The Geo-Institute

of the American Society of Civil Engineers

Presents

The Competition Rules for the 14th *Annual* National

GeoPREDICTION at

2023 Geo-Congress - Los Angeles, CA

Important Dates

GeoPrediction Reports Due……..…….January 20, 2023 6:00PM EST

Invitation to GeoPrediction Finale……..…. February 10, 2023

2023 Geo-Congress……..…….……March 26 – 29, 2023

Geo-Congress 2023 Information…….……https://www.geocongress.org/

GeoPrediction Presentations……..……..March 27, 2023

14th Annual National GeoPrediction Rules – 2023 Geo-Congress

1. Objective: The objective of the GeoPrediction competition is to develop an accurate prediction of geotechnical behavior given information regarding subsurface, boundary, and initial conditions, as well as the geotechnical/ structural/hydraulic loading. The GeoPrediction competition may involve using available geotechnical software, empirical correlations, or developing a simple but accurate computer code for making this prediction.

For the 2023 GeoPrediction, the competing teams will develop the estimated movement of a slope failure.

2. Geotech data: Input data for the problem including problem description, boring logs, and test data are found on the following sheets.

3. Eligibility: A GeoPrediction team will consist of one or two students. Each team MUST include at least one undergraduate student. Graduate students can not submit a prediction without mentoring an undergraduate student. However, a team may consist of one or two undergraduate students. Students must be enrolled during the Spring 2023 Semester or Quarter. Up to two teams per school may compete.

4. Submittal: Each GeoPrediction team will submit a GeoPrediction Report that will, at a minimum, contain the following information.

a. The Report shall be no more than three (3) pages long (not including any references and title page). One inch margins, single spacing, and 12 point Time New Roman font are required.
b. Include the provided Table 1 (completed) in your report.
c. The Report shall contain the methods (assumptions, correlations, analytical procedures, numerical procedures, computers software, etc.) that the team employed to develop the GeoPrediction. Methods must be referenced properly.
d. The cover page must include the name of the institution; names, email addresses, and status (i.e., graduate or undergraduate) of each team member; as well as the name and contact information of the faculty that advised the team in developing their prediction.
e. Submit your report electronically in PDF format to Dr. Matthew Sleep (sleepmw@uc.edu) by 6pm Eastern Standard Time on January 20, 2023 with the subject line "2023 Geo-Congress GeoPrediction Submittal – *School Name*". Sender will receive confirmation of receipt by email. Late submissions are not accepted. If you do not receive a confirmation email within 24 hours of submission, please re-send the information.

5. Judging: The submitted GeoPrediciton reports will be judged and ranked by an anonymous panel of geotechnical faculty and engineers. Initial judging will be based on criterial (a) through (d) below.

a.	Format, length, grammar, English usage	15%
b.	Clarity of technical presentation	15%
c.	Logical and concise use of appropriate geotechnical methods and principles	20%
d.	Accuracy of GeoPrediction	20%
e.	Presentation at the 2020 Geo-Congress	30%

6. Selection: The winning team will receive the prestigious Mohr's Circle Award. Up to fifteen (15) teams may be invited to the GeoPrediction Presentation based on the ranking of their GeoPrediction reports. The selected teams will be notified by **February 10, 2023**. The top teams (based total score of items a-d listed in section #5) will receive partial reimbursement for student registration (amount to be determined) for up to two team members. After judging of presentations at Geo-Congress 2023, top ranked teams will also receive partial travel stipends.

7. Presentations: Teams invited to present their GeoPrediction Results will prepare a 10-minute (maximum) presentation that describes their methods and GeoPrediction for viewing by judges and the public. The order and location of the presentations will be determined at the conference site. It is expected that a room with a projector and computer will be used for these presentations.
As noted in Item 5, the Presentation will constitute the final 30% of each invited team's final GeoPrediction score.

8. Questions: Questions should be emailed to Matthew Sleep (sleepmw@uc.edu).
It is anticipated that these questions will be uploaded for all to review at the GeoWorld Website (TBD)

Project Description

Sustained movement has been observed along a large slope near a small river.

The area of observed movement has been separated into Area A(west) and Area B(east). This location is significant because in addition to general infrastructure, a 60" diameter water main is in the slope. Movement has generated large strains in the pipe causing concern and the need for remediation. Surface representations of the slope movement are shown below.

Provided for your analysis is information from Area A. An overview is presented showing the locations of borings, piezometers, strain gages connected to the water main pipe, and surface movement monitors. Cross sections are also provided for your reference.

Monitoring of stress in the water main began in February 2017. It is assumed that the modulus of elasticity for the pipe is 10,000,000 psi for stress calculations. Strain was measured at 3 locations on the pipe as shown in the figure.

Ground surface movement monitor 167 is located in Area A. This monument's baseline 'zero' was recorded on 3/31/2017. **A total lateral movement of 3.21" in the downslope direction** has occurred at this location from the baseline monitoring point until 7/13/2017. This movement occurred with regional rainfall shown in Figure 2.

Your prediction is to take the information from Area A, and the limited information presented from Area B, and determine total lateral movement of 2 different ground surface movement monitors, 132 and 141. Determine the cumulative lateral movement of the ground surface from 4/17/2017 to 6/26/2017. Monitor 132 had baseline 'zero' measurements taken on 2/17/2017 (installation date). Monitor 141 had baseline 'zero' measurements taken on 3/31/2017 (installation date). This information should be presented as a completed Table 1 (below) in your report.

Table 1 – Complete this table as your prediction and include in your report

Monitoring Point	Lateral Ground Surface Movement from 4/17/2017 to 6/26/2017 (inches)
132	
141	

