-Tech Drilling Co., Inc	12. MANUFACTURER'S DESIGNATION OF DRILL CME-750
4. HOLE NO. *(As shown on drawing title and file number)* CB-300	13. TOTAL NO. OF OVERBURDEN SAMPLES TAKEN — DISTURBED 0 — UNDISTURBED 0
5. NAME OF DRILLER Jim Evans	14. TOTAL NUMBER CORE BOXES 2
6. DIRECTION OF HOLE ☒ VERTICAL ☐ INCLINED --- DEG. FROM VERT.	15. ELEVATION GROUND WATER 0.0
7. THICKNESS OF OVERBURDEN 0.0	16. DATE HOLE — STARTED 5/20/2010 — COMPLETED 5/20/2010
8. DEPTH DRILLED INTO ROCK 20.5	17. ELEVATION TOP OF HOLE -42.7
9. TOTAL DEPTH OF HOLE 20.5	18. TOTAL CORE RECOVERY FOR BORING 98 %
	19. GEOLOGIST Steve Scott

ELEVATION a	DEPTH b	LEGEND c	CLASSIFICATION OF MATERIALS (Description) d	% CORE RECOVERY e	BOX OR SAMPLE NO. f	REMARKS *(Drilling time, water loss, depth weathering, etc., if significant)* g
-42.7	0.0		BEDROCK - See Core Log CB-300			
-47.0	4.3					
-63.2	20.5					
			Boring Terminated at 20.5 ft. below river bottom.			

O'BRIEN & GERE

ROCK CORE LOG

TEST HOLE No. **CB-300**

Project **Geotechnical Inv. of Rock Cut Areas**
Location **N365,624.600/E249,437.700**
Elevation **-42.70ft**
Driller **Jim Evans**
Method **HQ Diamond Drill**
Dates **5/20/10**
Hole Orientation **Vertical**
Logged By **SRS**
Date **5/20/10**

Coring Started at 0ft

Drilling Details: HQ Diamond Impregnated; HQ

Depth (ft)	Core Recovery (%)	Core Condition	Discontinuity Spacing	R.Q.D. (%)	Intact Rock Strength (psi)	Weathering	Structural Discontinuity Description	Unconf. Comp. Strength (ksi)	Rock Mass Description	Tests
0–4.5	94	Moderately Fractured	7	70	R2, R3	F - SW	Joint, 10°; Joint, 56°; Joint, horiz.; Joint, horiz.; joint, 75°; Joint, horiz.; MB, 15°; MB, 30°; Joint, 5°	3.3,5.8	RUN #1: GNEISS, fine grained, 80° foliation, black, white, gray, phaneritic, fresh to sl. weathered, hard, moderately fractured; biotite & quartz are predominant; fracture surfaces are sl. weathered.	
4.5–9.5	96	Moderately Fractured	10	65		F - SW	Joint, 5°; Joint, 7°; Joint, 5; MB, horiz.; MB, 35°; Mutiple joints to 9.5', 5°		RUN #2: Same as RUN #1, except foliation is 85°, fracture zone at 9' is mod. Weathered	
9.5–14.5	100	Unfractured	0	100		F	MB, horiz.; MB, horiz.; MB, horiz.; MB, horiz.; MB, horiz.; MB, 5°; MB, 5°		RUN #3: Same as RUN #1, except foliation is 65°,fresh, unfractured	
14.5–18	100	Unfractured	0	100		F	MB, 5°; MB, 5°; MB, 10°		RUN #4: Same as RUN #3	

CORE RECOVERY: $\frac{\text{Length of core}}{\text{core run}} \times 100$

R.Q.D.: $\frac{\text{Sum core lengths > 4 in.}}{\text{length of core run}} \times 100$

DISCONTINUITY SPACING
No. of fractures/Run

ROCK STRENGTH (ksi)

R0	Extremely weak	<0.15
R1	Very weak	0.15 - 0.7
R2	Weak	0.7 - 3.5
R3	Medium strong	3.5 - 7.0
R4	Strong	7.0 -14.5
R5	Very strong	14.5 - 30.0
R6	Extremely strong	>30.0

WEATHERING

F	Fresh
SW	Slightly
MW	Moderately
HW	Highly
CW	Completely
RS	Residual Soil

FILE No. **46126**
PREPARED By: **DDW**

O'BRIEN & GERE

ROCK CORE LOG

TEST HOLE No. **CB-300**

Project **Geotechnical Inv. of Rock Cut Areas**
Location **N365,624.600/E249,437.700** Elevation **-42.70ft**
Driller **Jim Evans** Method **HQ Diamond Drill** Dates **5/20/10**
Hole Orientation **Vertical** Logged By **SRS** Date **5/20/10**

Drilling Details	Depth (ft)	Core Recovery (%)	Core Condition	Discontinuity Spacing	R.Q.D. (%)	Intact Rock Strength (psi)	Weathering	Structural Discontinuity Description	Unconf. Comp. Strength (ksi)	Rock Mass Description	Tests
HQ	19									RUN #4: Same as RUN #3 *(continued)*	
	20	100	Unfractured	0	100		F	MB, 10°		RUN #5: Same as RUN #3	
	21									Boring Terminated at 20.5 ft.	
	22										
	23										
	24										
	25										
	26										
	27										
	28										
	29										
	30										
	31										
	32										
	33										
	34										
	35										

CORE RECOVERY

$$\frac{\text{Length of core}}{\text{core run}} \times 100$$

R.Q.D.

$$\frac{\text{Sum core lengths > 4 in.}}{\text{length of core run}} \times 100$$

DISCONTINUITY SPACING
No. of fractures/Run

ROCK STRENGTH (ksi)

R0 Extremely weak	<0.15
R1 Very weak	0.15 - 0.7
R2 Weak	0.7 - 3.5
R3 Medium strong	3.5 - 7.0
R4 Strong	7.0 -14.5
R5 Very strong	14.5 - 30.0
R6 Extremely strong	>30.0

WEATHERING

F	Fresh
SW	Slightly
MW	Moderately
HW	Highly
CW	Completely
RS	Residual Soil

FILE No. **46126**
PREPARED By: **DDW**

DRILLING LOG	DIVISION North Atlantic	INSTALLATION Philadelphia District	SHEET 1 OF 1 SHEETS

1. PROJECT Geotechnical Inv. of Rock Cut Areas	10. SIZE AND TYPE OF BIT 6" Tri-Cone / HQ Diamond Bit
2. LOCATION (Coordinates or Station) STA. 107 + 400 N 366,464.7 E 251,030.2	11. DATUM FOR ELEVATION SHOWN (TBM or MSL) MLLW
3. DRILLING AGENCY Uni-Tech Drilling Co., Inc	12. MANUFACTURER'S DESIGNATION OF DRILL CME-750
4. HOLE NO. (As shown on drawing title and file number) CB-301	13. TOTAL NO. OF OVERBURDEN SAMPLES TAKEN: DISTURBED 2; UNDISTURBED 0
5. NAME OF DRILLER Jim Evans	14. TOTAL NUMBER CORE BOXES 2
6. DIRECTION OF HOLE ☒ VERTICAL ☐ INCLINED --- DEG. FROM VERT.	15. ELEVATION GROUND WATER 0.0
7. THICKNESS OF OVERBURDEN 2.8	16. DATE HOLE STARTED 5/20/2010 COMPLETED 5/20/2010
8. DEPTH DRILLED INTO ROCK 17.7	17. ELEVATION TOP OF HOLE -45.4
9. TOTAL DEPTH OF HOLE 20.5	18. TOTAL CORE RECOVERY FOR BORING 96 %
	19. GEOLOGIST Steve Scott

ELEVATION a	DEPTH b	LEGEND c	CLASSIFICATION OF MATERIALS (Description) d	% CORE RECOVERY e	BOX OR SAMPLE NO. f	REMARKS (Drilling time, water loss, depth weathering, etc., if significant) g
-45.4	0.0		Poorly-graded GRAVEL with silt and sand (GP-GM), wet, very dense, medium brown gravel (fine to coarse, sub-rounded, sub-angular, mixed lithology) with little fine to coarse, sub-rounded sand and silt	58	S-1 0.0 2.0	25-33-27-24 N = 60
-47.0	1.6					
-47.4	2.0		Top of spoon interval consists of gray quartzite cobble	100	S-2 2.0 2.8	35-50/4"
-48.4	3.0		Well-graded GRAVEL with silt and sand (GW-GM), wet, very dense, medium-reddish brown cobbles to fine to coarse gravel (sub-angular, quartzite, shale) with little fine to coarse sand and silt Weathered mafic gneiss in spoon tip BEDROCK - See Core Log CB-301			NOTE: DRIVE SAMPLING OF SOILS WAS COMPLETED PER ASTM D3550 USING A 300-LB. HAMMER AND 30-INCH FALL TO DRIVE A 3-IN. O.D. SPLIT BARREL SAMPLER. THE N-VALUE REPORTED ON THE LOGS IS NOT EQUIVALENT TO THE STANDARD PENETRATION TEST N-VALUE PER ASTM D1586.
-65.9	20.5		Boring Terminated at 20.5 ft. below river bottom.			

O'BRIEN & GERE

ROCK CORE LOG

TEST HOLE No. **CB-301**

Project **Geotechnical Inv. of Rock Cut Areas**
Location **N366,464.700/E251,030.200**
Elevation **-45.40ft**
Driller **Jim Evans**
Method **HQ Diamond Drill**
Dates **5/20/10**
Hole Orientation **Vertical**
Logged By **SRS**
Date **5/20/10**

Drilling Details	Depth (ft)	Core Recovery (%)	Core Condition	Discontinuity Spacing	R.Q.D. (%)	Intact Rock Strength (psi)	Weathering	Structural Discontinuity Description	Unconf. Comp. Strength (ksi)	Rock Mass Description	Tests
HQ Diamond Impregnated; HQ	3–6.5 (4, 5, 6)	93	Slightly Fractured; Unfractured	2	64	R3; R5	F - SW	Joint, 15°; MB, 15°; MB, 5°; MB, 45°; Joint, 5°; MB, 5°	5.2,14.6	Coring Started at 3ft RUN #1: (3-5.67') GNEISS, fine grained, 71° foliation, white, black, light green, gray, phaneritic, fresh to sl. weathered, hard, slightly fractured; quartz, feldspar, biotite, muscovite; fracture surfaces are slightly weathered; (5.67-6.5') PEGMATITE, coarse grained, foliation absent, white, black, light green, phaneritic, fresh, v. hard, unfractured; quartz, feldspar, biotite, muscoite, trace pyrite; contact at 5.67' is on 50° angle	
	6.5–11.5 (7, 8, 9, 10, 11)	100	Unfractured	0	100		F	MB, 30°; MB, horiz.; MB, 15°; MB, 10°; MB, 35°; MB, 35°		RUN #2: (6.5-9') Same as RUN #1 (5.67-6.5'), except an 80° contact at 9' with GNEISS; (9-11.5') Same as RUN #1 (3-5.67') except unfractured and fresh; MBs as noted	
	11.5–16.5 (12, 13, 14, 15, 16)	93	Slightly Fractured - Intensely Fractured	9	66		F - SW	MB, 45°; MB, 30°; Joint, horiz.; joint, 76° with multiple connected horiz. joints to 14.3'; Joint, 20°; Joint, 20°; Joint, 20°; MB, 35°; Joint, horiz.		RUN #3: (11.5-16.5') Same as RUN #1 (3-5.67'), except intensely fractured between 13.5-15.25'.	
	16.5–20.5 (17, 18, 19, 20)	98	Slightly Fractured	4	93		F - SW	MB, 15°; Joint, horiz.; Joint, horiz.; Joint, horiz.; MB, horiz.; Joint, horiz.		RUN #4: Same as RUN #1 (3-5.67'). Boring Terminated at 20.5 ft.	

CORE RECOVERY

$\frac{\text{Length of core}}{\text{core run}} \times 100$

R.Q.D.

$\frac{\text{Sum core lengths > 4 in.}}{\text{length of core run}} \times 100$

DISCONTINUITY SPACING
No. of fractures/Run

ROCK STRENGTH (ksi)	
R0 Extremely weak	<0.15
R1 Very weak	0.15 - 0.7
R2 Weak	0.7 - 3.5
R3 Medium strong	3.5 - 7.0
R4 Strong	7.0 -14.5
R5 Very strong	14.5 - 30.0
R6 Extremely strong	>30.0

WEATHERING	
F	Fresh
SW	Slightly
MW	Moderately
HW	Highly
CW	Completely
RS	Residual Soil

FILE No. **46126**
PREPARED By: **DDW**

DRILLING LOG	DIVISION North Atlantic	INSTALLATION Philadelphia District	SHEET 1 OF 1 SHEETS

1. PROJECT Geotechnical Inv. of Rock Cut Areas	10. SIZE AND TYPE OF BIT HQ Diamond Bit
2. LOCATION (Coordinates or Station) STA. 106 +500 N 367,063.9 E 251,894.8	11. DATUM FOR ELEVATION SHOWN *(TBM or MSL)* MLLW
3. DRILLING AGENCY Uni-Tech Drilling Co., Inc	12. MANUFACTURER'S DESIGNATION OF DRILL CME-750
4. HOLE NO. *(As shown on drawing title and file number)* CB-302	13. TOTAL NO. OF OVERBURDEN SAMPLES TAKEN: DISTURBED 0; UNDISTURBED 0
5. NAME OF DRILLER Jim Evans	14. TOTAL NUMBER CORE BOXES 2
6. DIRECTION OF HOLE ☒ VERTICAL ☐ INCLINED --- DEG. FROM VERT.	15. ELEVATION GROUND WATER 0.0
	16. DATE HOLE: STARTED 5/19/2010; COMPLETED 5/19/2010
7. THICKNESS OF OVERBURDEN 0.0	17. ELEVATION TOP OF HOLE -44.4
8. DEPTH DRILLED INTO ROCK 20.5	18. TOTAL CORE RECOVERY FOR BORING 98 %
9. TOTAL DEPTH OF HOLE 20.5	19. GEOLOGIST Steve Scott

ELEVATION a	DEPTH b	LEGEND c	CLASSIFICATION OF MATERIALS (Description) d	% CORE RECOV-ERY e	BOX OR SAMPLE NO. f	REMARKS *(Drilling time, water loss, depth weathering, etc., if significant)* g
-44.4	0.0		BEDROCK - See Core Log CB-302			
-47.0	2.6					
-64.9	20.5					
			Boring Terminated at 20.5 ft. below river bottom.			

O'BRIEN & GERE

ROCK CORE LOG

TEST HOLE No. **CB-302**

Project	**Geotechnical Inv. of Rock Cut Areas**				
Location	**N367,063.900/E251,894.800**			Elevation	**-44.40ft**
Driller	**Jim Evans**	Method	**HQ Diamond Drill**	Dates	**5/19/10**
Hole Orientation	**Vertical**	Logged By	**SRS**	Date	**5/19/10**

Drilling Details: HQ Diamond Impregnated; HQ

Coring Started at 0ft

Depth (ft)	Core Recovery (%)	Core Condition	Discontinuity Spacing	R.Q.D. (%)	Intact Rock Strength (psi)	Weathering	Structural Discontinuity Description	Unconf. Comp. Strength (ksi)	Rock Mass Description	Tests
0 – 4.5	94	Moderately Fractured	9	70	R2; R2; R2; R3	F	Joint, horiz.; Joint, horiz.; Joint, 5°; Joint, horiz.; Joint, 5°; Joint, 30°; Joint, 5°; Joint, horiz.; Joint, 5°	2.9,3.0,1.9	RUN #1: GNEISS, fine grained, 70° foliation, black, white, gray, phaneritic, fresh, hard, mod. fractured with sl. to no separation; gneiss consists of mainly of biotite, quartz, plagioclase; fracture surfaces sl. weathered	
4.5 – 9.5	100	Moderately Fractured	11	76		F	Joint, horiz.; Joint, horiz.; Joint, horiz.; Joint, horiz.; Joint, 5°; Joint, 30°; Joint, 20°; Joint, 25°; Joint, 30°; Joint, 20°; Joint, 5° limbs	6.0	RUN #2: Same as RUN #1.	
9.5 – 14.5	100	Moderately Fractured	5	76		F	Joint, horiz.; Joint, horiz.; Joint, 5°; Joint, 5°; MB, horiz.; MB, 5°; MB, 5°; MB, horiz.; Joint, horiz.; MB, horiz.		RUN #3: Same as RUN #1.	
14.5 – 18	100	Slightly Fractured	4	86		F	MB, 15°; MB, 20°; Joint, horiz.; MB, 20°		RUN #4: Same as RUN #1, except 85° to vertical foliation, sl. fractured with sl. separation.	

CORE RECOVERY

$$\frac{\text{Length of core}}{\text{core run}} \times 100$$

R.Q.D.

$$\frac{\text{Sum core lengths > 4 in.}}{\text{length of core run}} \times 100$$

DISCONTINUITY SPACING
No. of fractures/Run

ROCK STRENGTH (ksi)	
R0 Extremely weak	<0.15
R1 Very weak	0.15 - 0.7
R2 Weak	0.7 - 3.5
R3 Medium strong	3.5 - 7.0
R4 Strong	7.0 -14.5
R5 Very strong	14.5 - 30.0
R6 Extremely strong	>30.0

WEATHERING	
F	Fresh
SW	Slightly
MW	Moderately
HW	Highly
CW	Completely
RS	Residual Soil

FILE No. **46126**

PREPARED By: **DDW**

O'BRIEN & GERE

ROCK CORE LOG

TEST HOLE No. **CB-302**

Project **Geotechnical Inv. of Rock Cut Areas**
Location **N367,063.900/E251,894.800** Elevation **-44.40ft**
Driller **Jim Evans** Method **HQ Diamond Drill** Dates **5/19/10**
Hole Orientation **Vertical** Logged By **SRS** Date **5/19/10**

Drilling Details	Depth (ft)	Core Recovery (%)	Core Condition	Discontinuity Spacing	R.Q.D. (%)	Intact Rock Strength (psi)	Weathering	Structural Discontinuity Description	Unconf. Comp. Strength (ksi)	Rock Mass Description	Tests
HQ								Joint, 20°		RUN #4: Same as RUN #1, except 85° to vertical foliation, sl. fractured with sl. separation. *(continued)*	
	19							Joint, horiz.; joint, 75° Joint, 60°			
	20	100	Unfractured	0	100		F	MB, 35°		RUN #5: Same as RUN #4, except unfractured.	
	21									Boring Terminated at 20.5 ft.	
	22										
	23										
	24										
	25										
	26										
	27										
	28										
	29										
	30										
	31										
	32										
	33										
	34										
	35										

CORE RECOVERY

$\frac{\text{Length of core}}{\text{core run}} \times 100$

R.Q.D.

$\frac{\text{Sum core lengths > 4 in.}}{\text{length of core run}} \times 100$

DISCONTINUITY SPACING
No. of fractures/Run

ROCK STRENGTH (ksi)
R0 Extremely weak <0.15
R1 Very weak 0.15 - 0.7
R2 Weak 0.7 - 3.5
R3 Medium strong 3.5 - 7.0
R4 Strong 7.0 -14.5
R5 Very strong 14.5 - 30.0
R6 Extremely strong >30.0

WEATHERING
F Fresh
SW Slightly
MW Moderately
HW Highly
CW Completely
RS Residual Soil

FILE No. **46126**
PREPARED By: **DDW**

DRILLING LOG	DIVISION North Atlantic	INSTALLATION Philadelphia District	SHEET 1 OF 1 SHEETS

1. PROJECT Geotechnical Inv. of Rock Cut Areas	10. SIZE AND TYPE OF BIT 6" Tri-Cone / HQ Diamond Bit
2. LOCATION (Coordinates or Station) STA. 106 + 000 N 367,645.3 E 251,931.6	11. DATUM FOR ELEVATION SHOWN *(TBM or MSL)* MLLW
3. DRILLING AGENCY Uni-Tech Drilling Co., Inc	12. MANUFACTURER'S DESIGNATION OF DRILL CME-750
4. HOLE NO. *(As shown on drawing title and file number)* CB-303	13. TOTAL NO. OF OVERBURDEN SAMPLES TAKEN: DISTURBED 1, UNDISTURBED 0
5. NAME OF DRILLER Jim Evans	14. TOTAL NUMBER CORE BOXES 3
6. DIRECTION OF HOLE ☒ VERTICAL ☐ INCLINED --- DEG. FROM VERT.	15. ELEVATION GROUND WATER 0.0
	16. DATE HOLE STARTED 5/19/2010 COMPLETED 5/19/2010
7. THICKNESS OF OVERBURDEN 1.3	17. ELEVATION TOP OF HOLE -45.0
8. DEPTH DRILLED INTO ROCK 19.2	18. TOTAL CORE RECOVERY FOR BORING 99 %
9. TOTAL DEPTH OF HOLE 20.5	19. GEOLOGIST Steve Scott

ELEVATION a	DEPTH b	LEGEND c	CLASSIFICATION OF MATERIALS (Description) d	% CORE RECOVERY e	BOX OR SAMPLE NO. f	REMARKS *(Drilling time, water loss, depth weathering, etc., if significant)* g
-45.0	0.0		Poorly-graded GRAVEL with silt and sand (GP-GM), wet, very dense, dark gray (5YR 4/1), fine to coarse gravel (sub-rounded, sub-angular, mixed lithology) with fine to coarse, sub-rounded sand and trace silt	63	S-1 0.0 1.3	25-21-50/4"
-46.3	1.3					
-47.0	2.0		BEDROCK - See Core Log CB-303			NOTE: DRIVE SAMPLING OF SOILS WAS COMPLETED PER ASTM D3550 USING A 300-LB. HAMMER AND 30-INCH FALL TO DRIVE A 3-IN. O.D. SPLIT BARREL SAMPLER. THE N-VALUE REPORTED ON THE LOGS IS NOT EQUIVALENT TO THE STANDARD PENETRATION TEST N-VALUE PER ASTM D1586.
-65.5	20.5					
			Boring Terminated at 20.5 ft. below river bottom.			

O'BRIEN & GERE

ROCK CORE LOG

TEST HOLE No. **CB-303**

Project **Geotechnical Inv. of Rock Cut Areas**
Location **N367,645.300/E251,931.600**
Driller **Jim Evans** Method **HQ Diamond Drill**
Hole Orientation **Vertical** Logged By **SRS**
Elevation **-45.00ft**
Dates **5/19/10**
Date **5/19/10**

Coring Started at 1.67ft

Drilling Details	Depth (ft)	Core Recovery (%)	Core Condition	Discontinuity Spacing	R.Q.D. (%)	Intact Rock Strength (psi)	Weathering	Structural Discontinuity Description	Unconf. Comp. Strength (ksi)	Rock Mass Description	Tests
HQ Diamond Impregnated; HQ	2–4	93	Moderately Fractured	2	32		F	Joint, horiz. Joint, 10° MB, horiz. MB, 20° MB, horiz. MB, 10° MB, 10°		RUN # 1: GNEISS, fine grained, horiz. foliation is not present, white, black, gray, phaneritic, fresh, hard, mod. fractured; fractured surfaces slightly weathered with secondary mineralization present	
	4–9	100	Moderately Fractured - Intensely Fractured	Multiple	33	R5	F		14.6	RUN # 2: GNEISS, fine grained, foliation not present, white, black, gray, phaneretic, fresh, hard, mod. to intensely fractured on 2 to 4" intervals for entire 4 to 9' run, some enhanced by mechanical breaks at horiz. to 10° angles	
	9–14	100	Unfractured	0	81		F			RUN # 3: 9-10.5' Same as RUN # 2 except unfractured with mechanical breaks on 2-5" intervals 10.5-14' PEGMATITE, coarse grained, 60° foliation, phaneritic, fresh, hard, unfractured; pegmatitic minerals are quartz, muscovite, light, green mineral; pegmatite contact with gneiss 56° at top and 76° at bottom.	
	14–18	100	Unfractured	0	88		F			RUN # 4: Same as RUN # 2 except unfractured with mechanical breaks on 3-10" intervals	

CORE RECOVERY
$\frac{\text{Length of core}}{\text{core run}} \times 100$

R.Q.D.
$\frac{\text{Sum core lengths > 4 in.}}{\text{length of core run}} \times 100$

DISCONTINUITY SPACING
No. of fractures/Run

ROCK STRENGTH (ksi)	
R0 Extremely weak	<0.15
R1 Very weak	0.15 - 0.7
R2 Weak	0.7 - 3.5
R3 Medium strong	3.5 - 7.0
R4 Strong	7.0 -14.5
R5 Very strong	14.5 - 30.0
R6 Extremely strong	>30.0

WEATHERING	
F	Fresh
SW	Slightly
MW	Moderately
HW	Highly
CW	Completely
RS	Residual Soil

FILE No. **46126**
PREPARED By: **DDW**
SHEET 1 of 2

O'BRIEN & GERE

ROCK CORE LOG

TEST HOLE No. **CB-303**

Project **Geotechnical Inv. of Rock Cut Areas**
Location **N367,645.300/E251,931.600**
Elevation **-45.00ft**
Driller **Jim Evans**
Method **HQ Diamond Drill**
Dates **5/19/10**
Hole Orientation **Vertical**
Logged By **SRS**
Date **5/19/10**

Drilling Details	Depth (ft)	Core Recovery (%)	Core Condition	Discontinuity Spacing	R.Q.D. (%)	Intact Rock Strength (psi)	Weathering	Structural Discontinuity Description	Unconf. Comp. Strength (ksi)	Rock Mass Description	Tests
HQ	20	100	Unfractured	1	86		F	Joint, 70°		RUN # 5: Same as RUN # 2 except unfractured with mechanical breaks on 8-16" intervals; pegmatic material penetrates core on 70° angle, 1" thick centered at 20.25', bottom surface of pegmatite is seperated from gneiss with mod. weathering	
	21									Boring Terminated at 21.5 ft.	
	22										
	23										
	24										
	25										
	26										
	27										
	28										
	29										
	30										
	31										
	32										
	33										
	34										
	35										
	36										

CORE RECOVERY

$\frac{\text{Length of core}}{\text{core run}} \times 100$

R.Q.D.

$\frac{\text{Sum core lengths > 4 in.}}{\text{length of core run}} \times 100$

DISCONTINUITY SPACING
No. of fractures/Run

ROCK STRENGTH (ksi)	
R0 Extremely weak	<0.15
R1 Very weak	0.15 - 0.7
R2 Weak	0.7 - 3.5
R3 Medium strong	3.5 - 7.0
R4 Strong	7.0 -14.5
R5 Very strong	14.5 - 30.0
R6 Extremely strong	>30.0

WEATHERING	
F	Fresh
SW	Slightly
MW	Moderately
HW	Highly
CW	Completely
RS	Residual Soil

FILE No. **46126**

PREPARED By: **DDW**

Hole No. CB-304

DRILLING LOG	DIVISION North Atlantic	INSTALLATION Philadelphia District	SHEET 1 OF 1 SHEETS

1. PROJECT: Geotechnical Inv. of Rock Cut Areas	10. SIZE AND TYPE OF BIT: HQ Diamond Bit
2. LOCATION (Coordinates or Station): STA. 104 + 800 N 368,339.7 E 252,848.0	11. DATUM FOR ELEVATION SHOWN *(TBM or MSL)*: MLLW
3. DRILLING AGENCY: Uni-Tech Drilling Co., Inc	12. MANUFACTURER'S DESIGNATION OF DRILL: CME-750
4. HOLE NO. *(As shown on drawing title and file number)*: CB-304	13. TOTAL NO. OF OVERBURDEN SAMPLES TAKEN: DISTURBED 0; UNDISTURBED 0
5. NAME OF DRILLER: Jim Evans	14. TOTAL NUMBER CORE BOXES: 2
6. DIRECTION OF HOLE: ☒ VERTICAL ☐ INCLINED --- DEG. FROM VERT.	15. ELEVATION GROUND WATER: 0.0
	16. DATE HOLE: STARTED 5/17/2010; COMPLETED 5/17/2010
7. THICKNESS OF OVERBURDEN: 0.0	17. ELEVATION TOP OF HOLE: -46.7
8. DEPTH DRILLED INTO ROCK: 20.0	18. TOTAL CORE RECOVERY FOR BORING: 95 %
9. TOTAL DEPTH OF HOLE: 20.0	19. GEOLOGIST: Steve Scott

ELEVATION a	DEPTH b	LEGEND c	CLASSIFICATION OF MATERIALS (Description) d	% CORE RECOVERY e	BOX OR SAMPLE NO. f	REMARKS *(Drilling time, water loss, depth weathering, etc., if significant)* g
-47.0	0.3		BEDROCK - See Core Log CB-304			
-66.7	20.0					
			Boring Terminated at 20 ft. below river bottom.			

ENG FORM 1836 MAR 71 PREVIOUS EDITIONS ARE OBSOLETE. PROJECT Geotechnical Inv. of Rock Cut Areas HOLE NO. CB-304

O'BRIEN & GERE

ROCK CORE LOG

TEST HOLE No. **CB-304**

Project **Geotechnical Inv. of Rock Cut Areas**

Location **N368,339.700/E252,848.000** Elevation **-46.70ft**

Driller **Jim Evans** Method **HQ Diamond Drill** Dates **5/17/10**

Hole Orientation **Vertical** Logged By **SRS** Date **5/17/10**

Drilling Details	Depth (ft)	Core Recovery (%)	Core Condition	Discontinuity Spacing	R.Q.D. (%)	Intact Rock Strength (psi)	Weathering	Structural Discontinuity Description	Unconf. Comp. Strength (ksi)	Rock Mass Description	Tests
										Coring Started at 0.5ft	
HQ Diamond Impregnated — HQ	0–3	100	V. Slightly Fractured		90	R3	SW		3.8	RUN # 1: GNEISS, foliated 75° to vertical, black, white, gray, sl. weathered, hard (except foliation planes are mod. soft), v. sl. fractured; biotite, amphibolite, quartz, muscovite; horiz. MBs present from 0.5-2' at 2-3" intervals	
	3–8	83	Moderately Fractured - V. Slightly Fractured		50	R2	MW - SW		3.1	RUN # 2: GNIESS, foliated at 75°, white, black, gray, sl. weathered, hard (except foliation planes are mod. soft), v. sl. fractured along foliation planes; predominantly quartz from 4-6', foliated quartz, mica, and amphibolite from 6-8'; fracture surfaces are sl. to mod. weathered; MBs throughout	
	8–13	100	Moderately Fractured		73		SW			RUN # 3: GNEISS, foliated 75°, white, black, gray, quartz, biotite, amphibolite, muscovite, sl. weathered, hard except foliation planes are mod. soft, mod. fractured horizontally (avg. fracture spacing is 3-4", overall fracutres spaced 1-13"); quartz, biotite, amphibolite, muscovite; fracture surfaces mod. weathered, fractured along foliation at 12.75'	
	13–17	96	Intensely Fractured		48		SW			RUN # 4: Same as RUN # 3 except mod. fractured along foliation planes, intensely fractured on foliation planes	

CORE RECOVERY

$$\frac{\text{Length of core}}{\text{core run}} \times 100$$

R.Q.D.

$$\frac{\text{Sum core lengths > 4 in.}}{\text{length of core run}} \times 100$$

DISCONTINUITY SPACING
No. of fractures/Run

ROCK STRENGTH (ksi)

R0	Extremely weak	<0.15
R1	Very weak	0.15 - 0.7
R2	Weak	0.7 - 3.5
R3	Medium strong	3.5 - 7.0
R4	Strong	7.0 -14.5
R5	Very strong	14.5 - 30.0
R6	Extremely strong	>30.0

WEATHERING

F	Fresh
SW	Slightly
MW	Moderately
HW	Highly
CW	Completely
RS	Residual Soil

FILE No. **46126**

PREPARED By: **DDW**

O'BRIEN & GERE

ROCK CORE LOG

TEST HOLE No. **CB-304**

Project **Geotechnical Inv. of Rock Cut Areas**
Location **N368,339.700/E252,848.000**
Elevation **-46.70ft**
Driller **Jim Evans**
Method **HQ Diamond Drill**
Dates **5/17/10**
Hole Orientation **Vertical**
Logged By **SRS**
Date **5/17/10**

Drilling Details	Depth (ft)	Core Recovery (%)	Core Condition	Discontinuity Spacing	R.Q.D. (%)	Intact Rock Strength (psi)	Weathering	Structural Discontinuity Description	Unconf. Comp. Strength (ksi)	Rock Mass Description	Tests
HQ	19									RUN # 5: Same as RUN # 3 except horiz. MBs on 4-9" intervals, sl. fractured along foliation planes with mod. weathered surfaces	
		100	Slightly Fractured		66		SW				
	20										
	21									Boring Terminated at 21 ft.	
	22										
	23										
	24										
	25										
	26										
	27										
	28										
	29										
	30										
	31										
	32										
	33										
	34										
	35										

CORE RECOVERY

$\frac{\text{Length of core}}{\text{core run}} \times 100$

R.Q.D.

$\frac{\text{Sum core lengths > 4 in.}}{\text{length of core run}} \times 100$

DISCONTINUITY SPACING
No. of fractures/Run

ROCK STRENGTH (ksi)

R0	Extremely weak	<0.15
R1	Very weak	0.15 - 0.7
R2	Weak	0.7 - 3.5
R3	Medium strong	3.5 - 7.0
R4	Strong	7.0 -14.5
R5	Very strong	14.5 - 30.0
R6	Extremely strong	>30.0

WEATHERING

F	Fresh
SW	Slightly
MW	Moderately
HW	Highly
CW	Completely
RS	Residual Soil

FILE No. **46126**
PREPARED By: **DDW**

DRILLING LOG	DIVISION North Atlantic	INSTALLATION Philadelphia District	SHEET 1 OF 2 SHEETS

1. PROJECT Geotechnical Inv. of Rock Cut Areas	10. SIZE AND TYPE OF BIT 6" Tri-Cone
2. LOCATION (Coordinates or Station) STA. 98 + 100 N 370,847.7 E 259,158.2	11. DATUM FOR ELEVATION SHOWN *(TBM or MSL)* MLLW
3. DRILLING AGENCY Uni-Tech Drilling Co., Inc	12. MANUFACTURER'S DESIGNATION OF DRILL CME-750
4. HOLE NO. *(As shown on drawing title and file number)* CB-305	13. TOTAL NO. OF OVERBURDEN SAMPLES TAKEN: DISTURBED 10; UNDISTURBED 0
5. NAME OF DRILLER Jim Evans	14. TOTAL NUMBER CORE BOXES 0
6. DIRECTION OF HOLE ☒ VERTICAL ☐ INCLINED --- DEG. FROM VERT.	15. ELEVATION GROUND WATER 0.0
	16. DATE HOLE STARTED 5/14/2010 COMPLETED 5/14/2010
7. THICKNESS OF OVERBURDEN 20.0	17. ELEVATION TOP OF HOLE -42.4
8. DEPTH DRILLED INTO ROCK 0.0	18. TOTAL CORE RECOVERY FOR BORING N/A %
9. TOTAL DEPTH OF HOLE 20.0	19. GEOLOGIST Steve Scott

ELEVATION a	DEPTH b	LEGEND c	CLASSIFICATION OF MATERIALS (Description) d	% CORE RECOV-ERY e	BOX OR SAMPLE NO. f	REMARKS *(Drilling time, water loss, depth weathering, etc., if significant)* g
-42.4	0.0		Poorly-graded GRAVEL with silt and sand (GP-GM), wet, dense, very dark grayish brown (3Y 5/2), fine to coarse (up to 2" diameter) gravel (sub-rounded, mixed lithology) with fine to coarse sand, silt	54	S-1 0.0 2.0	20-17-22-19 N = 39
			Becoming very dense	100	S-2 2.0 2.8	58-50/3"
-47.0	4.6		With quartzite cobbles	54	S-3 4.0 6.0	27-48-23-17 N = 71
				100	S-4 6.0 8.0	17-25-25-26 N = 50
				100	S-5 8.0 9.8	15-28-48-50/3" N = 76
-54.4	12.0			104	S-6 10.0 10.1	100/1"
			Saprolitic GNEISS, wet, medium dense, white (N9), black (N1), light greenish gray (56Y 8/1), quartz (medium to coarse sand sized), banded with biotite and muscovite, trace garnet	63	S-7 12.0 14.0	7-9-15-18 N = 24
-57.4	15.0		Band of mica at 45° contact	67	S-8 14.0 16.0	8-9-12-19 N = 21
			Sharp contact on 45° angle with saprolitic mica SCHIST, foliated, predominantly mafic, very soft, grayish black (N2), biotite and likely chlorite	67	S-9 16.0 18.0	12-27-43-49 N = 70
-62.4	20.0		Mylonitic 3" felsic band with sharp 45° contacts Below felsic band saprolitic SCHIST is soft, mafic, with clear mineral assemblage Felsic assemblage consisting of muscovite and quartz, very soft, saprolitic foliation not identified, mylonitic mafic intrusions	100	S-10 18.0 20.0	17-33-39-54 N = 72
			Boring Terminated at 20 ft. below river bottom.			NOTE: DRIVE SAMPLING OF SOILS WAS COMPLETED PER ASTM D3550 USING A 300-LB. HAMMER AND 30-INCH FALL TO DRIVE A 3-IN. O.D. SPLIT BARREL SAMPLER. THE N-VALUE

DRILLING LOG (Cont Sheet)	ELEVATION TOP OF HOLE -42.4		Hole No. CB-305
PROJECT Geotechnical Inv. of Rock Cut Areas		INSTALLATION Philadelphia District	SHEET 2 OF 2 SHEETS

ELEVATION a	DEPTH b	LEGEND c	CLASSIFICATION OF MATERIALS (Description) d	% CORE RECOVERY e	BOX OR SAMPLE NO. f	REMARKS (Drilling time, water loss, depth weathering, etc., if significant) g
						REPORTED ON THE LOGS IS NOT EQUIVALENT TO THE STANDARD PENETRATION TEST N-VALUE PER ASTM D1586.

Hole No. CB-306

DRILLING LOG | DIVISION: North Atlantic | INSTALLATION: Philadelphia District | SHEET 1 OF 1 SHEETS

1. PROJECT: Geotechnical Inv. of Rock Cut Areas
2. LOCATION (Coordinates or Station): STA. 140 + 100 N 348,466.7 E 223,737.2
3. DRILLING AGENCY: Uni-Tech Drilling Co., Inc
4. HOLE NO. *(As shown on drawing title and file number)*: CB-306
5. NAME OF DRILLER: Jim Evans
6. DIRECTION OF HOLE: ☒ VERTICAL ☐ INCLINED --- DEG. FROM VERT.
7. THICKNESS OF OVERBURDEN: 6.0
8. DEPTH DRILLED INTO ROCK: 14.5
9. TOTAL DEPTH OF HOLE: 20.5
10. SIZE AND TYPE OF BIT: 6" Tri-Cone / HQ Diamond Bit
11. DATUM FOR ELEVATION SHOWN *(TBM or MSL)*: MLLW
12. MANUFACTURER'S DESIGNATION OF DRILL: CME-750
13. TOTAL NO. OF OVERBURDEN SAMPLES TAKEN: DISTURBED 3; UNDISTURBED 0
14. TOTAL NUMBER CORE BOXES: 1
15. ELEVATION GROUND WATER: 0.0
16. DATE HOLE: STARTED 6/4/2010; COMPLETED 6/4/2010
17. ELEVATION TOP OF HOLE: -44.6
18. TOTAL CORE RECOVERY FOR BORING: 75 %
19. GEOLOGIST: Steve Scott

ELEVATION a	DEPTH b	LEGEND c	CLASSIFICATION OF MATERIALS (Description) d	% CORE RECOV-ERY e	BOX OR SAMPLE NO. f	REMARKS *(Drilling time, water loss, depth weathering, etc., if significant)* g
-44.6	0.0		Sandy FAT CLAY (CH), wet, medium soft, yellowish red (5YR 5/8), some fine to coarse sub-rounded mixed lithology gravel and trace varving of fine to medium sand	83	S-1 0.0 2.0	7-2-3-4 N = 5
-47.0	2.4			100	S-2 2.0 4.0	1-4-5-7 N = 9
-48.6	4.0		Saprolitic GNEISS, wet, dense, grayish green black, saprolitic gneiss, biotite and foliation present, crumbles to medium to coarse sand sized particles	83	S-3 4.0 6.0	9-12-18-40 N = 30
-50.6	6.0		BEDROCK - See Core Log CB-306			NOTE: DRIVE SAMPLING OF SOILS WAS COMPLETED PER ASTM D3550 USING A 300-LB. HAMMER AND 30-INCH FALL TO DRIVE A 3-IN. O.D. SPLIT BARREL SAMPLER. THE N-VALUE REPORTED ON THE LOGS IS NOT EQUIVALENT TO THE STANDARD PENETRATION TEST N-VALUE PER ASTM D1586.
-65.1	20.5		Boring Terminated at 20.5 ft. below river bottom.			

O'BRIEN & GERE

ROCK CORE LOG

TEST HOLE No. **CB-306**

Project **Geotechnical Inv. of Rock Cut Areas**
Location **N348,466.700/E223,737.200** Elevation **-44.60ft**
Driller **Jim Evans** Method **HQ Diamond Drill** Dates **6/4/10**
Hole Orientation **Vertical** Logged By **SRS** Date **6/4/10**

Drilling Details	Depth (ft)	Core Recovery (%)	Core Condition	Discontinuity Spacing	R.Q.D. (%)	Intact Rock Strength (psi)	Weathering	Structural Discontinuity Description	Unconf. Comp. Strength (ksi)	Rock Mass Description (Coring Started at 6ft)	Tests
HQ Diamond Impregnated; HQ	7–9	5	Intensely Fractured	Multiple	0		F			RUN # 1: 2" Recovery, broken GNEISS fragments	
	10–14	96	Moderately Fractured	11	51		F	Joint, 60° Joint, horiz. Multiple joints, horiz. and 70° Joint, horiz. Joint, horiz. Joint, horiz. Joint, 65° Joint, horiz. Joint, 75° Joint, 75° MB, horiz.		RUN # 2: GNEISS, fine grained, foliations absent, black, dark green, phaeritic, fresh, hard, mod. fractured; fractured surfaces are sl. weathered and contain secondary mineralization	
	15–19	98	Moderately Fractured	2	92		F	MB and Joint, 75° Joint, 60° MB, horiz.		RUN # 3: Same as RUN # 2	
	20	100	Moderately Fractured	1	0		F	MB, horiz Joint, 75° MB, horiz. MB, horiz. MB, horiz.		RUN # 4: Same as RUN # 2	
	21–23									Boring Terminated at 20.5 ft.	

CORE RECOVERY

$$\frac{\text{Length of core}}{\text{core run}} \times 100$$

R.Q.D.

$$\frac{\text{Sum core lengths > 4 in.}}{\text{length of core run}} \times 100$$

DISCONTINUITY SPACING
No. of fractures/Run

ROCK STRENGTH (ksi)

R0 Extremely weak	<0.15
R1 Very weak	0.15 - 0.7
R2 Weak	0.7 - 3.5
R3 Medium strong	3.5 - 7.0
R4 Strong	7.0 -14.5
R5 Very strong	14.5 - 30.0
R6 Extremely strong	>30.0

WEATHERING

F	Fresh
SW	Slightly
MW	Moderately
HW	Highly
CW	Completely
RS	Residual Soil

FILE No. **46126**
PREPARED By: **DDW**

Hole No. CB-307

DRILLING LOG	DIVISION North Atlantic	INSTALLATION Philadelphia District	SHEET 1 OF 1 SHEETS

1. PROJECT Geotechnical Inv. of Rock Cut Areas	10. SIZE AND TYPE OF BIT HQ Diamond Bit
2. LOCATION (Coordinates or Station) STA. 107 + 400 N 367,110.7 E 251,024.5	11. DATUM FOR ELEVATION SHOWN *(TBM or MSL)* MLLW
3. DRILLING AGENCY Uni-Tech Drilling Co., Inc	12. MANUFACTURER'S DESIGNATION OF DRILL CME-750
4. HOLE NO. *(As shown on drawing title and file number)* CB-307	13. TOTAL NO. OF OVERBURDEN SAMPLES TAKEN: DISTURBED 0; UNDISTURBED 0
5. NAME OF DRILLER Jim Evans	14. TOTAL NUMBER CORE BOXES 2
6. DIRECTION OF HOLE ☒ VERTICAL ☐ INCLINED --- DEG. FROM VERT.	15. ELEVATION GROUND WATER 0.0
	16. DATE HOLE: STARTED 5/20/2010; COMPLETED 5/20/2010
7. THICKNESS OF OVERBURDEN 0.0	17. ELEVATION TOP OF HOLE -44.4
8. DEPTH DRILLED INTO ROCK 20.5	18. TOTAL CORE RECOVERY FOR BORING 92 %
9. TOTAL DEPTH OF HOLE 20.5	19. GEOLOGIST Steve Scott

ELEVATION a	DEPTH b	LEGEND c	CLASSIFICATION OF MATERIALS (Description) d	% CORE RECOV-ERY e	BOX OR SAMPLE NO. f	REMARKS *(Drilling time, water loss, depth weathering, etc., if significant)* g
-44.4	0.0		BEDROCK - See Core Log CB-307			
-47.0	2.6					
-64.9	20.5					
			Boring Terminated at 20.5 ft. below river bottom.			

O'BRIEN & GERE

ROCK CORE LOG

TEST HOLE No. **CB-307**

Project **Geotechnical Inv. of Rock Cut Areas**
Location **N367,110.700/E251,024.500**
Elevation **-44.40ft**
Driller **Jim Evans**
Method **HQ Diamond Drill**
Dates **5/20/10**
Hole Orientation **Vertical**
Logged By **SRS**
Date **5/20/10**

Drilling Details	Depth (ft)	Core Recovery (%)	Core Condition	Discontinuity Spacing	R.Q.D. (%)	Intact Rock Strength (psi)	Weathering	Structural Discontinuity Description	Unconf. Comp. Strength (ksi)	Rock Mass Description	Tests
HQ Diamond Impregnated; HQ	0–3	40		Multiple	0		F			Coring Started at 0ft. RUN # 1: GNIESS, fine grained, massive (mica orientation present, foliation not present), white, black, gray, phaneritic, fresh, hard, quartz, biotite, muscovite; mechanial breaks on 1-2" intervals for 0-1' of core; MBs are all horizontal	
	3–8	100	Unfractured	0	93	R5	F	MB, horiz.; MB, horiz.; MB, horiz.	14.1	RUN # 2: Same as RUN # 1 except unfractured with trace pyrite and mica orientation on 75° angle	
	8–13	100	Slightly Fractured	2	90		F	Joint, 5°; Joint, horiz.; MB, 5°; MB, 25°; MB, 15°		RUN # 3: Same as RUN # 2 except slighly fractured; fractured surfaces are slighly weathered and secondary mineralization is present	
	13–18	100	V. Slightly Fractured	1	96		F	Joint, 40°		RUN # 4: Same as RUN # 2 except v. sl. fractured; fractured surfaces are slighly weathered and secondary mineralization is present	

CORE RECOVERY

$\frac{\text{Length of core}}{\text{core run}} \times 100$

R.Q.D.

$\frac{\text{Sum core lengths > 4 in.}}{\text{length of core run}} \times 100$

DISCONTINUITY SPACING
No. of fractures/Run

ROCK STRENGTH (ksi)

R0	Extremely weak	<0.15
R1	Very weak	0.15 - 0.7
R2	Weak	0.7 - 3.5
R3	Medium strong	3.5 - 7.0
R4	Strong	7.0 -14.5
R5	Very strong	14.5 - 30.0
R6	Extremely strong	>30.0

WEATHERING

F	Fresh
SW	Slightly
MW	Moderately
HW	Highly
CW	Completely
RS	Residual Soil

FILE No. **46126**

PREPARED By: **DDW**

O'BRIEN & GERE

ROCK CORE LOG

TEST HOLE No. **CB-307**

Project **Geotechnical Inv. of Rock Cut Areas**
Location **N367,110.700/E251,024.500**
Elevation **-44.40ft**
Driller **Jim Evans**
Method **HQ Diamond Drill**
Dates **5/20/10**
Hole Orientation **Vertical**
Logged By **SRS**
Date **5/20/10**

Drilling Details	Depth (ft)	Core Recovery (%)	Core Condition	Discontinuity Spacing	R.Q.D. (%)	Intact Rock Strength (psi)	Weathering	Structural Discontinuity Description	Unconf. Comp. Strength (ksi)	Rock Mass Description	Tests
HQ	19	100	Unfractured	0	100		F			RUN # 5: Same as RUN # 2 except unfractured	
	20										
	21									Boring Terminated at 20.5 ft.	
	22										
	23										
	24										
	25										
	26										
	27										
	28										
	29										
	30										
	31										
	32										
	33										
	34										
	35										

CORE RECOVERY

$\frac{\text{Length of core}}{\text{core run}} \times 100$

R.Q.D.

$\frac{\text{Sum core lengths > 4 in.}}{\text{length of core run}} \times 100$

DISCONTINUITY SPACING
No. of fractures/Run

ROCK STRENGTH (ksi)

R0	Extremely weak	<0.15
R1	Very weak	0.15 - 0.7
R2	Weak	0.7 - 3.5
R3	Medium strong	3.5 - 7.0
R4	Strong	7.0 -14.5
R5	Very strong	14.5 - 30.0
R6	Extremely strong	>30.0

WEATHERING

F	Fresh
SW	Slightly
MW	Moderately
HW	Highly
CW	Completely
RS	Residual Soil

FILE No. **46126**

PREPARED By: **DDW**

Hole No. CB-308

DRILLING LOG	DIVISION North Atlantic	INSTALLATION Philadelphia District	SHEET 1 OF 2 SHEETS

1. PROJECT: Geotechnical Inv. of Rock Cut Areas
2. LOCATION (Coordinates or Station): STA. 96 + 300 N 370,925.3 E 260,818.7
3. DRILLING AGENCY: Uni-Tech Drilling Co., Inc
4. HOLE NO. (*As shown on drawing title and file number*): CB-308
5. NAME OF DRILLER: Jim Evans
6. DIRECTION OF HOLE: ☒ VERTICAL ☐ INCLINED --- DEG. FROM VERT.
7. THICKNESS OF OVERBURDEN: 20.0
8. DEPTH DRILLED INTO ROCK: 0.0
9. TOTAL DEPTH OF HOLE: 20.0
10. SIZE AND TYPE OF BIT: 6" Tri-Cone
11. DATUM FOR ELEVATION SHOWN (*TBM or MSL*): MLLW
12. MANUFACTURER'S DESIGNATION OF DRILL: CME-750
13. TOTAL NO. OF OVERBURDEN SAMPLES TAKEN: DISTURBED 10; UNDISTURBED 0
14. TOTAL NUMBER CORE BOXES: 0
15. ELEVATION GROUND WATER: 0.0
16. DATE HOLE: STARTED 5/13/2010; COMPLETED 5/13/2010
17. ELEVATION TOP OF HOLE: -45.2
18. TOTAL CORE RECOVERY FOR BORING: N/A %
19. GEOLOGIST: Steve Scott

ELEVATION a	DEPTH b	LEGEND c	CLASSIFICATION OF MATERIALS (Description) d	% CORE RECOV-ERY e	BOX OR SAMPLE NO. f	REMARKS (*Drilling time, water loss, depth weathering, etc., if significant*) g
-45.2	0.0		Poorly-graded SAND (SP), wet, medium dense to very loose, brownish gray, fine to medium sand with trace muscovite flakes, fine quartz gravel, wood, coal flecks, stratified coal fleck layers present (1/4" thick on 1-2" intervals)	29	S-1 0.0 2.0	6-7-7-4 N = 14
-47.0	1.8			100	S-2 2.0 4.0	2-2-2-1 N = 4
-48.5	3.3		FAT CLAY (CH), wet, very soft, dark gray, little interbedded lenses of fine sand (varving)	33	S-3 4.0 6.0	1-1-1-1 N = 2
				100	S-4 6.0 8.0	WOH/24" N = WOH
				100	S-5 8.0 10.0	2-1-2-1 N = 3
-55.2	10.0		Gravel seam consisting of fine to coarse gravel (up to 1.5" diameter) sub-rounded, felsic, less mafic Silty clayey SAND (SM-SC), wet, very soft, dark gray, silty clay with little interbedded lenses of fine sand and peat	100	S-6 10.0 12.0	WOH/24" N = WOH
				71	S-7 12.0 13.2	2-17-50/2"
-58.1	12.9		Well-graded GRAVEL with silt and sand (GW-GM), wet, very dense gravel (sub-rounded, sub-angular, up to 1.5" in diameter, mixed lithology) with little fine to medium sand and silt	58	S-8 14.0 16.0	10-27-34-45 N = 61
			Becoming dense	54	S-9 16.0 18.0	20-23-17-14 N = 40
			Becoming medium dense	79	S-10 18.0 20.0	10-12-11-14 N = 23
-65.2	20.0		Boring Terminated at 20 ft. below river bottom.			NOTE: DRIVE SAMPLING OF SOILS WAS COMPLETED PER ASTM D3550 USING A 300-LB. HAMMER AND 30-INCH FALL TO DRIVE A 3-IN. O.D. SPLIT BARREL SAMPLER. THE N-VALUE

DRILLING LOG (Cont Sheet)	ELEVATION TOP OF HOLE -45.2		Hole No. CB-308
PROJECT Geotechnical Inv. of Rock Cut Areas		INSTALLATION Philadelphia District	SHEET 2 OF 2 SHEETS

ELEVATION a	DEPTH b	LEGEND c	CLASSIFICATION OF MATERIALS (Description) d	% CORE RECOVERY e	BOX OR SAMPLE NO. f	REMARKS (Drilling time, water loss, depth weathering, etc., if significant) g
						REPORTED ON THE LOGS IS NOT EQUIVALENT TO THE STANDARD PENETRATION TEST N-VALUE PER ASTM D1586.

