

ADDENDUM NO. 3



TO:	Interested Parties
FROM:	Blair Reynolds, Chief Project Manager, Division of Engineering
DATE:	Friday, July 22, 2022
RE:	Professional Boulevard – Phase II Contract No. RD-PB-270-10 State Contract No. WA071ZM1 FAP No. APL-3(779)E

Acknowledge receipt of this <u>Addendum No. 3</u> by signing in the space provided below and returning with your Bid.

Failure to sign and return with your Bid may subject the Bidder to disqualification. This Addendum No. 3 forms a part of the Bid Documents, it supplements and modifies them as outlined herein.

This Addendum No. 3 consists of <u>164</u> pages, including this page and attachments.

I hereby acknowledge receipt of Addendum No. 3:

By:

Date

Signed Name

Typed Name

Title

For:

Firm

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ADDENDUM NO. 3

Professional Boulevard – Phase II Contract No. RD-PB-270-10; State Contract No. WA071ZM1; FAP No. APL-3(779)E

Date Issued: July 22, 2022

Bids Due: July 27, 2022 3:00 p.m.

The following addendum material is hereby made a part of the Bid Documents. Please note the following changes, information, and/or instructions in connection with the proposed work and submit proposals accordingly.

Blair Reynolds

Blair Reynolds Chief Project Manager Division of Engineering

By Authority of: Board of County Commissioners Washington County, Maryland

Scott Hobbs, P.E. Director Division of Engineering

To: All prime Contractors and all others to whom specifications have been issued.

- Item 1.01 Special Provisions, Page SP-48R DELETE in its entirety REPLACE with Revised SP-48R
- Item 1.02 Bid Forms, Page 2.24 DELETE in its entirety REPLACE with Revised BF-2.24R

Bid Forms, Page 2.34 DELETE in its entirety REPLACE with Revised BF-2.34R

Item 1.03 QUESTIONS THAT WERE SUBMITTED BY THURSDAY, JULY 14, 2022 (4:00PM)

<u>Question #1– Valentine Electric</u> Please verify Item 8004A quantity of 6,100 LF of No. 6 AWG Stranded Bare Copper Ground Wire.

Response: The item is to be used within both conduits shown on the lighting pages as well as for the signal work.

Question #2– Valentine Electric

Please confirm locations and quantities of Items 8006A, 8007A, and 8008A as drawing sheets 86 and 87 show different locations for said items.

Response: Drawing sheets 86 and 87 are shown differently because the existing roadway is not to be widened if the Add Alternate is not selected.

Question #3– Valentine Electric

Drawings sheets 8 and 9 propose new sidewalks and business entrances on both side of Professional Boulevard from station 10+75 to approximately 25+00. Can item 8006A be used in these locations with Item 8008A used at 18+50 to go across Professional Blvd?

<u>Response: The Contractor is to bid the trenched, slotted, and bored items as</u> provided on the Construction Drawings. During construction, if the contractor wishes to use an alternate method, it will be considered by the County. <u>Question #4– Valentine Electric</u> Will Item 8007A only be needed at the concrete entrances at station 22+80?

Response: See response to the question immediately above.

Question #5– Valentine Electric

Please confirm Items 8006A, 8007A and 8008A are paid by each L.F. of conduit and not per L.F. of trench, slotting or boring of 2 conduits.

Response: Measurement and payment will be made per linear foot of conduit.

Question #6– Valentine Electric

Drawing sheet 87 shows 12 pole locations on bridge while there are 13 bases already installed. Please verify quantities for these bid items.

Response: Drawing sheet 87R shows 13 bases for the Canto Poles (one on the end of the concrete barrier West of the bridge). The additional poles (Item 8011A) and Luminaires (Item 8009A) are to go to the Hagerstown Light Department per the Special Provisions.

<u>Question #7– Valentine Electric</u> Please verify quantities of Items 8010A and 8012A.

Response: The quantities are correct.

<u>Question #8– Valentine Electric</u> Please verify quantities for Item 8014A.

Response: The quantity is correct.

<u>Question #9– Valentine Electric/Rommel Infrastructure</u> Drawing sheet 88R equipment list proposes quantities and Add Alternate quantities. Please explain intentions as there are no electrical bid items listed on base bid items list.

<u>Response: This federal aid project would not allow contingent items; therefore, if</u> <u>the add alternate is not selected, the lighting items needed would be addressed in a</u> <u>change order.</u>

Question #10- Rustler Construction

Please consider removing, on the bid forms, the requirement to provide total on each sheet.

Response: The Bid Forms will remain the same.

Question #11 – Rustler Construction

Note that on the bid forms, the quantity is normally 1 when the unit is lump sum. Please revise accordingly.

Response: Lump Sum payment is tied directly to the percentage of work completed, or as stated in the Bid Documents.

Question #12-Rustler Construction

SP-48R provided in Addendum No. 2 indicates Contingent 30 Mil Synthetic Liner. Bid forms do not describe it as a contingent item (item 3020B). Please clarify.

Response: See revised SP-48R for clarification.

<u>Question #13– Rustler Construction</u> Is there any water relocation in this project? Please clarify and provide bid items.

Response: There is no anticipated water relocation.

<u>Question #14– Rustler Construction</u> Is all rebar to be used in this project to be epoxy coated?

Response: Yes, per MDOT SHA Standard Specification 917.02.

<u>Question #15– Rustler Construction</u> What is the MD SHA Concrete Mix number to be used in bid item 3003B?

Response: Item 3003B – Nonstandard Endwall shall use Concrete Mix # 2.

Question #16- Rustler Construction

Is there any rebar to be placed in the driveway? If affirmative, please provide sizes, details, epoxy coated, etc.

<u>Response: No, use MDOT SHA Standard Detail 630.01 as shown on Construction</u> <u>Drawing Sheet 6.</u>

<u>Question #17– Rustler Construction</u> How is the County going to pay for the 12" GAB shown on detail-Eastern Boulevard on Sheet 7?

<u>Response: We have added Item 5016A Graded Aggregate Base – 12 Inch Depth.</u> <u>The Item and quantity have been added to the Bid Forms Schedule of Prices page</u> <u>2.24R.</u>

Question #18- Rustler Construction

Under what items are the excavations for Curb & Gutters/Sidewalks/Driveways going to be paid?

Response: Use Items 2001B and 2001A – Class 1 and 2 Excavation.

Question #19- Rustler Construction

Provide quantities of existing Curb & Gutters/Sidewalks/Driveways to be removed and replaced. How much is new vs how much needs to be replaced in each line item?

Response: All of the existing curbs, gutters, sidewalks, and driveway entrances will be removed in the Add Alternate using Item 2001A and replaced with the corresponding items (6001A, 6002A, 6004A, 5008A).

<u>Question #20– Rustler Construction</u> Please provide Geotechnical report (text) for this project.

Response: The Geotechnical report for Professional Boulevard Phases 1 and 2 combined is included in this Addendum.

Question #21– Rustler Construction

Does the County anticipate awarding any adjacent work during the construction period of this project?

Response: No.

Question #22-Rustler Construction

There is a requirement for builder's risk insurance – this is not typical on a roadway project. What is the County wanting covered as we will need a cost replacement value for said items.

Response: Coverage should include construction equipment and materials awaiting installation onsite or for damage while in transit. See GC-67.

Question #23-Rustler Construction

Please provide additional time for questions. The county will benefit from more accurate and competitive bids.

Response: Two weeks additional time was given from the original question deadline.

Question #24- C. William Hetzer, Inc.

Page SP-19 of the Specification states "The total of the Base Bid plus the Add Alternate if selected will be used as the basis for evaluation of quotations and award of the Contract". Can we be assured that if awarded, the Project will include both Base and Add Alternate Items?

Response: See Page ITB-10 of the Bid Document Section ITB 1.14 AWARD. "The total base bid plus any add alternates selected will be used as a basis for evaluation of the bids and award of the Contract. If the add alternate is not selected, the base bid alone will be used as the basis for evaluation."

Question #25- C. William Hetzer, Inc.

Based on utility information shown on Plan Sheets 8, 8A, and 9, there are numerous gas line conflicts encountered in the storm drain installation. Note 6 on page 8 states, "Gas main may require relocation if impacted by proposed storm drain." Please confirm that the Owner will pay for all costs and delays associated with utility relocation(s).

Response: Please refer to the Utility Statement beginning on SP-122 of the Bid Document. The owner will pay the utility company directly for all costs associated with its relocation.

Question #26– C. William Hetzer, Inc.

Note 3 on Sheet 8 states, "Existing inlets, water valves, and manholes shall be adjusted to proposed grades". Items 8050A and 8051A of the Bid Form provides for adjustments to the sanitary manholes and cleanouts only. Please provide additional bid items for adjusting storm drain inlets and waterline valve boxes.

Response: We have added Item 8052A Adjust Existing Stormdrain Manhole and Item 8053A Adjust Existing Water Valves. The Items and quantities have been added to the Bid Forms Schedule of Prices page 2.34R.

Attachments:

Special Provisions, Page SP-48R (1 Page) Bid Forms, Page BF-2.24R (1 Page) Bid Forms, Page BF-2.34R (1 Page) Geotechnical Report (154 Pages)

END ADDENDUM No. 2

SPECIAL PROVISIONS 316 — SWM FILTRATION FACILITIES

COUNTY CONTRACT NO. RD-PB-270-10 SHA CONTRACT NO. WA071ZM1 FAP NO. APL-3(779)E 1 of 1

CATEGORY 300 DRAINAGE

30 MIL SYNTHETIC LINER

DESCRIPTION. This work is to install a synthetic liner in the proposed bioswales when rock is encountered during excavation and the Engineer determines the subgrade poses an increased possibility of sinkhole development.

MATERIALS. 30 mil U/V Resistant Polyethylene D4397

30 mil U/V Resistant PCV per Construction Dwg SW-09

CONSTRUCTION. When rock is encountered, contact the Geotech and the Engineer to make the determination. Install per the details on the Construction Drawings.

MEASURMENT AND PAYMENT. 30 Mil Synthetic Liner will be measured at the Contract Unit Price per Square Yard accepted in place. The payment will be full compensation for all excavation, material, labor, backfill, and for all overlap. All liner overlap shall be incidental to the cost of the liner installation.

FAP NO. APL-3(779)E ITEM TOTAL Total This Sheet STATE CONTRACT WA071ZM1 UNIT PRICE 5 INCH WHITE THERMOPLASTIC PAVEMENT MARKING LINES REMOVAL OF EXISTING PAVEMENT MARKING LINES, ANY WIDTH **GRADED AGGREGATE BASE - 12 INCH DEPTH** WHITE PREFORMED THERMOPLASTIC PAVEMENT MARKING LEGENDS AND SYMBOLS 24 INCH WHITE PREFORMED THERMOPLASTIC PAVEMENT MARKING LINES 5 INCH YELLOW THERMOPLASTIC PAVEMENT MARKING LINES REMOVAL OF EXISTING PAVEMENT LETTERS, SYMBOLS, ARROWS, AND NUMBERS 12 INCH WHITE THERMOPLASTIC PAVEMENT MARKING LINES COUNTY CONTRACT RD-PB-270-10 ITEM DESCRIPTION **BID FORMS - PROFESSIONAL BOULEVARD PHASE II** S.Y. TINU L.F. L.F. L.F. L.F. S.F. L.F. S.F. End Category <u>5000-"A" Items</u> Contract No. RD-PB-270-10 "A" Is For Add Alternate Bid QUANTITY 490 670 830 625 400 120 134 31 CODE ı ı 1 ı ı 5016A ITEM 5011A 5014A 5015A 5010A 5012A 5013A 5009A

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BID FORMS - PROFESSIONAL BOULEVARD PHASE II COUNTY CONTRACT RD-PB-270-10 STATE CONTRACT WA071ZM1 FAP NO. APL-3(779)E

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UNIT PRICE								Total Th
ITEM DESCRIPTION	10 FT BREAKAWAY PEDESTAL POLE (POWDER COATED HADCO GREEN)	COATED HADCO GREEN) 27 FT STEEL POLE WITH A SINGLE 50 FT MAST ARM (POWDER COATED HADCO GREEN)	REMOVE AND DISPOSE OF EXISTING SIGNAL EQUIPMENT	ADJUST EXISTING SEWER MANHOLE	ADJUST EXISTING SEWER CLEAN OUT	ADJUST EXISTING STORMDRAIN MANHOLE	ADJUST EXISTING WATER VALVES	
TINU	EA.	EA.	L.S.	EA.	EA.	EA.	EA.	
QUANTITY	2	1	LUMP SUM	2	3	3	8	7 8000-"A" Items . RD-PB-270-10
CODE	ı		ı	ı	ı	I	ı	End Category Contract No.
ITEM	8047A	8048A	8049A	8050A	8051A	8052A	8053A	, ,

PAGE 2.34R OF 34



Professional Boulevard Bridge and Extension

Washington County, Maryland

Prepared for: Washington County Division of Engineering and Construction Management

> RK&K Commission No. 14187-03.4 December 5, 2016

Eric M. Klein, P.E., D.GE Senior Manager, Geotechnical Engineering Department

Jasiu Raczynski Geotechnical Engineer

Prepared by: RUMMEL, KLEPPER & KAHL, LLP 81 Mosher Street Baltimore, Maryland 21217

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Figure B-1:Field Classification System for Soil ExplorationFigure B-2:Field Classification System for Rock ExplorationFigure B-3:Unified Soil Classification SystemFigure B-4:AASHTO Soil Classification SystemTest Boring Logs (47)

APPENDIX C

Summary of Laboratory Test Results (3) Modified Proctor Moisture-Density Relationship (6) California Bearing Ratio (6) Summary of Rock Mass Rating (1)

APPENDIX D

Final Report Geophysical Survey Pinnacles and Sinkholes beneath Proposed Roadway, 4300 Linear Feet of Proposed Roadway, March 24, 2016



1 INTRODUCTION

In accordance with our proposal dated September 12, 2014, Rummel, Klepper & Kahl, LLP (RK&K) has completed the Subsurface Exploration and Geotechnical Engineering Evaluation for the Professional Boulevard Bridge and Extension project in Washington County, Maryland.

The purpose of this study was to determine general subsurface conditions at the project site and to evaluate those conditions with respect to geotechnical engineering considerations for the proposed construction. The specific scope of our services on this project consisted of exploring the subsurface conditions using geophysics, soil borings, and laboratory testing, evaluating the conditions encountered, developing geotechnical recommendations, and submitting our findings in a report. Based on this geotechnical study, recommendations are provided for bridge foundations, mechanically stabilized earth walls, earthwork, pavement sections, stormwater management and other geotechnical concerns.

Also included in this report are descriptions of the field and laboratory testing on which this report is based. The results of this work are contained in the appendix of this report.



2 SITE AND PROJECT DESCRIPTION

2.1 SITE DESCRIPTION

The project site is located at the existing Professional Court near Antietam Creek in Washington County, Maryland as shown in Figure A-1 and will continue to intersect with the extended Yale Drive.

Professional Court is an unstriped local road on the east side of Eastern Boulevard with entrances to commercial and retail businesses. Professional Court is approximately 1,200-ft long from its intersection at Eastern Boulevard, 35-ft wide and terminates at a cul-de-sac. It is a closed end section and there are sidewalks on both sides of Professional Court. East of the cul-de-sac is Antietam Creek that flows north to south. East of the creek, the project site is about one mile of rolling hills with forest and farmland. Table 2.1 summarizes existing ground surface elevations and grades along the project alignment.

Table 2.1 – Summary of Existing Ground Surface Elevations					
Location	Station	Elevation			
Professional Court and Eastern Boulevard	10+50	497			
Professional Court	14+75	495			
Professional Court	20+00	511			
Professional Court Eastern Terminus	22+75	507			
Antietam Creek West Bank	26+50	468			
Antietam Creek Stream Elevation	27+25	460			
Antietam Creek East Bank	27+50	469			
Proposed Professional Boulevard (Rock Outcropping)	31+50	511			
Proposed Professional Boulevard	36+50	488			
Proposed Professional Boulevard	40+40	508			
Proposed Professional Boulevard	42+50	495			
Proposed Professional Boulevard	45+40	528			
Proposed Professional Boulevard	46+60	517			
Proposed Professional Boulevard: End Project Limits	52+50	530			

Table 2.2 summarizes the water levels in Antietam Creek.



Table 2.2 – Antietam Creek Water Levels				
Location Elevation (ft)				
Normal	465.19			
10 Year Storm	477.04			
100 Year Storm	484.20			

The area west of Antietam Creek contains several existing underground utilities including water, sewer, gas, electric and communications. Approximate locations of known utilities are shown on Figures A-2a through A-2h in Appendix A.

2.2 PROJECT DESCRIPTION

The proposed construction will include the widening of the existing Professional Court and extending the roadway eastward over and beyond Antietam Creek where it will intersect the proposed limits of another roadway project, Yale Drive. Professional Court will be renamed Professional Boulevard.

2.2.1 Roadway

The proposed Professional Boulevard will be approximately 4,200-ft in length including the existing Professional Court, bridge and roadway extension. The existing Professional Court will be widened and the cul-de-sac will be removed. The proposed roadway will consist of two lanes in each direction. The roadway will be 48-ft wide undivided west of STA 30+60, and it will be 68-ft wide divided including a 12-ft grass median east of STA 30+60. Table 2.3 summarizes the earthwork involved in meeting the proposed grade elevations.

Table 2.3 – Summary of Proposed Earthwork Cut and Fill							
Start Station End Station Cut / Fill Depth (ft)							
10+50	21+75	Match Existing	Professional Court				
21+75	25+60	Fill	0 - 20				
25+60	28+60	Bridge Over Antietam Creek					
28+60	29+20	Fill	1-3				
29+20	35+10	Cut	1-10				
35+10	40+25	Fill	1-5				
40+25	41+00	Cut	0-2				
41+00	44+20	Fill	1-12				
44+20	46+20	Cut	1-15				
46+50	50+00	Fill	1-3				



It is anticipated that the existing asphalt concrete pavement of Professional Court will be milled and overlaid. The extension of Professional Boulevard will consist of a new flexible pavement section. Table 2.4 summarizes the pavement design parameters that were developed for this project. The subgrade elevations of the new pavement will need to match the existing subgrade elevations. This road will be a minor arterial.

Table 2.4 – Summary of Pavement Design Parameters					
Parameter	Value				
Average Daily Traffic	See Section 5.5				
Percent Truck Traffic	4.7 (Class 4 or greater)				
Truck ESAL Factor	Based on MDSHA Truck Class				
Performance Period	25 - years				
Annual Growth	2.0 - percent				
Total Equivalent Single Axles Loads (ESAL)	See Section 5.5				
Reliability	85 - percent				
Overall Standard Deviation	0.49				
Initial Serviceability	4.2				
Terminal Serviceability	2.8				
Soil Resilient Modulus, Mr*	4,500 - psi				
Rock Resilient Modulus, Mr*	10,500 - psi				
Mr = 1,500 x California Bearing Ratio (CBR)					

2.2.2 Bridge

The bridge over Antietam Creek will be a 3-span semi-integral, continuous, steel girder bridge. The bridge will be 300-ft long, with span lengths of 90-ft, 120-ft, and 90-ft. The elevations of the proposed foundation elements and the scour elevations at each foundation are summarized in Table 2.5 and Table 2.6, respectively.

Table 2.5 – Bridge Proposed Foundation Elevations						
Bottom of Footir						
Structural Element	Station	EL (ft)				
Abutment A (West)	25+59.00	491.10				
Pier 1	26+49.00	465.50				
Pier 2	27+69.00	465.50				
Abutment B (East)	28+59.00	483.95				



Table 2.6 - Scour Elevations								
Location	ocation 100-Year 500-Year Contraction Contraction Top of Storm Storm Scour 100-Yr Scour 500-Yr Bedroc							
Pier No.1	461.1*	458.3*	465.9	465.22	463			
Pier No. 2	459.0*	461.6	468.64	468.14	461			
Abutment A	462.8*	466.8*	476	475.3	472			

*The Erodibility Index Method and conservative values indicate that the rock is resistant to scour. Therefore, the scour elevations used in design should be no lower than the top of bedrock.

Table 2.7 summarizes the design loads for each foundation element.

Table 2.7 – Summary of Drilled Shaft Loads					
	Abutment A		Abutment A Piers		rs
Load	Strength	Service	Strength	Service	
Longitudinal – Fz (kips)	218	150	155	140	
Transverse - Fx (kips)	0	0	20	15	
Axial - Fy (kips)	1,756	1,357	3,510	2,475	
Moment – Mx (kip-ft)	365	247	4,030	3,645	
Moment – Mz (kip-ft)	N/A	N/A	19,990	15,275	
* Loads are for the whole foundation					

2.2.3 Mechanically Stabilized Earth Walls

Mechanically stabilized earth wall construction within the limits of the proposed Professional Boulevard extension will consist of the following structures.

2.2.3.1 Retaining Wall 1: Right Offset

Retaining Wall 1 will be approximately 70-ft 6-in in length and will be located along the south side of the west approach to the bridge. The wall will extend from approximately STA 24+93.50 to STA 25+64.00. The existing ground surface in this area ranges from approximately EL 499.03 to EL 480.4.

Table 2.8 summarizes the dimensions of the proposed Retaining Wall 1. The design wall height is measured from the bottom of the leveling pad to the top elevation of the proposed wall. The anticipated front slope is also included in Table 2.8.



Table 2.8 – Dimensions of Retaining Wall 1				
STA Design Wall Lev		Bottom of Leveling Pad EL.	Top of Wall EL.	
24+93.50	9.66	492.50	502.16	
25+04.00	11.60	490.50	502.10	
25+14.00	13.40	488.50	501.90	
25+24.00	16.20	485.50	501.70	
25+34.00	20.00	481.50	501.50	
25+44.00	24.80	476.50	501.30	

As indicated above, the maximum wall height of Retaining Wall 1 is near 24.8-ft.

2.2.3.2 Retaining Wall 2: Abutment Face

Retaining Wall 2 will be approximately 65.8-ft in length and will be located in front of the western bridge abutment, between the abutment and the river. The wall will be located at approximately STA 25+64. The existing ground surface in this area ranges from approximately EL 478 to EL 480.4. Above the wall will be the Professional Boulevard Bridge and below the wall will be Antietam Creek.

Table 2.9 summarizes the dimensions of the proposed Retaining Wall 2. The design wall height is measured from the bottom of the leveling pad to the top elevation of the proposed wall.

Table 2.9 – Dimensions of Retaining Wall 2				
STA Design Wall Leve Height (ft)		Bottom of Leveling Pad EL.	Top of Wall EL.	
25+64.00	18.45	476.50	494.95	
25+64.00	19.45	475.50	494.95	
25+64.00	20.45	474.50	494.95	

As indicated above, the maximum wall height of Retaining Wall 2 is near 20.45-ft.



2.2.3.3 Retaining Wall 3: Left Offset

Retaining Wall 3 will be approximately 238-ft in length and will be located on the north side of the proposed western approach, opposite RW 1. The wall will extend from approximately STA 23+74.00 to STA 25+64.00. The existing ground surface in this area ranges from approximately EL 478.8 to EL 500.2.

Table 2.10 summarizes the dimensions of the proposed Retaining Wall 3. The design wall height is measured from the bottom of the leveling pad to the top elevation of the proposed wall.

Table 2.10 – Dimensions of Retaining Wall 3				
STA	Design Wall Height (ft)	Bottom of Leveling Pad EL.	Top of Wall EL.	
23+74.00	8.58	495.50	504.08	
24+00.00	10.16	493.50	503.66	
24+25.00	12.76	490.50	503.26	
24+50.00	14.86	488.00	502.86	
24+75.00	16.45	486.00	502.45	
25+00.00	18.55	483.50	502.05	
25+25.00	21.15	480.50	501.65	
25+50.00	23.75	477.50	501.25	
25+64.00	20.45	474.50	494.95	

As indicated above, the maximum wall height of Retaining Wall 3 is near 23.75-ft.

2.2.3.4 Retaining Wall 4

Retaining Wall 4 is proposed from STA 41+62.81 to STA 44+20.20 to avoid impacting a recently constructed pond that was built for an adjacent project. The wall will be approximately 273-ft long. The existing ground surface in this area ranges from approximately EL 494 to EL 507.

Table 2.11 summarizes the dimensions of the proposed Retaining Wall 4. The design wall height is measured from the bottom of the leveling pad to the top elevation of the proposed wall. The ground surface in front of RW4 ranges from horizontal to sloping at approximately 10(H):1(V).



Table 2.11 – Dimensions of Retaining Wall 4				
STA	Design Wall Height (ft)	Bottom of Leveling Pad EL.	Top of Wall EL.	
41+62.81	7.05	500.50	507.55	
41+75.00	8.92	498.50	507.42	
42+00.00	11.26	496.00	507.26	
42+25.00	13.22	494.00	507.22	
42+50.00	15.31	492.00	507.31	
43+50.00	14.93	494.00	508.93	
43+75.00	13.65	496.00	509.65	
44+00.00	8.00	499.00	510.50	
44+10.14	8.89	502.00	510.89	
44+20.28	6.28	505.00	511.28	

As indicated above, the maximum wall height of Retaining Wall 4 is near 15.31-ft.

2.2.4 Stormwater Management

The proposed construction includes bioswales for stormwater management on both the north and south sides of Professional Boulevard. The bioswales will run from the cul-de-sac at STA 22+00 to the east end of the project limits and will have invert elevations consistently 1.5-ft below the proposed roadway surface. Sideslopes will be cut to 3(H):1(V). Infiltration will not be used to manage storm runoff because of the existence of karst features in the area.

2.3 UTILITIES

The approximate locations of many of the currently known utilities are shown in Figure A-2 in Appendix A. There is an existing underground gas utility in the area of the proposed Retaining Wall 3. Test pits are proposed to be excavated to locate the gas utility underlying Retaining Wall 3. Once the test pits are complete, the utility owner should evaluate whether reinforcing or relocating the utility will be required based on recommendations provided in Section 5.8.

Several storm drain pipes are proposed to extend through or under RW4. The details of these storm drain pipes were not available at the time of the writing of this report.



3 FIELD AND LABORATORY WORK

3.1 FIELD EXPLORATION

The subsurface exploration consisted of drilling forty-seven Standard Penetration Test (SPT) borings from April 25 through May 17, 2016. The test borings were drilled by AB Consultants, Inc. of Lanham, Maryland, under contract to Rummel, Klepper & Kahl, LLP. The borings were drilled using a Mobile B57 ATV-mounted drill rig equipped with an automatic hammer. Ground surface elevations of the borings were estimated from the plans. Table 3.1 summarizes the locations and depths of the borings. Boring locations are shown in Figures A-2a through A-2h in Appendix A of this report.

Table 3.1 – Summary of Borings				
Boring No.	Primary Purpose	Station / Offset	G.S. Elevation	Depth (ft)
RB-01	Roadway	15+50 30 RT	497	10.0
RB-02	Roadway	20+35 25 LT	510	10.0
SWM-26	Bioswale	22+10 45 RT	506	11.0
SWM-27	Bioswale	22+20 95 RT	501	5.0
SWM-28	Bioswale	23+10 70 RT	503	10.0
SWM-29	Bioswale	23+75 30 LT	501	9.0
AR-01	Bridge Approach	24+60 0	493	13.0
SWM-30	Bioswale	25+00 30 LT	496	7.0
AB-01	Bridge West Abutment	25+60 24 LT	481	26.0
AB-02	Bridge West Abutment	25+60 22 RT	481	29.5
P-01	Bridge Pier 1	26+50 20 LT	470	17.5
P-01A*	Bridge Pier 1	26+50 15 LT	470	27.5
P-02	Bridge Pier 2	27+65 17 RT	470	29.0
AB-03	Bridge East Abutment	28+60 22 LT	492	23.0
AB-04	Bridge East Abutment	28+60 22 RT	490	23.0
SWM-01	Bioswale	29+50 37 LT	500	18.0
SWM-13	Bioswale	29+50 40 RT	503	11.0
SWM-18	Bioswale	29+50 40 LT	503	12.0
RB-03	Roadway	31+80 0	510	10.0
SWM-02	Bioswale	32+00 41 LT	507	17.2
SWM-14	Bioswale	32+00 41 RT	509	5.5
SWM-14A*	Bioswale	32+05 41 RT	509	7.5
SWM-03	Bioswale	34+50 41 LT	502	18.0
SWM-05	Bioswale	34+50 41 RT	502	11.0
SWM-15	Bioswale	34+50 41 RT	501	16.0



Table 3.1 – Summary of Borings				
Boring No.	Primary Purpose	Station / Offset	G.S. Elevation	Depth (ft)
RB-04	Roadway	35+60 0	493	10.0
SWM-04	Bioswale	36+00 41 LT	490	10.0
SWM-16	Bioswale	36+00 41 RT	491	10.0
RB-05	Roadway	40+00 0	504	12.0
SWM-06	Bioswale	41+00 41 LT	502	8.1
SWM-19	Bioswale	29+50 37 LT	502	14.0
RB-06	Roadway	29+50 40 RT	502	10.0
SWM-07	Bioswale	43+00 41 LT	495	7.5
SWM-20	Bioswale	43+00 41 RT	497	9.0
SWM-08	Bioswale	44+50 41 LT	518	1.0
SWM-21	Bioswale	44+50 41 RT	498	1.0
RB-08	Roadway	45+00 0	512	20.0
SWM-09	Bioswale	46+00 41 LT	525	6.0
SWM-22	Bioswale	46+00 41 RT	514	2.5
RB-07	Roadway	47+50 16 LT	518	9.9
SWM-10	Bioswale	48+00 41 LT	520	15.0
SWM-23	Bioswale	48+00 41 LT	518	13.0
SWM-11	Bioswale	50+00 41 LT	522	12.0
SWM-24	Bioswale	50+00 41 RT	520	7.0
SWM-12	Bioswale	52+00 37 LT	525	10.0
SWM-17	Bioswale	52+00 37 RT	525	4.0
SWM-25	Bioswale	52+00 41 RT	529	14.0
* Offset boring	s. See Test Boring Logs ir	Appendix B for de	etails	

3.2 SOIL SAMPLING

Soil samples for the roadway and bridge borings were obtained at 2.5-ft intervals. Soil samples for the stormwater management borings were obtained continuously. In general, the SPT consists of advancing a 2-inch outside diameter sampling spoon 18-inches by driving it with a 140-pound hammer falling 30-inches (ASTM D 1586). Soil samples for all SWM borings were obtained by advancing the sampling spoon 24-inches. The values reported on the boring logs are the blows required to advance the sampling spoon each 6-inch increments. The first 6-inch increment is considered as seating. The sum of the number of blows for the second and third increments is the "N" value.

Bulk samples were obtained from the auger cuttings of Borings RB-01 to RB-08.



The soils were classified in general accordance with the Unified Soil Classification System (USCS) (ASTM D 2487) and the American Association of State Highway and Transportation Officials (AASHTO) Method 145. The USCS designations are shown on the Summary of Boring Data, Figure A-3. An RK&K field engineer recorded the classifications, observations, water and cave in depths and field sampling information on the Test Boring Logs contained in Appendix B.

Depth to groundwater was noted during the drilling operations. Groundwater levels were measured at the completion of drilling and, when possible, 24 hours or longer after the completion of drilling. The depth to the bottom of each borehole was also measured after the removal of the drilling augers to determine the susceptibility of the borehole to collapse or cave. This information is summarized in Section 4.3 Table 4.4.

3.3 ROCK SAMPLING

Bedrock was sampled using an NQ diamond bit with a double tube, swivel type barrel, which provides a 1.875-inch diameter core. The core description, core recovery, the Rock Quality Designation (RQD), and other pertinent information were recorded on the Test Boring Logs and on the Summary of Boring Data. The RQD value reflects the quality and fracture spacing of the rock and is defined as the sum of the length of rock pieces greater than 4-inches divided by the total core run length. The percentage of core recovery and RQD values provide an understanding of the physical and engineering properties of the rock.

3.4 LABORATORY TESTING

The laboratory testing consisted of determining the natural moisture content, grain-size distribution, Atterberg limits, modified Proctor moisture-density relationship, and California Bearing Ratio (CBR) for selected soil samples. The unconfined compressive strength was determined for selected rock core samples using the Point Load Test (PLT) method. Results of the soil and rock testing are included in Appendix C.

3.5 GEOPHYSICAL INVESTIGATION

To supplement the test borings, electrical resistivity tomography was performed by Enviroscan, Inc. on March 3, 2016. Please see Appendix D for the full Geophysical Investigation Report. Please see Appendix A-5 for an approximate interpretation of the bedrock profile.



4 SUBSURFACE CONDITIONS

4.1 GEOLOGY

4.1.1 Available Mapping

According to the Geologic Map of Maryland (1968) the project site is located in the South Mountain Anticlinorium and Frederick Valley section of the Eastern Piedmont Physiographic Province. Natural soils in this region are residual soils which have formed in place by the weathering of the parent bedrock. The project site appears to be located where the parent materials are mapped as the Frederick Formation consisting of limestone deposited during the Cambrian Period.