Figure 1 – Surface expression of movement

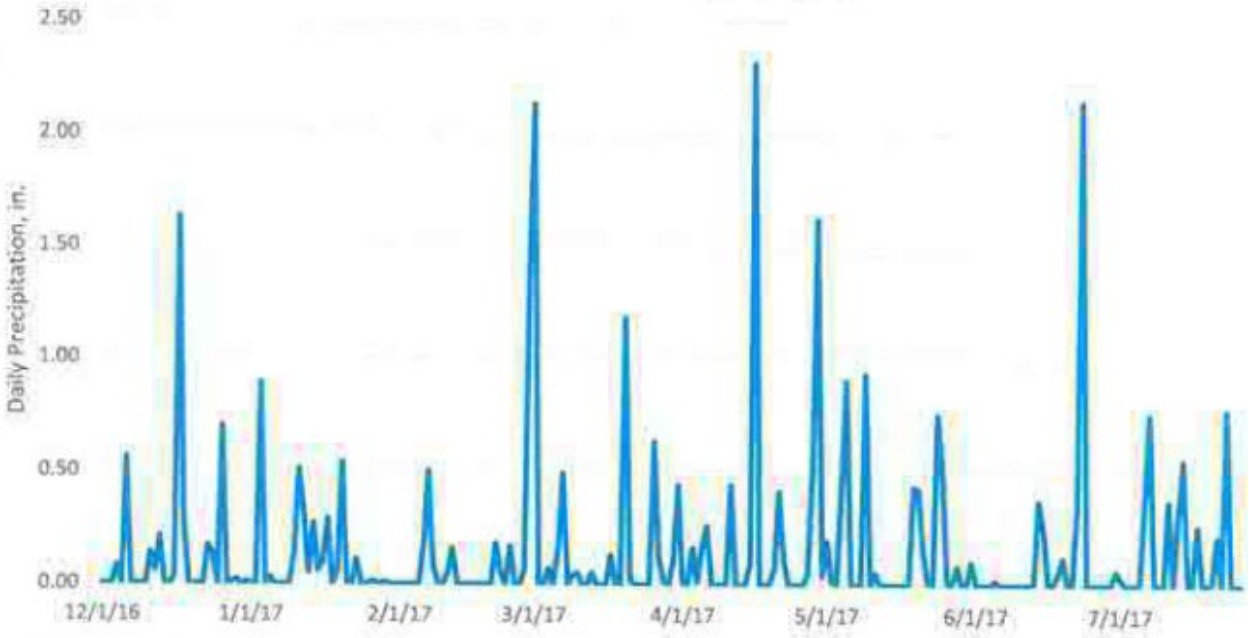
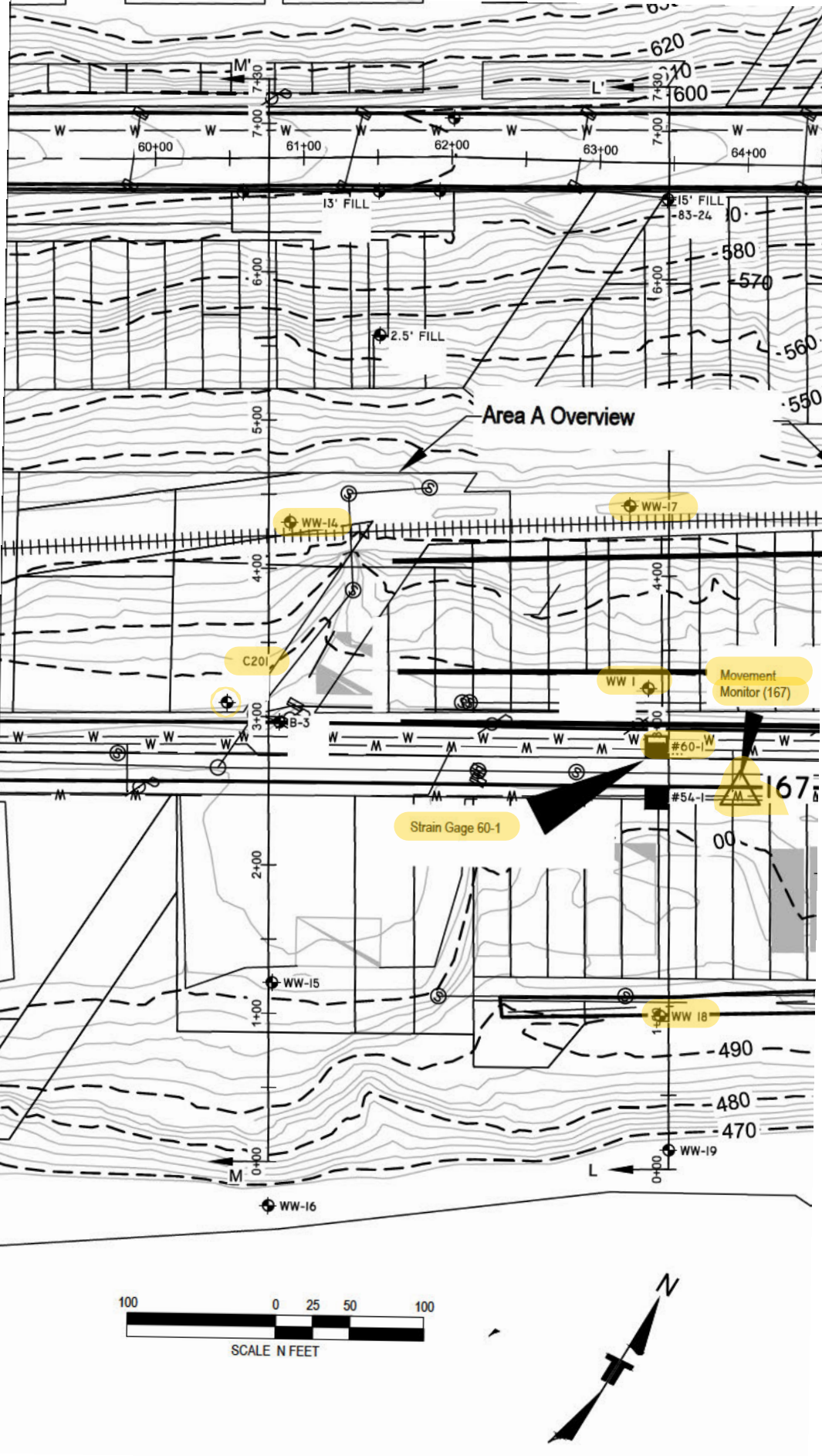
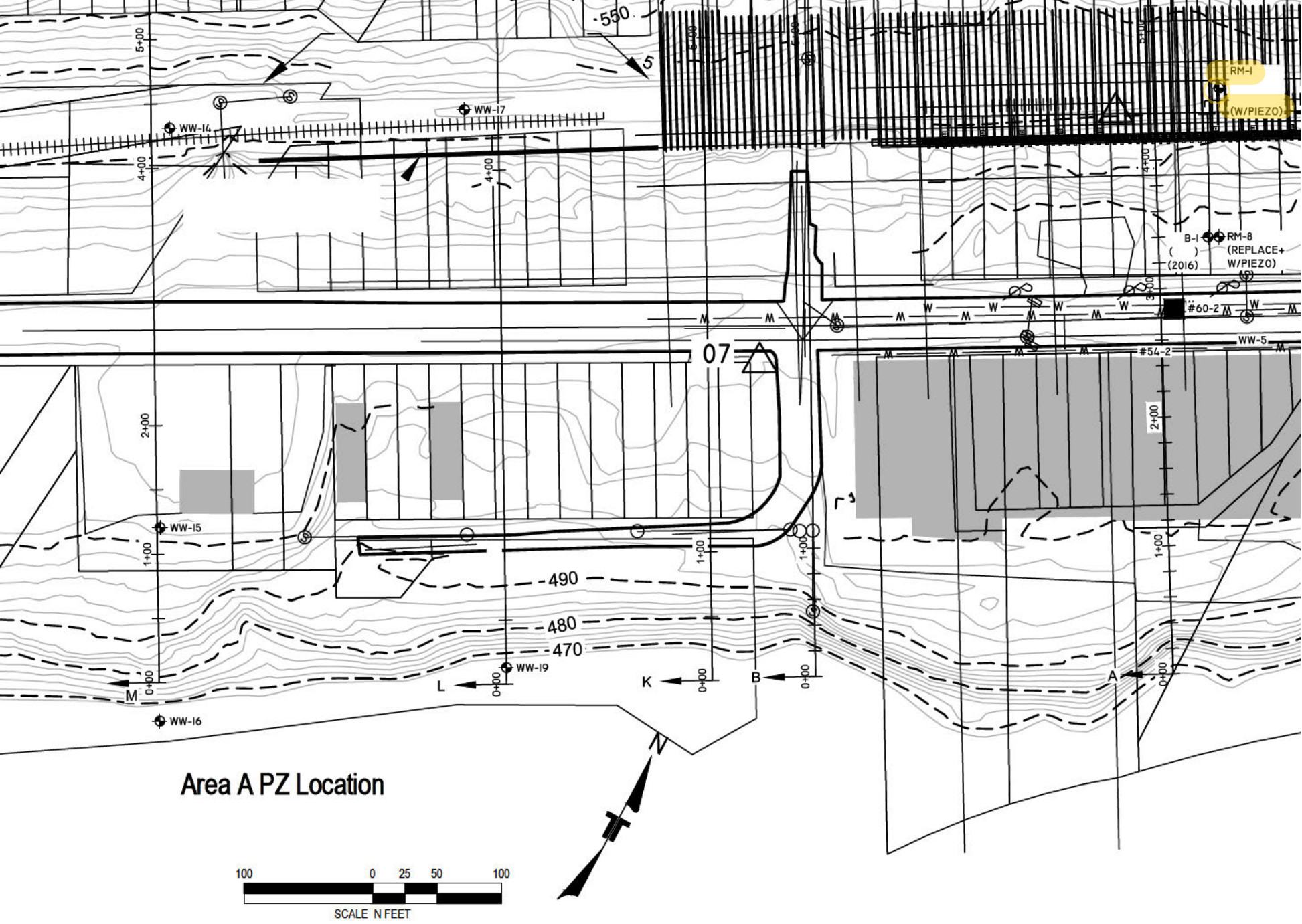


Figure 2 – Regional daily rainfall

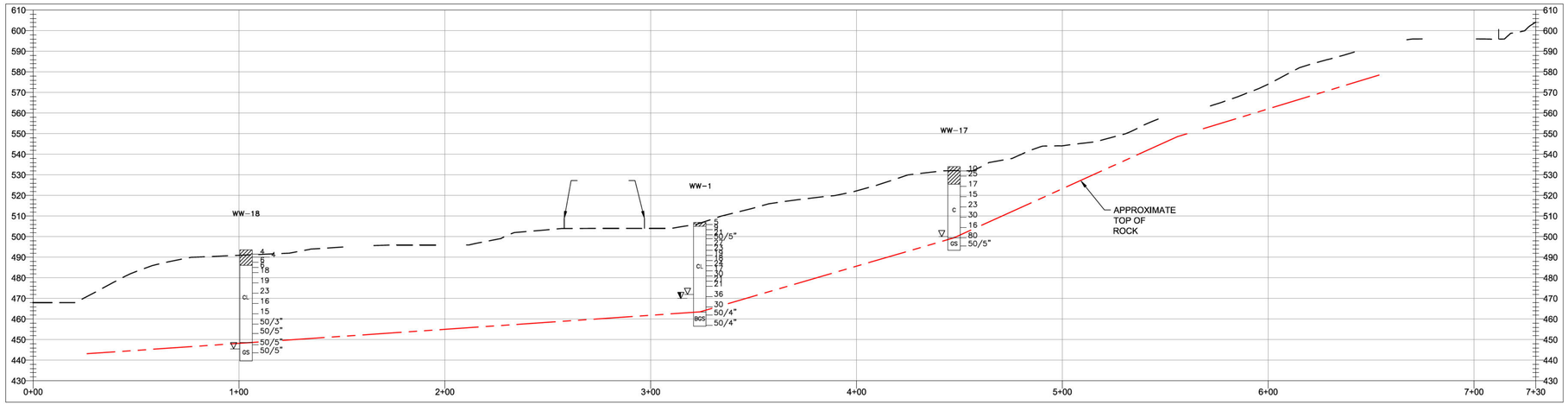
Area A Information


Area A Overview
Strain Gage 60-1
Movement Monitor (167)
WW-14
WW-17
WW-15
WW-16
WW-19
WW 18
WW 1
C20
B-3
#60-1
#54-1
M'
L'
M
L
13' FILL
15' FILL
2.5' FILL
83-24
60+00
61+00
62+00
63+00
64+00
620
610
600
580
570
560
550
490
480
470
SCALE N FEET
100
0
25
50
100
N