Appendix B

Laboratory Test Reports

GeoTesting express

1145 Massachusetts Avenue
Boxborough, MA 01719
978 635 0424 Tel
978 635 0266 Fax

Geotechnical Test Report

7/9/2010

GTX-9915
Delaware River Deepening Project

Tinicum to Marcus Hook Ranges, PA

Prepared for:

O'Brien & Gere Engineering

GeoTesting express
a subsidiary of Geocomp Corporation

Client:	O'Brien & Gere Engineering		
Project:	Delaware River Deepening Project		
Location:	Tinicum to Marcus Hook Ranges, PA	Project No:	GTX-9915
Boring ID: ---	Sample Type: ---	Tested By:	mmd
Sample ID:---	Test Date: 07/01/10	Checked By:	njh
Depth : ---	Sample Id: ---		

Moisture Content of Soil - ASTM D 2216-05

Boring ID	Sample ID	Depth	Description	Moisture Content,%
CB-289	S-1	0-2 ft	Wet, very dark grayish brown clay	138.2
CB-289	S-2	2-2 ft 11 in	Moist, very dark grayish brown gravel with silt and sand	5.6
CB-292	S-1	0-2 ft	Moist, very dark grayish brown gravel with silt and sand	5.4
CB-292	S-2	2-2 ft 10 in	Moist, dark olive gray gravel with silt and sand	4.8
CB-293	S-2	2-4 ft	Moist, very dark grayish brown silt with sand	59.1
CB-295	S-1	0-2 ft	Moist, very dark grayish brown gravel with silt and sand	7.1
CB-296	S-1	0-2 ft	Moist, dark olive brown gravel with silt and sand	7.1
CB-296	S-2	2-4 ft	Moist, olive brown silty clayey sand with gravel	5.2
CB-298	S-1	0-2 ft	Moist,very dark grayish brown gravel with silt and sand	7
CB-298	S-2A	2-3 ft	Moist, dark olive brown gravel with silt and sand	5.9

Notes: Temperature of Drying : 110° Celsius

GeoTesting
express
a subsidiary of GeoComp Corporation

Client:	O'Brien & Gere Engineering		
Project:	Delaware River Deepening Project		
Location:	Tinicum to Marcus Hook Ranges, PA	Project No:	GTX-9915
Boring ID: ---	Sample Type: ---	Tested By:	mmd
Sample ID:---	Test Date: 07/01/10	Checked By:	njh
Depth : ---	Sample Id: ---		

Moisture Content of Soil - ASTM D 2216-05

Boring ID	Sample ID	Depth	Description	Moisture Content,%
CB-298	S-2B	3-4 ft	Moist, dark olive gray silty sand	14
CB-299	S-1	0-2 ft	Moist, very dark grayish brown gravel with silt and sand	7.1
CB-301	S-1	0-2 ft	Moist, dark olive brown gravel with silt and sand	6.3
CB-301	S-2	2-4 ft	Moist, dark olive brown gravel with silt and sand	5.8
CB-303	S-1	0-2 ft	Moist, dark olive brown sand with silt and gravel	9.8
CB-306	S-1	0-2 ft	Moist, yellowish red sandy clay	53.1
CB-306	S-2	2-4 ft	Moist, mottled bluish gray and yellowish brown sandy clay	38.4

Notes: Temperature of Drying : 110° Celsius

GeoTesting express
a subsidiary of Geocomp Corporation

Client:	O'Brien & Gere Engineering		
Project:	Delaware River Deepening Project		
Location:	Tinicum to Marcus Hook Ranges, PA	Project No:	GTX-9915
Boring ID: ---	Sample Type: ---	Tested By:	mmd
Sample ID:---	Test Date: 06/09/10	Checked By:	jdt
Depth : ---	Sample Id: ---		

Moisture Content of Soil - ASTM D 2216-05

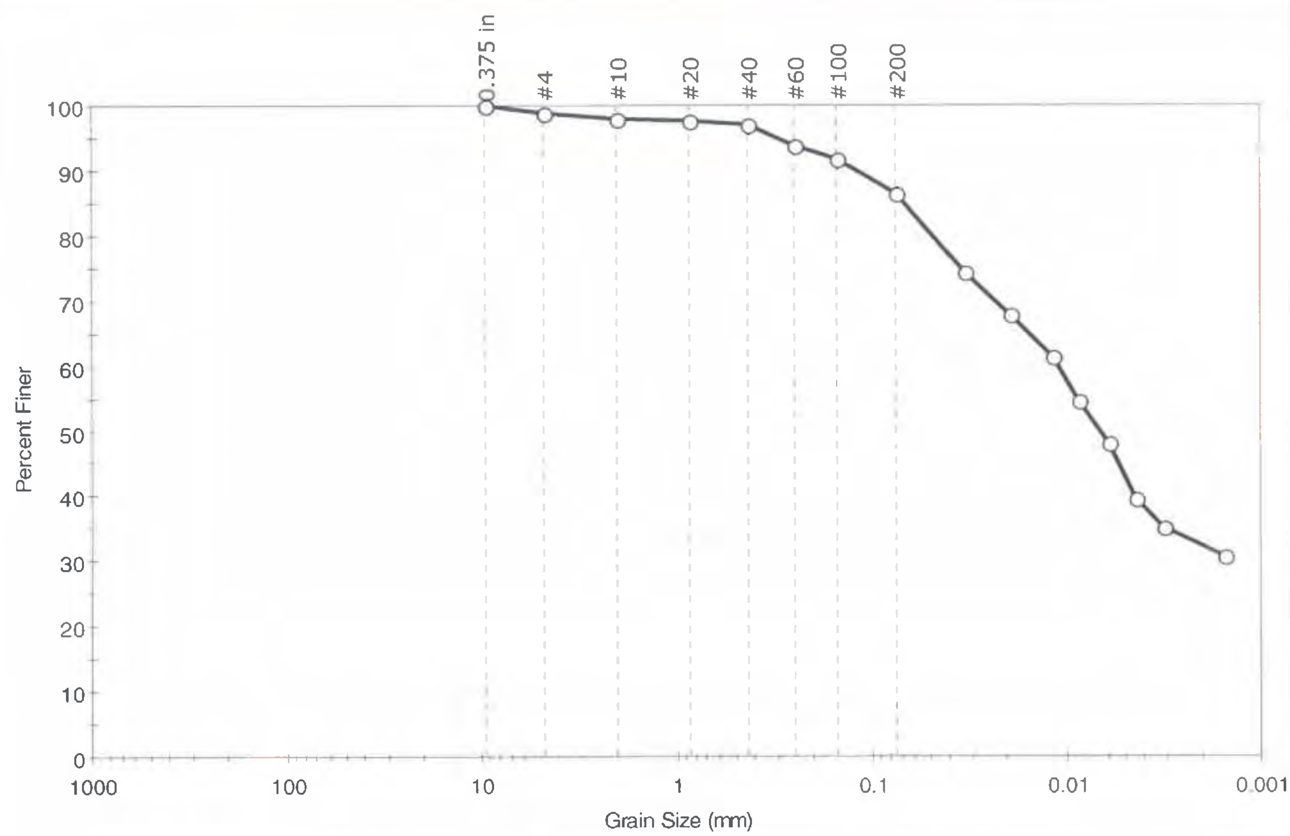
Boring ID	Sample ID	Depth	Description	Moisture Content,%
CB-305	S-1	0-2 ft	Moist, dark brown gravel with sand	8.3
CB-305	S-2	2-4 ft	Moist, dark brown gravel with sand	10.3
CB-305	S-3	4-6 ft	Moist, dark brown gravel with sand	2.1
CB-308	S-1	0-2 ft	Moist, dark brown sand	25
CB-308	S-2A	2-4 ft	Moist, dark brown sand	26
CB-308	S-2B	2-4 ft	Moist, dark gray clay	76.3

Notes: Temperature of Drying : 110° Celsius

GeoTesting express
a subsidiary of Geocomp Corporation

Client: O'Brien & Gere Engineering			
Project: Delaware River Deepening Project			
Location: Tinicum to Marcus Hook Ranges, PA		Project No:	GTX-9915
Boring ID: CB-289	Sample Type: jar	Tested By:	jbr
Sample ID: S-1	Test Date: 06/21/10	Checked By:	njh
Depth : 0-2 ft	Test Id: 183148		
Test Comment: ---			
Sample Description: Wet, very dark grayish brown clay			
Sample Comment: ---			

Particle Size Analysis - ASTM D 422-63 (reapproved 2002)



% Cobble	% Gravel	% Sand	% Silt & Clay Size
---	1.3	12.2	86.5

Sieve Name	Sieve Size, mm	Percent Finer	Spec. Percent	Complies
0.375 in	9.50	100		
#4	4.75	99		
#10	2.00	98		
#20	0.85	98		
#40	0.42	97		
#60	0.25	94		
#100	0.15	92		
#200	0.075	87		
---	Particle Size (mm)	Percent Finer	Spec. Percent	Complies
---	0.0335	74		
---	0.0195	68		
---	0.0118	61		
---	0.0085	55		
---	0.0060	48		
---	0.0044	39		
---	0.0032	35		
---	0.0015	31		

Coefficients

D_{85} = 0.0678 mm	D_{30} = N/A
D_{60} = 0.0111 mm	D_{15} = N/A
D_{50} = 0.0066 mm	D_{10} = N/A
C_u = N/A	C_c = N/A

Classification

ASTM fat clay (CH)

AASHTO Clayey Soils (A-7-5 (81))

Sample/Test Description

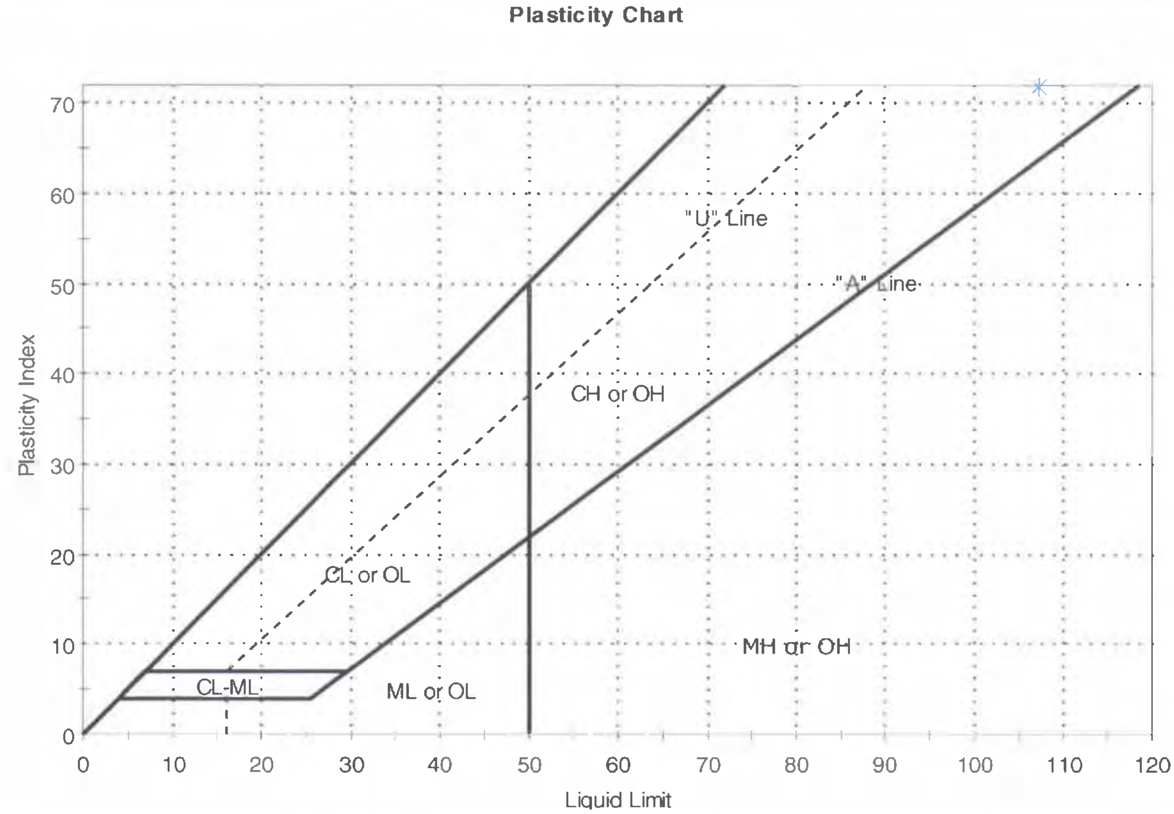
Sand/Gravel Particle Shape : ---

Sand/Gravel Hardness : ---

GeoTesting express
a subsidiary of Geocomp Corporation

Client: O'Brien & Gere Engineering			
Project: Delaware River Deepening Project			
Location: Tinicum to Marcus Hook Ranges, PA		Project No:	GTX-9915
Boring ID: CB-289	Sample Type: jar	Tested By:	cam
Sample ID:S-1	Test Date: 06/21/10	Checked By:	njh
Depth : 0-2 ft	Test Id: 183141		
Test Comment: ---			
Sample Description: Wet, very dark grayish brown clay			
Sample Comment: ---			

Atterberg Limits - ASTM D 4318-05



Symbol	Sample ID	Boring	Depth	Natural Moisture Content,%	Liquid Limit	Plastic Limit	Plasticity Index	Liquidity Index	Soil Classification
*	S-1	CB-289	0-2 ft	138	107	36	71	1	fat clay (CH)

Sample Prepared using the WET method

3% Retained on #40 Sieve

Dry Strength: VERY HIGH

Dilentancy: SLOW

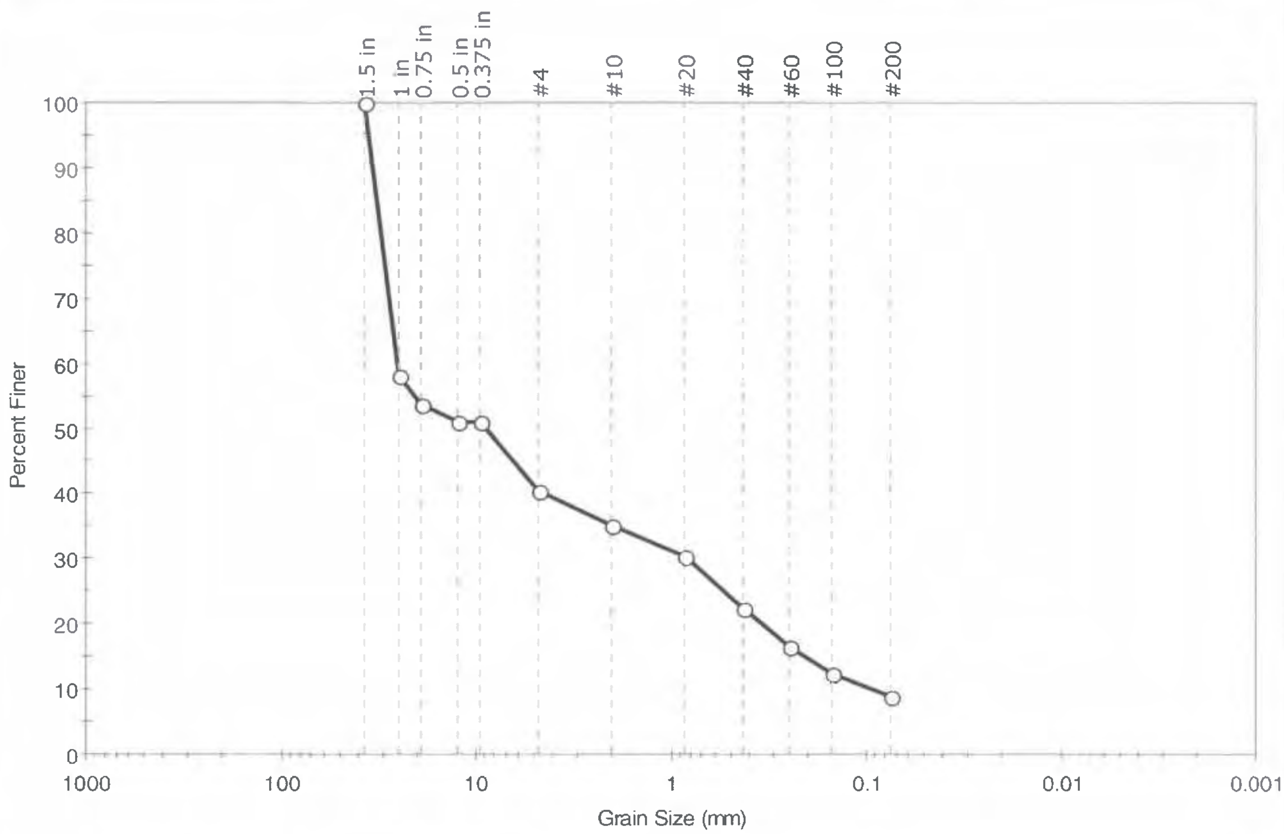
Toughness: LOW

GeoTesting express

a subsidiary of Geocomp Corporation

Client: O'Brien & Gere Engineering			
Project: Delaware River Deepening Project			
Location: Tinicum to Marcus Hook Ranges, PA		Project No:	GTX-9915
Boring ID: CB-289	Sample Type: jar	Tested By:	jbr
Sample ID:S-2	Test Date: 06/23/10	Checked By:	njh
Depth : 2-2 ft 11 in	Test Id: 183152		
Test Comment: ---			
Sample Description: Moist, very dark grayish brown gravel with silt and sand			
Sample Comment: Removed one 3" rock from sample			

Particle Size Analysis - ASTM D 422-63 (reapproved 2002)



% Cobble	% Gravel	% Sand	% Silt & Clay Size
---	59.6	31.4	9.0

Sieve Name	Sieve Size, mm	Percent Finer	Spec. Percent	Complies
1.5 in	37.50	100		
1 in	25.00	58		
0.75 in	19.00	54		
0.5 in	12.50	51		
0.375 in	9.50	51		
#4	4.75	40		
#10	2.00	35		
#20	0.85	30		
#40	0.42	23		
#60	0.25	17		
#100	0.15	13		
#200	0.075	9		

Coefficients

D_{85} = 32.4288 mm | D_{30} = 0.8321 mm

D_{60} = 25.4544 mm | D_{15} = 0.2052 mm

D_{50} = 8.9236 mm | D_{10} = 0.0916 mm

C_u = 277.886 | C_c = 0.297

Classification

ASTM N/A

AASHTO Stone Fragments, Gravel and Sand (A-1-a (0))

Sample/Test Description

Sand/Gravel Particle Shape : ANGULAR

Sand/Gravel Hardness : HARD

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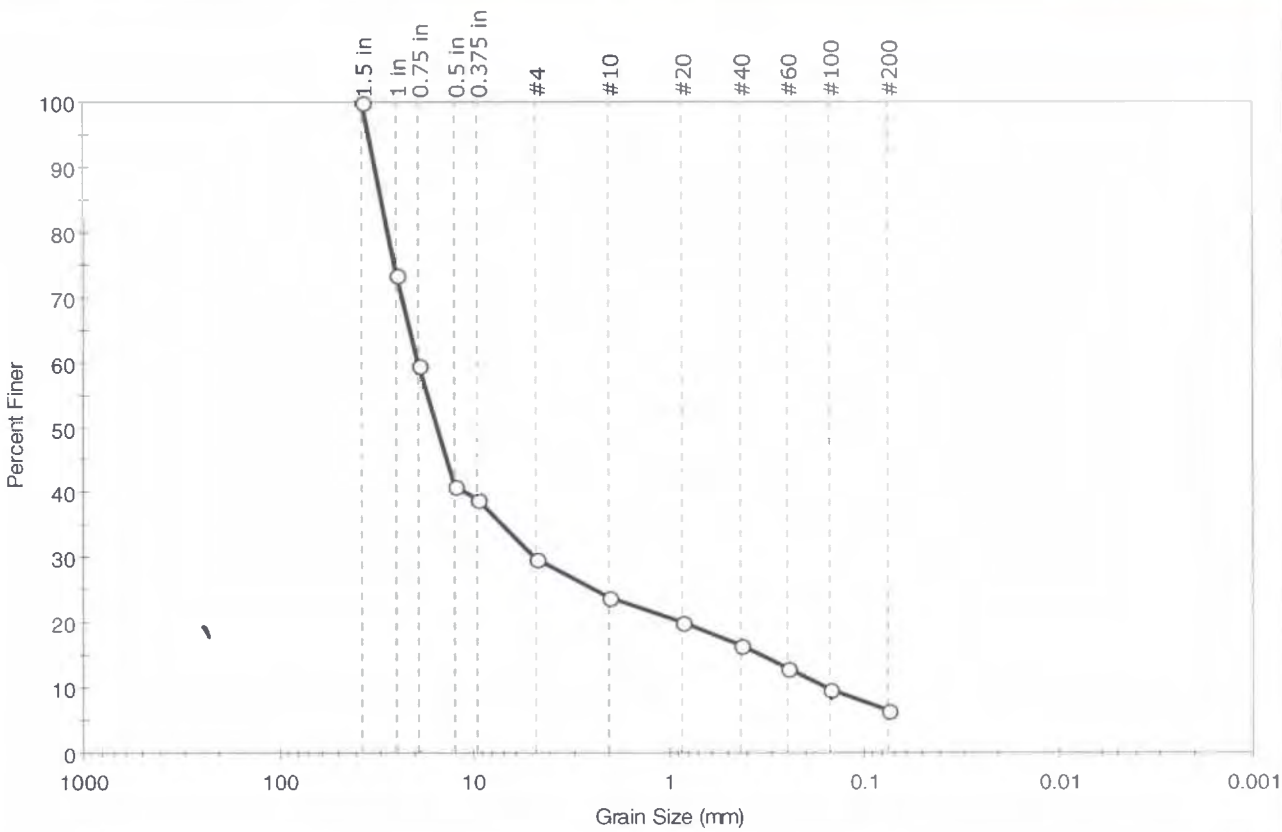
GeoTesting express

Client: O'Brien & Gere Engineering			
Project: Delaware River Deepening Project			
Location: Tinicum to Marcus Hook Ranges, PA		Project No:	GTX-9915
Boring ID: CB-292	Sample Type: jar	Tested By:	jbr
Sample ID: S-1	Test Date: 06/23/10	Checked By:	njh
Depth : 0-2 ft	Test Id: 183153		
Test Comment: ---			
Sample Description: Moist, very dark grayish brown gravel with silt and sand			
Sample Comment: ---			

Particle Size Analysis - ASTM D 422-63 (reapproved 2002)



% Cobble	% Gravel	% Sand	% Silt & Clay Size
---	70.3	23.1	6.6

Sieve Name	Sieve Size, mm	Percent Finer	Spec. Percent	Complies
1.5 in	37.50	100		
1 in	25.00	73		
0.75 in	19.00	60		
0.5 in	12.50	41		
0.375 in	9.50	39		
#4	4.75	30		
#10	2.00	24		
#20	0.85	20		
#40	0.42	16		
#60	0.25	13		
#100	0.15	10		
#200	0.075	7		

Coefficients

D_{85} = 29.8438 mm D_{30} = 4.8763 mm
D_{60} = 19.1189 mm D_{15} = 0.3386 mm
D_{50} = 15.2660 mm D_{10} = 0.1570 mm
C_u = 121.776 C_c = 7.922

Classification

ASTM N/A

AASHTO Stone Fragments, Gravel and Sand (A-1-a (0))

Sample/Test Description

Sand/Gravel Particle Shape : ROUNDED

Sand/Gravel Hardness : HARD

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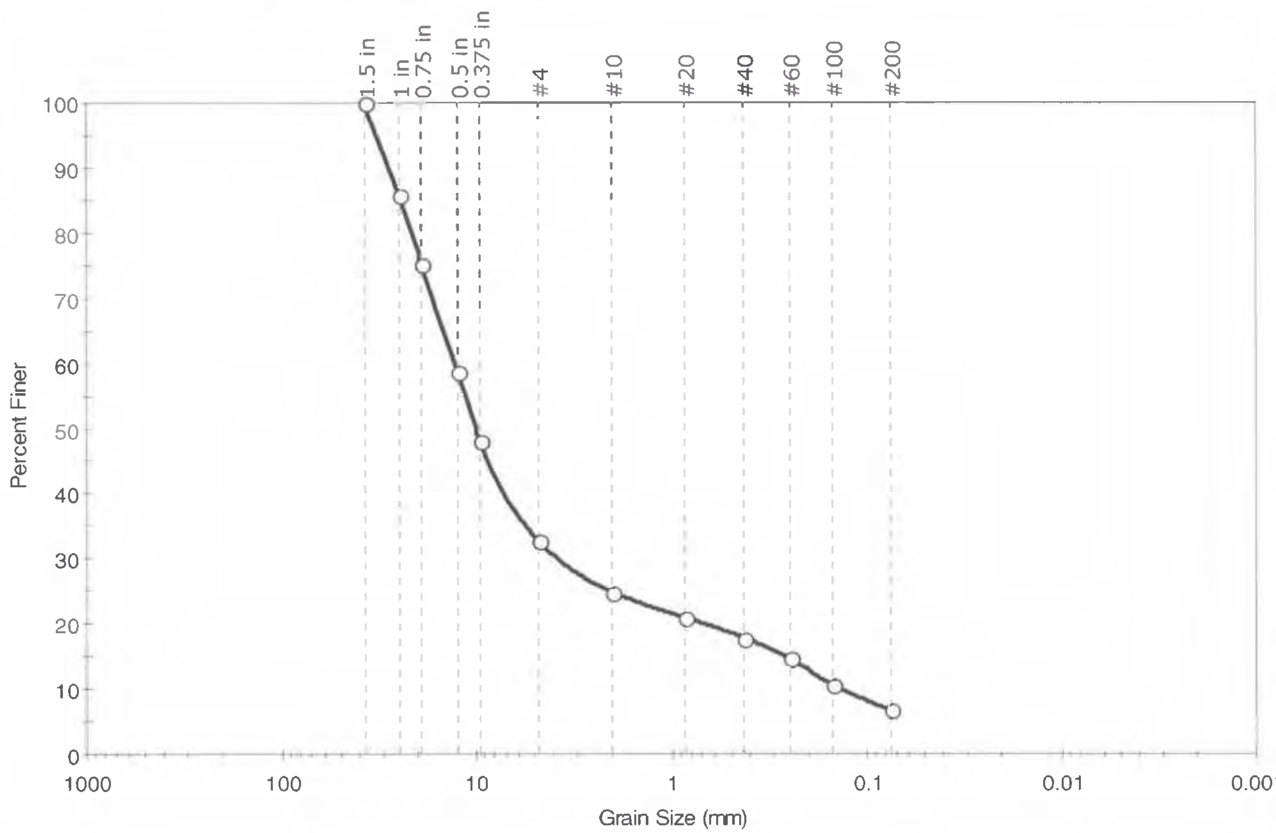
Client: O'Brien & Gere Engineering			
Project: Delaware River Deepening Project			
Location: Tinicum to Marcus Hook Ranges, PA		Project No:	GTX-9915
Boring ID: CB-292	Sample Type: jar	Tested By:	jbr
Sample ID: S-2	Test Date: 06/23/10	Checked By:	njh
Depth : 2-2 ft 10 in	Test Id: 183154		
Test Comment: ---			
Sample Description: Moist, dark olive gray gravel with silt and sand			
Sample Comment: Removed one 2" rock from sample			

Particle Size Analysis - ASTM D 422-63 (reapproved 2002)



% Cobble	% Gravel	% Sand	% Silt & Clay Size
---	67.3	26.0	6.7

Sieve Name	Sieve Size, mm	Percent Finer	Spec. Percent	Complies
1.5 in	37.50	100		
1 in	25.00	86		
0.75 in	19.00	75		
0.5 in	12.50	59		
0.375 in	9.50	48		
#4	4.75	33		
#10	2.00	25		
#20	0.85	21		
#40	0.42	18		
#60	0.25	15		
#100	0.15	11		
#200	0.075	7		

Coefficients

D_{85} = 24.4588 mm — D_{30} = 3.5423 mm
D_{60} = 12.9218 mm — D_{15} = 0.2654 mm
D_{50} = 10.0123 mm — D_{10} = 0.1350 mm
C_u = 95.717 — C_c = 7.193

Classification

ASTM N/A

AASHTO Stone Fragments, Gravel and Sand (A-1-a (0))

Sample/Test Description

Sand/Gravel Particle Shape : ROUNDED

Sand/Gravel Hardness : HARD

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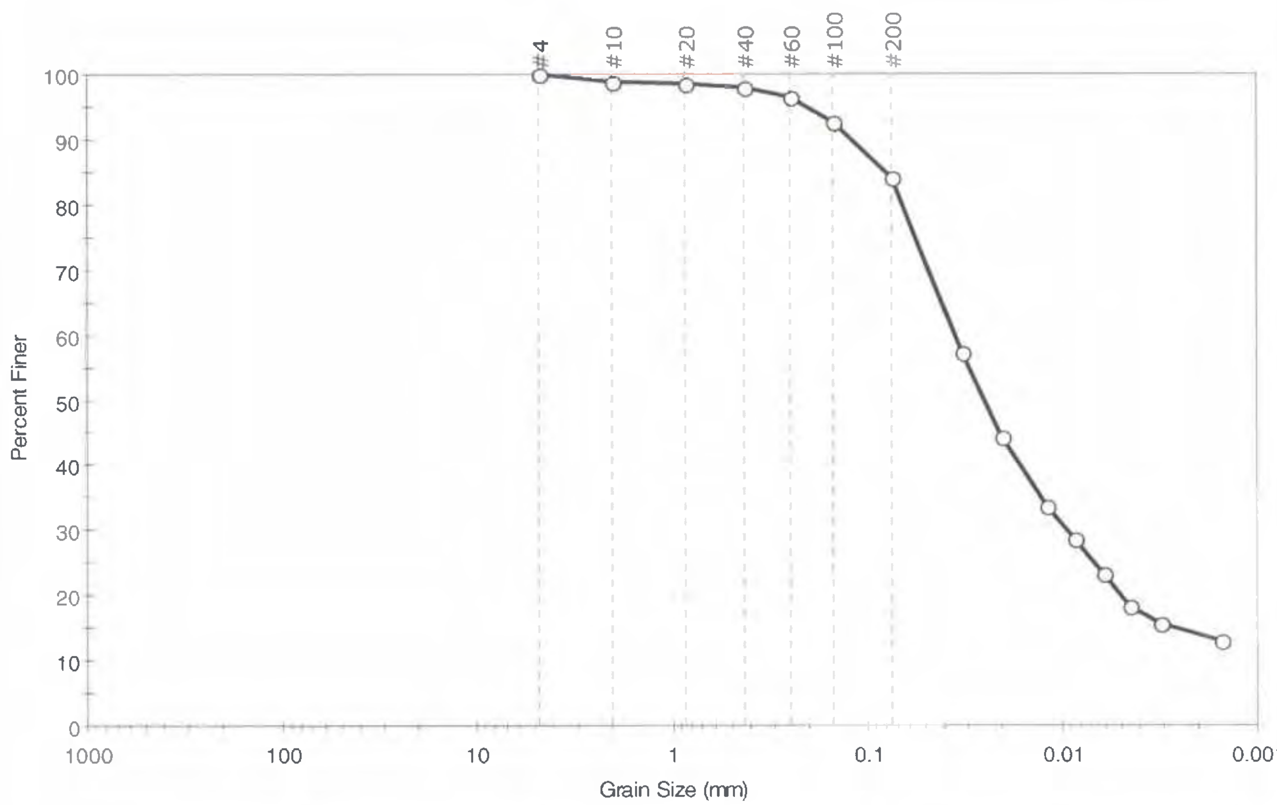
Client: O'Brien & Gere Engineering			
Project: Delaware River Deepening Project			
Location: Tinicum to Marcus Hook Ranges, PA		Project No:	GTX-9915
Boring ID: CB-293	Sample Type: jar	Tested By:	jbr
Sample ID:S-2	Test Date: 06/21/10	Checked By:	njh
Depth : 2-4 ft	Test Id: 183150		
Test Comment: ---			
Sample Description: Moist, very dark grayish brown silt with sand			
Sample Comment: ---			

Particle Size Analysis - ASTM D 422-63 (reapproved 2002)



% Cobble	% Gravel	% Sand	% Silt & Clay Size
---	0.0	16.1	83.9

Sieve Name	Sieve Size, mm	Percent Finer	Spec. Percent	Complies
#4	4.75	100		
#10	2.00	99		
#20	0.85	99		
#40	0.42	98		
#60	0.25	97		
#100	0.15	93		
#200	0.075	84		
---	Particle Size (mm)	Percent Finer	Spec Percent	Complies
---	0.0324	57		
---	0.0202	44		
---	0.0118	34		
---	0.0086	29		
---	0.0061	23		
---	0.0044	18		
---	0.0032	16		
---	0.0015	13		

Coefficients

D_{85} = 0.0816 mm D_{30} = 0.0094 mm
D_{60} = 0.0354 mm D_{15} = 0.0027 mm
D_{50} = 0.0250 mm D_{10} = 0.0007 mm
C_u = N/A C_c = N/A

Classification

ASTM elastic silt with sand (MH)

AASHTO Clayey Soils (A-7-5 (31))

Sample/Test Description

Sand/Gravel Particle Shape : ---

Sand/Gravel Hardness : ---

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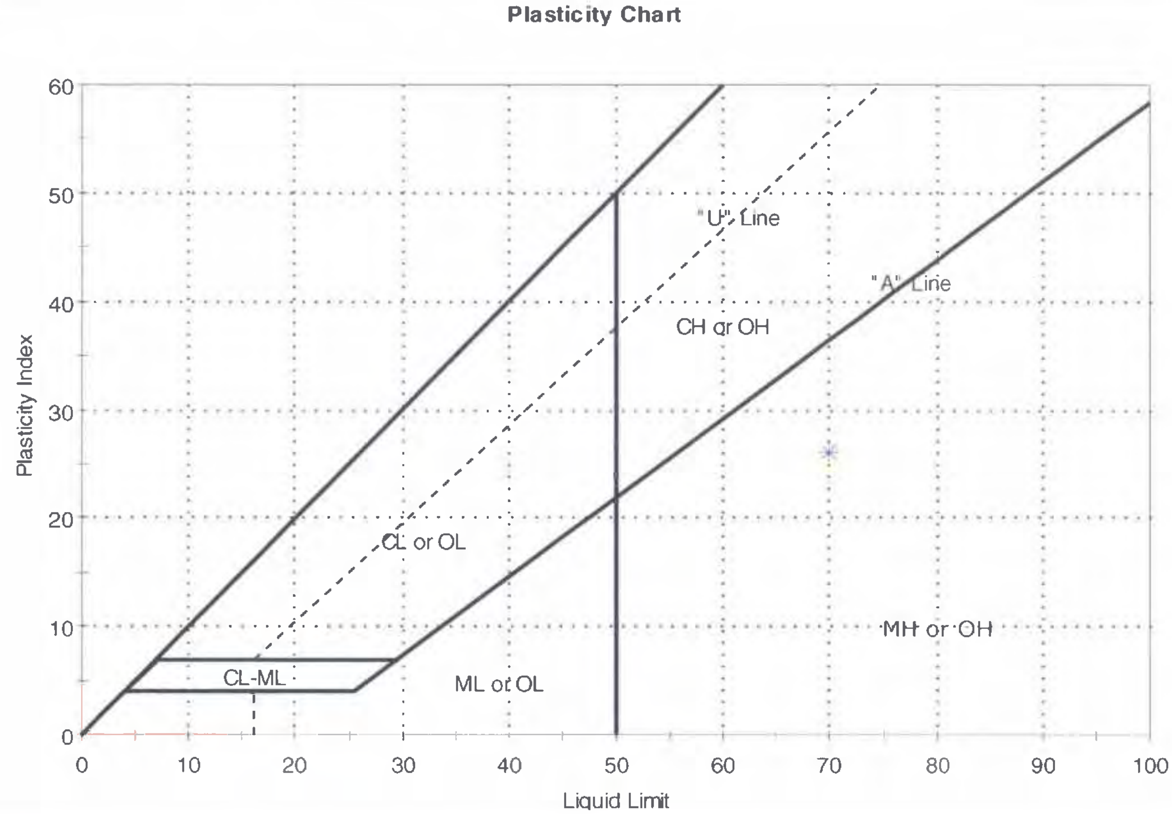
Client:	O'Brien & Gere Engineering		
Project:	Delaware River Deepening Project		
Location:	Tinicum to Marcus Hook Ranges, PA	Project No:	GTX-9915
Boring ID: CB-293	Sample Type: jar	Tested By:	cam
Sample ID: S-2	Test Date: 06/18/10	Checked By:	njh
Depth : 2-4 ft	Test Id: 183143		
Test Comment:	---		
Sample Description:	Moist, very dark grayish brown silt with sand		
Sample Comment:	---		

Atterberg Limits - ASTM D 4318-05



Symbol	Sample ID	Boring	Depth	Natural Moisture Content,%	Liquid Limit	Plastic Limit	Plasticity Index	Liquidity Index	Soil Classification
*	S-2	CB-293	2-4 ft	59	70	44	26	1	elastic silt with sand (MH)

Sample Prepared using the WET method

2% Retained on #40 Sieve

Dry Strength: VERY HIGH

Dilentancy: SLOW

Toughness: LOW

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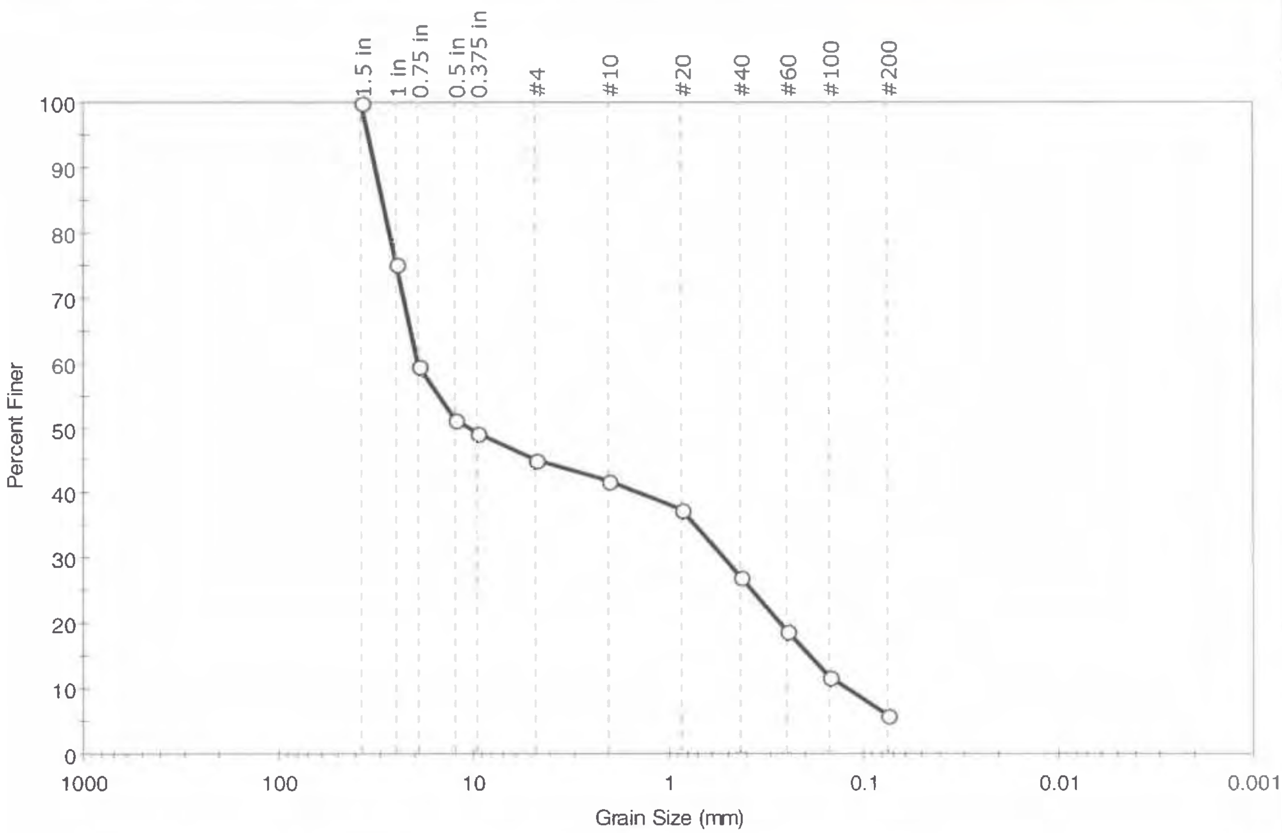
Client: O'Brien & Gere Engineering			
Project: Delaware River Deepening Project			
Location: Tinicum to Marcus Hook Ranges, PA		Project No:	GTX-9915
Boring ID: CB-295	Sample Type: jar	Tested By:	jbr
Sample ID:S-1	Test Date: 06/23/10	Checked By:	njh
Depth : 0-2 ft	Test Id: 183155		
Test Comment: ---			
Sample Description: Moist, very dark grayish brown gravel with silt and sand			
Sample Comment: Removed one 2" rock from sample			

Particle Size Analysis - ASTM D 422-63 (reapproved 2002)



% Cobble	% Gravel	% Sand	% Silt & Clay Size
—	55.0	39.1	5.9

Sieve Name	Sieve Size, mm	Percent Finer	Spec. Percent	Complies
1.5 in	37.50	100		
1 in	25.00	75		
0.75 in	19.00	60		
0.5 in	12.50	51		
0.375 in	9.50	49		
#4	4.75	45		
#10	2.00	42		
#20	0.85	37		
#40	0.42	27		
#60	0.25	19		
#100	0.15	12		
#200	0.075	6		

Coefficients

D_{85} =29.3222 mm D_{30} =0.5135 mm

D_{60} =19.1318 mm D_{15} =0.1891 mm

D_{50} =10.3724 mm D_{10} =0.1208 mm

C_u =158.376 C_c =0.114

Classification

ASTM N/A

AASHTO Stone Fragments, Gravel and Sand (A-1-a (0))

Sample/Test Description

Sand/Gravel Particle Shape : ROUNDED

Sand/Gravel Hardness : HARD

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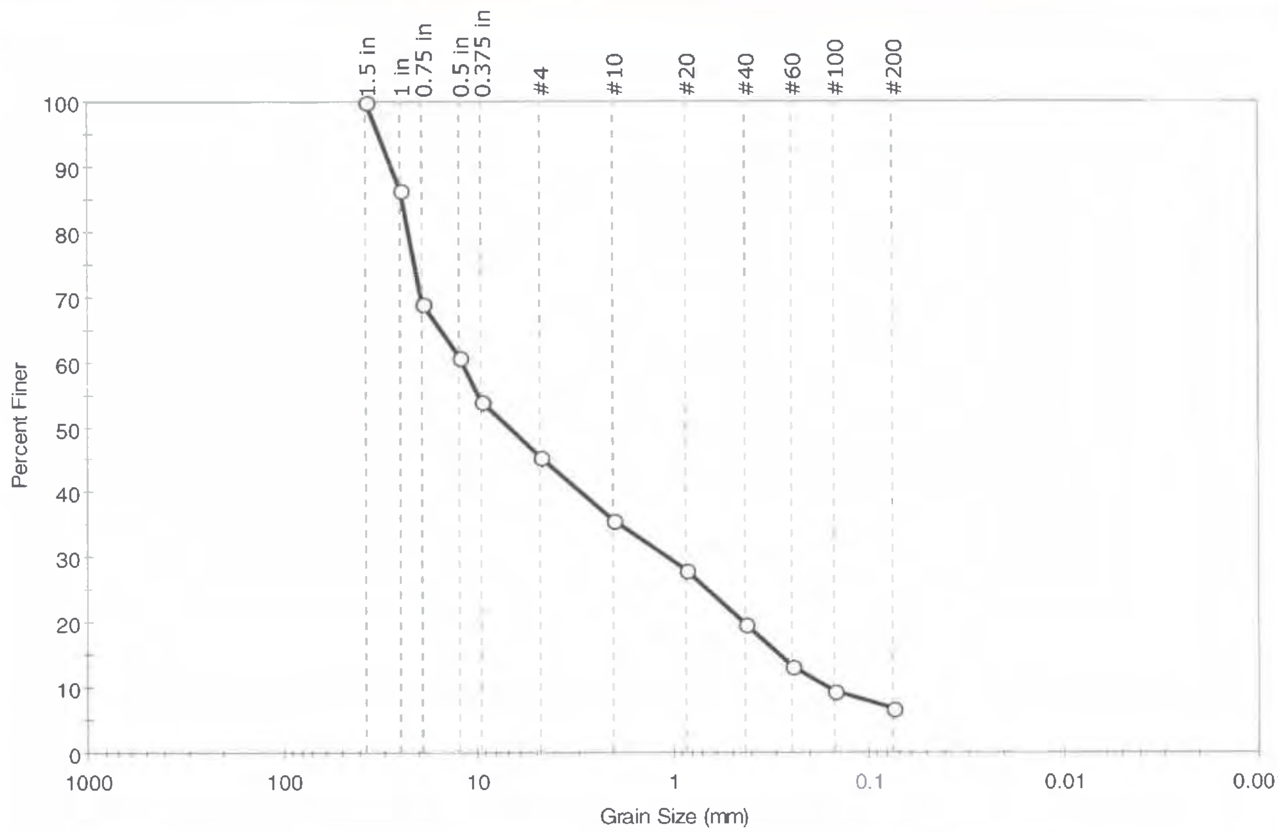
Client: O'Brien & Gere Engineering			
Project: Delaware River Deepening Project			
Location: Tinicum to Marcus Hook Ranges, PA		Project No:	GTX-9915
Boring ID: CB-296	Sample Type: jar	Tested By:	jbr
Sample ID: S-1	Test Date: 06/23/10	Checked By:	njh
Depth : 0-2 ft	Test Id: 183156		
Test Comment: ---			
Sample Description: Moist, dark olive brown gravel with silt and sand			
Sample Comment: ---			

Particle Size Analysis - ASTM D 422-63 (reapproved 2002)



% Cobble	% Gravel	% Sand	% Silt & Clay Size
---	54.7	38.6	6.7

Sieve Name	Sieve Size, mm	Percent Finer	Spec. Percent	Complies
1.5 in	37.50	100		
1 in	25.00	86		
0.75 in	19.00	69		
0.5 in	12.50	61		
0.375 in	9.50	54		
#4	4.75	45		
#10	2.00	36		
#20	0.85	28		
#40	0.42	20		
#60	0.25	13		
#100	0.15	9		
#200	0.075	7		

Coefficients

D_{85} = 24.4882 mm D_{30} = 1.0636 mm

D_{60} = 12.1650 mm D_{15} = 0.2874 mm

D_{50} = 6.9230 mm D_{10} = 0.1642 mm

C_u = 74.086 C_c = 0.566

Classification

ASTM N/A

AASHTO Stone Fragments, Gravel and Sand (A-1-a (0))

Sample/Test Description

Sand/Gravel Particle Shape : ROUNDED

Sand/Gravel Hardness : HARD

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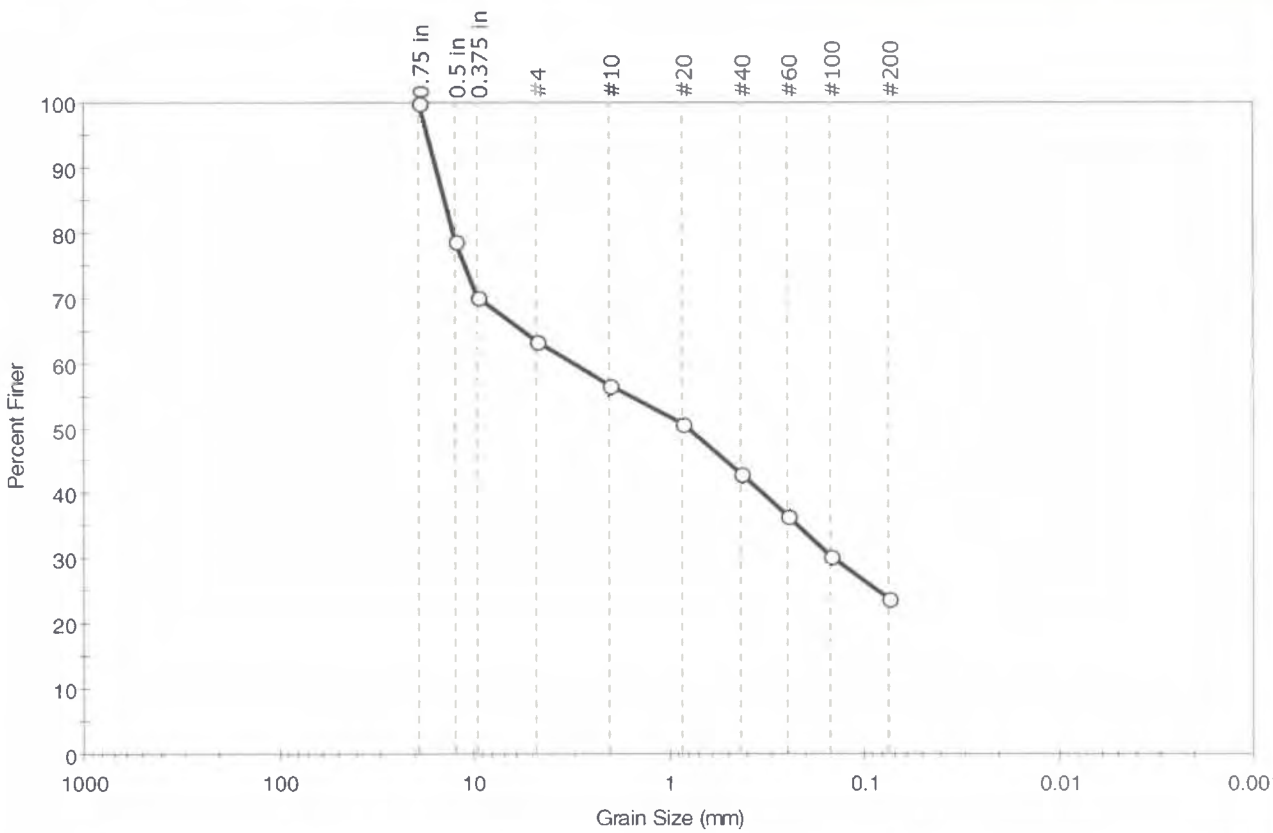
Client: O'Brien & Gere Engineering			
Project: Delaware River Deepening Project			
Location: Tinicum to Marcus Hook Ranges, PA		Project No:	GTX-9915
Boring ID: CB-296	Sample Type: jar	Tested By:	jbr
Sample ID: S-2	Test Date: 06/21/10	Checked By:	njh
Depth : 2-4 ft	Test Id: 183157		
Test Comment: ---			
Sample Description: Moist, olive brown silty clayey sand with gravel			
Sample Comment: ---			

Particle Size Analysis - ASTM D 422-63 (reapproved 2002)



% Cobble	% Gravel	% Sand	% Silt & Clay Size
---	36.6	39.5	23.9

Sieve Name	Sieve Size, mm	Percent Finer	Spec. Percent	Complies
0.75 in	19.00	100		
0.5 in	12.50	79		
0.375 in	9.50	70		
#4	4.75	63		
#10	2.00	57		
#20	0.85	51		
#40	0.42	43		
#60	0.25	37		
#100	0.15	30		
#200	0.075	24		

Coefficients

D_{85} = 14.1326 mm | D_{30} = 0.1443 mm

D_{60} = 3.0802 mm | D_{15} = N/A

D_{50} = 0.7871 mm | D_{10} = N/A

C_u = N/A | C_c = N/A

Classification

ASTM Silty, clayey sand with gravel (SC-SM)

AASHTO Stone Fragments, Gravel and Sand (A-1-b (0))

Sample/Test Description

Sand/Gravel Particle Shape : ROUNDED

Sand/Gravel Hardness : HARD

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GeoTesting express
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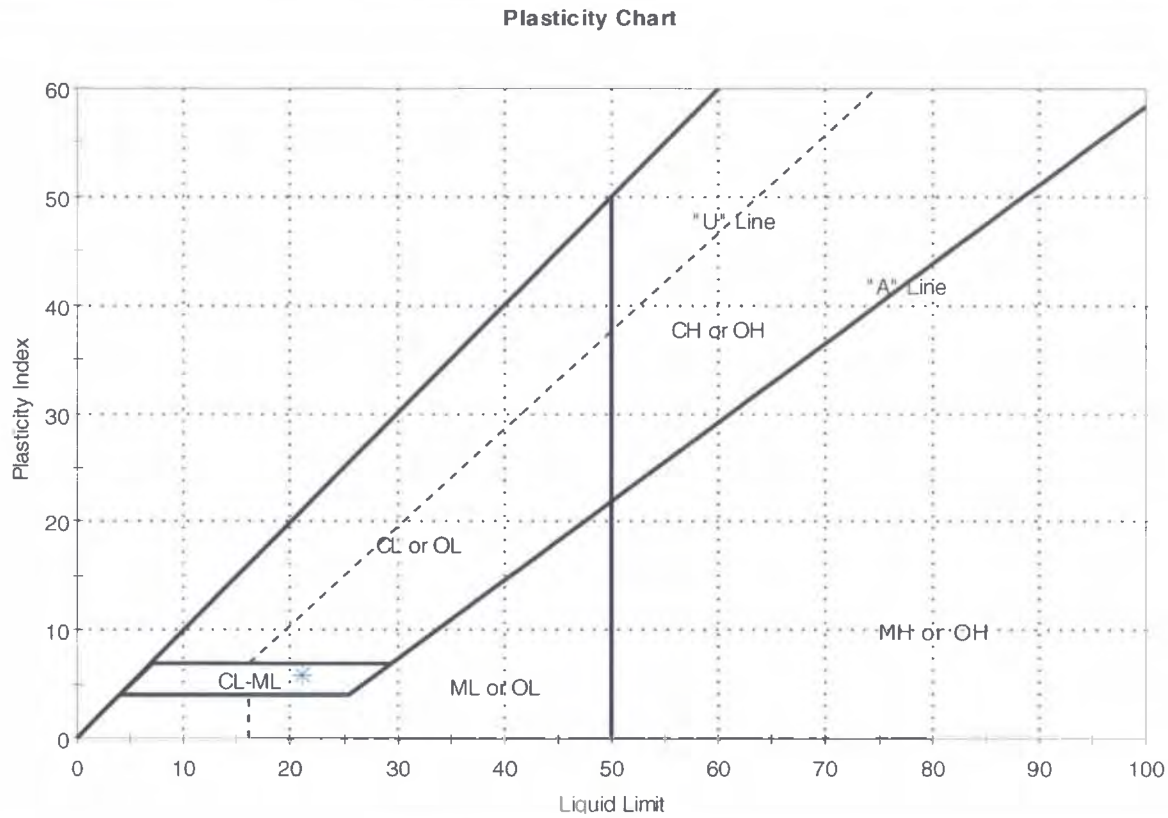
Client:	O'Brien & Gere Engineering				
Project:	Delaware River Deepening Project				
Location:	Tinicum to Marcus Hook Ranges, PA			Project No:	GTX-9915
Boring ID: CB-296		Sample Type:	jar	Tested By:	cam
Sample ID:S-2		Test Date:	06/23/10	Checked By:	njh
Depth : 2-4 ft		Test Id:	183144		
Test Comment:	---				
Sample Description:	Moist, olive brown silty clayey sand with gravel				
Sample Comment:	---				

Atterberg Limits - ASTM D 4318-05



Symbol	Sample ID	Boring	Depth	Natural Moisture Content,%	Liquid Limit	Plastic Limit	Plasticity Index	Liquidity Index	Soil Classification
*	S-2	CB-296	2-4 ft	5	21	15	6	-2	Silty, clayey sand with gravel (SC-SM)

Sample Prepared using the WET method

57% Retained on #40 Sieve

Dry Strength: VERY HIGH

Dilentancy: SLOW

Toughness: LOW

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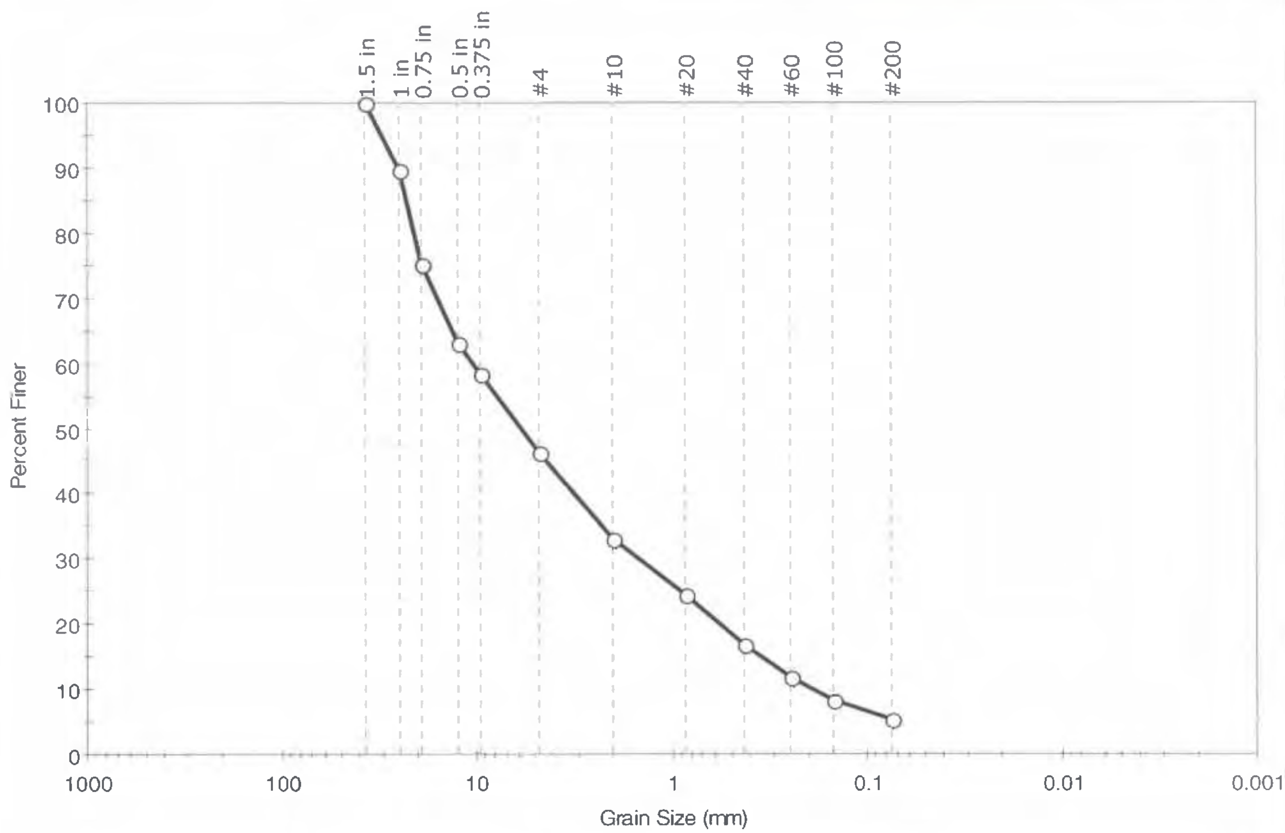
a subsidiary of Geocomp Corporation