In situ decomposition of the parent carbonate rock typically produces a surficial layer of residual soil of variable thickness. Localized concentrations of bedding planes, fractures and other discontinuities often result in decomposition extending to deeper levels. Occasionally, solution activity develops below the rock surface, and these are generally filled with very soft reworked residual material. Sometimes the soils will arch over the cavity until the cavity becomes too large and then the soil collapses forming a sink hole. The more resistant less fractured rock will often form pinnacles of unweathered rock often extending to the ground surface. This combines with the solution cavities to form a very irregular rock surface.

More specifically, the site is located in the Cambrian Region, containing limestone, dolomite, shale, and sandstone. Conococheague Limestone described as dark blue, laminated, oolitic, argillaceous and siliceous limestone, algal limestone, and flat-pebble conglomerate; siliceous shale partings; some sandstone and dolomite. The Stonehenge Formation is part of a syncline/anticline trending N-NE, with the syncline running along Antietam Creek and the anticline to the east.

According to the Geologic and Karst Features Map of the Hagerstown Quadrangle, Washington County, Maryland (2013), the site spans across the following formations. The location of each is shown in Figure A-4 in Appendix A.

Stonehenge Formation Middle Member (Osm): The lower part of the middle member is composed of massive, medium gray, algal lime boundstone. Grades upsection into interbedded medium to dark algal thrombolites and medium gray, thinly bedded to ribbony, locally fossiliferous, lime wackestone to lime packstone. Several thin, tan dolomite beds occur near the middle of the unit.



Stonehenge Formation-Stoufferstown Member(Oss): Dark gray, argillaceous, thinly bedded to ribbony, lime mudstone with thin beds of flat-pebble lime grainstone conglomerate and hummocky, discontinuous, thin beds of laminated limestone. A single, 10-ft interval of massive, dark gray, thrombolytic, algal boundstone occurs approximately 30-ft above the base of the member. The member weathers into thin, brown and orange chips, which litter overlaying soil. Forms a low, discontinuous ridge. There are two known sinkholes mapped near the proposed alignment and several sinkholes near MD-64 found within this unit.

Stonehenge Formation-Upper Member(Osu): Medium to medium dark gray, medium-bedded, ribbony and oolitic, lime mudstone to packstone. Near the base of the member ribbony lime mudstone predominates. Upsection, medium gray, ribbony lime mudstone becomes interbedded with intervals of flat-pebble lime grainstone, and hummocky, thickly laminated lime packstone and oolitic lime packstone to grainstone. Locally, thin, algal thrombolites are present. This member commonly forms a persistent and mappable ridge and is frequently well-exposed. There is a high angle reverse fault mapped between the Stonehenge Formation Middle Member and the Stonehenge Formation-Upper member.

Rockdale Run Formation (Orr): Interbedded and cyclic limestone and dolomite, cherty in the lower 400-ft. Limestone intervals consist of medium to light gray, ribbony and thrombolytic to stromatolitic, lime mudstone to boundstone. Locally, limestone layers are light gray oolitic packstone to oolitic grainstone. Lies near the axis of a syncline, beneath Antietam Creek and the overlying alluvium deposits. Generally, strikes N-NE and dips 24-deg to 32-deg to the east.

Conococheague Formation Upper Member (Ecu): Interbedded medium to light gray, ribbony, lime mudstone that weathers to flaggy to platy beds, and arenaceous grainstone exhibiting edgewise and flat-pebble conglomerates. Locally, thin, pastel blue and pink marble strata are developed. Black or gray chert fragments and brown-weathering quartz sandstone cobbles are frequently abundant in overlaying soil. Generally strikes N-NE and has vertical bedding.

Conococheague Formation Middle Member (Ecm): Predominantly cyclically bedded, medium to dark gray, limestone and gray, laminated limestone and tan, laminated dolomite. Generally strikes N-NE and dips 35-deg to 60-deg.



Terrace Deposits (Qt): Reddish brown, sandy and clayey mixture of rounded pebbles to cobbles of sandstone, vein quartz, and quartzite. Present along elevated areas above Antietam Creek. Thickness ranges from a thin veneer to more than 10-ft. This unit is mapped as a cap in the area of the existing Professional Court. Although mapped in this area, borings did not encounter this material.

Alluvium: Poorly sorted, unconsolidated, tan, reddish brown, to dark gray mud, silt, sand and pebbles. Deposited within the channels of streams and on the flood plain adjacent to the streams. Mostly occurs along Antietam Creek.

4.1.2 Results of Geophysical Survey

The geophysical survey by Enviroscan, Inc. revealed a number of potential pinnacles and slots in the karsted bedrock. Potential pinnacles were located near STA 29+00, STA 30+00, STA 31+20, STA 40+50, STA 42+20, and STA 50+50. Potential slots were located near STA 22+20, STA 23+50, STA 30+50, STA 31+50, STA 32+50, STA 40+00, STA 42+00 and STA 43+90.

4.2 SUBSURFACE CONDITIONS

The Summary of Boring Data and the Test Boring Logs in Appendices A and B provide details related to the subsurface conditions encountered in the various borings. The stratification lines shown on the Summary of Boring Data and Test Boring Logs represent approximate transitions between material types. In situ, strata changes could occur gradually or at slightly different levels. Also, the borings depict conditions at particular locations and at the particular times indicated. Some conditions, particularly groundwater conditions between borings, could vary from the conditions encountered at the particular boring locations.

Topsoil: Topsoil was typically encountered at the surface of the borings and extends to depths ranging from 2-inches to 12-inches as shown in Table 4.1.



Table 4.1 – Topsoil	Thickness Encountered in Test Borings
Boring No.	Topsoil Thickness (inches)
AB-01	6
AB-02	6
AB-03	6
AB-04	6
AR-01	6
P-01	6
P-02	12
RB-03	6
RB-04	10
RB-05	2
RB-06	6
RB-07	6
RB-08	<1
SWM-01	3
SWM-02	6
SWM-03	8
SWM-04	6
SWM-05	6
SWM-06	2
SWM-07	3
SWM-08	12
SWM-09	12
SWM-10	6
SWM-11	6
SWM-12	6
SWM-13	6
SWM-14	6
SWM-15	10
SWM-16	10
SWM-17	3
SWM-18	2
SWM-19	6
SWM-20	6
SWM-21	12
SWM-22	6



Table 4.1 – Topsoil Thickness Encountered in Test Borings				
Boring No.	Topsoil Thickness (inches)			
SWM-23	6			
SWM-24	6			
SWM-25	6			
SWM-26	3			
SWM-27	3			
SWM-28	3			
SWM-29	6			
SWM-30	6			

Existing Pavement: Borings RB-01 and RB-02 were drilled through the existing Professional Court roadway. Table 4.2 summarizes the pavement types and thicknesses observed.

Table 4.2 – Pavement Thickness Encountered in Test Borings				
Boring No.	Bituminous Concrete (inches)	Aggregate Base (inches)		
RB-01	5	4		
RB-02	5	5		

The borings encountered the following three strata:

Stratum I – Alluvial Material: Stratum I was encountered in borings AB-01, AB-02, AB-03, P-1, and P-2 underneath surficial material and extended to depths ranging from 3-ft to 9.5-ft beneath the existing ground surface. Stratum I typically consists of brown to brownish gray, soft to stiff, medium to high plasticity CLAY with varying percentages of Silt and Sand and trace to no Gravel (CL, CH) [A-6, A-7-6]. SPT-N values ranged from 2 blows per foot (bpf) to 13 blows per foot (bpf). The natural moisture content ranges from 20.4-percent to 33-percent and averages 27.7-percent. The liquid limit ranges from 29 to 64, and the plastic limit ranges from 15 to 24.



Stratum II – Residual Soils: Stratum II was encountered in all borings except for AB-04 and RB-08, where rock was encountered immediately below the ground surface, underneath surficial material (topsoil) and extended to depths ranging from 2-ft to 13-ft beneath the existing ground surface. Stratum II typically consists of brown to brownish gray, soft to very stiff, medium to high plasticity CLAY with varying percentages of Silt, trace Sand, and trace to no Gravel (CL, CH) [A-6, A-7-6]. SPT-N values ranged from 4 blows per foot (bpf) to 50/5-inches blows per foot (bpf). The natural moisture content ranges from 14.0-percent to 37.6-percent and averages 30.6-percent. The liquid limit ranges from 43 to 77, and the plastic limit ranges from 15 to 28.

Auger refusal was encountered at depths ranging from 0.0-ft to 12.0-ft below the existing ground surface as shown in Table 4.3. Auger refusal may result from hard cemented soil, soft weathered rock, coarse gravel or boulders, thin rock seams, or the upper surface of sound continuous rock. Rock coring techniques are required to determine the character and continuity of the refusal materials.

Table 4.3 – Summary of Auger and Spoon Refusal				
Boring No.	Auger Refusal		Spoon F	Refusal
Boning No.	Depth (ft)	Elevation	Depth (ft)	Elevation
AB-01	6.0	475.0	6.0	475.0
AB-02	9.5	471.5	8.5	472.5
AB-03	3.0	489.0		
AB-04	3.0	487.0	1.0	489.0
AR-01*	10.0	483.0		
P-01	7.5	462.5	6.0	464.0
P-01A	7.5	462.5		
P-02	9.0	461.0	8.0	462.0
RB-05	12.0	491.5	12.0	491.5
RB-07			9.5	508.0
RB-08	0.0	511.7		
SWM-02			17.0	490.2
SWM-06	8.0	494.1	8.0	494.1
SWM-07			7.5	488.0
SWM-08	1.0	516.9		
SWM-09	6.0	518.7		
SWM-13	11.0	491.5	10.0	492.5



Table 4.3 – Summary of Auger and Spoon Refusal					
Boring No	Auger Refusal		Spoon	Spoon Refusal	
Boning No.	Depth (ft)	Elevation	Depth (ft)	Elevation	
SWM-14	5.5	503.5	4.0	505.0	
SWM-14A	7.5	501.5	7.5	501.5	
SWM-17	4.0	521.1	4.0	521.1	
SWM-18	12.0	490.5			
SWM-21	1.0	496.6			
SWM-22	2.5	511.7	2.0	512.2	
SWM-24	7.0	512.9	7.0	512.9	
* Auger refus	* Auger refusal at 10-ft, but spoon broke through.				

<u>Stratum III – Bedrock</u>: Bedrock was encountered beneath surficial material, Stratum I, or Stratum II. Stratum III consisted of light gray, medium strong to strong LIMESTONE. Recovery ranged from 31 to 100-percent and averaged 90-percent. The Rock Quality Designation (RQD) ranged from 0 to 100-percent and averaged of 83.7-percent. Unconfined compressive strength ranged from 648-ksf to 2,399-ksf with an average of 1,643-ksf. Electrical resistivity surveys suggest that this stratum is pinnacled and contains some soft areas extending to depth as well as other anomalies.

4.3 GROUNDWATER

Groundwater was not encountered in the borings during drilling. It is generally desirable to allow test borings to remain open for at least 24 hours after the completion of drilling and the removal of the drill tools and casing from the borehole. The purpose of this procedure is to allow the groundwater level in each borehole to recover from the effects of the test drilling. In clay soils, the length of time may extend several days before the groundwater level recovers to the predrilling elevation. It was necessary to backfill certain borings immediately after the completion of drilling due to traffic, safety and/or logistical concerns. Groundwater data is summarized in Table 4.4.

A more accurate determination of the hydrostatic water table would require the installation of perforated pipes or piezometers which could be monitored over an extended period of time. The actual level of the hydrostatic water table and the amount and level of perched water should be anticipated to fluctuate throughout the year, depending upon variations in precipitation, surface runoff, infiltration, site topography, and drainage.



In addition to groundwater levels, the depth to the bottom of each borehole was measured to determine the susceptibility of the borehole to collapse or cave. This information provides the contractor with information regarding the "stand-up" time of the soil, or the ability of the sides of an excavation to remain vertical or near vertical during trench excavation. This information is summarized in Table 4.4.

Table 4.4 – Summary of Borehole Groundwater and Cave Data						
	Ground	Groundwater				
	Surface	Elevation		24-Hour Cave Depth		
Boring No.	Elevation	Initial	24-Hour	(ft)		
AB-01	481.0	NE	NE	4		
AB-02	481.0	NE	NE	7		
AB-03	492.0	NE	NE	7		
AB-04	490.0	NE	NE	10		
AR-01	493.0	NE	NE	8.3		
P-01A	470.0	NE	467.0	7		
P-02	470.0	NE	466.0	8		
RB-01	497.0	NE	NE	3		
RB-02	510.0	NE	NE	5		
RB-03	510.0	NE	NE	7.5		
RB-04	493.0	NE	NE	5		
RB-05	503.5	NE	NE	7.9		
RB-06	502.0	NE	NE	4.5		
RB-07	517.5	NE	NE	5.3		
RB-08	511.7	NE	500.7	20		
SWM-1	500.0	NE	NE			
SWM-2	507.2	NE	NE	3.5		
SWM-3	502.3	NE	NE	15		
SWM-4	490.0	NE	NE	5.5		
SWM-5	502.3	NE	NE	4		
SWM-6	502.1	NE	NE			
SWM-7	495.0	NE	NE	4		
SWM-8	517.9	NE	NE			
SWM-9	524.7	NE	NE			
SWM-10	520.2	NE	NE	7		
SWM-11	522.4	NE	NE	6.2		
SWM-12	525.1	NE	NE	4		
SWM-13	502.5	NE	NE	7.5		



Table 4.4 – Summary of Borehole Groundwater and Cave Data							
	Ground	Groundwater					
	Surface	Elevation		24-Hour Cave Depth			
Boring No.	Elevation	Initial	24-Hour	(ft)			
SWM-14	509.0	NE	NE				
SWM-15	500.9	NE	NE	6.5			
SWM-16	491.0	NE	NE	6.5			
SWM-17	525.1	NE	NE	4.7			
SWM-18	502.5	NE	NE	7.4			
SWM-19	502.1	NE	NE	5.5			
SWM-20	496.8	NE	NE	4.6			
SWM-21	497.6	NE	NE				
SWM-22	514.2	NE	NE				
SWM-23	518.4	NE	NE	7			
SWM-24	519.9	NE	NE	4.5			
SWM-25	529.4	NE	NE	5.5			
SWM-26	506.3	NE	NE	6			
SWM-27	500.5	NE	NE				
SWM-28	503.0	NE	NE	3.5			
SWM-29	500.6	NE	NE	4			
SWM-30	495.7	NE	NE	2			
"" Borehole backfilled upon completion "NE" Groundwater not encountered							


5 EVALUATIONS AND RECOMMENDATIONS

The following recommendations have been developed on the basis of the previously described project characteristics and subsurface conditions. If there are any significant changes to the project characteristics or if significantly different subsurface conditions are encountered during construction, RK&K should be consulted so that the recommendations of this report can be reviewed.

5.1 GENERAL EARTHWORK

Topsoil, other organic materials, frozen, wet, soft or loose soils, and other deleterious materials should be removed and wasted before placement of fill. These stripping operations should be performed in a manner consistent with good erosion and sediment control practices. Stripping, clearing and grubbing should be performed in accordance with Section 101 of the Maryland Department of Transportation State Highway Administration *Standard Specifications for Constructions and Materials*, 2008.

5.2 DEWATERING AND DRAINAGE

The proposed construction is anticipated to encounter surface water and groundwater. The site drainage should be such that the runoff onto adjacent properties, into the creek, streams, and storm drains is controlled properly.

It is likely that groundwater will be encountered in some of the undercutting for the MSE walls and possibly in the bridge abutment foundations. Appropriate dewatering should be carried out so that construction will be performed in a relatively dry condition. Dewatering inside excavations should be able to be handled with conventional ditching, sumps, and pumps. The actual dewatering plan is the responsibility of the Contractor.

Sediment laden water should not be allowed to flow into any watercourse, adjacent drainageway, or over land without first filtering it through an approved desilting device.

5.3 FILL SELECTION, PLACEMENT AND COMPACTION

In general, existing on-site soils free from environmental contamination, building debris, frozen, organic or wet materials, are anticipated to meet the requirements for common borrow as per Maryland Department of Transportation State Highway Administration *Standard Specifications for Constructions and Materials* Section 916.01. If imported materials are required, the material



should be in accordance with Section 916.01.01. Embankments and areas supporting pavements should be prepared in accordance with Maryland Department of Transportation State Highway Administration *Standard Specifications for Constructions and Materials* Section 204. Fill in structural areas should be placed and compacted in accordance with Section 402.03. Smaller lift thicknesses may be required near structures or retaining walls to avoid overstressing the retaining walls or other structures.

5.4 ROCK SLOPE

In some areas, cuts will be required to reach the proposed subgrade elevation of the proposed Professional Boulevard. Some of these cuts will require rock excavation. The cut required to reach the roadway grade from approximately STA 44+25 to 46+60 will be as deep as 15-ft and will likely require rock excavation.

Because of the high quality of rock (RQD > 90%), predictable and moderate joint angle (~45-deg), rough joints (Jr = 3), and the maximum slope height of approximately 15-ft, there is minimal concern for global stability or failure on the face but rock falls could be an issue which is hard to predict. Once blasting is complete, the exposed rock surface should be observed to locate any loose rock. It may be necessary to scale the rock face to remove loose rocks and thereby reduce the risk of rock fall in the future.

A "Ritchie Ditch" should be constructed between the rock cut and the roadway for rock fall protection purposes. The ditch width and depth depend on the slope angle and height. A summary of the ditch dimensions based on different slope angles of the rock cut is shown in Table 5.1 below.

Table 5.1 – Summary of Ditch Dimensions and Rock Fall Protection						
2H:1V (~27-deg) 1H:1V (45-deg) 0.5H:1V (~63-deg) 0.1H:1V (~84-deg						
Rock Motion	Rolling	Rolling	Bounce	Free Fall		
Ditch Depth	3.5-ft	3.5-ft	4-ft	3-ft		
Ditch Width	12-ft	12-ft	10-ft	10-ft		
Fall Protection	Vertical Barrier	Vertical Barrier	Vertical Barrier	None		



We recommend a 0.1H:1V angle for the rock cut and a 3-ft deep, 10-ft wide ditch between the rock cut and the roadway. A 0.1H:1V slope will minimize rock excavation, has minimal risk of global stability or rock slide failures, has minimized ditch dimensions, and does not require barriers since the rocks will free fall and land in the ditch.

5.5 PAVEMENT

Pavement design was performed in accordance with AASHTO Guide for Design of Pavement Structures, 2015. Two traffic models were used to evaluate pavement design options; one developed by Sabra, Wang & Associates using NCHRP, and the second using a HEMPMO model.

5.5.1 Pavement Design for New Roadway Sections

Table 5.2 summarizes the estimated service life of the three proposed pavement sections depending on the traffic conditions. The Yale Drive pavement section in Table 5.2c is designed to match that of the existing pavement section at Yale Drive. The ESAL values for Yale Drive and the mill and overlay pavement sections were back-calculated based on the structural number of the existing pavement and a 25-year design life.

If the pavement is designed assuming NCHRP traffic loads (ADT = 4,075), the required pavement Structural Number (SN) is 4.15 for a 25-year design life. However, if the HEMPMO model (ADT = 6,943) is actually more accurate, then the service life will be only 16 years. If the pavement is designed using the HEMPMO model, the required SN is 4.76 for a 25-year design life, but if the actual traffic is closer to the NCHRP model, then the service life will be approximately 45 years. If the Yale Drive section (SN = 4.72) is used and the HEMPMO model is accurate the service life will be 24 years, but if the NCHRP model is more accurate, the service life will be about 34 years.

All of these estimates assume that regular maintenance, such as crack sealing, slurry seals, or mill and overlay are performed on a regular basis. Table 5.2a, 5.2b, and 5.2c summarize the three proposed sections in detail.



If the NCHRP traffic model is chosen, we recommend using the pavement section in Table 5.2a. If the HEMPMO traffic model is chosen, we recommend using the pavement section in Table 5.2b. All these sections assumed the subgrade CBR is 3.0. The in situ CBR value should be determined prior to placing pavement to verify the design CBR. The in situ CBR can be verified using the Clegg Impact Hammer, light weight deflectometer, drop hammer penetrometer or the field CBR procedure.

Table 5.2 – Summary of New Pavement Section Service Life							
Traffic Model	SN Required	Estir	Estimated Service Life (Years)				
	(25-Vears)	NCHRP Design	HEMPMO Design	Yale Dr. Section			
(701)	(25-16813)	(SN = 4.18)	(SN = 4.9)	(SN = 4.72)			
NCHRP	1 15	25	45	30			
(4,075)	4.15	25	40	59			
HEMPMO	1 76	16	25	24			
(6,943)	4.70	10	20	24			

Table 5.2a – Pavement Section (NCHRP)				
	1.5-inches Superpave Asphalt Mix,			
	9.5 mm, PG 64S-22, Level 2			
	7.0-inches Superpave Asphalt Mix,			
RCHRF(ADT = 4,075)	19.0 mm, PG 64S-22, Level 2			
EGAL = 055,500	6.0-inches Dense Graded			
MINO Alteria	Aggregate Base			
	GSSA			



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Table 5.2b – Pavement Section (HEMPMO)				
	1.5-inches Superpave Asphalt Mix,			
	9.5 mm, PG 64S-22, Level 2			
	7.0-inches Superpave Asphalt Mix,			
ESAL = 2.250.000	19.0 mm, PG 64S-22, Level 2			
ESAL = 2,250,900 Minor Arterial	12.0-inches Dense Graded			
Minor Anenai	Aggregate Base			
	GSSA			

Table 5.2c – Pavement Section (Yale Dr.)				
	4.0-inches Superpave Asphalt Mix,			
	9.5 mm, PG 64S-22, Level 2			
(Back Calculated)	5.0-inches Superpave Asphalt Mix,			
(Back Calculated)	19.0 mm, PG 64S-22, Level 2			
Minor Arterial	8.0-inches Dense Graded			
	Aggregate Base			
	GSSA			



5.5.2 Pavement Design for Existing Professional Court

A portion of the existing pavement section of the existing Professional Court will be reused in constructing the new roadway. Table 5.3 summarizes pavement section options considering removal of all of the existing bituminous concrete.

Table 5.3 – Existing Professional Court										
Traffic	Design	SN Required	SN Calculated	GAB (in)	# Lifts	Base (in)	# Lifts	Surface (in)	# Lifts	Service Life (yrs)
Sabra & Wang	4.5" 19.0mm	4.15	3	4.5	N/A	4.5	2	1.5	1	6
Sabra & Wang	5.5" 19.0mm	4.15	3.4	4.5	N/A	5.5	2	1.5	1	11
Sabra & Wang	6.5" 19.0mm	4.15	3.8	4.5	N/A	6.5	2	1.5	1	18
Sabra & Wang	7.5" 19.0mm	4.15	4.2	4.5	N/A	7.5	2	1.5	1	28
НЕМРМО	4.5" 19.0mm	4.76	3	4.5	N/A	4.5	2	1.5	1	3
НЕМРМО	5.5" 19.0mm	4.76	3.4	4.5	N/A	5.5	2	1.5	1	6
НЕМРМО	6.5" 19.0mm	4.76	3.8	4.5	N/A	6.5	2	1.5	1	10
НЕМРМО	7.5" 19.0mm	4.76	4.2	4.5	N/A	7.5	2	1.5	1	15
НЕМРМО	9.0" 19.0mm	4.76	4.8	4.5	N/A	9	3	1.5	1	25

Based on our analysis, to construct a new bituminous concrete pavement section for the existing Professional Court, if the NCHRP traffic model is chosen, we recommend using 7.5-inches of Superpave Asphalt Mix 19.0mm PG-64S-22, Level 2. If the HEMPMO model is chosen, we recommend using 9.0-inches of Superpave Asphalt Mix 19.0mm PG-64S-22, Level 2. In all sections the surface course should be Superpave Asphalt Mix 9.5mm PG 64S-22, Level 2, the base course should be Superpave Asphalt Mix 19.0mm PG-64S-22, Level 2, the should be Superpave Asphalt Mix 19.0mm PG-64S-22, Level 2, the base course should be Superpave Asphalt Mix 19.0mm PG-64S-22, Level 2, and the subbase should be graded aggregate base (GAB).



We also evaluated reusing some of the existing bituminous concrete pavement section on the existing Professional Court. We propose to mill the top 2-inches, then construct the new pavement section over the remaining existing bituminous concrete. Table 5.4 summarizes the required pavement sections for this option.

Table 5.4 - Existing Professional Court (2-inch Mill)												
Traffic	Design	SN Required	SN Calculated	Existing GAB (in)	# Lifts	Existing Base (in)	# Lifts	New Base (in)	# Lifts	New Surface (in)	# Lifts	Design Life (yrs)
Sabra & Wang	4.5" Base	4.15	2.88	4.5	N/A	3	N/A	1.5	1	1.5	1	4
Sabra & Wang	5.5" Base	4.15	3.28	4.5	N/A	3	N/A	2.5	1	1.5	1	9
Sabra & Wang	6.5" Base	4.15	3.68	4.5	N/A	3	N/A	3.5	1	1.5	1	15
Sabra & Wang	8.0" Base	4.15	4.28	4.5	N/A	3	N/A	5	2	1.5	1	30
НЕМРМО	4.5" Base	4.76	2.88	4.5	N/A	3	N/A	1.5	1	1.5	1	2
НЕМРМО	5.5" Base	4.76	3.28	4.5	N/A	3	N/A	2.5	1	1.5	1	5
НЕМРМО	6.5" Base	4.76	3.68	4.5	N/A	3	N/A	3.5	1	1.5	1	9
НЕМРМО	7.5" Base	4.76	4.08	4.5	N/A	3	N/A	4.5	2	1.5	1	14
НЕМРМО	9.5" Base	4.76	4.88	4.5	N/A	3	N/A	6.5	2	1.5	1	28

Based on our analysis, for the 2-inch mill option, if the NCHRP traffic model is chosen we recommend using 5-inches of Superpave Asphalt Mix 19.0mm PG-64S-22, Level 2. If the HEMPMO model is chosen, we recommend using 9.0inches of Superpave Asphalt Mix 19.0mm PG-64S-22, Level 2.

In all sections, the surface course should be Superpave Asphalt Mix 9.5mm PG 64S-22, Level 2, the base course should be Superpave Asphalt Mix 19.0mm PG-64S-22, Level 2, and the subbase should be graded aggregate base (GAB).



We recommend the 2-inch mill and overlay option for existing Professional Court. It will facilitate and simplify maintenance of traffic during construction. It will also provide time and cost savings for the project.

After the top 2-inches is removed, all visible cracks in the remaining pavement should be sealed in accordance with Maryland State Highway Administration *Standard Specifications for Construction and Materials*, Section 510. If any alligator cracking or otherwise highly distressed pavement is observed, the area should be saw cut and a full depth patch in accordance with Maryland State Highway Administration *Standard Specifications for Construction and Materials*, Section 510. If say alligator cracking or otherwise highly distressed pavement is observed, the area should be saw cut and a full depth patch in accordance with Maryland State Highway Administration *Standard Specifications for Construction and Materials*, Section 505 will be required.

5.5.3 Construction Recommendations

All pavement construction procedures should be in accordance with Maryland Department of Transportation State Highway Administration Standards. Pavement subgrades should be kept dry and should be sloped to prevent ponding of precipitation and run-off.

Prior to the placement of pavements, all subgrades should be proof-rolled with a heavily-loaded dump truck or other pneumatic-tired vehicle of similar size and weight. The purpose of the proof-rolling is to provide surficial densification and to locate any isolated areas of soft or loose soils.

Unsuitable subgrade materials should be undercut a minimum of 24-inches. A Class ST Geotextile should be placed in accordance with Maryland State Highway Administration *Standard Specifications for Construction and Materials*, Section 921.09 on the prepared subgrade, and then backfilled with compacted select fill. Based on the subsurface exploration, unsuitable areas that will require undercutting are anticipated between STA 20+35 to 44+00 and STA 46+50 to 52+50.

As an alternative to a 2-ft undercut, soft materials may be removed and replaced with Geosynthetic Stabilized Subgrade using Graded Aggregate Base (GSSA) in accordance with Maryland State Highway Administration *Standard Specifications for Construction and Materials*, Section 211. This consists of placing a stabilization geotextile on the prepared bottom of undercutting and placing and compacting 12-inches of Graded Aggregate Base (GAB).



5.6 STORMWATER MANAGEMENT

Based on the subsurface exploration, the proposed stormwater management facilities inverts will be in a karst area at or near bedrock. For this reason, infiltration practices are not recommended at this site. Ponds or swales should be lined to prevent infiltration into bedrock that could expand karst features.

5.7 BRIDGE FOUNDATION RECOMMENDATIONS

5.7.1 Shallow Foundations

Bearing resistance for shallow foundations was evaluated using AASHTO LRFD methods. It is recommended that the conventional spread footing for Abutment B be proportioned for a factored bearing resistance of 30-ksf, provided that sliding and eccentricity requirements are satisfied. The spread footing should be founded on competent, sound bedrock. Settlements are anticipated to be negligible.

Uneven rock surface and karst features discovered during excavation should be grouted to provide a stable bearing surface for the spread footing foundation. Over excavated areas should be backfilled using Mix No. 1 subfoundation concrete according to *MD SHA Standard Specifications for Construction and Materials* Section 402.02.

5.7.2 Drilled Shaft Foundations

Based on the foundation loads described in Section 2.2.2 of this report, the results of the subsurface exploration and our experience in the area, we recommend that the west abutment and the two piers of the Professional Boulevard Bridge be supported on drilled shaft foundations. The shaft diameter and socket length were governed by lateral loads for the West Abutment, and axial loads for the piers. Recommendations for the drilled shafts are summarized in Table 5.5.



Table 5.5 – Summary of Drilled Shaft Recommendations							
Structure	Shaft Diameter in Soil (in)	Rock Socket Diameter (in)	Approximate Total Shaft Length (ft)	Rock Socket Length (ft)	Estimated Lateral Deflection (in)		
West Abutment	42	36	22	3	0.22		
Pier 1	42	36	13	10	0.02		
Pier 2	42	36	15	10	0.04		

The drilled shaft foundations have been evaluated based on the results of the subsurface exploration and the foundation loads for each structure. The lateral deflections have been estimated for the service limit state lateral loads. The software Allpile7 was used to estimate lateral deflections. The axial resistance was checked manually using procedures in the AASHTO LRFD code. The drilled shaft design parameters used in the software were estimated using subsurface information from the test borings including SPT N-value correlations, PLT and UCC tests results, and our experience in this area.

For the design of the drilled shafts, it should be noted that the scour elevation is located below the bottom of footing elevation, therefore the drilled shafts have been designed for an unsupported length from the bottom of footing to the scour depth.

The shafts should extend a minimum of 3-ft into sound bedrock at the West Abutment foundation location and 10-ft into sound bedrock at both Pier 1 and Pier 2. It is recommended that prior to the installation of the drilled shafts, the Contractor conduct probe holes using either air track drilling or other testing methods at each of the drilled shaft locations to verify the depth of sound bedrock. These probes should extend to a depth of at least 10-ft below the design tip elevation.

The length of the drilled shaft extending through rock is the rock socket. The length of the rock socket is defined as the length of excavation through rock that cannot be drilled with conventional earth or rock augers and/or underreaming tools and requires the use of special rock core barrels, air tools, and/or other methods of hand excavation. Auger refusal is defined as drilling advancement of less than 2-inches per minute for a 42-inch diameter rock auger with carbide



teeth powered by a drilling machine exerting a rotary output of 80,000-ft-lbs of torque and 20,000-lb of crowd.

5.7.3 Construction and Monitoring Recommendations

We recommend that the installation of the drilled shafts be monitored by a Geotechnical Engineer or Engineering Geologist and supervised by a Geotechnical Engineer licensed in the State of Maryland. During the installation of the drilled shafts, the depth of embedment, the diameter of the shafts and sockets, plumbness, and appropriateness of the bearing materials should be verified. A Geotechnical Engineer should document the occurrence or absence of differing site conditions and verify that the construction is performed in accordance with the specifications.

At the West Abutment, permanent casing will be required extending through the proposed MSE wall at each drilled shaft location to isolate the foundation from the MSE wall. Temporary casing will be required to support the shaft excavation. Bentonite slurry should not be used. Water or polymer slurry may be used if necessary to balance any hydrostatic pressures.

Before concrete placement commences, the bottom of the shaft excavation should be cleaned out using procedures such as airlifts and video monitoring to verify the removal of loose material.