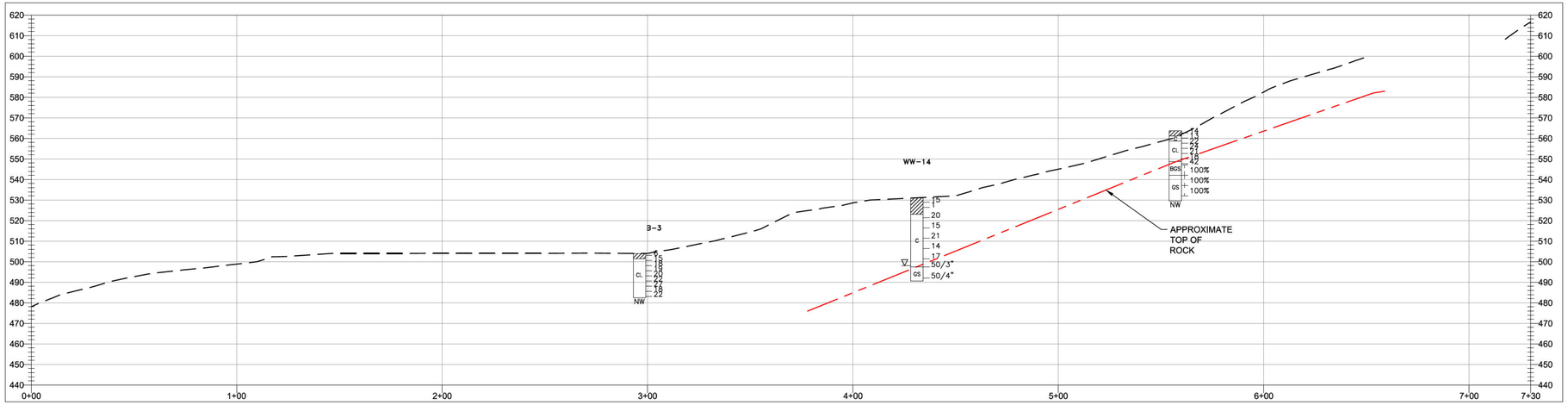
Area A PZ Location

Area A Cross Sections



CROSS-SECTION L-L'

SCALE: 1"=30' H
1"=30' V



CROSS-SECTION M-M'

SCALE: 1"=30' H
1"=30' V

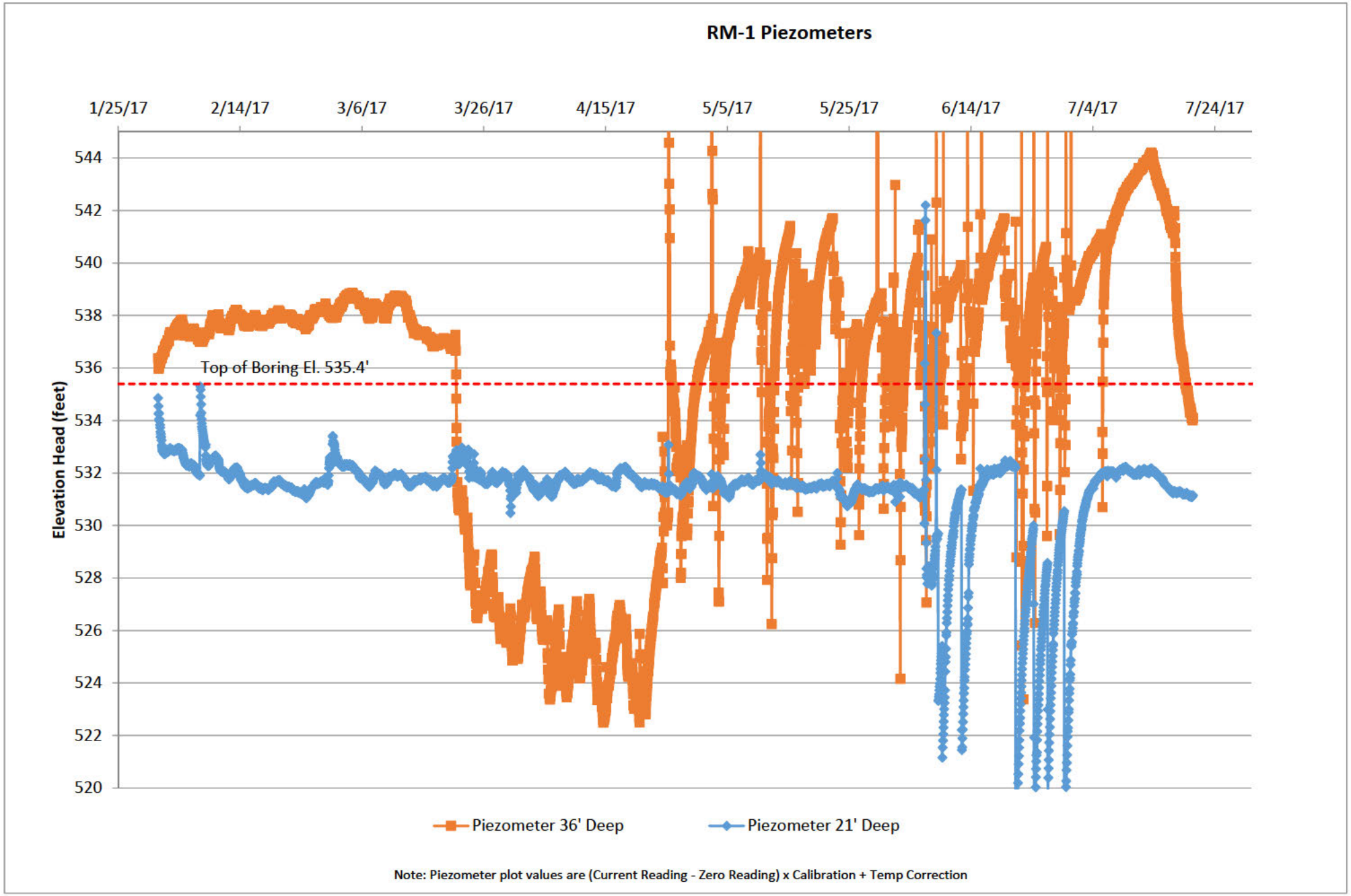
LEGEND

- EXISTING FILL
- C COLLUVIUM
- CL LEAN CLAY
- SA SAND
- ML SANDY SILT
- BS BROWN SHALE
- BGS BROWN AND GRAY SHALE
- GS GRAY SHALE
- IMMEDIATE WATER LEVEL
- WATER LEVEL UPON COMPLETION OF DRILLING
- FINAL (24 HR.) WATER LEVEL
- 22 NATURAL MOISTURE CONTENT (%)
- 15 STANDARD PENETRATION TEST RESULT "N-VALUE" (BLOWS/FT)
- (33/21) ATTERBERG LIMITS (LIQUID LIMITS/PLASTICITY INDEX)
- [4.5] POCKET PENETROMETER READING (TSF)
- LOI=2.8 LOSS-ON-IGNITION (%)
- Qu=2.87 UNCONFINED COMPRESSIVE STRENGTH (TSF)
- BAG SAMPLE
- SHELBY TUBE
- 100% ROCK CORE (PERCENT RECOVERED)
- NW NO WATER ENCOUNTERED DURING OR UPON COMPLETION OF DRILLING
- R REFUSAL TO DRILLING

NOTE:
THE TOP OF ROCK LINE SHOWN ON THESE CROSS SECTIONS IS APPROXIMATE AND IS BASED ON THE RESULTS OF THE TEST BORINGS THAT ARE SHOWN.

REV.	DATE	BY	DESCRIPTION

30 0 7.5 15 30
SCALE IN FEET

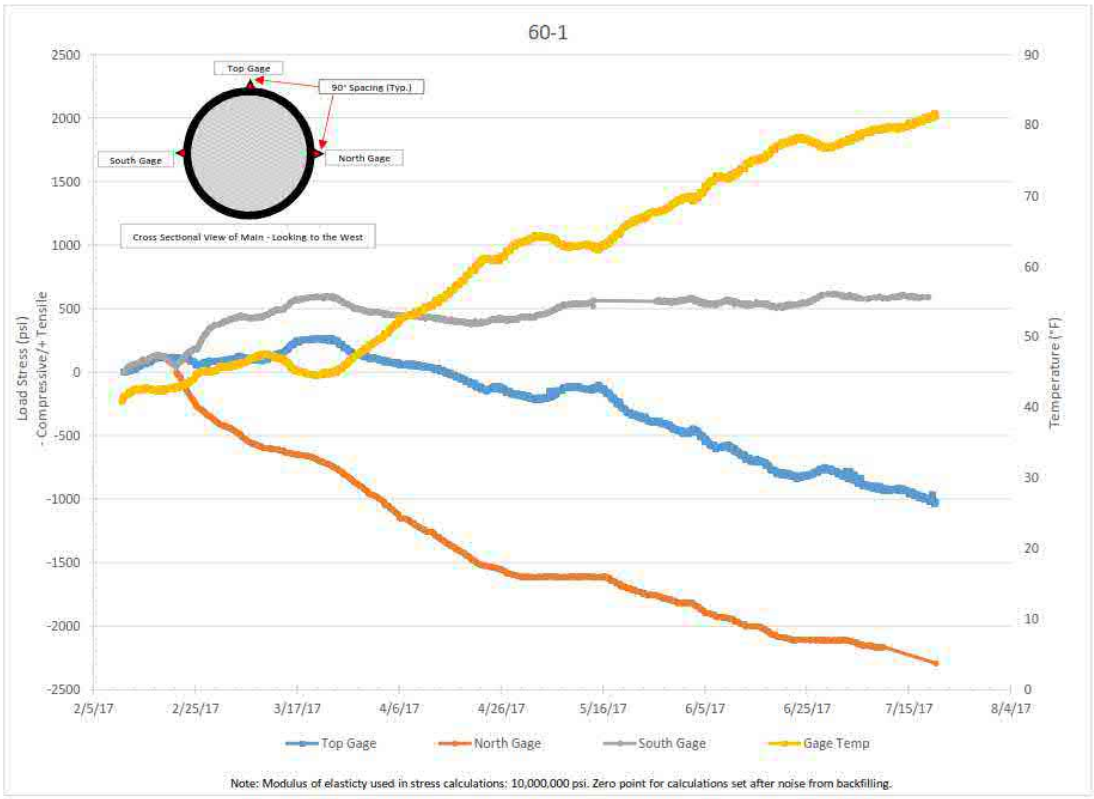

RM-1 Piezometers
1/25/17
2/14/17
3/6/17
3/26/17
4/15/17
5/5/17
5/25/17
6/14/17
7/4/17
7/24/17
544
542
540
538
536
534
532
530
528
526
524
522
520
Elevation Head (feet)
Top of Boring El. 535.4'
Piezometer 36' Deep
Piezometer 21' Deep
Note: Piezometer plot values are (Current Reading - Zero Reading) x Calibration + Temp Correction