Client: O'Brien & Gere Engineering			
Project: Delaware River Deepening Project			
Location: Tinicum to Marcus Hook Ranges, PA		Project No:	GTX-9915
Boring ID: CB-298	Sample Type: jar	Tested By:	jbr
Sample ID: S-1	Test Date: 06/23/10	Checked By:	njh
Depth : 0-2 ft	Test Id: 183158		

Test Comment: ---
Sample Description: Moist,very dark grayish brown gravel with silt and sand
Sample Comment: Removed one 2" rock from sample

Particle Size Analysis - ASTM D 422-63 (reapproved 2002)



% Cobble	% Gravel	% Sand	% Silt & Clay Size
---	53.6	41.0	5.4

Sieve Name	Sieve Size, mm	Percent Finer	Spec. Percent	Complies
1.5 in	37.50	100		
1 in	25.00	90		
0.75 in	19.00	75		
0.5 in	12.50	63		
0.375 in	9.50	58		
#4	4.75	46		
#10	2.00	33		
#20	0.85	24		
#40	0.42	17		
#60	0.25	12		
#100	0.15	8		
#200	0.075	5		

Coefficients

D_{85} = 22.9168 mm D_{30} = 1.4796 mm
D_{60} = 10.4558 mm D_{15} = 0.3495 mm
D_{50} = 5.8495 mm D_{10} = 0.1951 mm
C_u = 53.592 C_c = 1.073

Classification

ASTM N/A

AASHTO Stone Fragments, Gravel and Sand (A-1-a (0))

Sample/Test Description

Sand/Gravel Particle Shape : ROUNDED
Sand/Gravel Hardness : HARD

GeoTesting express
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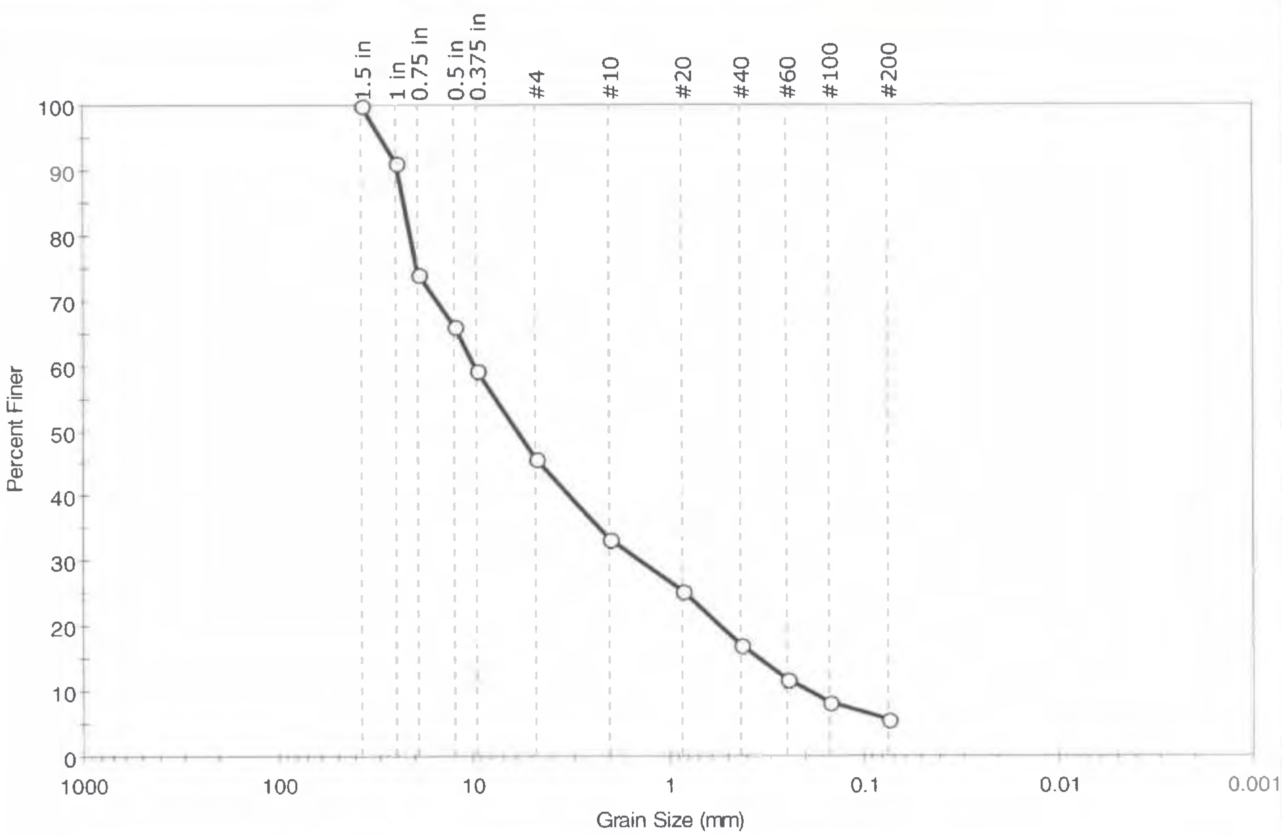
Client: O'Brien & Gere Engineering			
Project: Delaware River Deepening Project			
Location: Tinicum to Marcus Hook Ranges, PA		Project No:	GTX-9915
Boring ID: CB-298	Sample Type: jar	Tested By:	jbr
Sample ID: S-2A	Test Date: 06/23/10	Checked By:	njh
Depth : 2-3 ft	Test Id: 183149		
Test Comment: ---			
Sample Description: Moist, dark olive brown gravel with silt and sand			
Sample Comment: ---			

Particle Size Analysis - ASTM D 422-63 (reapproved 2002)



% Cobble	% Gravel	% Sand	% Silt & Clay Size
—	54.1	40.2	5.7

Sieve Name	Sieve Size, mm	Percent Finer	Spec. Percent	Complies
1.5 in	37.50	100		
1 in	25.00	91		
0.75 in	19.00	74		
0.5 in	12.50	66		
0.375 in	9.50	59		
#4	4.75	46		
#10	2.00	33		
#20	0.85	25		
#40	0.42	17		
#60	0.25	12		
#100	0.15	8		
#200	0.075	6		

Coefficients

D_{85} = 22.6257 mm	D_{30} = 1.3866 mm
D_{60} = 9.7866 mm	D_{15} = 0.3420 mm
D_{50} = 5.8877 mm	D_{10} = 0.1918 mm
C_u = 51.025	C_c = 1.024

Classification

ASTM Well-graded gravel with silt and sand (GW-GM)

AASHTO Stone Fragments, Gravel and Sand (A-1-a (0))

Sample/Test Description

Sand/Gravel Particle Shape : ROUNDED

Sand/Gravel Hardness : HARD

GeoTesting express
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Client:	O'Brien & Gere Engineering		
Project:	Delaware River Deepening Project		
Location:	Tinicum to Marcus Hook Ranges, PA	Project No:	GTX-9915
Boring ID: CB-298	Sample Type: jar	Tested By:	cam
Sample ID:S-2A	Test Date: 06/21/10	Checked By:	njh
Depth : 2-3 ft	Test Id: 183142		
Test Comment:	---		
Sample Description:	Moist, dark olive brown gravel with silt and sand		
Sample Comment:	---		

Atterberg Limits - ASTM D 4318-05

Sample Determined to be non-plastic

Symbol	Sample ID	Boring	Depth	Natural Moisture Content,%	Liquid Limit	Plastic Limit	Plasticity Index	Liquidity Index	Soil Classification
*	S-2A	CB-298	2-3 ft	6	n/a	n/a	n/a	n/a	Well-graded gravel with silt and sand (GW-GM)

83% Retained on #40 Sieve

Dry Strength: NONE

Dilentancy: RAPID

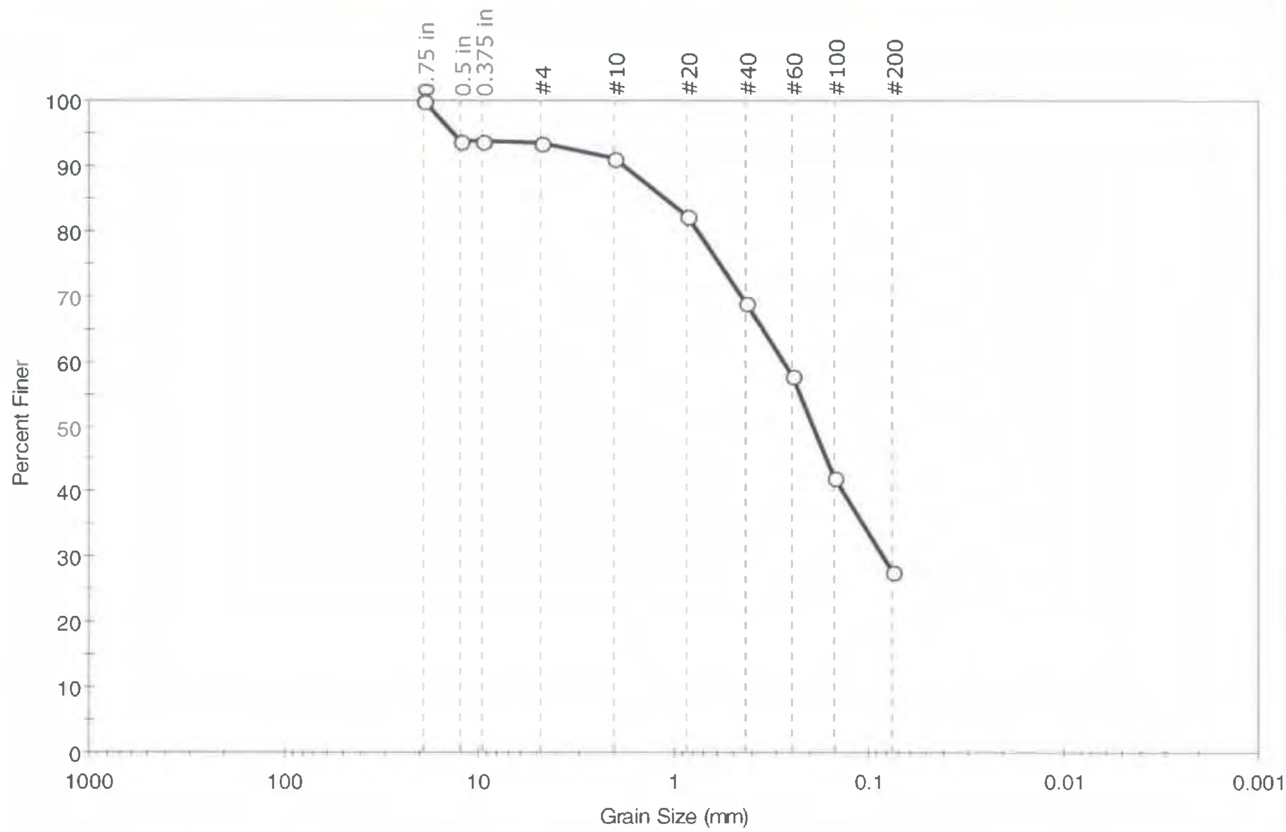
Toughness: n/a

The sample was determined to be Non-Plastic

GeoTesting express
a subsidiary of Geocomp Corporation

Client:	O'Brien & Gere Engineering		
Project:	Delaware River Deepening Project		
Location:	Tinicum to Marcus Hook Ranges, PA	Project No:	GTX-9915
Boring ID: CB-298	Sample Type: jar	Tested By:	jbr
Sample ID:S-2B	Test Date: 06/23/10	Checked By:	njh
Depth : 3-4 ft	Test Id: 183159		
Test Comment:	---		
Sample Description:	Moist, dark olive gray silty sand		
Sample Comment:	---		

Particle Size Analysis - ASTM D 422-63 (reapproved 2002)



% Cobble	% Gravel	% Sand	% Silt & Clay Size
—	6.6	65.8	27.6

Sieve Name	Sieve Size, mm	Percent Finer	Spec. Percent	Complies
0.75 in	19.00	100		
0.5 in	12.50	94		
0.375 in	9.50	94		
#4	4.75	93		
#10	2.00	91		
#20	0.85	82		
#40	0.42	69		
#60	0.25	58		
#100	0.15	42		
#200	0.075	28		

Coefficients

D_{85} =1.1100 mm D_{30} =0.0839 mm

D_{60} =0.2767 mm D_{15} =N/A

D_{50} =0.1932 mm D_{10} =N/A

C_u =N/A C_c =N/A

Classification

ASTM Silty sand (SM)

AASHTO Silty Gravel and Sand (A-2-4 (0))

Sample/Test Description

Sand/Gravel Particle Shape : ROUNDED

Sand/Gravel Hardness : HARD

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GeoTesting express

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Client:	O'Brien & Gere Engineering		
Project:	Delaware River Deepening Project		
Location:	Tinicum to Marcus Hook Ranges, PA	Project No:	GTX-9915
Boring ID: CB-298	Sample Type: jar	Tested By:	cam
Sample ID:S-2B	Test Date: 06/21/10	Checked By:	njh
Depth : 3-4 ft	Test Id: 183145		
Test Comment:	---		
Sample Description:	Moist, dark olive gray silty sand		
Sample Comment:	---		

Atterberg Limits - ASTM D 4318-05

Sample Determined to be non-plastic

Symbol	Sample ID	Boring	Depth	Natural Moisture Content,%	Liquid Limit	Plastic Limit	Plasticity Index	Liquidity Index	Soil Classification
*	S-2B	CB-298	3-4 ft	14	n/a	n/a	n/a	n/a	Silty sand (SM)

31% Retained on #40 Sieve

Dry Strength: MEDIUM

Dilentancy: RAPID

Toughness: n/a

The sample was determined to be Non-Plastic

GeoTesting express

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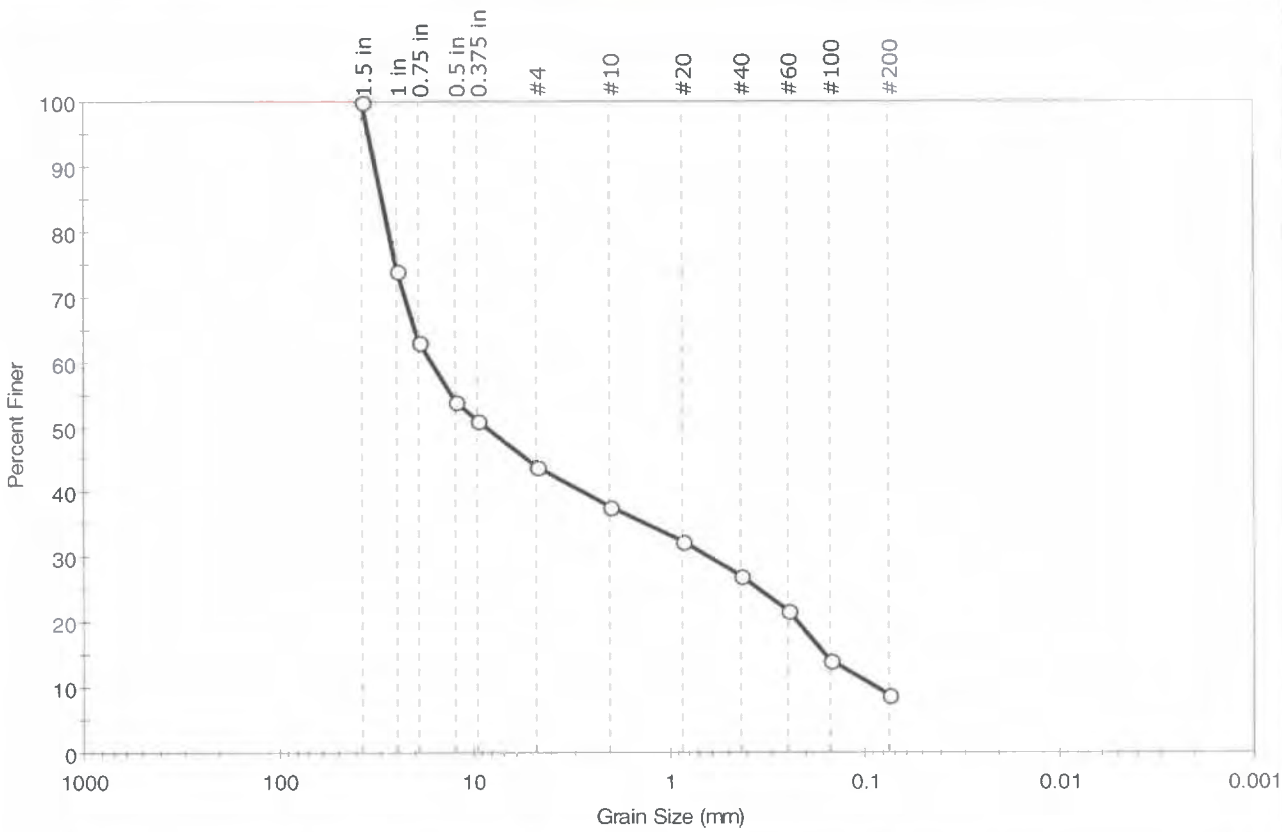
Client: O'Brien & Gere Engineering			
Project: Delaware River Deepening Project			
Location: Tinicum to Marcus Hook Ranges, PA		Project No:	GTX-9915
Boring ID: CB-299	Sample Type: jar	Tested By:	jbr
Sample ID: S-1	Test Date: 06/23/10	Checked By:	njh
Depth : 0-2 ft	Test Id: 183160		
Test Comment: ---			
Sample Description: Moist, very dark grayish brown gravel with silt and sand			
Sample Comment: ---			

Particle Size Analysis - ASTM D 422-63 (reapproved 2002)



% Cobble	% Gravel	% Sand	% Silt & Clay Size
---	56.1	35.0	8.9

Sieve Name	Sieve Size, mm	Percent Finer	Spec. Percent	Complies
1.5 in	37.50	100		
1 in	25.00	74		
0.75 in	19.00	63		
0.5 in	12.50	54		
0.375 in	9.50	51		
#4	4.75	44		
#10	2.00	38		
#20	0.85	33		
#40	0.42	27		
#60	0.25	22		
#100	0.15	14		
#200	0.075	9		

Coefficients

D_{85} = 29.6440 mm D_{30} = 0.6131 mm

D_{60} = 16.4288 mm D_{15} = 0.1598 mm

D_{50} = 8.6817 mm D_{10} = 0.0868 mm

C_u = 189.272 C_c = 0.264

Classification

ASTM N/A

AASHTO Stone Fragments, Gravel and Sand (A-1-a (0))

Sample/Test Description

Sand/Gravel Particle Shape : ROUNDED

Sand/Gravel Hardness : HARD

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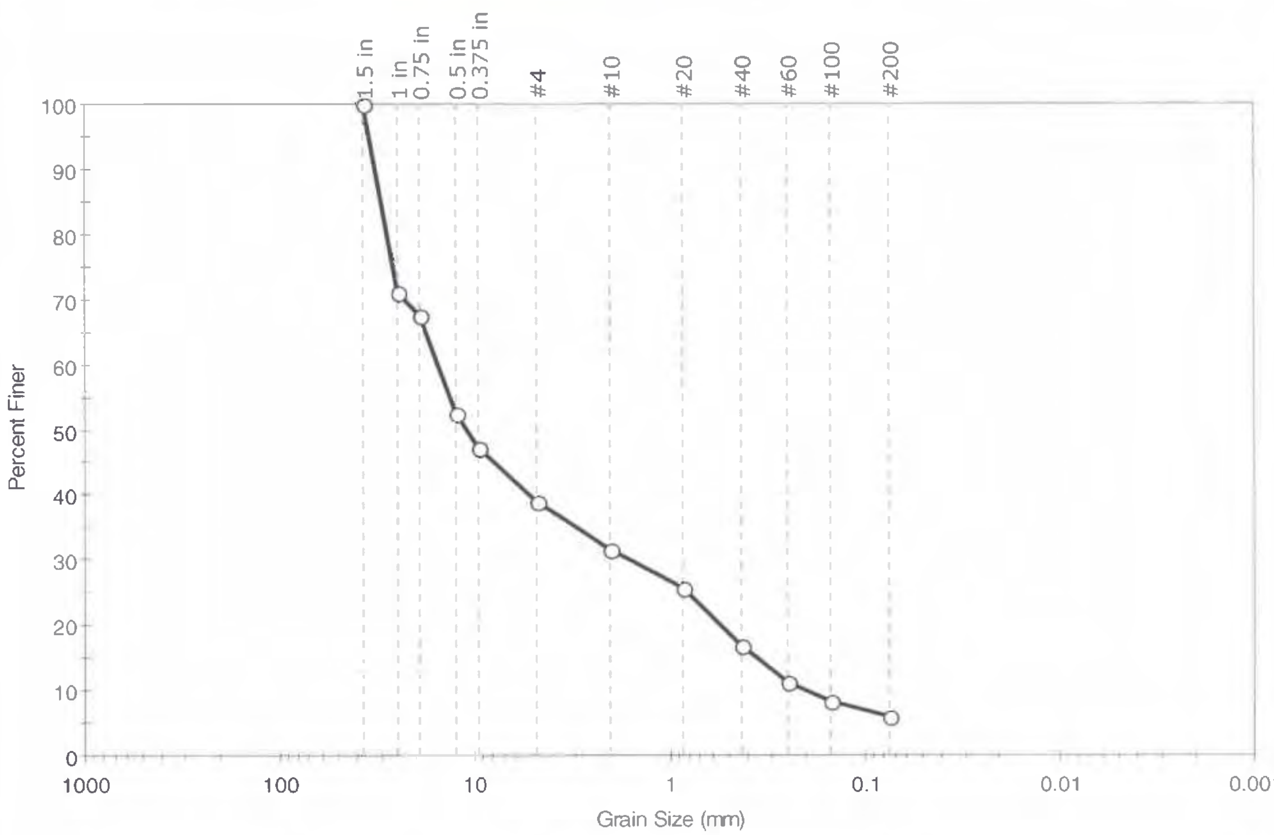
Client:	O'Brien & Gere Engineering		
Project:	Delaware River Deepening Project		
Location:	Tinicum to Marcus Hook Ranges, PA	Project No:	GTX-9915
Boring ID: CB-301	Sample Type: jar	Tested By:	jbr
Sample ID:S-1	Test Date: 06/23/10	Checked By:	njh
Depth : 0-2 ft	Test Id: 183161		
Test Comment:	---		
Sample Description:	Moist, dark olive brown gravel with silt and sand		
Sample Comment:	---		

Particle Size Analysis - ASTM D 422-63 (reapproved 2002)



% Cobble	% Gravel	% Sand	% Silt & Clay Size
—	61.1	33.1	5.8

Sieve Name	Sieve Size, mm	Percent Finer	Spec. Percent	Complies
1.5 in	37.50	100		
1 in	25.00	71		
0.75 in	19.00	67		
0.5 in	12.50	53		
0.375 in	9.50	47		
#4	4.75	39		
#10	2.00	32		
#20	0.85	26		
#40	0.42	17		
#60	0.25	11		
#100	0.15	8		
#200	0.075	6		

Coefficients

D_{85} = 30.3725 mm | D_{30} = 1.5795 mm
D_{60} = 15.4170 mm | D_{15} = 0.3568 mm
D_{50} = 10.9722 mm | D_{10} = 0.2004 mm
C_u = 76.931 | C_c = 0.807

Classification

ASTM N/A

AASHTO Stone Fragments, Gravel and Sand (A-1-a (0))

Sample/Test Description

Sand/Gravel Particle Shape : ROUNDED

Sand/Gravel Hardness : HARD

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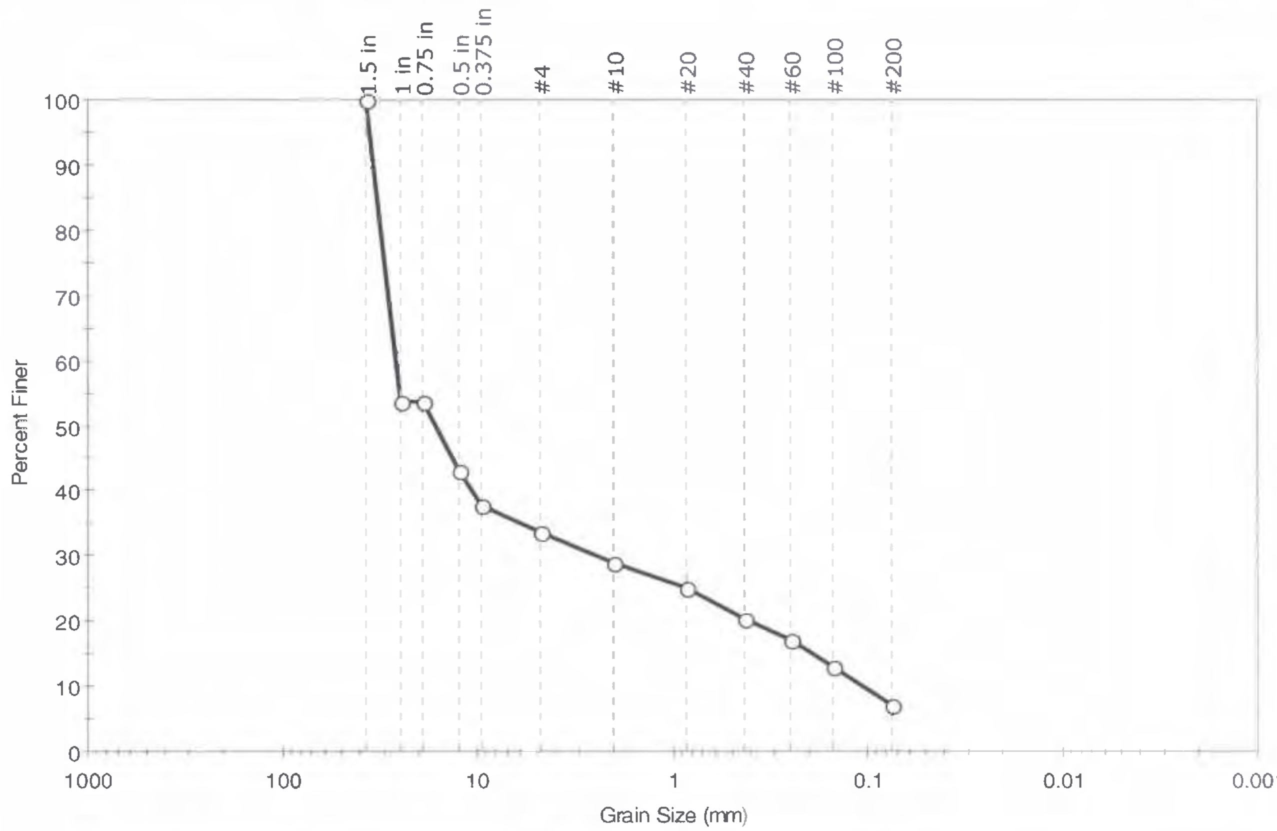
Client:	O'Brien & Gere Engineering		
Project:	Delaware River Deepening Project		
Location:	Tinicum to Marcus Hook Ranges, PA	Project No:	GTX-9915
Boring ID: CB-301	Sample Type: jar	Tested By:	jbr
Sample ID:S-2	Test Date: 06/23/10	Checked By:	njh
Depth : 2-4 ft	Test Id: 183162		
Test Comment:	---		
Sample Description:	Moist, dark olive brown gravel with silt and sand		
Sample Comment:	---		

Particle Size Analysis - ASTM D 422-63 (reapproved 2002)



% Cobble	% Gravel	% Sand	% Silt & Clay Size
—	66.5	26.4	7.1

Sieve Name	Sieve Size, mm	Percent Finer	Spec. Percent	Complies
1.5 in	37.50	100		
1 in	25.00	54		
0.75 in	19.00	54		
0.5 in	12.50	43		
0.375 in	9.50	38		
#4	4.75	34		
#10	2.00	29		
#20	0.85	25		
#40	0.42	20		
#60	0.25	17		
#100	0.15	13		
#200	0.075	7		

Coefficients

D_{85} = 32.8875 mm D_{30} = 2.4585 mm

D_{60} = 26.4260 mm D_{15} = 0.1948 mm

D_{50} = 16.4160 mm D_{10} = 0.1064 mm

C_u = 248.365 C_c = 2.150

Classification

ASTM N/A

AASHTO Stone Fragments, Gravel and Sand (A-1-a (0))

Sample/Test Description

Sand/Gravel Particle Shape : ROUNDED

Sand/Gravel Hardness : HARD

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GeoTesting express
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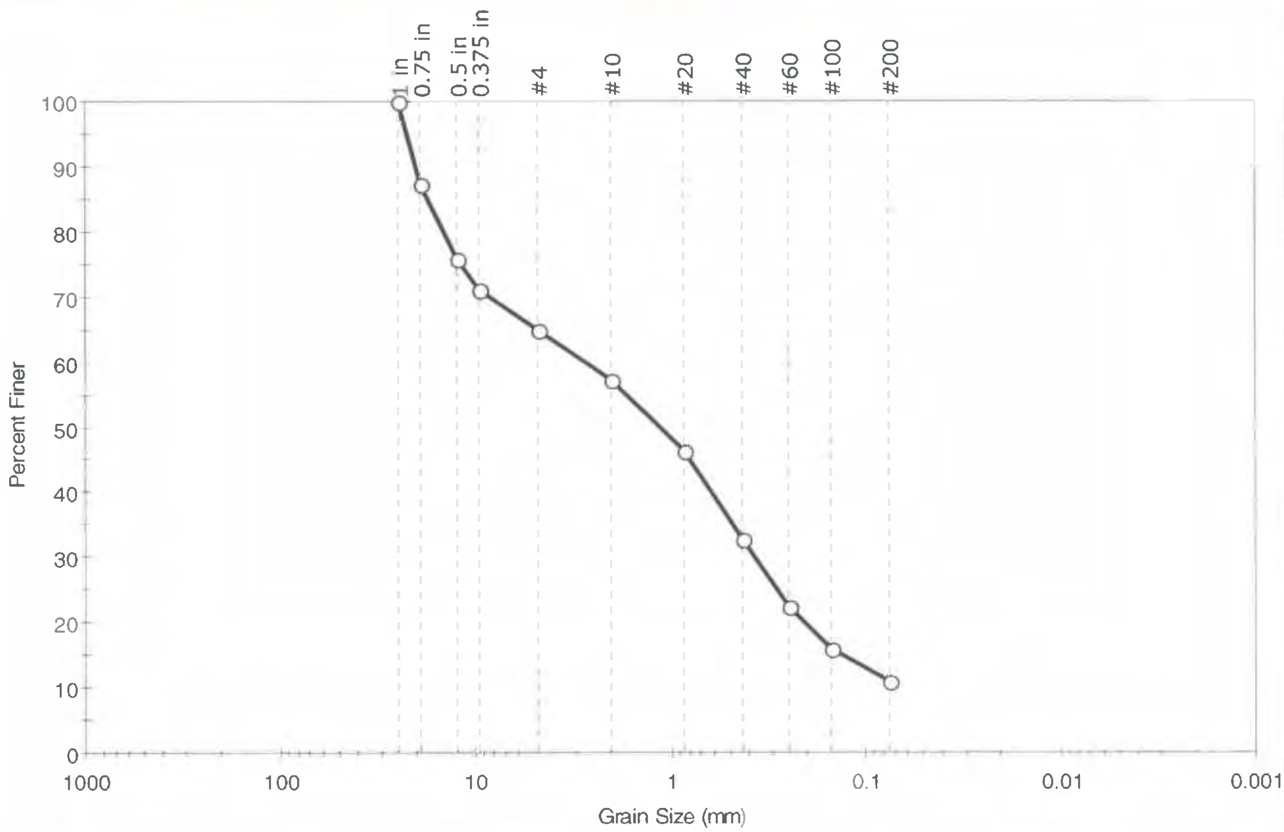
Client:	O'Brien & Gere Engineering		
Project:	Delaware River Deepening Project		
Location:	Tinicum to Marcus Hook Ranges, PA	Project No:	GTX-9915
Boring ID: CB-303	Sample Type: jar	Tested By:	jbr
Sample ID: S-1	Test Date: 06/23/10	Checked By:	njh
Depth : 0-2 ft	Test Id: 183163		
Test Comment:	---		
Sample Description:	Moist, dark olive brown sand with silt and gravel		
Sample Comment:	Removed one 2" rock from sample		

Particle Size Analysis - ASTM D 422-63 (reapproved 2002)



% Cobble	% Gravel	% Sand	% Silt & Clay Size
—	35.2	54.0	10.8

Sieve Name	Sieve Size, mm	Percent Finer	Spec. Percent	Complies
1 in	25.00	100		
0.75 in	19.00	87		
0.5 in	12.50	76		
0.375 in	9.50	71		
#4	4.75	65		
#10	2.00	57		
#20	0.85	46		
#40	0.42	33		
#60	0.25	22		
#100	0.15	16		
#200	0.075	11		

Coefficients

D_{85} = 17.3862 mm D_{30} = 0.3672 mm

D_{60} = 2.7332 mm D_{15} = 0.1325 mm

D_{50} = 1.1318 mm D_{10} = 0.0676 mm

C_u = 40.432 C_c = 0.730

Classification

ASTM N/A

AASHTO Stone Fragments, Gravel and Sand (A-1-b (0))

Sample/Test Description

Sand/Gravel Particle Shape : ROUNDED

Sand/Gravel Hardness : HARD

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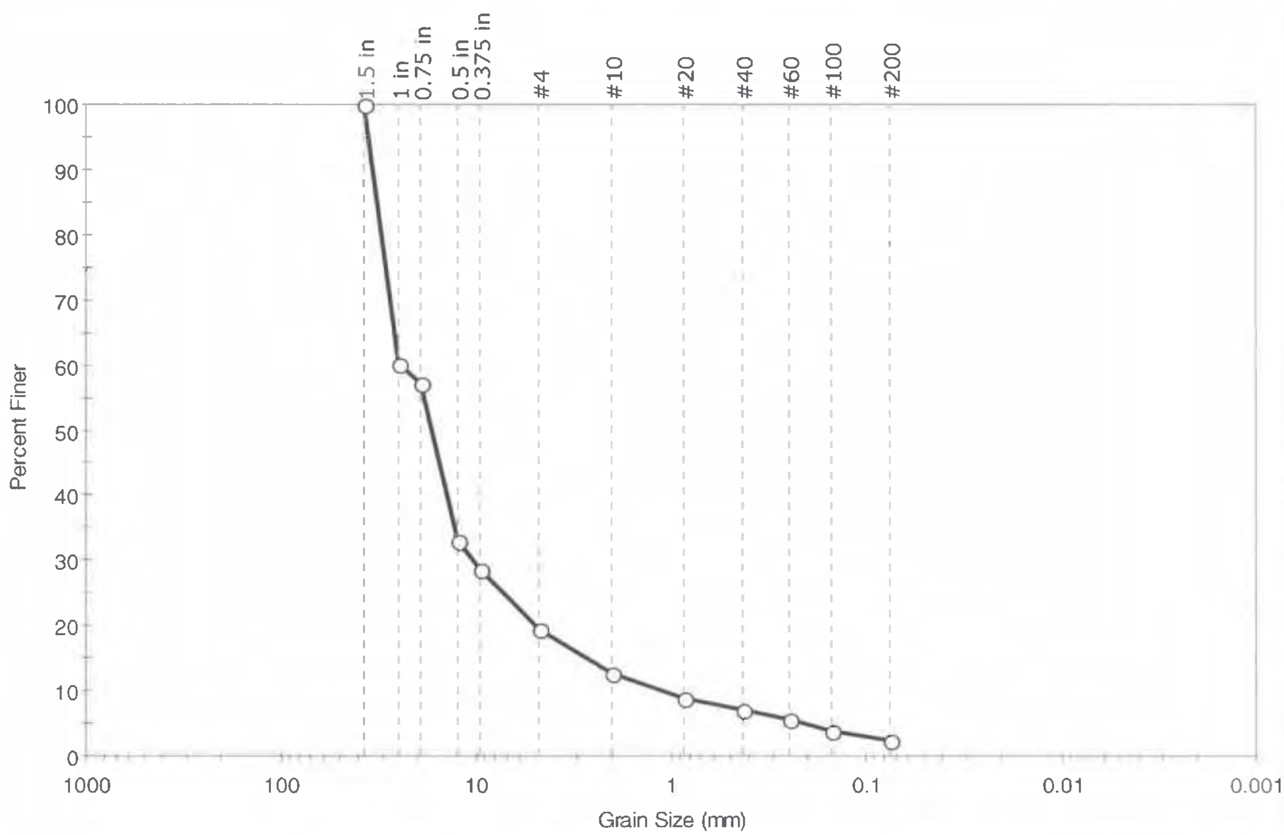
Client: O'Brien & Gere Engineering			
Project: Delaware River Deepening Project			
Location: Tinicum to Marcus Hook Ranges, PA		Project No:	GTX-9915
Boring ID: CB-305	Sample Type: jar	Tested By:	jbr
Sample ID:S-1	Test Date: 06/02/10	Checked By:	jdt
Depth : 0-2 ft	Test Id: 181651		
Test Comment: ---			
Sample Description: Moist, dark brown gravel with sand			
Sample Comment: ---			

Particle Size Analysis - ASTM D 422-63 (reapproved 2002)



% Cobble	% Gravel	% Sand	% Silt & Clay Size
---	80.6	17.0	2.4

Sieve Name	Sieve Size, mm	Percent Finer	Spec. Percent	Complies
1.5 in	37.50	100		
1 in	25.00	60		
0.75 in	19.00	57		
0.5 in	12.50	33		
0.375 in	9.50	29		
#4	4.75	19		
#10	2.00	13		
#20	0.85	9		
#40	0.42	7		
#60	0.25	6		
#100	0.15	4		
#200	0.075	2		

Coefficients

D_{85} = 32.1845 mm D_{30} = 10.3677 mm

D_{60} = 24.5117 mm D_{15} = 2.7098 mm

D_{50} = 16.7631 mm D_{10} = 1.0949 mm

C_u = 22.387 C_c = 4.005

Classification

ASTM Poorly graded gravel with sand (GP)

AASHTO Stone Fragments, Gravel and Sand (A-1-a (0))

Sample/Test Description

Sand/Gravel Particle Shape : ROUNDED

Sand/Gravel Hardness : HARD

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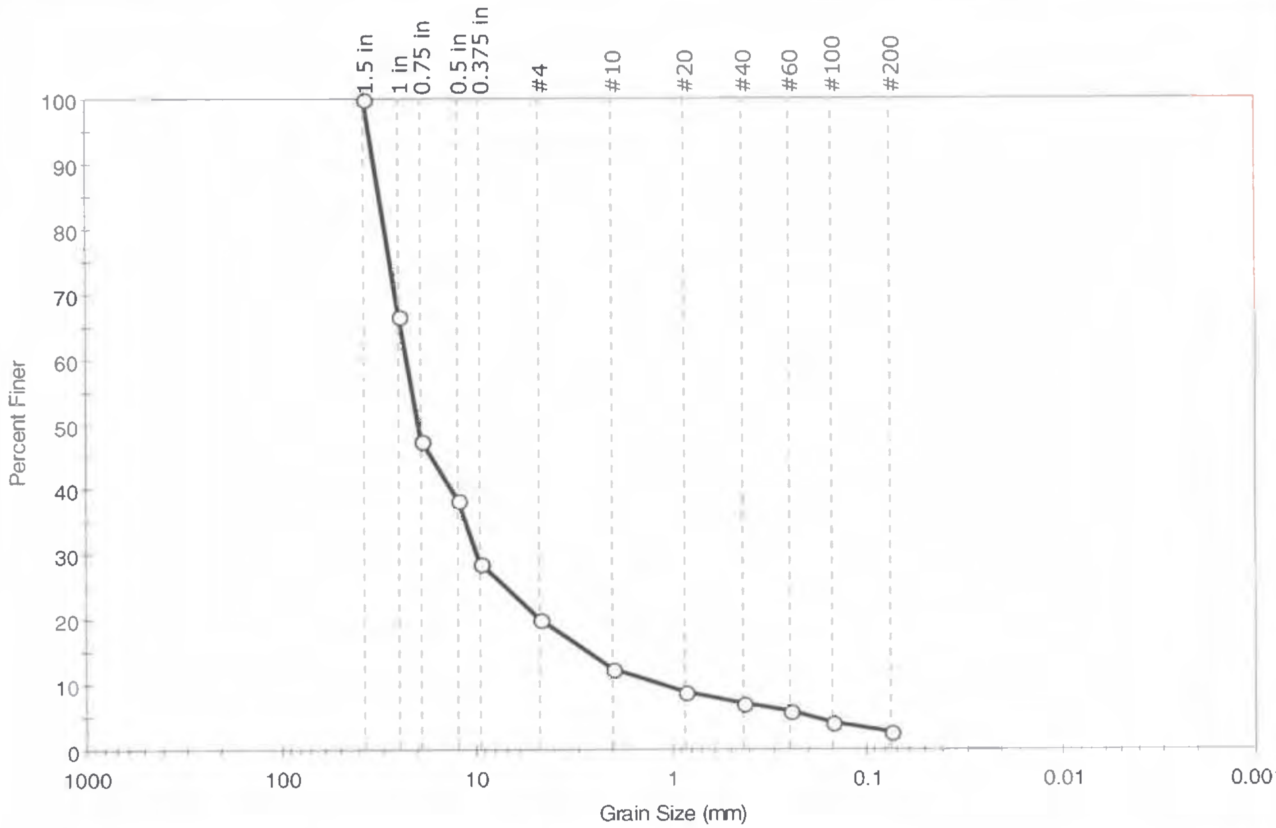
Client: O'Brien & Gere Engineering			
Project: Delaware River Deepening Project			
Location: Tinicum to Marcus Hook Ranges, PA		Project No:	GTX-9915
Boring ID: CB-305	Sample Type: jar	Tested By:	jbr
Sample ID: S-2	Test Date: 06/02/10	Checked By:	jdt
Depth : 2-4 ft	Test Id: 181652		

Test Comment: ---
Sample Description: Moist, dark brown gravel with sand
Sample Comment: ---

Particle Size Analysis - ASTM D 422-63 (reapproved 2002)



% Cobble	% Gravel	% Sand	% Silt & Clay Size
---	80.1	17.2	2.7

Sieve Name	Sieve Size, mm	Percent Finer	Spec. Percent	Complies
1.5 in	37.50	100		
1 in	25.00	67		
0.75 in	19.00	47		
0.5 in	12.50	38		
0.375 in	9.50	29		
#4	4.75	20		
#10	2.00	13		
#20	0.85	9		
#40	0.42	7		
#60	0.25	6		
#100	0.15	4		
#200	0.075	3		

Coefficients

D_{85} = 31.2320 mm	D_{30} = 9.8449 mm
D_{60} = 22.7163 mm	D_{15} = 2.6685 mm
D_{50} = 19.7092 mm	D_{10} = 1.1194 mm
C_u = 20.293	C_c = 3.812

Classification

ASTM Poorly graded gravel with sand (GP)

AASHTO Stone Fragments, Gravel and Sand (A-1-a (0))

Sample/Test Description

Sand/Gravel Particle Shape : ROUNDED

Sand/Gravel Hardness : HARD

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Client:	O'Brien & Gere Engineering		
Project:	Delaware River Deepening Project		
Location:	Tinicum to Marcus Hook Ranges, PA	Project No:	GTX-9915
Boring ID: CB-305	Sample Type: jar	Tested By:	cam
Sample ID:S-2	Test Date: 06/02/10	Checked By:	jdt
Depth : 2-4 ft	Test Id: 181641		
Test Comment:	---		
Sample Description:	Moist, dark brown gravel with sand		
Sample Comment:	---		

Atterberg Limits - ASTM D 4318-05

Sample Determined to be non-plastic

Symbol	Sample ID	Boring	Depth	Natural Moisture Content,%	Liquid Limit	Plastic Limit	Plasticity Index	Liquidity Index	Soil Classification
*	S-2	CB-305	2-4 ft	10	n/a	n/a	n/a	n/a	Poorly graded gravel with sand (GP)

93% Retained on #40 Sieve

Dry Strength: NONE

Dilentancy: RAPID

Toughness: n/a

The sample was determined to be Non-Plastic

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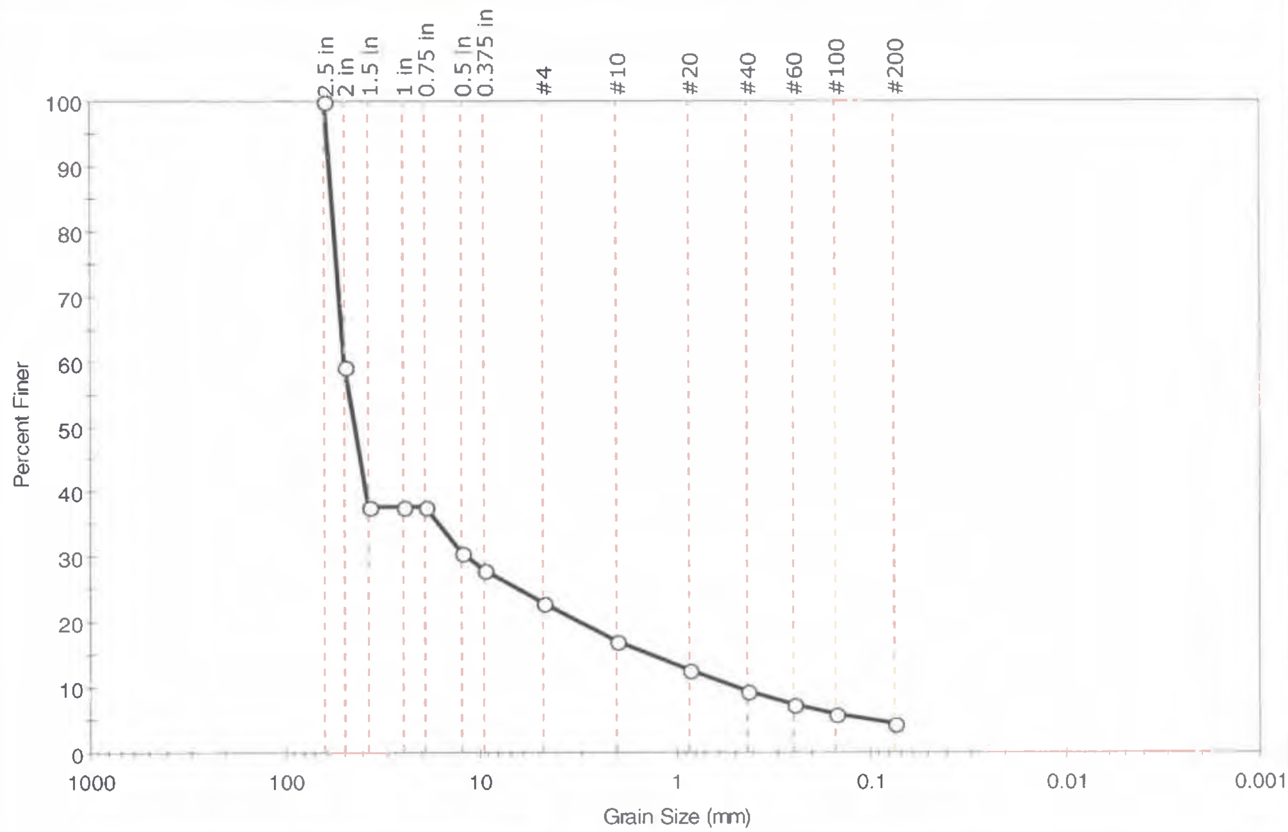
Client: O'Brien & Gere Engineering			
Project: Delaware River Deepening Project			
Location: Tinicum to Marcus Hook Ranges, PA		Project No:	GTX-9915
Boring ID: CB-305	Sample Type: jar	Tested By:	jbr
Sample ID:S-3	Test Date: 06/02/10	Checked By:	jdt
Depth : 4-6 ft	Test Id: 181653		
Test Comment: ---			
Sample Description: Moist, dark brown gravel with sand			
Sample Comment: ---			

Particle Size Analysis - ASTM D 422-63 (reapproved 2002)



% Cobble	% Gravel	% Sand	% Silt & Clay Size
—	77.1	18.6	4.3

Sieve Name	Sieve Size, mm	Percent Finer	Spec. Percent	Complies
2.5 in	63.00	100		
2 in	50.00	59		
1.5 in	37.50	38		
1 in	25.00	38		
0.75 in	19.00	38		
0.5 in	12.50	31		
0.375 in	9.50	28		
#4	4.75	23		
#10	2.00	17		
#20	0.85	13		
#40	0.42	9		
#60	0.25	7		
#100	0.15	6		
#200	0.075	4		

Coefficients

D_{85} =57.8415 mm
D_{30} =11.5271 mm
D_{60} =50.1654 mm
D_{15} =1.3436 mm
D_{50} =44.1320 mm
D_{10} =0.4744 mm
C_u =105.745
C_c =5.583

Classification

ASTM Poorly graded gravel with sand (GP)

AASHTO Stone Fragments, Gravel and Sand (A-1-a (0))

Sample/Test Description

Sand/Gravel Particle Shape : ROUNDED

Sand/Gravel Hardness : HARD

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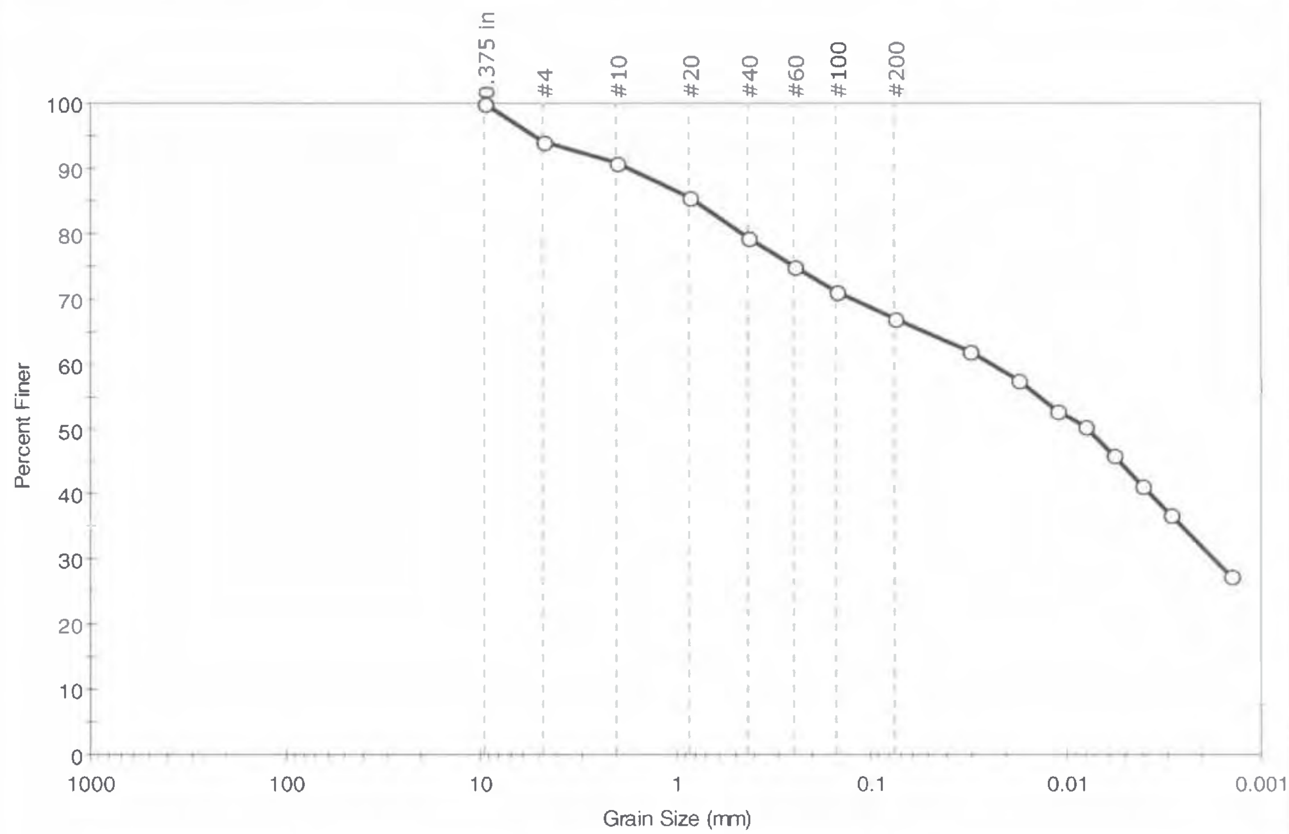
Client: O'Brien & Gere Engineering			
Project: Delaware River Deepening Project			
Location: Tinicum to Marcus Hook Ranges, PA		Project No:	GTX-9915
Boring ID: CB-306	Sample Type: jar	Tested By:	jbr
Sample ID:S-1	Test Date: 06/21/10	Checked By:	njh
Depth : 0-2 ft	Test Id: 183151		
Test Comment: ---			
Sample Description: Moist, yellowish red sandy clay			
Sample Comment: ---			

Particle Size Analysis - ASTM D 422-63 (reapproved 2002)



% Cobble	% Gravel	% Sand	% Silt & Clay Size
—	6.0	26.9	67.1

Sieve Name	Sieve Size, mm	Percent Finer	Spec. Percent	Complies
0.375 in	9.50	100		
#4	4.75	94		
#10	2.00	91		
#20	0.85	86		
#40	0.42	79		
#60	0.25	75		
#100	0.15	71		
#200	0.075	67		
---	Particle Size (mm)	Percent Finer	Spec. Percent	Complies
---	0.0312	62		
---	0.0175	57		
---	0.0111	53		
---	0.0079	51		
---	0.0057	46		
---	0.0041	41		
---	0.0030	37		
---	0.0014	28		

Coefficients

D_{85} =0.7908 mm D_{30} =0.0017 mm
D_{60} =0.0242 mm D_{15} =N/A
D_{50} =0.0076 mm D_{10} =N/A
C_u =N/A C_c =N/A

Classification

ASTM Sandy fat clay (CH)

AASHTO Clayey Soils (A-7-5 (42))