Given the small diameter of the shaft and socket, we recommend the use of a hopper, tremie, or other suitable device to control concrete placement. The placement of concrete in the shaft should proceed until the concrete level is above the external fluid level and should be maintained above this level throughout casing removal. If water or slurry is present in the drilled shaft at the time of concrete placement, a tremie tube should be used to place the concrete below the level of water or slurry. Concrete should be discharged with the tremie pipe within 6-inches off of the bottom of excavation. A concrete head of at least 5-ft above the discharge should be maintained at all times.

5.8 MSE WALL RECOMMENDATIONS

Retaining wall recommendations are provided below for each structure. These recommendations are based on the TS&L structural drawings and the available subsurface information at the time of this report. The MSE walls were evaluated using the software MSEW 3.0 by ADAMA Engineering.



The construction of the bridge will require three MSE walls at the western abutment, Abutment A. It is recommended that the MSE walls for the West Bridge abutments be constructed with No. 57 stone in the reinforced zone. The minimum reinforcement length, L, for the walls will need to be extended beyond the minimum length specified in AASHTO. This is detailed in the following sections.

Global stability analyses were also performed using the Morgenstern-Price method with the software application Slope/W 2012 and indicate a satisfactory factor of safety of at least 1.5.

5.8.1 Retaining Walls RW1

At the west abutment, due to scour elevations, RW1 will need to bear on bedrock. Alternatively, soil within the 100-year and 500-year floodplains may be undercut to bedrock and backfilled to the proposed leveling pad elevation with non-erodible Mix No. 1 subfoundation concrete according to *MD SHA Standard Specifications for Construction and Materials* Section 402.02.

Table 5.6 summarizes the soil parameters to be used by the Contractor during design of the MSE wall for this structure.

Table 5.6 – Retaining Wall RW1 Soil Parameters						
	Design Unit Drained Angle of					
Soil	Weight – γ (pcf)	Friction – ϕ (deg)	Shear - S _u (psf)			
Reinforced Soil	105	24				
(#57 Stone)	105	34	-			
Retained Soil	125	20				
(Common Borrow)	125	20	-			
Foundation Soil	120	24	1 550			
(Clay)	120	24	1,000			

It is recommended that the wall be constructed with No. 57 stone in the reinforced zone, and common borrow fill in the retained zone. The minimum reinforcement length for the wall is L = 1.1H, which was increased from the AASHTO minimum to satisfy minimum requirements for bearing resistance. The suitability of the wall subgrade and bearing resistance as shown on the approved shop drawings should be verified prior to wall construction.



It is anticipated that the maximum settlement for the wall will be about 7.4-inches. The differential settlement along the wall face satisfies the AASHTO minimum requirements of less than 1/100, so the wall can be constructed in one stage. Based on our evaluation, the settlement should occur within four to 17 months after fill placement to final grade. Settlements should be monitored with settlement plates and surface monitoring points to verify movement has substantially ceased or less than 1-inch of remaining settlement is predicted prior construction of parapets and pavements.

The topographical conditions at Retaining Wall 1 minimize the probability of global instability of Retaining Wall 1.

5.8.2 Retaining Wall RW2

Due to scour elevations, the base elevation of the MSE wall should be lowered to bedrock. Alternatively, soil in the scour zone may be undercut to bedrock and backfilled to the proposed leveling pad elevation with non-erodible lean concrete in according to MD SHA Standard Specification Section 402.02.

Table 5.7 summarizes the soil parameters to be used by the Contractor during design of the MSE wall for this structure.

Table 5.7 – Retaining Wall RW2 Soil Parameters						
	Design Unit	Drained Angle of	Undrained			
Soil	Weight – γ (pcf)	Friction – ϕ (deg)	Shear - S _u (psf)			
Reinforced Soil	105	24				
(No. 57 Stone)	105	54	-			
Retained Soil	105	20				
(Common Borrow)	125	20	-			
Foundation Soil	150	24				
(Bedrock)	150	54	-			

It is recommended that the wall be constructed with No. 57 Stone in the reinforced zone and common borrow fill in the retained zone.



The minimum reinforcement length for the walls is L = 0.8 H. The suitability of the wall subgrade and bearing resistance as shown on the approved shop drawings should be verified prior to wall construction.

Due to the wall bearing on bedrock, total and differential settlement will not be significant and global stability will be acceptable.

5.8.3 Retaining Wall RW3

At the abutment, due to scour elevations, the base of RW3 will need to be lowered to bedrock within the 100-year and 500-year floodplains. Alternatively, soil in the floodplains may be undercut to bedrock and backfilled to the proposed leveling pad elevation with non-erodible lean concrete in according to *MD SHA Standard Specifications for Construction and Materials* Section 402.02.

Table 5.8 summarizes the soil parameters to be used by the Contractor during design of the MSE wall for this structure.

Table 5.8 – Retaining Wall RW3 Soil Parameters						
	Undrained					
Soil	Weight γ (pcf)	Friction, ϕ (deg)	Shear, S _u (psf)			
Reinforced Soil	105	34	_			
(No. 57 Stone)	105	34	-			
Retained Soil	125	29				
(Common Borrow)	125	20	-			
Foundation Soil	125	30	_			
(Select Fill)	120	52	-			

It is recommended that the wall be constructed with No. 57 Stone in the reinforced zone and common borrow in the retained zone.

The minimum reinforcement length for the wall is L = 0.8H, which was increased from the AASHTO minimum to satisfy minimum requirements for bearing resistance and global stability.

Highly plastic clay was encountered in the test borings at the proposed foundation elevation of RW3 outside of the scour zone. The wall will need to be undercut to a depth of 0.5L, or to bedrock



if encountered shallower, and backfilled with select fill or CR-6. The suitability of the wall subgrade and bearing resistance as shown on the approved shop drawings should be verified prior to wall construction.

It is anticipated that the total settlement for the wall will be negligible as a result of the foundation soil being undercut and replaced with compacted select fill or CR-6. Global stability analyses indicate the factor of safety satisfies the AASHTO requirement.

The owner of the gas utility in the area of RW3 should be notified so that the impact, if any, of the proposed construction can be evaluated.

5.8.4 Retaining Wall RW4

Table 5.9 summarizes the soil parameters to be used by the Contractor during design of the MSE wall for this structure.

Table 5.9 – Retaining Wall RW4 Soil Parameters					
	Design Unit Weight	Undrained			
Soil	γ (pcf)	Angle of Friction, ϕ (deg)	Shear, S _u (psf)		
Reinforced Soil	105	24			
(No. 57 Stone)	105	54	-		
Retained Soil	125	28			
(Common Borrow)	125	20	-		
Foundation Soil	115	25	1 530		
(Clay)	115	25	1,000		

It is recommended that the wall be constructed with No. 57 Stone in the reinforced zone and common borrow in the retained zone.

The minimum reinforcement length for the wall is L = 1.0H, which was increased from the AASHTO minimum to satisfy minimum requirements for bearing resistance and global stability. The suitability of the wall subgrade and bearing resistance as shown on the approved shop drawings should be verified prior to wall construction.



It is anticipated that the maximum total settlement will be 9.5-inches. The differential settlement along the wall face satisfies the AASHTO minimum requirements of less than 1/100. Global stability analyses indicate the factor of safety satisfies the AASHTO requirement. Based on our evaluation, the settlement should occur within approximately 13 months after fill placement to final grade. Settlements should be monitored with settlement plates and surface monitoring points to verify movement has substantially ceased prior construction of parapets and pavements.

The effects of differential settlement along the length of the proposed storm drain pipes that extend through or below the wall should be evaluated to determine appropriate pipe type, joint type, joint spacing, elevation, and other pertinent design details. If the pipes extend through the wall, details should be provided by the wall manufacturer for layout of reinforcement in the areas of the proposed pipes.

5.8.5 MSE General Foundation Recommendations

The following sections are general recommendations for construction of the MSE walls.

The detailed internal and external stability design of the MSE walls is the Contractor's responsibility and will need to be designed by a Professional Engineer licensed in the State of Maryland and reviewed by the Engineer.

Bearing Resistance: The nominal bearing resistance, Meyerhof stress, and eccentricity (e) were estimated using a software program entitled MSEW, a design and analysis software for mechanically stabilized earth walls. The factored bearing resistance was estimated using the following equation:

$$q_r = \phi_b q_n$$

Where: q_r – Factored Bearing Resistance ϕ_b – Bearing Resistance Factor from AASHTO (Table 11.5.7.1) q_n – Nominal Bearing Resistance

Proper construction procedures should be used to maintain the bearing qualities of the MSE excavations. Foundations and excavations should be protected from the detrimental effects of precipitation, seepage, surface runoff, and frost. The top of the leveling pad should be a minimum



of 2.5-ft below the proposed ground surface to protect against frost heave. Before placing the leveling pad or new compacted fill, the subgrade should be reviewed and tested by a technician under the guidance of a professional Geotechnical Engineer, licensed in the State of Maryland. In the field, if the material is judged unsuitable, it should be undercut to firm material. The undercut area should be backfilled with crusher run, dense graded aggregate or sub-foundation concrete for taller walls. Where the design bearing stress is relatively low, select borrow as defined in the MD SHA Standard Specification Section 916.01.01, may provide adequate support.

Lightweight walk behind compaction equipment may be required near the wall face to attain the proper degree of compaction without overstressing connections or facing panels. Extra care should be given to avoid damaging the wall due to heavier loads produced by larger construction equipment.

Prior to placing new fill, the exposed ground surface should be proof-rolled to locate any soft spots requiring additional undercutting in accordance with Section 204.03.01 of the MD SHA Standard Specifications.

Corrosion Protection: As indicated in FHWA NHI-00-044, the retaining wall backfill material should meet certain electrochemical properties. Table 5.10 provides details regarding the limits of electrochemical properties and the corresponding test method for the reinforcement backfill. We recommend that No. 57 stone be used for fill in the reinforcement zone.

Table 5.10 – Limits of Electrochemical Properties for Backfill			
Property	Criteria	Test Method	
Resistivity	Greater than 3,000 ohm-cm	AASHTO T-288-91	
pН	5 to 10	AASHTO T-289-91	
Chlorides	Less than 100 PPM	AASHTO T-291-91	
Sulfates	Less than 200 PPM	AASHTO T-290-91	
Organic Content	1% max	AASHTO T-267-86	

Surface and Subsurface Drainage Requirements: It is possible that during excavation groundwater may be encountered. It is anticipated that minor dewatering during construction will be required using sumps and trenches. If No. 57 stone is used in the reinforcement zone, special drainage such as blanket, face, or chimney drains will not be required.



Erosion Control: Exposed slopes should be protected from erosion in accordance with local sediment and erosion control regulations and as described in the Erosion and Sediment Control Plans. Runoff onto new construction or other disturbed areas should be diverted until vegetation has been firmly established.

Reinforcement Length and Global Stability: A minimum Factor of Safety (FS) of 1.5 was used to evaluate global stability. The reinforcement length for all MSE walls should be a minimum of 0.8H to 1.1H (see Section 5.8), where H is the height of the retaining wall from the top of the leveling pad to the ground surface above the wall, unless otherwise noted. The minimum length of reinforcement regardless of the wall height should be 8-ft.

Settlement: Proposed underground utilities need to be evaluated for settlement due to the MSE walls. Utilities and inlets through the MSE reinforcement zone should be installed to avoid interferences with the reinforcement straps.



BASIS OF RECOMMENDATIONS

This report has been prepared to present the geotechnical conditions at the site and the recommended method of founding the proposed construction. Adequate recommendations have been provided to serve as a basis for design and preparation of plans and specifications. The opinions, conclusions and recommendations contained in this report are based upon our professional judgment and generally accepted principles of geotechnical engineering. Inherent to these are the assumptions that the earthwork and foundation construction should be monitored and tested by an engineering technician acting under the guidance of a geotechnical engineer licensed in the State of Maryland.

These analyses and recommendations are, of necessity, based on the information available at the time of the actual writing of the report and on the site conditions, surface and subsurface, that existed at the time the exploratory borings were drilled. Further, assumptions have been made regarding the limited exploratory borings, in relation to both the lateral extent of the site conditions and to the depth.

The nature and extent of variations between borings may not become evident until construction. If variations from the anticipated conditions are encountered, it may be necessary to revise the recommendations in this report.

Our professional services have been performed in accordance with generally accepted engineering principles and practices; no other warranty, expressed or implied, is made. RK&K assumes no responsibility for interpretations made by others on the work performed by RK&K.

We recommend that this report be made available in its entirety to contractors for informational purposes only. The boring logs and laboratory test data contained in this report represent an integral part of this report and incorrect interpretation of the data may occur if the attachments are separated from the text. The project plans or specifications should include the following note:

A geotechnical report has been prepared for this project by Rummel, Klepper & Kahl, LLP. This report is for informational purposes only and shall not be considered as part of the contract documents. The opinions and conclusions of RK&K represent our interpretation of the subsurface conditions and the planned construction at the time of the report preparation. The data in this report may not be adequate for contractors estimating purposes.

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Appendix A

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Permitted Use Number 21003214

Expiration: 03/31/2017

RKK	Professional Boulevard Road Extension				Figure No: A-1
81 Mosher Street Baltimore, Maryland 21217	Vicinity Map				
(410) 728-2900	DRAWN BY: JAR	APPROVED BY: EMK	SCALE: NTS	DATE: November 2016	COMM. NO. 14187-03.4



Rummel, Klepper & Kahl, LLP		PROFE BR BOR
Engineers Construction Managers Planners Scientist 81 Mosher Street Baltimore, Maryland 21217 410.728.2900	drawn by TR	APPRO

DRAIN DRAIN SIGNAGE UGE M UGE M UGE M CONC C	SETH GREENBERG, ET AL (TRUSTEE) INFERT 1060 FOLD 952 MAP 50 PARCEL 1658 107 6 TINAL PLAT FOR NK.S. DEVELOPMENT COMPANY" SEG20 50 FT GREE 0.C. = 0.00' TOT = 200 = 101 - 200 = 200 - 15 COMPANY - 200 = 101 - 200 = 10 TOT = 200 = 101 - 200 = 200 - 15 COMPANY - 200 = 101 - 200 = 10 COMPANY - 200 = 101 - 200 = 15 COMPANY - 200 = 101 - 200 = 100 COMPANY - 200 = 100 - 200 = 100 - 200 = 100 COMPANY - 200 = 100	MATCH LINE - STATION 20+00
FESSION/ RIDGE & RING LO	AL BOULEVARD Extension Cation Plan	FIGURE NO. A-2a
roved by EMK	scale AS SHOWN 06/2016	14187.03-04 SHEET NO. 01 OF 08













		c. woods	000 ⁵	
C C C C C C C C C C C C C C	C V V S F			
		TATION 36+00		
RB A	MATCH LINE	S - JAN		
3		0	20' 40'	
FESSION BRIDGE &	AL BOUL Extens	EV ARD SION		FIGURE NO. A-2d
DRING L(CATION	PLAN		commission. No. 1418.03-04
proved by EMK	scale AS SHO	WN DATE	/2016	sheet no. 04 OF 08





VE - STATION 41+00 VE - STATION 41+00	
FESSIONAL BOULEVARD	FIGURE NO.
RIDGE & EXTENSION RING LOCATION PLAN Roved by scale EMK AS SHOWN 06/2016	A-Ze commission. no. 14187.06-04 sheet no. 05 OF 08





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FESSIONAL BOULEVARD RIDGE & EXTENSION	FIGURE NO. A-2f
RING LOCATION PLAN ROVED BY SCALE DATE	commission. no. 14187.06-04 Sheet no.
EMK AS SHOWN 06/2016	06 OF 08





PROPOSED CONCRETE SIDEWALK BORING LOCATIONS



CRASS	
F	
D D D D D D D D D D D D D D D D D D D	
50+00	
0 20' 40'	
	FIGURE NO.
FESSIONAL BOULEVARD RIDGE & EXTENSION RING LOCATION PLAN	FIGURE NO. A-2g
FESSIONAL BOULEVARD RIDGE & EXTENSION RING LOCATION PLAN	FIGURE NO. A-2g COMMISSION. NO. 14187.06-04





GRASS	
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GRASS	
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	-
0 20' GRASS 40'	~
	FIGURE NO.
- ESSIUNAL BUULEVARD RIDGE & EXTENSION	A-2h
RING LOCATION PLAN	COMMISSION NO
	14187.06-04
PROVED BY SCALE DATE	SHEET NO.













)R 11/28116












Appendix B

COHESIONLESS SOILS (Silt, Sand, Gravel, and Combinations)

Den	<u>isity</u>	Particle Size Identification						
Very Loose	4 blows/ft or less	Boulders	12 inches diameter or more					
Medium Dense	11 to 30 blows/ft 31 to 50 blows/ft	Cobbles	3 to 12 inch diameter					
Very Dense	51 blows/ft or more	Gravel	Coarse: 3/4 to 3 inch diameter					
			Fine: 1/4 to 3/4 inch diameter					
<u>Relative P</u>	<u>roportions</u>	Sand	Coarse: 2 mm to 1/4 inch (diameter of pencil lead)					
Descriptive Tern	n <u>Percent</u>							
			Medium: 0.425 to 2 mm					
Trace	1 to 10		(diameter of broom straw)					
Little	11 to 20							
Some	21 to 35		Fine: 0.075 to 0.425 mm					
And	35 to 50		(diameter of human hair)					
		Silt	0.005 to 0.075 mm					

Silt

(Cannot see particles)

Plasticity

COHESIVE SOILS

(Clay, Silt, and Combinations)

Consistency

Very Soft 2 blows/ft or less **Degree of Plasticity Plasticity Index** Soft 3 to 4 blows/ft No to Slight Medium Stiff 5 to 8 blows/ft 0 - 4 Slight 5 - 7 Stiff 9 to 15 blows/ft Very Stiff 16 to 30 blows/ft Medium 8 - 22 Hard 31 blows/ft or more High to Very High over 22

Soil Classifications on Test Boring Logs are made by visual-manual inspection of samples. Soil classification symbols using lower case letters are based on a visual-manual classification. Soil classification symbols using upper case letters are based on laboratory testing.

Standard Penetration Test - Driving a 2.0-inch OD, 1 3/8-inch ID sampler a distance of 1.0-foot into undisturbed soil with a 140-lb hammer free falling a distance of 30.0-inches. It is required to drive the spoon 6.0-inches to seat into undisturbed soil, then perform the test. The number of hammer blows for seating and making the test are recorded each 6.0-inches of penetration on the Test boring Log (Example 6-8-9, 8+9=17 blows/ft). (ASTM D-1586) - In the column "Soil Descriptions" on the Test Boring Logs, the horizontal lines represent strata Strata Changes changes. A solid line represents an actually observed change, a dashed line represents an estimated change. - Observations were made at the time indicated. Porosity of soil strata, weather conditions, site **Ground Water** topography, etc. may cause changes in the water levels indicated on the Test Boring Log.

81 Mosher Street Baltimore, Maryland 21217-4250	Title: FIELD CLAS	SSIFICATION SYSTEM	FOR	Figure No: B-1
(410) 728-2900	Drawn:	Approved:	Date:	Comm No:
	JLT	EMK	April 2004	General

FIELD CLASSIFICATION SYSTEM FOR ROCK EXPLORATION

Sampler:

Rock Penetrated by Split Spoon. A transitional material between soil and rock retains the relic structure of the parent rock and exhibits penetration resistance between 60 blows/ft and 100 blows/ 2-inches of penetration

RQD:

Rock Quality Designation: Ratio of the core lengths greater than 4-inches to the total length of the run. Applies only to sound, fresh, unweathered rock.

Recovery	Description	RQD	Description of Rock Quality	Approximate General Tunneler's Description
< 40%	Incompetent	0 - 25	Very Poor	Crushed
40-70	Competent	25 - 50	Poor	Shattered, very blocky and seamy
70-90	Fairly Continuous	50 - 75	Fair	Blocky and seamy
90-100	Continuous	75 - 90	Good	Massive, moderately jointed
		90 - 100	Excellent	Intact Rock

FIELD HARDNESS

(A measure of resistance to scratching or abrasion.)

Verv Hard

Cannot be scratched with knife or geologist's pick. Breaking of hand specimens requires hard blows of geologist's pick. Typical UCC > 28- ksi

Hard

Can be scratched with knife or geologist's pick only with difficulty. Hard blow of a hammer required to detach hand specimen. Typical UCC: 14 to 28- ksi

Medium Hard

Can be scratched with knife or geologist's pick. Gouges or grooves of 1/4inch deep can be excavated by hard blow of point of a geologist's pick. Hand specimens can be detached by moderate blow. Typical UCC: 10.5 to 14- ksi

Medium

Can be grooved or gouged 1/16-inch deep by firm pressure on knife or geologist's pick point. Can be excavated in small chips to pieces about 1inch maximum size by hard blows of the point of a geologist's pick. Typical UCC: 7 to 10.5- ksi

Soft

Can be gouged or grooved readily with knife or pick point. Can be excavated in chips and pieces several inches in size by moderate blows of a geologist's pick point. Small thin pieces can be broken by finger pressure. Typical UCC: 3.5 to 7- ksi

Very Soft

Can be carved with knife. Can be excavated with point of pick. Pieces 1inch or more in thickness can be broken with finger pressure. Can be scratched readily by fingernail. Typical UCC: 140 to 3,500- psi

ROCK FRACTURE FREQUENCY										
Description Spacing Between Fractures										
Extremely Fractured	< 1-in									
Moderately Fractured	1 to 4-in									
Slightly Fractured	4 to 8-in									
Sound	> 8-in									

NOTE: Fracture frequency terms are generalized to describe the average condition of the rock obtained from the core run. Portions of the rock within the run described may vary from the generalized descriptions. Where a core break appears to be due to drilling and not to natural causes, it has not been considered as a break for accessing fracture frequency. Frequency shown on the Test Boring Logs represents conditions of core as removed from the core barrel.

Very Slightly

Rock generally fresh, joints stained, some joints may contain thin clay coatings, crystals in broken face show bright. Rock rings under hammer if crystalline.

WEATHERING

(The action of the elements in altering the color, texture, and composition of the

Slightly

Rock generally fresh, joints stained, and discoloration extends into rock up to 1inch. Joints may contain clay. In granitoid rocks, some occasional feldspar crystals are dull and discolored. Crystalline rocks ring under hammer.

Moderately

Significant portions of rock show discoloration and weathering effects. In granitoid rocks, most feldspars are dull and discolored; some may be decomposed to clay. Rock has dull sound under hammer and has a significant loss of strength compared with fresh rock.

Severely

All rock except guartz discolored or stained. Rock "fabric" clear and evident but reduced in strength to strong soil. In granitoid rocks, all feldspars kaolinized to some extent. Some fragments of strong rock usually left.

Very Severely

All rock except quartz discolored or stained. Rock "fabric" discernible, but mass effectively reduced to "soil" with only fragments of strong rock remaining.

Completely

All rock completely altered to soil-like material.

	JOINTS, BEDDING AND FOLIATI	<u>ON</u>
Joints	Bedding and Foliation	Spacing
	Fissile	< 0.25-in
Very Close	Very Thin	< 2-in
Close	Thin	2-in to 1-ft
Moderately Close	Medium	1 to 3-ft
Wide	Thick	3 to 10-ft
Very Wide	Very Thick	> 10-ft

NOTE: Refers to perpendicular distance between discontinuities.

Attitude	Angle (Degrees)
Vertical	0 to 5
Steep or High Angle	5 to 35
Moderately Dipping	35 to 55
Shallow to Low Angle	55 to 85
Horizontal	85 to 90

RKKK 81 Mosher Street	Title: FIELD CLASSIFIC E)	CATION SYSTEM FO	R ROCK	Figure No: B-2
Baltimore, Maryland 21217	Drawn:	Approved:	Date:	Comm No:
(410) 728-2900	JJV	EMK	August, 2015	General

\\balsrv01\v2014\2014\14187_WashCoProf\Geotech\GER\Samples\JVReportFigures

N	AJOR DIVISI	ONS	SYM	BOLS		TYPICAL	
	- <u>r</u>	γ	GRAPH	LETTER	DESCRIPTIONS		
	GRAVEL AND	CLEAN GRAVELS		GW	WELL-GRAD SAND MIXTU FINES	ED GRAVELS, GRAV JRES, LITTLE OR NO	EL -
	GRAVELLY SOILS	(LITTLE OR NO FINES)		GP	POORLY-GR GRAVEL - S/ OR NO FINE	ADED GRAVELS, AND MIXTURES, LITT S	LE
COARSE GRAINED SOILS	MORE THAN 50% OF COARSE	GRAVELS WITH FINES		GM	SILTY GRAV SILT MIXTUR	els, gravel - Sane Res)-
	RETAINED ON NO. 4 SIEVE	(APPRECIABLE AMOUNT OF FINES)		GC	CLAYEY GR. CLAY MIXTU	AVELS, GRAVEL - SA RES	ND ·
MORE THAN 50% OF MATERIAL IS	SAND AND	CLEAN SANDS		SW	WELL-GRAD SANDS, LITT	ed Sands, gravel 'Le or no fines	LY
LARGER THAN NO. 200 SIEVE SIZE	SANDY SOILS	(LITTLE OR NO FINES)		SP	POORLY-GR GRAVELLY S FINES	ADED SANDS, SAND, LITTLE OR NO	
	MORE THAN 50% OF COARSE	SANDS WITH FINES		SM	SILTY SAND MIXTURES	S, SAND - SILT	
	FRACTION PASSING ON NO. 4 SIEVE	(APPRECIABLE AMOUNT OF FINES)		SC	CLAYEY SAM	NDS, SAND - CLAY	
				ML	INORGANIC SANDS, ROC CLAYEY FIN SILTS WITH	SILTS AND VERY FIN XK FLOUR, SILTY OR E SANDS OR CLAYE SLIGHT PLASTICITY	NE Y
FINE GRAINED SOILS	SILTS AND CLAYS	LIQUID LIMIT LESS THAN 50		CL	INORGANIC MEDIUM PLA CLAYS, SAN CLAYS, LEA	CLAYS OF LOW TO ASTICITY, GRAVELLY DY CLAYS, SILTY N CLAYS	,
		5 . Y		OL	ORGANIC SI SILTY CLAY	LTS AND ORGANIC S OF LOW PLASTICI	ΓY
MORE THAN 50% OF MATERIAL IS SMALLER THAN NO. 200 SIEVE				МН	INORGANIC DIATOMACE SILTY SOILS	SILTS, MICACEOUS OUS FINE SAND OR	OR
SIZE	SILTS AND CLAYS	LIQUID LIMIT GREATER THAN 50		СН	INORGANIC PLASTICITY	CLAYS OF HIGH	
ŕ				OH	ORGANIC C HIGH PLAST	LAYS OF MEDIUM TO TICITY, ORGANIC SIL) TS
HI	GHLY ORGANIC S	SOILS	70 70 70 70 70 7 77 77 77 77 72 75 76 76 77	PT	Peat, hum High orga	JS, SWAMP SOILS W NIC CONTENTS	/ІТН
OTE: DUAL SYMBO	LS ARE USED TO IND	ICATE BORDERLINE SOIL	- CLASSIFICA	TIONS			
		Title: UNIFIED	SOIL CL	ASSIFIC	ATION SY	STEM	Fi
r Street							1
Maryland 2121	7	Drawn:	A	pproved:		Date:	Co
900		JJV		EMł	۲	August, 2015	1

	AA	SHTO SOIL		CATION CHART		
GENERAL CLASSIFICATION	SOIL TYPE	SYM graph	BOLS LETTER	GRADING REQUIREMENTS	PHYSIC CHARACTE	CAL RISTICS
	GRAVEL &		A-1-a	Sieve analysis % passing No. 10 = 50 max No. 40 = 30 max No. 200 = 15 max	P.I. = 6	max
	SAND		A-1-b	Sieve analysis % passing No. 40 = 50 max No. 200 = 25 max	P.I. = 6	max
GRANULAR MATERIALS	FINE SAND		A-3	Sieve analysis % passing No. 40 = 51 max No. 200 = 10 max	Non-plas	tic
(35 percent or less of total sample passing No. 200)			A-2-4	Sieve analysis % passing No. 200 = 35 max	L.L. = 40 P.I. = 10) max) max
	SILTY OR		A-2-5	Sieve analysis % passing No. 200 = 35 max	L.L = 41 P.I. = 10	min) max
	GRAVEL & SAND		A-2-6	Sieve analysis % passing No. 200 = 35 max	L.L. = 44 P.I. = 11) max ∣min
			A-2-7	Sieve analysis % passing No. 200 = 35 max	L.L. = 4 P.I. = 11	l min min
			A-4	Sieve analysis % passing No. 200 = 36 min	L.L. = 40 P.I. = 10) max) max
SILT-CLAY MATERIALS			A-5	Sieve analysis % passing No. 200 = 36 min	L.L. = 4 P.I. = 10	1 min) max
(More than 35 oercent of total			A-6	Sieve analysis % passing No. 200 = 36 min	L.L. = 44 P.I. = 11	0 max 1 min
sample passing No. 200)	CLAYEY SOILS		A-7-5	Sieve analysis % passing No. 200 = 36 min	L.L. = 4 P.I. = 11	1 min I min
			A-7-6	Sieve analysis % passing No. 200 = 36 min	L.L. = 4 P.I. = 11	1 min ∣min
	PEAT OR MUCK	<u>70 70 70</u> 7 70 70 70 70 70 70 70	A-8	Based on Visu	ual Classification	
NOTE: DUAL SYMBOLS A	RE USED TO INDICATE BO	RDERLINE SOIL CLA	SSIFICATIONS			
RKs	K	Title:	SHTO SOIL	CLASSIFICATION S	SYSTEM	Figure No: B-
o Fiviosner Street Baltimore, Maryland 2	21217	Drawn:		Approved: Date:		Comm No:
,410) 728-2900			JJV	EMK	August, 2015	Gen

Boring No. AB-01 Page 1 of 1

	C PROJECT: Professional Boulevard														COMMISSIO	COMMISSION NO.: 14187-03.4			
				- -	ITE. \	Noo	hina	ton C	ount	. NA	londo	nd				NC	ORTH	l: 717914	
				3		was	ming		ount	<u>y</u> , ivi	aryia					EAS	Г: 1117748		
				D	RILLI	NG	CO.	AB			F	_ RIG/HAMMERSafety				ELEVATION: 481 - ft			
		(GRO	UNDV	VATEF	R DA	TA (f	t)		EQUI	IPMEN	IT	CASING	SAMPLER	CORE	START	DATI	E: 4/25/2016	
L 4/27	Date Time Water Casing Cave-In TYPE 4/27/2016 9:00:00 AM Drv 4 Orze in												HSA	S	NQ2	END	DAT	E: 4/25/2016	
4/27/	2016		12:20:0	0 PM	Dry	+			4	HAMM	1D (IN) 1ER WT.	. (lb)	3.25	1.375	-	– DRI	LLEF	R: K. Manos	
			-				0.001			HAMM	IER FAL	L (in)		30	-	LOGGE	ED B'	Y: ACR	
SAMPLE		SAMPLE TYPE	SAMPLE RECOVERY (in	BLOWS/6" (% RQD)	Eac. Freq.			DEPTH	ELE DEP	V. — ТН	GRAPHIC		DES0 (moist	CRIPTION A	AND CLASS	IFICATION		NOTES:	
		$\left\langle \right\rangle$	18	4 6 7			-	-	- EL 4 0.	30.5 5		6-inc Moist Sand	hes Topsor t, Stiff, Brov I (CL) [A-6]	I vn, Medium	Plasticity C	LAY, Some Fine	/	-	
- S-2 -	<u>2</u> Z	$\left\langle \right\rangle$	18	4 6 4	20.4%	29	14	- 5	EL 4	75.0								Rough Augerin	g at 5-ft
S-3 - R-7	3		0 60	100 %				-	6.	0		Light to Ur Wide RMR	Gray, Argil weathered Fracture S =72	laceous LIN , Fine-grain spacing, Me	/ESTONE, Sightly dium Strong	Slightly Weathere Fractured to Sour	ed nd,	Water Loss Fro 26-ft	m 6 to
- R-2 - -	2		60	93%				- 10 - - -				Run I and I band RMR	R-2: Moder Dolomite, V s of quartz =72	ately Fractu ery Close to	ired to Soun Wide Frac	d gray Limestone ure Spacing, Thir	e n		
- R-: - -	3		60	91%				- 15 - - -				Run I Close RMR	R-3: Moder e to Wide F =59	ately Fractu racture Spa	ired to Soun	d Limestone, Ver	У	Laboratory UCC=16,660-p at 16-ft	si
	1		60	93%				- 20 - - -				Run I RMR	R-4: Brown =53	Silt on Join	t Faces				
LEVARU.GFJ RNA_L								- 25 - - -	<u>EL 4</u> 26	<u>55.0</u> .0		Botto	om of Boring	g @ 26.0 ft				Grouted on 4/2	7/16
								- 30 - - -											
CEFA S	SAMF	PLE	IDEN	TIFICA	TION		DRII	LING N	METHC	D	BLO							IONS	
	SAMPLE IDENTIFICATION DRILLING METHOD Image: Solution of the stress of the s										25 1 3 0\	0-4 5-10 11-30 31-50 VER 5	VERY LO MEDIUI DE 0 VERY	LOOSE OSE M DENSE NSE DENSE	0-2 3-4 5-8 9-15 16-30 OVER 30	VERY SOFT SOFT MEDIUM STIFF STIFF VERY STIFF HARD	tf Li ⁻ SC AN	RACE 1 T TTLE 11 T DME 21 T ND 36 T	O 10 O 20 O 35 O 50