Movement Monitor 167 Information

Point	Date	Total North	North Increment	Total East	East Increment	Total Movement (ft)	Total Movement (inches)	Total increment (inches)

							Total Movement in Downslope Direction (in)	
167	3/31/2017							
	4/14/2017	0.022	0.022	0.015	0.015	0.03	**0.32**	0.32
	4/28/2017	0.022	0	-0.008	-0.023	0.02	**0.28**	-0.04
	5/15/2017	-0.067	-0.089	0.011	0.019	0.07	**0.81**	0.53
	5/27/2017	-0.21	-0.143	0.087	0.076	0.23	**2.73**	1.91
	6/23/2017	-0.247	-0.037	0.135	0.048	0.28	**3.38**	0.65
	7/13/2017	-0.247	0	0.103	-0.032	0.27	**3.21**	-0.17

Strain Gage on 60" water main



BORING LOG NO. WW-1

SITE:

Surface Elev.: 509.6 (Ft.)

DEPTH	ELEVATION (Ft.)		DEPTH (Ft.)	WATER LEVEL OBSERVATIONS	SAMPLE TYPE	RECOVERY (%)	FIELD TEST RESULTS	LABORATORY HP (tsf)	WATER CONTENT (%)	ATTERBERG LIMITS LL-PL-PI
2 0	507.5	**FILL - LEAN CLAY (CL)**, dark brown, medium stiff			X	100	1-2-3 N=5		38.8	
		LEAN CLAY (CL), with trace limestone fragments and gravel, brown and gray mottled, stiff to very stiff, (Colluvium)			X	100	4-4-5 N=9	2.75 (HP)	28.4	
			5		X	100	6-7-14 N=21	2.75 (HP)	28.3	
					X	100	5-50/5"	3.0 (HP)	15.7	
			10		X	100	11-12-15 N=27	4.5 (HP)	13.9	
					X	100	7-9-14 N=23	4.5 (HP)	15.7	
			15		X	100	5-7-12 N=19	4.25 (HP)	20.6	
					X	100	5-7-11 N=18	4.0 (HP)	19.5	
			20		X	100	11-10-14 N=24	2.5 (HP)	17.8	
					X	11	7-7-10 N=17		8.8	
			25		X	100	11-13-17 N=30	4.5 (HP)	18.7	
					X	100	6-7-14 N=21	4.5 (HP)	19.5	
			30		X	100	7-9-12 N=21	3.5 (HP)	19.3	
				▽						
			35	▽	X	100	8-16-20 N=36	3.75 (HP)	19.4	
			40		X	100	13-15-15 N=30		13.6	
43.5	466									
		SHALE, with limestone fragments, gray, "soft rock"	45			100	50/4"	4.0 (HP)	11.9	
50.4	459		50			100	50/4"	4.5 (HP)	11.2	
		Boring Terminated at 50.4 Feet								

Stratifica ion lines are approximate. In-situ, he transition may be gradual.

Hammer Type: Automatic

Advancement Method:
Hollow Stem Auger

Abandonment Method:
Boring backfilled with soil cut ings upon completion.

Notes:

WATER LEVEL OBSERVATIONS

▽ *Water observed @ 35' upon drilling*

▽ *Water observed @ 37' upon completion of drilling*

BORING LOG NO. WW-14

GRAPHIC LOG		Surface Elev 531 (Ft) ELEVATION (Ft)	DEPTH (Ft)	WATER LEVEL OBSERVATIONS	SAMPLE TYPE	RECOVERY (%)	FIELD TEST RESULTS	LABORATORY TORVANE/HP (tsf)	WATER CONTENT (%)	ATTERBERG LIMITS LL-PL-P
	1.0	**FILL - RAILROAD BALLAST** 530								
		FILL - SAND and gravel, trace silt, clay, and cinders, black			X	72	3 6 9 N=15			
					X	0	1 0 1 N=1			
	8.0	523	5							
		LEAN CLAY (CL), trace rock fragments, olive brown and bush gray, (COLLUVIUM)			X	100	4 6 14 N=20	4.0 (HP)		
			10							
					X	100	4 7 8 N=15	4.0 (HP)		
			15							
					X	100	5 10 11 N=21	3.5 (HP)		
			20							
					X	100	8 7 7 N=14			
			25							
					X	100	5 7 10 N=17			
			30	▽						
	33.5	497.5								
		SHALE, gray, very weak, with limestone fragments			X	100	50/3"			
			35							
					X	100	31 50/4"			
	40.5	490.5	40							
		Boring Terminated at 40.5 Feet								

Stratification lines are approximate in-situ the transition may be gradual

Hammer Type Automatic

Advancement Method
3.25 Hollow Stem Auger

Abandonment Method
Inclinometer grouted in borehole

WATER LEVEL OBSERVATIONS

▽ *Water observed @ 33' during drilling*

BORING LOG NO. WW-17

SITE:

Surface Elev 534 0 (Ft)

ELEVAT ON (Ft)

GRAPH C LOG		DEPTH (Ft)	WATER LEVEL OBSERVAT ONS	SAMPLE TYPE	RECOVERY (%)	F ELD TEST RESULTS	LABORATORY TORVANE/HP (tsf)	WATER CONTENT (%)	A ERBERG L M S LL-PL-P
	1 0 **FILL - RAILROAD BALLAST** 533								
	FILL - SAND AND GRAVEL, w th c ay, brown and b ack			X	72	4 4 6 N=10			
	3 5 530 5								
	FILL - CLAYEY SAND, b u sh gray, w th wood fragments	5		X	100	17 16 9 N=25			
	8 5 525 5								
	LEAN CLAY (CL), trace rock fragments, o ve brown and b u sh gray, (COLLUVIUM)	10		X	100	4 5 12 N=17	2.0 (HP)		
		15		X	72	5 5 10 N=15	3.0 (HP)		
		20		X	100	6 11 12 N=23	2.5 (HP)		
		25		X	100	4 10 20 N=30	2.5 (HP)		
		30		X	100	7 7 9 N=16	1.5 (HP)		
	34 5 499 5		▽						
	SHALE, gray, very weak, w th mestone fragments	35		X	100	22 30 50 N=80			
				X	100	50/5"			
	40 5 493 5	40							
	Boring Terminated at 42 Feet								

Stratification lines are approximate n-situ the transition may be gradual

Hammer Type Automatic

Advancement Method
3 25 Hollow Stem Auger

Abandonment Method
nclinometer grouted in borehole

Notes
nclinometer set at 42 feet

WATER LEVEL OBSERVATIONS

▽ *Water observed @ 34' during drilling*

BORING LOG NO. WW-18

GRAPHIC LOG		Surface Elev 493.6 (Ft.) ELEVATION (Ft.)	DEPTH (Ft.)	WATER LEVEL OBSERVATIONS	SAMPLE TYPE	RECOVERY (%)	FIELD TEST RESULTS	LABORATORY TORVANE/HP (tsf)	WATER CONTENT (%)	ATTERBERG LIMITS LL-PL-P
	1.0	**ASPHALT** 492.5								
		FILL - LEAN CLAY (CL), with sand, trace rock fragments, trace organics, dark brown to black			X	72	2 2 2 N=4			
					X	53	2 2 2 N=4	1.0 (HP)		
			5		X	53	2 1 5 N=6	1.25 (HP)		
	7.5	486			X	72	2 3 3 N=6	1.0 (HP)		
		LEAN CLAY (CL), with silt, tannish brown with orange ish brown mottles	10		X	100	5 6 12 N=18	4.5 (HP)		
			15		X	11	7 9 10 N=19			
	20.0	473.5								
		LEAN CLAY (CL), with silt, trace rock fragments, gray and olive brown	20		X	100	9 11 12 N=23	4.0 (HP)		
			25		X	0	7 7 9 N=16			
			30		X	78	6 7 8 N=15	2.5 (HP)		
	35.0	458.5								
		LEAN CLAY (CL), with silt and rock fragments, bush gray	35		X	93	9 12 50/3"	2.5 (HP)		
			40		X	72	10 50/5"	3.5 (HP)		
	45.0	448.5								
		SHALE, gray, very weak, with limestone fragments	45	▽	X	0	9 14 50/5"			
			50		X	100	50/5"			
	54.0	439.5								
		Boring Terminated at 54 Feet								

Stratification lines are approximate. In-situ, the transition may be gradual.