Sample/Test Description

Sand/Gravel Particle Shape : ROUNDED

Sand/Gravel Hardness : HARD

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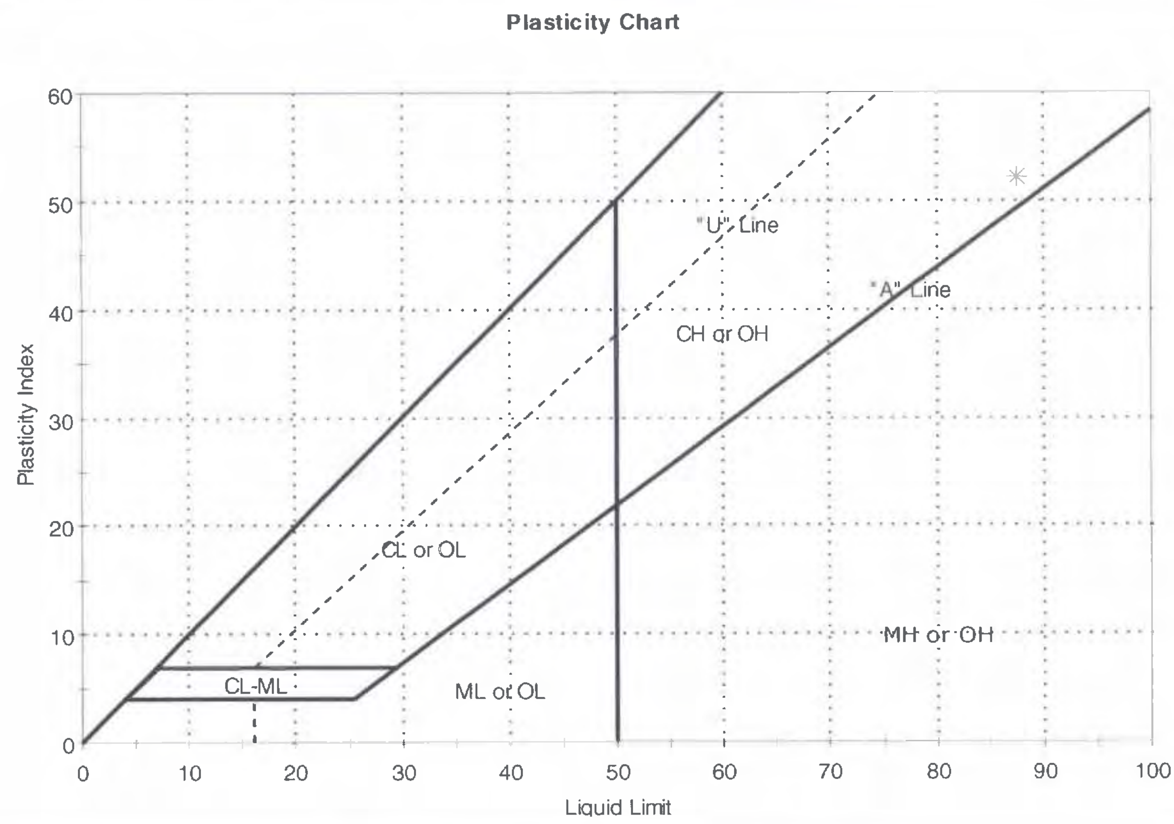
Client: O'Brien & Gere Engineering			
Project: Delaware River Deepening Project			
Location: Tinicum to Marcus Hook Ranges, PA		Project No:	GTX-9915
Boring ID: CB-306	Sample Type: jar	Tested By:	cam
Sample ID:S-1	Test Date: 06/23/10	Checked By:	njh
Depth : 0-2 ft	Test Id: 183146		
Test Comment: ---			
Sample Description: Moist, yellowish red sandy clay			
Sample Comment: ---			

Atterberg Limits - ASTM D 4318-05



Symbol	Sample ID	Boring	Depth	Natural Moisture Content,%	Liquid Limit	Plastic Limit	Plasticity Index	Liquidity Index	Soil Classification
*	S-1	CB-306	0-2 ft	53	88	35	53	0	Sandy fat clay (CH)

Sample Prepared using the WET method

21% Retained on #40 Sieve

Dry Strength: VERY HIGH

Dilentancy: SLOW

Toughness: LOW

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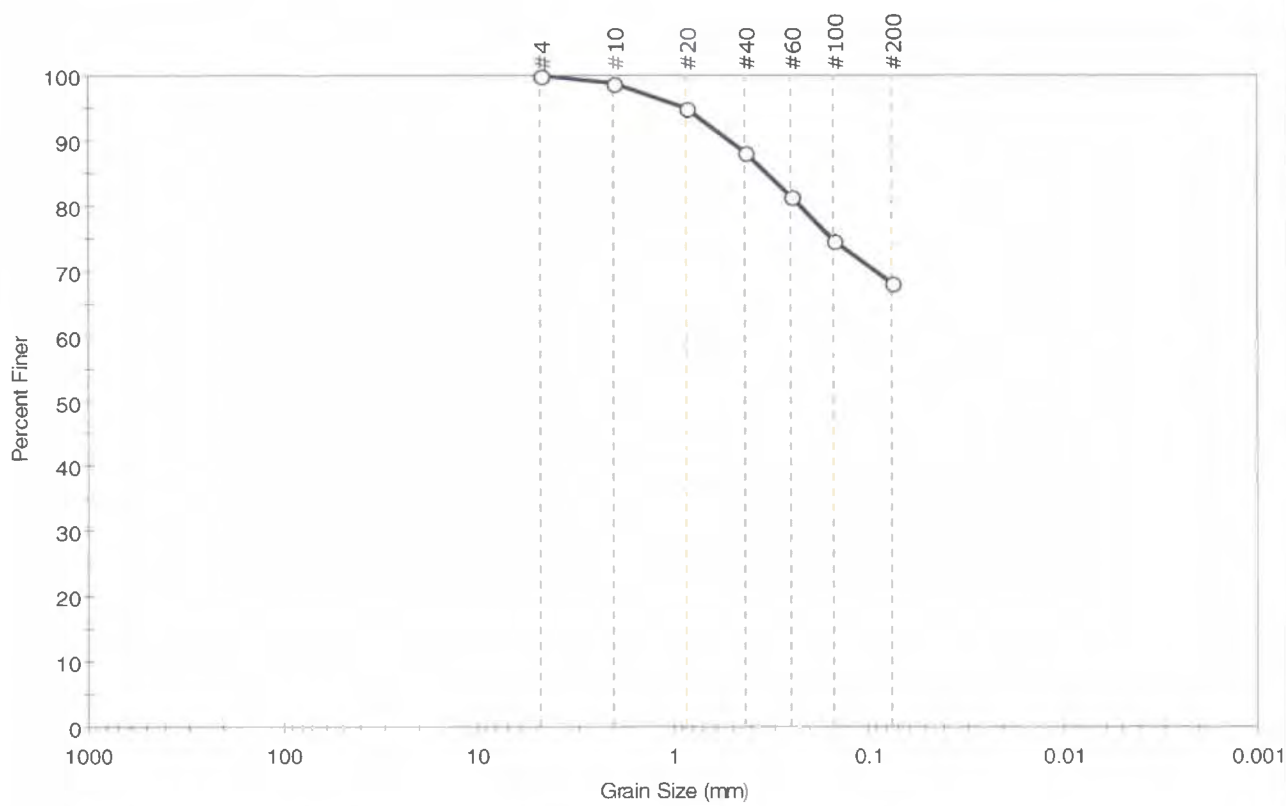
Client: O'Brien & Gere Engineering			
Project: Delaware River Deepening Project			
Location: Tinicum to Marcus Hook Ranges, PA		Project No:	GTX-9915
Boring ID: CB-306	Sample Type: jar	Tested By:	jbr
Sample ID:S-2	Test Date: 06/23/10	Checked By:	njh
Depth : 2-4 ft	Test Id: 183164		
Test Comment: ---			
Sample Description: Moist, mottled bluish gray and yellowish brown sandy clay			
Sample Comment: ---			

Particle Size Analysis - ASTM D 422-63 (reapproved 2002)



% Cobble	% Gravel	% Sand	% Silt & Clay Size
—	0.0	31.9	68.1

Sieve Name	Sieve Size, mm	Percent Finer	Spec. Percent	Complies
#4	4.75	100		
#10	2.00	99		
#20	0.85	95		
#40	0.42	88		
#60	0.25	82		
#100	0.15	75		
#200	0.075	68		

Coefficients

D_{85} =0.3284 mm
D_{30} =N/A
D_{60} =N/A
D_{15} =N/A
D_{50} =N/A
D_{10} =N/A
C_u =N/A
C_c =N/A

Classification

ASTM Sandy fat clay (CH)

AASHTO Clayey Soils (A-7-6 (19))

Sample/Test Description

Sand/Gravel Particle Shape : ---

Sand/Gravel Hardness : ---

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GeoTesting express
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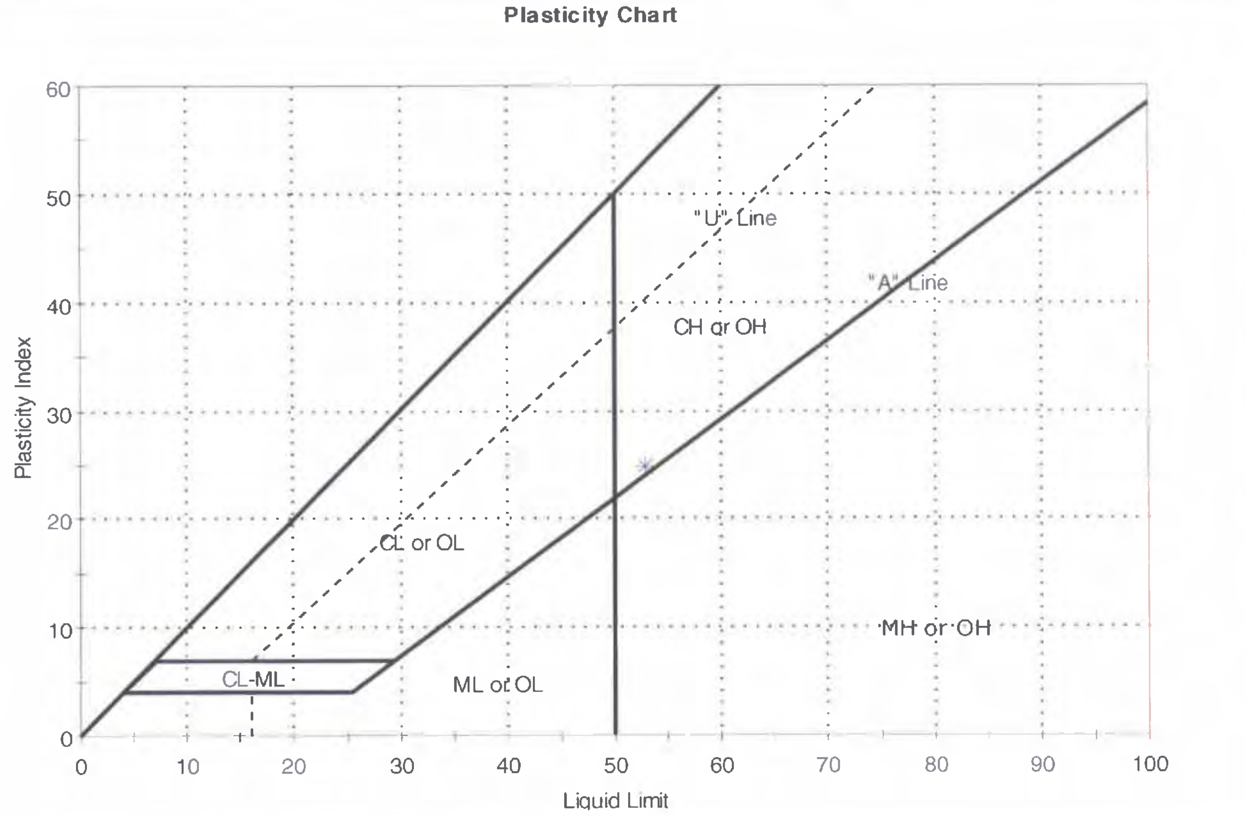
Client: O'Brien & Gere Engineering			
Project: Delaware River Deepening Project			
Location: Tinicum to Marcus Hook Ranges, PA		Project No:	GTX-9915
Boring ID: CB-306	Sample Type: jar	Tested By:	cam
Sample ID: S-2	Test Date: 06/18/10	Checked By:	njh
Depth : 2-4 ft	Test Id: 183147		
Test Comment: ---			
Sample Description: Moist, mottled bluish gray and yellowish brown sandy clay			
Sample Comment: ---			

Atterberg Limits - ASTM D 4318-05



Symbol	Sample ID	Boring	Depth	Natural Moisture Content,%	Liquid Limit	Plastic Limit	Plasticity Index	Liquidity Index	Soil Classification
*	S-2	CB-306	2-4 ft	38	53	28	25	0	Sandy fat clay (CH)

Sample Prepared using the WET method

12% Retained on #40 Sieve

Dry Strength: VERY HIGH

Dilentancy: SLOW

Toughness: LOW

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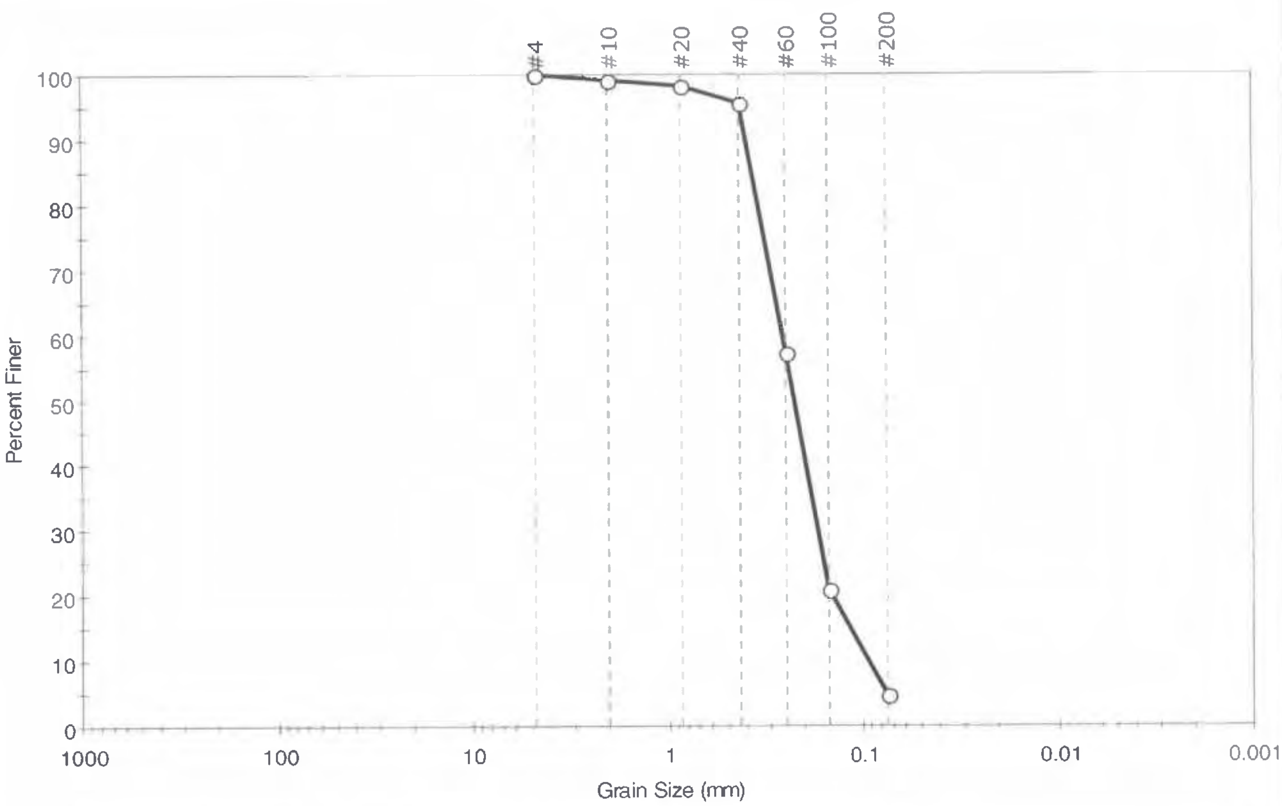
Client:	O'Brien & Gere Engineering		
Project:	Delaware River Deepening Project		
Location:	Tinicum to Marcus Hook Ranges, PA	Project No:	GTX-9915
Boring ID: CB-308	Sample Type: jar	Tested By:	jbr
Sample ID:S-1	Test Date: 06/02/10	Checked By:	jdt
Depth : 0-2 ft	Test Id: 181648		
Test Comment:	---		
Sample Description:	Moist, dark brown sand		
Sample Comment:	---		

Particle Size Analysis - ASTM D 422-63 (reapproved 2002)



% Cobble	% Gravel	% Sand	% Silt & Clay Size
—	—	95.2	4.8

Sieve Name	Sieve Size, mm	Percent Finer	Spec. Percent	Complies
#4	4.75	100		
#10	2.00	99		
#20	0.85	98		
#40	0.42	96		
#60	0.25	57		
#100	0.15	21		
#200	0.075	5		

Coefficients

D_{85} =0.3667 mm	D_{30} =0.1702 mm
D_{60} =0.2599 mm	D_{15} =0.1158 mm
D_{50} =0.2259 mm	D_{10} =0.0936 mm
C_u =2.777	C_c =1.191

Classification

ASTM Poorly graded sand (SP)

AASHTO Fine Sand (A-3 (0))

Sample/Test Description

Sand/Gravel Particle Shape : ---

Sand/Gravel Hardness : ---

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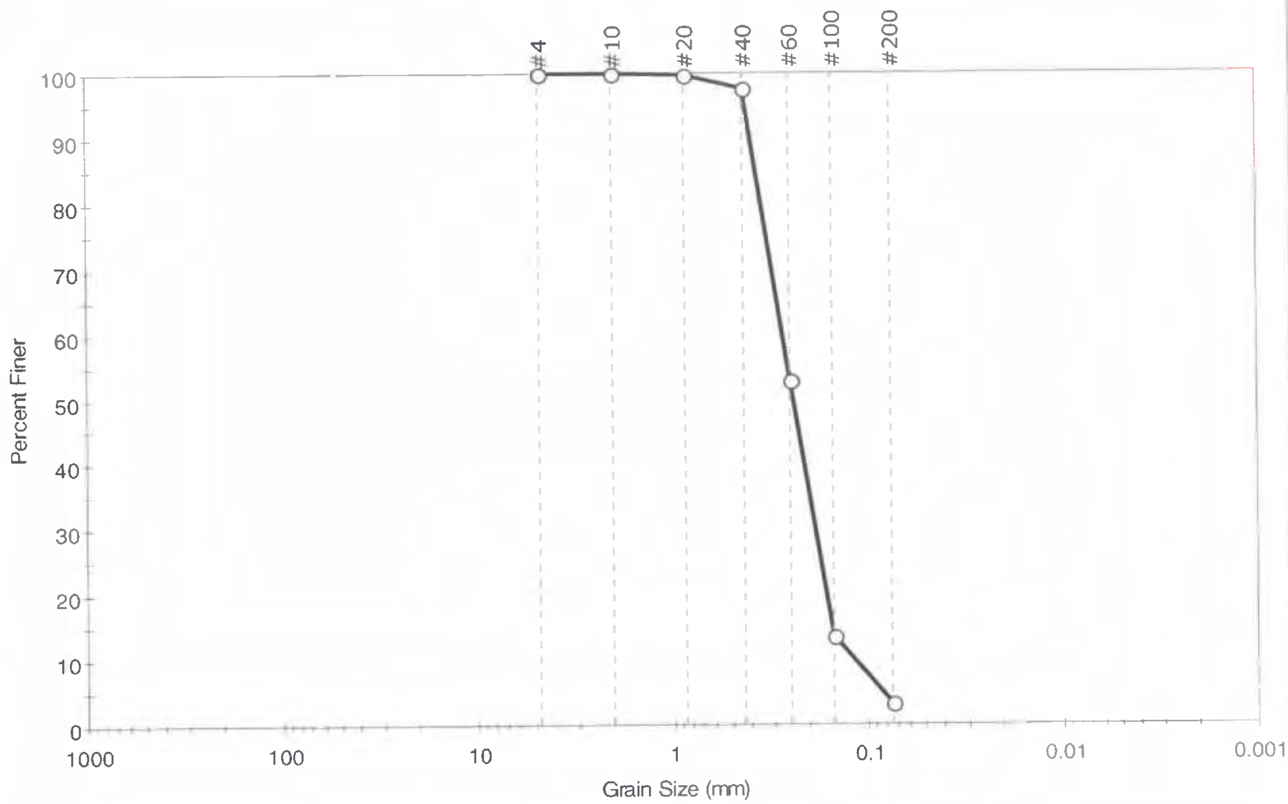
Client: O'Brien & Gere Engineering			
Project: Delaware River Deepening Project			
Location: Tinicum to Marcus Hook Ranges, PA		Project No:	GTX-9915
Boring ID: CB-308	Sample Type: jar	Tested By:	jbr
Sample ID:S-2A	Test Date: 06/02/10	Checked By:	jdt
Depth : 2-4 ft	Test Id: 181649		
Test Comment: ---			
Sample Description: Moist, dark brown sand			
Sample Comment: ---			

Particle Size Analysis - ASTM D 422-63 (reapproved 2002)



% Cobble	% Gravel	% Sand	% Silt & Clay Size
---	0.0	96.8	3.2

Sieve Name	Sieve Size, mm	Percent Finer	Spec. Percent	Complies
#4	4.75	100		
#10	2.00	100		
#20	0.85	100		
#40	0.42	98		
#60	0.25	53		
#100	0.15	14		
#200	0.075	3		

Coefficients

D_{85} = 0.3656 mm D_{30} = 0.1858 mm

D_{60} = 0.2723 mm D_{15} = 0.1529 mm

D_{50} = 0.2412 mm D_{10} = 0.1183 mm

C_u = 2.302 C_c = 1.072

Classification

ASTM Poorly graded sand (SP)

AASHTO Fine Sand (A-3 (0))

Sample/Test Description

Sand/Gravel Particle Shape : ---

Sand/Gravel Hardness : ---

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GeoTesting express
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Client: O'Brien & Gere Engineering			
Project: Delaware River Deepening Project			
Location: Tinicum to Marcus Hook Ranges, PA		Project No:	GTX-9915
Boring ID: CB-308	Sample Type: jar	Tested By:	cam
Sample ID:S-2A	Test Date: 06/02/10	Checked By:	jdt
Depth : 2-4 ft	Test Id: 181639		
Test Comment: ---			
Sample Description: Moist, dark brown sand			
Sample Comment: ---			

Atterberg Limits - ASTM D 4318-05

Sample Determined to be non-plastic

Symbol	Sample ID	Boring	Depth	Natural Moisture Content,%	Liquid Limit	Plastic Limit	Plasticity Index	Liquidity Index	Soil Classification
*	S-2A	CB-308	2-4 ft	26	n/a	n/a	n/a	n/a	Poorly graded sand (SP)

2% Retained on #40 Sieve
Dry Strength: NONE
Dilentancy: RAPID
Toughness: n/a
The sample was determined to be Non-Plastic

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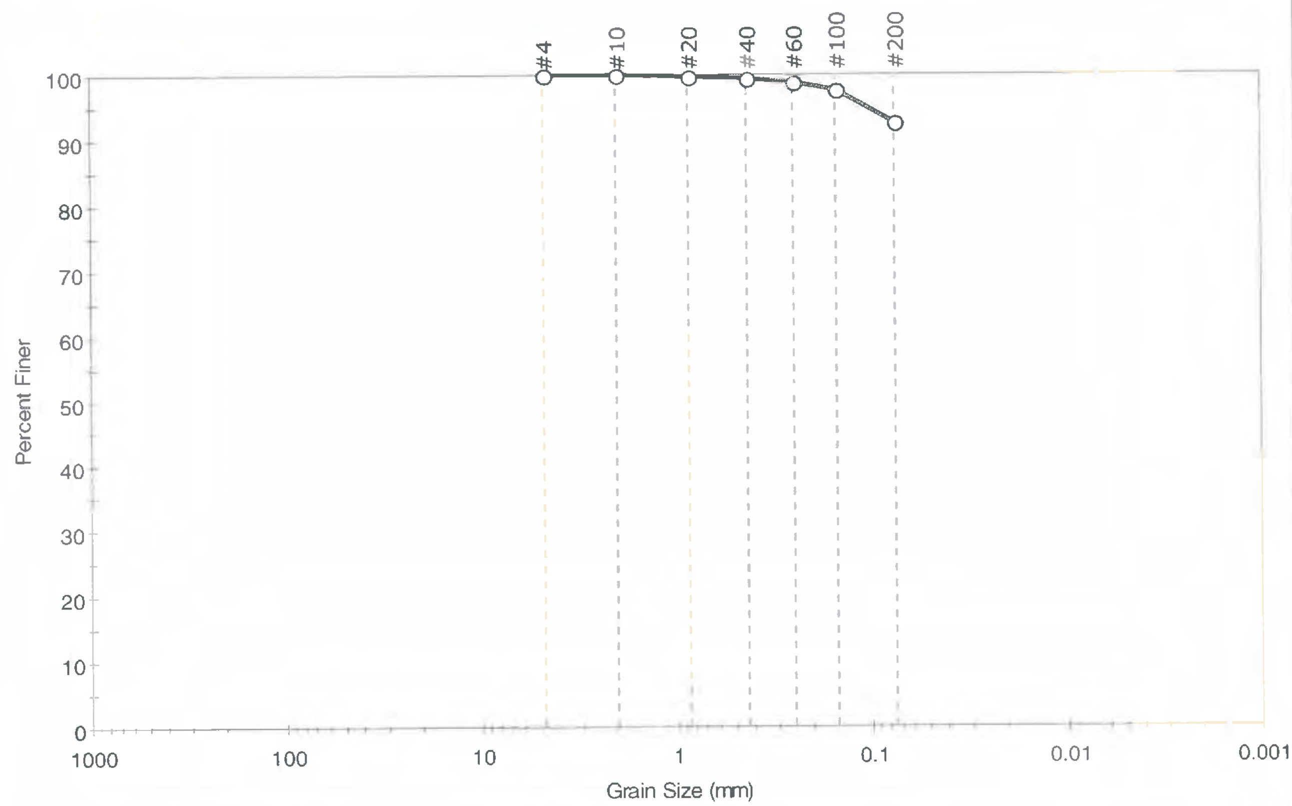
Client:	O'Brien & Gere Engineering		
Project:	Delaware River Deepening Project		
Location:	Tinicum to Marcus Hook Ranges, PA	Project No:	GTX-9915
Boring ID: CB-308	Sample Type: jar	Tested By:	jbr
Sample ID:S-2B	Test Date: 06/02/10	Checked By:	jdt
Depth : 2-4 ft	Test Id: 181650		
Test Comment:	---		
Sample Description:	Moist, dark gray clay		
Sample Comment:	---		

Particle Size Analysis - ASTM D 422-63 (reapproved 2002)



% Cobble	% Gravel	% Sand	% Silt & Clay Size
—	0.0	7.4	92.6

Sieve Name	Sieve Size, mm	Percent Finer	Spec. Percent	Complies
#4	4.75	100		
#10	2.00	100		
#20	0.85	100		
#40	0.42	99		
#60	0.25	99		
#100	0.15	97		
#200	0.075	93		

Coefficients

D_{85} = N/A	D_{30} = N/A
D_{60} = N/A	D_{15} = N/A
D_{50} = N/A	D_{10} = N/A
C_u = N/A	C_c = N/A

Classification

ASTM fat clay (CH)

AASHTO Clayey Soils (A-7-5 (61))

Sample/Test Description

Sand/Gravel Particle Shape : ---

Sand/Gravel Hardness : ---

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GeoTesting express
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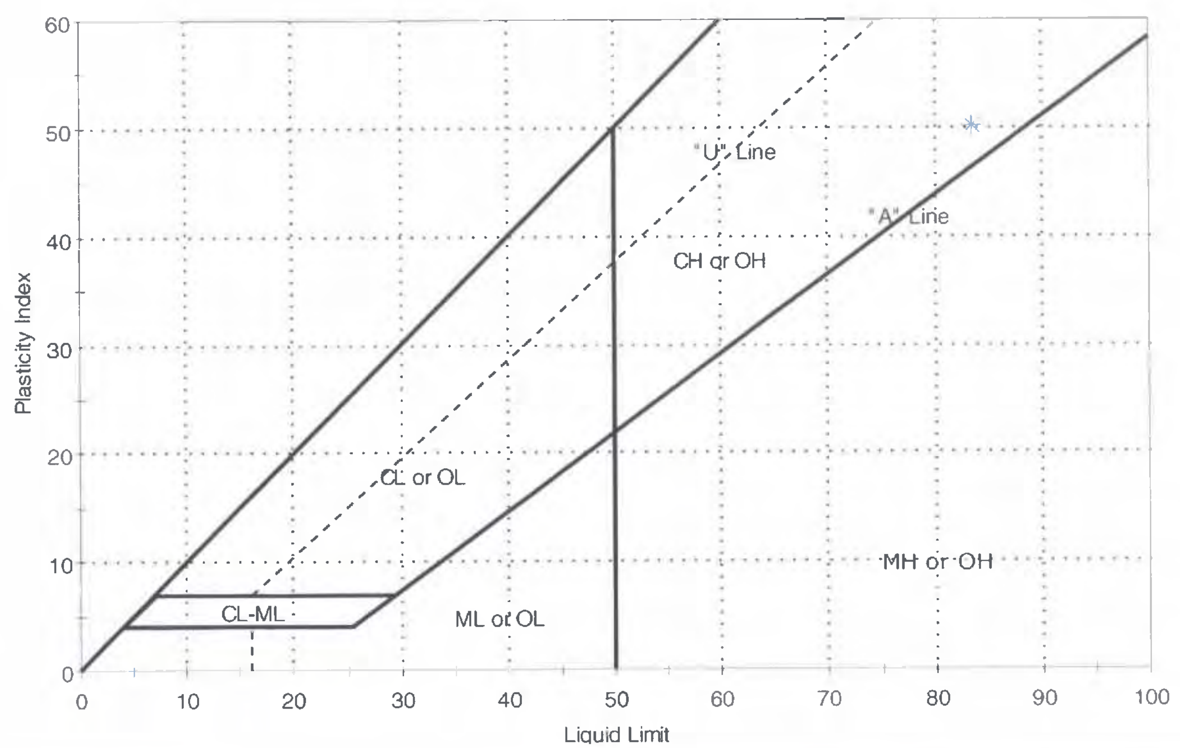
Client:	O'Brien & Gere Engineering				
Project:	Delaware River Deepening Project				
Location:	Tinicum to Marcus Hook Ranges, PA			Project No:	GTX-9915
Boring ID:	CB-308	Sample Type:	jar	Tested By:	cam
Sample ID:	S-2B	Test Date:	06/03/10	Checked By:	n/a
Depth :	2-4 ft	Test Id:	181640		
Test Comment:	---				
Sample Description:	Moist, dark gray clay				
Sample Comment:	---				

Atterberg Limits - ASTM D 4318-05



Symbol	Sample ID	Boring	Depth	Natural Moisture Content,%	Liquid Limit	Plastic Limit	Plasticity Index	Liquidity Index	Soil Classification
*	S-2B	CB-308	2-4 ft	76	84	34	50	1	fat clay (CH)

Sample Prepared using the WET method

1% Retained on #40 Sieve

Dry Strength: VERY HIGH

Dilentancy: SLOW

Toughness: LOW

GeoTesting express

Client:	O'Brien & Gere Engineering	Test Date:	07/06/10
Project Name:	Delaware River Deepening Project	Tested By:	daa
Project Location	Tinicum to Marcus Hook Ranges, PA	Checked By:	mpd
GTX #:	9915	Sample Type:	rock core

Point Load Strength Index of Rock by ASTM D 5731

Boring No.	Sample No.	Depth, ft.	Test No.	Test Type	Width (W), in.	Depth (D), in.	Failure Load (P), lb	D_e^2, in^2	D_e, in.	I_s, psi	F	$I_{s(50)}$, psi	Generalized Correction Factor, K	Estimated Compressive Strength, psi
CB-292	R-1	6.34-6.44	PLA - 4	Axial	2.49	1.23	2298	3.89	1.97	591	1.001	591	19	11,200

PLA - 4
before

PLA - 4
after

Intact material failure

Notes:

Generalized correction factor, K, used to estimate the compressive strength based on the specimen depth and ASTM D 5731 Table 1.
D_e = the equivalent core diameter
I_s = the uncorrected point load strength
F = the size correction factor
$I_{s(50)}$ = the size corrected point load strength index

GeoTesting express

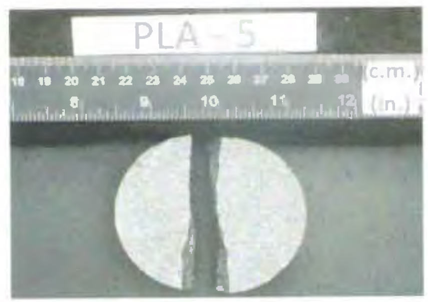
Client:	O'Brien & Gere Engineering	Test Date:	07/06/10
Project Name:	Delaware River Deepening Project	Tested By:	daa
Project Location	Tinicum to Marcus Hook Ranges, PA	Checked By:	mpd
GTX #:	9915	Sample Type:	rock core

Point Load Strength Index of Rock by ASTM D 5731

Boring No.	Sample No.	Depth, ft.	Test No.	Test Type	Width (W), in.	Depth (D), in.	Failure Load (P), lb	D_e^2, in^2	D_e, in.	I_s, psi	F	$I_{s(50)}$, psi	Generalized Correction Factor, K	Estimated Compressive Strength, psi
CB-303	R-1	2.12-2.22	PLA - 5	Axial	2.48	1.26	2554	3.98	2.00	642	1.006	646	19	12,200

PLA - 5
before

PLA - 5
after



Intact material failure

Shale

Notes: Generalized correction factor, K, used to estimate the compressive strength based on the specimen depth and ASTM D 5731 Table 1.
D_e = the equivalent core diameter
I_s = the uncorrected point load strength
F = the size correction factor
$I_{s(50)}$ = the size corrected point load strength index

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Client:	O'Brien & Gere Engineering
Project Name:	Delaware River Deepening Project
Project Location:	Tinicum to Marcus Hook Ranges, PA
GTX #:	9915
Test Date:	07/06/10
Tested By:	daa
Checked By:	mpd
Sample Type:	Rock Core
Sample Description:	---
Strain Rate:	1%/min.

Splitting Tensile Strength of Intact Rock Core Specimens by ASTM D 3967

Boring ID	Sample ID	Depth, ft.	Test No.	Thickness (L), in.			Diameter (D), in.	Failure Load (P), lb.	Splitting Tensile Strength, psi
CB-287	R-1	0.80-0.90	ST-1	1.24	1.23	1.23	2.46	4536	955
CB-287	R-2	5.09-5.20	ST-2	1.30	1.31	1.30	2.48	9474	1,870
CB-288	R-1	0.80-0.90	ST-3	1.25	1.25	1.25	2.49	7917	1,620

ST-1

Intact material failure

ST-2

Intact material failure

ST-3

Intact material failure

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Client:	O'Brien & Gere Engineering
Project Name:	Delaware River Deepening Project
Project Location:	Tinicum to Marcus Hook Ranges, PA
GTX #:	9915
Test Date:	07/06/10
Tested By:	daa
Checked By:	mpd
Sample Type:	Rock Core
Sample Description:	---
Strain Rate:	1%/min.

Splitting Tensile Strength of Intact Rock Core Specimens by ASTM D 3967

Boring ID	Sample ID	Depth, ft.	Test No.	Thickness (L), in.			Diameter (D), in.	Failure Load (P), lb.	Splitting Tensile Strength, psi
CB-288	R-1	4.02-4.12	ST-4	1.22	1.22	1.22	2.50	5653	1,180
CB-289	R-2	7.60-7.69	ST-5	1.08	1.08	1.09	2.48	5313	1,260
CB-290	R-2	1.80-1.89	ST-6	1.12	1.12	1.12	2.48	6798	1,560

ST-4

Intact material failure

ST-5

Intact material failure

ST-6

Intact material failure

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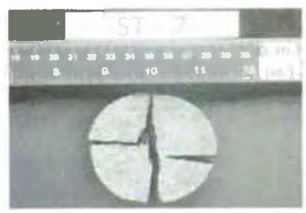
Client:	O'Brien & Gere Engineering
Project Name:	Delaware River Deepening Project
Project Location:	Tinicum to Marcus Hook Ranges, PA
GTX #:	9915
Test Date:	07/06/10
Tested By:	daa
Checked By:	mpd
Sample Type:	Rock Core
Sample Description:	---
Strain Rate:	1%/min.

Splitting Tensile Strength of Intact Rock Core Specimens by ASTM D 3967

Boring ID	Sample ID	Depth, ft.	Test No.	Thickness (L), in.			Diameter (D), in.	Failure Load (P), lb.	Splitting Tensile Strength, psi
CB-291	R-1	2.60-2.71	ST-7	1.32	1.32	1.32	2.49	5402	1,043
CB-292	R-1	3.40-3.51	ST-8	1.28	1.28	1.27	2.50	3793	758
CB-294	R-1	1.30-1.40	ST-9	1.20	1.20	1.21	2.47	3103	663

ST-7



Intact material failure

ST-8

Intact material failure
and
Discontinuity failure

ST-9

Intact material failure

GeoTesting express

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Client:	O'Brien & Gere Engineering
Project Name:	Delaware River Deepening Project
Project Location:	Tinicum to Marcus Hook Ranges, PA
GTX #:	9915
Test Date:	07/06/10
Tested By:	daa
Checked By:	mpd
Sample Type:	Rock Core
Sample Description:	---
Strain Rate:	1%/min.

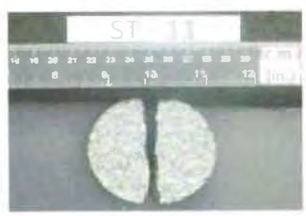
Splitting Tensile Strength of Intact Rock Core Specimens by ASTM D 3967

Boring ID	Sample ID	Depth, ft.	Test No.	Thickness (L), in.			Diameter (D), in.	Failure Load (P), lb.	Splitting Tensile Strength, psi
CB-297	R-2	5.07-5.17	ST-10	1.27	1.27	1.27	2.48	7456	1,510
CB-300	R-2	4.79-4.89	ST-11	1.22	1.23	1.22	2.48	2414	506
CB-307	R-2	4.96-5.05	ST-12	1.12	1.12	1.11	2.49	2041	468

ST-10

Intact material failure and discontinuity failure

ST-11



Intact material failure

ST-12

Intact material failure

GeoTesting express

Client:	O'Brien & Gere Engineering
Project Name:	Delaware River Deepening Project
Project Location:	Tinicum to Marcus Hook Ranges, PA
GTX #:	9915
Test Date:	07/03/10
Tested By:	daa
Checked By:	mpd

Bulk Density and Compressive Strength of Rock Core Specimens by ASTM D 7012 Method C

Boring ID	Sample ID	Depth, ft	Bulk Density, lb/ft^3	Compressive Strength, psi	Failure Type	In conformance with ASTM D 4543
CB-287	R-1	3.52-3.98	165	22,727	1	YES
CB-288	R-1	0.12-0.57	164	22,624	1	NO *
CB-288	R-1	1.32-1.78	164	25,971	1	YES
CB-289	R-1	5.58-6.05	171	15,241	1	YES
CB-289	R-2	7.96-8.42	171	17,134	1	YES
CB-290	R-1	2.88-3.32	184	31,331	1	YES
CB-290	R-2	1.03-1.48	182	6,643	2	NO *
CB-290	R-3	6.40-6.81	164	8,520	1 & 2	NO *
CB-291	R-2	5.52-5.98	168	11,487	2	YES
CB-294	R-2	4.45-4.91	171	9,964	1	NO *

Notes: Density determined on core samples by measuring dimensions and weight and then calculating.

All specimens tested at the approximate as-received moisture content and at standard laboratory temperature.

Failure Type: 1 = Intact Material Failure; 2 = Discontinuity Failure (See attached photographs)

* The as-received core did not meet the ASTM side straightness tolerance.

GeoTesting express

Client:	O'Brien & Gere Engineering
Project Name:	Delaware River Deepening Project
Project Location:	Tinicum to Marcus Hook Ranges, PA
GTX #:	9915
Test Date:	07/03/10
Tested By:	daa
Checked By:	mpd

Bulk Density and Compressive Strength of Rock Core Specimens by ASTM D 7012 Method C

Boring ID	Sample ID	Depth, ft	Bulk Density, lb/ft^3	Compressive Strength, psi	Failure Type	In conformance with ASTM D 4543
CB-294	R-2	5.08-5.46	167	13,137	1	NO *
CB-295	R-1	3.14-3.58	166	11,152	1	NO *
CB-295	R-1	5.72-6.18	174	5,524	1	NO *
CB-297	R-1	1.62-1.96	186	17,023	1	NO *
CB-300	R-1	0.02-0.48	168	3,348	2	NO *
CB-300	R-1	1.28-1.64	170	5,846	2	NO *
CB-301	R-1	3.54-3.96	164	5,234	2	YES
CB-301	R-1	4.54-5.00	164	13,582	1	YES
CB-303	R-2	5.03-5.38	166	14,630	1	YES
CB-307	R-2	3.95-4.41	170	14,145	2	YES

Notes: Density determined on core samples by measuring dimensions and weight and then calculating.

All specimens tested at the approximate as-received moisture content and at standard laboratory temperature.

Failure Type: 1 = Intact Material Failure; 2 = Discontinuity Failure (See attached photographs)

* The as-received core did not meet the ASTM side straightness tolerance.

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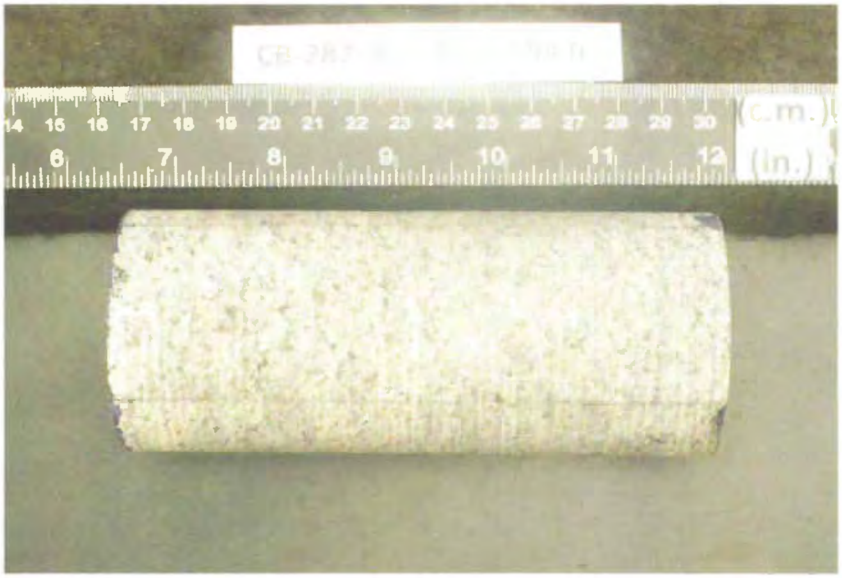
express

Client:	O'Brien & Gere Engineering
Project Name:	Delaware River Deepening Project
Project Location:	Tinicum to Marcus Hook Ranges, PA
GTX #:	9915
Test Date:	07/03/10
Tested By:	daa
Checked By:	mpd
Boring ID:	CB-287
Sample ID:	R-1
Depth, ft:	3.52-3.98



After cutting and grinding

After break

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Client:	O'Brien & Gere Engineering	Test Date:	7/3/2010
Project Name:	Delaware River Deepening Project	Tested By:	daa
Project Location:	Tinicum to Marcus Hook Ranges, PA	Checked By:	mpd
GTX #:	9915		
Boring ID:	CB-287		
Sample ID:	R-1		
Depth:	3.52-3.98 ft		
Visual Description:	See photographs		

UNIT WEIGHT DETERMINATION AND DIMENSIONAL AND SHAPE TOLERANCES OF ROCK CORE SPECIMENS BY ASTM D 4543-04

BULK DENSITY

	1	2	Average
Specimen Length, in:	5.47	5.48	5.48
Specimen Diameter, in:	2.47	2.47	2.47
Specimen Mass, g:	1137.28		
Bulk Density, lb/ft^3	165		
Length to Diameter Ratio:	2.2		

DEVIATION FROM STRAIGHTNESS (Procedure S1)

Maximum gap between side of core and reference surface plate:
Is the maximum gap ≤ 0.02 in.? YES

Maximum difference must be < 0.020 in.
Straightness Tolerance Met? **YES**

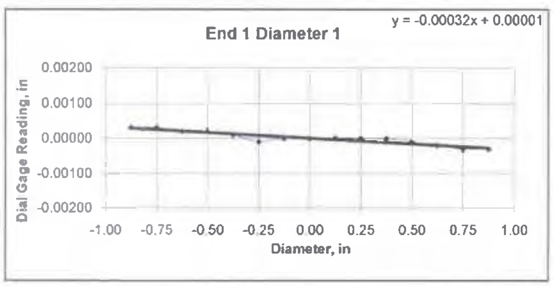
END FLATNESS AND PARALLELISM (Procedure FP1)

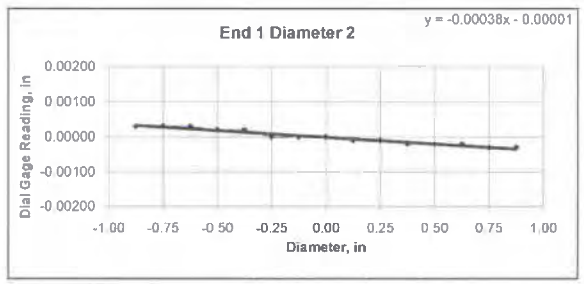
END 1	-0.875	-0.750	-0.625	-0.500	-0.375	-0.250	-0.125	0.000	0.125	0.250	0.375	0.500	0.625	0.750	0.875
Diameter 1, in	0.00030	0.00030	0.00020	0.00020	0.00010	-0.00010	0.00000	0.00000	0.00000	0.00000	0.00000	-0.00010	-0.00020	-0.00030	-0.00030
Diameter 2, in (rotated 90°)	0.00030	0.00030	0.00030	0.00020	0.00020	0.00000	0.00000	0.00000	-0.00010	-0.00010	-0.00020	-0.00020	-0.00020	-0.00030	-0.00030

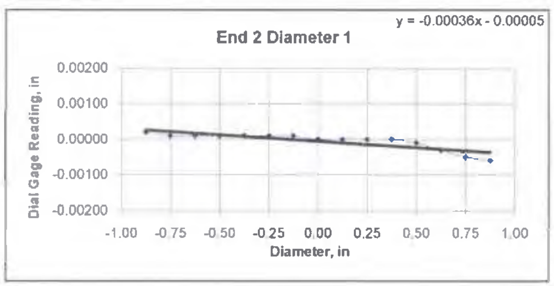
Difference between max and min readings, in:
0° = 0.00060 90° = 0.00060

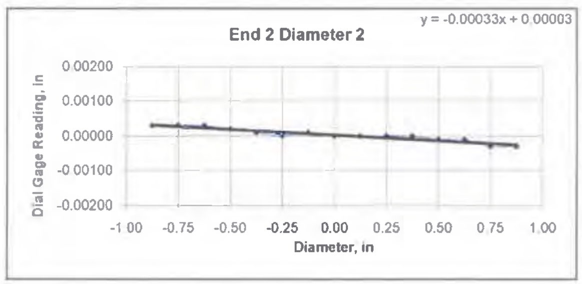
END 2	-0.875	-0.750	-0.625	-0.500	-0.375	-0.250	-0.125	0.000	0.125	0.250	0.375	0.500	0.625	0.750	0.875
Diameter 1, in	0.00020	0.00010	0.00010	0.00010	0.00010	0.00010	0.00010	0.00000	0.00000	0.00000	0.00000	-0.00010	-0.00030	-0.00050	-0.00060
Diameter 2, in (rotated 90°)	0.00030	0.00030	0.00030	0.00020	0.00010	0.00000	0.00010	0.00000	0.00000	0.00000	0.00000	-0.00010	-0.00010	-0.00030	-0.00030

Difference between max and min readings, in:
0° = 0.0008 90° = 0.0006
Maximum difference must be < 0.0020 in. Difference = + 0.00040
Flatness Tolerance Met? YES









DIAMETER 1

End 1:
Slope of Best Fit Line -0.00032
Angle of Best Fit Line: -0.01833

End 2:
Slope of Best Fit Line -0.00036
Angle of Best Fit Line: -0.02063

Maximum Angular Difference: 0.00229

Parallelism Tolerance Met? **YES**
Spherically Seated

DIAMETER 2

End 1:
Slope of Best Fit Line -0.00038
Angle of Best Fit Line: -0.02177

End 2:
Slope of Best Fit Line -0.00033
Angle of Best Fit Line: -0.01891

Maximum Angular Difference: 0.00286

Parallelism Tolerance Met? **YES**
Spherically Seated

PERPENDICULARITY (Procedure P1) (Calculated from End Flatness and Parallelism measurements above)

END 1	Difference, Maximum and Minimum (in.)	Diameter (in.)	Slope	Angle°	Perpendicularity Tolerance Met?
Diameter 1, in	0.00060	2.470	0.00024	0.014	YES
Diameter 2, in (rotated 90°)	0.00060	2.470	0.00024	0.014	YES
END 2					
Diameter 1, in	0.00080	2.470	0.00032	0.019	YES
Diameter 2, in (rotated 90°)	0.00060	2.470	0.00024	0.014	YES

Maximum angle of departure must be ≤ 0.25°

Perpendicularity Tolerance Met? **YES**

GeoTesting express

Client:	O'Brien & Gere Engineering
Project Name:	Delaware River Deepening Project
Project Location:	Tinicum to Marcus Hook Ranges, PA
GTX #:	9915
Test Date:	07/03/10
Tested By:	daa
Checked By:	mpd
Boring ID:	CB-288
Sample ID:	R-1
Depth, ft:	0.12-0.57

After cutting and grinding

After break

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a subsidiary of Geocomp Corporation

Client:	O'Brien & Gere Engineering	Test Date:	7/3/2010
Project Name:	Delaware River Deepening Project	Tested By:	daa
Project Location:	Tinicum to Marcus Hook Ranges, PA	Checked By:	mpd
GTX #:	9915		
Boring ID:	CB-288		
Sample ID:	R-1		
Depth:	0.12-0.57 ft		
Visual Description:	See photographs		

UNIT WEIGHT DETERMINATION AND DIMENSIONAL AND SHAPE TOLERANCES OF ROCK CORE SPECIMENS BY ASTM D 4543-04

BULK DENSITY

	1	2	Average
Specimen Length, in:	5.42	5.43	5.43
Specimen Diameter, in:	2.48	2.49	2.49
Specimen Mass, g:	1138.21		
Bulk Density, lb/ft^3	164		
Length to Diameter Ratio:	2.2		

DEVIATION FROM STRAIGHTNESS (Procedure S1)

Maximum gap between side of core and reference surface plate:
Is the maximum gap ≤ 0.02 in.? NO

Maximum difference must be < 0.020 in.
Straightness Tolerance Met? **NO**

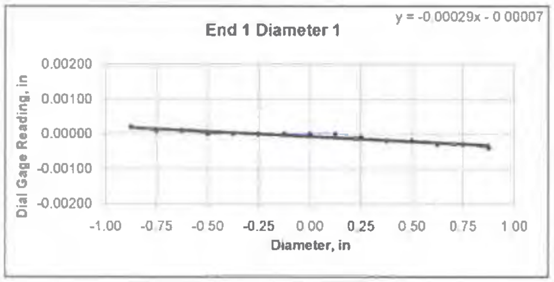
END FLATNESS AND PARALLELISM (Procedure FP1)

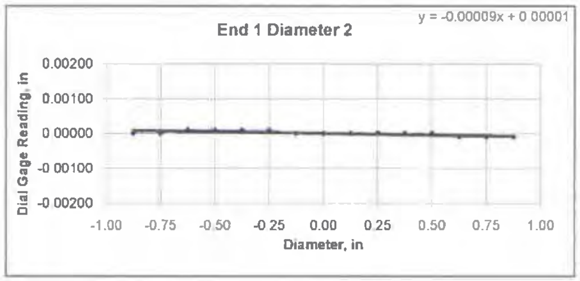
END 1	-0.875	-0.750	-0.625	-0.500	-0.375	-0.250	-0.125	0.000	0.125	0.250	0.375	0.500	0.625	0.750	0.875
Diameter 1, in	0.00020	0.00010	0.00010	0.00000	0.00000	0.00000	0.00000	0.00000	0.00000	-0.00010	-0.00020	-0.00020	-0.00030	-0.00030	-0.00040
Diameter 2, in (rotated 90°)	0.00000	0.00000	0.00010	0.00010	0.00010	0.00010	0.00000	0.00000	0.00000	0.00000	0.00000	0.00000	-0.00010	-0.00010	-0.00010

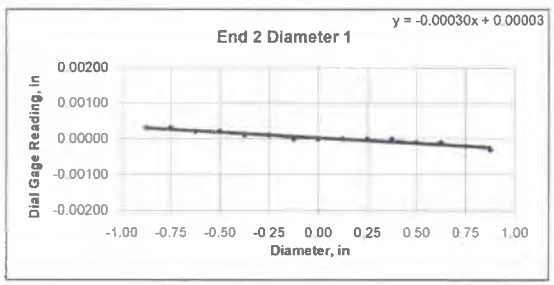
Difference between max and min readings, in:
0° = 0.00060 90° = 0.00020

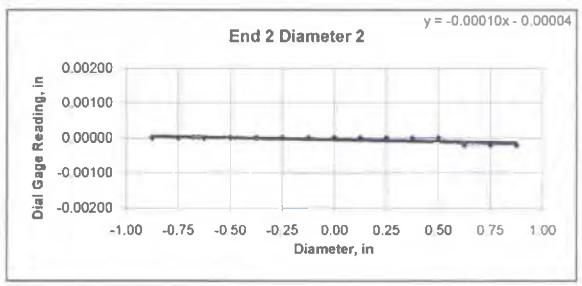
END 2	-0.875	-0.750	-0.625	-0.500	-0.375	-0.250	-0.125	0.000	0.125	0.250	0.375	0.500	0.625	0.750	0.875
Diameter 1, in	0.00030	0.00030	0.00020	0.00020	0.00010	0.00010	0.00000	0.00000	0.00000	0.00000	0.00000	-0.00010	-0.00010	-0.00020	-0.00030
Diameter 2, in (rotated 90°)	0.00000	0.00000	0.00000	0.00000	0.00000	0.00000	0.00000	0.00000	0.00000	0.00000	0.00000	0.00000	-0.00020	-0.00020	-0.00020

Difference between max and min readings, in:
0° = 0.0006 90° = 0.0002
Maximum difference must be < 0.0020 in. Difference = ± 0.00030
Flatness Tolerance Met? YES









DIAMETER 1

End 1:
Slope of Best Fit Line -0.00029
Angle of Best Fit Line: -0.01662

End 2:
Slope of Best Fit Line -0.00030
Angle of Best Fit Line: -0.01719

Maximum Angular Difference: 0.00057

Parallelism Tolerance Met? **YES**
Spherically Seated

DIAMETER 2

End 1:
Slope of Best Fit Line -0.00009
Angle of Best Fit Line: -0.00516

End 2:
Slope of Best Fit Line -0.00010
Angle of Best Fit Line: -0.00573

Maximum Angular Difference: 0.00057

Parallelism Tolerance Met? **YES**
Spherically Seated

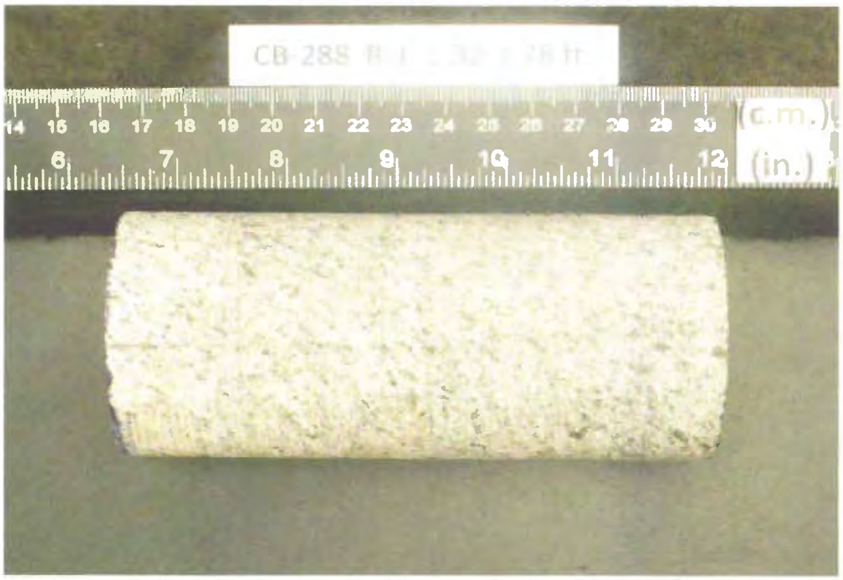
PERPENDICULARITY (Procedure P1) (Calculated from End Flatness and Parallelism measurements above)