Boring No. AB-02 Page 1 of 1

F	PROJECT: Professional Boulevard														COMMISSIC	ON NO	.: 14187-03.4
			5		Was	hina	ton C	Count	v Ma	arvlan	h				N	ORTH	l: 717872
			0		vvuo	ining		Journ	<u>y</u> , ivi	arylan	Mobil B57 ATV /					EAST	: 1117730
			D	RILL	NG	CO.:	AB			RI	_ RIG/HAMMERSafety						1: 481 - ft
	ato	GRO				TA (ft	:) 			PMENT	CASINO	SAMPL	ER	CORE		DATE	: 4/25/2016
4/27/2	2016	12:15:	00 PM	Dry		Jasing		7.0	SIZE, I	D (in)	<u>HSA</u> 3.25	1.37	5	2			: 4/26/2016
									HAMM	ER WT. (I	b)	140		-			
	ш			LAR		ORY			HAMM	ER FALL	(in)	30		-	LOGG	ED BA	r: ACR
SAMPLE	SAMPLE TYPI	SAMPLE RECOVERY (in	BLOWS/6" (% RQD)	Erac. Freq.			DEPTH		:v. — РТН	GRAPHIC	DE (moi	SCRIPTIC sture, den	ON AI sity,	ND CLASSI color, propo	FICATION		NOTES:
S-1 		12	4 4 6			-		<u>-EL</u> 48 0.	8 0.5 5	M C S	oist, Stiff, Goarse to Finance S-1: 7 oarse to Finance S-1: 7	ayish Brove Sand (Cl Trace Grav	wn, H H) [A el	High Plastici -7-6]	ty CLAY, Little	/	
- S-2 -		12	4 6 7	31%	59	35	- 5			Si	ample S-2: E	Brown, Tra	ce F	ine Sand			
- - -		12	4 4 8	27.3%						S	ample S-3: E	Brown, Tra	ce F	ine Sand			
- S-4 - R-1	\geq	8 54	14 50/5" 85%				- 10	EL 4 ⁻ 9.	71.5 5	Sa G	ample S-4: H ray, LIMEST	lard, Brow ONE, Slig	n, G htly '	ray Weathered	to Unweathered	l,	Auger Refusal at 9.5-ft
-						-			-		ne-Grained, racture Spac aces MR=56	Slightly Fi ing, Mediu	actu ım S	red to Soun trong, Brow	ıd, Close to Wid n Silt on Joint	e	uCC=13,540-psi at 9.5-ft
- R-2 - -		59	98%			-	- 15		-	⊥ R Jo ⊥ R	un R-2: Unw bints) MR=74	eathered,	Sou	nd, Wide Fr	acture Spacing	(No	
- R-3		60	98%				- 20		-		un R-3: Unw pints) MR=72	eathered,	Sou	nd, Wide Fr	acture Spacing	(No	
	- R-4 - R-4 - 43 63% - 25 - 25 - 25 - 25 - 25 - 25 - 25 - 25											/					
							- 30	29	.5	B	ottom of Bor	ing @ 29.8	5 ft				Grouted on 4/27/16
S	AMPL	E IDEN	ITIFICA	TION		DRIL	LING N	METHC	D	BLO	NS/FT D	ENSITY	E	BLOWS/FT	CONSISTENCY	SA	MPLE PROPORTIONS (PERCENT)
	SAMPLE IDENTIFICATION DRILLING METHOD Image: Constraint of the stress										BLOWS/FTDENSITYBLOWS/FTCONSISTENCYCONSISTENCYCONTINUET FOR ONTOWN (PERCENT)0-4VERY LOOSE0-2VERY SOFT(PERCENT)5-10LOOSE3-4SOFTTRACE1 TO 1011-30MEDIUM DENSE5-8MEDIUM STIFFLITTLE11 TO 2031-50DENSE16-30VERY STIFFSOME21 TO 35OVER 50VERY DENSEOVER 30HARDAND36 TO 50						

Boring No. AB-03 Page 1 of 1

R	PROJECT: Professional Boulevard														COMMISSION NO.: 14187-03.4			
			_		Nac	hinat	on C	ount	V M	arvland				N	DRTH: 71	7792		
			3		ivas	migu		oun	<u>y</u> , ivi	aryiariu		Mobil B	57 ATV /		EAST: 11	18022		
			D	RILLI	NG	CO.:	AB			RI	_ RIG/HAMMERSafety			ELEVATION: 492 - ft				
		GRO	UNDV	VATER	DA	TA (ft))		EQUI	PMENT	CASING	SAMPLEF	CORE	START	DATE: 5/9	9/2016		
5/18/2	te 016	Time	9	Water		Casing	Ca	ve-In 7	TYPE		HSA	S	NQ2	END	DATE: 5/9	9/2016		
0/10/2	010			Diy					HAMM	ID (IN) IER WT. (Ib	3.25	1.375	-	- DRI	LLER: K.	Manos		
		_							НАММ	IER FALL (i	n)	30	-	LOGGE	DBY: AC	CR		
SAMPLE NUMBER	SAMPLE TYPE	SAMPLE RECOVERY (in)	BLOWS/6" (% RQD)	LABC RE Lac. Fred.			DEPTH	ELE DEP	:V. — PTH	GRAPHIC	DES (moist	CRIPTION	AND CLASS	IFICATION	N	IOTES:		
S-1	S-1 12 2 22.7% 64 44 0.5 Moist, Medium Stiff, Reddish Brown, High Plasticity CLAY, Trace Fine Sand (CH) [A-7-6]													Y,				
															Auger	Refusal at 3.0-ft		
R-1		59	98%				- 5	3.	0	Lig So RN	ht Gray, LIM und, Wide Fr IR=59	ESTONE, U acture Spac	Inweathered sing, Medium	Fine Grained, Strong	Labor UCC= at 3-ft	atory :9,580-psi		
- -		59	98%			-	- 10				n R-2: 1R=67							
- - R-3 - -		60	100%				- 15			Ru Fra RN	n R-3: Mode acture Spacir IR=61	rately Fractu lg, Oxidized	ured to Soun Joint Faces	d, Close to Wide	Water to 23-	Loss From 13 ft		
- R-4 -		60	100%				- 20				n R-4: IR=59							
							- 25	EL 4 23	69.0 .0	Bo	ttom of Borin	g @ 23.0 ft			Grout	ed on 5/18/16		
							- 30											
SA	MPL	E IDEN	TIFICA	TION		DRILI		ЛЕТНС	D	BLOW	S/FT DE	NSITY	BLOWS/FT	CONSISTENCY	SAMPLE (PF	PROPORTIONS ERCENT)		
	SAMPLE IDENTIFICATION DRILLING METHOD Image: Solution of the stress of the s										VERY 0 LC 0 MEDIU 0 DE 250 VERY	Í LOOSE DOSE M DENSE INSE Í DENSE	0-2 3-4 5-8 9-15 16-30 OVER 30	VERY SOFT SOFT MEDIUM STIFF STIFF VERY STIFF HARD	TRACE LITTLE SOME AND	1 TO 10 11 TO 20 21 TO 35 36 TO 50		

Boring No. AB-04 Page 1 of 1

R	22	R		PROJE	СТ	: Prof	essi	onal	Boule	evard						COMMISSIC	ON NO	.: 1418	87-03.4	
					Maa	binat	on C	ount	V M	ondone						N	ORTH	I: 7177	752	
				SIIE:	was	sningt		ount	<u>y</u> , ivi	aryiand	1		Mobil E	057	AT\/ /		EAST	: 1118	3004	
			I	DRILLI	NG	CO.:	AB			RI	G/HA	MME	RSafety	507	AIV/	ELEV	ATION	1: 490	- ft	
		GRC	UND	WATEF	R DA	TA (ft)		EQUI	PMENT	CA	SING	SAMPLE	R	CORE		DATE	E: 5/10/	/2016	
Da	ate	Tin	ne	Water	(Casing	Ca	ve-In	TYPE			HSA	S		NQ2	END	DATE	: 5/10/	/2016	
5/18/2	2016			Dry				10	SIZE, I HAMM	ID (in) IFR WT <i>(</i> IF		3.25	1.375		2	DR	ILLEF	R: K. M	anos	
									НАММ	IER FALL (in)		30		-	LOGG	ED B)	: ACR	1	
SAMPLE NUMBER	SAMPI E TVPE	SAMPLE SAMPLE RECOVERY (in)	BLOWS/6" (% RQD)	BAL NMC/ Frac. Freq.			DEPTH	ELE DEF	EV. — • •TH	GRAPHIC		DES0	CRIPTION ure, densit	AND y, co) CLASSI	FICATION		NO	TES:	
								EL 4	89.5		nches	Topsoi								
_S-1		1	50/1	"				0.	5		OMPLE ery Der	s I ELY 1 se, Gra	weather ay, Coarse		ROCK Sa angular (ampled As: Mois Gravel-sized RC	st, ICK			
- - - -		39	53%				- 5	EL 4 3. EL 4 5.	87.0 0 85.0 0	FF Lig Ur Cl	RÁGME oht Gra weath ose to MR=40	ENT (gp ay, LIME ered, F Wide F	o) [a-1-a] ESTONE, S ine Graine racture Sp	Sligh d, Sli acing	tly Weath lightly Fra g, Mediur	nered to actured to Sound m Strong	, t, 	Auger R Laborato UCC=12 at 3-ft	efusal at 3. pry 2,080-psi	.0-ft
- - R-2 -		- 58	92%				- 10	EL 4 5	84.2 8	No Liç Ur Cl Ri Ri	ote: Vo oht Gra weath ose to un R-2: MR=53	id Enco ay, LIME ered, F Wide F Unwea	untered fro ESTONE, S ine Graine racture Sp athered, Sc	om 5 Slight d, Sli acing ound,	.0-ft to 5. tly Weath lightly Fra g, Mediur , Modera	8-ft hered to hotured to Sound n Strong te Fracture Spa	d, cing			
- R-3 - -	R-3 60 100% - 15										ın R-3: ∕IR=53	: Unwea	athered, So	ound,	, Wide Fr	acture Spacing				
R-4		60	100%	6		-	- 20			RI RI	ın R-4∶ ∕IR=69	: Unwea	athered, So	ound,	, Wide Fr	acture Spacing				
	L					-		FI 4	67.0											
							- 25	23	.0	Bc	ottom o	f Borino	g @ 23.0 ft	t				Grouted	on 5/18/16	;
							- 30													
S S			NTIFIC	ATION		DRII		ИЕТНО	DD	BI OV	/S/FT	DEN	ISITY	BLC	OWS/FT	CONSISTENCY	SA			S
		- S - SF - T - T - SS - 3 - D - D - RC - F	PLIT SF HIN WA "SPLIT ENISO ROCK C	POON ALL TUBE SPOON N	HSA SSA DC MD HA	A - HOLI A - SOLI - DRIVII - MUD I - HAND	D STE	STEM AUG SING NG	AUGER GERS	S 0 5-1 11- 31- OVEI	4 0 30 50 R 50	VERY LO MEDIUI DE VERY	LOOSE OSE M DENSE NSE DENSE	0	0-2 3-4 5-8 9-15 16-30 VER 30	VERY SOFT SOFT MEDIUM STIFF STIFF VERY STIFF HARD	TR LIT SC AN	ACE TLE DME ID	1 TO 10 11 TO 20 21 TO 33 36 TO 50)) 5 0

Boring No. AB-04

Boring No. AR-01 Page 1 of 1

R	K		P	ROJE	СТ	: Pro	fessi	onal	Boule	evard				COMMISSIC	ON NO	.: 14187-03.4
			– s	ITE: \	Nas	shina	ton (Count	v M	arvland				N	ORTH	l: 717932
			Ŭ	··· <u>·</u>	vac	Jinig		Journ	<u>y</u> , ivi	aryland		Mobil B	57 ATV /		EAST	: 1117647
			D	RILLI	NG	CO.:	: AB			RIG	HAMME	RSafety		ELEV/		1: 493 - ft
		GRO		VATER	DA	TA (fl	t)		EQUI	PMENT	CASING	SAMPLER	CORE		DATE	E: 4/25/2016
4/25/20	e)16	10:50:0	e 00 AM	Dry	-	Casing	Ca	ave-in 8.3	SIZE I	ID (in)	HSA 3 25	S 1 375		END	DATE	: 4/25/2016
4/27/20	16	12:30:0	0 PM	Dry				8.3	HAMM	IER WT. (lb)	0.20	140	-	DR		R: K. Manos
								1	НАММ	IER FALL (in)	30	-	LOGG	ED BY	: ACR
SAMPLE NUMBER	AMPLE TYPE	SAMPLE RECOVERY (in	BLOWS/6" (% RQD)	RE Freq.			DEPTH	ELE — DEF	EV. — PTH	GRAPHIC	DES ⁽	CRIPTION A	AND CLASS	FICATION		NOTES:
	0			LL.				FI 4	92 5	<u>√</u> /⁄. 6-in	ches Topso	l	, 00101, propt			
- -		18	2 3 4				-	0.	5	Fine	st, Medium 3 e Sand (CH)	Stiff, Brown, [A-7-6]	High Plastic	ity CLAY, Trace		
S-2 18 $\begin{array}{c} 2\\ 4\\ 6\\ \end{array}$ 30.8% 67 41 $\begin{array}{c} -\\ -\\ -\\ 5\\ \end{array}$ Sample S-2: Stiff S-3 18 $\begin{array}{c} 4\\ 6\\ 7\\ 7\\ \end{array}$ 18 $\begin{array}{c} 4\\ 6\\ 7\\ 7\\ \end{array}$ $\begin{array}{c} -\\ -\\ -\\ -\\ \end{array}$ Sample S-2: Stiff Sample S-3: Stiff Sample S-3: Stiff Sample S-3: Stiff Sample S-3: Stiff																
S-3 18 4 7 EL 484.5																
_ S-4	\mathbb{X}	8	28 27 20				- - 10	8. _ <u>EL</u> 4	5 8 <u>3.0</u>	o Moi o Gra San	st, Dense, L vel-Sized R(d [gp] [a-1-a	ight Gray, C OCK FRAGI I]	MENTS, Tra	e Angular ce Coarse to Fin	ne	
S-5		6	1 1 2	18.2%	47	28		10 <u>EL_4</u>	.0 <u>81.5</u>	Fine	st, Soft, Bro	wn, High Pla e Gravel (C	asticity CLAY L) [A-7-6]		to 	Initial Auger Refusal at 10-ft, But Spoon Broke Through
	X	4	20 16 12				-	11 EL 4 13	.5 80.0	o (gp)	st, Medium I angular Gra [a-1-a] com of Borin	Dense, Lign vel-Sized R g @ 13.0 ft	Coars, Coars OCK FRAGI	se to Fine MENTS, Trace S	Sand	Grouted on 4/27/16
							- - 15 - -									
														CONDICTENCY	SA	MPLE PROPORTIONS
					HS/					BLOWS	DEI DEI		BLOWS/FT			(PERCENT)
	- C - T - S - C - F	5 - 31" 55 - 3" 50 - DE RC - R(IIN WAL SPLIT ENISON	L TUBE SPOON I DRE	SSA DC MD HA	- SOL - DRIVI - MUD - HANE	ID STE ING CA DRILL AUGE	EM AUC ASING ING ER	GERS	0-4 5-10 11-30 31-50 OVER	VERY LC) MEDIU) DE 50 VERY	LOOSE OSE M DENSE NSE DENSE	0-2 3-4 5-8 9-15 16-30 OVER 30	SOFT SOFT MEDIUM STIFF STIFF VERY STIFF HARD	TR LIT SO AN	ACE 1 TO 10 TLE 11 TO 20 DME 21 TO 35 ID 36 TO 50

Boring No. P-01 Page 1 of 1

R	K	R	F	ROJE	CT	Prof	essio	onal E	Boule	evard				COMMISSION	N NO.: 14187-03.4
				TE. \	Noo	binat	~~ C	ount		andand				NC	DRTH: 717874
			3		was	ningt		ounty	<u>y</u> , ivi	aryianu		Mobil P	57 ΔT\/ /	E	AST : 1117829
			C	RILLI	NG	CO <u>.:</u>	AB			RI0	G/HAMME	RSafety	57 ATV /	ELEVA	TION: 470 - ft
		GRO	UND	VATEF	R DA	TA (ft))		EQUI	IPMENT	CASING	SAMPLEF	CORE		DATE: 4/26/2016
Dat	е	Time	e	Water	0	Casing	Ca	ve-In	TYPE		HSA	S	NQ2	END E	DATE: 4/26/2016
					-				SIZE,	ID (in) IER WT (lb	3.25	1.375	2	DRIL	LER: K. Manos
									HAMM	IER FALL (i	n)	30	-	LOGGE	DBY: ACR
SAMPLE NUMBER	AMPLE TYPE	SAMPLE ECOVERY (in)	BLOWS/6" (% RQD)	LABO RE Igc. Freq.			DEPTH	ELE DEP	V. – TH	GRAPHIC	DES		AND CLASS	IFICATION	NOTES:
	S	2		LL.				-EL-46	<u>69.5</u>	→ <u>//</u> 6-i	nches Topso	il	, color, prop		<i>(</i> -
	X	12	3 3 3					0.5	5	Mc CL Sa	ist, Medium AY, Little Co mple S-1: Tra	Stiff, Browni arse to Fine ace Roots	sh Gray, Me Sand (CL) [dium Plasticity A-6]	
- S-2 -	X	8	2 2 2	30.8%	34	13 -	- 5			Sa	mple S-2: Sc	oft			
S-3	\boxtimes	6	2 50/5							Sa Tra	mple S-3: Ha	ard, Dark Gr	ay, Some Me	edium to Fine San	nd, Water on Spoon at 6.0-ft
- R-1		60	100%					<u>EL 46</u> 7.5	5 <u>2.5</u> 5	Gr	ay, LIMESTO	NE, Unwea	thered, Fine	-grained, Slightly	
- -						-	- 10		-		actured to So ong IR=45	und, Close	Fracture Spa	icing, Medium	
- - R-2 - -		45	63%			-	- 15		-		n R-2: Extrer ose Fracture IR=44	nely Fractur Spacing	red to Sound	, Very Close to	Laboratory UCC=16,400-psi at 12.5-ft
-								<u>EL 45</u> 17.	52.5 .5	Bo	ttom of Borin	g @ 17.5 ft			Sampler Jammed with Rock Fragments.
						-	- 20								Offset performed 5-ft South. See Log for P-01A. Grouted upon completion
						-	- 25								
							- 30								
						-									
SAMPLE IDENTIFICATION DRILLING METHOD BLOWS/FT												NSITY	BLOWS/FT	CONSISTENCY	SAMPLE PROPORTIONS (PERCENT)
	- \$ - 7 - \$ - [S - SP F - TH SS - 3" D - DE	LIT SP IIN WA SPLIT ENISON	OON LL TUBE SPOON	HSA SSA DC - MD	- HOLI - SOLI DRIVII - MUD I	LOW S D STE NG CA DRILLI	TEM A M AUG SING NG	UGER SERS	2S 0-4 5-1 11-3 31-5	VERY 0 LC 30 MEDIU	LOOSE DOSE M DENSE ENSE	0-2 3-4 5-8 9-15 16-30	VERY SOFT SOFT MEDIUM STIFF STIFF VERY STIFF	TRACE 1 TO 10 LITTLE 11 TO 20 SOME 21 TO 35
	- F	RC - R(OCK C	ORE	HA -	HAND	AUGE	R		OVER	VERY	DENSE	OVER 30	HARD	AND 36 TO 50

Boring No. P-01

Boring No. P-01A Page 1 of 1

R	K	2,	F	PROJE	ECT:	Profe	essio	onal I	Boule	evard				COMMISSIO	ON NO.:	: 14187-03.4	
			_		Mac	bingt		ount	. M	andand				N	ORTH:	717869	
					vvas	migu		ount	<u>y</u> , ivie	aryianu		Mobil B	57 ATV /		EAST:	1117829	
			0	DRILLI	NG	CO <u>.:</u>	AB			RIG	HAMME	RSafety		ELEVA	ATION:	: 470 - ft	
		GRO	UND	WATEF	R DA	TA (ft)			EQUI	PMENT	CASING	SAMPLER	CORE	START	DATE:	: 4/27/2016	
Dat	e	Time	e	Water	0	Casing	Ca	ve-In 7	TYPE		HSA	S	NQ2	END	DATE:	4/27/2016	
5/10/20	/10			5				,	SIZE, II HAMM	D (in) ER WT. (lb)	3.25	1.375	- 2	DRI	ILLER:	K. Manos	
									HAMM	ER FALL (in)		30	-	LOGGE	ED BY:	ACR	
SAMPLE NUMBER	AMPLE TYPE	SAMPLE ECOVERY (in)	BLOWS/6" (% RQD)	RAL RE BIN Sac. Freq.			DEPTH	ELE DEP	V. — TH	GRAPHIC	DES		AND CLASSI	FICATION		NOTES:	
	Ś	R		Ĕ	5-1					I \ Blan	(moist) k Auger to 7	ure, density	, color, propo	ortions, etc.)			
- - - - - - - - - - - - - - - - - - -		53	75%				∑ 5 10	<u>EL 4</u> 7.	62.5 5 - - - - - - - - - - - - - - - - - -	Gray Fine Med Thrc RMF	7, LIMESTO -grained, So ium Strong, pughout R=31 R-2: Moder e Fracture S t on Joint Fa R=23	NE, Slightly ound, Moder Quartz Lay ately Fractu pacing, Qua	Weathered rate to Wide ers Sparsely red to Sound artz Layers T	to Unweathered Fracture Spacin Present d, Very Close to hroughout, Brov	, L g, L a wn	aboratory JCC=4,500-psi t 7.5-ft	
- R-3 - -		59	98%			-	20			Run Brov RMF	R-3: Unwea vn Rust on R=51	athered, Sou loint Face	und, Wide Fr	acture Spacing,			
- R-4 - - - -		54	83%				25	<u>EL 4</u> 27	4 <u>2.5</u> 5	Run RMF	R-4: Unwea	athered, Wid	le Fracture S	Spacing, No Qua	artz G	Grouted on 5/18/16	i
	MPLE - \$ - 1 - \$ - [- [E IDEN 6 - SPI 7 - TH 6S - 3" 0 - DE 8C - R0	TIFIC/ LIT SP IN WA SPLIT ENISOI	ATION OON LL TUBE SPOON N ORF	HSA SSA DC - MD -	DRILL - HOLL - SOLIE DRIVIN - MUD E HAND	ING N OW S D STE IG CA DRILLI	METHC STEM A M AUG SING NG	D UGERS SERS	BLOWS S 0-4 5-10 11-30 31-50 OVER 5	/FT DEN VERY LO MEDIUI DE 50 VERY	ISITY LOOSE OSE M DENSE NSE DENSE	BLOWS/FT 0-2 3-4 5-8 9-15 16-30 OVER 30	CONSISTENCY VERY SOFT SOFT MEDIUM STIFF STIFF VERY STIFF HARD	SAM TRA LITT SOM AND	IPLE PROPORTIONS (PERCENT) ICE 1 TO 10 ILE 11 TO 20 ILE 21 TO 35 0 36 TO 50	S)) 5)

Boring No. P-01A

Boring No. P-02 Page 1 of 2

R	X		F	PROJE	СТ	: Pro	fessi	onal I	Boule	evard				COMMISSIC	DN NO.: 14187-03.4
			-		Nas	shinat	ton (Count	v M	arvland				N	ORTH: 717794
					//ac	sinig		Jouni	<u>y</u> , ivi	aryland		Mobil B	57 ATV /		EAST: 1117919
			0	DRILLI	NG	CO.:	AB			RIG		RSafety		ELEV	ATION: 470 - ft
		GRO		NATEF		TA (ft	:)		EQUI	PMENT	CASING	SAMPLEF	CORE	START	DATE: 5/9/2016
Dat 5/18/20	te 016	Time	e	Water 4		Casing	Ca	ave-In 8	TYPE	D (in)	HSA	S 1.275	NQ2	END	DATE: 5/9/2016
								-	HAMM	ER WT. (lb)	5.25	1.375	-	- DR	ILLER: K. Manos
									НАММ	ER FALL (in)	30	-	LOGG	ED BY: ACR
SAMPLE NUMBER	SAMPLE TYPE	SAMPLE RECOVERY (in)	BLOWS/6" (% RQD)	LABO RE Lac: Freq.			DEPTH	ELE DEP	:v. — РТН	GRAPHIC	DES0 (moist	CRIPTION A	AND CLASS	IFICATION	NOTES:
		<u> </u>							ŀ	<u>\ //</u> 12-i	nches Topso	oil	, , p p.		
- -		11	2 2 2	29%	31	12		<u>EL</u> 41 1.	69.0 / 0	Moi (CL	st, Soft, Gra) [A-6]	y, Medium F	Plasticity CL/	AY, Little Fine S	and
S-2	S-2 $\begin{bmatrix} 18 \\ 1 \\ 1 \\ 1 \\ 1 \\ 1 \\ 1 \\ 1 \\ 1 \\ 1 $														
- S-3		12	1 2 2 50/1"	35.7%				<u>EL 4</u> 6.	6 <u>4.0</u>	Moi	st. Soft, Darl	Gray, CLA	Y, Some Fir	e Sand (cl) [a-6] Auger Refusal at 9-ft
R-1		25	27%			-		EL 4 9. EL 4	61.0 0 60.5	Ligh	It Gray, LIME	ESTONE, Se-grained, E	lightly Weath	nered to Complete	
							- 10	9. -EL 41 -EL 41 -EL 41 10 -EL 41 11	5 60.0 5 9.5 .5 59.0 .0	Extr Strc RMI Voic Ligh Wea Extr Strc Voic Ligh Wea Extr Strc	emely Close ong R=33 ds Encounte athered, Fine emely Close ong ds Encounte athered, Fine emely Close ong	red from 9.5 ESTONE, S e-grained, E to Modera red from 10 ESTONE, S e-grained, E e to Modera	5-ft to 10.0-ft lightly Weath extremely Fra te Fracture S .5-ft to 11.0-f lightly Weath extremely Fra te Fracture S	hered to Complete control to Complete control to Sound pacing, Medium ft nered to Complete control to Sound pacing, Medium	-, UCC=7,130-psi at 9-ft
R-2		19	0%							Rur Extr RM	R-2: Extren emely Close R=25	nely Fractur to Close F	ed to Modera r	ately Fractured,	
SA	MPLE	E IDEN	ITIFICA	ATION		DRIL	LING I	METHC	D	BLOWS	S/FT DEN	ISITY	BLOWS/FT	CONSISTENCY	SAMPLE PROPORTIONS (PERCENT)
	- S - T - S - C - F	S - SP T - TH SS - 3" D - DE RC - R(lit sp iin wa split Enison ock c	OON LL TUBE SPOON N ORE	HSA SSA DC MD HA	A - HOL A - SOL - DRIVI - MUD - HAND	LOW S ID STE NG CA DRILL AUGE	STEM A Em Aug Asing Ing Er	UGER	S 0-4 5-10 11-30 31-50 OVER	VERY LO MEDIUI) DE 50 VERY	LOOSE OSE M DENSE NSE DENSE	0-2 3-4 5-8 9-15 16-30 OVER 30	VERY SOFT SOFT MEDIUM STIFF STIFF VERY STIFF HARD	TRACE 1 TO 10 LITTLE 11 TO 20 SOME 21 TO 35 AND 36 TO 50

R	K		P	ROJE	ECT	Pro	fessio	onal Bou	leva	rd	
			S	ITE:_	Was	hing	ton C	ounty , N	/lary	land	
			D	RILL	ING	CO.	: AB			RIG/HAMMERSafety	
SAMPLE NUMBER	SAMPLE TYPE	SAMPLE RECOVERY (in)	BLOWS/6" (% RQD)	IAD RI Lac: Freq.		LASTICITY SI INDEX	DEPTH	ELEV. DEPTH	GRAPHIC	DESCRIPTION AND CLASSIFICATION	NOTES:
-		<u> </u>			_	<u> </u>	-			Light Gray, LIMESTONE, Slightly Weathered to Completely Weathered, Fine-grained, Extremely Fractured to Sound, Extremely Close to Moderate Fracture Spacing, Medium Strong	
- -		60	100%			-	- 20 -			Run R-3: Slightly Weathered, Sound, Wide Fracture Spacing RMR=57	
		60	100%			-	- 25 -			Run R-4: Slightly Weathered, Sound, Wide Fracture Spacing RMR=59	
							- 30 -	<u>EL 441.0</u> 29.0		Bottom of Boring @ 29.0 ft	Grouted on 5/18/16

Boring No. RB-01 Page 1 of 1

F	2		Ķ	P	ROJE	CT	: Prof	essi	onal	Boul	evar	d					COMMISSIC	ON NC).: 14187-03.4	
				- -	ITE. \	Maa	hinat	~~ (Sount		lond	and					N	ORTH	i: 718271	
				3		/vas	mingt		Jount	<u>y</u> , iv	aryi	anu		Mobil	DE	7 4 1 1 / /		EAST	Г: 1116802	
				D	RILLI	NG	CO.:	AB				RIG	/HAMME	RSafet	<u>у</u>		ELEV	ATION	N: 497 - ft	
		G	ROL	JNDV	VATER	R DA	TA (ft)		EQU	IPME	NT	CASING	SAMPL	.ER	CORE	START	DATE	E: 5/2/2016	
D	ate	1	Time		Water	0	Casing	Ca	ave-In	TYPE			HSA	S			END	DATE	E: 5/2/2016	
5/2/2	016	-	0.10.0		Diy				3	SIZE, HAMN	ID (in) /IER W	T (lb)	3.25	1.375	5	-	DR	ILLEF	R: K. Manos	
					-					HAMN	ЛER FA	ALL (in)		30		-	LOGG	ED B	r: ACR	
		Ц Д Д	(in)	0	LABO	DRAT TEST	ORY				с									
		_ ц	ERYE	NS/	RE	SUL	TS ≿	PTH	ELE	V.	ΗH		DES	SCRIPTIO	N AI	ND CLASSI	FICATION		NOTES.	
SAN			NOC N	% F	MC/ Free	₽₽	DEX	DEI		— лтн	GRA									
		RA N	RE	ш	Frac	βĘ	PLAS						(mois	sture, den	sity,	color, propo	ortions, etc.)			
									EL 4	96.6 1	<i>-</i>	5-inc	ches Bitum	ninous Cor	ncret	te Base (Crust	hed Stone)			
_ S-1		$\langle $	6	7 7	28.4%	47	32		EL 4	96.3		Mois	st, Very Sti	ff, Brown,	High	n Plasticity (CLAY, Little Coa	arse	MDD = 116.1-pcf	
_	ŕ			10					0.	7		to Fi	ne Sand, ⁻	Trace Coa	rse f	to Fine Grav	vel (CL) [A-7-6]		CBR =9.7	
- S-2	2		6	4	26.7%		-					Sam	ple S-2: S	tiff						
4 -5 5 -5 6 -5 6 -5															Bulk Sample Take	'n				
-	S-3 16 6 Sample S-3: Reddish Brown, Trace Fine Sand															From Auger Cuttin	igs			
-	S-3 16 6 6 11 Sample S-3: Reddish Brown, Trace Fine Sand															1.0 to 6.0-ft				
╞	$\begin{array}{c ccccccccccccccccccccccccccccccccccc$																			
- S-4	S-4 $\begin{bmatrix} 6\\11\\8\\6\\6\end{bmatrix}$ 37.4% $\begin{bmatrix} L 487.0\\8\end{bmatrix}$ Sample S-4: Stiff, Reddish Brown																			
-				6			-	- 10	10	.0	////	Botto	om of Bori	ng @ 10.0) ft				Backfilled with auc	ger
-																			cuttings and patch upon completion	ied
-																				
-																				
								15												
								- 15												
_																				
-																				
- 9							-	- 20												
							-													
- 1 <u>0</u> -							-													
2. -							-													
Ϋ́Ϋ́Ϋ́Ϋ́Ϋ́Ϋ́Ϋ́Ϋ́Ϋ́Ϋ́Ϋ́Ϋ́Ϋ́Υ							-													
5 							-	- 25												
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5																				
HAV-																				
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- ALE								- 30												
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S (DEF	SAMF	PLE	IDEN	TIFICA	TION		DRIL	LING I	METHC	D	В	LOWS	/FT DE	ENSITY	E	BLOWS/FT	CONSISTENCY	SA	MPLE PROPORTION (PERCENT)	NS
	3	- S	- SPL	IT SPC	DON	HSA	- HOLI	LOW S	STEM A	UGEF	RS	0-4		YIOOSE		0-2	VERY SOFT	AT	RACE 1 TO 2	10
		- T - <u>S</u> S	- TH 3 - 3"	IN WAL	L TUBE	SSA DC	- SOLI		M AUG	SERS		5-10 11-30		00SE		3-4 5-8	MEDIUM STIFF		TLE 11 TO 2	20
	\mathbb{Z}	- D	- DE	NISON		MD	- MUD I	DRILL	ING			31-50 7 סבער				9-15 16-30	STIFF VERY STIFF	sc	DME 21 TO 3	35
ž 🔳		- R0	C - RC	оск сс	DRE	HA -	HAND	AUGE	R			JVER	v VER	Y DENSE		OVER 30	HARD	AN	ND 36 TO 5	50