Hammer Type: Automatic

Advancement Method
3.25 Hollow Stem Auger

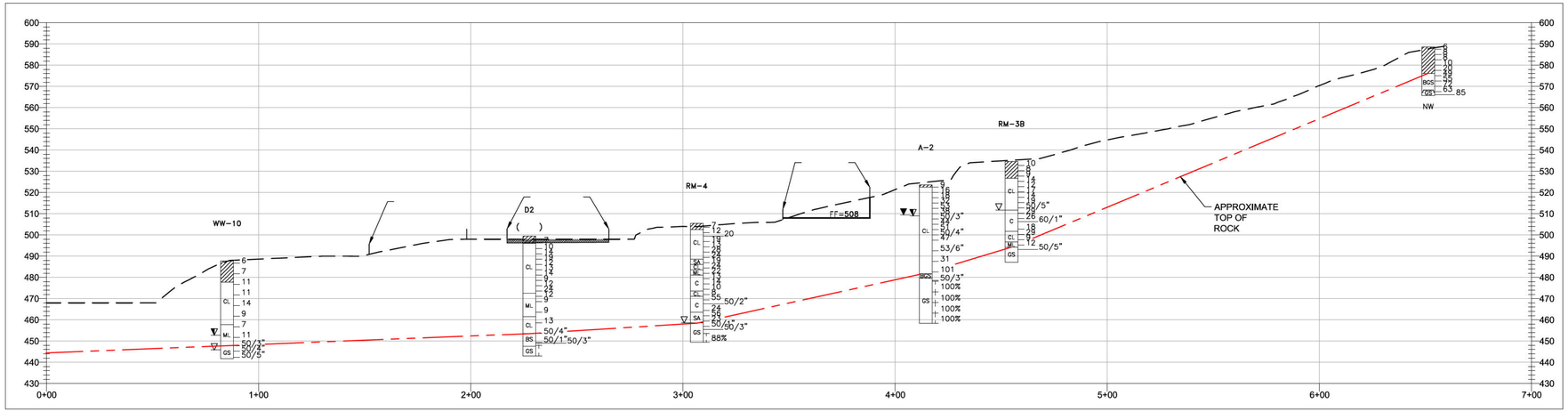
Abandonment Method
Inclinometer grouted in borehole

WATER LEVEL OBSERVATIONS

▽ *Water observed @ 48' during drilling*

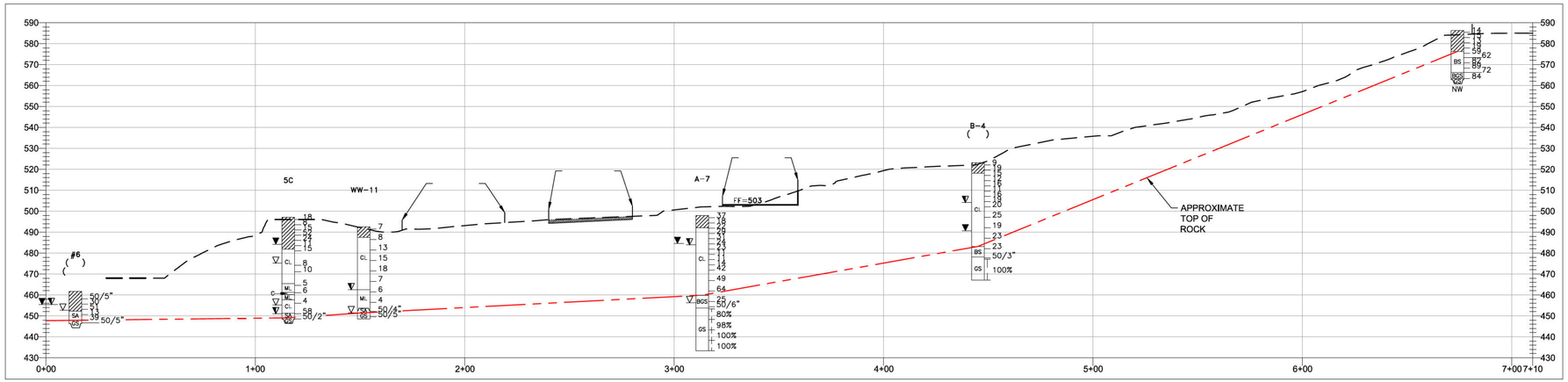
Area B Information

Area B Overview



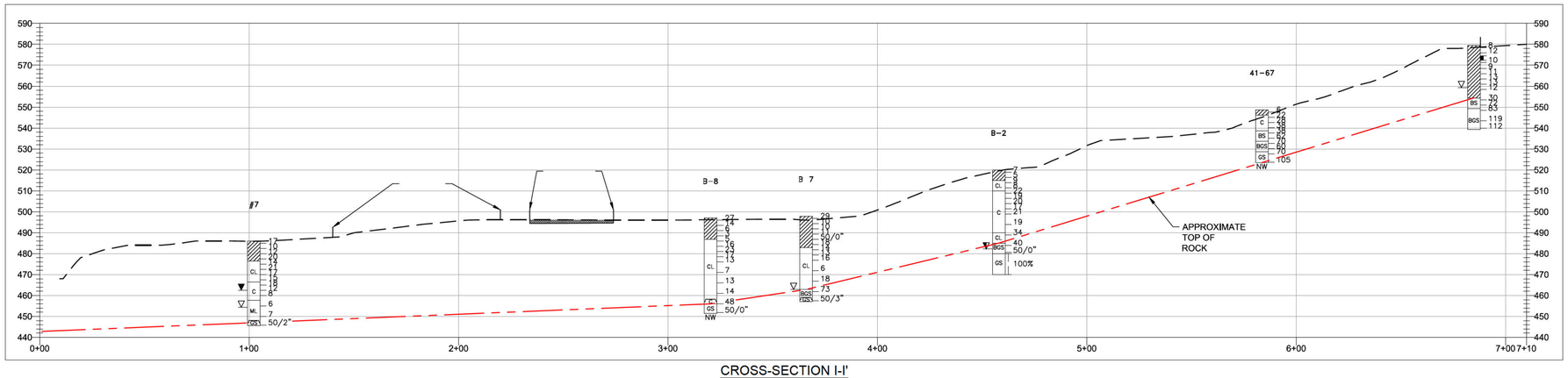
CROSS-SECTION G-G'

SCALE: 1"=30' H
1"=30' V



CROSS-SECTION H-H'

SCALE: 1"=30' H
1"=30' V



CROSS-SECTION I-I'