END 1	Difference, Maximum and Minimum (in.)	Diameter (in.)	Slope	Angle°	Perpendicularity Tolerance Met?
Diameter 1, in	0.00060	2.485	0.00024	0.014	YES
Diameter 2, in (rotated 90°)	0.00020	2.485	0.00008	0.005	YES
END 2					
Diameter 1, in	0.00060	2.485	0.00024	0.014	YES
Diameter 2, in (rotated 90°)	0.00020	2.485	0.00008	0.005	YES

Maximum angle of departure must be ≤ 0.25°
Perpendicularity Tolerance Met? **YES**

GeoTesting express

Client:	O'Brien & Gere Engineering
Project Name:	Delaware River Deepening Project
Project Location:	Tinicum to Marcus Hook Ranges, PA
GTX #:	9915
Test Date:	07/03/10
Tested By:	daa
Checked By:	mpd
Boring ID:	CB-288
Sample ID:	R-1
Depth, ft:	1.32-1.78



After cutting and grinding

After break

GeoTesting express
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Client:	O'Brien & Gere Engineering	Test Date:	7/3/2010
Project Name:	Delaware River Deepening Project	Tested By:	daa
Project Location:	Tinicum to Marcus Hook Ranges, PA	Checked By:	mpd
GTX #:	9915		
Boring ID:	CB-288		
Sample ID:	R-1		
Depth:	1.32-1.78 ft		
Visual Description:	See photographs		

UNIT WEIGHT DETERMINATION AND DIMENSIONAL AND SHAPE TOLERANCES OF ROCK CORE SPECIMENS BY ASTM D 4543-04

BULK DENSITY

	1	2	Average
Specimen Length, in:	5.48	5.49	5.49
Specimen Diameter, in:	2.49	2.50	2.50
Specimen Mass, g:	1159.9		
Bulk Density, lb/ft^3	164		
Length to Diameter Ratio:	2.2		

DEVIATION FROM STRAIGHTNESS (Procedure S1)

Maximum gap between side of core and reference surface plate:
Is the maximum gap ≤ 0.02 in.? YES

Maximum difference must be < 0.020 in.
Straightness Tolerance Met? YES

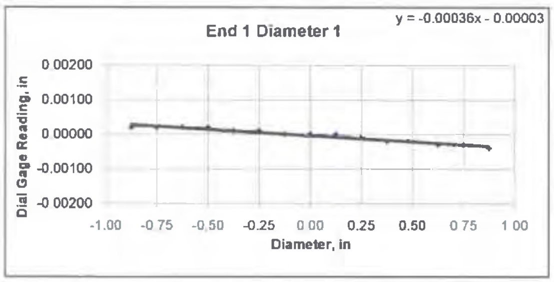
END FLATNESS AND PARALLELISM (Procedure FP1)

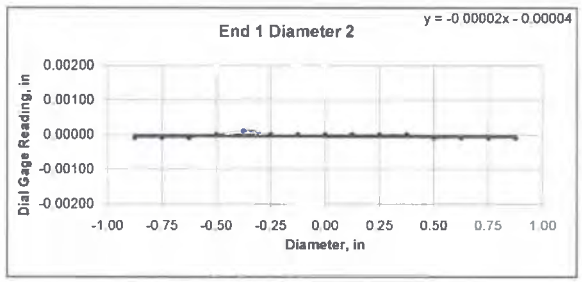
END 1	-0.875	-0.750	-0.625	-0.500	-0.375	-0.250	-0.125	0.000	0.125	0.250	0.375	0.500	0.625	0.750	0.875
Diameter 1, in	0.00020	0.00020	0.00020	0.00020	0.00010	0.00010	0.00000	0.00000	0.00000	-0.00010	-0.00020	-0.00020	-0.00030	-0.00030	-0.00040
Diameter 2, in (rotated 90°)	-0.00010	-0.00010	-0.00010	0.00000	0.00010	0.00000	0.00000	0.00000	0.00000	0.00000	0.00000	-0.00010	-0.00010	-0.00010	-0.00010

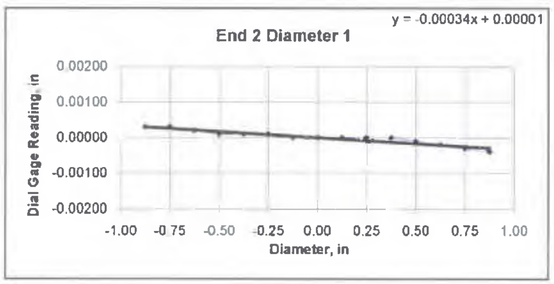
Difference between max and min readings, in:
0° = 0.00060 90° = 0.00020

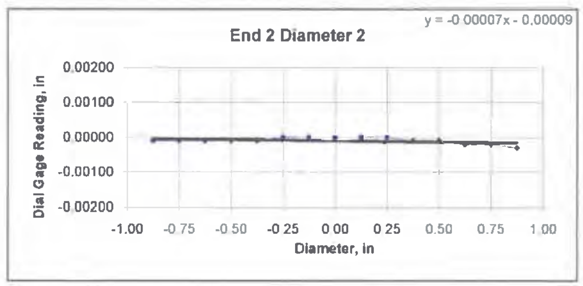
END 2	-0.875	-0.750	-0.625	-0.500	-0.375	-0.250	-0.125	0.000	0.125	0.250	0.375	0.500	0.625	0.750	0.875
Diameter 1, in	0.00030	0.00030	0.00020	0.00010	0.00010	0.00010	0.00000	0.00000	0.00000	0.00000	0.00000	-0.00010	-0.00020	-0.00030	-0.00040
Diameter 2, in (rotated 90°)	-0.00010	-0.00010	-0.00010	-0.00010	-0.00010	0.00000	0.00000	0.00000	0.00000	0.00000	-0.00010	-0.00010	-0.00020	-0.00020	-0.00030

Difference between max and min readings, in:
0° = 0.0007 90° = 0.0003
Maximum difference must be < 0.0020 in. Difference = + 0.00035
Flatness Tolerance Met? YES









DIAMETER 1

End 1:
Slope of Best Fit Line -0.00036
Angle of Best Fit Line: -0.02063

End 2:
Slope of Best Fit Line -0.00034
Angle of Best Fit Line: -0.01948

Maximum Angular Difference: 0.00115

Parallelism Tolerance Met? YES
Spherically Seated

DIAMETER 2

End 1:
Slope of Best Fit Line -0.00002
Angle of Best Fit Line -0.00115

End 2:
Slope of Best Fit Line -0.00007
Angle of Best Fit Line: 0.00401

Maximum Angular Difference: 0.00286

Parallelism Tolerance Met? YES
Spherically Seated

PERPENDICULARITY (Procedure P1) (Calculated from End Flatness and Parallelism measurements above)

END 1	Difference, Maximum and Minimum (in.)	Diameter (in.)	Slope	Angle°	Perpendicularity Tolerance Met?
Diameter 1, in	0.00060	2.495	0.00024	0.014	YES
Diameter 2, in (rotated 90°)	0.00020	2.495	0.00008	0.005	YES
END 2					
Diameter 1, in	0.00070	2.495	0.00028	0.016	YES
Diameter 2, in (rotated 90°)	0.00030	2.495	0.00012	0.007	YES

Maximum angle of departure must be ≤ 0.25°
Perpendicularity Tolerance Met? YES

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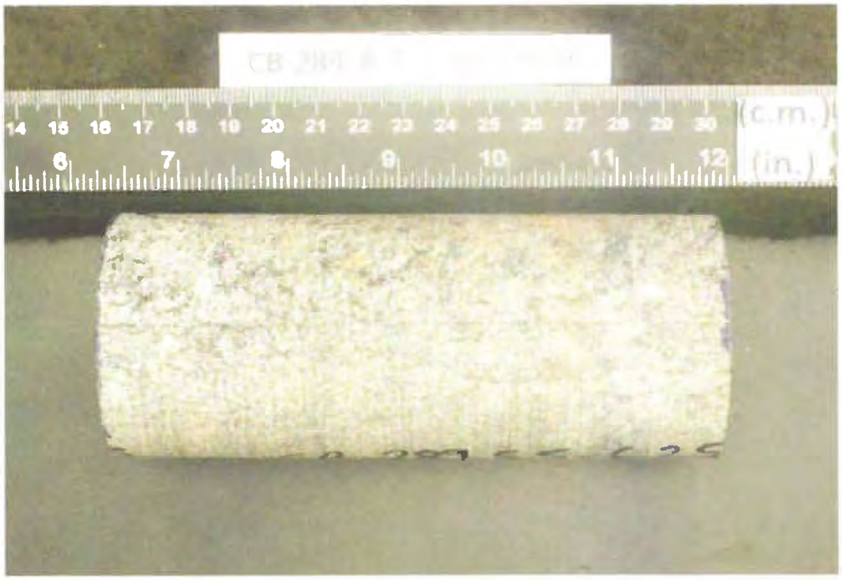
Client:	O'Brien & Gere Engineering
Project Name:	Delaware River Deepening Project
Project Location:	Tinicum to Marcus Hook Ranges, PA
GTX #:	9915
Test Date:	07/03/10
Tested By:	daa
Checked By:	mpd
Boring ID:	CB-289
Sample ID:	R-1
Depth, ft:	5.58-6.05



After cutting and grinding

After break

GeoTesting express
a subsidiary of Geocomp Corporation

Client:	O'Brien & Gere Engineering	Test Date:	7/3/2010
Project Name:	Delaware River Deepening Project	Tested By:	daa
Project Location:	Tinicum to Marcus Hook Ranges, PA	Checked By:	mpd
GTX #:	9915		
Boring ID:	CB-289		
Sample ID:	R-1		
Depth:	5.58-6.05 ft		
Visual Description:	See photographs		

UNIT WEIGHT DETERMINATION AND DIMENSIONAL AND SHAPE TOLERANCES OF ROCK CORE SPECIMENS BY ASTM D 4543-04

BULK DENSITY

	1	2	Average
Specimen Length, in:	5.59	5.60	5.60
Specimen Diameter, in:	2.48	2.49	2.49
Specimen Mass, g:	1221.66		
Bulk Density, lb/ft^3	171		
Length to Diameter Ratio:	2.3		

DEVIATION FROM STRAIGHTNESS (Procedure S1)

Maximum gap between side of core and reference surface plate:
Is the maximum gap ≤ 0.02 in.? YES

Maximum difference must be < 0.020 in.
Straightness Tolerance Met? **YES**

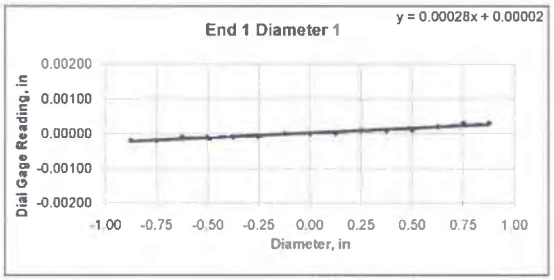
END FLATNESS AND PARALLELISM (Procedure FP1)

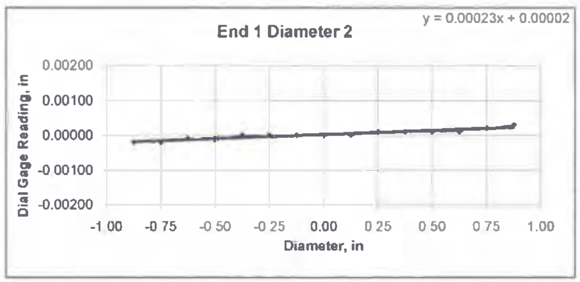
END 1	-0.875	-0.750	-0.625	-0.500	-0.375	-0.250	-0.125	0.000	0.125	0.250	0.375	0.500	0.625	0.750	0.875
Diameter 1, in	-0.00020	-0.00020	-0.00010	-0.00010	-0.00010	-0.00010	0.00000	0.00000	0.00000	0.00010	0.00010	0.00010	0.00020	0.00030	0.00030
Diameter 2, in (rotated 90°)	-0.00020	-0.00020	-0.00010	-0.00010	0.00000	0.00000	0.00000	0.00000	0.00000	0.00010	0.00010	0.00010	0.00010	0.00020	0.00030

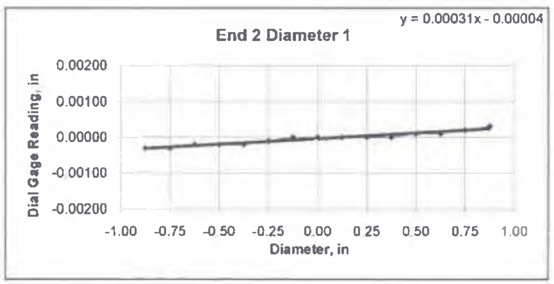
Difference between max and min readings, in:
0° = 0.00050 90° = 0.00050

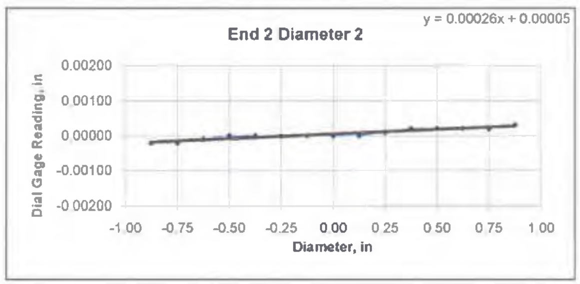
END 2	-0.875	-0.750	-0.625	-0.500	-0.375	-0.250	-0.125	0.000	0.125	0.250	0.375	0.500	0.625	0.750	0.875
Diameter 1, in	-0.00030	-0.00030	-0.00020	-0.00020	-0.00020	-0.00010	0.00000	0.00000	0.00000	0.00000	0.00000	0.00010	0.00010	0.00020	0.00030
Diameter 2, in (rotated 90°)	-0.00020	-0.00020	-0.00010	0.00000	0.00000	0.00000	0.00000	0.00000	0.00000	0.00010	0.00020	0.00020	0.00020	0.00020	0.00030

Difference between max and min readings, in:
0° = 0.0006 90° = 0.0005
Maximum difference must be < 0.0020 in. Difference = + 0.00030
Flatness Tolerance Met? YES









DIAMETER 1

End 1:

Slope of Best Fit Line	0.00028
Angle of Best Fit Line:	0.01604

End 2:

Slope of Best Fit Line	0.00031
Angle of Best Fit Line:	0.01776

Maximum Angular Difference: 0.00172

Parallelism Tolerance Met? **YES**
Spherically Seated

DIAMETER 2

End 1:

Slope of Best Fit Line	0.00023
Angle of Best Fit Line:	0.01318

End 2:

Slope of Best Fit Line	0.00026
Angle of Best Fit Line:	0.01490

Maximum Angular Difference: 0.00172

Parallelism Tolerance Met? **YES**
Spherically Seated

PERPENDICULARITY (Procedure P1) (Calculated from End Flatness and Parallelism measurements above)

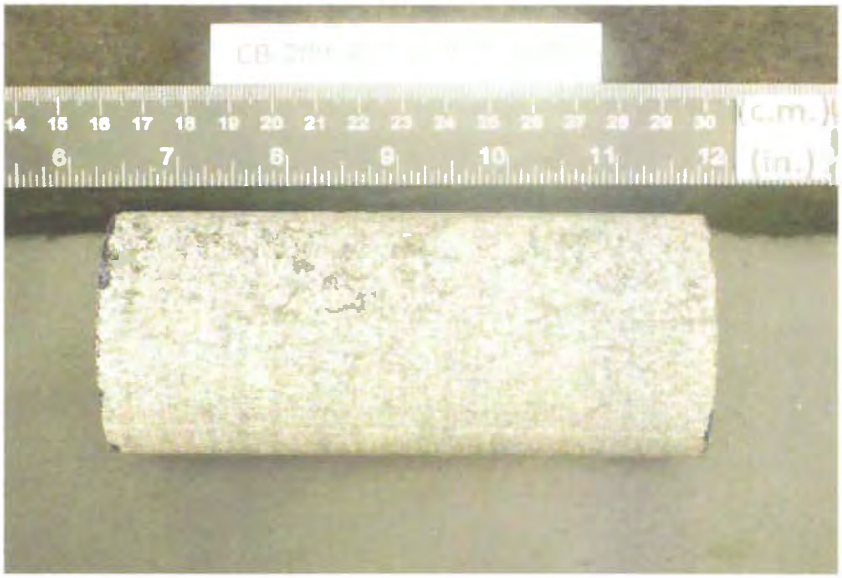
END 1	Difference, Maximum and Minimum (in.)	Diameter (in.)	Slope	Angle°	Perpendicularity Tolerance Met?
Diameter 1, in	0.00050	2.485	0.00020	0.012	YES
Diameter 2, in (rotated 90°)	0.00050	2.485	0.00020	0.012	YES
END 2					
Diameter 1, in	0.00060	2.485	0.00024	0.014	YES
Diameter 2, in (rotated 90°)	0.00050	2.485	0.00020	0.012	YES

Maximum angle of departure must be ≤ 0.25°

Perpendicularity Tolerance Met? **YES**

GeoTesting express

Client:	O'Brien & Gere Engineering
Project Name:	Delaware River Deepening Project
Project Location:	Tinicum to Marcus Hook Ranges, PA
GTX #:	9915
Test Date:	07/03/10
Tested By:	daa
Checked By:	mpd
Boring ID:	CB-289
Sample ID:	R-2
Depth, ft:	7.96-8.42



After cutting and grinding

After break

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Client:	O'Brien & Gere Engineering	Test Date:	7/3/2010
Project Name:	Delaware River Deepening Project	Tested By:	daa
Project Location:	Tinicum to Marcus Hook Ranges, PA	Checked By:	mpd
GTX #:	9915		
Boring ID:	CB-289		
Sample ID:	R-2		
Depth:	7.96-8.42 ft		
Visual Description:	See photographs		

UNIT WEIGHT DETERMINATION AND DIMENSIONAL AND SHAPE TOLERANCES OF ROCK CORE SPECIMENS BY ASTM D 4543-04

BULK DENSITY

	1	2	Average
Specimen Length, in:	5.47	5.48	5.48
Specimen Diameter, in:	2.48	2.48	2.48
Specimen Mass, g:	1191.82		
Bulk Density, lb/ft^3	171		
Length to Diameter Ratio:	2.2		

DEVIATION FROM STRAIGHTNESS (Procedure S1)

Maximum gap between side of core and reference surface plate:
Is the maximum gap ≤ 0.02 in.? YES

Maximum difference must be < 0.020 in.
Straightness Tolerance Met? YES

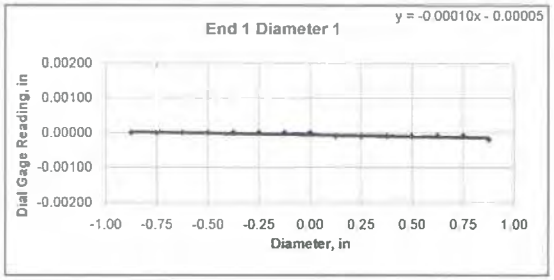
END FLATNESS AND PARALLELISM (Procedure FP1)

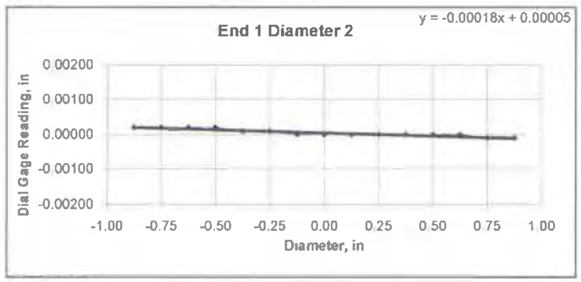
END 1	-0.875	-0.750	-0.625	-0.500	-0.375	-0.250	-0.125	0.000	0.125	0.250	0.375	0.500	0.625	0.750	0.875
Diameter 1, in	0.00000	0.00000	0.00000	0.00000	0.00000	0.00000	0.00000	0.00000	-0.00010	-0.00010	0.00010	-0.00010	-0.00010	-0.00010	-0.00020
Diameter 2, in (rotated 90°)	0.00020	0.00020	0.00020	0.00020	0.00010	0.00010	0.00000	0.00000	0.00000	0.00000	0.00000	0.00000	0.00000	-0.00010	-0.00010

Difference between max and min readings, in:
0° = 0.00020 90° = 0.00030

END 2	-0.875	-0.750	-0.625	-0.500	-0.375	-0.250	-0.125	0.000	0.125	0.250	0.375	0.500	0.625	0.750	0.875
Diameter 1, in	0.00000	0.00000	0.00000	0.00000	0.00000	0.00000	0.00000	0.00000	0.00000	0.00000	0.00000	0.00000	-0.00010	-0.00010	-0.00020
Diameter 2, in (rotated 90°)	0.00030	0.00020	0.00010	0.00010	0.00010	0.00010	0.00000	0.00000	0.00000	-0.00010	-0.00010	-0.00010	-0.00010	-0.00010	-0.00020

Difference between max and min readings, in:
0° = 0 0002 90° = 0.0005
Maximum difference must be < 0.0020 in. Difference = ± 0.00025
Flatness Tolerance Met? YES





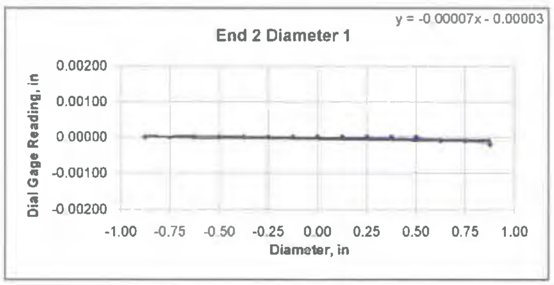
DIAMETER 1

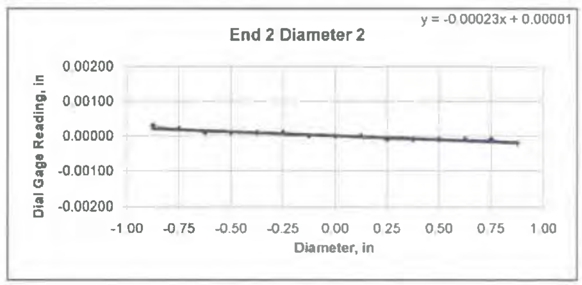
End 1:
Slope of Best Fit Line -0.00010
Angle of Best Fit Line: -0.00573

End 2:
Slope of Best Fit Line -0.00007
Angle of Best Fit Line: -0.00401

Maximum Angular Difference: 0.00172

Parallelism Tolerance Met? YES
Spherically Seated





DIAMETER 2

End 1:
Slope of Best Fit Line -0.00018
Angle of Best Fit Line: -0.01031

End 2:
Slope of Best Fit Line -0.00023
Angle of Best Fit Line: -0.01318

Maximum Angular Difference: 0.00286

Parallelism Tolerance Met? YES
Spherically Seated

PERPENDICULARITY (Procedure P1) (Calculated from End Flatness and Parallelism measurements above)

END 1	Difference, Maximum and Minimum (in.)	Diameter (in.)	Slope	Angle°	Perpendicularity Tolerance Met?
Diameter 1, in	0.00020	2.480	0.00008	0.005	YES
Diameter 2, in (rotated 90°)	0.00030	2.480	0.00012	0.007	YES
END 2					
Diameter 1, in	0.00020	2.480	0.00008	0.005	YES
Diameter 2, in (rotated 90°)	0.00050	2.480	0.00020	0.012	YES

Maximum angle of departure must be ≤ 0.25°
Perpendicularity Tolerance Met? YES

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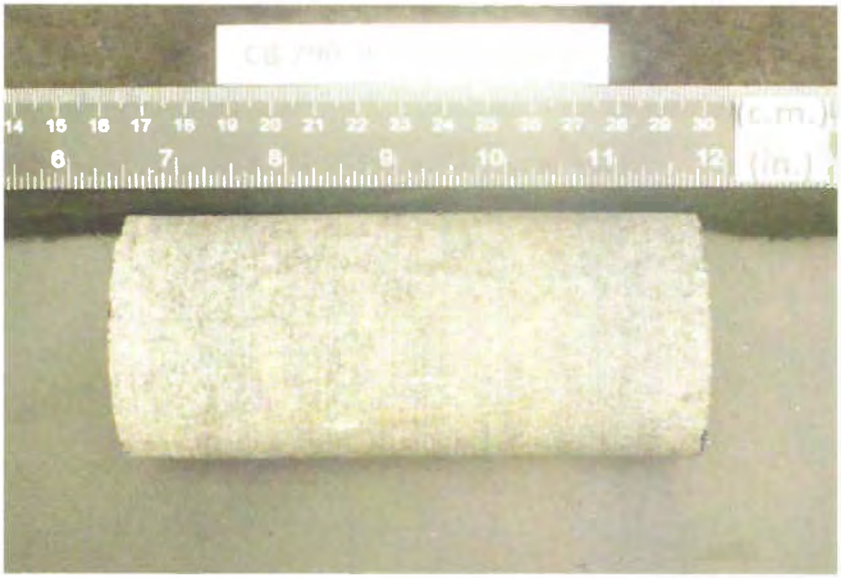
Client:	O'Brien & Gere Engineering
Project Name:	Delaware River Deepening Project
Project Location:	Tinicum to Marcus Hook Ranges, PA
GTX #:	9915
Test Date:	07/03/10
Tested By:	daa
Checked By:	mpd
Boring ID:	CB-290
Sample ID:	R-1
Depth, ft:	2.88-3.32



After cutting and grinding

After break

GeoTesting express
a subsidiary of Geocomp Corporation

Client:	O'Brien & Gere Engineering	Test Date:	7/3/2010
Project Name:	Delaware River Deepening Project	Tested By:	daa
Project Location:	Tinicum to Marcus Hook Ranges, PA	Checked By:	mpd
GTX #:	9915		
Boring ID:	CB-290		
Sample ID:	R-1		
Depth:	2.88-3.32 ft		
Visual Description:	See photographs		

UNIT WEIGHT DETERMINATION AND DIMENSIONAL AND SHAPE TOLERANCES OF ROCK CORE SPECIMENS BY ASTM D 4543-04

BULK DENSITY

	1	2	Average
Specimen Length, in:	5.31	5.32	5.32
Specimen Diameter, in:	2.48	2.49	2.49
Specimen Mass, g:	1248.02		
Bulk Density, lb/ft^3	184		
Length to Diameter Ratio:	2.1		

DEVIATION FROM STRAIGHTNESS (Procedure S1)

Maximum gap between side of core and reference surface plate:
Is the maximum gap ≤ 0.02 in.? YES

Maximum difference must be < 0.020 in.
Straightness Tolerance Met? **YES**

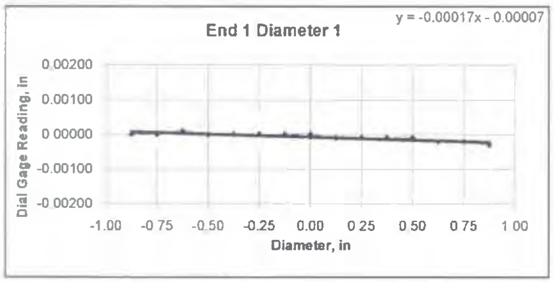
END FLATNESS AND PARALLELISM (Procedure FP1)

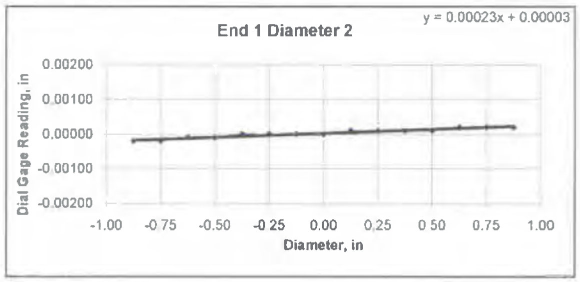
END 1	-0.875	-0.750	-0.625	-0.500	-0.375	-0.250	-0.125	0.000	0.125	0.250	0.375	0.500	0.625	0.750	0.875
Diameter 1, in	0.00000	0.00000	0.00010	0.00000	0.00000	0.00000	0.00000	0.00000	-0.00010	-0.00010	-0.00010	-0.00010	-0.00020	0.00020	-0.00030
Diameter 2, in (rotated 90°)	-0.00020	-0.00020	-0.00010	-0.00010	0.00000	0.00000	0.00000	0.00000	0.00010	0.00010	0.00010	0.00010	0.00020	0.00020	0.00020

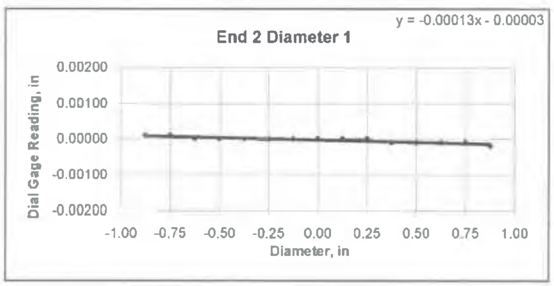
Difference between max and min readings, in:
0° = 0.00040 90° = 0.00040

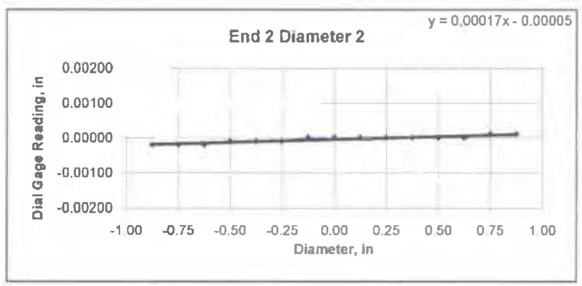
END 2	-0.875	0.750	0.625	-0.500	-0.375	-0.250	-0.125	0.000	0.125	0.250	0.375	0.500	0.625	0.750	0.875
Diameter 1, in	0.00010	0.00010	0.00000	0.00000	0.00000	0.00000	0.00000	0.00000	0.00000	0.00000	-0.00010	-0.00010	-0.00010	-0.00010	-0.00020
Diameter 2, in (rotated 90°)	-0.00020	-0.00020	-0.00020	-0.00010	-0.00010	-0.00010	0.00000	0.00000	0.00000	0.00000	0.00000	0.00000	0.00000	0.00010	0.00010

Difference between max and min readings, in:
0° = 0.0003 90° = 0.0003
Maximum difference must be < 0.0020 in. Difference = ± 0.00020
Flatness Tolerance Met? **YES**









DIAMETER 1

End 1:
Slope of Best Fit Line -0.00017
Angle of Best Fit Line: -0.00974

End 2:
Slope of Best Fit Line -0.00013
Angle of Best Fit Line: 0.00745

Maximum Angular Difference: 0.00229

Parallelism Tolerance Met? **YES**
Spherically Seated

DIAMETER 2

End 1:
Slope of Best Fit Line 0.00023
Angle of Best Fit Line: 0.01318

End 2:
Slope of Best Fit Line 0.00017
Angle of Best Fit Line: 0.00974

Maximum Angular Difference: 0.00344

Parallelism Tolerance Met? **YES**
Spherically Seated

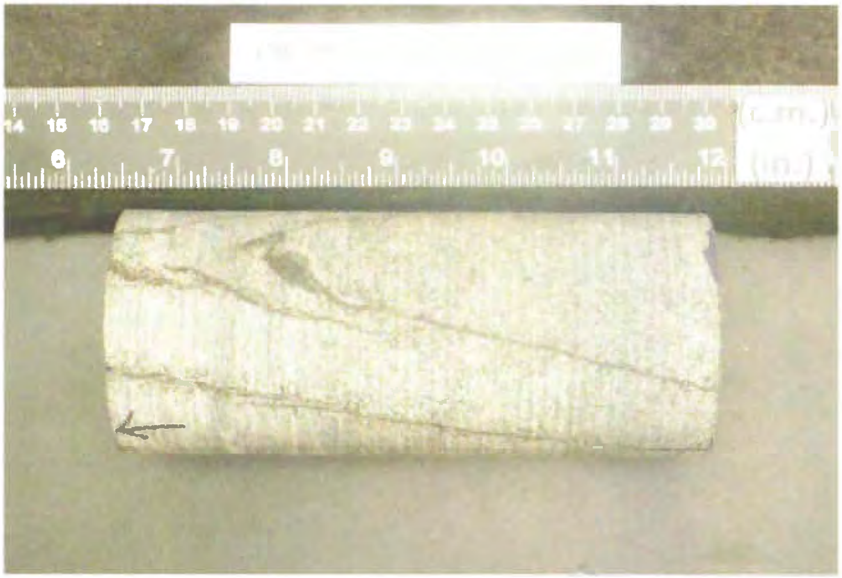
PERPENDICULARITY (Procedure P1) (Calculated from End Flatness and Parallelism measurements above)

END 1	Difference, Maximum and Minimum (in.)	Diameter (in.)	Slope	Angle°	Perpendicularity Tolerance Met?
Diameter 1, in	0.00040	2.485	0.00016	0.009	YES
Diameter 2, in (rotated 90°)	0.00040	2.485	0.00016	0.009	YES
END 2					
Diameter 1, in	0.00030	2.485	0.00012	0.007	YES
Diameter 2, in (rotated 90°)	0.00030	2.485	0.00012	0.007	YES

Maximum angle of departure must be ≤ 0.25°
Perpendicularity Tolerance Met? **YES**

GeoTesting express

Client:	O'Brien & Gere Engineering
Project Name:	Delaware River Deepening Project
Project Location:	Tinicum to Marcus Hook Ranges, PA
GTX #:	9915
Test Date:	07/03/10
Tested By:	daa
Checked By:	mpd
Boring ID:	CB-290
Sample ID:	R-2
Depth, ft:	1.03-1.48



After cutting and grinding

After break

GeoTesting express a subsidiary of Geocomp Corporation

Client:	O'Brien & Gere Engineering	Test Date:	7/3/2010
Project Name:	Delaware River Deepening Project	Tested By:	daa
Project Location:	Tinicum to Marcus Hook Ranges, PA	Checked By:	mpd
GTX #:	9915		
Boring ID:	CB 290		
Sample ID:	R-2		
Depth:	1.03-1.48 ft		
Visual Description:	See photographs		

UNIT WEIGHT DETERMINATION AND DIMENSIONAL AND SHAPE TOLERANCES OF ROCK CORE SPECIMENS BY ASTM D 4543-04

BULK DENSITY

	1	2	Average
Specimen Length, in:	5.42	5.43	5.43
Specimen Diameter, in:	2.49	2.48	2.49
Specimen Mass, g:	1261.94		
Bulk Density, lb/ft^3	182		
Length to Diameter Ratio:	2.2		

DEVIATION FROM STRAIGHTNESS (Procedure S1)

Maximum gap between side of core and reference surface plate:
Is the maximum gap ≤ 0.02 in.? NO

Maximum difference must be < 0.020 in.
Straightness Tolerance Met? **NO**

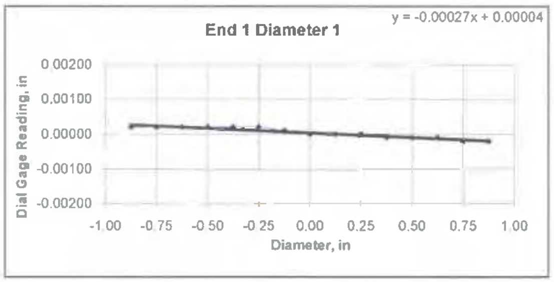
END FLATNESS AND PARALLELISM (Procedure FP1)

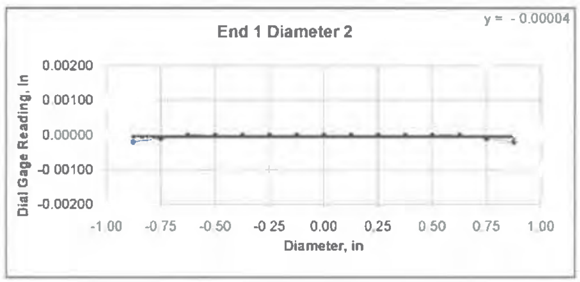
END 1	-0.875	-0.750	-0.625	-0.500	-0.375	-0.250	-0.125	0.000	0.125	0.250	0.375	0.500	0.625	0.750	0.875
Diameter 1, in	0.00020	0.00020	0.00020	0.00020	0.00020	0.00020	0.00010	0.00000	0.00000	0.00000	-0.00010	-0.00010	-0.00010	-0.00020	-0.00020
Diameter 2, in (rotated 90°)	-0.00020	-0.00010	0.00000	0.00000	0.00000	0.00000	0.00000	0.00000	0.00000	0.00000	0.00000	0.00000	0.00000	-0.00010	-0.00020

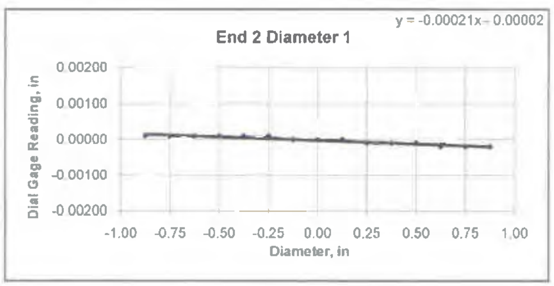
Difference between max and min readings, in:
0° = 0.00040 90° = 0.00020

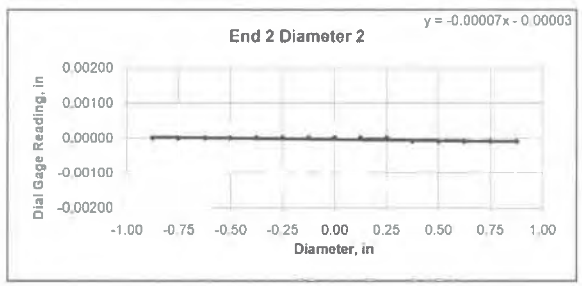
END 2	-0.875	-0.750	-0.625	-0.500	-0.375	-0.250	-0.125	0.000	0.125	0.250	0.375	0.500	0.625	0.750	0.875
Diameter 1, in	0.00010	0.00010	0.00010	0.00010	0.00010	0.00010	0.00000	0.00000	0.00000	-0.00010	-0.00010	0.00010	0.00020	-0.00020	-0.00020
Diameter 2, in (rotated 90°)	0.00000	0.00000	0.00000	0.00000	0.00000	0.00000	0.00000	0.00000	0.00000	0.00000	-0.00010	-0.00010	0.00010	-0.00010	-0.00010

Difference between max and min readings, in:
0° = 0.0003 90° = 0.0001
Maximum difference must be < 0.0020 in. Difference = + 0.00020
Flatness Tolerance Met? YES









DIAMETER 1

End 1:
Slope of Best Fit Line -0.00027
Angle of Best Fit Line: -0.01547

End 2:
Slope of Best Fit Line -0.00021
Angle of Best Fit Line: -0.01203

Maximum Angular Difference: 0.00344

Parallelism Tolerance Met? **YES**
Spherically Seated

DIAMETER 2

End 1:
Slope of Best Fit Line -0.00004
Angle of Best Fit Line: -0.00229

End 2:
Slope of Best Fit Line -0.00007
Angle of Best Fit Line: -0.00401

Maximum Angular Difference: 0.00172

Parallelism Tolerance Met? **YES**
Spherically Seated

PERPENDICULARITY (Procedure P1) (Calculated from End Flatness and Parallelism measurements above)

END 1	Difference, Maximum and Minimum (in.)	Diameter (in.)	Slope	Angle°	Perpendicularity Tolerance Met?
Diameter 1, in	0.00040	2.485	0.00016	0.009	YES
Diameter 2, in (rotated 90°)	0.00020	2.485	0.00008	0.005	YES
END 2					
Diameter 1, in	0.00030	2.485	0.00012	0.007	YES
Diameter 2, in (rotated 90°)	0.00010	2.485	0.00004	0.002	YES

Maximum angle of departure must be < 0.25°

Perpendicularity Tolerance Met? **YES**

Client:	O'Brien & Gere Engineering
Project Name:	Delaware River Deepening Project
Project Location:	Tinicum to Marcus Hook Ranges, PA
GTX #:	9915
Test Date:	07/03/10
Tested By:	daa
Checked By:	mpd
Boring ID:	CB-290
Sample ID:	R-3
Depth, ft:	6.40-6.81

After cutting and grinding

After break

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Client:	O'Brien & Gere Engineering	Test Date:	7/3/2010
Project Name:	Delaware River Deepening Project	Tested By:	daa
Project Location:	Tinicum to Marcus Hook Ranges, PA	Checked By:	mpd
GTX #:	9915		
Boring ID:	CB-290		
Sample ID:	R-3		
Depth:	6.40-6.81 ft		
Visual Description:	See photographs		

UNIT WEIGHT DETERMINATION AND DIMENSIONAL AND SHAPE TOLERANCES OF ROCK CORE SPECIMENS BY ASTM D 4543-04

BULK DENSITY

	1	2	Average
Specimen Length, in:	4.91	4.92	4.92
Specimen Diameter, in:	2.49	2.49	2.49
Specimen Mass, g:	1035.15		
Bulk Density, lb/ft^3	164		
Length to Diameter Ratio:	2.0		

DEVIATION FROM STRAIGHTNESS (Procedure S1)

Maximum gap between side of core and reference surface plate:
Is the maximum gap $\leq$ 0.02 in.? NO

Maximum difference must be < 0.020 in.
Straightness Tolerance Met? **NO**

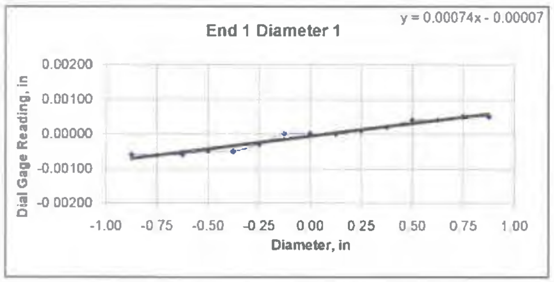
END FLATNESS AND PARALLELISM (Procedure FP1)

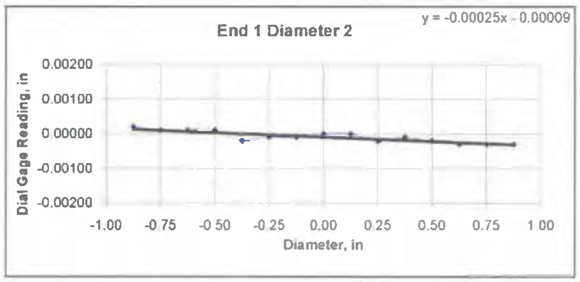
END 1	0.875	0.750	-0.625	-0.500	-0.375	-0.250	-0.125	0.000	0.125	0.250	0.375	0.500	0.625	0.750	0.875
Diameter 1, in	-0.00060	-0.00060	-0.00060	-0.00050	-0.00050	-0.00030	0.00000	0.00000	0.00000	0.00010	0.00020	0.00040	0.00040	0.00050	0.00050
Diameter 2, in (rotated 90°)	0.00020	0.00010	0.00010	0.00010	-0.00020	-0.00010	-0.00010	0.00000	0.00000	-0.00020	-0.00010	-0.00020	-0.00030	-0.00030	-0.00030

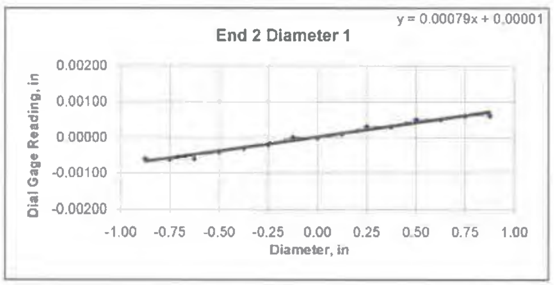
Difference between max and min readings, in:
0° = 0.00110 90° = 0.00050

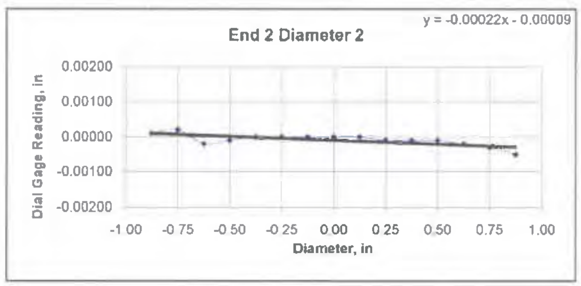
END 2	-0.875	-0.750	-0.625	-0.500	-0.375	-0.250	-0.125	0.000	0.125	0.250	0.375	0.500	0.625	0.750	0.875
Diameter 1, in	-0.00060	-0.00060	-0.00060	-0.00040	-0.00030	-0.00020	0.00000	0.00000	0.00010	0.00030	0.00030	0.00050	0.00050	0.00060	0.00060
Diameter 2, in (rotated 90°)	0.00010	0.00020	0.00020	-0.00010	0.00000	0.00000	0.00000	0.00000	0.00000	-0.00010	-0.00010	-0.00010	-0.00020	-0.00030	-0.00050

Difference between max and min readings, in:
0° = 0.0012 90° = 0.0007
Maximum difference must be < 0.0020 in. Difference = ± 0.00060
Flatness Tolerance Met? **YES**









DIAMETER 1

End 1:
Slope of Best Fit Line 0.00074
Angle of Best Fit Line: 0.04240

End 2:
Slope of Best Fit Line 0.00079
Angle of Best Fit Line: 0.04526

Maximum Angular Difference: 0.00286

Parallelism Tolerance Met? **YES**
Spherically Seated

DIAMETER 2

End 1:
Slope of Best Fit Line 0.00025
Angle of Best Fit Line: -0.01432

End 2:
Slope of Best Fit Line -0.00022
Angle of Best Fit Line: -0.01261

Maximum Angular Difference: 0.00172

Parallelism Tolerance Met? **YES**
Spherically Seated

PERPENDICULARITY (Procedure P1) (Calculated from End Flatness and Parallelism measurements above)

END 1	Difference, Maximum and Minimum (in.)	Diameter (in.)	Slope	Angle°	Perpendicularity Tolerance Met?
Diameter 1, in	0.00110	2.490	0.00044	0.025	YES
Diameter 2, in (rotated 90°)	0.00050	2.490	0.00020	0.012	YES
END 2					
Diameter 1, in	0.00120	2.490	0.00048	0.028	YES
Diameter 2, in (rotated 90°)	0.00070	2.490	0.00028	0.016	YES

Maximum angle of departure must be $\leq$ 0.25°
Perpendicularity Tolerance Met? **YES**

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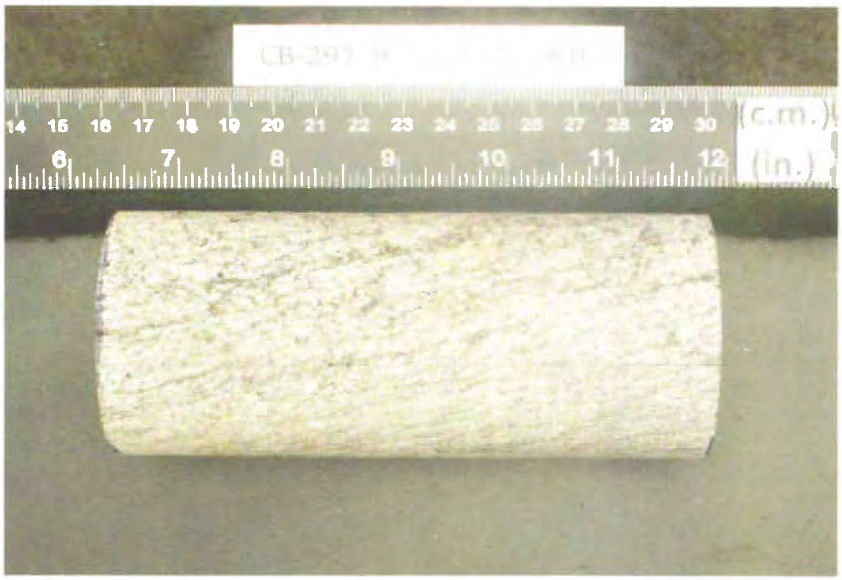
Client:	O'Brien & Gere Engineering
Project Name:	Delaware River Deepening Project
Project Location:	Tinicum to Marcus Hook Ranges, PA
GTX #:	9915
Test Date:	07/03/10
Tested By:	daa
Checked By:	mpd
Boring ID:	CB-291
Sample ID:	R-2
Depth, ft:	5.52-5.98



After cutting and grinding

After break

GeoTesting express
a subsidiary of Geocomp Corporation

Client:	O'Brien & Gere Engineering	Test Date:	7/3/2010
Project Name:	Delaware River Deepening Project	Tested By:	daa
Project Location:	Tinicum to Marcus Hook Ranges, PA	Checked By:	mpd
GTX #:	9915		
Boring ID:	CB-291		
Sample ID:	R-2		
Depth:	5.52-5.98 ft		
Visual Description:	See photographs		

UNIT WEIGHT DETERMINATION AND DIMENSIONAL AND SHAPE TOLERANCES OF ROCK CORE SPECIMENS BY ASTM D 4543-04

BULK DENSITY

	1	2	Average
Specimen Length, in:	5.51	5.51	5.51
Specimen Diameter, in:	2.49	2.50	2.50
Specimen Mass, g:	1189.8		
Bulk Density, lb/ft^3	168		
Length to Diameter Ratio:	2.2		

DEVIATION FROM STRAIGHTNESS (Procedure S1)

Maximum gap between side of core and reference surface plate:
Is the maximum gap ≤ 0.02 in.? YES

Maximum difference must be < 0.020 in.
Straightness Tolerance Met? **YES**

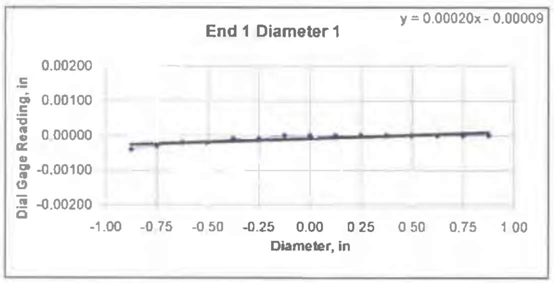
END FLATNESS AND PARALLELISM (Procedure FP1)

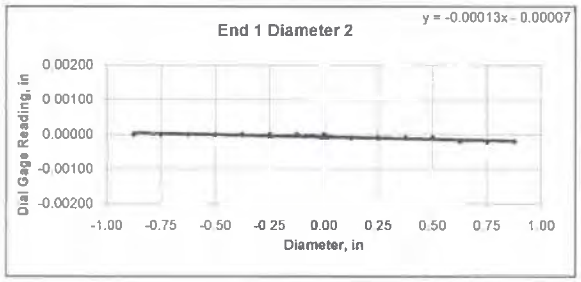
END 1	-0.875	-0.750	-0.625	-0.500	-0.375	-0.250	-0.125	0.000	0.125	0.250	0.375	0.500	0.625	0.750	0.875
Diameter 1, in	-0.00040	-0.00030	-0.00020	-0.00020	-0.00010	-0.00010	0.00000	0.00000	0.00000	0.00000	0.00000	0.00000	0.00000	0.00000	0.00000
Diameter 2, in (rotated 90°)	0.00000	0.00000	0.00000	0.00000	0.00000	0.00000	0.00000	0.00000	-0.00010	-0.00010	-0.00010	-0.00010	-0.00020	-0.00020	-0.00020

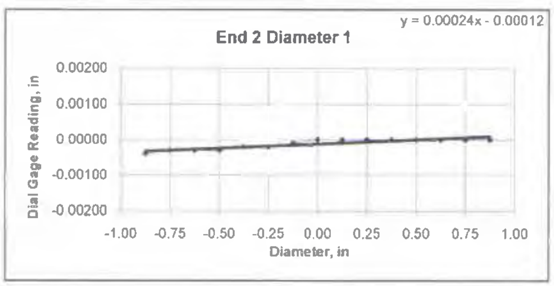
Difference between max and min readings, in:
0° = 0.00040 90° = 0.00020

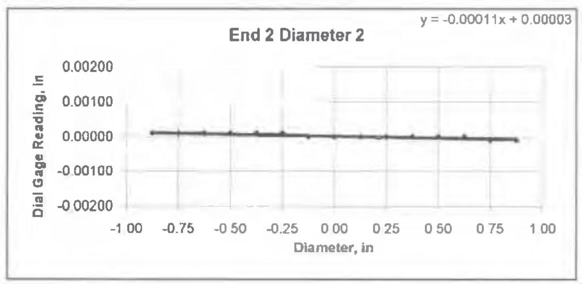
END 2	-0.875	-0.750	-0.625	-0.500	-0.375	-0.250	-0.125	0.000	0.125	0.250	0.375	0.500	0.625	0.750	0.875
Diameter 1, in	-0.00040	-0.00030	-0.00030	-0.00030	-0.00020	-0.00020	-0.00010	0.00000	0.00000	0.00000	0.00000	0.00000	0.00000	0.00000	0.00000
Diameter 2, in (rotated 90°)	0.00010	0.00010	0.00010	0.00010	0.00010	0.00010	0.00000	0.00000	0.00000	0.00000	0.00000	0.00000	0.00000	-0.00010	-0.00010

Difference between max and min readings, in:
0° = 0.0004 90° = 0.0002
Maximum difference must be < 0.0020 in. Difference = ± 0.00020
Flatness Tolerance Met? YES









DIAMETER 1

End 1:
Slope of Best Fit Line 0.00020
Angle of Best Fit Line: 0.01146

End 2:
Slope of Best Fit Line 0.00024
Angle of Best Fit Line: 0.01375

Maximum Angular Difference: 0.00229

Parallelism Tolerance Met? **YES**
Spherically Seated

DIAMETER 2

End 1:
Slope of Best Fit Line -0.00013
Angle of Best Fit Line: -0.00745

End 2:
Slope of Best Fit Line -0.00011
Angle of Best Fit Line: -0.00630

Maximum Angular Difference: 0.00115

Parallelism Tolerance Met? **YES**
Spherically Seated

PERPENDICULARITY (Procedure P1) (Calculated from End Flatness and Parallelism measurements above)

END 1	Difference, Maximum and Minimum (in.)	Diameter (in.)	Slope	Angle°	Perpendicularity Tolerance Met?
Diameter 1, in	0.00040	2.495	0.00016	0.009	YES
Diameter 2, in (rotated 90°)	0.00020	2.495	0.00008	0.005	YES
END 2					
Diameter 1, in	0.00040	2.495	0.00016	0.009	YES
Diameter 2, in (rotated 90°)	0.00020	2.495	0.00008	0.005	YES

Maximum angle of departure must be ≤ 0.25°

Perpendicularity Tolerance Met? **YES**

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Client:	O'Brien & Gere Engineering
Project Name:	Delaware River Deepening Project
Project Location:	Tinicum to Marcus Hook Ranges, PA
GTX #:	9915
Test Date:	07/03/10
Tested By:	daa
Checked By:	mpd
Boring ID:	CB-294
Sample ID:	R-2
Depth, ft:	4.45-4.91

After cutting and grinding

After break

GeoTesting express
a subsidiary of Geocomp Corporation

Client:	O'Brien & Gere Engineering	Test Date:	7/3/2010
Project Name:	Delaware River Deepening Project	Tested By:	daa
Project Location:	Tinicum to Marcus Hook Ranges, PA	Checked By:	mpd
GTX #:	9915		
Boring ID:	CB-294		
Sample ID:	R-2		
Depth:	4.45-4.91 ft		
Visual Description:	See photographs		