Boring No. RB-02 Page 1 of 1

R	K		P	ROJE	СТ	: Prof	essi	onal	Boul	evaro	d					SION NO).: 14187-03.4
			_ c		Nae	hinat	on C	ount	V M	larvla	and					NORTH	H: 718126
			5	,,,,,,,,,,,,,,,,,,,,,,,,,,,,,,,,,,,,,,	ivas	migi		Journ	<u>y</u> , iv	iai yic			Mobil F	857 ΔTV	-	EAS	T: 1117268
			D	RILLI	NG	CO.:	AB				RIG/	HAMME	RSafety		ELI	EVATIO	N: 510 - ft
		GRO		VATER	R DA	TA (ft)		EQU	IPME	NT	CASING	SAMPLE	R CORE	STA	RT DAT	E: 5/2/2016
5/2/201	e 6	10:50:0	e 00 AM	Water Drv		Casing	Ca	ive-In 5.0	TYPE	ID (in)		HSA 2.25	S 1 275		EI		E: 5/2/2016
	-			,					HAMN	IER W	T. (lb)	3.25	1.375	-		DRILLEF	R: K. Manos
								1	HAMN	IER FA	LL (in)		30	-	LOC	GGED B	Y: ACR
шК	YPE	Ë.	.9	LABO	TEST	ORY	_			<u>ں</u>							
APL	ЦЩ.	APLI AR	WS/ RQI	c	SUL	È	ЪТ	ELE	V.	APH		DES	CRIPTION	AND CLAS	SIFICATION		NOTES:
SAN	MPI	SA	%) %	c. Fre		NDEX	DE	DEF	тн	GR							
	SA	RE		Z œ	25	PLA PLA					F is a	(moist	ure, densit	y, color, pro	portions, etc.)		
Fai		10	2					EL 5 0.	09.6 4		5-inc	hes Bitumii hes Cemer	nous Conci Inted Sand	ete			-
- 5-1	X	12	4	29.4%	65	44		EL 5	09.2		Mois	t, Stiff, Brov	vn, High Pl	asticity CL	Y, Trace Fine	Sand	MDD = 113.5-pcf OMC = 14.9%
-						-		0.	0		(CH)	[A-7-6]					CBR =1.7
- S-2	\square	13	6 9	36.2%		-					Sam	ole S-2: Ve	ry Stiff				
Image: 10 Image: 5 Bull Image: 10 Image: 5 Sample S 3: Poddich Brown Von/ Stiff															Bulk Sample Taken		
S-3 18 6 7 10 Sample S-3: Reddish Brown, Very Stiff															From Auger Cuttings		
-	S-3 18 6 10 - 10 - 10 - 10 - 10 - 10 - 10 - 10 -															1.0 10 0.0-11	
- S-4	S-4 18 4 4 6 37.6% EL 500.0 Sample S-4: Reddish Brown																
-	\square		6				- 10	10	.0		Botto	m of Boring	g @ 10.0 ft				Backfilled with auger
-																	upon completion
-																	
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SA DELA	MPLE	E IDEN	ITIFICA	TION		DRIL	LING	METHC	D	BI	_OWS/	FT DEM	NSITY	BLOWS/F1	CONSISTEN	ICY SA	AMPLE PROPORTIONS (PERCENT)
	- 5	6 - SP	LIT SPO	NOC	HSA	- HOL	LOWS	STEM A	UGEF	RS	0-4		10095	0-2	VERY SOI	FT TE	RACE 1 TO 10
	- T _ s	- TH 3S - 3"	IIN WAI SPLIT	LL TUBE	SSA				BERS		5-10 11-30		OSE	3-4 5-8	SOFT MEDIUM ST		TTLE 11 TO 20
	- C) - DE	ENISON		MD	- MUD		ING			31-50		NSE	9-15 16-30	STIFF VERY STII	FF SC	OME 21 TO 35
ž	- F	RC - R	оск со	ORE	HA -	HAND	AUGE	R			VER 5	VERY	DENSE	OVER 30	HARD	AN AN	ND 36 TO 50

Boring No. RB-03 Page 1 of 1

F	2%		F	PROJE	ECT:	: Prof	essi	onal	Boule	evard						COMMISSIC	ON NO	.: 14187-03.4
			`	NTC. 1		hinat	~~ C				n d					N	ORTH	: 717643
			3		vvas	ningt	on C	Jount	y, IVI	aryıar	na		Mahil	057	<u>AT\//</u>		EAST	: 1118306
			C	DRILLI	NG	CO.:	AB			F	RIG/I	HAMME	R Safety	577	AIV/	ELEV	ATION	l: 510 - ft
		GRO		NATEF	R DA	TA (ft)		EQUI	IPMEN	IT	CASING	SAMPLE	R	CORE	START	DATE	: 5/3/2016
D	ate	Tim	e	Water	0	Casing	Ca	ave-In	TYPE			HSA	s			END	DATE	: 5/3/2016
5/3/2	016			Dry			-	1.5	SIZE, I	ID (in)	(lb)	3.25	1.375		_	DR	ILLER	: K. Manos
									HAMM	IER FAL	. (ib) .L (in)		30		-	LOGG	ED BY	: ACR
SAMPLE	AMPLE TYPE	SAMPLE RECOVERY (in)	BLOWS/6" (% RQD)	BAT NMC/ iac. Freq.			DEPTH	ELE DEF	:V. — ?TH	GRAPHIC		DES ⁽	CRIPTION	I AND	CLASSI	FICATION		NOTES:
	0			<u> </u>				-EL-5	09.5		6-inch	nes Topsoi	il	ty, 00				Bulk Sample Taken
S-1		6	8 7 6	14%				0.	5		Moist	, Stiff, Gra	y, Brown, S	SILT,	And Fine	SAND (ml) [a-4	4] 	From Auger Cuttings 0.0 to 6.0-ft
- S-2		18	4 6 10				- 5	<u>EL 5</u> 3.	0 <u>6.5</u> 5		Moist (cl) [a	, Very Stiff -6]	, Yellowish	n Brov	wn, CLAY	, And Fine San	d	
$\begin{bmatrix} S-3 \\ -S-4 \end{bmatrix} 18 \begin{vmatrix} 4 \\ 4 \\ 6 \end{vmatrix} 28\% = \begin{bmatrix} - \\ -S-4 \end{bmatrix} Sample S-3: Stiff$ Sample S-4: Stiff																		
$\begin{array}{c c c c c c c c c c c c c c c c c c c $																		
-S-4 18 4 5 6 - 10 EL 500.0 Sample S-4: Stiff - 10 Bottom of Boring @ 10.0 ft 															Backfilled with auger cuttings upon completion			
							- 15											
-						-												
-						-												
01 0/30/10						-	- 20											
						-												
							- 25											
						-												
						-	- 30											
S (DEF	AMPL	E IDEN	ITIFICA	ATION		DRILI	LING	METHC	D	BLC	OWS/F	T DEI	NSITY	BLC	OWS/FT	CONSISTENCY	SA	MPLE PROPORTIONS (PERCENT)
$\frac{1}{2}$ $\frac{1}$													ACE 1 TO 10					
- T - THIN WALL TUBE SSA - SOLID STEM AUGERS - T - THIN WALL TUBE SSA - SOLID STEM AUGERS - SS - 3" SPLIT SPOON DC - DRIVING CASING - SS - 3" SPLIT SPOON DC - DRIVING - SS - 3" SPLIT SPOON DC - DRIVING - SS - 3" SPLIT SPOON DC													TLE 11 TO 20					
	- D	D - DI	ENISO	N	MD	- MUD I		ING		3	31-50 81-50			1	9-15 16-30	STIFF VERY STIFF	SO	ME 21 TO 35
¥	-	RC - R	оск с	ORE	HA -	HAND	AUGE	R		0	/ER 50	VERY	DENSE	0\	/ER 30	HARD	AN	D 36 TO 50

Boring No. RB-04 Page 1 of 1

R	K	2	P	ROJE	ст:	Prof	essi	onal I	Boul	evar	d					COMMISSIO	N NC).: 14187-03.4
			- -		Noo	hinat	~~ C	-		lond	and					N	ORTH	i : 717423
			5		/vas	ningto	on C	ount	y, iv	laryi	and		Mahil		7 4 T) / /		EAST	Г: 1118613
			D	RILLI	NG	со <u>.:</u>	AB				RIG	/HAMME	RSafety	351	/ AIV /	ELEVA		N: 493 - ft
	(GRO	UNDV	VATER	DA'	TA (ft))		EQU	IPME	NT	CASING	SAMPLE	R	CORE	START	DATE	E: 5/2/2016
Dat	е	Time	e	Water	C	Casing	Са	ive-In	TYPE			HSA	S			END	DATE	E: 5/2/2016
5/2/201	6	1:55:00	PM	Dry	_		{	5.0	SIZE,	ID (in)	T (11-)	3.25	1.375	_		DRI	LLEF	R: K. Manos
									HAM	VIER VV	ALL (in)		30		-	LOGGI	ED B	/ : ACR
	ЫШ	(in)	-	LABO		ORY				0								
С Ш Н Н Н Н Н	≿	김주	/S/6 QD)	RE	SULT	rs >	Ŧ		N I	H		DES				FICATION		NOTEO
MM	IPLE	SAMI OVE	NO'N N	IC/ Freq.	۹⊢	EXE	OEP			ßAl		DEC			02/1001			NOTES.
νz	SAM	S C S	BI (, BI	Lac.	LIMI	IND		DEP	PTH	Ö		(moist	ture, densit	tv. c	color, propo	ortions, etc.)		
	0,					<u> </u>		EL 4	92.2	<u>, </u>	10-ir	nches Tops	oil					
S-1	\bigtriangledown	9	5	33.2%	58	37		0.	8		Mois	st, Stiff, Bro rse Sand ((wn, High P	last	ticity CLAY	, Trace Fine to		MDD = 115.4-pcf
-	\square		7								000		,,,,,,,,,,,					OMC = 14.5%
62	\vdash	12	2	00.5%														
$\begin{bmatrix} -5^{-2} \\ - \\ - \\ - \\ - \\ - \\ - \\ - \\ - \\ - \\ $																		
																	Bulk Sample Taken	
S-3	S-3 18 3 5																From Auger Cuttings	
	S-3 18 3 6 8 12 12 13 6 8 12 13 14 14 14 14 14 14 14 14															0.0 10 7.0-11		
- S-4	\bigtriangledown	18	4	29.2%							Sam	ple S-4: Ve	ery Stiff, So	me	Coarse to	Fine Sand, Trac	e	
_	\square		7 9	20.270			- 10	EL 4	83.0		Fine	Angular G	ravel					
-								10	.0		Botto	om of Borin	g @ 10.0 f	t				cuttings upon
F																		completion
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	- 5	<u></u> 8 - SP	LIT SPO	DON	HSA	- HOLL	.ow s	STEM A	UGEF	RS				DI	0-2	VERY SOFT		
	- 1	T - TH	IN WAI		SSA	- SOLII	D STE	MAUG	BERS		0-4 5-10	VERY LC	LOOSE		3-4 5-8	SOFT MEDIUM STIFF	TR	RACE 1 TO 10
	- 8 - Г	3S-3" ח-0F	SPLIT	SPOON	DC -	DRIVIN	NG CA	SING			11-30 31-50	MEDIU	M DENSE		9-15 16-30	STIFF	SC	DME 21 TO 35
	- F	RC - R	CK C	ORE	HA -	HAND	AUGE	R		0	OVER 5	50 VERY	DENSE	(OVER 30	HARD	AN	ND 36 TO 50

Boring No. RB-05 Page 1 of 1

R	X	2	P	ROJE	СТ	: Prof	essi	onal	Boul	evar	d				COMMISSIC	ON NO	.: 1418	7-03.4
			•		Mae	hinat	on C	ount	V N/	larvl	and				N	ORTH	: 7170	49
			3	IIE. <u></u>	lva5	migu		Jouni	y, iv	iai yi	anu		Mohil B	57 AT\/ /		EAST	: 1118	838
			D	RILLI	NG	CO.:	AB				RIG/	HAMME	RSafety		ELEV	ATION	l: 503.5	5 - ft
	(GRO		VATER	DA	TA (ft))		EQU	IPME	NT	CASING	SAMPLEF	CORE	START	DATE	: 5/10/2	2016
Da	te 016	Time	9 00 PM	Water		Casing	Ca	ive-In 7 9	TYPE	ID (im)		HSA	S		END	DATE	: 5/10/2	2016
0/10/2	010	.2.00.0		Diy					HAMN	ID (III) ИER W	T. (lb)	3.25	1.375	-	DR	ILLER	а: К. Ма	anos
		-							HAMN	/IER F/	ALL (in)		30	-	LOGG	ED BY	: ACR	
ше	ΥPE	Ē			DRAT TEST	ORY	_			<u>ں</u>								
APL ABE	ЦЩ	IPLE ER	NS/ SQL	RE 	SUL	rs ∣≿	РТН	ELE	V.	Ηd		DES		AND CLASS	IFICATION		NOT	ES:
SAN	MPL	SAN	3LO	in C/	GF	STICI	DE	DEF	— ТН	GR								
	SA	RE		∠ ac ∠ ⊥	ΞΞ	PLA				· , ,		(moist	ure, density	, color, prop	ortions, etc.)			
			2					EE 5	03.3 2		∆ 2-inc Mois	t Stiff Red	l dish Brown	High Plastic	city CLAY Trace			
- S-1	X	12	5	32.6%		-			_		Fine	Sand (CH)	[A-7-6]	ingii iaoa	,,			
-			8			-												
- S-2	\square	16	3 8			-					Sam	ple S-2: Ve	ry Stiff, Little	e Sand				
Bulk Si															Bulk Sam	ple Taken		
Sample S-3: Very Stiff															ger Cuttings			
$\begin{bmatrix} S-3 \\ 10 \\ 10 \\ 37.1\% \\ 77 \\ 49 \end{bmatrix}$ Sample S-3: Very Stiff $\begin{bmatrix} From Auger Cutting \\ 7.0 to 12.0-ft \\ MDD = 105.3-pcf \\ OMC = 18.0\% \\ \end{bmatrix}$															05 3-pcf			
	S-3 $\begin{bmatrix} 16 & 3 \\ 8 & 32.2\% \\ 10 & 37.1\% & 77 & 49 \end{bmatrix}$ Sample S-3: Very Stiff Sample S-3: Very Stiff MDE = 105.3-pcf OMC = 18.9% CBR = 1.4																	
- 5-4	$\begin{array}{c ccccccccccccccccccccccccccccccccccc$																	
Ē			1				- 10											
						[EL 4	91.5				_					
_ S-5		0	50/0"					12	.0		Sam	ple S-5: No om of Boring	Recovery			/	Auger Re 12.0-ft	fusal at
												·					Deelefillee	
-							- 15										Backfilled	i with auger
+						-											completic	on
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20 DEFAL			ITIFICA	TION					חו	R	LOWS		ISITY		CONSISTENCY	SA		
	SAMPLE IDENTIFICATION DRILLING METHOD BLOWS/FT DENSITY BLOWS/FT CONSISTENCY (PERCENT) Image: State of the state of t																	
	 ✓ - S - SPLIT SPOON HSA - HOLLOW STEM AUGERS 0-4 VERY LOOSE - T - THIN WALL TUBE SSA - SOLID STEM AUGERS 0-4 VERY LOOSE 3-4 SOFT TRACE 1 TO 10 LOOSE 5-8 MEDIUM STIEF LITLE 11 TO 20 																	
	SS - 3" SPLIT SPOON DC - DRIVING CASING 11-30 MEDIUM DENSE 9-15 STIFF 11 TO 20 9-15 STIFF SOME 21 TO 35																	
	F	<u>RC - R</u>		DRE	HA -	HAND	AUGE	R		C	OVER 5	50 VERY	DENSE	OVER 30	HARD	AN	D	36 TO 50

R	K	R	P	ROJE	CT:	Prof	essi	onal I	Boul	evard						COMMISSIC	ON NC).: 1418	37-03.4
			_		Nee	hingt	~~ (londo	n d					N	ORTH	l: 7168	310
			3		was	ningt	on C	ount	y, iv	laryiai	na		Mahil		Δ Τ \ / /		EAS	r: 1118	3912
			D	RILLI	NG	CO.:	AB			F	RIG/H	HAMME	R Safety	397 F	417/	ELEV		N: 502	- ft
		GRO	UNDV	VATEF	R DA	TA (ft)		EQU	IPMEN	IT	CASING	SAMPLE	R	CORE	START	DAT	E: 5/11/	/2016
Dat	e	Tim	e	Water	0	Casing	Ca	ave-In	TYPE			HSA	S			END	DATE	E: 5/11/	/2016
5/11/20	016	9:15:00		Dry	-		-	4.5	SIZE, HAMN	ID (in) //FR WT	(lb)	3.25	1.375			DR	ILLEF	R: K. M	anos
									HAMN	IER FAL	.L (in)		30		-	LOGG	ED B	Y: ACR	
	PE	(ii		LABO	ORAT TEST	ORY				υ									
IPLE IBEF	н Ш	IPLE ERY	NS/	RE	SULT	rs ≥	ЪТН	ELE	V.	HU		DES	CRIPTION	AND	CLASSI	FICATION		NO	TFS [.]
SAN	MPL	SAN	10/ % F	MC/ Free	₽₽	DEX	DEI		— тн	GR∕									
	SAI	RE	ш	Frac	E L L R	PLAS						(moist	ure, densit	ty, colo	or, propo	rtions, etc.)			
_		,						EL 5	01.5 5		6-inch Moist	Stiff Red	l dish Brow	n Hia	h Plastic	ity CLAY Some			
S-1	\mathbb{N}	18	2 5	28.2%	43	24		0.			Coars	e to Fine	Sand, Trac	e Fine	e Gravel	(CL) [A-7-6]		MDD = 1	115.8-pcf
	\square		5															CBR =3.	.3
- S-2	\bigtriangledown	18	3	33%		-					Samp	le S-2: Ve	ry Stiff, Bro	own, C	Gray, Litt	le Coarse to Fin	ne		
-	\square		4 20				- 5				้ Little Gra า	vel-sized F	KOCK F	-ragment	is at the Tip of		Bulk Sar	nnle Taken	
- S-3	\vdash	16	4			-			ļ		Samn	le S-3 [.] Me	edium Stiff	Gravi	ish Brow	n. Trace		From Au	iger Cuttings
-	S-3 16 4 4 4 4 4															.,		0.0 to 10).0-π
\vdash	Gravel-sized Rock Fragments																		
- S-4		18	3 2	37.5%		-			02.0		Samp	le S-4: So	ft, Grayish	Brow	'n				
-	\square	1	2				- 10	10	.0		Bottor	n of Borin	g @ 10.0 f	ť				Backfille	d with auger
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SA	MPLI		ITIFICA	TION		DRIL	LING	METHC	D	BLC	OWS/F	T DEM	NSITY	BLO	WS/FT	CONSISTENCY	SA	AMPLE PR (PER)	CENT)
- S - SPLIT SPOON HSA - HOLLOW STEM AUGERS -4 VERY LOOSE 0-2 VERY SOFT TRACE													RACE	1 TO 10					
- T - THIN WALL TUBE SSA - SOLID STEM AUGERS 5-10 LOOSE 5-8 MEDIUM STIFF LITTLE													TTLE	11 TO 20					
	- [D - DE	ENISON	1	MD -	- MUD I	DRILL	ING			31-50 /ER 50		NSE	9 1	9-15 6-30	STIFF VERY STIFF	SC	OME	21 TO 35
	- F	RC - R	оск со	ORE	HA -	HAND	AUGE	R		00	יבת אנ	VERY	DENSE	OV	'ER 30	HARD	AN	١D	36 TO 50

Boring No. RB-07 Page 1 of 1

F	Z	?,	P	ROJE	СТ	Prof	essi	onal	Bou	levai	rd					COMMISSIO	N NO	.: 14187-03.4
			_		Nee	hingt	~~ (N	1000	and					N	ORTH	I: 716492
			5		was	ningt	on C	Jount	<u>y</u> , n	/laryi	and		Mahil				EAST	: 1119270
			D	RILLI	NG	CO.:	AB				RIG	HAMM	RSafet	в5 У	07 ATV /	ELEVA	ATION	l: 517.5 - ft
		GRO	UNDV	VATER	R DA	TA (ft)		EQL	JIPME	INT	CASING	SAMPL	ER	CORE	START	DATE	: 5/12/2016
Da	ite	Time	e	Water	(Casing	Ca	ave-In	TYPE	Ξ		HSA	S			END	DATE	: 5/12/2016
5/12/	2016	9:00:00	ОАМ	Dry				5.3	SIZE,	, ID (in)) /T (lb)	3.25	1.375			DRI	ILLER	R: K. Manos
									HAM	MER F.	ALL (in)		30		-	LOGGE	ED BY	: ACR
	ΡE	(in)		LABO	ORAT	ORY				U								
		PLE	VS/6	RE	SUL	rs ≻	TH	ELE	V.	HH		DES	SCRIPTIO		ND CLASSI	FICATION		NOTES
SAM	IPLI	SAM	NO NR	AC/ Freq	<u></u> ≘⊨	DEXE	DEF		— тц	GRA								NOTEO.
0,2	SAN	REC	шÚ	Frac	LINC	PLAS						(mois	sture, dens	sity,	color, propo	ortions, etc.)		
								EL 5	17.0-		_ 6-inc	thes Tops	oil ff Doddiah				/	
_ S-1	\mathbb{N}	14	4 7	25.7%				0.	Э		Trac	e Fine to (Coarse Sa	nd (CH) [A-7-6]	asticity CLAT,		
	\vdash		9															
- S-2		18	6	28%	72	49					Sam	ple S-2: Y	ellowish B	rowr	n			MDD = 110.3-pcf
	\square		8 12				- 5											CBR =2.3
F.		10	7			-					Sam	nlo S 2· D	oddich to '	Valle	owich Brow	•		Bulk Sample Taken
- 5-3	X	18	9	29.5%		-					San	ipie 3-3. N		I Elic		1		0.0 to 6.0-ft
-			11			-												
- S-4		16	6 6			-			07.6		Sam	ple S-4: H	ard, Redd	ish t	o Yellowish	Brown		
-			50/5"			-	- 10	<u>EL 5</u> 9.	9		Botte	om of Bori	ng @ 9.9 f	t				Backfilled with auger
-						-												cuttings upon
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													ENSITY	F	BLOWS/FT	CONSISTENCY	SA	MPLE PROPORTIONS
] -	S - SP	LIT SPO	DON	HSA	- HOLI	LOW	STEM A		RS	0.4				0-2	VERY SOFT		
												VER L	Y LOOSE OOSE		3-4 5-8	SOFT MEDIUM STIFF	TR TI I	ACE 1 TO 10
	∃ - 1 -	"SS - 3 ח - ח	SPLIT	SPOON	DC -	DRIVII - MI	NG CA DRILI	ASING ING			11-30 31-50	MEDI	JM DENSE ENSE		9-15 16-30		SC	DME 21 TO 35
	- D - DENISON MD - MUD DRILLING - RC - ROCK CORE HA - HAND AUGER										OVER 5	50 VER	Y DENSE		OVER 30	HARD	AN	ID 36 TO 50

Boring No. RB-08

SITE: Washington County , Maryland	RTH: 716606
	AST: 1119053
DRILLING CO.: AB RIG/HAMMERSafety ELEVAT	FION: 511.7 - ft
GROUNDWATER DATA (ft) EQUIPMENT CASING SAMPLER CORE START D	ATE: 5/16/2016
Date Time Water Casing Cave-In TYPE HSA S NQ2 END D 5(48/2016 0:20:00 AM 11 20 0:75 HS (to b) 0:55 HS (to b) 0:50 HS (to b) 0:55 HS (to b)	ATE: 5/16/2016
S/18/2010 S/00.00 AW FT 20 SIZE, ID (in) 3.25 1.375 2 DRIL HAMMER WT (lb) 140 -	LER: K. Manos
HAMMER FALL (in) 30 - LOGGEI	DBY: ACR
	NOTES:
$ \nabla \nabla$	
R-1 60 98% Light Gray to Gray, LIMESTONE, Unweathered, Fine-grained, Sound, Moderate Fracture Spacing, Medium	Laboratory
Strong to Strong	at 0-ft
$ _{R-2} _{60} _{\mathbf{98\%}} _{60} _{\mathbf{98\%}} _{7} _{\mathbf$	Rock outcrops
	observed in the vicinity
	or boring
R-3 60 90% -10 -10 ∇ -10 -10 -10	
R-4 60 98%	
20 EL 491.7 L Bottom of Boring @ 20.0 ft	Grouted on 5/18/16
	SAMPLE PROPORTIONS
SAMPLE IDENTIFICATION DRILLING METHOD BLOWS/FT DENSITY BLOWS/FT CONSISTENCY	(PERCENT)
- T - THIN WALL TUBE SSA - SOLID STEM AUGERS - T - T - THIN WALL TUBE SSA - SOLID STEM AUGERS - T - T - THIN WALL TUBE SSA - SOLID STEM AUGERS - T - T - THIN WALL TUBE SSA - SOLID STEM AUGERS - T - T - T - THIN WALL TUBE SSA - SOLID STEM AUGERS - T - T - T - T - T - T - T - T - T - T	TRACE 1 TO 10
- SS - 3" SPLIT SPOON DC - DRIVING CASING 11-30 MEDIUM DENSE 5-8 MEDIUM STIFF	LITTLE 11 TO 20 SOME 21 TO 35
Z C - D - DENISON MD - MUD DRILLING OVER 50 DENSE 16-30 VERY STIFF C - RC - ROCK CORE HA - HAND AUGER OVER 50 VERY DENSE OVER 30 HARD	AND 36 TO 50

Boring No. SWM-01 Page 1 of 1

F	2	K		P	ROJE	CT:	Pro	fessi	onal I	Boule	evard					N NO.:	14187-03.4
				s	ITE:	Was	hina	ton C	Count	v.M	arvland				N	ORTH:	717702
				-						,			Mobil B	57 ATV /		EAST:	1118081
				D	RILLI	NG	<u>CO.:</u>	AB			RIC	S/HAMMEF	R:Safety		ELEV	ATION:	500 - ft
		(GRO		VATE	R DA	TA (f	t)		EQUI	PMENT	CASING	SAMPLER	CORE		DATE:	5/3/2016
	Date		Tim	e	Water	(Casing	Ca	ave-In			HSA	S		_ END	DATE:	5/3/2016
										HAMM	ER WT. (lb	3.25	1.375	_	- DR	ILLER:	K. Manos
										НАММ	ER FALL (i	n)	30	-	LOGG	ED BY:	ACR
APLE	ABER	Е ТҮРЕ	APLE 'ERY (in)	WS/6" RQD)	LABO RE	DRATO TEST <u>ESULT</u>	ORY S	РТН	ELE	V.	APHIC	DES	CRIPTION A	ND CLASS	IFICATION		NOTES:
SAN		AMPL	SAN	BLO (%	NMC/ ac. Fre	QUID	ASTIC	DE	DEP	тн	GR	<i>,</i>			<i></i>		
-	1	<u>8</u>	19	2	Ë	5-	Ъ.			0.0	,∖_/ 3_ii	(moist aches Topsoi	ure, density	color, prop	ortions, etc.)		
-		X	10	3 3 3			_	-	0.2	2	Mo	ist, Medium (Stiff, Brown,	CLAY (cl) [a	a-7-6]		
		$^{\prime}$						-	EL 49	98.0							
- S-	2	\bigvee	10	6 8 5 2	9.9%	20	7	-	2.0		Mo Cla	ist, Stiff, Gra ay (ML) [A-4]	ay, Brown, S	ILT, Some F	ine Sand, Little		
		/						_									
S-	3	\backslash	8	20 13 8							Sa	mple S-3: Ve	ry Stiff, Brov	vn, And Coa	rse to Fine SAN		
F		Å		5				- 5									
-s-	4	\rightarrow	18	4				-	EL 49	94.0	Mc	ist, Stiff, Red	dish Brown,	CLAY (cl) [a	a-7-6]		
		V		4				-							-		
		\wedge		9													
s-	5	$\langle \rangle$	18	4				-			Sa	mple S-5: Bro	own, Little Fi	ne Angular	Gravel		
╞		X		5 6				-									
-		$ \rightarrow $		1				- 10				mpla S 6: Pr	we little Fi	no Angular	Croyal		
5-		\bigvee	24	4 5	15.9%						Jan Sa	Inple 3-0. Bit	JWII, LILLIE I		Glavel		
_ ٩		\wedge		8				-									
S-	7	\rightarrow	17	4			-	-			Sa	mple S-7: Bro	own, Little Fi	ne Sand, Lit	ttle Fine Angula	r	
- 19		V		6 7 10				-			Gra	avel					
KKEN		$/ \setminus$		10													
S-S-S-	8	$\langle \rangle$	18	6 7				-			Sa	mple S-8: Ve	ry Stiff, Trac	e Fine Sand	1		
2 2		X		10 9				- 15		Ę							
		$^{\prime}$		_				-		ľ							
S-	9	\backslash	12	8 8						F	Sa	mpie S-9: Ve	ry Suif, And	ivieaium to l	FINE SAND		
		Å		7				-		F							
	ł							-	EL 48	32.0 0	Ro Ro	ttom of Borin	a@ 180 ft			F	Backfilled with auger
ACTEX CTEX								_	.0.								uttings upon
							[P
EFAUL		-										o/FT = -				SAM	IPLE PROPORTIONS
	SAM	PLE				Нел					BLOW	S/FT DEN	ISITY	BLOWS/FT			(PERCENT)
	Π	- a - T	- TH	IIN WAL	L TUBE	SSA	- SOLI	ID STE	M AUGE	ERS	0-4	VERY	LOOSE	0-2 3-4	SOFT	TRA	CE 1 TO 10
		- 8	SS - 3"	SPLIT	SPOON	DC -			SING		11-3			5-8 9-15	STIFF	SON	LE 11 TO 20 /IE 21 TO 35
	- D - DENISON MD - MUD DRILLING - RC - ROCK CORE HA - HAND AUGER										OVER	50 VERY	DENSE	16-30 OVER 30	VERY STIFF HARD	ANE) 36 TO 50