SCALE: 1"=30' H
1"=30' V

LEGEND

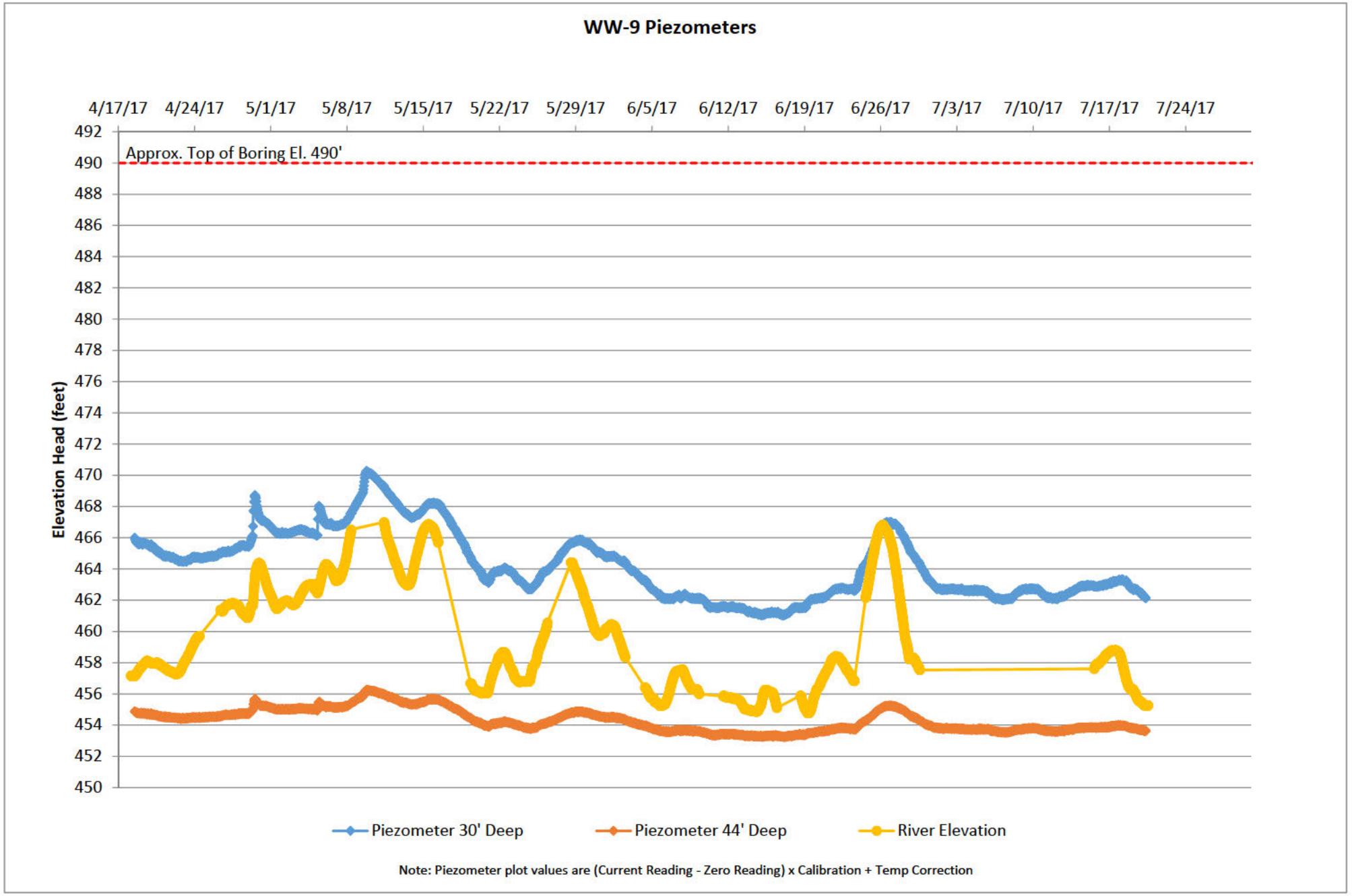
- EXISTING FILL
- C COLLUVIUM
- CL LEAN CLAY
- SA SAND
- ML SANDY SILT
- BS BROWN SHALE
- BGS BROWN AND GRAY SHALE
- GS GRAY SHALE
- IMMEDIATE WATER LEVEL
- WATER LEVEL UPON COMPLETION OF DRILLING
- FINAL (24 HR.) WATER LEVEL
- 22 NATURAL MOISTURE CONTENT (%)
- 15 STANDARD PENETRATION TEST RESULT "N-VALUE" (BLOWS/FT)
- (33/21) ATTERBERG LIMITS (LIQUID LIMITS/PLASTICITY INDEX)
- [4.5] POCKET PENETROMETER READING (TSF)
- LOI=2.8 LOSS-ON-IGNITION (%)
- Qu=2.87 UNCONFINED COMPRESSIVE STRENGTH (TSF)
- BAG SAMPLE
- SHELBY TUBE
- 100% ROCK CORE (PERCENT RECOVERED)
- NW NO WATER ENCOUNTERED DURING OR UPON COMPLETION OF DRILLING
- R REFUSAL TO DRILLING

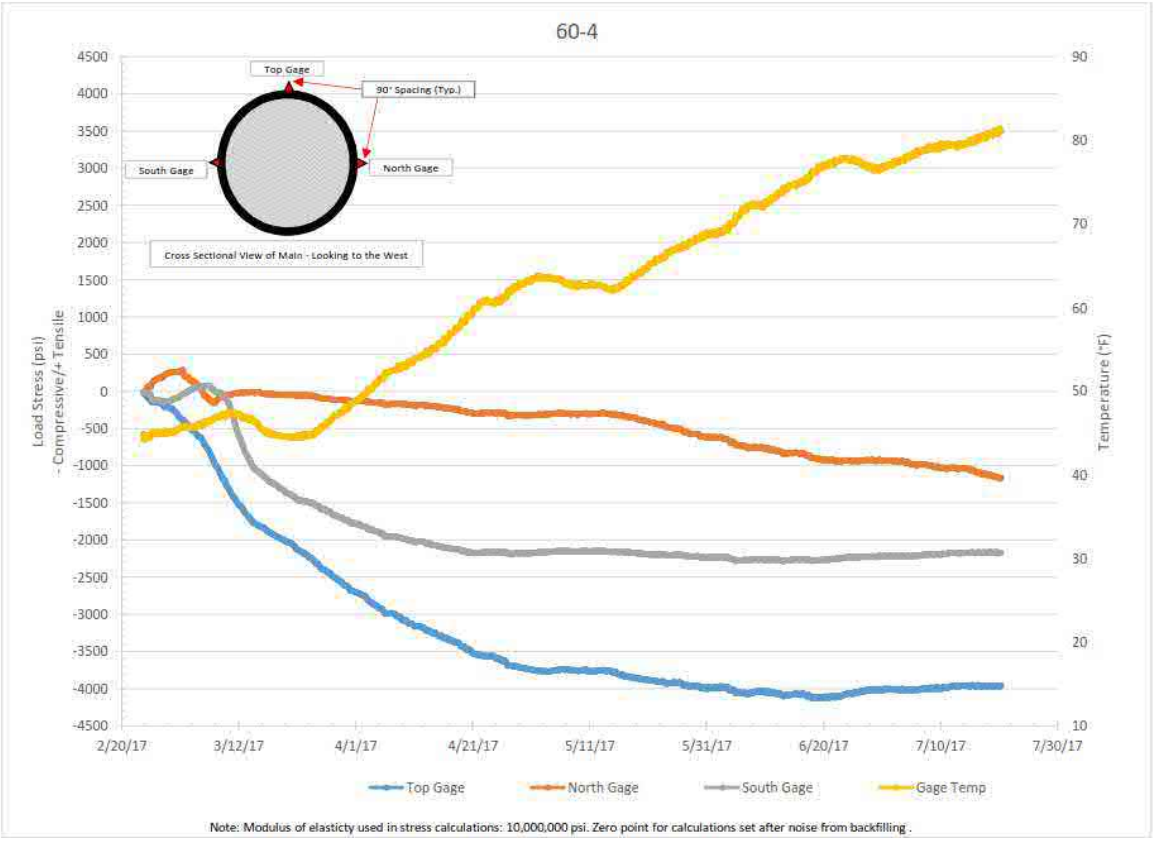
NOTE:
THE TOP OF ROCK LINE SHOWN ON THESE CROSS SECTIONS IS APPROXIMATE AND IS BASED ON THE RESULTS OF THE TEST BORINGS THAT ARE SHOWN.

REV.	DATE	BY	DESCRIPTION

CROSS-SECTIONS

30 0 7.5 15 30
SCALE IN FEET


WW-9 Piezometers
4/17/17
4/24/17
5/1/17
5/8/17
5/15/17
5/22/17
5/29/17
6/5/17
6/12/17
6/19/17
6/26/17
7/3/17
7/10/17
7/17/17
7/24/17
492
490
488
486
484
482
480
478
476
474
472
470
468
466
464
462
460
458
456
454
452
450
Approx. Top of Boring El. 490'
Elevation Head (feet)
Piezometer 30' Deep
Piezometer 44' Deep
River Elevation
Note: Piezometer plot values are (Current Reading - Zero Reading) x Calibration + Temp Correction



Note: Modulus of elasticty used in stress calculations: 10,000,000 psi. Zero point for calculations set after noise from backfilling .

BORING LOG NO. WW-10

GRAPHIC LOG	LOCATION / DEPTH	ELEVATION (Ft)	DEPTH (Ft)	WATER LEVEL OBSERVATIONS	SAMPLE TYPE	RECOVERY (%)	FIELD TEST RESULTS	LABORATORY TORVANE/HP (tsf)	WATER CONTENT (%)	ATTERBERG LIMITS LL-PL-PI
	Surface Elev 488 (Ft)									
	0.3 **TOPSOIL (3")**	488								
	FILL - LEAN CLAY (CL), trace sand, trace gravel, trace brick fragments, trace cinders, brown and gray					44	1 3 3 N=6	1.0 (HP)		
	5.0	483	5							
	FILL - LEAN CLAY (CL), trace gravel, trace cinders, brown and gray					44	3 3 4 N=7	1.75 (HP)		
	10.0	478	10							
	LEAN CLAY (CL), with silt, reddish brown, stiff to very stiff					100	4 5 6 N=11	2.25 (HP)		
			15			89	6 5 6 N=11	1.25 (HP)		
			20			100	3 6 8 N=14	1.25 (HP)		
			25			100	3 4 5 N=9	1.0 (HP)		
	30.0	458	30			100	2 3 4 N=7	0.75 (HP)		
	SILT (ML), trace sand, gray, medium stiff									
	35.0	453	35	▽		100	3 5 6 N=11	1.0 (HP)		
	LEAN CLAY (CL), with silt, gray, stiff									
	40.0	448	40			100	50/3"			
	SHALE, gray, very weak, with limestone fragments			▽		75	50/4"			
	45.9	442	45			63	27 50/5"			
	Boring Terminated at 45.9 Feet									

Stratification lines are approximate. In-situ, the transition may be gradual.