UNIT WEIGHT DETERMINATION AND DIMENSIONAL AND SHAPE TOLERANCES OF ROCK CORE SPECIMENS BY ASTM D 4543-04

BULK DENSITY

	1	2	Average
Specimen Length, in:	5.49	5.50	5.50
Specimen Diameter, in:	2.48	2.49	2.49
Specimen Mass, g:	1201.61		
Bulk Density, lb/ft^3	171		
Length to Diameter Ratio:	2.2		

DEVIATION FROM STRAIGHTNESS (Procedure S1)

Maximum gap between side of core and reference surface plate:
Is the maximum gap ≤ 0.02 in.? NO

Maximum difference must be < 0.020 in.
Straightness Tolerance Met? **NO**

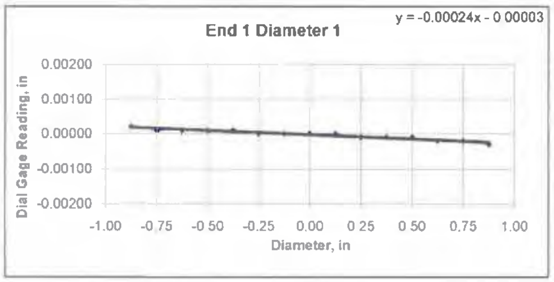
END FLATNESS AND PARALLELISM (Procedure FP1)

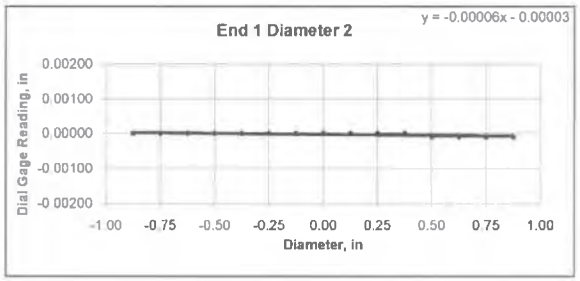
END 1	-0.875	-0.750	-0.625	-0.500	-0.375	-0.250	-0.125	0.000	0.125	0.250	0.375	0.500	0.625	0.750	0.875
Diameter 1, in	0.00020	0.00010	0.00010	0.00010	0.00010	0.00000	0.00000	0.00000	0.00000	-0.00010	-0.00010	-0.00010	-0.00020	-0.00020	-0.00030
Diameter 2, in (rotated 90°)	0.00000	0.00000	0.00000	0.00000	0.00000	0.00000	0.00000	0.00000	0.00000	0.00000	0.00000	-0.00010	-0.00010	-0.00010	-0.00010

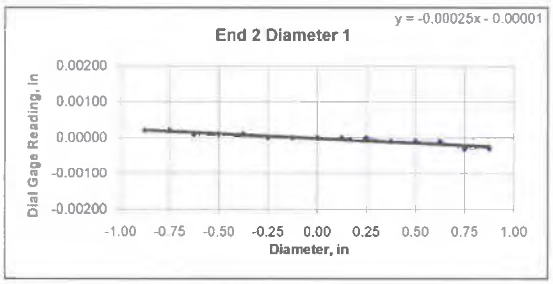
Difference between max and min readings, in:
0° = 0.00050 90° = 0.00010

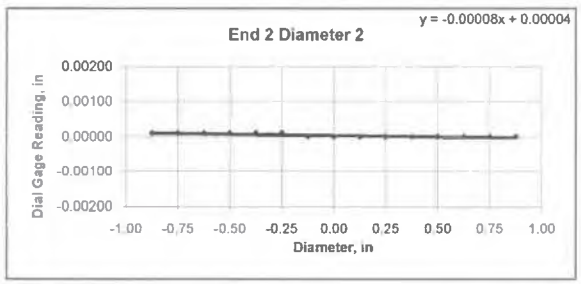
END 2	-0.875	-0.750	-0.625	-0.500	-0.375	-0.250	-0.125	0.000	0.125	0.250	0.375	0.500	0.625	0.750	0.875
Diameter 1, in	0.00020	0.00020	0.00010	0.00010	0.00010	0.00000	0.00000	0.00000	0.00000	0.00000	-0.00010	-0.00010	-0.00010	-0.00030	-0.00030
Diameter 2, in (rotated 90°)	0.00010	0.00010	0.00010	0.00010	0.00010	0.00010	0.00000	0.00000	0.00000	0.00000	0.00000	0.00000	0.00000	0.00000	0.00000

Difference between max and min readings, in:
0° = 0.0005 90° = 0.0001
Maximum difference must be < 0.0020 in. Difference = + 0.00025
Flatness Tolerance Met? YES









DIAMETER 1

End 1:
Slope of Best Fit Line -0.00024
Angle of Best Fit Line: -0.01375

End 2:
Slope of Best Fit Line -0.00025
Angle of Best Fit Line: -0.01432

Maximum Angular Difference: 0.00057

Parallelism Tolerance Met? **YES**
Spherically Seated

DIAMETER 2

End 1:
Slope of Best Fit Line -0.00006
Angle of Best Fit Line: -0.00344

End 2:
Slope of Best Fit Line -0.00008
Angle of Best Fit Line: -0.00458

Maximum Angular Difference: 0.00115

Parallelism Tolerance Met? **YES**
Spherically Seated

PERPENDICULARITY (Procedure P1) (Calculated from End Flatness and Parallelism measurements above)

END 1	Difference, Maximum and Minimum (in.)	Diameter (in.)	Slope	Angle°	Perpendicularity Tolerance Met?
Diameter 1, in	0.00050	2.485	0.00020	0.012	YES
Diameter 2, in (rotated 90°)	0.00010	2.485	0.00004	0.002	YES
END 2					
Diameter 1, in	0.00050	2.485	0.00020	0.012	YES
Diameter 2, in (rotated 90°)	0.00010	2.485	0.00004	0.002	YES

Maximum angle of departure must be ≤ 0.25°

Perpendicularity Tolerance Met? **YES**

Client:	O'Brien & Gere Engineering
Project Name:	Delaware River Deepening Project
Project Location:	Tinicum to Marcus Hook Ranges, PA
GTX #:	9915
Test Date:	07/03/10
Tested By:	daa
Checked By:	mpd
Boring ID:	CB-294
Sample ID:	R-2
Depth, ft:	5.08-5.46

After cutting and grinding

After break

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Client:	O'Brien & Gere Engineering	Test Date:	7/3/2010
Project Name:	Delaware River Deepening Project	Tested By:	daa
Project Location:	Tinicum to Marcus Hook Ranges, PA	Checked By:	mpd
GTX #:	9915		
Boring ID:	CB-294		
Sample ID:	R-2		
Depth:	5.08-5.46 ft		
Visual Description:	See photographs		

UNIT WEIGHT DETERMINATION AND DIMENSIONAL AND SHAPE TOLERANCES OF ROCK CORE SPECIMENS BY ASTM D 4543-04

BULK DENSITY

	1	2	Average
Specimen Length, in:	4.51	4.50	4.51
Specimen Diameter, in:	2.48	2.49	2.49
Specimen Mass, g:	961.42		
Bulk Density, lb/ft^3	167		
Length to Diameter Ratio:	1.8		

DEVIATION FROM STRAIGHTNESS (Procedure S1)

Maximum gap between side of core and reference surface plate:
Is the maximum gap ≤ 0.02 in.? NO

Maximum difference must be < 0.020 in.
Straightness Tolerance Met? **NO**

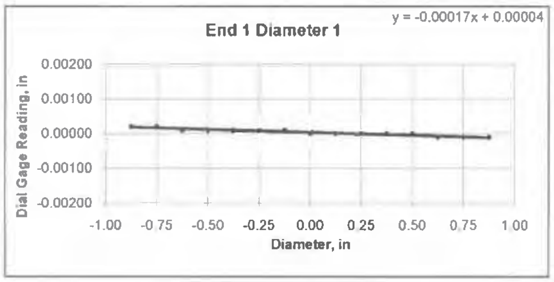
END FLATNESS AND PARALLELISM (Procedure FP1)

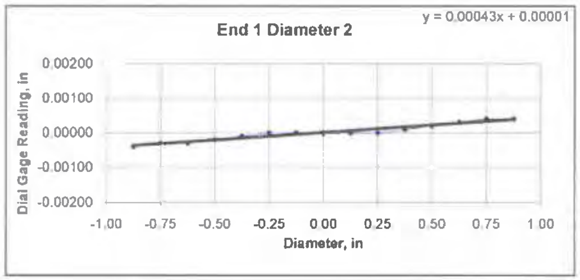
END 1	-0.875	-0.750	-0.625	-0.500	-0.375	-0.250	-0.125	0.000	0.125	0.250	0.375	0.500	0.625	0.750	0.875
Diameter 1, in	0.00020	0.00020	0.00010	0.00010	0.00010	0.00010	0.00010	0.00000	0.00000	0.00000	0.00000	0.00000	-0.00010	-0.00010	-0.00010
Diameter 2, in (rotated 90°)	-0.00040	-0.00030	-0.00030	-0.00020	-0.00010	0.00000	0.00000	0.00000	0.00000	0.00000	0.00010	0.00020	0.00030	0.00040	0.00040

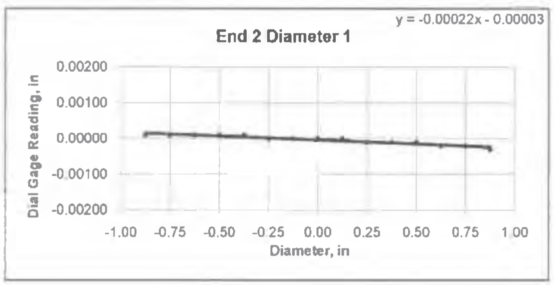
Difference between max and min readings, in:
0° = 0.00030 90° = 0.00080

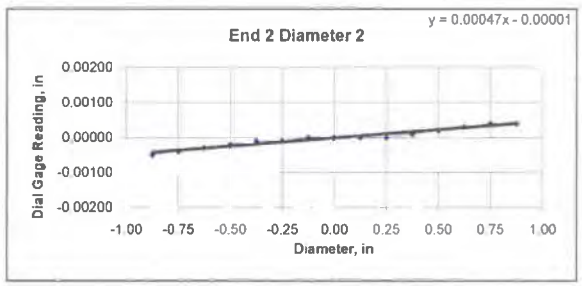
END 2	-0.875	-0.750	-0.625	-0.500	-0.375	-0.250	-0.125	0.000	0.125	0.250	0.375	0.500	0.625	0.750	0.875
Diameter 1, in	0.00010	0.00010	0.00010	0.00010	0.00010	0.00000	0.00000	0.00000	0.00000	-0.00010	-0.00010	-0.00010	0.00020	0.00020	-0.00030
Diameter 2, in (rotated 90°)	0.00050	-0.00040	-0.00030	-0.00020	-0.00010	-0.00010	0.00000	0.00000	0.00000	0.00000	0.00010	0.00020	0.00030	0.00040	0.00040

Difference between max and min readings, in:
0° = 0.0004 90° = 0.0009
Maximum difference must be < 0.0020 in. Difference = + 0.00045
Flatness Tolerance Met? **YES**









DIAMETER 1

End 1:	Slope of Best Fit Line	-0.00017
	Angle of Best Fit Line:	-0.00974
End 2:	Slope of Best Fit Line	-0.00022
	Angle of Best Fit Line:	-0.01261
Maximum Angular Difference:		0.00286

Parallelism Tolerance Met? **YES**
Spherically Seated

DIAMETER 2

End 1:	Slope of Best Fit Line	0.00043
	Angle of Best Fit Line:	0.02464
End 2:	Slope of Best Fit Line	0.00047
	Angle of Best Fit Line:	0.02693
Maximum Angular Difference:		0.00229

Parallelism Tolerance Met? **YES**
Spherically Seated

PERPENDICULARITY (Procedure P1) (Calculated from End Flatness and Parallelism measurements above)

END 1	Difference, Maximum and Minimum (in.)	Diameter (in.)	Slope	Angle°	Perpendicularity Tolerance Met?
Diameter 1, in	0.00030	2.485	0.00012	0.007	YES
Diameter 2, in (rotated 90°)	0.00080	2.485	0.00032	0.018	YES
END 2					
Diameter 1, in	0.00040	2.485	0.00016	0.009	YES
Diameter 2, in (rotated 90°)	0.00090	2.485	0.00036	0.021	YES

Maximum angle of departure must be ≤ 0.25°
Perpendicularity Tolerance Met? **YES**

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Client:	O'Brien & Gere Engineering
Project Name:	Delaware River Deepening Project
Project Location:	Tinicum to Marcus Hook Ranges, PA
GTX #:	9915
Test Date:	07/03/10
Tested By:	daa
Checked By:	mpd
Boring ID:	CB-295
Sample ID:	R-1
Depth, ft:	3.14-3.58

After cutting and grinding

After break

GeoTesting express
a subsidiary of Geocomp Corporation

Client:	O'Brien & Gere Engineering	Test Date:	7/3/2010
Project Name:	Delaware River Deepening Project	Tested By:	daa
Project Location:	Tinicum to Marcus Hook Ranges, PA	Checked By:	mpd
GTX #:	9915		
Boring ID:	CB-295		
Sample ID:	R-1		
Depth:	3.14-3.58 ft		
Visual Description:	See photographs		

UNIT WEIGHT DETERMINATION AND DIMENSIONAL AND SHAPE TOLERANCES OF ROCK CORE SPECIMENS BY ASTM D 4543-04

BULK DENSITY

	1	2	Average
Specimen Length, in:	5.33	5.33	5.33
Specimen Diameter, in:	2.47	2.49	2.48
Specimen Mass, g:	1122.91		
Bulk Density, lb/ft^3	166		
Length to Diameter Ratio:	2.1		

DEVIATION FROM STRAIGHTNESS (Procedure S1)

Maximum gap between side of core and reference surface plate:
Is the maximum gap ≤ 0.02 in.? NO

Maximum difference must be < 0.020 in.
Straightness Tolerance Met? **NO**

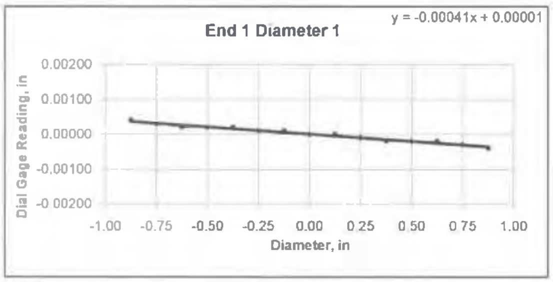
END FLATNESS AND PARALLELISM (Procedure FP1)

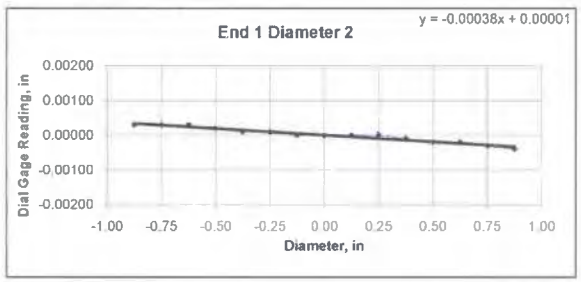
END 1	-0.875	-0.750	-0.625	-0.500	-0.375	-0.250	-0.125	0.000	0.125	0.250	0.375	0.500	0.625	0.750	0.875
Diameter 1, in	0.00040	0.00030	0.00020	0.00020	0.00020	0.00010	0.00010	0.00000	0.00000	-0.00010	-0.00020	-0.00020	-0.00020	-0.00030	-0.00040
Diameter 2, in (rotated 90°)	0.00030	0.00030	0.00030	0.00020	0.00010	0.00010	0.00000	0.00000	0.00000	0.00000	-0.00010	-0.00020	-0.00020	-0.00030	-0.00040

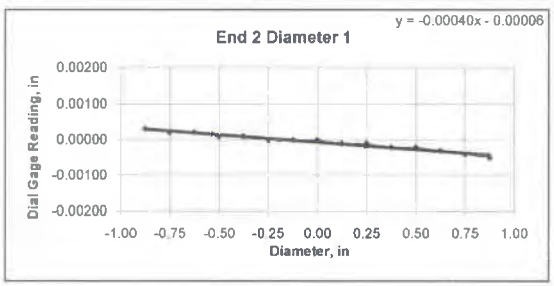
Difference between max and min readings, in:
0° = 0.00080 90° = 0.00070

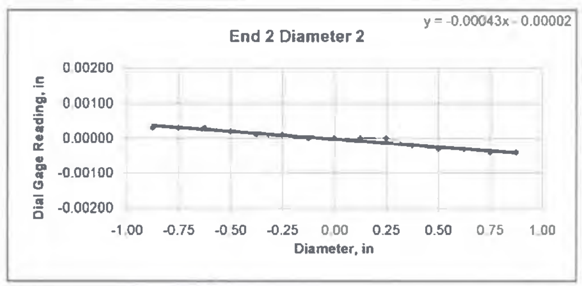
END 2	-0.875	-0.750	-0.625	-0.500	-0.375	-0.250	-0.125	0.000	0.125	0.250	0.375	0.500	0.625	0.750	0.875
Diameter 1, in	0.00030	0.00020	0.00020	0.00010	0.00010	0.00000	0.00000	0.00000	-0.00010	-0.00010	-0.00020	-0.00020	-0.00030	-0.00040	-0.00050
Diameter 2, in (rotated 90°)	0.00030	0.00030	0.00030	0.00020	0.00010	0.00010	0.00000	0.00000	0.00000	0.00000	-0.00020	-0.00030	-0.00030	-0.00040	-0.00040

Difference between max and min readings, in:
0° = 0.0008 90° = 0.0007
Maximum difference must be < 0.0020 in. Difference = + 0.00040
Flatness Tolerance Met? **YES**









DIAMETER 1

End 1:
Slope of Best Fit Line -0.00041
Angle of Best Fit Line: -0.02349

End 2:
Slope of Best Fit Line -0.00040
Angle of Best Fit Line: -0.02292

Maximum Angular Difference: 0.00057

Parallelism Tolerance Met? **YES**
Spherically Seated

DIAMETER 2

End 1:
Slope of Best Fit Line -0.00038
Angle of Best Fit Line: -0.02177

End 2:
Slope of Best Fit Line -0.00043
Angle of Best Fit Line: -0.02464

Maximum Angular Difference: 0.00286

Parallelism Tolerance Met? **YES**
Spherically Seated

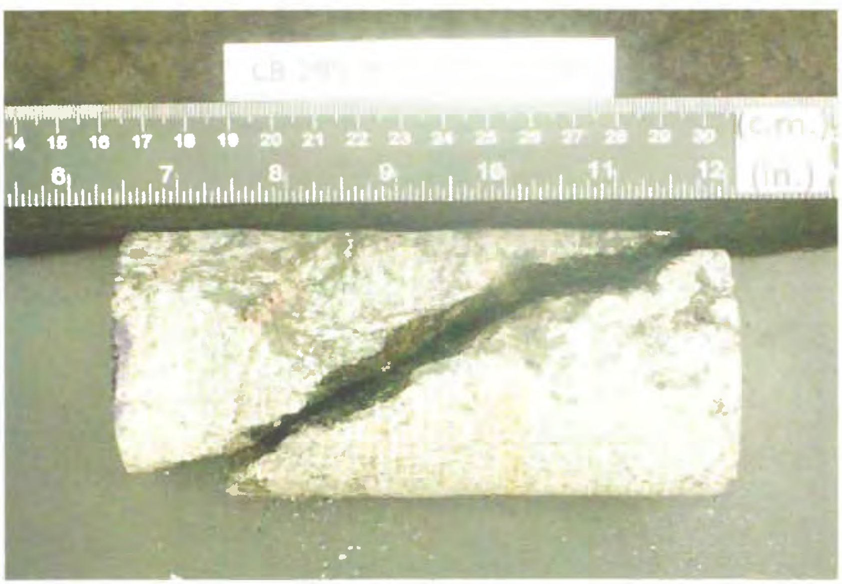
PERPENDICULARITY (Procedure P1) (Calculated from End Flatness and Parallelism measurements above)

END 1	Difference, Maximum and Minimum (in.)	Diameter (in.)	Slope	Angle°	Perpendicularity Tolerance Met?
Diameter 1, in	0.00080	2.480	0.00032	0.018	YES
Diameter 2, in (rotated 90°)	0.00070	2.480	0.00028	0.016	YES
END 2					
Diameter 1, in	0.00080	2.480	0.00032	0.018	YES
Diameter 2, in (rotated 90°)	0.00070	2.480	0.00028	0.016	YES

Maximum angle of departure must be ≤ 0.25°
Perpendicularity Tolerance Met? **YES**

Client:	O'Brien & Gere Engineering
Project Name:	Delaware River Deepening Project
Project Location:	Tinicum to Marcus Hook Ranges, PA
GTX #:	9915
Test Date:	07/03/10
Tested By:	daa
Checked By:	mpd
Boring ID:	CB-295
Sample ID:	R-1
Depth, ft:	5.72-6.18

After cutting and grinding



After break

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Client:	O'Brien & Gere Engineering	Test Date:	7/3/2010
Project Name:	Delaware River Deepening Project	Tested By:	daa
Project Location:	Tinicum to Marcus Hook Ranges, PA	Checked By:	mpd
GTX #:	9915		
Boring ID:	CB-295		
Sample ID:	R-1		
Depth:	5.72-6.18 ft		
Visual Description:	See photographs		

UNIT WEIGHT DETERMINATION AND DIMENSIONAL AND SHAPE TOLERANCES OF ROCK CORE SPECIMENS BY ASTM D 4543-04

BULK DENSITY

	1	2	Average
Specimen Length, in:	5.47	5.48	5.48
Specimen Diameter, in:	2.49	2.48	2.49
Specimen Mass, g:	1217.63		
Bulk Density, lb/ft^3	174		
Length to Diameter Ratio:	2.2		

DEVIATION FROM STRAIGHTNESS (Procedure S1)

Maximum gap between side of core and reference surface plate:
Is the maximum gap ≤ 0.02 in.? NO

Maximum difference must be < 0.020 in.
Straightness Tolerance Met? NO

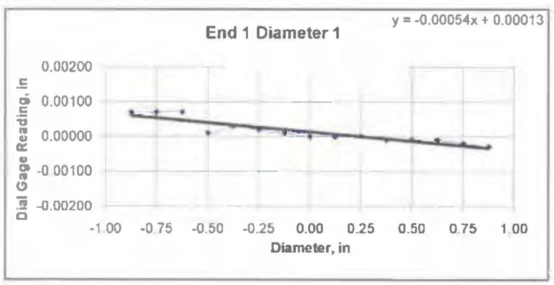
END FLATNESS AND PARALLELISM (Procedure FP1)

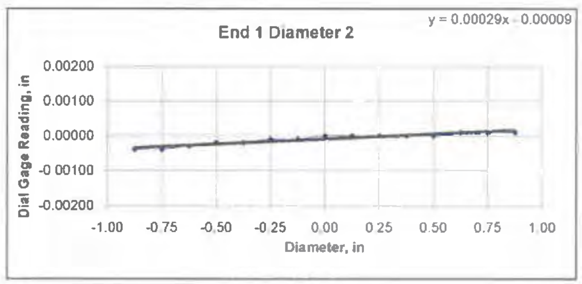
END 1	-0.875	-0.750	-0.625	-0.500	-0.375	-0.250	-0.125	0.000	0.125	0.250	0.375	0.500	0.625	0.750	0.875
Diameter 1, in	0.00070	0.00070	0.00070	0.00010	0.00030	0.00020	0.00010	0.00000	0.00000	0.00000	-0.00010	-0.00010	-0.00010	-0.00020	-0.00030
Diameter 2, in (rotated 90°)	-0.00040	-0.00040	-0.00030	-0.00020	0.00020	-0.00010	-0.00010	0.00000	0.00000	0.00000	0.00000	0.00000	0.00010	0.00010	0.00010

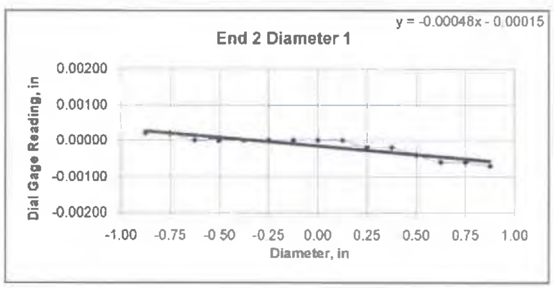
Difference between max and min readings, in:
0° = 0.00100 90° = 0.00050

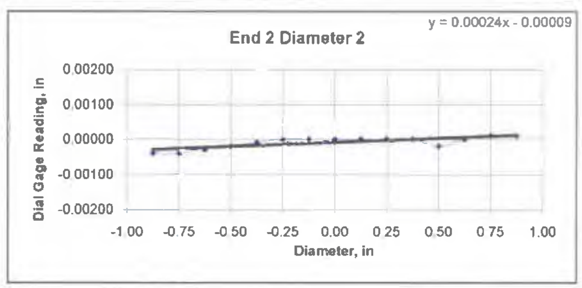
END 2	-0.875	-0.750	-0.625	-0.500	-0.375	-0.250	-0.125	0.000	0.125	0.250	0.375	0.500	0.625	0.750	0.875
Diameter 1, in	0.00020	0.00020	0.00000	0.00000	0.00000	0.00000	0.00000	0.00000	0.00000	-0.00020	-0.00020	-0.00040	-0.00060	-0.00060	-0.00070
Diameter 2, in (rotated 90°)	-0.00040	-0.00040	-0.00030	-0.00020	-0.00010	0.00000	0.00000	0.00000	0.00000	0.00000	0.00000	-0.00020	0.00000	0.00010	0.00010

Difference between max and min readings, in:
0° = 0.0009 90° = 0.0005
Maximum difference must be < 0.0020 in. Difference = + 0.00050
Flatness Tolerance Met? YES









DIAMETER 1

End 1:	Slope of Best Fit Line	-0.00054
	Angle of Best Fit Line:	-0.03094
End 2:	Slope of Best Fit Line	-0.00048
	Angle of Best Fit Line:	-0.02750
Maximum Angular Difference:		0.00344

Parallelism Tolerance Met? YES
Spherically Seated

DIAMETER 2

End 1:	Slope of Best Fit Line	0.00029
	Angle of Best Fit Line:	0.01662
End 2:	Slope of Best Fit Line	0.00024
	Angle of Best Fit Line:	0.01375
Maximum Angular Difference:		0.00286

Parallelism Tolerance Met? YES
Spherically Seated

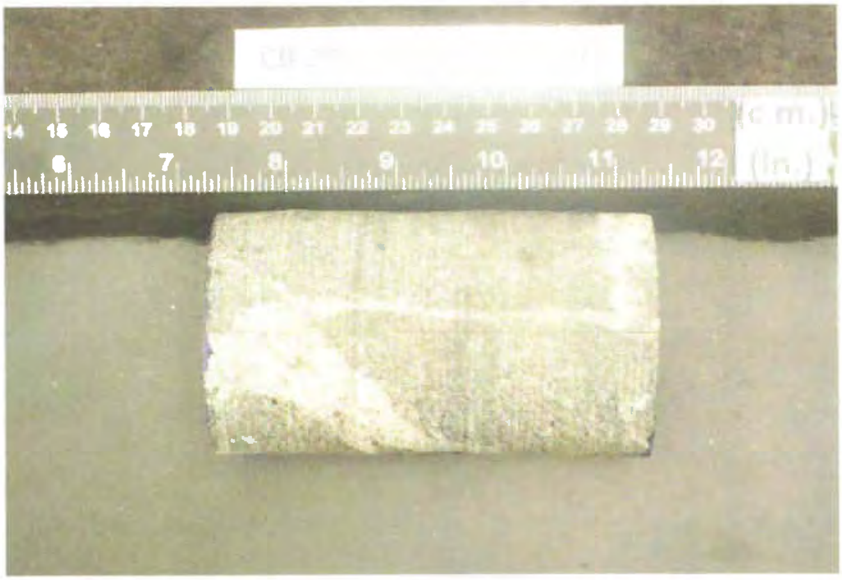
PERPENDICULARITY (Procedure P1) (Calculated from End Flatness and Parallelism measurements above)

END 1	Difference, Maximum and Minimum (in.)	Diameter (in.)	Slope	Angle°	Perpendicularity Tolerance Met?
Diameter 1, in	0.00100	2.485	0.00040	0.023	YES
Diameter 2, in (rotated 90°)	0.00050	2.485	0.00020	0.012	YES
END 2					
Diameter 1, in	0.00090	2.485	0.00036	0.021	YES
Diameter 2, in (rotated 90°)	0.00050	2.485	0.00020	0.012	YES

Maximum angle of departure must be < 0.25°
Perpendicularity Tolerance Met? YES

GeoTesting express

Client:	O'Brien & Gere Engineering
Project Name:	Delaware River Deepening Project
Project Location:	Tinicum to Marcus Hook Ranges, PA
GTX #:	9915
Test Date:	07/03/10
Tested By:	daa
Checked By:	mpd
Boring ID:	CB-297
Sample ID:	R-1
Depth, ft:	1.62-1.96



After cutting and grinding

After break

GeoTesting express
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Client:	O'Brien & Gere Engineering	Test Date:	7/3/2010
Project Name:	Delaware River Deepening Project	Tested By:	daa
Project Location:	Tinicum to Marcus Hook Ranges, PA	Checked By:	mpd
GTX #:	9915		
Boring ID:	CB-297		
Sample ID:	R-1		
Depth:	1.62-1.96 ft		
Visual Description:	See photographs		

UNIT WEIGHT DETERMINATION AND DIMENSIONAL AND SHAPE TOLERANCES OF ROCK CORE SPECIMENS BY ASTM D 4543-04

BULK DENSITY

	1	2	Average
Specimen Length, in:	4.01	4.02	4.02
Specimen Diameter, in:	2.48	2.49	2.49
Specimen Mass, g:	952.33		
Bulk Density, lb/ft^3	186		
Length to Diameter Ratio:	1.6		

DEVIATION FROM STRAIGHTNESS (Procedure S1)

Maximum gap between side of core and reference surface plate:
Is the maximum gap ≤ 0.02 in.? NO

Maximum difference must be < 0.020 in.
Straightness Tolerance Met? **NO**

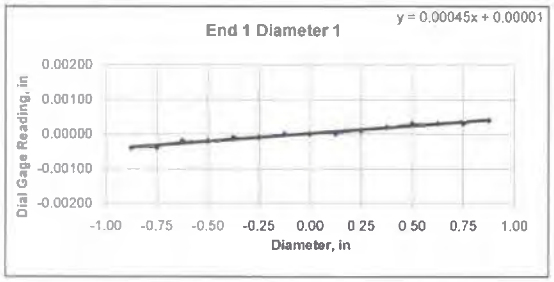
END FLATNESS AND PARALLELISM (Procedure FP1)

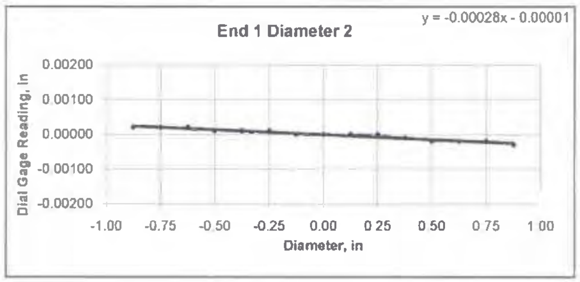
END 1	-0.875	-0.750	-0.625	-0.500	-0.375	-0.250	-0.125	0.000	0.125	0.250	0.375	0.500	0.625	0.750	0.875
Diameter 1, in	-0.00040	-0.00040	-0.00020	-0.00020	-0.00010	-0.00010	0.00000	0.00000	0.00000	0.00010	0.00020	0.00030	0.00030	0.00030	0.00040
Diameter 2, in (rotated 90°)	0.00020	0.00020	0.00020	0.00010	0.00010	0.00010	0.00000	0.00000	0.00000	0.00000	-0.00010	-0.00020	-0.00020	-0.00020	-0.00030

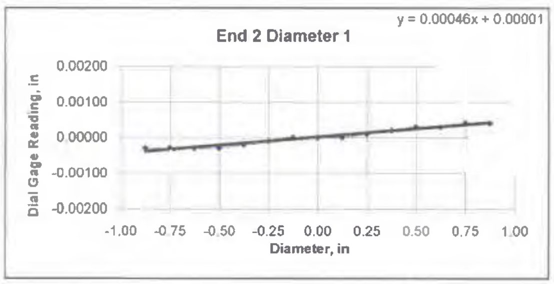
Difference between max and min readings, in:
0° = 0.00080 90° = 0.00050

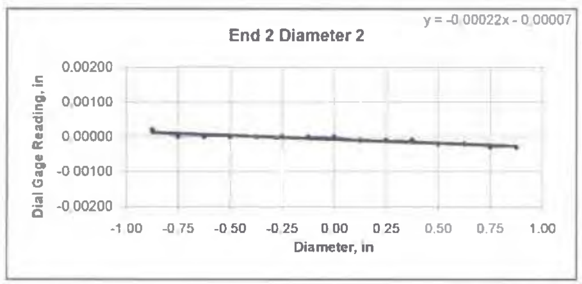
END 2	-0.875	-0.750	-0.625	-0.500	-0.375	-0.250	-0.125	0.000	0.125	0.250	0.375	0.500	0.625	0.750	0.875
Diameter 1, in	-0.00030	-0.00030	-0.00030	-0.00030	-0.00020	-0.00010	0.00000	0.00000	0.00000	0.00010	0.00020	0.00030	0.00030	0.00040	0.00040
Diameter 2, in (rotated 90°)	0.00020	0.00000	0.00000	0.00000	0.00000	0.00000	0.00000	0.00000	-0.00010	-0.00010	-0.00010	-0.00020	-0.00020	-0.00030	-0.00030

Difference between max and min readings, in:
0° = 0.0007 90° = 0.0005
Maximum difference must be < 0.0020 in. Difference = ± 0.00040
Flatness Tolerance Met? **YES**









DIAMETER 1

End 1:	Slope of Best Fit Line	0.00045
	Angle of Best Fit Line:	0.02578
End 2:	Slope of Best Fit Line	0.00046
	Angle of Best Fit Line:	0.02636
Maximum Angular Difference:		0.00057

Parallelism Tolerance Met? **YES**
Spherically Seated

DIAMETER 2

End 1:	Slope of Best Fit Line	-0.00028
	Angle of Best Fit Line:	-0.01604
End 2:	Slope of Best Fit Line	-0.00022
	Angle of Best Fit Line:	-0.01261
Maximum Angular Difference:		0.00344

Parallelism Tolerance Met? **YES**
Spherically Seated

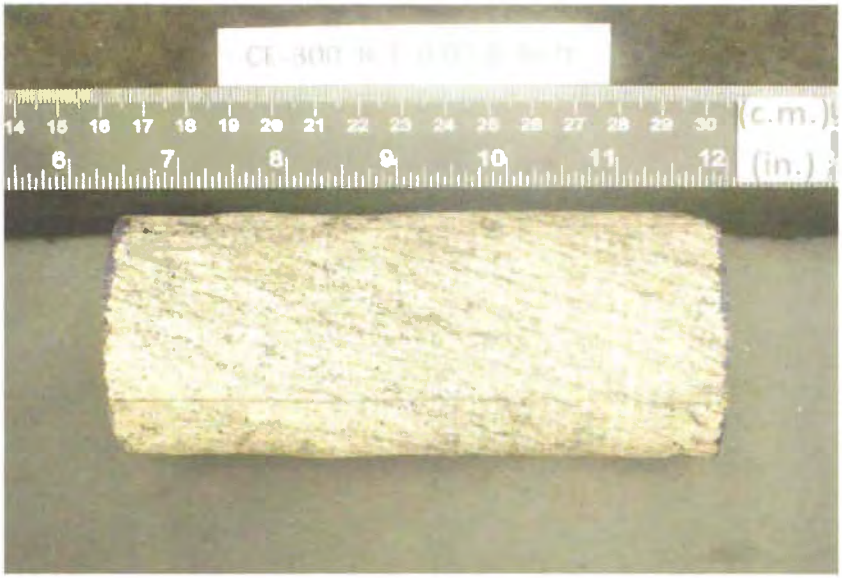
PERPENDICULARITY (Procedure P1) (Calculated from End Flatness and Parallelism measurements above)

END 1	Difference, Maximum and Minimum (in.)	Diameter (in.)	Slope	Angle°	Perpendicularity Tolerance Met?
Diameter 1, in	0.00080	2.485	0.00032	0.018	YES
Diameter 2, in (rotated 90°)	0.00050	2.485	0.00020	0.012	YES
END 2					
Diameter 1, in	0.00070	2.485	0.00028	0.016	YES
Diameter 2, in (rotated 90°)	0.00050	2.485	0.00020	0.012	YES

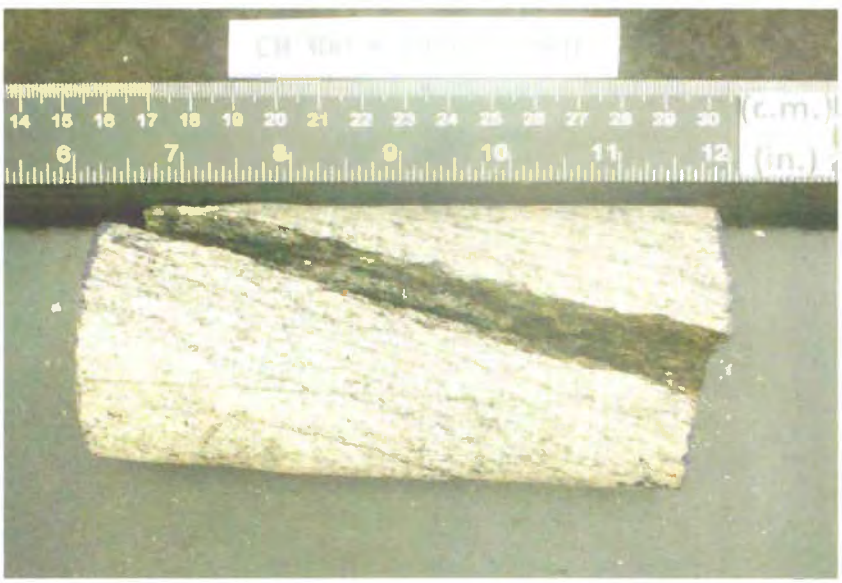
Maximum angle of departure must be ≤ 0.25°
Perpendicularity Tolerance Met? **YES**

GeoTesting
express

Client:	O'Brien & Gere Engineering
Project Name:	Delaware River Deepening Project
Project Location:	Tinicum to Marcus Hook Ranges, PA
GTX #:	9915
Test Date:	07/03/10
Tested By:	daa
Checked By:	mpd
Boring ID:	CB-300
Sample ID:	R-1
Depth, ft:	0.02-0.48



After cutting and grinding



After break

GeoTesting express
a subsidiary of Geocomp Corporation

Client:	O'Brien & Gere Engineering	Test Date:	7/3/2010
Project Name:	Delaware River Deepening Project	Tested By:	daa
Project Location:	Tinicum to Marcus Hook Ranges, PA	Checked By:	mpd
GTX #:	9915		
Boring ID:	CB-300		
Sample ID:	R-1		
Depth:	0.02-0.48 ft		
Visual Description:	See photographs		

UNIT WEIGHT DETERMINATION AND DIMENSIONAL AND SHAPE TOLERANCES OF ROCK CORE SPECIMENS BY ASTM D 4543-04

BULK DENSITY

	1	2	Average
Specimen Length, in:	5.51	5.53	5.52
Specimen Diameter, in:	2.47	2.46	2.47
Specimen Mass, g:	1164.35		
Bulk Density, lb/ft^3	168		
Length to Diameter Ratio:	2.2		

DEVIATION FROM STRAIGHTNESS (Procedure S1)

Maximum gap between side of core and reference surface plate:
Is the maximum gap ≤ 0.02 in.? NO

Maximum difference must be < 0.020 in.
Straightness Tolerance Met? **NO**

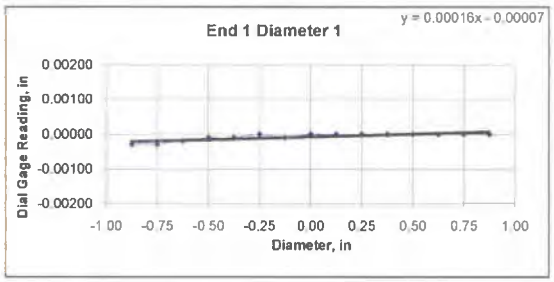
END FLATNESS AND PARALLELISM (Procedure FP1)

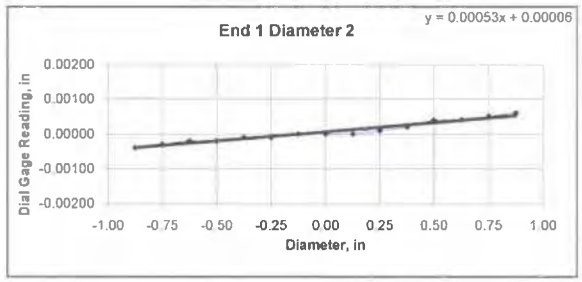
END 1	-0.875	-0.750	-0.625	-0.500	-0.375	0.250	-0.125	0.000	0.125	0.250	0.375	0.500	0.625	0.750	0.875
Diameter 1, in	-0.00030	-0.00030	-0.00020	-0.00010	-0.00010	0.00000	-0.00010	0.00000	0.00000	0.00000	0.00000	0.00000	0.00000	0.00000	0.00000
Diameter 2, in (rotated 90°)	-0.00040	-0.00030	-0.00020	-0.00020	-0.00010	-0.00010	0.00000	0.00000	0.00000	0.00010	0.00020	0.00040	0.00040	0.00050	0.00060

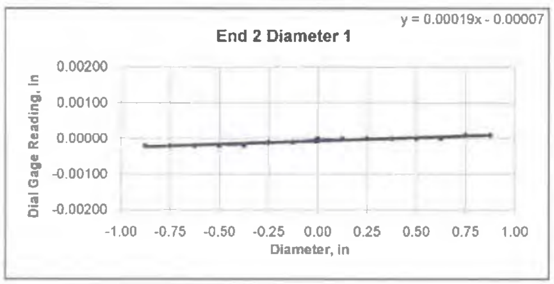
Difference between max and min readings, in:
0° = 0.00030 90° = 0.00100

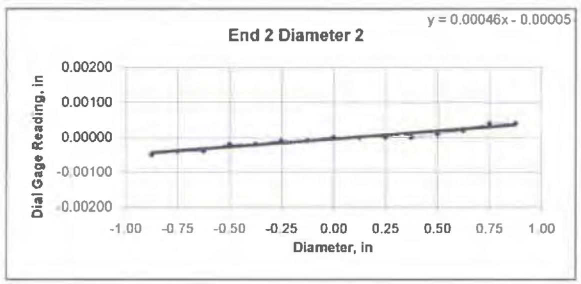
END 2	-0.875	-0.750	-0.625	-0.500	-0.375	-0.250	-0.125	0.000	0.125	0.250	0.375	0.500	0.625	0.750	0.875
Diameter 1, in	-0.00020	-0.00020	-0.00020	-0.00020	-0.00020	-0.00010	-0.00010	0.00000	0.00000	0.00000	0.00000	0.00000	0.00000	0.00010	0.00010
Diameter 2, in (rotated 90°)	-0.00050	-0.00040	-0.00040	-0.00020	-0.00020	-0.00010	-0.00010	0.00000	0.00000	0.00000	0.00000	0.00010	0.00020	0.00040	0.00040

Difference between max and min readings, in:
0° = 0.0003 90° = 0.0009
Maximum difference must be < 0.0020 in. Difference = ± 0.00050
Flatness Tolerance Met? YES









DIAMETER 1

End 1:	Slope of Best Fit Line	0.00016
	Angle of Best Fit Line:	0.00917
End 2:	Slope of Best Fit Line	0.00019
	Angle of Best Fit Line:	0.01089
Maximum Angular Difference:		0.00172

Parallelism Tolerance Met? **YES**
Spherically Seated

DIAMETER 2

End 1:	Slope of Best Fit Line	0.00053
	Angle of Best Fit Line:	0.03037
End 2:	Slope of Best Fit Line	0.00046
	Angle of Best Fit Line:	0.02636
Maximum Angular Difference:		0.00401

Parallelism Tolerance Met? **YES**
Spherically Seated

PERPENDICULARITY (Procedure P1) (Calculated from End Flatness and Parallelism measurements above)

END 1	Difference, Maximum and Minimum (in.)	Diameter (in.)	Slope	Angle°	Perpendicularity Tolerance Met?
Diameter 1, in	0.00030	2.465	0.00012	0.007	YES
Diameter 2, in (rotated 90°)	0.00100	2.465	0.00041	0.023	YES
END 2					
Diameter 1, in	0.00030	2.465	0.00012	0.007	YES
Diameter 2, in (rotated 90°)	0.00090	2.465	0.00037	0.021	YES

Maximum angle of departure must be ≤ 0.25°

Perpendicularity Tolerance Met? **YES**

GeoTesting express

Client:	O'Brien & Gere Engineering
Project Name:	Delaware River Deepening Project
Project Location:	Tinicum to Marcus Hook Ranges, PA
GTX #:	9915
Test Date:	07/03/10
Tested By:	daa
Checked By:	mpd
Boring ID:	CB-300
Sample ID:	R-1
Depth, ft:	1.28-1.64

After cutting and grinding

After break

GeoTesting express
a subsidiary of Geocomp Corporation

Client:	O'Brien & Gere Engineering	Test Date:	7/3/2010
Project Name:	Delaware River Deepening Project	Tested By:	daa
Project Location:	Tinicum to Marcus Hook Ranges, PA	Checked By:	mpd
GTX #:	9915		
Boring ID:	CB-300		
Sample ID:	R-1		
Depth:	1.28-1.64 ft		
Visual Description:	See photographs		

UNIT WEIGHT DETERMINATION AND DIMENSIONAL AND SHAPE TOLERANCES OF ROCK CORE SPECIMENS BY ASTM D 4543-04

BULK DENSITY

	1	2	Average
Specimen Length, in:	4.26	4.27	4.27
Specimen Diameter, in:	2.47	2.48	2.48
Specimen Mass, g:	916.49		
Bulk Density, lb/ft^3	170		
Length to Diameter Ratio:	1.7		

DEVIATION FROM STRAIGHTNESS (Procedure S1)

Maximum gap between side of core and reference surface plate:
Is the maximum gap ≤ 0.02 in.? NO

Maximum difference must be < 0.020 in.
Straightness Tolerance Met? **NO**

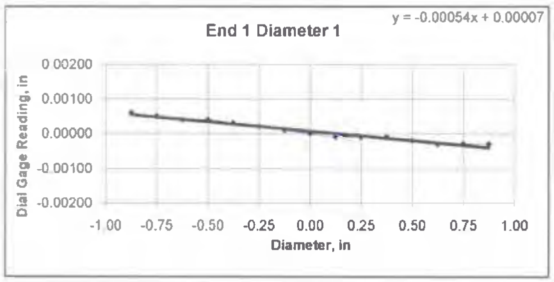
END FLATNESS AND PARALLELISM (Procedure FP1)

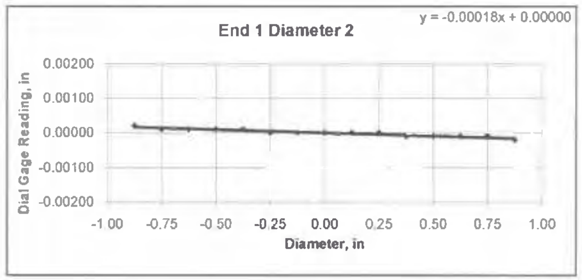
END 1	-0.875	-0.750	-0.625	-0.500	-0.375	-0.250	-0.125	0.000	0.125	0.250	0.375	0.500	0.625	0.750	0.875
Diameter 1, in	0.00060	0.00050	0.00040	0.00040	0.00030	0.00020	0.00010	0.00000	-0.00010	-0.00010	-0.00010	-0.00020	-0.00030	-0.00030	-0.00030
Diameter 2, in (rotated 90°)	0.00020	0.00010	0.00010	0.00010	0.00010	0.00000	0.00000	0.00000	0.00000	0.00000	-0.00010	-0.00010	-0.00010	-0.00010	-0.00020

Difference between max and min readings, in:
0° = 0.00090 90° = 0.00040

END 2	-0.875	-0.750	-0.625	-0.500	-0.375	-0.250	-0.125	0.000	0.125	0.250	0.375	0.500	0.625	0.750	0.875
Diameter 1, in	0.00050	0.00040	0.00040	0.00020	0.00020	0.00010	0.00010	0.00000	0.00000	0.00000	0.00000	-0.00020	-0.00020	-0.00040	-0.00050
Diameter 2, in (rotated 90°)	0.00020	0.00020	0.00010	0.00010	0.00010	0.00000	0.00000	0.00000	-0.00010	-0.00010	-0.00010	-0.00010	-0.00010	-0.00020	-0.00030

Difference between max and min readings, in:
0° = 0.001 90° = 0.0005
Maximum difference must be < 0.0020 in. Difference = ± 0.00050
Flatness Tolerance Met? YES





DIAMETER 1

End 1:

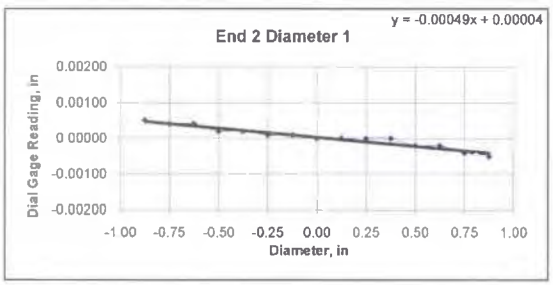
Slope of Best Fit Line	-0.00054
Angle of Best Fit Line:	-0.03094

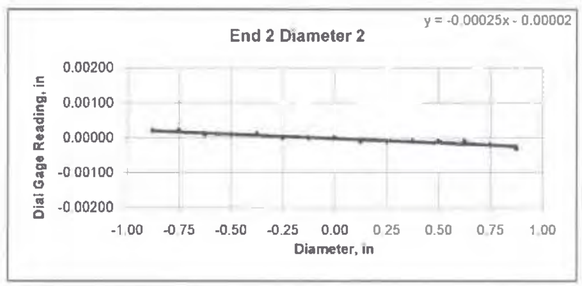
End 2:

Slope of Best Fit Line	-0.00049
Angle of Best Fit Line:	-0.02807

Maximum Angular Difference: 0.00286

Parallelism Tolerance Met? **YES**
Spherically Seated





DIAMETER 2

End 1:

Slope of Best Fit Line	-0.00018
Angle of Best Fit Line:	-0.01031

End 2:

Slope of Best Fit Line	-0.00025
Angle of Best Fit Line:	-0.01432

Maximum Angular Difference: 0.00401

Parallelism Tolerance Met? **YES**
Spherically Seated

PERPENDICULARITY (Procedure P1) (Calculated from End Flatness and Parallelism measurements above)

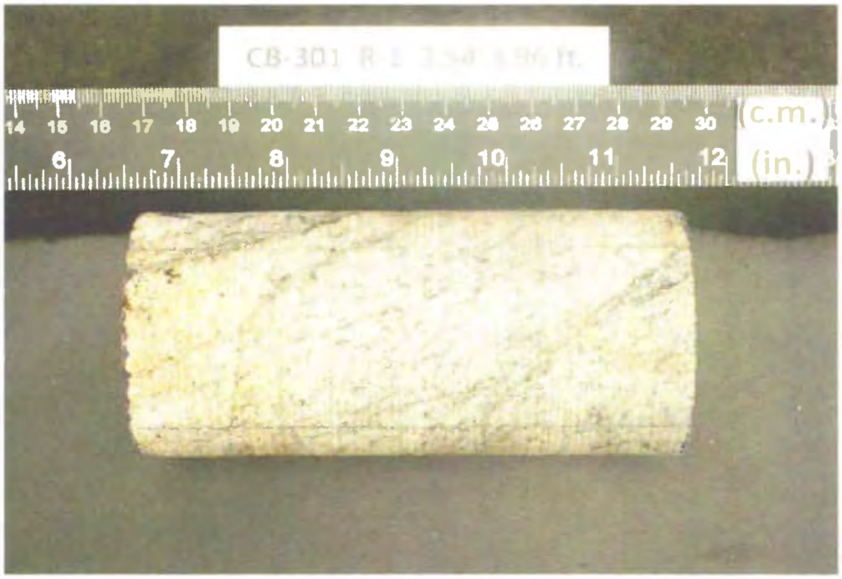
END 1	Difference, Maximum and Minimum (in.)	Diameter (in.)	Slope	Angle°	Perpendicularity Tolerance Met?
Diameter 1, in	0.00090	2.475	0.00036	0.021	YES
Diameter 2, in (rotated 90°)	0.00040	2.475	0.00016	0.009	YES
END 2					
Diameter 1, in	0.00100	2.475	0.00040	0.023	YES
Diameter 2, in (rotated 90°)	0.00050	2.475	0.00020	0.012	YES

Maximum angle of departure must be ≤ 0.25°

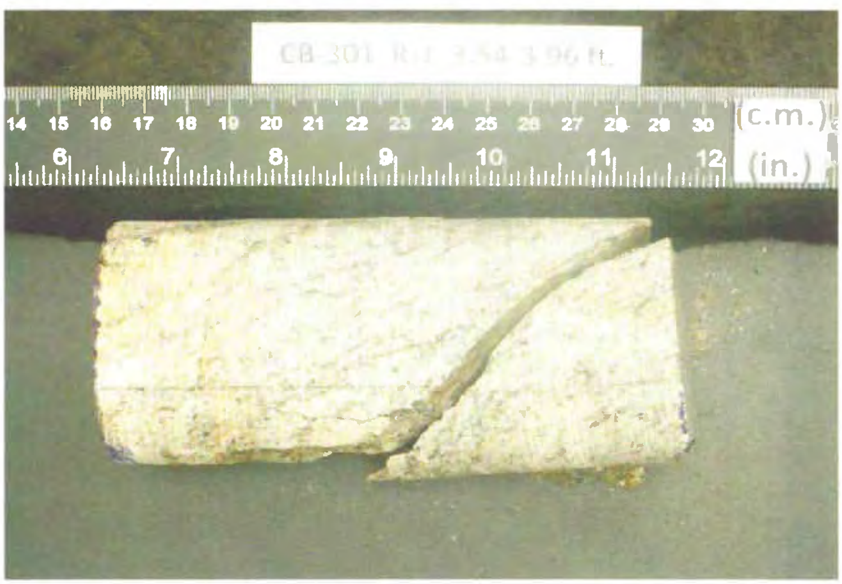
Perpendicularity Tolerance Met? **YES**

GeoTesting express

Client:	O'Brien & Gere Engineering
Project Name:	Delaware River Deepening Project
Project Location:	Tinicum to Marcus Hook Ranges, PA
GTX #:	9915
Test Date:	07/03/10
Tested By:	daa
Checked By:	mpd
Boring ID:	CB-301
Sample ID:	R-1
Depth, ft:	3.54-3.96



After cutting and grinding



After break

GeoTesting express
a subsidiary of Geocomp Corporation

Client:	O'Brien & Gere Engineering	Test Date:	7/3/2010
Project Name:	Delaware River Deepening Project	Tested By:	daa
Project Location:	Tinicum to Marcus Hook Ranges, PA	Checked By:	mpd
GTX #:	9915		
Boring ID:	CB-301		
Sample ID:	R-1		
Depth:	3.54-3.96 ft		
Visual Description:	See photographs		

UNIT WEIGHT DETERMINATION AND DIMENSIONAL AND SHAPE TOLERANCES OF ROCK CORE SPECIMENS BY ASTM D 4543-04

BULK DENSITY

	1	2	Average
Specimen Length, in:	5.05	5.05	5.05
Specimen Diameter, in:	2.48	2.49	2.49
Specimen Mass, g:	1054.66		
Bulk Density, lb/ft^3	164		
Length to Diameter Ratio:	2.0		

DEVIATION FROM STRAIGHTNESS (Procedure S1)