Boring No. SWM-02 Page 1 of 1

F	2			P	ROJE	CT:	Prof	essi	onal E	Boule	evar	d					N NO.:	14187-03.4
				S	ITE: \	Nas	shingt	on C	Count	/ . Ma	arvla	and						/ 1/ 598
				_					,		,			Mobil E	357 ATV /		EASI:	1118307 507.0 #
				D	RILLI	NG	<u>CO.:</u>	AB				RIG/	HAMMEF	Safety			ATION:	507.2 - π
	ato		SRO				TA (f	t)			PME	NT	CASING	SAMPLE	R CORE		DATE:	5/3/2016
5/3/2	2016		11:15:0	e 00 AM	Dry		Jasing	Li	3.5	IYPE SIZE II	D (in)		<u>HSA</u> 3 25	S 1 375		END	DATE:	5/3/2016
									I	HAMME	ER W	T. (lb)	5.25	140	-		ILLER:	K. Manos
			~						<u> </u>	HAMME	ER FA	LL (in)		30	-	LOGG	ED BY:	ACR
AMPLE		PLE TYPI	AMPLE OVERY (in	_OWS/6" % RQD)				ОЕРТН	ELE	V.	RAPHIC		DES	CRIPTION	AND CLASS	IFICATION		NOTES:
ω Σ	Ž	SAM	RECO	, BL	Frac. I	LIMI	PLAST IND		DEP	TH .	U A	6 incl	(moist	ure, density	y, color, prop	ortions, etc.)		
- -		$\left \right $	9	3 4 3 4			-		<u>EL 50</u> 0.5	6.7		-Incl Moist	, Medium S	Stiff, Brown	, CLAY (CH)	[A-7-6]		
- -	2	$\langle \rangle$	12	3 5 7 11								Sam	ole S-2: Sti	f				
- -	$\begin{array}{c ccccccccccccccccccccccccccccccccccc$											Sam	ole S-3: Sti	f				
- S-4	1	$\langle \rangle$	18	4 7 10 15			-					Samı	ole S-4: Ve	ry Stiff				
- S-{	5	$\langle \rangle$	24	5 7 9 10			-					Sam	ble S-5: Ve	ry Stiff				
- -	3	$\langle \rangle$	18	3 5 7 11	27.8%	61	39	- 10				Sam	ole S-6: Sti	f				
	7	$\left \right\rangle$	24	3 6 7 8			-					Samı	ole S-7: Sti	f				
641 KKK_CUKK	S-8 18 $3 \\ 5 \\ 9 \\ 5 \\ 5 \\ - 15 \\$											Sam	ole S-8: Sti	f				
S-S			15	16 8 50/3"					EL 49	0.0		Sam	ole S-9: Ha	rd, Light G	ray at Tip of	Spoon		
												Botto	m of Borin	g @ 17.2 ft			B CL CC	ackfilled with auger uttings upon ompletion
DEF	SAM	PLE	IDEN	TIFICAT	ION		DRIL		METHOD)	BL	_OWS/F	T DEN	ISITY	BLOWS/FT	CONSISTENCY	SAM	PLE PROPORTIONS (PERCENT)
	- S - SPLIT SPOON HSA - HOLLOW STEM AUGE - T - THIN WALL TUBE SSA - SOLID STEM AUGERS - S - 3" SPLIT SPOON DC - DRIVING CASING - D - DENISON MD - MUD DRILLING - RC - ROCK CORE HA - HAND AUGER									IGERS RS	c	0-4 5-10 11-30 31-50 VER 50	VERY LO MEDIUI DE VERY	LOOSE DSE 1 DENSE NSE DENSE	0-2 3-4 5-8 9-15 16-30 OVER 30	VERY SOFT SOFT MEDIUM STIFF STIFF VERY STIFF HARD	TRAC LITTI SOM AND	CE 1 TO 10 LE 11 TO 20 E 21 TO 35 36 TO 50

Boring No. SWM-03 Page 1 of 1

R	X	2	P	ROJE	CT:	Pro	fessi	onal I	Boule	evard				COMMISSIO	N NO.:	14187-03.4
			S		Nas	hina	ton (Count	v M	arvland				N	ORTH:	717468
			Ŭ	··· <u>·</u>	vuc	, ining		Jouni	<u>y</u> , ivi	aryland		Mobil B ^r	57 ATV /		EAST:	1118507
			D	RILLII	NG	CO. <u>:</u>	AB			RIG	;/HAMME	R:Safety		ELEVA	ATION:	502.3 - ft
		GRO	UNDV	VATEF	R DA	TA (1	ft)		EQUI	PMENT	CASING	SAMPLER	CORE		DATE:	5/2/2016
Da	te	Tim	e	Water	(Casing	Ca	ave-In	TYPE		HSA	S		END	DATE:	5/2/2016
5/2/20	10	4:15:00	PIN	Dry	_		_	15	SIZE, I	D (in)	3.25	1.375		DR	ILLER:	K. Manos
									HAMM	IER FALL (ir	1)	30	-	LOGGE	ED BY:	ACR
AMPLE UMBER	IPLE TYPE	SAMPLE OVERY (in)	LOWS/6" % RQD)	LABC RE	RAT IEST SUL1	ORY	ОЕРТН	ELE	V.	RAPHIC	DES	CRIPTION A	ND CLASSI	FICATION		NOTES:
ωz	SAM	S C C	B	Lac.	LIMI	LAS ⁻		DEP	тн	0	(moist	ture, density,	color, propo	ortions, etc.)		
S-1		12	4	<u> </u>						<u>\^ //</u> 8-ir	iches Topso	il	, pp.	,		
-			6 6 6				-	<u>EL 50</u> 0.	0 <u>1.6</u> 7	Mo	ist, Stiff, Red	ldish Brown,	CLAY (CH)	[A-7-6]		
- -		6	4 6 9 9				-									
- S-3 -		12	4 5 7 9	26.7%		-	- 5									
- S-4		18	5 7			-	_			Sar	mple S-4: Ve	ery Stiff				
		15	9 12				-									
-		15	5 6 9			-	-									
S-6		18	4 5 8 10			-	— 10 -			Sar	mple S-6: Re	eddish to Yel	owish Brow	n		
S-7		18	3 3 3 5	28.4%	48	28	-			Sar	mple S-7: Mé	edium Stiff, E	rown			
S-8	$\begin{bmatrix} S-8 \\ - \\ - \\ - \\ - \\ - \\ - \\ - \\ - \\ - \\$										nple S-8: Me	edium Stiff, E	rown, Trace	Fine Sand		
S-9		6	2 3 2 11	30.1%			-			Sar Me	nple S-9: Me dium to Fine	edium Stiff, L Sand	ight Gray to	Brown, Little		
						-	-	EL 48	<u>34.3</u> .0	Bot	tom of Borin	g @ 18.0 ft			B c c	Backfilled with auger uttings upon ompletion
SA	MPLE		TIFICAT			DRIL	LING N	NETHO)	BLOWS	S/FT DEI	NSITY	BLOWS/FT	CONSISTENCY	SAM	IPLE PROPORTIONS
] - \$	5 - SPI	LIT SPC	DON	HSA	- HOL	LOW S		JGERS	3			0-2	VERY SOFT		
] - '	Г - TH		L TUBE	SSA	- SOL	ID STE	MAUGE	ERS	0-4 5-10	VERY	LOOSE	3-4 5-8	SOFT MEDIUM STIFF	TRA	UE 1 FO 10 LE 11 TO 20
- SS - 3" SPLIT SPOON DC - DRIVING CASING											0 MEDIU 0 DE	M DENSE ENSE	9-15 16-30	STIFF VFRY STIFF	SON	1E 21 TO 35
2 - D - DENISON MD - MUD DRILLING *** - RC - ROCK CORE HA - HAND AUGER										OVER	50 VERY	DENSE	OVER 30	HARD	AND	36 TO 50

Boring No. SWM-04 Page 1 of 1

R	X		P	ROJE	CT:	Pro	fessi	onal	Boule	evarc	1				COMMISSIC	ON NO).: 14187-03.4
					Mae	hina	ton (Count	V M	arvla	and				N	ORTH	i: 717367
			0		1103	inng		Journ	<u>y</u> , ivi	aryia			Mohil B	57 ATV /		EAST	Г: 1118610
			D	RILLI	NG	CO.	: AB			I	RIG/	HAMME	RSafety		ELEV	ATION	N: 490 - ft
		GRO	UNDV	VATEF	R DA	TA (f	t)		EQUI	IPMEN	NT	CASING	SAMPLEF	CORE	START	DATE	E: 5/2/2016
Da	ite	2:15:00	e PM	Water	(Casing	Ca	ave-In 5.5	TYPE			HSA	S		END	DATE	E: 5/2/2016
0/2/20	10	2.10.00		Diy				0.0	HAMM	ID (IN) IER WT	. (lb)	3.25	1.375	_		ILLEF	R: K. Manos
									НАММ	IER FAI	LL (in)		30	-	LOGG	ED B	r : ACR
SAMPLE	AMPLE TYPE	SAMPLE ECOVERY (in)	BLOWS/6" (% RQD)	RAD REC/ Leed Igc. Freed		ASTICITY SJ INDEX	DEPTH	ELE DEF	EV. — PTH	GRAPHIC		DES		AND CLASS	FICATION		NOTES:
S-1		18	2	ш.		료		FI 4	89.5	<u>\\ //</u>	6-incl	hes Topsoi					
-		10	2 2 2				_	<u>EL 4</u> 0. <u>EL 4</u>	89.5 5 88.0		Moist	t, Very Loos	se, Brown, I	Fine SAND, 7	And Silt (sm) [a-	4] — — —	
-		/ 18	4 7 3 5			-	-	2.	0		Coars	se to Fine (Gravel-sized	d Rock Fragr	nents (cl) [a-7-6]]	
S-3		18	4 4 7 10				- 5				Samp Little	ole S-3: Litt Fine Angul	le Coarse to ar Gravel	o Medium Sa	and in a Pocket,		
¯ S-4 -	S-4 24 4 4 8 11 EL 48										Samp	ole S-4: Gra	ayish Browr	n, And Fine S	Sand		
- S-5 -		24	7 7 7 8				_	<u>EL 4</u> 8.	8 <u>2.0 (</u>		Moist SANI	, Medium I D, Some Si	Dense, Ligh It (sm) [a-2-	t Gray, Brow 4]	n, Coarse to Fin		
1 1 1 1							— 10 - -	EL 4 10	<u>80.0</u> .0		Botto	m of Boring	g @ 10.0 ft				Backfilled with auger cuttings upon completion
							- 15										
							-										
											0.000				001010	SA	MPLE PROPORTIONS
	SAMPLE IDENTITICATION DRILLING METHOD State - S - SPLIT SPOON HSA - HOLLOW STEM AUGER - T - THIN WALL TUBE SSA - SOLID STEM AUGERS - SS - 3" SPLIT SPOON DC - DRIVING CASING - D - DENISON MD - MUD DRILLING - RC - ROCK CORE HA - HAND AUGER										0-4 5-10 11-30 31-50 VER 50	VERY LO MEDIUI DE VERY	LOOSE OSE M DENSE NSE DENSE	0-2 3-4 5-8 9-15 16-30 OVER 30	VERY SOFT SOFT MEDIUM STIFF STIFF VERY STIFF HARD	TR LIT SC AN	(PERCENT) RACE 1 TO 10 ITLE 11 TO 20 DME 21 TO 35 ND 36 TO 50

Boring No. SWM-05 Page 1 of 1

R	27		F	PROJE	CT:	Pro	fessi	onal	Boule	evaro	d					COMMISSIC	ON NO	.: 14187-03	3.4
					Was	hina	ton (Cunt	v M	larvla	and					N	ORTH	l: 717468	
				///	1103	mig		Journ	<u>y</u> , ivi	iai yic			Mohil	R 5	7 ΔT\/ /		EAST	: 1118507	,
			C	RILLI	NG	CO.:	AB				RIG/	HAMME	RSafety			ELEV	ATION	1: 502.3 - fl	t
		GRO	UND	NATEF	R DA	TA (fl	:)		EQU	IPMEI	NT	CASING	SAMPLE	ER	CORE		DATE	: 5/10/201	6
Da	ate	Tim	e	Water	0	Casing	Ca	ave-In	TYPE			HSA	S			END	DATE	: 5/10/201	6
5/10/	2016	11:45:0	DO AM	Dry	_			4.0	SIZE,	ID (in)	T (Ib)	3.25	1.375				ILLER	R: K. Manos	s
					-				HAMN		LL (in)		30		-	LOGGI	ED BY	: ACR	
SAMPLE	SAMPLE TYPE	SAMPLE RECOVERY (in)	BLOWS/6" (% RQD)	LAB RI Lac. Freq.		LASTICITY GJ	DEPTH		:V. ?TH	GRAPHIC		DES (mois	CRIPTION	N AN	ND CLASS	FICATION		NOTES:	:
S-1		/ 14	1					EL 5	01.8	<u>, 17</u>	6-inc	hes Topso	pil	,	<i>,</i> , ,	. ,			
- - S-2 -		14	1 1 2 3 4 9 10			-	- -	0. <u>EL 5</u> 2.	00.3		Mois Mois Fine	t, Very So t, Stiff, Re Gravel (cl	ft, Brown, (ddish Brow) [a-7-6]	ĊĹĂ vn, (NY, Trace F	ine Sand (cl) [a- e Fine Sand, Tra	7-6] - ace -		
- S-3		20	7 9 11 13			-	- 5				Sam	ple S-3: V	ery Stiff						
- - -		24	8 10 13 15			-					Sam	ple S-4: V	ery Stiff						
- - -		18	7 10 11			-	-				Sam	ple S-5: V	ery Stiff, Tr	ace	e Lignite				
S-6		18	6 8 10			_	— 10	<u>EL 4</u> 11	<u>91.3</u> .0		Sam	ple S-6: V	ery Stiff ng @ 11.0	ft				Backfilled wit cuttings upor completion	th auger າ
Bottom of Boring @ 11.0 ft Independent Indepindent <td></td> <td></td> <td></td> <td></td> <td></td> <td></td>																			
DEFA						DRII	LING	ИЕТНО	D	BI	OWS	FT DF	NSITY	P		CONSISTENCY	SA		RTIONS
	SAMPLE IDENTIFICATION DRILLING METHOD Image: Solution of the state o											VER Li MEDIU 50 VER	Y LOOSE DOSE JM DENSE ENSE Y DENSE		0-2 3-4 5-8 9-15 16-30 OVER 30	VERY SOFT SOFT MEDIUM STIFF STIFF VERY STIFF HARD	TR LIT SC AN	ACE 1 TLE 1 DME 2 ID 3	1 TO 10 1 TO 20 1 TO 35 6 TO 50

Boring No. SWM-06 Page 1 of 1

	2	K		P	ROJE	CT:	Pro	fessi	onal	Boul	evar	d						ON NO	.: 14187	-03.4	
				s	SITE: \	Was	hing	ton C	Count	y, N	1aryl	and					N	ORTH	1: 71694	2	
				_			~~							Mob	oil B5	7 ATV /			: 11100 I. 502.1	6∠7 ft	
						NG		: AB				RIG/	HAMM	=RSate	ety				502.1	- IL 016	
	Date		GRO		Water		IA (T Casing	τ) Ca	ave-In	EQU	IPME	NT			PLER	CORE			. 5/10/2	016	
										SIZE,	ID (in)		3.25	1.3	, 75				. 5/10/2	010	
_										HAMN	MER W	'T. (lb)		14	0	-				105	
_		ш	Ê		LAB		ORY			HAMN	MER FA	ALL (in)		3	0	-	1000		. ACK		
SAMPLE	NUMBER	AMPLE TYP	SAMPLE ECOVERY (ir	BLOWS/6" (% RQD)	I BO NMC/ Iac. Freq.			DEPTH		EV. — PTH	GRAPHIC		DE (moi	SCRIPTI	ON AI	ND CLASS			NOTE	ES:	
s	5-1	<u> </u>	14	4		_	<u> </u>		EL 5	02.0	777	∖2-inc	hes Tops	oil	nony,			1			
	-2	X	14	4 6 8 3				_	0.	.1		Mois [a-7-	t, Stiff, Re 6]	ddish Br	own, (CLAY, Trad	ce Fine Sand (cl))			
-		X		5 9 11				-													
-s	-3		24	7			-	_				Sam	ple S-3: \	ery Stiff							
		V		9 9				- 5			\square										
		\wedge		10				5													
Fs	-4	$\left(\right)$	24	4			-	-				Sam	ple S-4: L	ight Grav	/ to Re	eddish Brov	wn. Little Coarse	to			
		\bigvee	27	4 5								Fine	Sand, Lit	le Coars	e to F	ine Angula	r Gravel-sized R	ock			
		Å		7				-				гау	ments at	ine rip o	i Spoc	11					
F.	_	\square	_	50/1"				_	EL 4	94.0										fueal at 8 (0 #
s	5-5		0	50/1					8.	.1		Botto	om of Bor	ng @ 8.′	1 ft				Auger Rei	usai al o.u	J-IL
-								- 10											Backfilled cuttings u completion	with auge pon n	۶r
1								_													
								_													
1.GU								_													
AKEN A																					
5-							-	_													
T XX								- 15													
0.GPJ								10													
- AR								-													
JULE																					
AL B(-													
								_													
CFEX																					
ξ_								-													
SAMPLE IDENTIFICATION DRILLING METHOD BLOWS/FT													FT D	ENSITY	E	BLOWS/FT	CONSISTENCY	SA	MPLE PRO (PERCE	PORTIONS	3
													0-2	VERY SOFT	TR	ACE	1 TO 10)			
		- 1 - 8	- TH SS - 3"	IIN WAI SPLIT	LL TUBE SPOON	DC -	- SOL DRIV	LID STE ING CA	IM AUC SING	JERS		5-10 11-30		OOSE	E	5-4 5-8	MEDIUM STIFF	LIT	TLE	11 TO 20)
	X	- 0) - DE	ENISON	۔ ۱	MD -	MUD	DRILL	ING		6	31-50 DVER 5	0 VES	ENSE	-	9-15 16-30	VERY STIFF	SO	ME	21 TO 35	i N
ž	- D - DENISON MD - MUD DRILLING - RC - ROCK CORE HA - HAND AUGER												- VĽF		•	OVER 30	HARD	AN	U	JO I U 50	1

Boring No. SWM-07 Page 1 of 1

	2	K		F	PROJE	ECT	: Prof	fessio	onal	Boul	evaro	d						COMMISSIC	ON NC).: 1418	7-03.4
				-	NTE.	M 00	hinat	on C	ount	. N	londe	and						N	ORTH	l: 7167	46
				3		vvas	mingi		ount	y, w	aryia				Mahili				EAS	F: 1118	897
				C	RILL	ING	CO.:	AB				RIG/	/HAI	MME	RSafety	50		ELEV	ATIO	1: 495 -	ft
		(GRO	UND	NATE	R DA	TA (ft)		EQU	IPME	NT	CAS	SING	SAMPLE	R	CORE	START	DAT	E: 5/11/	2016
1	Date		Time	e	Water	0	Casing	Ca	ive-In	TYPE			Н	ISA	S			END	DATE	E: 5/11/	2016
5/11	1/201	6	8:20:00	D AM	Dry			4	4.0	SIZE,	ID (in)	- /// \	3	.25	1.375			DR		R: K. Ma	anos
											/IER W	LL (in)			140 30		-	LOGG	ED B	: ACR	
φ SAMPLE	1 NUMBER	SAMPLE TYPE	∞ RECOVERY (in)	° № BLOWS/6" (% RQD)	RI NMC/ Frac. Freq.			DEPTH		V. 	GRAPHIC	<u>3-inc</u>	hes_	DESC (moistr Topsoi	CRIPTION ure, densi	I AN ty, c	ND CLASS	FICATION] =	ΝΟΤ	ES:
- - -	$\begin{array}{c ccccccccccccccccccccccccccccccccccc$									2		Mois Sam Sam Fine	t, Sot ple S ple S SAN	ft, Gray -1: Tra -2: Me D	y, CLAY, ⊺ ice Roots dium Stiff,	Γrac	ce Fine Sar	nd (cl) [a-7-6]	to		
- - -	$ \begin{array}{c ccccccccccccccccccccccccccccccccccc$											Sam Sand	ple S d, Tra	-3: Stil ice Ang	ff, Brownis gular Grav rd, Brown	sh G vel	Gray, Some	Medium to Fin	e		
5-	4	\bigvee	18	9 50/6"								Sam	pie 3	-4. ⊓a	IU, DIOWII	, LIU	lie Fille Sa	IIU			
F		\wedge		30/0					EL 4	87.5											
	SAMPLE IDENTIFICATION 0 -							5		Bottc	om of	' Borinç	g @ 7.5 ft					Backfilled cuttings i completio	d with auger upon on		
JELA	SAM								ИЕТНО	חכ	RI	OWS	/FT		ISITY	P		CONSISTENCY	SA		
	Solution - S - SPLIT SPOON HSA - HOLLOW STEM AUGE - T - THIN WALL TUBE SSA - SOLID STEM AUGERS - SS - 3" SPLIT SPOON DC - DRIVING CASING - D - DENISON MD - MUD DRILLING - RC - ROCK CORE HA - HAND AUGER									AUGER GERS	RS 0	0-4 5-10 11-30 31-50 VER 5	50	VERY LO MEDIUI DE VERY	LOOSE OSE M DENSE NSE DENSE	в	0-2 3-4 5-8 9-15 16-30 OVER 30	VERY SOFT SOFT MEDIUM STIFF STIFF VERY STIFF HARD	TF LIT SC AN	(PERC RACE ITLE DME ID	1 TO 10 11 TO 20 21 TO 35 36 TO 50

Boring No. SWM-08

	2)	K		F	ROJE	СТ	Pro	ofess	ional	Boul	evard					_ commiss).: 1418	37-03.4
				_		Nae	hinc	nton (Count	w M	larvlai	hd					NORTH	l: 7166	515
				U U		ivas	anne		Journ	.y , w	iai yiai	lu		Mobil F	857 ATV /	-	EAS	F: 1118	988
				0	RILLI	NG	CO,	: AB			F	RIG/H	IAMME	RSafety		ELE	VATIO	N: 517.	9 - ft
	Data	(GRO		NATER	R DA	TA (1	ft)	ava la	EQU	IPMEN	T	CASING	SAMPLE	R CORE			E: 5/16/	/2016
_	Date		lime	9	Water		Jasing		ave-In	TYPE SIZE	ID (in)		<u>HSA</u> 3 25	S 1 375				E: 5/16/	/2016
										HAMN	1ER WT.	(lb)	0.20	140	-	D	RILLEF	R: K.M	anos
		ш	$\widehat{}$		LABO		ORY			HAMN	IER FAL	L (in)		30	-	LOG	GED B	r: ACR	
SAMPLE	NUMBER	SAMPLE TYPI	SAMPLE RECOVERY (in	BLOWS/6" (% RQD)	Erac. Freq.			DEPTH		EV. PTH	GRAPHIC		DES (moist	CRIPTION ure, densit	AND CLAS	SIFICATION		NO	TES:
											<u></u>	12-inc	ches Tops	oil		·,		Rock ou	tcrops
								_	EL 5	16.9		Detter	en of Donin	10#				of boring	a in the vicinity J
									1	.0		Bottor	n of Borin	g@1.0π					
-								_										Auger R	efusal at 1-ft
-																		Backfille cuttings completi	d with auger upon on
-		- 5																	
-																			
-																			
-								_											
-								_											
-								- 10											
								_											
DT 6/30/								_											
RENT.GI								_											
								-											
3PJ RK		- 15																	
EVARD.(
L BOUL																			
SSIONA								_											
PROFE 1																			
EFAULT)																	SA		OPORTIONS
ST (DE	SAN	1PLE					DRI		METHO		BLO	OWS/F	T DEI	NSITY	BLOWS/FT	CONSISTENC	Y	(PER	CENT)
	- S - SPLIT SPOON HSA - HOLLOW STEM AUGE - T - THIN WALL TUBE SSA - SOLID STEM AUGERS - SS - 3" SPLIT SPOON DC - DRIVING CASING - D - DENISON MD - MUD DRILLING											0-4 5-10 1-30 1-50 /ER 50	VERY LC MEDIU DE	LOOSE OSE M DENSE NSE DENSE	0-2 3-4 5-8 9-15 16-30	VERY SOFT SOFT MEDIUM STII STIFF VERY STIFF	TF FF LI ^T = SC	RACE ITLE DME	1 TO 10 11 TO 20 21 TO 35
Σ Σ	- D - DENISON MD - MUD DRILLING - RC - ROCK CORE HA - HAND AUGER													DENGE	OVER 30	HARD	AN	ND	30 10 50

Boring No. SWM-09 Page 1 of 1

	R	K		P	ROJE	СТ:	Prof	essi	onal	Boul	evar	d					сомміззіо	N NO	.: 14187-0	3.4
				s		Nas	hinat	on C	ount	v M	larvla	and					NO	ORTH	: 716510	
						1140	mg		oun	y , iv	iai yie				Mobil B5	57 ATV /		EAST	: 1119109	9
				D	RILLI	NG	CO.:	AB				RIG/	HAMM	IER	Safety			ATION	l: 524.7 - f	ť
			GRO		VATEF	R DA	TA (ft)		EQU	IPME	NT	CASIN	G S	SAMPLER	CORE	START	DATE	: 5/12/201	16
-	Date	е	Tim	e	Water	0	Casing	Ca	ve-In	TYPE			HSA		S		END	DATE	: 5/12/201	16
ŀ						+				SIZE, HAMN	ID (in) /IFR W	т (њ)	3.25		1.375	-	DRI	LLER	: K. Mano	s
ľ										HAMN	ЛER FA	LL (in)			30	-	LOGGE	ED BY	: ACR	
-	SAMPLE NUMBER	SAMPLE TYPE	BAMPLE BRECOVERY (in)	0 4 5 BLOWS/6"	LABO RE VWC Lac. Fred.			DEPTH		2V. PTH 23.7	GRAPHIC	12-ir	DE (mc iches To	SCF istur psoil	RIPTION A	ND CLASS	IFICATION ortions, etc.)		NOTES	:
-	S-2 S-3	$ \begin{array}{c ccccccccccccccccccccccccccccccccccc$								0	+	Mois Sand Sam Sam	t, Stiff, G d (cl) [a-7 ple S-2: ⁻ ple S-3: ⁻	Very	to Reddish Stiff, Redd	Brown, CL dish Brown dish Brown	AY, Trace Fine			
		$ \begin{array}{c ccccccccccccccccccccccccccccccccccc$							18.7		Botto	om of Bo	ring (@ 6.0 ft				Auger Refus Backfilled wi cuttings upo completion	al at 6.0-ft th auger n	
נגא NURTH/EAST (UEFAULT) איטרבססוטואב שטטבבעאהט.טרע		MPLI - { - { - []	E IDEN S - SP T - TH SS - 3" D - DE RC - R	ITIFICA LIT SPC IIN WAI SPLIT ENISON OCK CC	TION DON LL TUBE SPOON N DRE	HSA SSA DC - MD HA -	DRILL - HOLI - SOLI - SOLI - MUD I HAND	LING N LOW S D STEE NG CAA DRILLI AUGE	IETHC TEM A M AUC SING NG R	DD UGEFRS	BI RS C	0-4 5-10 11-30 31-50 VVER 5	/FT [VE MEC 30 VE	DENS RY LI LOOS JIUM RY D	SITY OOSE SE DENSE SE IENSE	BLOWS/FT 0-2 3-4 5-8 9-15 16-30 OVER 30	CONSISTENCY VERY SOFT SOFT MEDIUM STIFF STIFF VERY STIFF HARD	SAI TR/ LIT SOI ANI	MPLE PROPO (PERCEN ACE TLE 1 ME 2 D 3	DRTIONS T) 1 TO 10 1 TO 20 21 TO 35 36 TO 50
Boring No. SWM-10 Page 1 of 1

	R	K		P	ROJE	CT:	: Pro	fessi	onal	Boule	evard					сомміззіо	N NO.	: 14187-03.4
ľ						W/26	hina	ton (ount	V M	arvlan	Ч				N	ORTH	: 716423
				0		vvas	inny		Journ	<u>y</u> , ivi	arylari	u		Mobil P	57 AT\//	-	EAST:	1119303
				D	RILL	NG	CO.	AB			R	IG/	HAMME	RSafety	57 ATV /	ELEVA	ATION	: 520.2 - ft
F		(GRO	UNDV	VATEF	R DA	TA (f	t)		EQUI	IPMENT	-	CASING	SAMPLER	CORE	START	DATE	: 5/12/2016
	Date	9	Time	e	Water	(Casing	Ca	ave-In	TYPE			HSA	S		END	DATE	: 5/12/2016
	5/12/20	16	8:30:00) AM	Dry	_			7.0	SIZE,	ID (in)		3.25	1.375		– DRI	ILLER:	K. Manos
┢						_		-			IER WT. ((ip)		140	-		ED BY	: ACR
F		Щ	Ê		LAB	ORAT	ORY							30	-			-
	SAMPLE NUMBER	MPLE TYP	SAMPLE ECOVERY (i	BLOWS/6" (% RQD)	NMC/ ac. Freq.		ASTICITY SI NDEX	DEPTH		EV. — PTH	GRAPHIC		DES		AND CLAS	SIFICATION		NOTES:
F	<u> </u>	5	E E	4	E ²	27	7_					in a	(moist	ure, density	, color, pro	portions, etc.)		
	S-1	$\mathbb{N}/$	9	4					EL 5	19.7			TOPSOI	l dish Brown				
┢		X		5 6				-	0.	5	[4	a-7-6	6]	uisii biowii,	CLAT, AI			
		$ / \setminus$								ł								
F	S-2	()	15	9				-			/// s	amp	ole S-2: Tra	ace Fine Sa	nd			
		V		7 8														
S-3 18 5 5																		
S-3 18 5 7 11 Sample S-3: Yellowish Brown, Little Fine Sand																		
S-3 18 5 7 11 5 5 7 11 5 5 7 11 5 5 7 11 5 5 7 11 5 5 7 11 5 5 7 11 5 5 5 7 11 5 5 5 7 11 5 5 5 7 11 5 5 5 7 11 5 5 5 7 11 5 5 5 7 11 5 5 5 7 11 5 5 7 11 5 11 5																		
S-3 18 5 5 7 11 5 S-4 18 3 6 5 5 5 S-4 18 3 6 5 5 5																		
	S-3 $ -$																	
┢	Solution 10^{-5} S-4 18 3^{-5} 11^{-5} 11^{-5} Sample S-4: Yellowish Brown																	
$\begin{bmatrix} S-4 \\ - \\ - \\ - \\ - \\ - \\ - \\ - \\ - \\ - \\$																		
F	S-4 18 3 5 Sample S-4: Yellowish Brown																	
	3-4 18 3 5 5 Sample S-4: Yellowish Brown S-5 18 4 Sample S-5: Brown, Trace Fine Sand																	
	- 11 - 5 - 18 3 - - - 10 - - Sample S-4: Yellowish Brown - 18 4 - - S-5 18 4 - - Sample S-5: Brown, Trace Fine Sand - -																	
S-4 18 3 6 6 10 Sample S-4: Yellowish Brown S-5 18 4 5 5 Sample S-5: Brown, Trace Fine Sand																		
		$ \Lambda $		6						ł								
L		\square		2				- 10							David have David			
	S-6	$\mathbb{N}/$	20	3						F		amp	DIE S-6: ME	dium Stiff, (Frayish Bro	wn, Trace Fine Sa	and	
┢		X		4				-										
91/		$ / \rangle$								ł								
- 19	S-7	\vdash	18	3				-		f	/// s	am	ole S-7: Tra	ace Fine Sa	nd			
<u>n</u>	01	V		4						Í								
z -		$ / \rangle$		5				-		Ę								
IXXE I	S-8	5	12	6						F	/// s	amp	ple S-8: Ha	rd, Brown, (Gray, And (Coarse to Fine		
3		X		15 20				-		ł	/// A	ngu	lar Gravel-	sized Rock	Fragments	Trace Fine Sand		
ž Y		$\angle $						- 15	EL 5	05.2								
GPJ								15	15	.0	E	otto	m of Boring	g @ 15.0 ft			E	Backfilled with auger
AKU								-									c	completion
N H																		
22-								-										
NAL																		
								-										
U C L L																		
Ĭ								-										
DEFA	SAM	SAMPLE IDENTIFICATION DRILLING METHOD BLOWS/FT DENSITY BLOWS/FT CONSISTENCY (PERCENT)																
	-S - SPLIT SPOON HSA - HOLLOW STEM AUGERS 0-4 VERY LOOSE 0-2 VERY SOFT TRACE 1 TO 10																	
НÈ	T - THIN WALL TUBE SSA - SOLID STEM AUGERS 5-10 LOOSE 5-8 MEDIUM STIFF LITTLE 11 TO 20																	
NO1	- SS - 3" SPLIT SPOON DC - DRIVING CASING 11-30 MEDIUM DENSE 9-15 STIFF LITTLE 11 TO 20 - D - DENISON MD - MUD DRIULING 31-50 DENSE 16 20 VERY STIFF SOME 21 TO 35																	
ζKK Γ		- L - F	RC - R	OCK C	ORE	HA -) AUGE	ER		OVE	ER 5	0 VERY	DENSE	OVER 30	HARD	ANE	D 36 TO 50