Hammer Type: Automatic

Advancement Method
4.25 Hollow Stem Auger

Abandonment Method
Inclinometer grouted in borehole and flush mount installed at surface

Notes
Inclinometer set at 45'

WATER LEVEL OBSERVATIONS

▽ *Water observed @ 42' during drilling*

▽ *Water observed @ 35' upon completion of drilling*

BORING LOG NO. WW-11

GRAPHIC LOG	LOCATION / DEPTH / ELEVATION (Ft)	DEPTH (Ft)	WATER LEVEL OBSERVATIONS	SAMPLE TYPE	RECOVERY (%)	FIELD TEST RESULTS	LABORATORY TORVANE/HP (tsf)	WATER CONTENT (%)	ATTERBERG LIMITS LL-PL-P
	Surface Elev 490 (Ft)								
	0.3 **TOPSOIL (3")** 490								
	FILL - LEAN CLAY (CL), with cinders, brown and gray								
	5.0 485								
	LEAN CLAY (CL), with silt, reddish brown, medium stiff to very stiff	5			67	2 3 5 N=8	2.5 (HP)		
		10			78	5 6 7 N=13	3.0 (HP)		
		15			100	6 7 8 N=15	2.25 (HP)		
		20			100	4 8 10 N=18	1.25 (HP)		
		25			89	0 3 4 N=7	0.5 (HP)		
	30.0 460								
	SILT (ML), gray, soft	30	▽		89	0 3 3 N=6	0.25 (HP)		
		35			100	2 2 2 N=4	0.5 (HP)		
	40.0 450								
	LEAN CLAY (CL), with limestone fragments, bush gray	40	▽		80	39 50/4"			
	44.0 446				80	50/5"			
	Boring Terminated at 44 Feet								

Stratification lines are approximate in-situ the transition may be gradual

Hammer Type Automatic

Advancement Method
4.25 Hollow Stem Auger

Abandonment Method
inclinometer grouted in borehole and flush mount installed at surface

Notes
inclinometer set at 44'

WATER LEVEL OBSERVATIONS

▽ *Water observed @ 41' during drilling*

▽ *Water observed @ 30' upon completion of drilling*

BORING LOG NO. WW-23

GRAPHIC LOG		Surface Elev 502.8 (Ft) / ELEVATION (Ft)	DEPTH (Ft)	WATER LEVEL OBSERVATIONS	SAMPLE TYPE	RECOVERY (%)	FIELD TEST RESULTS	LABORATORY TORVANE/HP (tsf)	WATER CONTENT (%)	ATTERBERG LIMITS LL-PL-P
	0.3	**ASPHALT** 502.5								
	1.0	**CONCRETE** 502								
	5.0	**FILL - LEAN CLAY (CL)**, with sand and gravel, trace limestone fragments, brown gray 498			X	11	4 3 2 N=5	1.75 (HP)		
					X	100	4 9 6 N=15	1.0 (HP)		
		LEAN CLAY (CL), with silt, trace sand and gravel, brown gray	5		X	22	0 0 0 N=0			
	10.0	493			X	53	9 11 12 N=23	4.0 (HP)		
		LEAN CLAY (CL), with silt and limestone fragments, brown and gray	10		X	53	7 8 9 N=17	3.5 (HP)		
			15		X	78	7 8 10 N=18	4.5 (HP)		
			20		X	67	8 27 19 N=46	4.5 (HP)		
			25		X	53	6 7 9 N=16	4.5 (HP)		
			30		X	89	7 9 7 N=16	2.25 (HP)		
			35		X	100	6 7 8 N=15	3.0 (HP)		
			40			100	50/5"	2.5 (HP)		
			45	▽	X	53	7 9 10 N=19	4.5 (HP)		
	50.0	453								
		SHALE, gray, very weak, with limestone fragments	50			100	50/4"			
	56.0	447	55			100	50/2"			
		Boring Terminated at 56 Feet								

Stratification lines are approximate in-situ the transition may be gradual

Hammer Type Automatic

Advancement Method
3.25 Hollow Stem Auger

Abandonment Method
inclinometer grouted in borehole

Notes
inclinometer set at 56 feet

WATER LEVEL OBSERVATIONS

▽ *Water observed @ 48' during drilling*

BORING LOG NO. D-2

SITE:

Surface Elev 499 5 (Ft)

DEPTH	ELEVAT ON (Ft)	DESCRIPTION
0 4	499	**ASPHALT**
0 8	498 5	**CONCRETE**
1 3	498 5	**FILL - SAND AND GRAVEL**
3 5	496	**FILL - LEAN CLAY (CL)**, trace grave and red br ck fragments, dark brown, soft
		LEAN CLAY (CL), trace grave , b ue sh gray and brown mott ed, st ff
9 5	490	**LEAN CLAY (CL)**, trace ox de nodu es, brown to dark brown, st ff to very st ff
22 0	477 5	**LEAN CLAY (CL)**, w th grave and mestone fragments, dark brown, very st ff
27 0	472 5	**SILT (ML)**, w th sand, gray, st ff
38 0	461 5	**LEAN CLAY (CL)**, w th sand, grave and mestone fragments, b ue sh gray and brown, med um st ff
46 0	453 5	**SHALE**, comp ete y weathered

DEPTH (Ft)	FELD TEST RESULTS	LABORATORY TORVANE/HP (tsf)
	3 4 3 N=7	<0.25
5	3 4 6 N=10	1.75 (HP)
	5 6 8 N=14	2.0 (HP)
10	9 9 10 N=19	3.75 (HP)
	5 5 7 N=12	4.5 (HP)
15	4 5 8 N=13	3.5 (HP)
	5 6 8 N=14	2.0 (HP)
20	3 3 6 N=9	1.75 (HP)
	4 5 7 N=12	2.75 (HP)
25	4 10 14 N=24	
	4 5 7 N=12	1.0 (HP)
30	4 4 5 N=9	<0.25
35	4 4 5 N=9	0.5 (HP)
40	6 6 7 N=13	1.75 (HP)
45	5 7 50/4"	1.25 (HP)

WATER LEVEL OBSERVATIONS; WATER CONTENT (%); SAMPLE TYPE; A ERBERG L M S; LL-PL-P

Stratification lines are approximate n-situ the transition may be gradual

Hammer Type Automatic

Advancement Method
Hollow Stem Auger

Notes

Abandonment Method
Backfilled with Auger Cuttings and/or Bentonite

WATER LEVEL OBSERVATIONS

BORING LOG NO. D-2

GRAPH C LOG	DEPTH / ELEVAT ON (Ft)	DEPTH (Ft)	WATER LEVEL OBSERVAT ONS	SAMPLE TYPE	F ELD TEST RESULTS	LABORATORY TORVANE/HP (tsf)	WATER CONTENT (%)	A ERBERG L M S LL-PL-P
	Surface Elev 499 5 (Ft)							
	SHALE, comp ete y weathered *(continued)*	50			50/1"			
	52 0 / 447 5				50/3"			
	SHALE, w th nterbedded mestone ayers, moderate y weathered	55						
	56 5 / 443							
	Boring Terminated at 56.5 Feet							

Stratification lines are approximate n-situ the transition may be gradual

Hammer Type Automatic

Advancement Method
Hollow Stem Auger

Notes

Abandonment Method
Backfilled with Auger Cuttings and/or Bentonite

WATER LEVEL OBSERVATIONS

PROJECT: [redacted]
TYPE: [redacted]

DRILL NG F RM / OPERATOR: [redacted]

DRILL RIG: [redacted]
HAMMER: AUTOMATIC HAMMER
CAL BRAT ON DATE: [redacted]
ENERGY RATIO (%): 81.9

STAT ON / OFFSET:
ALIGNMENT:
ELEVAT ON: 534.7 (MSL) EOB: 47.5 ft.
COORD: [redacted]

EXPLORATION D RM-3B

MATERIAL DESCRIPTION AND NOTES	ELEV	DEPTHS	SPT/ ROD	N_{60}	REC (%)	SAMPLE D	HP (tsf)	GRADATION (%) GR	CS	FS	SI	CL	ATTERBERG LL	PL	PI	WC	ODOT CLASS (GI)	NCL
RA LROAD BALLAST	534.7																	
(COBBLES ENCOUNTERED)	533.7		5	14	0	SS-1	-	-	-	-	-	-	-	-	-	-		
			5															
			3	11	0	SS-2	-	-	-	-	-	-	-	-	-	-		
			5															
MEDIUM DENSE, BLACK, **GRAVEL AND/OR STONE FRAGMENTS WITH SAND, SILT, AND CLAY**, MO ST	529.2		5	12	17	SS-3	-	-	-	-	-	-	-	-	-	19	A-2-6 (V)	
			4															
@7.5': COBBLES ENCOUNTERED	526.7		6	19	67	SS-4	3.50	-	-	-	-	-	-	-	-	19	A-6b (V)	
VERY ST FF, BROWN, **SILTY CLAY**, LITTLE GRAVEL TRACE SAND, MO ST (COBBLES ENCOUNTERED)			8															
			5	16	33	SS-5	3.00	-	-	-	-	-	-	-	-	20	A-6b (V)	
			7															
			8	23	33	SS-6	4.00	-	-	-	-	-	-	-	-	15	A-6b (V)	
			9															
VERY STIFF, MOTTLED BROWN AND GRAY, **SILTY CLAY**, TRACE GRAVEL, LITTLE SAND, DAMP (COBBLES ENCOUNTERED)	519.2		5	19	61	SS-7	3.00	-	-	-	-	-	-	-	-	21	A-6b (V)	
			9															
VERY ST FF, BROWNISH GRAY TO BROWN, **SILT AND CLAY**, TRACE GRAVEL, TRACE SAND DAMP	516.7		7	26	78	SS-8	>4.5	-	-	-	-	-	-	-	-	18	A-6a (V)	
			12															
@21': COBBLE ENCOUNTERED			40 50/5"	-	76	SS-9	>4.5	-	-	-	-	-	-	-	-	18	A-6a (V)	
	511.7																	
HARD, BROWN AND GRAY **CLAY**, L TTLE GRAVEL, L TTLE SAND SOME S LT, MOIST			12	40	89	SS-10	1.25	-	-	-	-	-	-	-	-	21	A-7-6 (V)	
			17															
			10	35	56	SS-11	2.00	-	-	-	-	-	-	-	-	15	A-7-6 (V)	
@26' - 29': COBBLES ENCOUNTERED			16															
	505.7		50/1"	-	100	S-12	-	-	-	-	-	-	-	-	-	-		