Maximum gap between side of core and reference surface plate:
Is the maximum gap ≤ 0.02 in.? YES

Maximum difference must be < 0.020 in.
Straightness Tolerance Met? **YES**

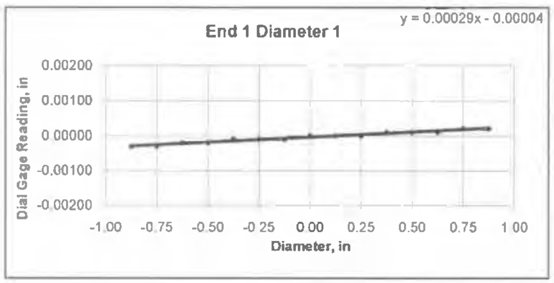
END FLATNESS AND PARALLELISM (Procedure FP1)

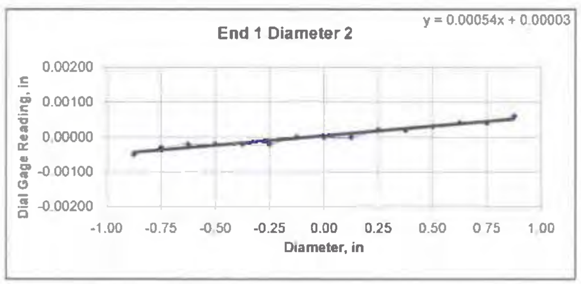
END 1	-0.875	-0.750	-0.625	-0.500	-0.375	-0.250	-0.125	0.000	0.125	0.250	0.375	0.500	0.625	0.750	0.875
Diameter 1, in	-0.00030	-0.00030	-0.00020	-0.00020	-0.00010	-0.00010	-0.00010	0.00000	0.00000	0.00000	0.00010	0.00010	0.00010	0.00020	0.00020
Diameter 2, in (rotated 90°)	-0.00050	-0.00030	-0.00020	-0.00020	-0.00020	-0.00020	0.00000	0.00000	0.00000	0.00020	0.00020	0.00030	0.00040	0.00040	0.00060

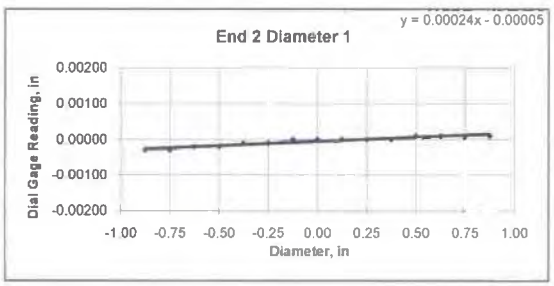
Difference between max and min readings, in:
0° = 0.00050 90° = 0.00110

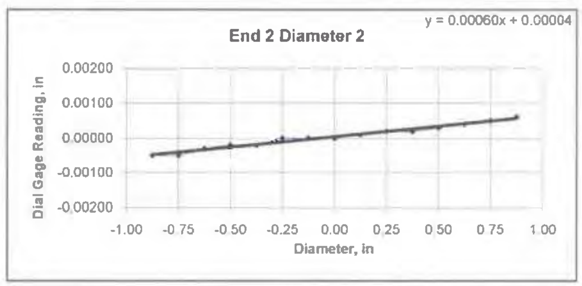
END 2	-0.875	-0.750	-0.625	-0.500	-0.375	-0.250	-0.125	0.000	0.125	0.250	0.375	0.500	0.625	0.750	0.875
Diameter 1, in	-0.00030	-0.00030	-0.00020	-0.00020	-0.00010	-0.00010	0.00000	0.00000	0.00000	0.00000	0.00000	0.00010	0.00010	0.00010	0.00010
Diameter 2, in (rotated 90°)	-0.00050	-0.00050	-0.00030	-0.00020	-0.00020	0.00000	0.00000	0.00000	0.00010	0.00020	0.00020	0.00030	0.00040	0.00050	0.00060

Difference between max and min readings, in:
0° = 0.0004 90° = 0.0011
Maximum difference must be < 0.0020 in. Difference = ± 0.00055
Flatness Tolerance Met? **YES**









DIAMETER 1

End 1:
Slope of Best Fit Line 0.00029
Angle of Best Fit Line: 0.01662

End 2:
Slope of Best Fit Line 0.00024
Angle of Best Fit Line: 0.01375

Maximum Angular Difference: 0.00286

Parallelism Tolerance Met? **YES**
Spherically Seated

DIAMETER 2

End 1:
Slope of Best Fit Line 0.00054
Angle of Best Fit Line: 0.03094

End 2:
Slope of Best Fit Line 0.00060
Angle of Best Fit Line: 0.03438

Maximum Angular Difference: 0.00344

Parallelism Tolerance Met? **YES**
Spherically Seated

PERPENDICULARITY (Procedure P1) (Calculated from End Flatness and Parallelism measurements above)

END 1	Difference, Maximum and Minimum (in.)	Diameter (in.)	Slope	Angle°	Perpendicularity Tolerance Met?
Diameter 1, in	0.00050	2.485	0.00020	0.012	YES
Diameter 2, in (rotated 90°)	0.00110	2.485	0.00044	0.025	YES
END 2					
Diameter 1, in	0.00040	2.485	0.00016	0.009	YES
Diameter 2, in (rotated 90°)	0.00110	2.485	0.00044	0.025	YES

Maximum angle of departure must be ≤ 0.25°

Perpendicularity Tolerance Met? **YES**

GeoTesting
express

Client:	O'Brien & Gere Engineering
Project Name:	Delaware River Deepening Project
Project Location:	Tinicum to Marcus Hook Ranges, PA
GTX #:	9915
Test Date:	07/03/10
Tested By:	daa
Checked By:	mpd
Boring ID:	CB-301
Sample ID:	R-1
Depth, ft:	4.54-5.000

After cutting and grinding

After break

GeoTesting express
a subsidiary of Geocomp Corporation

Client:	O'Brien & Gere Engineering	Test Date:	7/3/2010
Project Name:	Delaware River Deepening Project	Tested By:	daa
Project Location:	Tinicum to Marcus Hook Ranges, PA	Checked By:	mpd
GTX #:	9915		
Boring ID:	CB-301		
Sample ID:	R-1		
Depth:	4.54-5.00 ft		
Visual Description:	See photographs		

UNIT WEIGHT DETERMINATION AND DIMENSIONAL AND SHAPE TOLERANCES OF ROCK CORE SPECIMENS BY ASTM D 4543-04

BULK DENSITY

	1	2	Average
Specimen Length, in:	5.63	5.62	5.63
Specimen Diameter, in:	2.49	2.49	2.49
Specimen Mass, g:	1179.48		
Bulk Density, lb/ft^3	164		
Length to Diameter Ratio:	2.3		

DEVIATION FROM STRAIGHTNESS (Procedure S1)

Maximum gap between side of core and reference surface plate:
Is the maximum gap $\leq$ 0.02 in.? YES

Maximum difference must be < 0.020 in.
Straightness Tolerance Met? YES

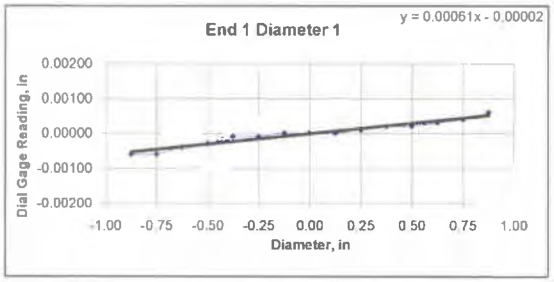
END FLATNESS AND PARALLELISM (Procedure FP1)

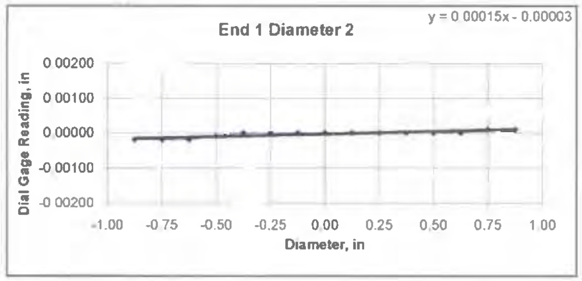
END 1	-0.875	-0.750	-0.625	-0.500	-0.375	-0.250	-0.125	0.000	0.125	0.250	0.375	0.500	0.625	0.750	0.875
Diameter 1, in	-0.00060	-0.00060	-0.00040	-0.00030	-0.00010	-0.00010	0.00000	0.00000	0.00000	0.00010	0.00020	0.00020	0.00030	0.00040	0.00060
Diameter 2, in (rotated 90°)	-0.00020	-0.00020	-0.00020	-0.00010	0.00000	0.00000	0.00000	0.00000	0.00000	0.00000	0.00000	0.00000	0.00000	0.00010	0.00010

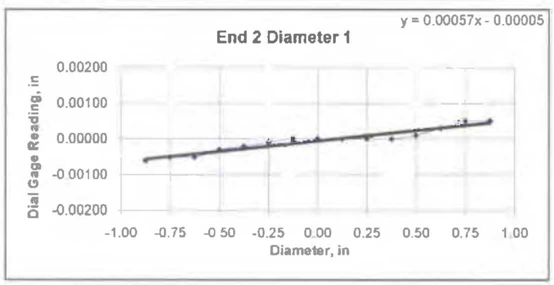
Difference between max and min readings, in:
0° = 0.00120 90° = 0.00030

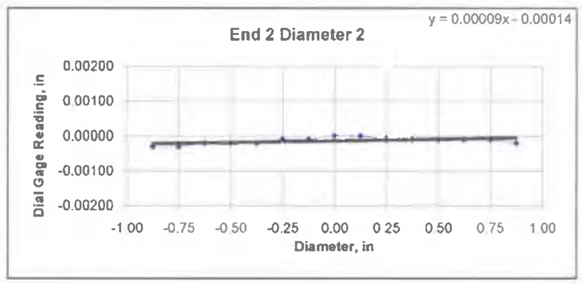
END 2	-0.875	-0.750	-0.625	-0.500	-0.375	-0.250	-0.125	0.000	0.125	0.250	0.375	0.500	0.625	0.750	0.875
Diameter 1, in	-0.00060	-0.00050	-0.00050	-0.00030	-0.00020	-0.00010	0.00000	0.00000	0.00000	0.00000	0.00000	0.00010	0.00030	0.00050	0.00050
Diameter 2, in (rotated 90°)	-0.00030	-0.00030	-0.00020	-0.00020	-0.00020	-0.00010	-0.00010	0.00000	0.00000	-0.00010	-0.00010	-0.00010	-0.00010	-0.00010	-0.00020

Difference between max and min readings, in:
0° = 0.0011 90° = 0.0003
Maximum difference must be < 0.0020 in. Difference = + 0.00060
Flatness Tolerance Met? YES









DIAMETER 1

End 1:
Slope of Best Fit Line 0.00061
Angle of Best Fit Line: 0.03495

End 2:
Slope of Best Fit Line 0.00057
Angle of Best Fit Line: 0.03266

Maximum Angular Difference: 0.00229

Parallelism Tolerance Met? YES
Spherically Seated

DIAMETER 2

End 1:
Slope of Best Fit Line 0.00015
Angle of Best Fit Line: 0.00859

End 2:
Slope of Best Fit Line 0.00009
Angle of Best Fit Line: 0.00516

Maximum Angular Difference: 0.00344

Parallelism Tolerance Met? YES
Spherically Seated

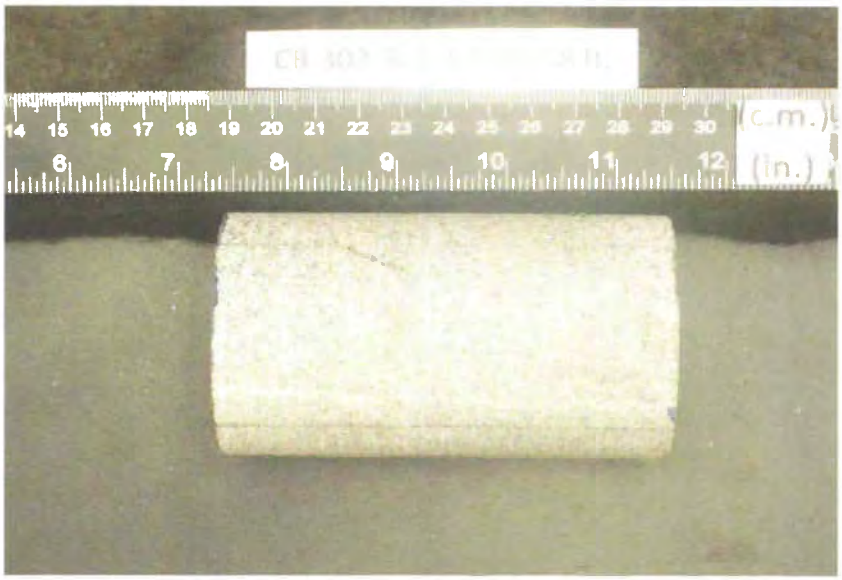
PERPENDICULARITY (Procedure P1) (Calculated from End Flatness and Parallelism measurements above)

END 1	Difference, Maximum and Minimum (in.)	Diameter (in.)	Slope	Angle°	Perpendicularity Tolerance Met?
Diameter 1, in	0.00120	2.490	0.00048	0.028	YES
Diameter 2, in (rotated 90°)	0.00030	2.490	0.00012	0.007	YES
END 2					
Diameter 1, in	0.00110	2.490	0.00044	0.025	YES
Diameter 2, in (rotated 90°)	0.00030	2.490	0.00012	0.007	YES

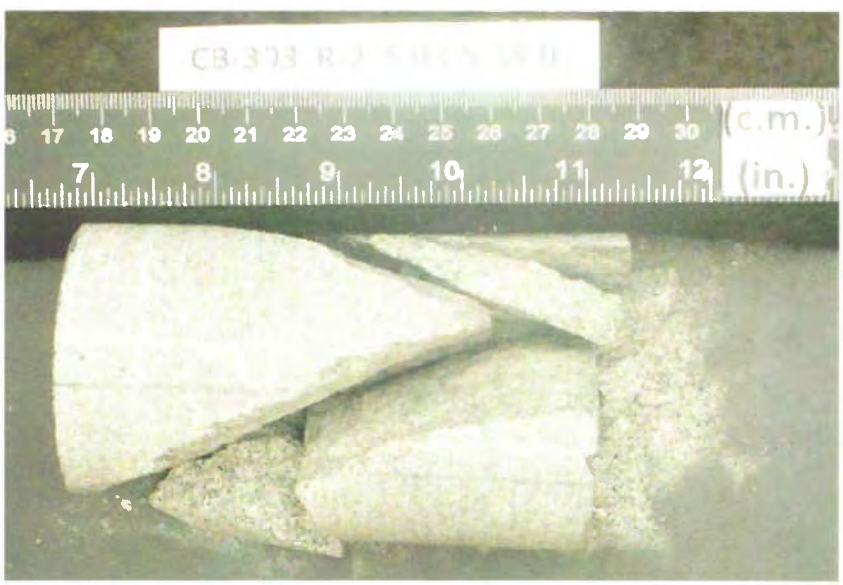
Maximum angle of departure must be $\leq$ 0.25°
Perpendicularity Tolerance Met? YES

GeoTesting express

Client:	O'Brien & Gere Engineering
Project Name:	Delaware River Deepening Project
Project Location:	Tinicum to Marcus Hook Ranges, PA
GTX #:	9915
Test Date:	07/03/10
Tested By:	daa
Checked By:	mpd
Boring ID:	CB-303
Sample ID:	R-2
Depth, ft:	5.03-5.38



After cutting and grinding



After break

GeoTesting express
a subsidiary of Geocomp Corporation

Client:	O'Brien & Gere Engineering	Test Date:	7/3/2010
Project Name:	Delaware River Deepening Project	Tested By:	daa
Project Location:	Tinicum to Marcus Hook Ranges, PA	Checked By:	mpd
GTX #:	9915		
Boring ID:	CB-303		
Sample ID:	R-2		
Depth:	5.03-5.38 ft		
Visual Description:	See photographs		

UNIT WEIGHT DETERMINATION AND DIMENSIONAL AND SHAPE TOLERANCES OF ROCK CORE SPECIMENS BY ASTM D 4543-04

BULK DENSITY

	1	2	Average
Specimen Length, in:	4.14	4.13	4.14
Specimen Diameter, in:	2.48	2.49	2.49
Specimen Mass, g:	874.48		
Bulk Density, lb/ft^3	166		
Length to Diameter Ratio:	1.7		

DEVIATION FROM STRAIGHTNESS (Procedure S1)

Maximum gap between side of core and reference surface plate:
Is the maximum gap ≤ 0.02 in.? YES

Maximum difference must be < 0.020 in.
Straightness Tolerance Met? **YES**

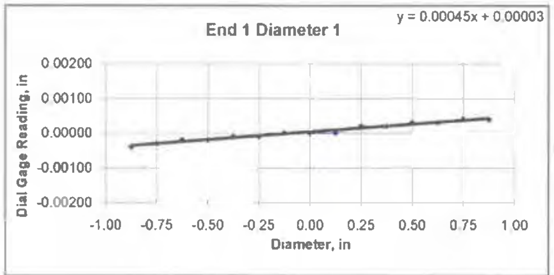
END FLATNESS AND PARALLELISM (Procedure FP1)

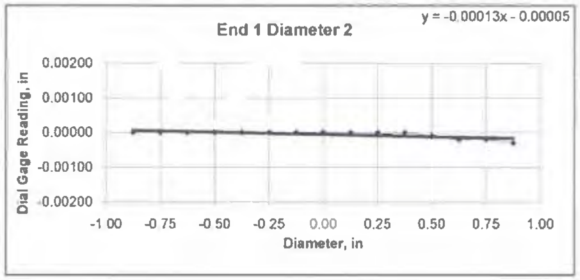
END 1	-0.875	-0.750	-0.625	-0.500	-0.375	-0.250	-0.125	0.000	0.125	0.250	0.375	0.500	0.625	0.750	0.875
Diameter 1, in	-0.00040	-0.00030	-0.00020	-0.00020	-0.00010	-0.00010	0.00000	0.00000	0.00000	0.00020	0.00020	0.00030	0.00030	0.00040	0.00040
Diameter 2, in (rotated 90°)	0.00000	0.00000	0.00000	0.00000	0.00000	0.00000	0.00000	0.00000	0.00000	0.00000	0.00000	-0.00010	-0.00020	-0.00020	-0.00030

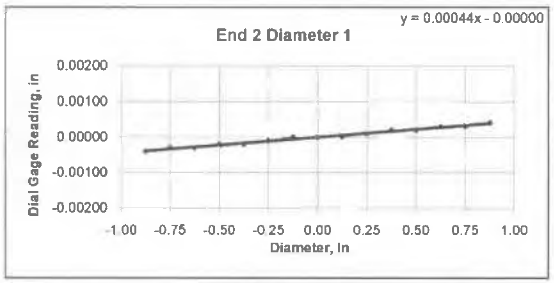
Difference between max and min readings, in:
0° = 0.00080 90° = 0.00030

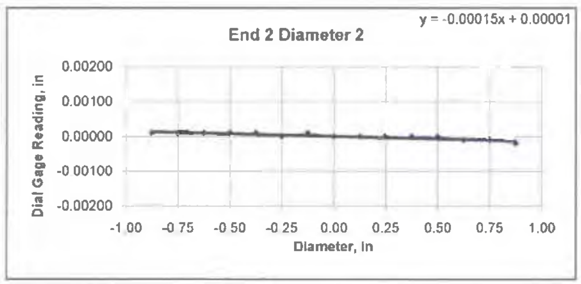
END 2	-0.875	-0.750	-0.625	-0.500	-0.375	-0.250	-0.125	0.000	0.125	0.250	0.375	0.500	0.625	0.750	0.875
Diameter 1, in	-0.00040	-0.00030	-0.00030	-0.00020	-0.00020	-0.00010	0.00000	0.00000	0.00000	0.00010	0.00020	0.00020	0.00030	0.00030	0.00040
Diameter 2, in (rotated 90°)	0.00010	0.00010	0.00010	0.00010	0.00010	0.00000	0.00010	0.00000	0.00000	0.00000	0.00000	0.00000	-0.00010	-0.00010	-0.00020

Difference between max and min readings, in:
0° = 0.0008 90° = 0.0003
Maximum difference must be < 0.0020 in. Difference = + 0.00040
Flatness Tolerance Met? **YES**









DIAMETER 1

End 1:	Slope of Best Fit Line	0.00045
	Angle of Best Fit Line:	0.02578
End 2:	Slope of Best Fit Line	0.00044
	Angle of Best Fit Line:	0.02521
Maximum Angular Difference:		0.00057

Parallelism Tolerance Met? **YES**
Spherically Seated

DIAMETER 2

End 1:	Slope of Best Fit Line	-0.00013
	Angle of Best Fit Line:	-0.00745
End 2:	Slope of Best Fit Line	-0.00015
	Angle of Best Fit Line:	-0.00859
Maximum Angular Difference:		0.00115

Parallelism Tolerance Met? **YES**
Spherically Seated

PERPENDICULARITY (Procedure P1) (Calculated from End Flatness and Parallelism measurements above)

END 1	Difference, Maximum and Minimum (in.)	Diameter (in.)	Slope	Angle°	Perpendicularity Tolerance Met?
Diameter 1, in	0.00080	2.485	0.00032	0.018	YES
Diameter 2, in (rotated 90°)	0.00030	2.485	0.00012	0.007	YES
END 2					
Diameter 1, in	0.00080	2.485	0.00032	0.018	YES
Diameter 2, in (rotated 90°)	0.00030	2.485	0.00012	0.007	YES

Maximum angle of departure must be ≤ 0.25°
Perpendicularity Tolerance Met? **YES**

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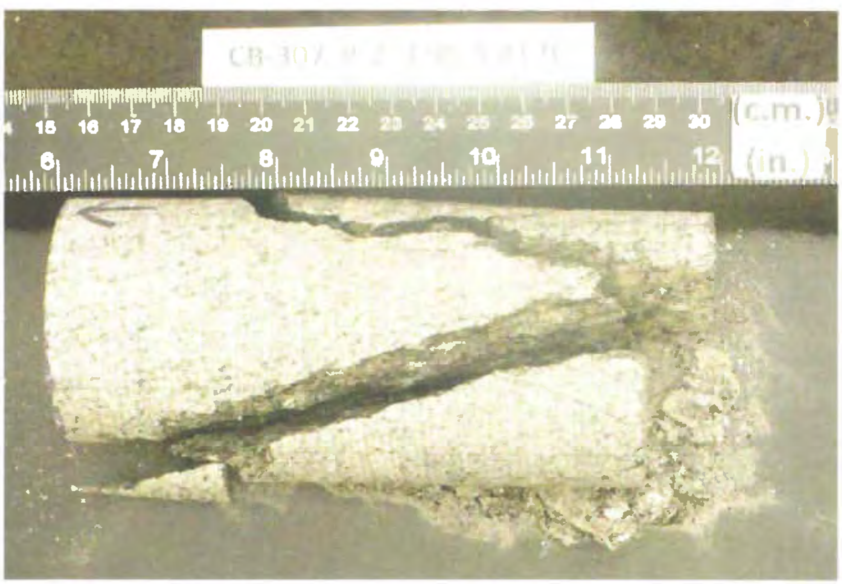
Client:	O'Brien & Gere Engineering
Project Name:	Delaware River Deepening Project
Project Location:	Tinicum to Marcus Hook Ranges, PA
GTX #:	9915
Test Date:	07/03/10
Tested By:	daa
Checked By:	mpd
Boring ID:	CB-307
Sample ID:	R-2
Depth, ft:	3.95-4.41

After cutting and grinding



After break

GeoTesting express
a subsidiary of Geocomp Corporation

Client:	O'Brien & Gere Engineering	Test Date:	7/3/2010
Project Name:	Delaware River Deepening Project	Tested By:	daa
Project Location:	Tinicum to Marcus Hook Ranges, PA	Checked By:	mpd
GTX #:	9915		
Boring ID:	CB-307		
Sample ID:	R-2		
Depth:	3.95-4.41 ft		
Visual Description:	See photographs		

UNIT WEIGHT DETERMINATION AND DIMENSIONAL AND SHAPE TOLERANCES OF ROCK CORE SPECIMENS BY ASTM D 4543-04

BULK DENSITY

	1	2	Average
Specimen Length, in:	5.58	5.57	5.58
Specimen Diameter, in:	2.48	2.49	2.49
Specimen Mass, g:	1205.86		
Bulk Density, lb/ft^3	170		
Length to Diameter Ratio:	2.2		

DEVIATION FROM STRAIGHTNESS (Procedure S1)

Maximum gap between side of core and reference surface plate:
Is the maximum gap $\leq$ 0.02 in.? YES

Maximum difference must be < 0.020 in.
Straightness Tolerance Met? **YES**

END FLATNESS AND PARALLELISM (Procedure FP1)

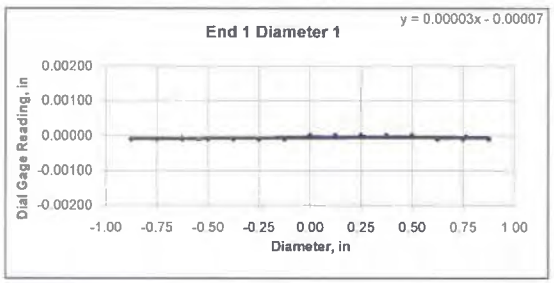
END 1	-0.875	-0.750	-0.625	-0.500	-0.375	-0.250	-0.125	0.000	0.125	0.250	0.375	0.500	0.625	0.750	0.875
Diameter 1, in	-0.00010	-0.00010	-0.00010	-0.00010	-0.00010	-0.00010	-0.00010	0.00000	0.00000	0.00000	0.00000	0.00000	-0.00010	-0.00010	-0.00010
Diameter 2, in (rotated 90°)	-0.00020	-0.00020	-0.00020	-0.00020	-0.00010	0.00000	0.00000	0.00000	0.00000	0.00010	0.00010	0.00010	0.00020	0.00030	0.00030

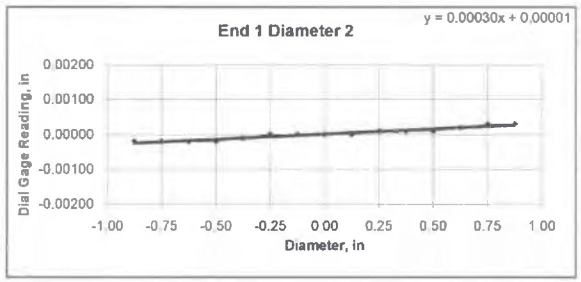
Difference between max and min readings, in:
0° = 0.00010 90° = 0.00050

END 2	-0.875	-0.750	-0.625	-0.500	-0.375	-0.250	-0.125	0.000	0.125	0.250	0.375	0.500	0.625	0.750	0.875
Diameter 1, in	-0.00020	-0.00020	-0.00020	-0.00020	-0.00020	-0.00020	-0.00010	0.00000	0.00000	-0.00010	-0.00010	-0.00010	-0.00020	-0.00020	-0.00020
Diameter 2, in (rotated 90°)	-0.00020	-0.00010	-0.00010	-0.00010	0.00000	0.00000	0.00000	0.00000	0.00010	0.00010	0.00020	0.00020	0.00030	0.00030	0.00040

Difference between max and min readings, in:
0° = 0.0002 90° = 0.0006

Maximum difference must be < 0.0020 in. Difference = + 0.00030
Flatness Tolerance Met? YES

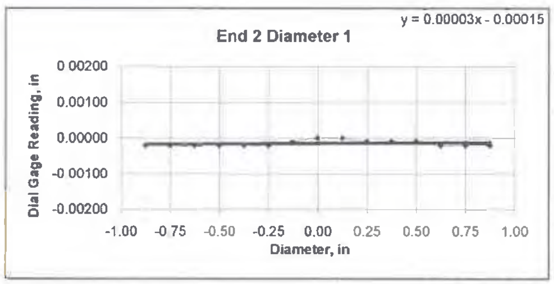


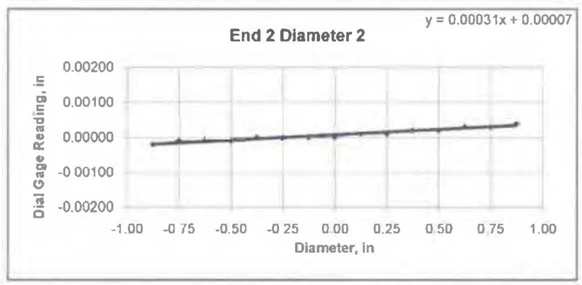


DIAMETER 1

End 1:	Slope of Best Fit Line	0.00003
	Angle of Best Fit Line:	0.00172
End 2:	Slope of Best Fit Line	0.00003
	Angle of Best Fit Line:	0.00172
Maximum Angular Difference:		0.00000

Parallelism Tolerance Met? **YES**
Spherically Seated





DIAMETER 2

End 1:	Slope of Best Fit Line	0.00030
	Angle of Best Fit Line:	0.01719
End 2:	Slope of Best Fit Line	0.00031
	Angle of Best Fit Line:	0.01776
Maximum Angular Difference:		0.00057

Parallelism Tolerance Met? **YES**
Spherically Seated

PERPENDICULARITY (Procedure P1) (Calculated from End Flatness and Parallelism measurements above)

	Difference, Maximum and Minimum (in.)	Diameter (in.)	Slope	Angle°	Perpendicularity Tolerance Met?
END 1					
Diameter 1, in	0.00010	2.485	0.00004	0.002	YES
Diameter 2, in (rotated 90°)	0.00050	2.485	0.00020	0.012	YES
END 2					
Diameter 1, in	0.00020	2.485	0.00008	0.005	YES
Diameter 2, in (rotated 90°)	0.00060	2.485	0.00024	0.014	YES

Maximum angle of departure must be $\leq$ 0.25°

Perpendicularity Tolerance Met? **YES**

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WARRANTY and LIABILITY

GeoTesting Express (GTX) warrants that all tests it performs are run in general accordance with the specified test procedures and accepted industry practice. GTX will correct or repeat any test that does not comply with this warranty. GTX has no specific knowledge as to conditioning, origin, sampling procedure or intended use of the material.

GTX may report engineering parameters that require us to interpret the test data. Such parameters are determined using accepted engineering procedures. However, GTX does not warrant that these parameters accurately reflect the true engineering properties of the *in situ* material. Responsibility for interpretation and use of the test data and these parameters for engineering and/or construction purposes rests solely with the user and not with GTX or any of its employees.

GTX's liability will be limited to correcting or repeating a test which fails our warranty. GTX's liability for damages to the Purchaser of testing services for any cause whatsoever shall be limited to the amount GTX received for the testing services. GTX will not be liable for any damages, or for any lost benefits or other consequential damages resulting from the use of these test results, even if GTX has been advised of the possibility of such damages. GTX will not be responsible for any liability of the Purchaser to any third party.

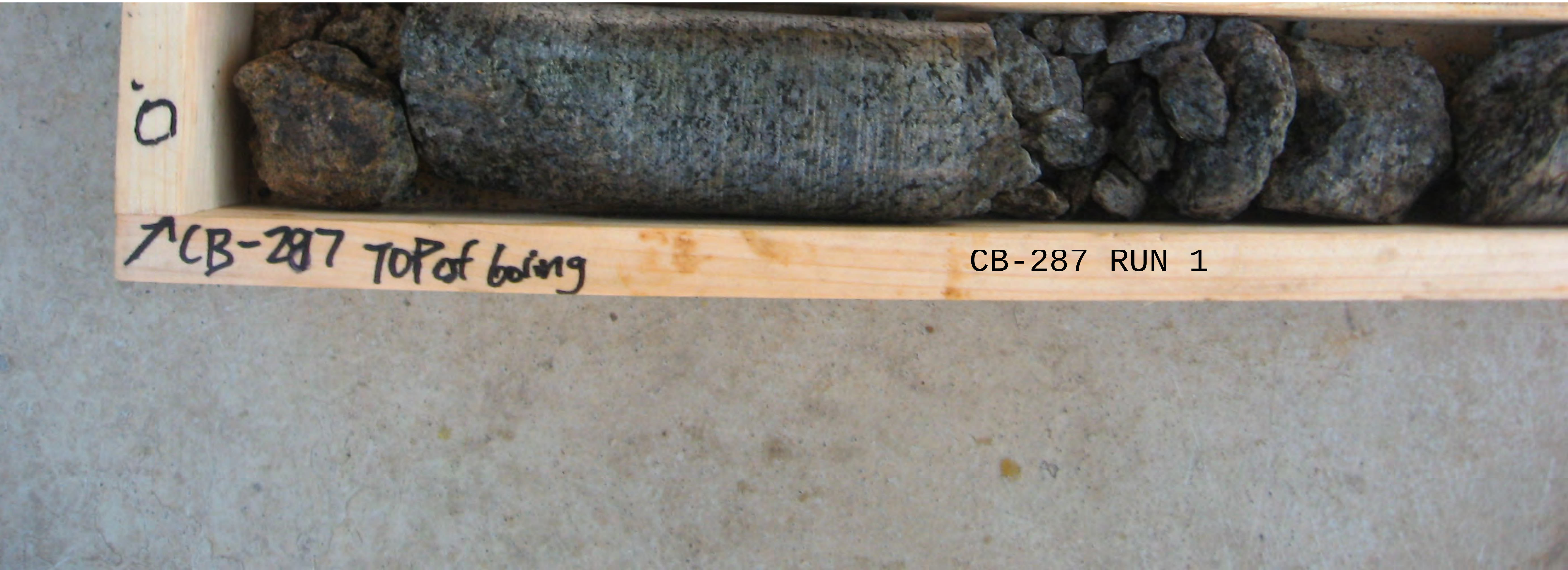
Commonly Used Symbols

A	pore pressure parameter for $\Delta\sigma_1 - \Delta\sigma_3$
B	pore pressure parameter for $\Delta\sigma_3$
CIU	isotropically consolidated undrained triaxial shear test
CR	compression ratio for one dimensional consolidation
C_c	coefficient of curvature, $(D_{30})^2 / (D_{10} \times D_{60})$
C_u	coefficient of uniformity, D_{60}/D_{10}
C_c	compression index for one dimensional consolidation
C_α	coefficient of secondary compression
c_v	coefficient of consolidation
c	cohesion intercept for total stresses
c'	cohesion intercept for effective stresses
D	diameter of specimen
D_{10}	diameter at which 10% of soil is finer
D_{15}	diameter at which 15% of soil is finer
D_{30}	diameter at which 30% of soil is finer
D_{50}	diameter at which 50% of soil is finer
D_{60}	diameter at which 60% of soil is finer
D_{85}	diameter at which 85% of soil is finer
d_{50}	displacement for 50% consolidation
d_{90}	displacement for 90% consolidation
d_{100}	displacement for 100% consolidation
E	Young's modulus
e	void ratio
e_c	void ratio after consolidation
e_o	initial void ratio
G	shear modulus
G_s	specific gravity of soil particles
H	height of specimen
PI	plasticity index
i	gradient
K_o	lateral stress ratio for one dimensional strain
k	permeability
LI	Liquidity Index
m_v	coefficient of volume change
n	porosity
PI	plasticity index
P_c	preconsolidation pressure
p	$(\sigma_1 + \sigma_3) / 2$, $(\sigma_v + \sigma_h) / 2$
p'	$(\sigma'_1 + \sigma'_3) / 2$, $(\sigma'_v + \sigma'_h) / 2$
p'_c	p' at consolidation
Q	quantity of flow
q	$(\sigma_1 - \sigma_3) / 2$
q_f	q at failure
q_o, q_i	initial q
q_c	q at consolidation
S	degree of saturation
SL	shrinkage limit
s_u	undrained shear strength
T	time factor for consolidation

T	temperature
t	time
U, UC	unconfined compression test
UU, Q	unconsolidated undrained triaxial test
u_a	pore gas pressure
u_e	excess pore water pressure
u, u_w	pore water pressure
V	total volume
V_g	volume of gas
V_s	volume of solids
V_v	volume of voids
V_w	volume of water
V_o	initial volume
v	velocity
W	total weight
W_s	weight of solids
W_w	weight of water
w	water content
w_c	water content at consolidation
w_f	final water content
w_l	liquid limit
w_n	natural water content
w_p	plastic limit
w_s	shrinkage limit
w_o, w_i	initial water content
α	slope of q_f versus p_f
α'	slope of q_f versus p_f'
γ_t	total unit weight
γ_d	dry unit weight
γ_s	unit weight of solids
γ_w	unit weight of water
ε	strain
ε_{vol}	volume strain
ε_h, ε_v	horizontal strain, vertical strain
μ	Poisson's ratio, also viscosity
σ	normal stress
σ'	effective normal stress
σ_c, σ'_c	consolidation stress in isotropic stress system
σ_h, σ'_h	horizontal normal stress
σ_v, σ'_v	vertical normal stress
σ_1	major principal stress
σ_2	intermediate principal stress
σ_3	minor principal stress
τ	shear stress
φ	friction angle based on total stresses
φ'	friction angle based on effective stresses
φ'_r	residual friction angle
φ_{ult}	φ for ultimate strength

Appendix C

Core Photographs


0
CB-287 TOP of boring
CB-287 RUN 1


CB-287 RUN 1

CB-287 RUN 1


CB-287 RUN 1


CB-287 RUN 1


CB-287 TOP
CB-287 RUN 2
6'
9'4"
CB-287 RUN 3
14'4"
CB-287 RUN 4


CB-287 RUN 2
CB-287 RUN 3
CB-287 RUN 4


CB-287 RUN 2
CB-287 RUN 3
CB-287 RUN 4


CB-287 RUN 3
CB-287 RUN 4


CB-287
TOP
CB-287 RUN 5
19'
CB-287
20'4" END

CB-288 RUN 1


CB-288
CB-288 RUN 1
CB-288 RUN 1


CB-288 RUN 1
CB-288 5'
CB-288 RUN 1
CB-288 RUN 2

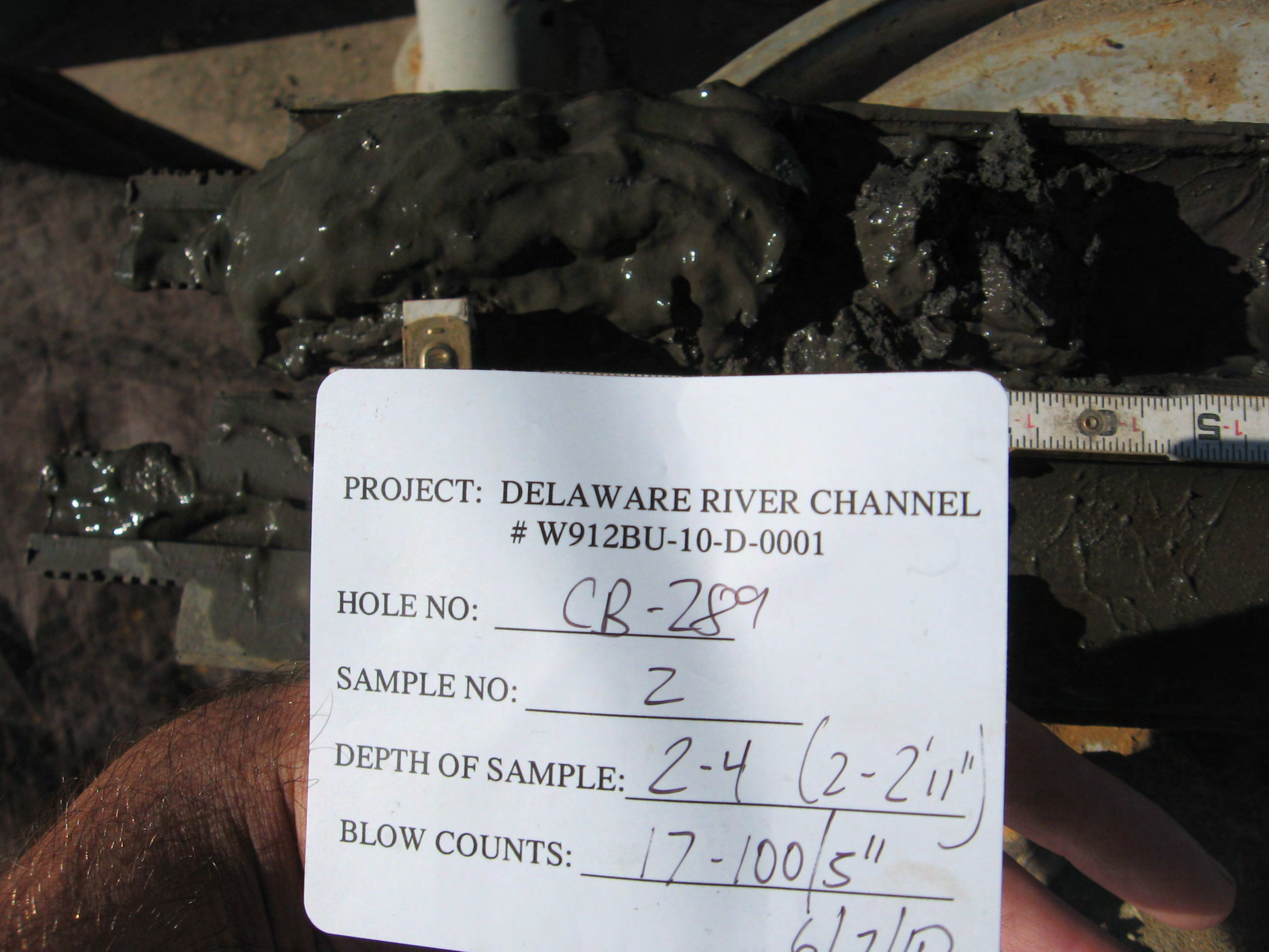

CB-288 RUN 1
CB-288 RUN 2
CB-288 6'9"


CB-288 RUN 2
CB-288
TOP
6'9"
15'
Lufkin
RUGGED
RED END
ENGINEERS
JOINTS
CB-288 RUN 3


CB-288 RUN 2
CB-288 RUN 3
CB-288 10'
CB-288 RUN 4


CB-288 RUN 3
CB-288 RUN 4


CB-288 RUN 3
15
CB-288 20' End
CB-288 RUN 4


PROJECT: DELAWARE RIVER CHANNEL
W912BU-10-D-0001
HOLE NO: CB-289
SAMPLE NO: 2
DEPTH OF SAMPLE: 2-4 (2-2'11")
BLOW COUNTS: 17-100/5"

CB-289 SAMPLE 2


CB-289 TOP
CB-289 RUN 1
4'
8.5'
CB-289 RUN 2
13'4"
CB-289 RUN 3


CB-289 RUN 1
CB-289 RUN 2
CB-289 6.25'
CB-289 RUN 2
CB-289 RUN 3


CB-289 RUN 2
CB-289 11.25'
CB-289 RUN 2
CB-289 RUN 3
CB-289 16.25'
CB-289 RUN 3
CB-289 RUN 4


CB-289 RUN 2
CB-289 RUN 3
CB-289 RUN 3
CB-289 RUN 4

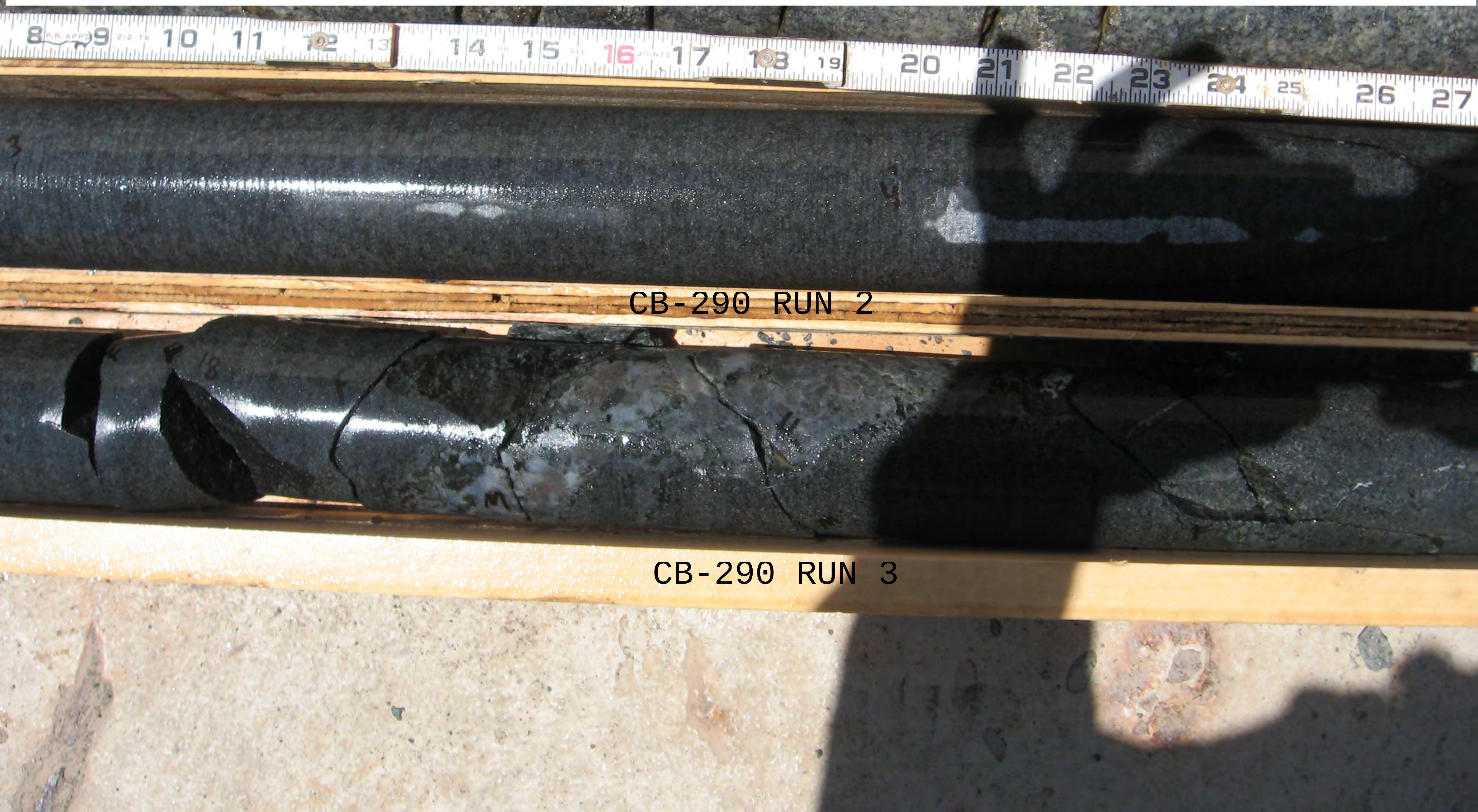

CB-289 RUN 2
CB-289 RUN 3
CB-289 RUN 4


CB-289 RUN 4


CB-289 RUN 4


CB-289 RUN 4
20
20'6"
CB-289
END 20.5'


CB-290 RUN 2
CB-290 RUN 3


CB-290 RUN 2
CB-290 RUN 3


CB-290 RUN 1
CB-290 RUN 2
CB-290 RUN 3

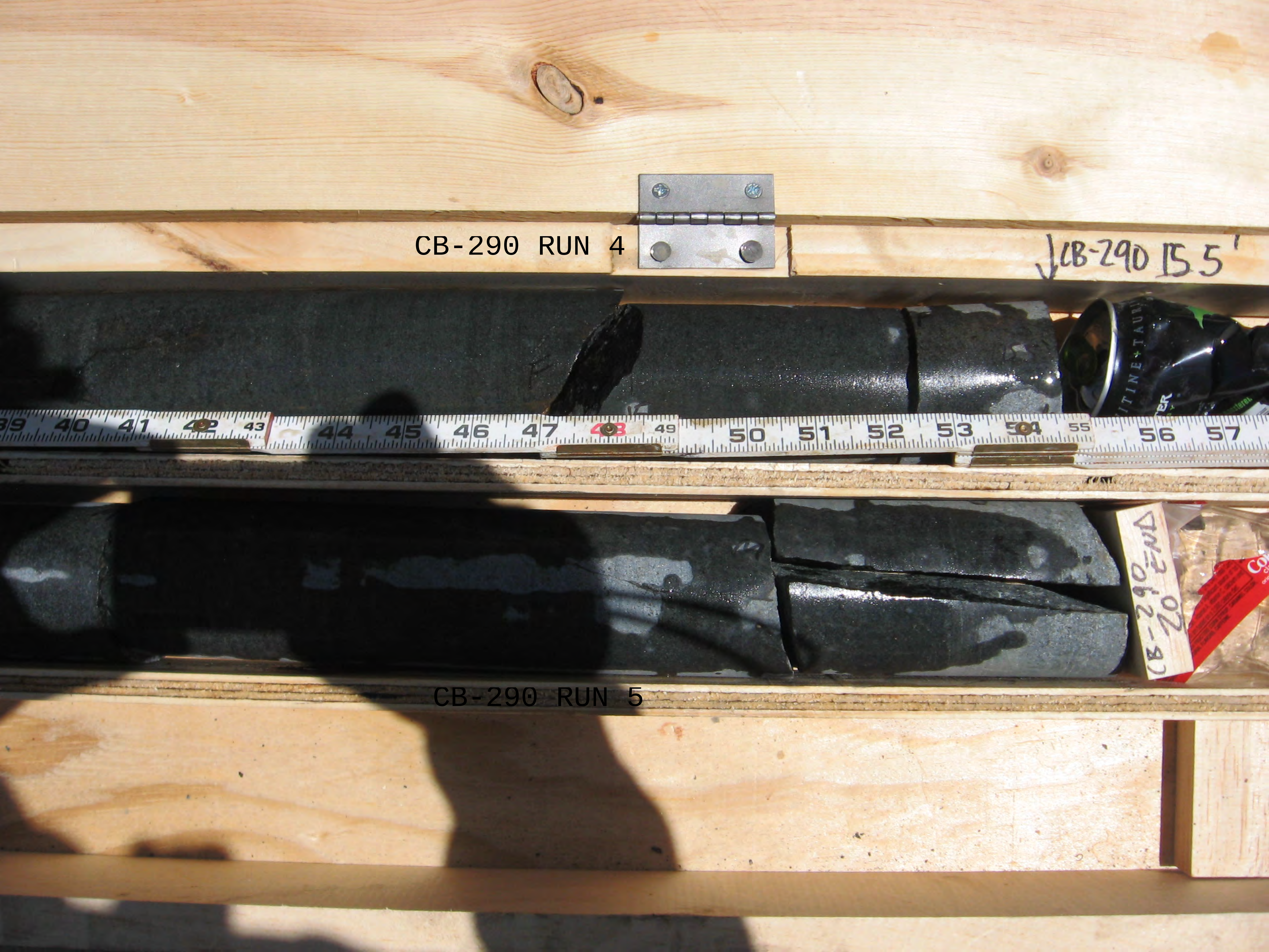

CB-290 RUN 1
CB-290 RUN 2
CB-290 1'
CB-290 RUN 2
CB-290 6'
CB-290 RUN 3
CB-290 11'
CB-290 RUN 3


CB-290 RUN 2
CB-290 RUN 3
CB-290 11'
CB-290 RUN 3


CB-290 TOP
CB-290 RUN 4
11'
15'
CB-290 16'
CB-290 RUN 5
CB-290 RUN 4


CB-290 RUN 4
CB-290 RUN 5


CB-290 RUN 4
CB-290 RUN 5


CB-290 RUN 4
CB-290 15.5'
CB-290 20 END
CB-290 RUN 5


CB-290 RUN 4
CB-290 15.5'
CB-290 RUN 5
CB-290 20' END
Tropicana
PURE PREMIUM
NO PULP
100% PURE & NATURAL ORANGE JUICE


CB-291 TOP
CB-291 RUN 1
0'
Lufkin
RUGGED
BRICK
MASON'S
RULE
CB-291 RUN 2
CB-291 RUN 3
TOP


CB-291 RUN 1
CB-291 RUN 2
CB-291 3'
CB-291 RUN 2
F CB-291 RUN 3 M
F→


CB-291 RUN 2
CB-291 4.5'
CB-291 8'
CB-291
12'9"-13'
CB-291 RUN 2
F
CB-291 RUN 3
F


CB-291 RUN 2
CB-291 9.5'
vitaminwater
GLACÉAU
revive
fruit punch
nutrient enhanced water
20 FL OZ (1.25 PT)
CB-291 8'
CB-291
12'9"-13'
CB-291 RUN 3
CB-291 RUN 2
CB-292 12'9"
CB-291 RUN 3


CB-291 TOP
CB-291 RUN 4
13'
No. 636 Lufkin RUGGED RED END BRICK MASON'S RULE
P.R. APP'D.
CB-291 RUN 5


CB-291 RUN 4
CB-291 RUN 5


CB-291 RUN 4
CB-291 END 20'
CB-291 RUN 5


CB-291 RUN 4
CB-291
17.8m


CB-292 SAMPLE 1
PROJECT: DELAWARE RIVER CHANNEL
W1928U-10-D-0001
HOLE NO: CB-292
SAMPLE NO: 1
DEPTH OF SAMPLE: 0-2
BLOW COUNTS: 26-32-19-38
6/2/10


CB-292 SAMPLE 2
PROJECT: DELAWARE RIVER CHANNEL
W912BU-10-D-0001
HOLE NO: CB-292
SAMPLE NO: 2
DEPTH OF SAMPLE: 2-4
BLOW COUNTS: 18-100/4"
6/2/10


CB-292 RUN 1
CB-295
20' End
CB-292 Top
3'
CB-292
3'
F
F
F
M
F
F
4'


CB-292 RUN 1


CB-292 RUN 1


CB-292 TOP
CB-292 RUN 2
6.5'
Fragments from 7'
CB-295 11.5
CB-292 RUN 2
CB-292 RUN 3
CB-295 16.5'
CB-292 RUN 3
CB-292 RUN 4


CB-292 RUN 2
CB-292 RUN 3
CB-292 RUN 4


CB-292 RUN 2
CB-292 RUN 3
CB-292 RUN 4


CB-292 RUN 2
CB-292 RUN 3
CB-292 RUN 4


CB-292 RUN 2
CB-295 11.5'
CB-292 RUN 3
20.5'
CB-292 RUN 4
CB-295 END

No. 636
Lufkin
RUGGED
RED END
BRICK
MASON'S
RULE
PROJECT: DELAWARE RIVER CHANNEL
W912BU-10-D-0001
HOLE NO: CB-293
SAMPLE NO: 1
DEPTH OF SAMPLE: 0-2'

PROJECT: DELAWARE RIVER CHANNEL
W912BU-10-D-0001
HOLE NO: CB-293
SAMPLE NO: 1
DEPTH OF SAMPLE: 0-2'
BLOW COUNTS: WH-WH. WH-WH
5/27/10


PROJECT: DELAWARE RIVER CHANNEL
W912BU-10-D-0001
HOLE NO: CB-2a3
SAMPLE NO: 2
DEPTH OF SAMPLE: 2-4'
LOW COUNTS: WH-WH-WH-17

CB-293 SAMPLE 2
2-4'


PROJECT: DELAWARE RIVER CHANNEL
W1928U-10-D-0001
HOLE NO: CB-293
SAMPLE NO: 3
DEPTH OF SAMPLE: 4-6'
BLOW COUNTS: 20-15-14-15
5/27/10


PROJECT: DELAWARE RIVER CHANNEL
W1928U-10-D-0001
HOLE NO: CB-293
SAMPLE NO: 4
DEPTH OF SAMPLE: 6-8'
BLOW COUNTS: 12-13-14-11


PROJECT: DELAWARE RIVER CHANNEL
W1928U-10-D-0001
HOLE NO: CB-293
SAMPLE NO: 4
DEPTH OF SAMPLE: 6-8'
BLOW COUNTS: 12-13-14-11


PROJECT: DELAWARE RIVER CHANNEL
W912BU-10-D-0001
HOLE NO: CB-293
SAMPLE NO: 5
H OF SAMPLE: 8-10'
OW COUNTS: 12-8-9-11
5/27/10