Boring No. SWM-11 Page 1 of 1

R	X	? ,'	F	ROJE	CT:	Pro	fessi	onal	Boule	evard				COMMISSION	NO.: 14187-03.4
			-		Nac	hinat	on C	`ount	V N/	andana				NOF	RTH: 716402
			3		/vas	ningi		Jount	<u>y</u> , ivi	aryland		Mobil P	57 AT\//	EA	AST: 1119511
			D	RILLI	NG	CO.:	AB			RI	G/HAMME	R Safety	57 ATV /	ELEVAT	ION: 522.4 - ft
		GRO	UND	VATEF	R DA	TA (ft)		EQUI	PMENT	CASING	SAMPLEF	CORE	START D	ATE: 5/11/2016
Da	te	Tim	e	Water	0	Casing	Ca	ave-In	TYPE		HSA	S		END DA	ATE: 5/11/2016
5/11/2	016	3:40:00) PM	Dry	_		-	6.2	SIZE, I	D (in)	3.25	1.375		DRILL	ER: K. Manos
									HAMM	ER FALL () n)	30	-	LOGGED	BY: ACR
SAMPLE NUMBER	AMPLE TYPE	SAMPLE RECOVERY (in)	BLOWS/6" (% RQD)	NMC/ Iac. Freq.		VRV INDEX INDEX	DEPTH		:V. ?TH	GRAPHIC	DES (mois		AND CLASS	FICATION	NOTES:
S-1		20	2		_			EL 5	21.9	<u>, 1/</u> 6-i	nches Topso	il	, сою, рюрс		
- - - - -		24	3 3 2 5 7 8 8			-		<u>EL 5</u> 2.	20.4 0	Ma [a- Ma [a-	iist, Medium 7-6] Jist, Stiff, Red 7-6]	Stiff, Gray, (Idish Brown	CLAY, Little F	Fine Sand (cl)	
- S-3 -		24	5 7 8 9				- 5								
S-4 - - S-5		24 24	7 10 11 12 7 8							Sa Bla Sa	mple S-4: Ve ack Gravel mple S-5: Ve	ery Stiff, Brov ery Stiff, Brov	wn, Little Coa wn	arse to Fine Angula	r
- - S-6		24	9 9 7 9 6 8			-	- 10			Sa	mple S-6: Br	own			
							- 15		<u>10.4</u> .0	BC	ttom of Borin	g @ 12.0 ft			Backfilled with auger cuttings upon completion
SAMPLE IDENTIFICATION DRILLING METHOD BLOWS/FT DENSITY BLOWS/FT CONSISTENCY													SAMPLE PROPORTIONS (PERCENT)		
] - ?] - ⁻] - ?] - [] - [S - SP T - TH SS - 3" D - DE RC - R(LIT SP IIN WA SPLIT ENISON OCK C	OON LL TUBE SPOON N ORE	HSA SSA DC - MD - HA -	- HOL - SOL - DRIVI - MUD - HAND	LOW S ID STE NG CA DRILL AUGE	STEM A EM AUC ASING ING ER	NUGER: BERS	S 0 5-1 11- 31- OVEI	4 VER) 0 LO 30 MEDIU 50 DE 350 VER)	/ LOOSE DOSE M DENSE ENSE / DENSE	0-2 3-4 5-8 9-15 16-30 OVER 30	VERY SOFT SOFT MEDIUM STIFF STIFF VERY STIFF HARD	TRACE 1 TO 10 LITTLE 11 TO 20 SOME 21 TO 35 AND 36 TO 50

Boring No. SWM-12 Page 1 of 1

R	27	R	F	PROJE	СТ	: Pro	fessi	onal	Boul	evaro	d				COMMISSIO	N NO.: 14187-0	3.4
			S	SITE: '	Was	hina	ton C	Count	v.M	1arvla	and				N	DRTH: 716401	
			-	···					,				Mobil B	57 ATV /		EAST: 111971	1
			C	RILL	ING	CO.:	AB				RIG/	HAMME	Safety		ELEVA	ATION: 525.1 - 1	t
		GRO		NATEF	R DA	TA (f	:)		EQU	IPMEN	NT	CASING	SAMPLEF	CORE		DATE: 5/11/20 ²	16
D/	ate 2016	2:15:00	e) PM	Water Drv		Casing	Ca	ave-In 4 0	TYPE	ID (in)		HSA	S 1.075			DATE: 5/11/20 ²	16
0, 1 11				2.9					HAMN	ID (III) IER WT	Г. (lb)	3.25	1.375	-	- DRI	LLER: K. Manc	S
									НАММ	IER FA	LL (in)		30	-	LOGGE	DBY: ACR	
SAMPLE	AMPLE TYPE	SAMPLE ECOVERY (in)	BLOWS/6" (% RQD)	IAD INNC/ Lied: Lied:			DEPTH	ELE DEF	EV. — PTH	GRAPHIC		DESC		AND CLASS	FICATION	NOTES	:
S-1	<u></u>	/ 12	3	ш.				EI 5	24.6	N 1/	6-inc	hes Topsoi	are, density	, color, prope			
-		12	3 4 3 17			-		<u>EL 5</u> 0. <u>EL 5</u> 2.	24.6 5 23.1 0		Mois	it, Medium S	tiff, Brown,	SILT, Little I	Fine Sand (ml) [a	a-4]	
S-2 12 15 13 10 S-3 22 7 13 Fine Sand (cl) [a-7-6] Sample S-2: Little Coarse to Fine Subangular Gravel Sample S-3: Some Medium to Fine Sand																	
S-3 22 7 S-3 22 7 13 - S-4 24 4 - 8 -															d		
¯ S-4 _		24	4 6 8 8			-	-				Sam Sano	ple S-4: Stif J	f, Reddish t	to Yellowish	Brown, Little Fin	e	
- -		24	5 5 6				-	EL 5	15 1		Sam	ple S-5: Stif	f, Yellowish	ı Brown, Little	e Fine Sand		
	<u>/</u>					-	- 10	10	.0		Botto	om of Boring) @ 10.0 ft			Backfilled wi cuttings upo completion	th auger n
							- 15										
						-											
																	D.T · · -
s	SAMPLE IDENTIFICATION DRILLING METHOD BLOWS/FT DENSITY BLOWS/FT CONSISTENCY (PERCENT)																
BIOWS/FT DENSITY BLOWS/FT CONSISTENCY CONSISTENCY CONSISTENCY Image: Sample identification DRILLING METHOD BLOWS/FT DENSITY BLOWS/FT CONSISTENCY (PI Image: Sample identification HSA - HOLLOW STEM AUGERS 0-4 VERY LOOSE 0-2 VERY SOFT TRACE Image: Sample identification SAMPLE identification D-4 VERY LOOSE 3-4 SOFT TRACE Image: Sample identification SAMPLE identification D-2 VERY SOFT TRACE LITTLE Image: Sample identification DC - DRIVING CASING 11-30 MEDIUM DENSE 9-15 STIFF LITTLE Image: Sample identification MD - MUD DRILLING 31-50 DENSE 0VER 30 VERY STIFF SOME Image: Sample identification MD - MUD DRILLING OVER 50 VERY DENSE OVER 30 HARD AND													TRACE LITTLE 1 SOME 2 AND 3	1 TO 10 11 TO 20 21 TO 35 36 TO 50			

Boring No. SWM-13 Page 1 of 1

R	$\langle \langle$	R	C P	ROJE	CT:	Pro	fessi	onal	Boul	evar	rd				COMMISSIO	N NO.: 14187-03.4
			S		Nas	hina	ton (Count	vN	larvl	and				N	ORTH: 717769
			Ŭ	// _	/ v u c	, ining		Journ	<u>y</u> , iv	laryi	unu		Mohil B	57 ATV /		EAST: 1118110
			D	RILLI	NG	CO.:	AB				RIG/	HAMMEF	R:Safety			ATION: 502.5 - ft
		GRO		VATEF	R DA	TA (ft)		EQU	IPME	INT	CASING	SAMPLER	CORE	START	DATE: 5/3/2016
Da 5/3/20	te 16	Tim		Water	(Casing	Ca	ave-In 7.5	TYPE			HSA	S		END	DATE: 5/3/2016
5/5/20	10	4.00.00	, , , , , , , , , , , , , , , , , , , ,	Diy	-			1.5	SIZE, HAMN	ID (IN) /IFR W	/T (lb)	3.25	1.375	-	DRI	ILLER: K. Manos
									HAMN	/ER F/	ALL (in)		30	-	LOGGE	ED BY: ACR
SAMPLE NUMBER	AMPLE TYPE	SAMPLE (ECOVERY (in)	BLOWS/6" (% RQD)	NMC/ Bac. Freq.			DEPTH	ELE 	EV. — PTH	GRAPHIC		DES(AND CLASS		NOTES:
S-1		<u>~</u>	2	ш					02.0	· . · <i>1.</i> /	6-inc	thes Topsoi		, color, prop		
-			2 3 6			-	-	<u>EL 5</u> 0.	0 <u>2.0</u> 5		Mois Fine	st, Medium Sand (cl-m	Stiff, Grayisl) [a-4]	n Brown, CL	AY, And SILT, TI	race
S-2 12 6 8 11 14 8 11 14 25.9% S-3 12 8 11 17 20 25.9% - S-4 12 7																
S-2 12 8 2.0 Moist, very Suir, Reddish Brown, CLAY (CH) [A-7-6] S-3 12 8 25.9% - - S-4 12 7 - - - Sample S-4: Brown, Little Silt - - - - Sample S-5: Modium Stiff Drawn Same Site - - -																
S-3 12 $\frac{8}{11}$ 25.9% - - 5 S-4 12 $\frac{7}{8}$ - - 5 - 5 S-4 12 $\frac{7}{8}$ - - 5 - 5 S-5 21 $\frac{4}{3}$ 29.1% 65 42 - Sample S-5: Medium Stiff, Brown, Some Silt																
- -	S-4 12 7 8 12 716 $29.1%$ 65 42 $ 5$ Sample S-4: Brown, Little Silt Sample S-5: Medium Stiff, Brown, Some Silt 10 $EL 492.5$ 10 $EL 492.5$ 10 $EL 492.5$															
 	\times	5	50/5"			-	— 10 -	<u>EL 4</u> 10 <u>EL 4</u> 11	<u>92.5</u> .0 91.5 .0		Corr Ligh Trac Botte	pletely Wea t Gray, CLA e Fine Grav om of Borin	athered Roc Y, And SIL rel-sized Ro g @ 11.0 ft	k, Sampled I, Trace Coa ck Fragmen	As: Moist, Hard, Irse to Fine Sand ts	— — – d, ——Auger Refusal at 11.0-ft
						-	- - - 15									Backfilled with auger cuttings upon completion
						-	-									
DEFA(ייםח							VTI2I		CONSISTENCY	SAMPLE PROPORTIONS
SAMPLE IDENTIFICATION DRILLING METHOD BLOWS/FT DENSITY BLOWS/FT CONSISTENCY SAMPLE PF (PER Image: Sample identification HSA - HOLLOW STEM AUGERS 0-4 VERY LOOSE 0-2 VERY SOFT TRACE Image: Sample identification SSA - SOLID STEM AUGERS 0-4 VERY LOOSE 3-4 SOFT TRACE Image: Sample identification SSA - SOLID STEM AUGERS 0-4 VERY LOOSE 3-4 SOFT TRACE Image: Sample identification DC - DRIVING CASING 11-30 MEDIUM DENSE 9-15 STIFF LITTLE Image: Sample identification MD - MUD DRILLING 31-50 DENSE 16-30 VERY STIFF SOME Image: Sample identification HA - HAND AUGER OVER 50 VERY DENSE OVER 30 HARD AND													(PERCENT) TRACE 1 TO 10 LITTLE 11 TO 20 SOME 21 TO 35 AND 36 TO 50			

Boring No. SWM-14 Page 1 of 1

ſ	R	K		P	ROJE	CT	Pro	fessi	onal	Bou	leva	rd					_ сомм	ISSION NO	D.: 14187-03.4
				s		Was	hina	ton C	Count	νN	/arv	land						NORTI	H: 717671
						1100	inig		Joann	y , n	nury				Mobil B	57 ATV	/	EAS	T: 1118342
				D	RILL	NG	CO.:	: AB				RIG	/HAMI	MER	Safety	57 7 (1 4	E	ELEVATIO	N: 509 - ft
			GRO		VATEF	R DA	TA (fl	t)		EQL	JIPME	ENT	CASI	١G	SAMPLER	CORE	S S	TART DAT	E: 5/3/2016
	Date	е	Tim	e	Water	0	Casing	Ca	ave-In	TYPE	<u> </u>		HSA		S		_	END DAT	E: 5/3/2016
ŀ								_		ISIZE, HAMI	, ID (in MER V) VT (lb)	3.25		1.375	_	_	DRILLE	R: K. Manos
t										НАМ	MER F	ALL (in)			30	-	L	OGGED B	Y: ACR
	SAMPLE NUMBER	SAMPLE TYPE	RECOVERY (in)	ه د BLOWS/6" (% RQD)	IABU RIMC/ Frac: Freq.			DEPTH	ELE DEF	EV. PTH 08.5	GRAPHIC	6-inc	D (m ches Top	ESC oistu	RIPTION A	ND CLAS	SIFICATIO	N c.)	NOTES:
-	S-2		8	3 3 5 5 5 5 7 7			-	-	0	<u>05.0</u>		Sam	ple S-2	Stiff	VEATHER		[a-7-6]	s: Moist	-
-	S-3		2	50/3"			-	- 5 -	4. <u>EL 5</u> 5.	.0 <u>03.5</u> .5		Botte	om of B	Gray,	@ 5.5 ft		Sampled A	S: MOIST,	Auger Refusal at 5.5-ft Backfilled with auger cuttings upon completion
0/30/10							-	- 10 -											Offset performed 5-ft East. See Log for SWM-14A
SAMPLE IDENTIFICATION DRILLING METHOD												BLOWS	/FT	DEN	SITY	BLOWS/F1	CONSIS	S/	AMPLE PROPORTIONS
KKK NUK I H/EAS I (I	- S - SPLIT SPOON HSA - HOLLOW STEM AUGE - T - THIN WALL TUBE SSA - SOLID STEM AUGERS - SS - 3" SPLIT SPOON DC - DRIVING CASING - D - DENISON MD - MUD DRILLING - RC - ROCK CORE HA - HAND AUGER										RS	0-4 5-10 11-30 31-50 OVER \$	VI ME 50 VI	ERY L LOC DIUM DEN ERY [LOOSE DSE DENSE ISE DENSE	0-2 3-4 5-8 9-15 16-30 OVER 30	VERY SOF MEDIUM STII VERY HAF	SOFT -T TI 1 STIFF LI -F SI STIFF SI RD AI	RACE 1 TO 10 TTLE 11 TO 20 OME 21 TO 35 ND 36 TO 50

Boring No. SWM-14A Page 1 of 1

	X	2	P	ROJE	ст:	Prof	essio	onal	Boule	evard					NO.:	14187-03.4
							~							NC	ORTH:	717671
			S	ITE:	Was	shingt	on C	ount	<u>y</u> , M	aryland				E	EAST:	1118347
			D	RILLI	NG	CO.:	AB			RIC) HAMME	Mobil E R:Safety	357 ATV /	ELEVA	TION:	509 - ft
		GRO	UNDV	VATE	R DA	TA (ft)		FQUI	PMENT	CASING	SAMPLE	R CORF	START [DATE:	5/3/2016
Da	te	Tim	e	Water	(Casing	Ca	ve-In	TYPE		HSA	S		END	DATE:	5/3/2016
									SIZE, I	D (in)	3.25	1.375		DRII	LLER:	K. Manos
									HAMM	ER WT. (Ib)	140	-		DBY:	ACR
	Ш	in)		LABO	ORAT	ORY				ER FALL (I	1)	30	-			
SAMPLE NUMBER	AMPLE TYF	SAMPLE ECOVERY (i	BLOWS/6" (% RQD)	NMC/ Rac. Freq.			DEPTH	ELE DEF	EV. — PTH	GRAPHIC	DES	SCRIPTION	AND CLASS			NOTES:
	S S	2		Ē						I \ Bla	nk Auger to	6.0-ft	y, color, prop	ortions, etc.)		
		18	4 5 6 50/1"	26.5%	60	40	- 10	EL 5 6. EL 5 7.	03.0 0 01.5 5	Bo	ist, Stiff, Bro	own, CLAY ng @ 7.5 ft	(CH) [A-7-6]		ABCC	uger Refusal at 7.5-ft ackfilled with auger uttings upon ompletion
SA	MPLF	E IDEN	TIFICAT	ION		DRILI	ING M	ETHO	D	BLOW	S/FT DF		BLOWS/FT	CONSISTENCY	SAM	PLE PROPORTIONS
] - 8	S - SP	LIT SPC	DON	HSA	- HOLL	OW S		- UGERS	8			0-2	VERY SOFT		
	j - 1	r - TH	IIN WAL	L TUBE	SSA	- SOLIE	O STEN	/I AUG	ERS	0-4 5-1	VER'	Y LOOSE DOSE	3-4	SOFT MEDIUM STIFE	TRA	UE 1 TO 10
Image: Signal and Signal an										11-3 31-5	0 MEDIL 0 n	JM DENSE ENSE	9-15	STIFF	SON	1E 21 TO 35
	- D - DENISON MD - MUD DRILLING - RC - ROCK CORE HA - HAND AUGER									OVEF	50 VER	Y DENSE	OVER 30	HARD	AND	36 TO 50

Boring No. SWM-15 Page 1 of 1

F	2	~		F	PROJE	CT:	Pro	fessi	onal	Boule	evard						COMMISSIO	N NO.:	14187-03.4
				-		Na	shina	ton (`ount	V M	lanılar	hd					N	ORTH:	717530
						Ivas	sningi		Juni	<u>y</u> , w	<u>iai yiai</u>	iu –		Mahil D	67 A T	$\overline{\gamma}$		EAST:	1118560
				0	DRILLI	NG	CO. <u>:</u>	AB			R	lG/	HAMMEF	R:Safety	JIAI	V /	ELEVA	ATION:	500.9 - ft
		(GRO	UND	WATEF	R DA	ATA (f	t)		EQU	IPMEN	Г	CASING	SAMPLEF	cc	RE	START	DATE:	5/2/2016
0	Date		Tim	e	Water	_	Casing	Ca	ave-In	TYPE			HSA	S			END	DATE:	5/2/2016
5/2/2	2016		3:25:00	D PM	Dry	+		-	6.5	SIZE, I	ID (in)	(11-)	3.25	1.375			DRI	LLER:	K. Manos
						-				HAMM	IER WI.	(in)		30		-	LOGGE	ED BY:	ACR
SAMPLE	NUMBER	SAMPLE TYPE	SAMPLE RECOVERY (in)	BLOWS/6" (% RQD)	LABC NWC/ Frac: Fred.		ORY TS INDEX INDEX	DEPTH	ELE DEF	:V. — РТН	GRAPHIC		DES(CRIPTION /	AND CI	_ASSI propc	FICATION		NOTES:
S-	1	$\langle $	18	2						00 1	<u>. <u>. · · / /</u> 1</u>	0-in	iches Topso	Dil					
_	4	X		2 4					0.	8 8		Mois	t, Soft, Brov	wnish Gray,	CLAY	(CH)	[A-7-6]		
- -	2	X	12	3 4 6 8	20.7%	48	30					Sam	ple S-2: Sti	ff, Grayish I	3rown				
- -	S-3 12 6 6 7 11 -5 S-4 24 6 6 11 14 32.1% $-$ Sample S-3: Stiff, Reddish Brown Sample S-4: Very Stiff, Reddish Brown																		
S-3126 6 711-5S-4246 11 -5S-524 4 7 8 Sample S-3: Stiff, Reddish BrownSample S-4: Very Stiff, Reddish BrownSample S-5: Stiff, Reddish Brown															rown				
- -	$\begin{bmatrix} - & -5 \\$														Brown				
-S- -S-	3 \	$\left \right $	24	6 8 9 7				- 10				Sam	ple S-6: Ve	ry Stiff, Rec	ldish Bı	rown			
	7	X	24	4 4 6	31.8%							Sam	ple S-7: Me	dium Stiff, I	Brown				
	в \	$\left \right $	18	3 4 6 7				- 15	EL 4	84.9		Sam	ple S-8: Sti	ff, Brown					
^a r ^b r ^c r														Backfilled with auger outtings upon completion					
DEF	SAMPLE IDENTIFICATION DRILLING METHOD BLOWS/FT DENSITY BLOWS/FT CONSISTENCY (PERCENT)																		
D SAWIPLE IDENTIFICATION DRILLING METHOD BLOWS/FT Level -S - SPLIT SPOON HSA - HOLLOW STEM AUGERS 0-4 Level -T - THIN WALL TUBE SSA - SOLID STEM AUGERS 5-10 Level -SS - 3" SPLIT SPOON DC - DRIVING CASING 11-30 Level -D - DENISON MD - MUD DRILLING 31-50 OVER 50 -RC - ROCK CORE HA - HAND AUGER OVER 50												VERY LO MEDIUN DE 0 VERY	LOOSE OSE // DENSE NSE DENSE	0-2 3-4 5-8 9-15 16-3 OVER	5 0 30	VERY SOFT SOFT MEDIUM STIFF STIFF VERY STIFF HARD	TRA LITT SON ANE	ACE 1 TO 10 TLE 11 TO 20 ME 21 TO 35 0 36 TO 50	

Boring No. SWM-16 Page 1 of 1

R	X	2	P	ROJE	СТ	: Pro	fessi	onal	Boule	evard						DN NO.: 14187-03.4
			s	ITE: Y	Was	hina	ton C	Count	v . M	larvlan	nd				N	ORTH: 717420
			_										_Mobil B	57 ATV /		EASI: 1118671
		000	D		NG		: AB			R	IG/F		RSafety			ATION: 491-11
Da	te					IA (†	t)	ave-In	EQU	IPMENT		CASING	SAMPLE	R CORE		DATE: 5/2/2016
5/2/20	16	2:40:00	PM	Dry		Jushig		4.7	SIZE,	ID (in)		3.25	1.375			DATE: 5/2/2010
									НАММ	IER WT.	(lb)		140	-		
	Ш	Ê		LAB		ORY			HAMN	IER FALL	_ (in)		30	-		
SAMPLE NUMBER	MPLE TYP	SAMPLE COVERY (ir	BLOWS/6" (% RQD)	NMC/ Ic. Freq.		VDEX STICITY ST	DEPTH		EV. — PTH	GRAPHIC		DESC	CRIPTION	AND CLASS	IFICATION	NOTES:
	SA	L RE	1	_ 6	32	2-	_			37.1	0 inc	(moist	ure, density	/, color, prop	ortions, etc.)	
5-1	$\left \right\rangle$	12	4					EL 4	90.2		0-1110					
-	X		6				-	0.	8	<u> </u>	/loist,	Stiff, Brov	vn, Fine SA	ND, And Sil	t (sm) [a-4]	
_	\square	4					_		[
S-2	Λ /	18	4 5							· S	Sampl	le S-2: Tra	ace Lignite			
- -																
$\begin{bmatrix} S-3 \\ -5 \\ -5 \\ -5 \\ -5 \end{bmatrix}$																
S-3 18 4 5 6 11 - Sample S-3: Trace Lignite																
S-3 18 4 5 5 Sample S-3: Trace Lignite S-4 24 5 5 Sample S-4: Grayish Brown																
S-3 18 4 5 6 11 5 Sample S-3: Trace Lignite S-4 24 5 6 5 <																
$\begin{bmatrix} 3 & 5 \\ 6 \\ 11 \\ 5 & 6 \\ 6 \\ 5 & 6 \\ 6 \\ 6 \\ 6 \\ 6 \\ 6 \\ 6 \\ 6 \\ 6 \\ 6$																
$\begin{bmatrix} - & - & 5 \\ - & - & 5 \\ - & - & - & - \\ - & - & - & - \\ - & - &$																
$\begin{bmatrix} S-4 \\ - \\ - \\ - \\ - \\ - \\ - \\ - \\ - \\ - \\$																
- S-5	$\left(\right)$	12	4				-			l s	Sampl	e S-5: Gra	ayish Brow	n		
			6 6										,			
F			9				-									
-	\square						- 10	EL 4	81.0		Potton		n @ 10.0 ft			Backfilled with auger
									.0		JOLION		y @ 10.0 it			cuttings upon
							-									completion
30/16							_									
19.							-									
XX X X X X																
3-							-									
							- 15									
1.GF							-									
L							-									
OULE							_									
IAL B						[
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CFEX																
<u>н</u>							-									
AULI																
SA	MPL		ITIFICA	TION		DRIL	LING	METHO	D	BLO	WS/F	T DEN	ISITY	BLOWS/FT	CONSISTENCY	SAMPLE PROPORTIONS (PERCENT)
S - S - SPLIT SPOON HSA - HOLLOW STEM AUGERS T THIN WALL THE SSA SOLD STEM AUGERS 0-4 VERY LOOSE 0-2 VERY SOFT 3-4 SOFT TRACE													TRACE 1 TO 10			
-T - THIN WALL TUBE SSA - SOLID STEM AUGERS 5-10 LOOSE 3-4 SOFT TRACE 1 TO 1 -SS - 3" SPLIT SPOON DC - DRIVING CASING 11-30 MEDIUM DENSE 5-8 MEDIUM STIFF LITTLE 11 TO 2													LITTLE 11 TO 20			
	, ,] - [D - DE	INISON	1	MD	- MUD	DRILL	ING		31	1-50 FR 50		NSE	9-15 16-30	STIFF VERY STIFF	SOME 21 TO 35
Ż 🗖	- F	RC - R(OCK CO	ORE	HA -	HAND) AUGE	ER		001	_1, 50	VERY	DENSE	OVER 30	HARD	AND 36 TO 50

Boring No. SWM-17 Page 1 of 1

STE: Washington County, Maryland DRILLING CO::AB RightAmmeRSafety CROUNDWATER DATA (ft) Dute Tree Washington County, Maryland Dete RightAmmeRSafety Date Image: Career in the state of the		R	K	2	P	ROJE	CT:	: Prof	fessio	onal	Boul	levai	rd					COMMISSIO	N NO	.: 14187-03	.4
STIE: Washington County, Mariyand LAST: 1119711 DRILLING CO.: AB RIG/HAMMERSAIDY Date Time Water County County Tree Ask S Date Time Water County County Tree Ask S Date Time Water County County Tree Ask S Date Time Water County County Tree Util Util Util Util Util Util Util Util	1				_	ITE. \	Noo	hinat	on C	-		lond	and					N	ORTH	: 716401	
DRILLING CO.: AB RIG/HAMMER State, 2017 (1) ELEV.101 E25.1-ft Date Time Wate Case of 100 2016 SAMPLER CORE START DATE: 5/10/2016 Date Time Wate Case of 100 2016 SAMPLER CORE SAMPLER CORE START DATE: 5/10/2016 END DATE: 5/10/2016 Date Time Wate Case of 100 2016 SAMPLER CORE SAMPLER CORE SAMPLER CORE Wate Streptone Hammer Nall Init So DESCRIPTION AND CLASSIFICATION NOTES: Wate Streptone Result Init Sample S2: Very Stiff, Reddish Brown, CLAY, Trace Fine NOTES: So Time Sample S2: Very Stiff, Reddish Brown, CLAY, Trace Fine Sample S2: Very Stiff, Some Fine Gravel-sized Rock So Time Sample S2: Very Stiff, Some Fine Gravel-sized Rock EL 52:1 Bottom of Boring @ 4.0 ft					Э		/vas	mingi		ount	<u>y</u> , iv	lary	anu		Mobil	DE	7 4 1 1 / /		EAST	: 1119711	
GROUNDWATER DATA (ft) EQUIPMENT COME CASING SAMPLER (mask and stress) STATUTE (mask and stress) Date Time Water (mask and stress) Come Stress (mask and stress) Up Up Up Up Up Up Up Up Up Up Up Up Up Up Up Up Up <td< td=""><th></th><td></td><td></td><td></td><td>D</td><td>RILLI</td><td>NG</td><td>CO.:</td><td>AB</td><td></td><td></td><td></td><td>RIG</td><td>HAMM</td><td>RSafet</td><td>у У</td><td></td><td>ELEVA</td><td>ATION</td><td>l: 525.1 - ft</td><td></td></td<>					D	RILLI	NG	CO.:	AB				RIG	HAMM	RSafet	у У		ELEVA	ATION	l: 525.1 - ft	
Date Time Veter Case of PALAMERY WT. (b) 3.25 Date PLO DATE: PLO DAT			(GRO	UNDV	VATEF	R DA	TA (ft)		EQU	JIPME	ENT	CASING	SAMPL	.ER	CORE	START	DATE	: 5/10/2016	6
Image: state in the s		Date	e	Time	e	Water	0	Casing	Ca	ive-In	TYPE			HSA	S			END	DATE	: 5/10/2016	6
Understand Description Description LoggeD BY: ACR Understand	┢						_				SIZE,	ID (in)) /T (lb)	3.25	1.375	5	_	DR	ILLER	: K. Manos	
Understand Underst										-	НАМ	MER F	ALL (in)		30		-	LOGG	ED BY	': ACR	
Hardson Were Were Were Were Were Were Were Wer		r	PE /			LABO	ORAT TEST	ORY				υ									
0.2 8 0.3 28 0.3 3-inches Topsiol 3-inches Topsiol 5.1 12 1 1 1 1 1 1 1 5.2 20 7 7 1			IPLE T	SAMPLE	LOWS/ % RQD	EFreq.			рертн	ELE	EV.	RAPHI		DE	SCRIPTIO	N AI	ND CLASSI	FICATION		NOTES:	
S-1 12 1 -		ωZ	SAN	REC	Ξ.	Frac.	LIQU	PLAS'		DEF	ЧН	0		(moi	sture, dens	sity,	color, propo	ortions, etc.)			
S-2 20 7 11 11 33 1 1 33 33 1 1 33 33 1 1 33 33 1 1 1 33 1 1 1 33 1	Γ	S-1	N /	12	1 3					EL 5	24.9	>\//	- 3-inc	ches Tops		diab			/		
S.2 20 7 13 - - Sample S-2: Very Stiff, Some Fine Gravel-sized Rock Fragments - - - - - - - 4.0 Bottom of Boring @ 4.0 ft - - Backfilled with auger cuttings upon completion - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - <t< td=""><th>╞</th><td></td><td>X</td><td></td><td>4</td><td></td><td></td><td> -</td><td></td><td>0.</td><td>3</td><td></td><td>San</td><td>d (cl) [a-7-</td><td>500, Red 6]</td><td>aisn</td><td>I Brown, CL</td><td>AY, Trace Fine</td><td></td><td></td><td></td></t<>	╞		X		4			-		0.	3		San	d (cl) [a-7-	500, Red 6]	aisn	I Brown, CL	AY, Trace Fine			
S-2 20 7 11 13 5005* 4 - Fragments Auger Refusal at 4.0 S-2 Very Stiff, Some Fine Gravel-sized Rock - <td< td=""><th></th><td></td><td>$/ \setminus$</td><td></td><td></td><td></td><td></td><td></td><td></td><td></td><td></td><td></td><td></td><td></td><td></td><td></td><td></td><td></td><td></td><td></td><td></td></td<>			$ / \setminus$																		
Image: Solution of Boring Image: All of the solution of Boring Image	F	S-2	$ \uparrow $	20	7								Sam	ple S-2: V	ery Stiff, S	Some	e Fine Grav	el-sized Rock			
Image: South of the second			IV		13								Frag	Iments							
Image: Problem of Boring @ 4.0 ft Auger Refusal at 4.0 Image: Problem of Boring @ 4.0 ft Backfilled with auger cuttings upon completion Image: Problem of Boring @ 4.0 ft Backfilled with auger cuttings upon completion Image: Problem of Boring @ 4.0 ft Backfilled with auger cuttings upon completion Image: Problem of Boring @ 4.0 ft Backfilled with auger cuttings upon completion Image: Problem of Boring @ 4.0 ft Image: Problem of Boring @ 4.0 ft Image: Problem of Boring @ 4.0 ft Image: Problem of Boring @ 4.0 ft Image: Problem of Boring @ 4.0 ft Image: Problem of Boring @ 4.0 ft Image: Problem of Boring @ 4.0 ft Image: Problem of Boring @ 4.0 ft Image: Problem of Boring @ 4.0 ft Image: Problem of Boring @ 4.0 ft Image: Problem of Boring @ 4.0 ft Image: Problem of Boring @ 4.0 ft Image: Problem of Boring @ 4.0 ft Image: Problem of Boring @ 4.0 ft Image: Problem of Boring @ 4.0 ft Image: Problem of Boring @ 4.0 ft Image: Problem of Boring @ 4.0 ft Image: Problem of Boring @ 4.0 ft Image: Problem of Boring @ 4.0 ft Image: Problem of Boring @ 4.0 ft Image: Problem of Boring @ 4.0 ft Image: Problem of Boring @ 4.0 ft Image: Problem of Boring @ 4.0 ft Image: Problem of Boring @ 4.0 ft Image: Problem of Boring @ 4.0 ft Image: Problem of Boring @ 4.0 ft Image: Problem of Boring @ 4			$ /\rangle$		50/5																
<th>╞</th> <td></td> <td></td> <td></td> <td></td> <td></td> <td></td> <td> -</td> <td></td> <td>EL 5</td> <td><u>21.1</u> 0</td> <td></td> <td>Botte</td> <td>om of Bori</td> <td>ng @ 4.0 f</td> <td>ft</td> <td></td> <td></td> <td>,</td> <td>Auger Refusa</td> <td>l at 4.0-ft</td>	╞							-		EL 5	<u>21.1</u> 0		Botte	om of Bori	ng @ 4.0 f	ft			,	Auger Refusa	l at 4.0-ft
Backfiled with auge -									F												
								[- 5											Backfilled with	n auger
	╞							-											ſ	completion	
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	LEVA																				
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SAMPLE PROPORTIONS																			SA	MPLE PROPOF	RTIONS
SAMPLE IDENTIFICATION DRILLING METHOD BLOWS/FT DENSITY BLOWS/FT CONSISTENCY (PERCENT)		SAI	MPLE					DRIL		METHO	D	E	BLOWS	/FT D	ENSITY	E	BLOWS/FT	CONSISTENCY		(PERCENT)	
	1/EA3		- S - T	5 - SP - TH	LTE SPO	JUN L TUBE	SSA	A - HOLI A - SOLI			AUGEI GERS	KS	0-4	VER	Y LOOSE		0-2 3-4	VERY SOFT SOFT	TR.	ACE 1	TO 10
- SS - 3" SPLIT SPOON DC - DRIVING CASING 11-30 MEDIUM DENSE 9-15 STIFF LITTLE 11 TO 20	120		- 5	SS - 3"	SPLIT	SPOON	DC -	DRIVI	NG CA	SING			11-30	MEDI	JM DENSE		5-8 9-15	MEDIUM STIFF STIFF	LIT	TLE 11	TO 20
z - D - DENISON MD - MUD DRILLING 01-50 DENSE 16-30 VERY STIFF SOME 21 10 35 z - RC - ROCK CORE HA - HAND AUGER OVER 50 VERY DENSE OVER 30 HARD AND 36 TO 50	2									OVER §	50 VER	ENSE Y DENSE		16-30 OVER 30	VERY STIFF HARD	AN	D 36	TO 50			