PID: N/A | SFN: N/A | PROJECT: [redacted] | STATION / OFFSET: [redacted] | PG 2 OF 2 | RM-3B

MATERIAL DESCRIPTION AND NOTES	ELEV.	DEPTHS	SPT/ RQD	N_{60}	REC (%)	SAMPLE ID	HP (tsf)	GRADATION (%) GR	CS	FS	SI	CL	ATTERBERG LL	PL	PI	WC	ODOT CLASS (GI)	INCL.
VERY STIFF, BROWN, **CLAY**, LITTLE GRAVEL, LITTLE SAND, LITTLE SILT, MOIST *(continued)*	504.7																	
	501.7	31	10 8 10	25	61	SS-13	2.75	-	-	-	-	-	-	-	-	19	A-7-6 (V)	
HARD, MOTTLED BROWN AND GRAY, **SILTY CLAY**, LITTLE GRAVEL, LITTLE SAND, MOIST		32																
	499.2	33																
		34	2 19 10	40	56	SS-14	1.75	-	-	-	-	-	-	-	-	22	A-6b (V)	
STIFF, BROWNISH GRAY, **SILTY CLAY**, LITTLE GRAVEL, TRACE SAND, MOIST		35																
	496.7	36																
		37	1 4 5	12	56	SS-15	0.75	-	-	-	-	-	-	-	-	21	A-6b (V)	
VERY STIFF, BLUISH GRAY AND GREENISH GRAY, **SANDY SILT**, LITTLE CLAY, DAMP WITH SHALE FRAGMENTS		38																
	494.2	39	1 5 7	16	61	SS-16	>4.5	-	-	-	-	-	-	-	-	19	A-4a (V)	
GRAY, SEVERELY WEATHERED SHALE		40																
		TR																
		41																
		42	12 50/5"	-	82	SS-17	>4.5	-	-	-	-	-	-	-	-	8	Rock (V)	
		43																
		44																
		45																
		46																
	487.2	47																
		EOB																

NOTES: INCLINOMETER SET AT 47.5'

ABANDONMENT METHODS, MATERIALS, QUANTITIES: INCLINOMETER INSTALLED WITH GROUT

[redacted]

DRILLING FIRM / OPERATOR: [redacted]
SAMPLING FIRM / LOGGER: [redacted]
DRILLING METHOD: 3.25" HSA / NX
SAMPLING METHOD: SPT/NX

DRILL RIG: [redacted]
HAMMER: AUTOMATIC HAMMER
CALIBRATION DATE: 7/1/15
ENERGY RATIO (%): 81.9

[redacted]

PLORATION ID
RM-4

PAGE
1 OF 2

MATERIAL DESCRIPTION AND NOTES	ELEV.	DEPTHS	SPT/ RQD	N_{60}	REC (%)	SAMPLE ID	HP (tsf)	GRADATION (%) GR	CS	FS	SI	CL	ATTERBERG LL	PL	PI	WC	ODOT CLASS (GI)	INCL.
ASPHALT (0.3')	505.2																	
STIFF, BROWN, GRAY, AND RED, **SANDY SILT**, LITTLE GRAVEL, SOME CLAY, MOIST (FILL)	502.5		4 4 3	10	67	SS-1	0.50	-	-	-	-	-	-	-	-	18	A-4a (V)	
VERY STIFF, BROWN, **SILT AND CLAY**, LITTLE GRAVEL, LITTLE SAND, DAMP (COBBLES ENCOUNTERED)	498.5		1 4 8	16	56	SS-2	3.50	-	-	-	-	-	-	-	-	17	A-6b (V)	
			4 10 10	27	22	SS-3	3.25	-	-	-	-	-	-	-	-	21	A-6b (V)	
VERY STIFF, MOTTLED BROWN AND GRAY, **SILTY CLAY**, TRACE GRAVEL, TRACE SAND, MOIST	493.5		4 9 10	26	94	SS-4	2.75	-	-	-	-	-	-	-	-	20	A-6b (V)	
			6 6 7	18	61	SS-5	3.50	-	-	-	-	-	-	-	-	20	A-6b (V)	
HARD, MOTTLED BROWN AND GRAY, **SILT AND CLAY**, LITTLE GRAVEL, LITTLE SAND, DAMP	491.0		4 12 16	38	83	SS-6	>4.5	-	-	-	-	-	-	-	-	19	A-6a (V)	
HARD, BROWN, **SILTY CLAY**, LITTLE GRAVEL, TRACE SAND, MOIST (COBBLES ENCOUNTERED)	488.5		16 12 12	33	44	SS-7	2.25	-	-	-	-	-	-	-	-	18	A-6b (V)	
MEDIUM DENSE, BROWN AND GRAY, **GRAVEL AND/OR STONE FRAGMENTS WITH SAND, SILT, AND CLAY**, MOIST	486.0		7 8 11	26	11	SS-8	-	-	-	-	-	-	-	-	-	22	A-2-6 (V)	
HARD, MOTTLED BROWN AND GRAY, **SILT AND CLAY**, TRACE GRAVEL, TRACE SAND, DAMP	483.5		4 10 14	33	72	SS-9	4.25	-	-	-	-	-	-	-	-	18	A-6a (V)	
VERY STIFF, BROWN, **SANDY SILT**, LITTLE GRAVEL, SOME CLAY, DAMP (COBBLES ENCOUNTERED)	481.0		14 10 12	30	89	SS-10	-	-	-	-	-	-	-	-	-	16	A-4a (V)	
STIFF TO VERY STIFF, BLUISH GRAY AND GREENISH GRAY, **CLAY**, TRACE GRAVEL, TRACE SAND, SOME SILT, MOIST			4 6 7	18	67	SS-11	1.25	-	-	-	-	-	-	-	-	20	A-7-6 (V)	
			5 5 9	19	67	SS-12	3.00	-	-	-	-	-	-	-	-	21	A-7-6 (V)	

PID: N/A | SFN: N/A | [redacted] | STATION / OFFSET: | [redacted] | PG 2 OF 2 | RM-4

MATERIAL DESCRIPTION AND NOTES	ELEV.	DEPTHS	SPT/ RQD	N_{60}	REC (%)	SAMPLE ID	HP (tsf)	GRADATION (%) GR	CS	FS	SI	CL	ATTERBERG LL	PL	PI	WC	ODOT CLASS (GI)	INCL.
STIFF TO VERY STIFF, BLUISH GRAY AND GREENISH GRAY, **CLAY**, TRACE GRAVEL, TRACE SAND, SOME SILT, MOIST *(continued)*	475.5	31	3 3 7	14	67	SS-13	1.50	-	-	-	-	-	-	-	-	27	A-7-6 (V)	
STIFF, MOTTLED BLUISH GRAY AND BROWN, **SILT AND CLAY**, TRACE GRAVEL, TRACE SAND, DAMP	473.5	32 33 34	1 2 6	11	72	SS-14	3.50	-	-	-	-	-	-	-	-	21	A-6a (V)	
HARD, MOTTLED BLUISH GRAY AND GREENISH GRAY, **CLAY**, LITTLE GRAVEL, LITTLE SAND, SOME SILT, MOIST (COBBLES ENCOUNTERED)	471.0	35 36 37	6 16 39	75	72	SS-15	1.25	-	-	-	-	-	-	-	-	24	A-7-6 (V)	
		38	11 50/2"	-	50	SS-16	1.00	-	-	-	-	-	-	-	-	18	A-7-6 (V)	
	463.5	39 40 41	2 9 15	33	61	SS-17	3.25	-	-	-	-	-	-	-	-	18	A-7-6 (V)	
DENSE TO VERY DENSE, GRAY AND BROWNISH GRAY, **GRAVEL AND/OR STONE FRAGMENTS WITH SAND, SILT, AND CLAY**, DAMP @44.5': COBBLE ENCOUNTERED		42 43 44	17 28 28	76	56	SS-18	-	-	-	-	-	-	-	-	-	16	A-2-6 (V)	
	458.5	45 46	2 10 13	31	11	SS-19	-	-	-	-	-	-	-	-	-	17	A-2-6 (V)	
GRAY, SEVERELY WEATHERED SHALE		WTR 47 48	12 49 50/1"	-	69	SS-20	-	-	-	-	-	-	-	-	-	15	Rock (V)	
	453.5	49 50	60/3"	-	33	SS-21	-	-	-	-	-	-	-	-	-	11	Rock (V)	
INTERBEDDED SHALE (55%) AND LIMESTONE (45%), RQD 21%, REC. 88%; **SHALE**, GRAY, HIGHLY WEATHERED, WEAK, THIN BEDDED; **LIMESTONE**, LIGHT GRAY, SLIGHTLY WEATHERED, STRONG, THIN BEDDED.	449.5	51 52 53 54 55 EOB 56	21		88												CORE	

NOTES: INCLINOMETER SET AT 54.25'

ABANDONMENT METHODS, MATERIALS, QUANTITIES: INCLINOMETER INSTALLED WITH GROUT