PROJECT: DELAWARE RIVER CHANNEL
W912BU-10-D-0001
HOLE NO: CB-293
SAMPLE NO: 5
H OF SAMPLE: 8-10'
OW COUNTS: 12-8-9-11
5/27/10


PROJECT: DELAWARE RIVER CHANNEL
W912BU-10-D-0001
HOLE NO: CB-293
SAMPLE NO: 6
DEPTH OF SAMPLE: 10-12'


CB-293 SAMPLE 7
PROJECT: DELAWARE RIVER CHANNEL
W912BU-10-D-0001
HOLE NO: CB-293


PROJECT: DELAWARE RIVER CHANNEL
W912BU-10-D-0001
HOLE NO: CB-293
SAMPLE NO: 8
DEPTH OF SAMPLE: 14-16'
BLOW COUNTS: 4-6-38-50/1"

CB-293 RUN 1

CB-293 RUN 1


CB-293 RUN 1
CB-293 RUN 1
CB-293 16' TOA
CB-293 21' END
CORE LOG
O'BRIEN & GERE ENGINEER
Project: Geotechnical Investigation of Rock Cut Areas
Client: USACE-Philadelphia District
Purpose: Investigation
Location: Del. River, Tinicum to Marcus Hook Ranges, PA
Hole Location:
Drilling Contractor:
Driller:
Geologist:
Length of Casing:
Casing Size:

CB-293 RUN 1

CB-293 RUN 1

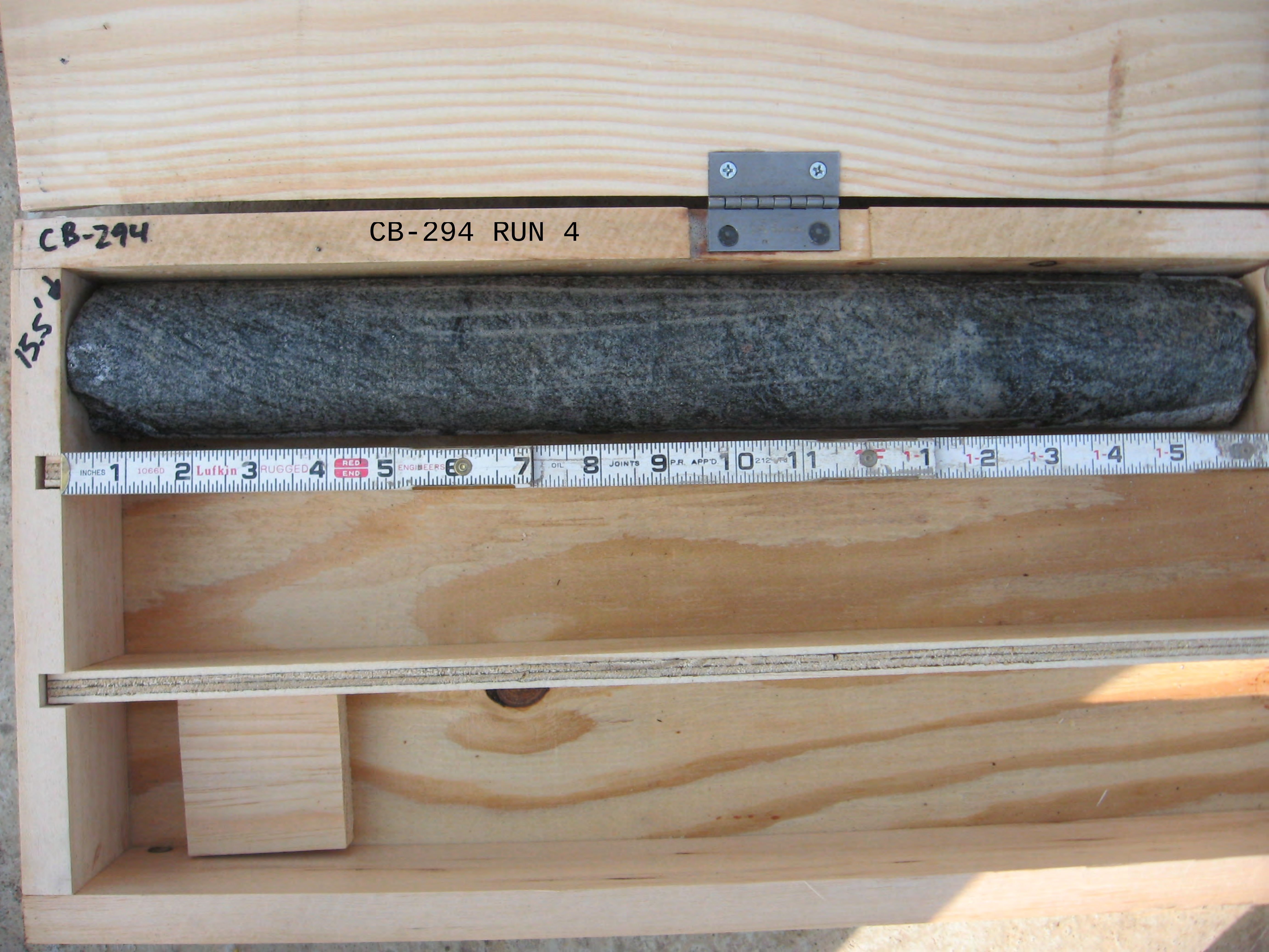

CB-294 RUN 1


CB-294 RUN 1
CB-294 RUN 2
CB-294 RUN 2
CB-294 RUN 3
CB-294 RUN 3


CB-294 RUN 2
CB-294 RUN 3
CB-294 RUN 3
CB-294 RUN 4
CB-294
12'2"


CB-294 RUN 2
CB-294 RUN 3
CB-294 RUN 4


CB-294 RUN 2
CB-294 RUN 3
Broken by geol.
CB-294 RUN 4



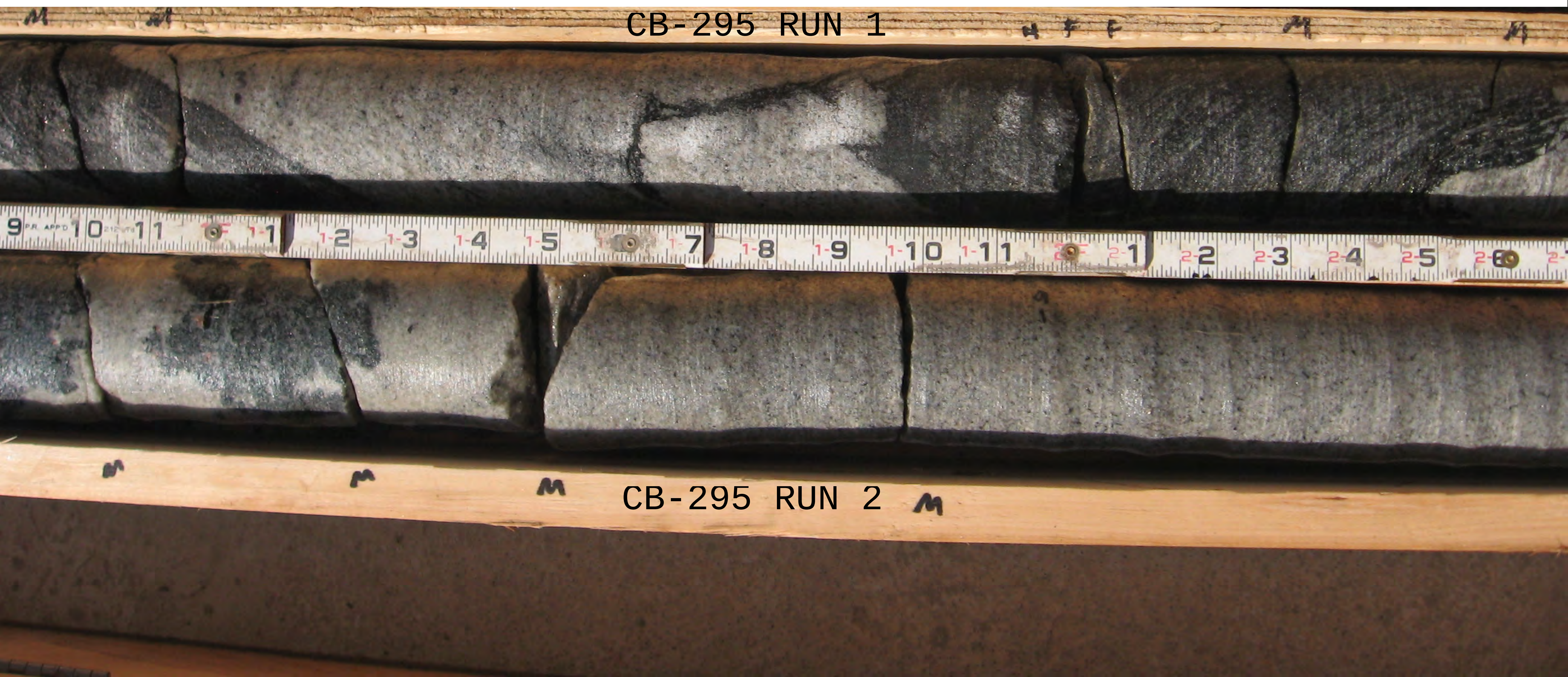
CB-294
CB-294 RUN 4
15.5'


CB-294 RUN 4
CB-294 RUN 5


CB-294 RUN 5


PROJECT: DELAWARE RIVER CHANNEL
W912BU-10-D-0001
HOLE NO: CB-295
SAMPLE NO: 1
DEPTH OF SAMPLE: 0-2'
BLOW COUNTS:


CB-295 RUN 1
CB-295 RUN 2


CB-295 RUN 1
CB-295 RUN 2


CB-295 RUN 1
CB-295 RUN 2


CB-295 RUN 1
CB-295 RUN 2


CB-295
CB-295 RUN 3
12'
CB-295 RUN 3
CB-295 15.5'
CB-295
CB-295 20' End
CB-295 RUN 4


CB-295 RUN 3
CB-295 RUN 3
CB-295 RUN 4
CB-295
17'

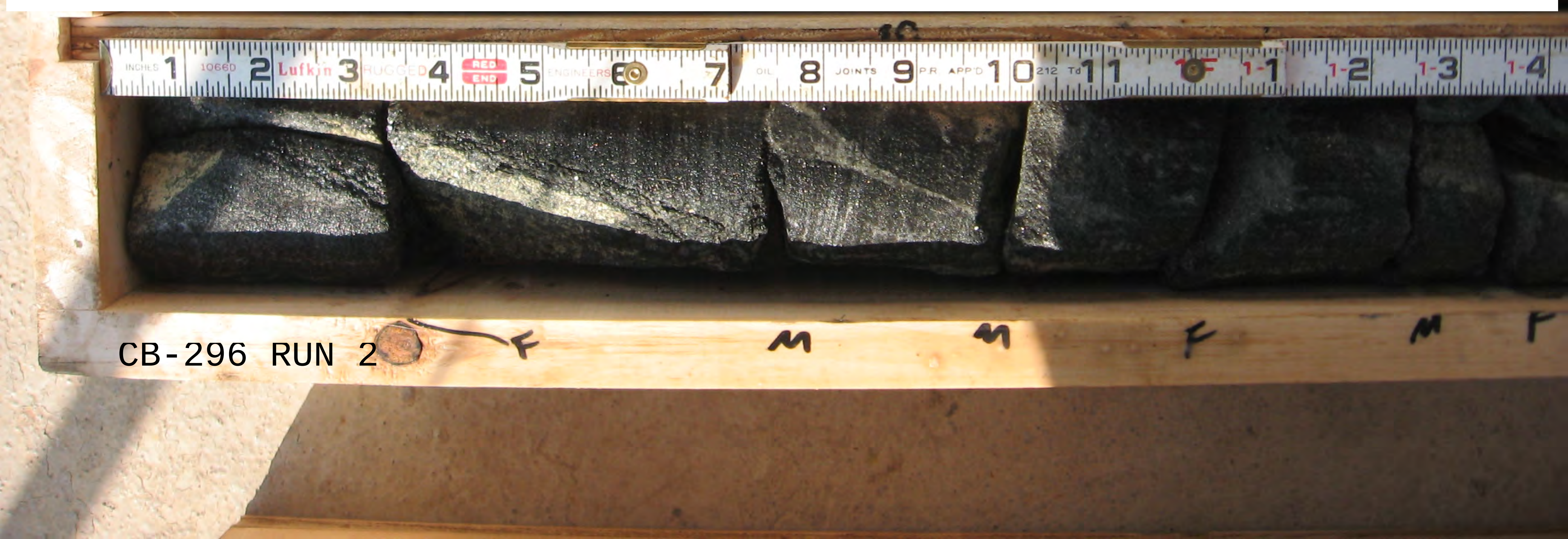

CB-295 RUN 3
CB-295 RUN 4


CB-295 RUN 3
CB-295 RUN 4


PROJECT: DELAWARE RIVER CHANN
W912BU-10-D-0001
HOLE NO: CB-296
SAMPLE NO: 1
TH OF SAMPLE: 0-2
OW COUNTS: 12-32-70-50/1"
5/26/10
HEAVY


PROJECT: DELAWARE RIVER CHANNEL
W912BU-10-D-0001
HOLE NO: CB-296
SAMPLE NO: 2
DEPTH OF SAMPLE: 2-4
BLOW COUNTS: 23-24-20-26
5/26/10


PROJECT: DELAWARE RIVER CHANNEL
W912BU-10-D-0001
HOLE NO: CB-296
SAMPLE NO: 3 SM
DEPTH OF SAMPLE: 4-6'
OW COUNTS: 11-70-50/2"


INCHES 1 1066D 2 Lufkin 3 RUGGED 4 RED END 5 ENGINEERS 6 7 OIL 8 JOINTS 9 P.R. APP'D 10 212 Td 11
F M M F M F

CB-296 RUN 2


CB-296 RUN 2

CB-296 RUN 1

CB-296 RUN 2


CB-296 RUN 1
CB-296 RUN 2
CB-296 8.5'
CB-296 RUN 2
CB-296 13.5'


TOP CB-296
CB-296 RUN 3
13.5'
CB-296 RUN 4


CB-296 RUN 3
CB-296 RUN 4


CB-296 RUN 3
F


CB-296 RUN 3

TOP CB-297
MB
CB-297 RUN 1
F
F
F
O
CB-297 RUN 2
CB-297 RUN 3
CB-297 7'4"
CB-297 12'4"
CB-297 RUN 3
MB
CB-297 RUN 4

CB-297 RUN 1
CB-297 RUN 2
CB-297 RUN 3
CB-297 RUN 4


CB-297 RUN 2
CB-297 2'4"
CB-297 RUN 3
CB-297 RUN 4

CB-297 RUN 2
CB-297 RUN 3
CB-297 RUN 4
CB-297 15'3"


TOP
CB-297
CB-297 RUN 4
15'3"
CB-297 RUN 5
CB-297


CB-297 RUN 4
CB-297 RUN 5
CB-297
17'4"
CB-297
20'4" END
CB-297 RUN 5


CB-297 RUN 5


CB-298 SAMPLE 1
PROJECT: DELAWARE RIVER CHANNEL
W912BU-10-D-0001
HOLE NO: CB-298
SAMPLE NO: 1
DEPTH OF SAMPLE: 0-2
BLOW COUNTS: 8-23-38-26
5/25/10


Use template for 5164™
PROJECT: DELAWARE RIVER CHANNEL
W912BU-10-D-0001
HOLE NO: CB-298
SAMPLE NO: 2
DEPTH OF SAMPLE: 2-4'
BLOW COUNTS: 8-19-16-28
5/25/10


Lufkin
RED END
RUGGED
BRICK
MASON'S
RULE
P.R. APP'D.
Use template for 5164™
PROJECT: DELAWARE RIVER CHANNEL
W912BU-10-D-0001
HOLE NO: CB-298
SAMPLE NO: 2


PROJECT: DELAWARE RIVER CHANNEL
W912BU-10-D-0001
HOLE NO: CB-298
SAMPLE NO: 3
DEPTH OF SAMPLE: 4-6
BLOW COU TS: 23-24-33-11


PROJECT: DELAWARE RIVER CHANNEL
W912BU-10-D-0001
HOLE NO: CB-298
SAMPLE NO: 3
DEPTH OF SAMPLE: 4-6


PROJECT: DELAWARE RIVER CHANNEL
W912BU-10-D-0001
HOLE NO: CB-298
SAMPLE NO: 4
DEPTH OF SAMPLE: 6-8'
BLOW COUNTS: 19-21-23-20
5/25/10


PROJECT: DELAWARE RIVER CHANNEL
W912BU-10-D-0001
HOLE NO: CB-298
SAMPLE NO: 5
DEPTH OF SAMPLE: 8-10'
Blow Counts: 5-7-6-8
9/25/10
Lufkin
RUGGED
RED END
BRICK
MASON'S
RULE


Weatherproof Laser Labels
PROJECT: DELAWARE RIVER CHANNEL
W1928U-10-D-0001
HOLE NO: CB-298
SAMPLE NO: 6
DEPTH OF SAMPLE: 10-12'
BLOW COUNTS: 7-11-20-50/3"
5/25/10

CB-298 RUN 1

CB-298 RUN 2


CB-298 RUN 1
CB-298 RUN 2
CB-298 RUN 3


CB-298 RUN 1
CB-298 RUN 3

CB-298 RUN 1
CB-298 RUN 2
CB-298 14'
CB-298 21' END
CB-298 RUN 3


CB-298 RUN 2

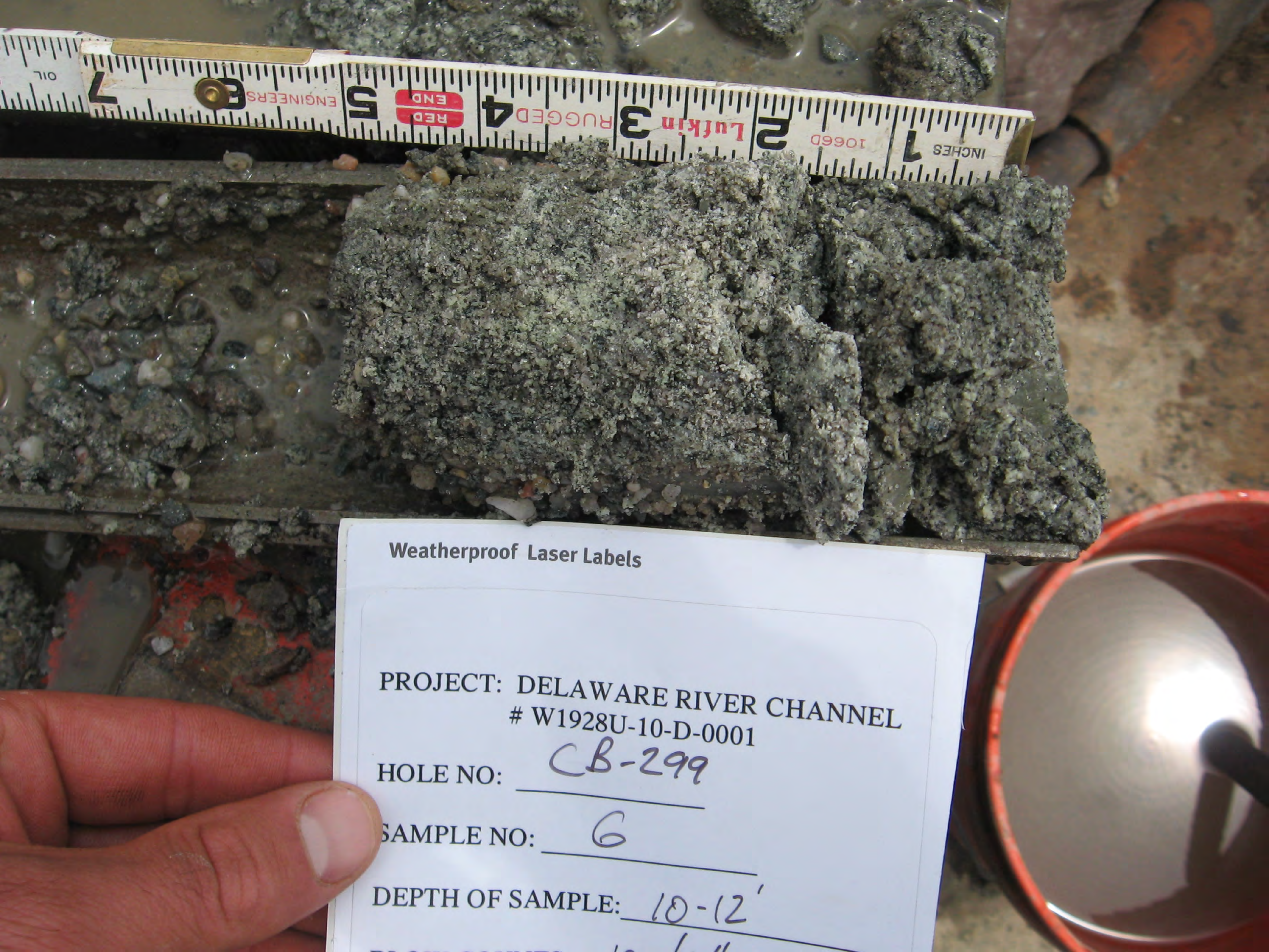

CB-299 SAMPLE 1
PROJECT: DELAWARE RIVER CHANNEL
W912BU-10-D-0001
HOLE NO: CB-299
SAMPLE NO: 1
DEPTH OF SAMPLE: 0-2'
BLOW COUNTS: 8-23-49-80
5/24/10
5524™
1-800-GO-AVE


PROJECT: DELAWARE RIVER CHANNEL
W912BU-10-D-0001
HOLE NO: CB-299
SAMPLE NO: 2
DEPTH OF SAMPLE: 2-4'
BLOW COUNTS: 23-41-49-53
5/24/10
AVERY® 5524™ 1-800-GO-


P OJECT: DELAWARE RIVER CHANNEL
W912BU-10-D-0001
OLE NO: CB-299
AMPLE NO: 3
EPTH OF SAMPLE: 4-6'
BLOW COUNTS: 30-33-38-32
5/24/10


Use template for 5164™
CB-299 SAMPLE 4
PROJECT: DELAWARE RIVER CHANNEL
W912BU-10-D-0001
HOLE NO: CB-299

Use template for 5164™
PROJECT: DELAWARE RIVER CHANNEL
W912BU-10-D-0001
HOLE NO: CB-299
SAMPLE NO: 5
PTH OF SAMPLE: 8-10'
Lufkin
RUGGED
RED END
INCHES


Weatherproof Laser Labels
PROJECT: DELAWARE RIVER CHANNEL
W1928U-10-D-0001
HOLE NO: CB-299
SAMPLE NO: 6
DEPTH OF SAMPLE: 10-12'


CB-300
20.5' End
CB-299
10.5'
CB-299
12.5'
Lufkin
RUGGED
RED END
BRICK
MASON'S
RULE
P.R. APP'D.
OIL
ALL
JOINTS

CB-299 RUN 1


CB-299 12.5'
CB-299 RUN 1
CB-299 RUN 2


CB-299 RUN 2

CB-299 RUN 2


CB-299 RUN 2
TOP CB-299
CB-299 RUN 4


CB-299 RUN 2
CB-299
20.5' END
CB-299 RUN 4


CB-299 RUN 2
CB-299 RUN 3
17.5'


CB-299 RUN 3
CB-299
17.5'


CB-299 RUN 3
CB-299 19'9"
21 22 23 24 25 26 27 28 29 30 31


CB-300 RUN 1
CB-300 RUN 2

CB-300 RUN 1

CB-300 RUN 2


CB-300 RUN 1
CB-300 RUN 2
CB-300 4.5'
CB-300 RUN 2
CB-300 RUN 3
CB-300 9.5'


CB-300
CB-300 RUN 1
CB-300 0'
CB-300 4.5'
CB-300 RUN 2
CB-300 9.5'
CB-300 RUN 2
CB-300 RUN 3
CB-300 10'10"


CB-300
CB-300 RUN 1
CB-300 RUN 2
CB-300 RUN 3
CB-300 10'10"
Bottom
Blueberry & MONSTER


TOP CB-300
CB-300 RUN 3
10'R
CB-300 RUN 4
CB-300 20.5' End
CB-300 RUN 5


CB-300 RUN 3
CB-300 RUN 4


CB-300 RUN 3
CB-300 14.5'
CB-300 RUN 4


CB-300 RUN 3
CB-300 RUN 4
CB-300 RUN 4
CB-300 RUN 5


RIDGID
PROJECT: DELAWARE RIVER CHANNEL
W912BU-10-D-0001
HOLE NO: CB-301
SAMPLE NO: 1
DEPTH OF SAMPLE: 0-2
BLOW COUNTS: 25-33-27-24
5/20/10
AVERY (462-8379)
www.avery.com

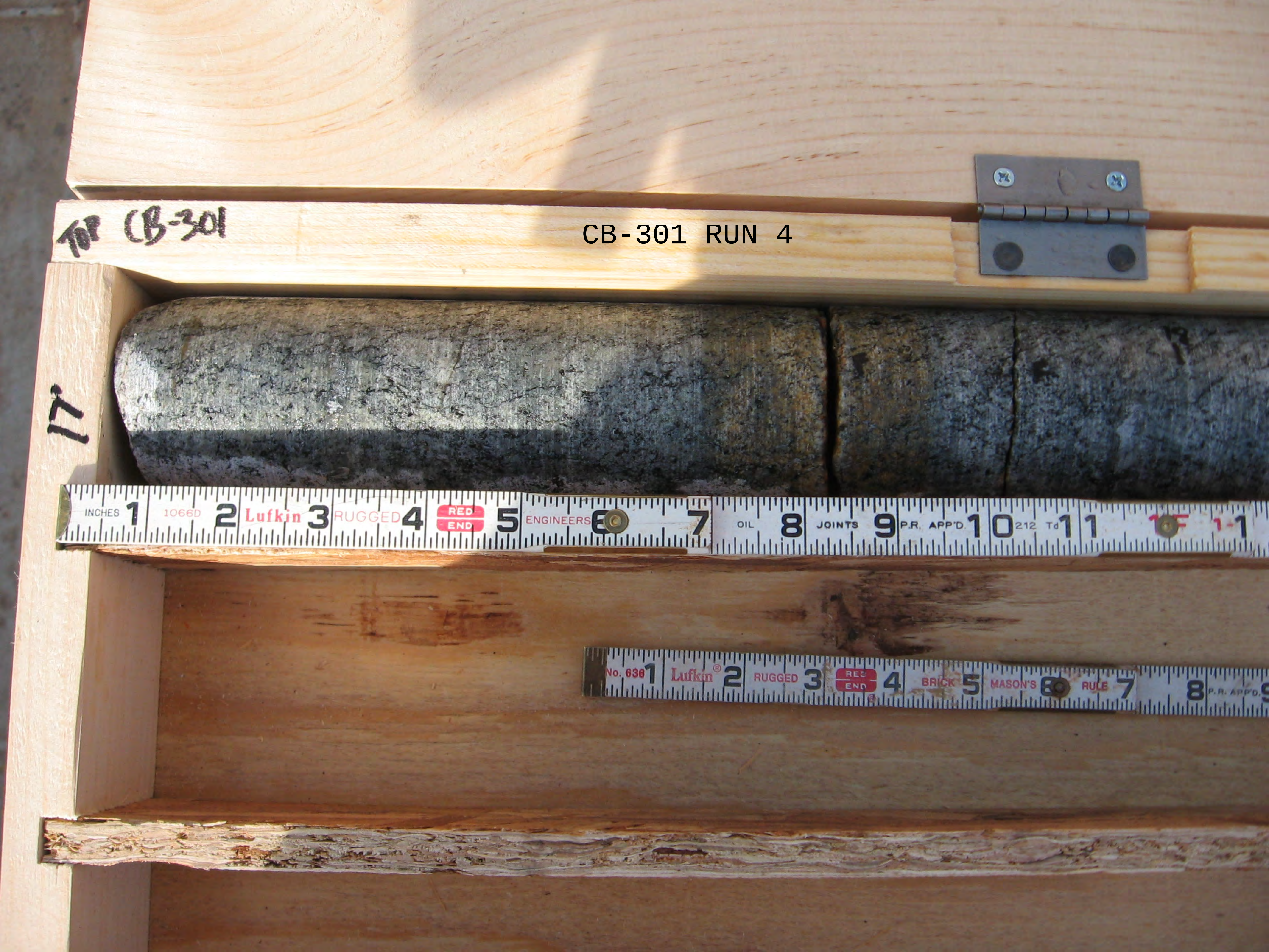

PROJECT: DELAWARE RIVER CHANNEL
W912BU-10-D-0001
HOLE NO: CB-301
SAMPLE NO: 2
DEPTH OF SAMPLE: 2-4
BLOW COUNTS: 35-50/4"


TOP CB-301
CB-301 RUN 1
CB-301 RUN 2
CB-301 RUN 3


CB-301 RUN 1
CB-301 RUN 2
CB-301 RUN 3


CB-301 RUN 1
CB-301 RUN 2
CB-301 65'
CB-301 RUN 2
CB-301 RUN 3


CB-301 RUN 2
CB-301 11.5'
CB-301 RUN 2
CB-301 RUN 3
CB-301 16.5'
CB-301 RUN 3
CB-301 RUN 4


CB-301 RUN 4
TOP CB-301
17'
INCHES
Lufkin
RUGGED
RED END
ENGINEERS
OIL
JOINTS
P.R. APP'D.
No. 636
BRICK
MASON'S
RULE


CB-301 RUN 4
MASON'S
RULE
P.R. APP'D
OIL
ALL
JOINTS


CB-301 RUN 4


CB-301 RUN 4
CB-301
20.5'
End


CB-302 RUN 1
INCHES
Lufkin
RUGGED
RED END
ENGINEERS
OIL
JOINTS
P.R. APP'D
CB-302 RUN 2


CB-302 RUN 1
CB-302 RUN 2


CB-302 RUN 1
CB-302 RUN 2


CB-302 RUN 1
TOP
CB-302 0'
CB-302 RUN 2
CB-302 RUN 1
CB-302 4.5'
CB-302 9.5'
CB-302 RUN 3
CB-302 RUN 2


CB-302 RUN 1
CB-302 RUN 2
CB-302 RUN 3
CB-302 11'3"


TOP CB-302
CB-302 RUN 3
11'3"
Broken by Geologist
CB-302 RUN 4


CB-302 RUN 3
CB-302 RUN 4


CB-302 RUN 3
CB-302 RUN 4


CB-302 RUN 3
CB-302 RUN 4
CB-302 14.5'
CB-302 19.5'
CB-302 RUN 4
CB-302 RUN 5


CB-302 RUN 4
TOP
CB-302
19.5'
CB-302 RUN 5


CB-302 RUN 4
CB-302 RUN 5
CB-302
205'


RIDGID HEAVY DUTY 18"
Weatherproof Laser Labels
PROJECT: DELAWARE RIVER CHANNEL
W1928U-10-D-0001
HOLE NO: CB-303
SAMPLE NO: 1
DEPTH OF SAMPLE: 0-2'
BLOW COUNTS: 25-21-50/4"

CB-303 RUN 1

CB-303 RUN 1

CB-303 RUN 1

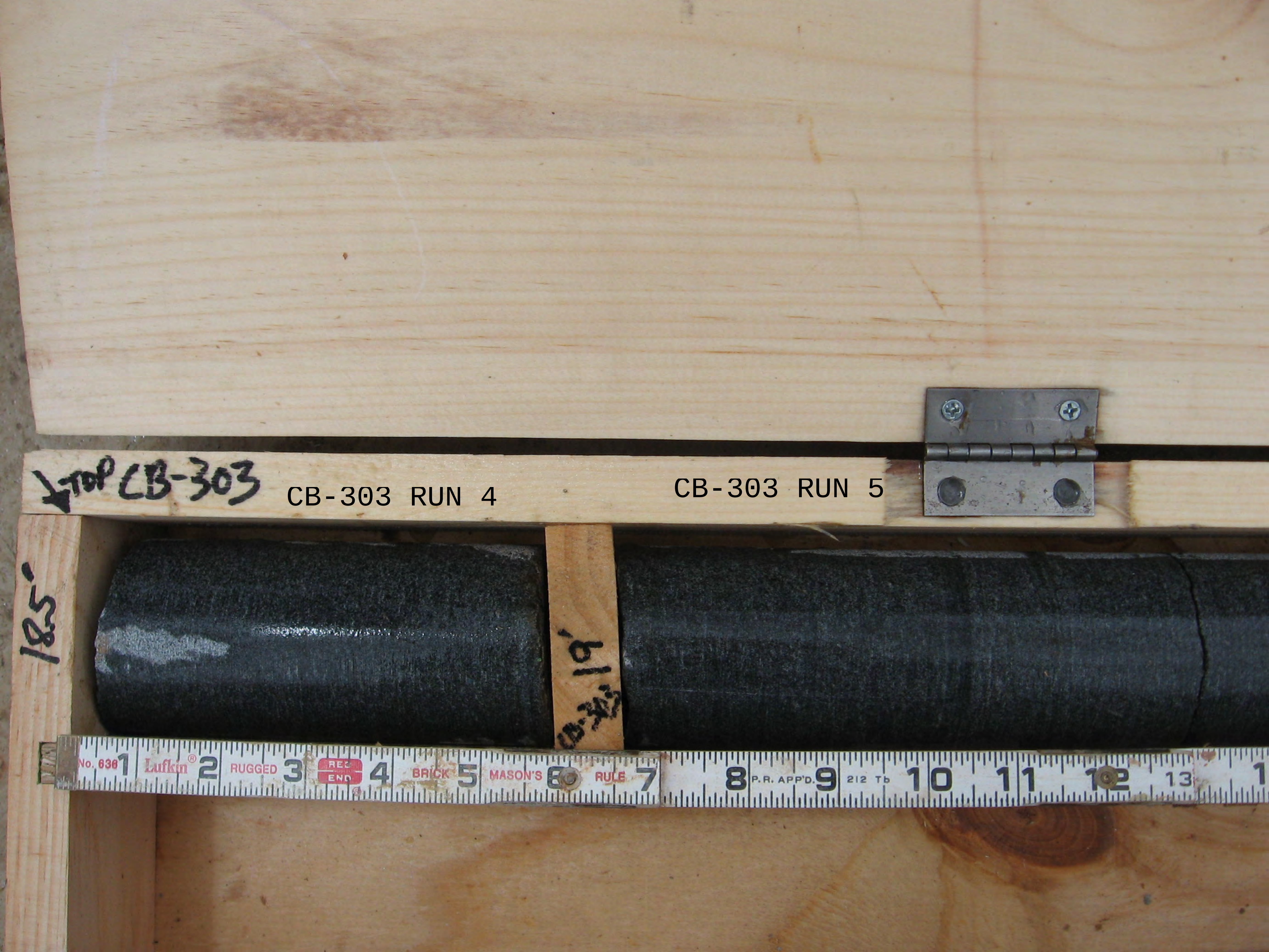

TOP
CB-303
CB-303 RUN 2
4'
CB-303 RUN 3
9'
CB-303 14'
CB-303 RUN 3
CB-303 RUN 4


CB-303 RUN 2
CB-303 RUN 3
CB-303 RUN 4


CB-303 RUN 2
CB-303 RUN 3
25 26 27 28 29 30 31 32 33 34 35 36 37
CB-303 RUN 4


CB-303 RUN 2
CB-303 RUN 3
CB-303 RUN 4


CB-303 RUN 2
CB-303 RUN 3
CB-303 RUN 4
18.5


TOP CB-303
CB-303 RUN 4
CB-303 RUN 5
185'
No. 636 Lufkin RUGGED RED END BRICK MASON'S RULE P.R. APP'D. 212 Tb


CB-303 RUN 5
13 14 OIL 15 ALL 16 JOINTS 17 19 20 21 22 23 25


CB-303 RUN 5


CB-303 RUN 5
CB-303
21.5'


TOP CB-304
CB-304 RUN 1
0.5'
CB-304 RUN 2
CB-304 RUN 3


CB-304 RUN 1
CB-304 RUN 2
CB-304 RUN 3


CB-304 RUN 1
CB-304 RUN 2
3'
8'
CB-304 RUN 2
CB-304 RUN 3
13'
CB-304 RUN 3
CB-304 RUN 4


CB-304 RUN 2
CB-304 RUN 3
13'
14.5'
CB-304 RUN 4


CB-304 RUN 4
CB-304 RUN 5

CB-304 RUN 4

CB-304 RUN 5

CB-304 RUN 4


CB-304 RUN 4


PROJECT: DELAWARE RIVER CHANNEL
W912BU-10-D-0001
HOLE NO: CB-305
SAMPLE NO: 1
DEPTH OF SAMPLE: 0-2
BLOW COUNTS: 20-17-22-19
5/14/10
AVERY® 5524™ 585263 1-800-GO-AV
Lufkin RUGGED RED END BRICK MASON'S RULE P.R. APP'D. 212 Tb
HEAVY DUTY RIDGID


PROJECT: DELAWARE RIVER CHANNEL
W912BU-10-D-0001
HOLE NO: CB-305
SAMPLE NO: 2
DEPTH OF SAMPLE: 2-4'
BLOW COUNTS: 58-50/3"
Lufkin
RUGGED
BRICK MASON'S RULE
RIDGID
HEAVY DUTY

W912BU-10-D-0001
HOLE NO: CB-305
SAMPLE NO: 3
DEPTH OF SAMPLE: 4-6
BLOW COUNTS: 27-48-23-17
5/14/10
No. 636
Lufkin
RUGGED
RED END
BRICK
MASON'S
RULE
P.R. APP'D.

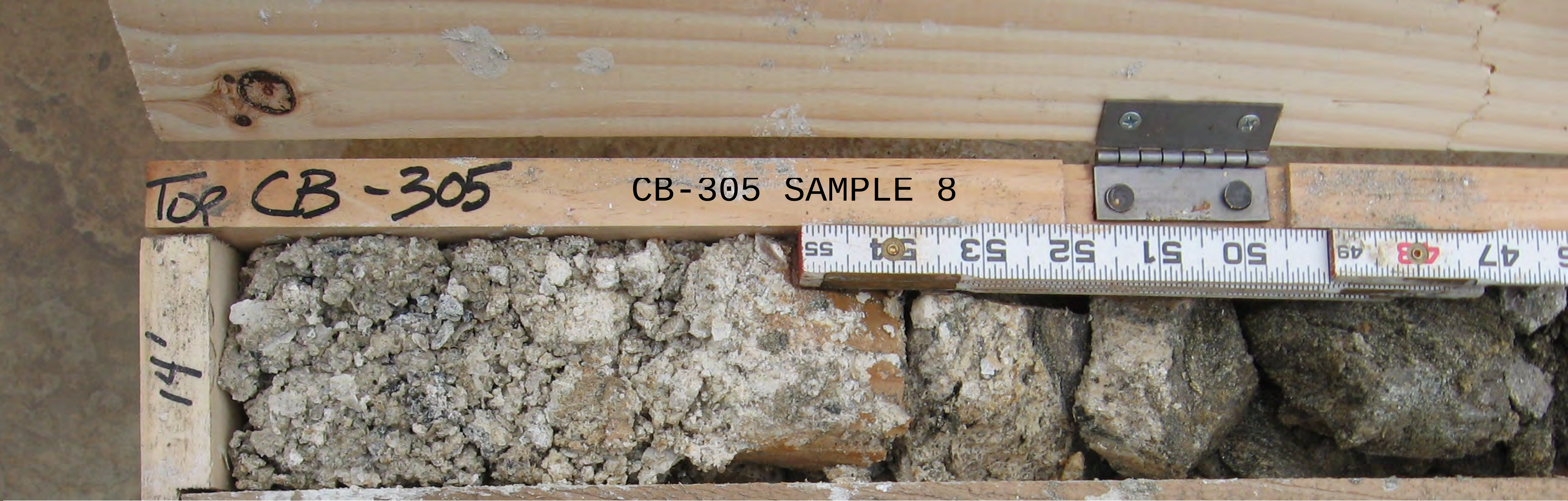

Labels
CB-305 SAMPLE 4
AWARE RIVER CHANNEL
028U-10-D-0001
-305
4
PLE: 6-8
17-25-25-26
8 P.R. APP'D. 9 212 Tb 10 11 12 13 14 OIL 15 ALL 16 JOINTS 17 18 19

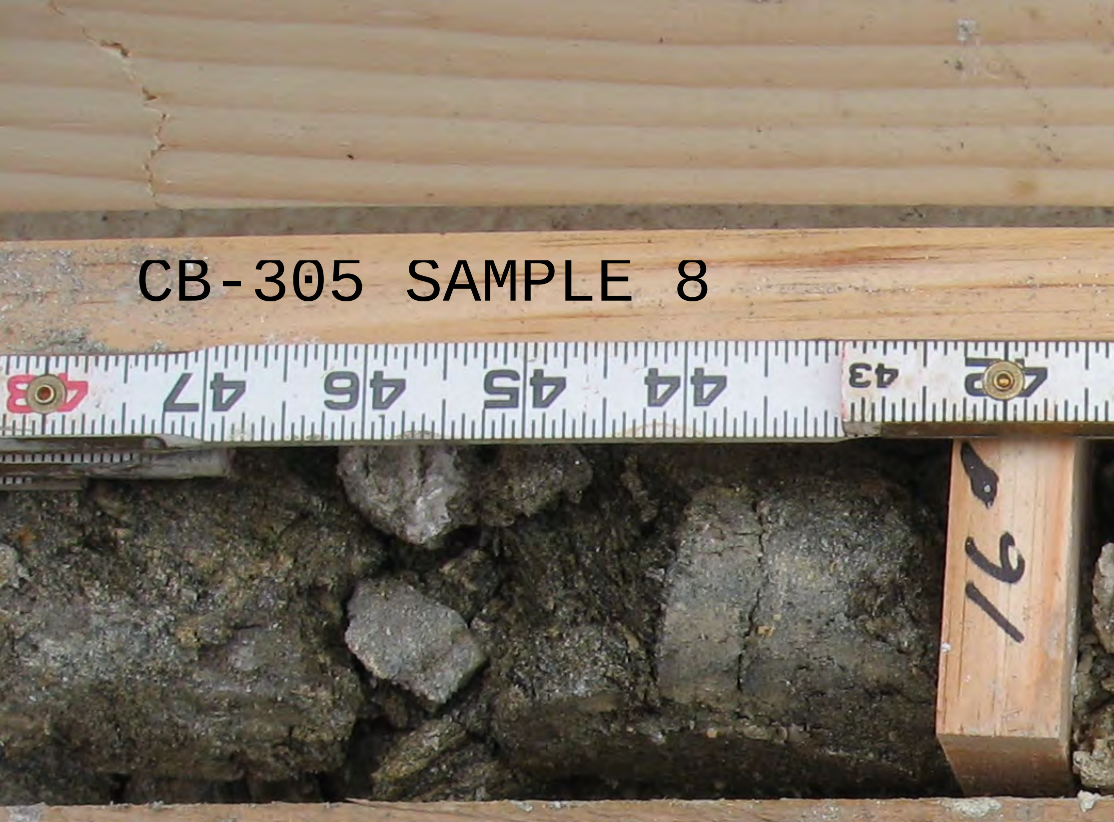

Use template for 5164™
PROJECT: DELAWARE RIVER CHANNEL
W912BU-10-D-0001
HOLE NO: CB-305
SAMPLE NO: 5
DEPTH OF SAMPLE: 8-10'
BLOW COUNTS: 15-28-48-50/3"


Use template for 5164™
CB-305 SAMPLE 5
DELAWARE RIVER CHANNEL
W912BU-10-D-0001
CB-305
5


CB-305 SAMPLE 7


PROJECT: DELAWARE RIVER CHANNEL
W912BU-10-D-0001
HOLE NO: CB-305
SAMPLE NO: 7
DEPTH OF SAMPLE: 12-14'
BLOW COUNTS: 7-9-15-18


TOP CB-305
CB-305 SAMPLE 8


CB-305 SAMPLE 8

CB-305 SAMPLE 9


CB-305 SAMPLE 9

CB-305 SAMPLE 10

CB-305 SAMPLE 10


CB-306 SAMPLE 1
PROJECT: DELAWARE RIVER CHANNEL
W1928U-10-D-0001
HOLE NO: CB-306
SAMPLE NO: 1
DEPTH OF SAMPLE: 0-2
BLOW COUNTS: 7-2-3-4
6/4/10
No. 636 Lufkin RUGGED RED END BRICK MASON'S RULE


CB-306 SAMPLE 1
PROJECT: DELAWARE RIVER CHANNEL
W1928U-10-D-0001
HOLE NO: CB-306
SAMPLE NO: 1
DEPTH OF SAMPLE: 0-2
BLOW COUNTS: 7-2-3-4
6/4/10


CB-306 SAMPLE 2
PROJECT: DELAWARE RIVER CHANNEL
W912BU-10-D-0001
HOLE NO: CB-306


CB-306 SAMPLE 2
PROJECT: DELAWARE RIVER CHANNEL
W912BU-10-D-0001
HOLE NO: CB-306


CB-306 SAMPLE 3
PROJECT: DELAWARE RIVER CHANNEL
W912BU-10-D-0001
HOLE NO: CB-306
SAMPLE NO: 3
DEPTH OF SAMPLE: 4-6
BLOW COUNTS: 9-12-18-40
6/4/10

CB-306 RUN 2

CB-306 RUN 3


CB-306 RUN 1
CB-306 RUN 2
CB-306 RUN 2
CB-306 RUN 3


CB-306 RUN 2
CB-306 RUN 2
CB-306 RUN 3
CB-306 14.5'
CB-306 RUN 3


CB-306 RUN 2
CB-306 12'
CB-306 RUN 3
CB-306 16'3"
CB-306 19.5'
CB-306 RUN 3
CB-306 RUN 4


CB-306 RUN 2
CB-306 12'
CB-306 RUN 3
CB-306 16'3"
20.5
CB-306 RUN 4
CB-306 END

CB-307 RUN 1

CB-307 RUN 1
13' CB-307
CB-307 RUN 2


CB-307 RUN 2

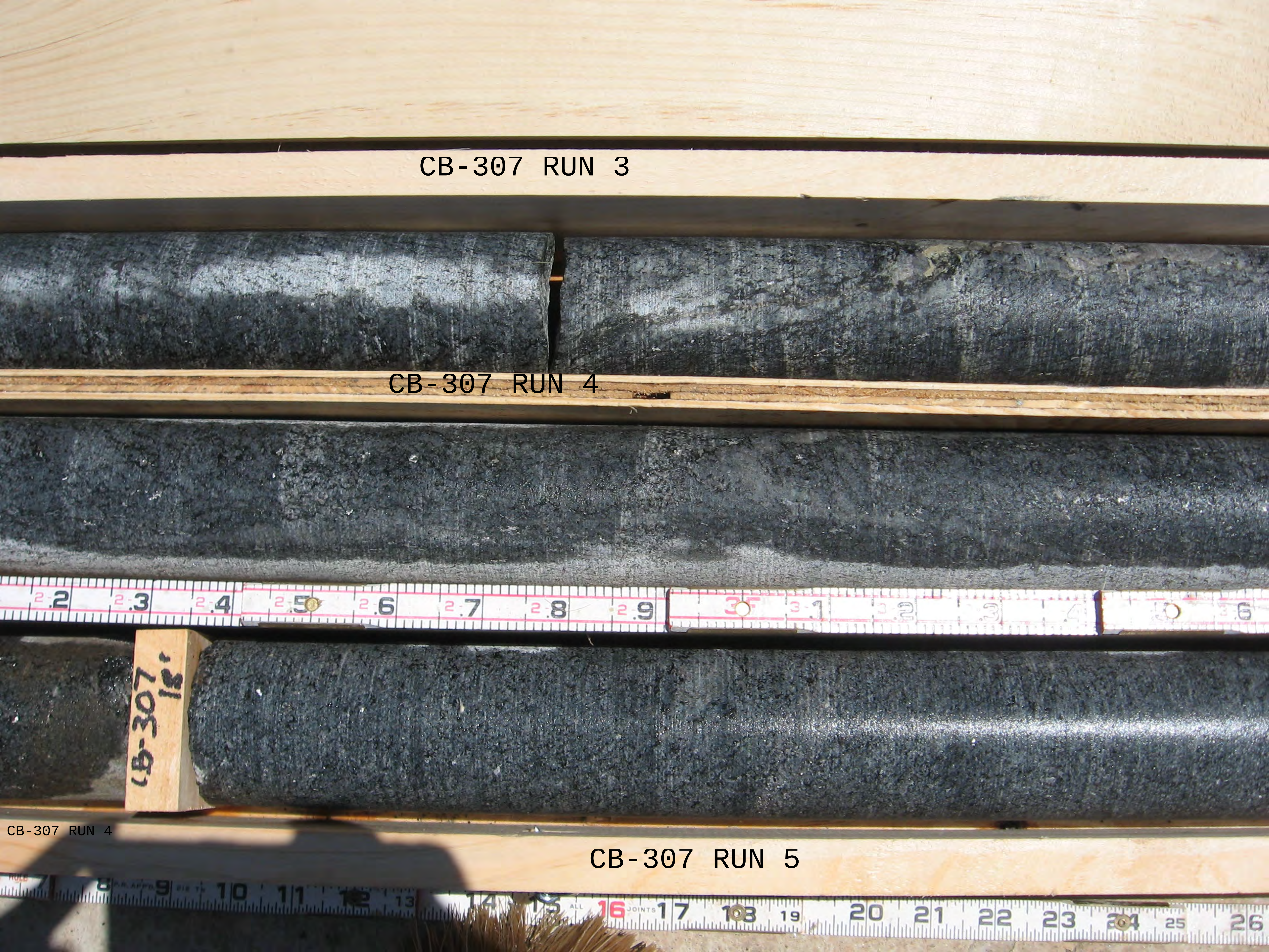
CB-307 RUN 2


CB-307 RUN 2

CB-307 RUN 2


TOP CB-307
CB-307 RUN 2
CB-307 RUN 3
6'11"
CB-307 8'
CB-307 RUN 3
CB-307 RUN 4


CB-307 RUN 3
CB-307 8'
CB-307 RUN 3
CB-307 RUN 4
CB-307 13'
CB-307 18'
CB-307 RUN 4
CB-307 RUN 5



CB-307 RUN 3
CB-307 RUN 4
CB-307 18'
CB-307 RUN 4
CB-307 RUN 5


CB-307 RUN 3
CB-307 RUN 4
CB-307 RUN 5
CB-307

CB-308 SAMPLE 1

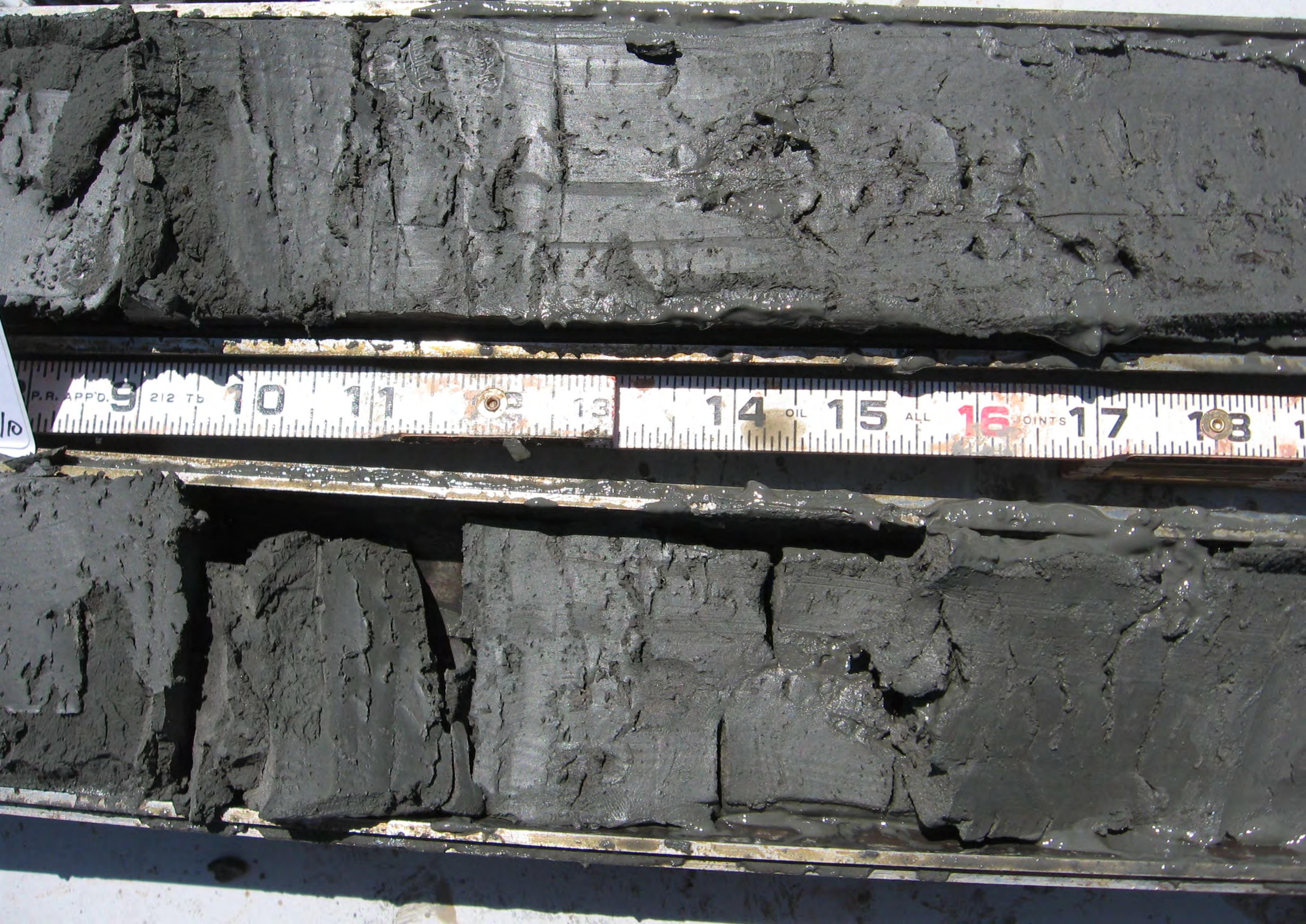
CB-308 SAMPLE 2


DRPD T-MH
CB-308
2A
2-4' 2A is 2-3.33'
2-2-21
5/13/10
CB-308 SAMPLE 2


DRDP T-MH
CB-308
3
4-6'
1-1-1-1
5/13/10
CB-308 SAMPLE 3


CB-308 SAMPLE 4
DRDP T-MH
CB-308
4
6-8'
WH-WH-WA-WH
5/13/10
RIDGID
HEAVY DUTY
18"
05/13/2010

CB-308 SAMPLE 5




DRDP T-MH
CB-308
5
8-10'
2-1-2-1
5/13/10
CB-308 SAMPLE 5
Lufkin
RUGGED
BRICK

CB-308 SAMPLE 6


DRDP T-MH
CB-308
6
10-12'
WH-WH-WH-WH
5/13/10
CB-308 SAMPLE 6
No. 838
Lufkin
RUGGED
RED END
BRICK
MASON'S
RULE
R.R. APP'D.
1 2 3 4 5 6 7 8 9 10


DRDP T-MH
CB-308
14A (14A is 12-12.9)
12-14'
2-17-50/2"
5/13/10
DRDF T-MH
14B
12-14'
2-17-50/2"
5/13/10
CB-308 SAMPLE 7 05/13/2010


DRDP T-MH
CB-308
8
14-16
10-27-34-45
5/13/10
CB-308 SAMPLE 8
Lufkin
RED END
BRICK
MASON'S
RULE
P.R. APP'D.


308
16 - 18'
CB-308 SAMPLE 9


DRDP T-MH
CB-308
10
18-20'
10-12-11-14
5/13/10
CB-308 SAMPLE 10
Lufkin
RUGGED
RED END
BRICK
MASON'S
RULE
2 3 4 5 6 7