Boring No. SWM-18 Page 1 of 1

F	2	K	S.	F	PROJE	СТ	: Pro	fessi	onal	Boul	evaro	d				COMMISSIO	N NO.: 14187-03.4
						Nas	hina	ton (Count	v M	larvla	and				NC	DRTH : 717769
						ivas	ming		Journ	<u>y</u> , iv	iai yic			Mobil B	57 AT\/ /	- E	EAST: 1118110
				C	RILLI	NG	CO.	: AB				RIG/	HAMME	RSafety	57 ATV /	ELEVA	TION: 502.5 - ft
		(GRO	UND\	NATER	R DA	TA (f	t)		EQU	IPMEI	NT	CASING	SAMPLEF	CORE	START	DATE: 5/10/2016
1	Date		Tim	e	Water	(Casing	Ca	ave-In	TYPE			HSA	S		ENDI	DATE: 5/10/2016
5/10	0/201	6	1:40:00) PM	Dry	_			7.4	SIZE,	ID (in)		3.25	1.375		DRI	LLER: K. Manos
						-		_				T. (lb)		140	-		DBY: ACR
		Щ	ĥ		LABO	ORAT	ORY								-		
SAMPLE	NUMBER	AMPLE TYF	SAMPLE ECOVERY (i	BLOWS/6" (% RQD)	BNMC/ Bac. Freq.			DEPTH	ELE DEF	EV. — PTH	GRAPHIC		DES		AND CLASS	IFICATION	NOTES:
-	1	ŝ	10	1	Ľ		2			09.2		2-inc	(MOIST	ure, density	, color, prop	ortions, etc.)	
5-	-1	\bigvee	18	3					EE 5	02.3 2	\square	Mois	t, Medium	Stiff, Reddis	h Brown, CL	AY, Trace Fine]
-		Å		4				-				Sand	a (ci) [a-7-o]				
-s-	.2	\rightarrow	20	5				-									
_		V		5				_									
$\begin{bmatrix} & & & & & & & & & & & & & & & & & & &$																	
-s-	.3		24	5				-				Sam	ple S-2: Sti	f, Little San	d		
-		X		, 11 13				- 5									
$\begin{bmatrix} S-3 \\ -5 \\ -5 \\ -5 \\ -5 \\ -5 \\ -5 \\ -5 \\ $																	
S-	4	$\langle \rangle$	24	4 4				-				Sam	ple S-3: Ve	ry Stiff			
-		X		7 7				-									
	4	$ \land $		_				_				_					
S-	.5	$\backslash /$	16	557								Sam	ple S-4: Sti	Ť			
-		X		8				-									
-	6	\rightarrow	10	7				- 10				Sam	nla S-5: Sti	f			
3-	-0	\bigvee	10	9 3								Jam	pie 0-0. Oli	1			
16		Å		2				-	EL 4	91.0	<u>//</u>	∖Sam	ple S-6A: S	tiff			_
6/30/	F							-	EL 4	.5 90.5	<u> </u>	Mois	t, Medium [Dense, Ligh	t Gray, Coar	se to Fine SAND	/ Auger Refusal at
BDT									12	.0		And	Gravel-size	d Rock Frag	gments, Trac	ce Silt (sp) [a-1-b]	12.0-ft
								-				Dotte		J @ 12.0 It			
								_									
Ϋ́ Ϋ́																	Backfilled with auger
								- 15									completion
D.G																	
EVAF								-									
								_									
ALE																	
								-									
DFES																	
ЧЧ Ч								-									
														T			
(DEF,	SAM	IPLE	IDEN	ITIFICA	ATION		DRIL	LING	METHO	D	BI	_OWS/	FT DEN	ISITY	BLOWS/FT	CONSISTENCY	SAMPLE PROPORTIONS (PERCENT)
Image: Solution of the second state of the second													TRACE 1 TO 10				
	-T <																
ÖZ E	\leq	- C) - DE	ENISO	N	MD	- MUD	DRILL	ING		0	31-50		NSE	9-15 16-30	VERY STIFF	SOME 21 TO 35
ž 🔳		- F	RC - R	OCK C	ORE	HA -	- HANE) AUGI	ER				VERT	DLINGE	OVER 30	HARD	AND 36 TO 50

Boring No. SWM-19 Page 1 of 1

F	2			F	PROJE	ЕСТ	: Pro	fessi	onal	Boul	evarc	ł					N NO.: 14187-03.4	
1						\//ac	hina	ton (`ount	V M	larvla	nd				NC	DRTH: 716916	
					DIIE	vvas	anny		Journ	<u>y</u> , ivi	iai yia	IIIU		Mobil P	57 AT\//	E	EAST: 1118919	
				0	RILL	ING	CO.	AB			I	RIG/	HAMME	RSafety	57 ATV /	ELEVA	TION: 502.1 - ft	
		(GRO	UND\	NATE	R DA	TA (f	:)		EQU	IPMEN	١T	CASING	SAMPLE	R CORE	STARTI	DATE: 5/11/2016	
[Date		Tim	e	Water	(Casing	Ca	ave-In	TYPE			HSA	S		END	DATE: 5/11/2016	
5/11	/2016	6	9:55:00	D AM	Dry	_			5.5	SIZE,	ID (in)		3.25	1.375		DRII	LLER: K. Manos	
						_					/ER WT	. (lb)		140	-	LOGGE	DBY: ACR	
SAMPLE	NUMBER	MPLE TYPE	SAMPLE ECOVERY (in)	BLOWS/6" (% RQD)	NMC/ ac. Freq.		VDEX NDEX STICITY	DEPTH	ELE DEF	EV. PTH	GRAPHIC		DES		AND CLASS	SIFICATION	NOTES:	
		ŝ	8	2	Ľ.	ΞΞ	7_					6 inc	(moist	ure, density	, color, prop	ortions, etc.)		
S-	1	$\langle $	12	2					EL 5	01.6	777	6-inc	t Soft Gra			Eine Sand Tra		
-		XI		3 3				-	0.	5		Root	ts (cl) [a-7-6]	, CLAT, Hat			
S-2 22 3 6 7 2.0 Moist, Stiff, Reddish Brown, C Lignite (cl) [a-7-6] S-3 24 3 - - Sample S-3: Reddish Brown to Lignite S-4: Reddish B-4: Reddish B-4: Reddish B-4: Red															, CLAY, Tra	ce Fine Sand, Tra	ice	
-s-	S-3 24 3 4 6 7 - - - - - - - - - - - - -																	
-	S-3 24 3 4 6 7 -5 Sample S-3: Reddish Brown to Yellow BrownS-4 24 3 5 7 -5 Sample S-4: Reddish Brown to Yellow Brown																	
S-	4	\langle	24	3 5 7 9				-				ple S-4: Re	ddish Brow	n to Yellow I	Brown			
- -	5	$\langle \rangle$	24	3 5 6 9			-					Sam	ple S-5: Re	ddish Brow	n to Yellow I	Brown		
	6		24	5 5 5 6			-	— 10				Sam	ple S-6: Re	ddish Brow	n			
RENT.GDT 6/30/1	7	$\left \right\rangle$	22	6 6 8 7						00.1		Sam	ple S-7: Re	ddish Brow	n			
Ъ-	ľ							-	<u> EL 4</u> 14	oo.1 .0		Botto	om of Boring	g @ 14.0 ft			Backfilled with auger	
March / / EL 488.1 14.0 Bottom of - 15 - - - - - - - - - - - - - - - - - - - - - - - - - - - -														,			cuttings upon completion	
														SAMPLE PROPORTIONS				
		- S - T - S - D - R	- SP - TH S - 3" - DE C - R	LIT SP IIN WA SPLIT ENISOI OCK C	OON LL TUBE SPOON N ORE	HSA SSA DC MD HA	- HOL - SOL - DRIV - MUD - HANE	LOW S ID STE NG CA DRILL	STEM AUC ASING ING ER	UGER GERS	RS O	0-4 5-10 11-30 31-50 VER 5	VERY LO MEDIUI 50 VERY	LOOSE OSE M DENSE NSE DENSE	0-2 3-4 5-8 9-15 16-30 OVER 30	VERY SOFT SOFT MEDIUM STIFF STIFF VERY STIFF HARD	(PERCENT) TRACE 1 TO 10 LITTLE 11 TO 20 SOME 21 TO 35 AND 36 TO 50	

Boring No. SWM-20 Page 1 of 1

ſ	R	K		P	ROJE	CT:	Pro	fessi	onal	Boule	evard	1				COMMISSIC	ON NO	.: 14187-03.4
				- -		Nael	hina	ton (`ount	V M	larvla	nd				N	ORTH	l: 716784
				3	··· E	ivas.	ming		Journ	<u>y</u> , ivi	iai yia	inu		Mobil B	57 ΔT\/ /		EAST	: 1118969
				D	RILLI	NG	CO.	: AB			I	RIG/	HAMME	RSafety		ELEV	ATION	l: 496.8 - ft
			GRO	UNDV	VATER	DA ⁻	TA (f	t)		EQU	IPMEN	T	CASING	SAMPLEF	CORE	START	DATE	: 5/11/2016
	Dat	e	Time	e	Water	C	Casing	Ca	ave-In	TYPE			HSA	S		END	DATE	: 5/11/2016
ŀ	5/11/20	016	8:45:00) AM	Dry				4.6	SIZE,	ID (in)	- (16)	3.25	1.375		DR	ILLER	R: K. Manos
F										HAMN	IER FAL	. (ib) LL (in)		30	-	LOGG	ED BY	: ACR
	SAMPLE NUMBER	SAMPLE TYPE	SAMPLE RECOVERY (in)	BLOWS/6" (% RQD)	Frac. Freq.		PLASTICITY ^G AU INDEX	DEPTH	ELE DEF	EV. — PTH	GRAPHIC		DES(CRIPTION /	AND CLASS	IFICATION		NOTES:
	S-1	Λ /	8	1 2					EL 4	<u>96.3</u>		6-incl	hes Topsoi	 				
				2 3			-	-	0.	5		Moist SANI	t, Soft, Gra D (cl) [a-7-6	y to Brown, 6]	CLAY, And	Medium to Fine		
	S-2		8	7 6 2 7			-	-				Samp Little	ole S-2: Me Coarse to	dium Stiff, S Fine Angula	Some Coarse ar Gravel	e to Fine Sand,		
-	S-3	$\left \right\rangle$	20	10 6			-	_				Samp	ole S-3: Sti	ff, Reddish	Brown, Trace	e Fine Sand		
ŀ		\mathbb{X}		8 9			-	- 5										
	S-4	$\left \right $	18	6 9 10			-	-				Samp Little	ole S-4: Ve Lignite	ry Stiff, Rec	dish Brown,	Trace Fine San	d,	
-	S-5	$\left \right\rangle$	18	6 9 10			-	_				Samp Trace	ole S-5: Ve e Lignite	ry Stiff, Rec	dish Brown,	Trace Fine San	d,	
							-	- — 10 -	<u>EL 4</u> 9.	87.8 0		Botto	m of Borin	g @ 9.0 ft				Backfilled with auger cuttings upon completion
UKKENI.GUI 6/30/16							-	-										
							-	— 15										
							-	-										
								-										
DEFA	SA	MPLI	E IDEN	ITIFICA	TION		DRI	LING	ИЕТНО	D	BL	.ows/	FT DE	NSITY	BLOWS/FT	CONSISTENCY	SA	MPLE PROPORTIONS (PERCENT)
KKK NUK I H/EASI (S - SPLIT SPOON HSA - HOLLOW STEM AUGE - T - THIN WALL TUBE SSA - SOLID STEM AUGERS - SS - 3" SPLIT SPOON DC - DRIVING CASING - D - DENISON MD - MUD DRILLING - RC - ROCK CORE HA - HAND AUGER											0-4 5-10 11-30 31-50 VER 5	VERY LO MEDIU DE 0 VERY	LOOSE OSE M DENSE NSE DENSE	0-2 3-4 5-8 9-15 16-30 OVER 30	VERY SOFT SOFT MEDIUM STIFF STIFF VERY STIFF HARD	TR LIT SC AN	ACE 1 TO 10 TLE 11 TO 20 ME 21 TO 35 ID 36 TO 50

	?			PROJE	СТ	Pro	fessi	onal	Boule	evard						N NO.	: 14187-03	3.4
			-	SITE: \	Nas	hinc	iton (Count	v M	arvla	nd				NC	ORTH:	716669	
								<i>vo</i> unit	,	-			_ Mobil E	357 ATV /		EAST:	1119049	
		CPC					: AB				RIG/		RSafety				- 497.0 - II - 5/16/2016	6
D	ate	Tin	ne	Water		Casing	Ca	ave-In	EQUI TYPE	IPMEN		CASING HSA	SAMPLE	R CORE			5/16/2016	6
									SIZE, I	ID (in)		3.25	1.375			LLER:	K. Manos	3
									НАММ	<u>IER WT.</u> IER FAL	. (lb) .L. (in)		140 30	-	LOGGE	D BY:	ACR	
SAMPLE		SAMPLE ITE SAMPLE RECOVERY (in)	BLOWS/6" (% RQD)	LABC NMC/ Frac: Freq.			DEPTH	ELE DEF	EV. — PTH	GRAPHIC		DES ⁱ	CRIPTION ure, densit	AND CLASS	SIFICATION		NOTES:	
										<u></u>	12-in	ches Tops	oil			F O	Rock outcrop: bserved in the	s he vicinity
F							_	EL 4	96.6 0		Botto	m of Borin	g @ 1.0 ft			0	f boring	,
-																A B c c	Auger Refusa Backfilled with uttings upon ompletion	al at 1-ft h auger
-							5 - -											
0.GPJ_RKK_CURRENT.GDT_6/30/16							— 10 - - - 15											
K NORTHIEAST (DEFAULT) PROFESSIONAL BOULEVARD	SAMPLE IDENTIFICATION DRILLING METHOD SAMPLE IDENTIFICATION MSA - HOLLOW STEM AUGER SAMPLE IDENTIFICATION SSA - SOLID STEM AUGER SAMPLE IDENTIFICATION MD - MUD DRILLING HA - HAND AUGER HA - HAND AUGER							DD AUGER GERS	BLC S 3 OV	0-4 5-10 11-30 /ER 50	FT DEI VERY LC MEDIU DU 0 VFRY	NSITY LOOSE OSE M DENSE NSE DENSE	BLOWS/FT 0-2 3-4 5-8 9-15 16-30 0//EP 20	CONSISTENCY VERY SOFT SOFT MEDIUM STIFF STIFF VERY STIFF	SAM	IPLE PROPOF (PERCENT ICE 1 ILE 11 ILE 21	RTIONS) TO 10 1 TO 20 1 TO 35 3 TO 50	

Boring No. SWM-22 Page 1 of 1

ſ	R	K	PROJECT: Professional Bou								evard						COMMISSIO	N NO.	: 14187-03.	4
						M 00	hine	nton (² ount	., N	londo	nd					N	ORTH	716578	
					SIIE:_\	vas	sning	jion C	Jouni	<u>y</u> , iv	laryia	na		Mahilf				EAST	1119154	
				I	DRILLI	NG	CO,	.: AB			F	rig/		RSafety	357 AI	V /	ELEVA	ATION	: 514.2 - ft	
F		(GRO	UND	WATER	DA	TA (ft)		EQU	IPMEN	IT	CASING	SAMPLE	R CC	DRE	START	DATE	: 5/12/2016	
	Date	•	Time	э	Water	(Casing		ave-In	TYPE			HSA	S			END	DATE	: 5/12/2016	
										SIZE,	ID (in)		3.25	1.375			DRI	ILLER	: K. Manos	
-											AER WT.	. (lb)		140		-	LOGGE	ED BY	: ACR	
	 SAMPLE NUMBER 	SAMPLE TYPE	B RECOVERY (in)	BLOWS/6" (% RQD)	LABC NMC/ Frac: Freq.			DEPTH	ELE DEF	EV. PTH	GRAPHIC	6-inc	DES((moist	CRIPTION ure, densit	AND C	LASSI	FICATION		NOTES:	
	S-1 S-2	X	0	6 9 7 50/0	"			-	EL 5 0. EL 5 2.	<u>13.6</u> 6 <u>11.7</u> 5		Mois [a-7- Botto	t, Stiff, Gray 6]	yish Browr	i, CLAY	, Little	Fine Sand (cl)		Auger Refusal	at 2.5-ft
															E	Backfilled with cuttings upon completion	auger			
		- 5 - - - - - - - - - - - - - - - - - -																		
CURRENT.GDT 6/30/16		- 10																		
ULT) PROFESSIONAL BOULEVARD.GPJ RKK								- 15 - -												
EFAL	0.44						-									0/57	CONCIOTENCE	SAN	MPLE PROPOR	TIONS
RKK NORTH/EAST (D		SAMPLE IDENTIFICATION DRILLING METHOD Image: Sample identification HSA - HOLLOW STEM AUGER Image: Sample identification HSA - HOLLOW STEM AUGER Image: Sample identification SSA - SOLID STEM AUGERS Image: Sample identification SSA - SOLID STEM AUGERS Image: Sample identification D - DENISON Image: Sample identification MD - MUD DRILLING Image: Sample identification HA - HAND AUGER					85 1 3 01 3 1 3 1 3 1 3 1 3 1 3 1 3 1 3 1	0-4 5-10 11-30 31-50 VER 5	VERY LO MEDIUI 00 VERY	LOOSE OSE M DENSE NSE DENSE	BLOW 0-2 3-4 5-8 9-1 16-3 OVEF	S/FT 2 4 3 5 30 2 30	VERY SOFT SOFT MEDIUM STIFF STIFF VERY STIFF HARD	TR/ LIT ⁻ SOI ANI	(PERCENT) ACE 1 ⁻ TLE 11 ⁻ ME 21 ⁻ D 36 ⁻	TO 10 TO 20 TO 35 TO 50				

Boring No. SWM-23 Page 1 of 1

R	X		F	PROJE	СТ	: Pro	fessi	onal	Boule	evard						COMMISSION	NO.	: 14187-03.4
			ç		Nas	hina	ton C	Cunt	v M	arvlan	н					NOF	RTH:	716501
					1103	mig		Journ	<u>y</u> , ivi	arylan	<u>u</u>		Mobil P	67 A T		E/	AST:	1119323
			0	RILLI	NG	CO.:	AB			RI	G/ł	AMME	RSafety	57 AT	V /	ELEVAT	ION:	518.4 - ft
		GRO		NATEF	DA	TA (ft	:)		EQUI	PMENT		CASING	SAMPLEF	co	RE	START D	ATE:	5/11/2016
Da	ite	Tim	e	Water	(Casing	Ca	ave-In	TYPE			HSA	S			END D	ATE:	5/11/2016
5/11/2	016	4:40:00) PM	Dry				7	SIZE, I	ID (in)		3.25	1.375				FR	K Manos
_									HAMM	IER WT. (I	b)		140	-				
	111			LABO					HAMM	IER FALL	(in)		30	-		LOGGEL	, ы.	AUN
SAMPLE NUMBER	MPLE TYPE	SAMPLE ECOVERY (in	BLOWS/6" (% RQD)	RE RE Sec. Freq.			DEPTH		EV. — PTH	GRAPHIC		DESC		AND CL	ASSI	FICATION		NOTES:
	رې ک		2	L L	27	7_						(moist	ure, density	, color,	propo	ortions, etc.)		
S-1	$\left \right /$	18	3					EL 5	17.9				l Stiff Grav F	20ddieh	Brow			
-			5 6					0.	5	Fi	ne S amp	Sand (cl) [a le S-1: Tra	a-7-6] ace Roots	veuuisii	DIOW	II, CLAT, Hace		
- S-2	$\left(-\right)$	22	6							s s	amp	le S-2: Ve	ry Stiff					
-	X		9 9															
	$ \rangle$																	
S-3		18	6				•			s s	amp	le S-3: Stil	ff, Reddish	Brown				
-	X		9 10				- 5											
	$ \rangle$		10															
- S-4	$\left(\right)$	18	6				-			// s	amp	le S-4: Stif	ff					
	V		6 8						F									
			9															
		11	3				-			/// s	amn	le S-5: Ha	rd Trace G	ravel-si	zed R	ock Fragments at	S	Sample S-5
5-5			50/3"							th	e Ti	p of Spoor	iu, mace o i		Leuiv	took i raginents at		Gravel-sized Rock
F																	⊢ e	ragments may have xaggerated SPT
							_ 10		F								N	I-Value.
S-6	\mathbb{N}	18	3 4				10			S S	amp	le S-6: Re	ddish Brow	n				
-	Ň		4															
9 5 S-7	$\left(\right)$	18	5						F	// s	amp	le S-7: Ve	ry Stiff, Red	ldish Bro	own			
	X		7 11						ł		•							
GDT	$ \rangle$							EL 5	05.4									
. –		1					•	13	.0	B	ottor	n of Boring	g @ 13.0 ft				B	ackfilled with auger
HXH H							-										c c	ompletion
с Ч																		
L RK							- 15											
J.GP.																		
AR							-											
0LE																		
L BO																		
NOL							-											
ESS						[
рх Ч																		
É.																		
EFAU							1.0.0	 			NO ''	T 55		D1 0111		001101277	SAN	IPLE PROPORTIONS
	۹MPL ۱				LCA					BLO	vS/F	DEN	NSILY	BLOWS	/FT			(PERCENT)
	י בי - י	э-5Р Г-Т⊦	LIT SP IIN WA	LL TUBE	SSA	A - HUL A - SOL			GERS	.3 0	-4 10	VERY	LOOSE	0-2 3-4		SOFT	TRA	CE 1 TO 10
	- :	SS - 3"	SPLIT	SPOON	DC -	- DRIVI	NG C/	SING	-		-30	LO MEDIUI	USE M DENSE	5-8 9-15		MEDIUM STIFF STIFF	LITT	LE 11 TO 20
2 - D - DENISON MD - MUD DRILLING										31 OVE	-50 R 50	DE VFRY	NSE DENSE	16-30	30		SON	/1E 21 TO 35
ž 🗖	- D - DENISON MD - MUD DRILLING - RC - ROCK CORE HA - HAND AUGER											. 2101		OVER	30	HARD		, 301030

Boring No. SWM-24 Page 1 of 1

F	2	K		F	PROJE	CT	Pro	fessi	onal	Boul	evard	ł					COMMISSIC	ON NO	.: 14187	7-03.4
—				_ ç		Was	hinat	ton (Count	vN	larvla	nd					N	ORTH	1: 71648	33
					///E	1103	mig		Journ	<u>y</u> , iv	iai yia	ina		Mo	bil B5	7 ΔT\/ /		EAST	: 1119	511
				0	RILL	NG	CO.:	AB			I	RIG/	/HAMME	RSa	fety		ELEV	ATION	I: 519.9	- ft
		(GRO		NATEF	R DA	TA (ft	:)		EQU	IPMEN	١T	CASING	SAM	1PLER	CORE		DATE	: 5/11/2	2016
514	Date	•	Tim	e	Water	(Casing	Ca	ave-In	TYPE			HSA	_	S		END	DATE	: 5/11/2	2016
5/1	1/201	6	4:00:00	РМ	Dry				4.5	SIZE,	ID (in)	· //b)	3.25	1.	.375		DR	ILLER	:: K. Ma	inos
										HAM		. (ib) LL (in)			30	-	LOGG	ED BY	: ACR	
SAMPLE	NUMBER	SAMPLE TYPE	RECOVERY (in)	BLOWS/6" (% RQD)	RAL RI Lac: Fred. Frac: Fred.		PLASTICITY SI INDEX	DEPTH		EV. — PTH	GRAPHIC	C in a	DES (mois	SCRIPT	ΓΙΟΝ Al ensity,	ND CLASS	FICATION		NOT	ES:
S- - - - -	$\begin{array}{c ccccccccccccccccccccccccccccccccccc$											6-inc Mois [a-7- Mois [a-7- Sam	ches Topso st, Medium 6] st, Stiff, Ye 6] ple S-2: T	bil Stiff, C llowish race Lig	Bray, Cl Brown	LAY, Little F	ine Sand (cl)			
- S- 	$\begin{array}{c ccccccccccccccccccccccccccccccccccc$									12.9 0		Sam Angu Botto	ple S-4: H ular Grave om of Borii	ard, Bri I-sized ng @ 7	own, Li Rock F .0 ft	ttle Coarse Fragments a	to Fine Sand, Li	ttle on	Backfilled cuttings u completio	with auger pon n
	SAMPLE IDENTIFICATION DRILLING METHOD																			
L L L	SAN	1PLE	IDEN	ITIFICA	ATION		DRIL	LING	METHO	DD	BL	OWS	/FT DE	INSITY	E	BLOWS/FT	CONSISTENCY	SA	MPLE PRO (PERC	ENT)
	- S - SPLIT SPOON HSA - HOLLOW STEM AUGER - T - THIN WALL TUBE SSA - SOLID STEM AUGERS - SS - 3" SPLIT SPOON DC - DRIVING CASING - D - DENISON MD - MUD DRILLING - RC - ROCK CORE HA - HAND AUGER									AUGEF GERS	RS ON	0-4 5-10 11-30 31-50 VER 5	VER L MEDII 50 VER	Y LOOS OOSE JM DEN ENSE Y DENS	SE ISE SE	0-2 3-4 5-8 9-15 16-30 OVER 30	VERY SOFT SOFT MEDIUM STIFF STIFF VERY STIFF HARD	TR LIT SO AN	ACE TLE ME D	1 TO 10 11 TO 20 21 TO 35 36 TO 50

Boring No. SWM-25 Page 1 of 1

	2			F	PROJE	СТ	: Pro	fessi	onal	Boule	evard						NO.: 14187-03.4
1						Was	hina	ton (Count	V M	arvlai	nd				NOF	RTH : 716482
				L.	// L	vvas	ming		Journ	y, ivi	aryiai	nu		Mohil B	57 ΔT\/ /	E/	AST : 1119711
				C	RILL	NG	CO.	AB			F	rig/	HAMME	RSafety		ELEVAT	ION: 529.4 - ft
		(GRO	UND	NATEF	R DA	TA (f	t)		EQUI	IPMEN	IT	CASING	SAMPLEF	CORE	START D	ATE: 5/11/2016
	Date		Time	e	Water	(Casing	Ca	ave-In	TYPE			HSA	S		END D	ATE: 5/11/2016
5/	11/201	16	3:00:00	РМ	Dry				5.5	SIZE, I	ID (in)	(16)	3.25	1.375		DRILI	LER: K. Manos
										HAMM	IER WI.	. (ib) .L (in)		30	-	LOGGED	BY: ACR
SAMPLE	NUMBER	MPLE TYPE	SAMPLE ECOVERY (in)	BLOWS/6" (% RQD)	LAB RI CLEG		ORY TS NDEX NDEX	DEPTH	ELE 	:V. — ?TH	GRAPHIC		DESC		AND CLASS	IFICATION	NOTES:
		_Q V	8	2	L no	32	- F					6 inc	(moist	ure, density	, color, prop	ortions, etc.)	
	5-1	$\setminus /$	18	2					EL 5	28.9		6-INC	t Medium	Stiff Brown		e Fine Sand (cl)	
-		X		4				-	0.	5		[a-7-	6]	buii, biowii,	CLAT, Hau		
		$/ \setminus$															
Ē	5-2		22	7				-		ł		Sam	ple S-2: Ve	ry Stiff, Red	ldish Brown		
		V		10				_		E							
		\wedge		11						ł							
-	3.3	$\left(\rightarrow \right)$	24	6				-		F		Sam	nle S-3 [.] Ve	rv Stiff Liah	t Grav to Br	own Some Fine	
	5-0	$\setminus / $	24	9 12								Sand		y oun, Ligi			
-		Å		16				- 5									
		$/ \setminus$						_		E							
5	5-4	\ /	24	5 6								Sam	ple S-4: Sti	f, Reddish	Brown, Trac	e Lignite	
-		X		8				-		E							
		$/\backslash $		5													
Fe	S-5	\rightarrow	24	4				-		E		Sam	ple S-5: Stit	f, Yellowish	Brown		
		$ \rangle $		5 5						ł				-			
-		Å		7				-		E							
		/		-				- 10				_			_		
5	6-6	\ /	24	6 9				10		E		Sam	ple S-6: Stit	f, Reddish	Brown		
-		XI		6 7				-		ł							
0/16		$/ \setminus$								E							
26/3C	S-7	\rightarrow	24	5				-		ł		Sam	ple S-7: Ve	ry Stiff, Brov	wn		
GDT		\mathbb{V}		9 10						E							
				10				-									
NKK N		/ \						_	EL 5	15.4		Dette	un of Doring	- A 1 4 0 H			Bookfilled with ourgon
ξ									14	.0		BOUC	om of Boriné	μ @ 14.0 π			cuttings upon
н Ч								- 15									completion
RD.G																	
EVAF								-									
								_									
IAL B																	
								-									
DFES																	
PR.								-									
DEFA	SAN	/IPLE	IDEN	ITIFICA			DRIL	LING	METHO	D	BLC	ows/	FT DEN	ISITY	BLOWS/FT	CONSISTENCY	SAMPLE PROPORTIONS
AST (\geq	- S	- SP	LIT SP	OON	HSA	A - HOL	LOW	STEM A	UGER	S	0.4			0-2	VERY SOFT	
	Ш	- T	- TH	IIN WA		SSA	- SOL	ID STE	EM AUC	BERS	į	0-4 5-10	VERY LO	LOOSE OSE	3-4 5-8	SOFT MEDIUM STIFF	IRACE 1 TO 10
		- S - Г	เร - 3") _ กะ	SPLIT	SPOON N		- DRIV - MUD	ING CA	ASING ING		1	1-30 1-50	MEDIUI DE	M DENSE NSE	9-15 16-30		SOME 21 TO 35
MD - D D D D D D D MD - MUD DRILLING MD - MUD DRILLING HA - HAND AUGER D D D											OV	/ER 5	0 VERY	DENSE	OVER 30	HARD	AND 36 TO 50

Boring No. SWM-26 Page 1 of 1

R	X		P	ROJE	ст:	Prof	fessio	onal	Boule	evarc	1					DN NO.: 14187-03.4
			- s		Nas	hinat	on C	Cunt	v M	larvla	and				N	IORTH: 718074
			Ŭ		1103	migi		Jouni	y, ivi	iai yia			Mobil B	57 ATV /		EAST: 1117436
			D	RILLI	NG	CO.:	AB			I	RIG/	НАММЕ	RSafety		ELEV	ATION: 506.3 - ft
		GRO	UNDV	VATEF	R DA	TA (ft)		EQUI	IPMEN	T	CASING	SAMPLEF	CORE	START	DATE: 5/17/2016
Da		Tim		Water	0	Casing	Ca	ive-In	TYPE			HSA	S		END	DATE: 5/17/2016
5/17/2	.010	11.40.0		Diy	-			0	SIZE, HAMM	ID (in) IFR WT	(h)	3.25	1.375		DR	RILLER: K. Manos
									HAMM	IER FAI	LL (in)		30	-	LOGG	ED BY: ACR
SAMPLE NUMBER	SAMPLE TYPE	SAMPLE RECOVERY (in)	BLOWS/6" (% RQD)	LABO RE Lac. Freq.		LASTICITY ^S INDEX	DEPTH		:V. — ?TH	GRAPHIC		DES (mois	CRIPTION	AND CLASS	SIFICATION	NOTES:
S-1		/ 14	3	ш.	-	<u> </u>		Et 5	06.1		3-inc	hes Topso	il/Grass	, co.o., p.o.		-
-			3 3 4 3			-		0.	2		Moist Sand	t, Medium (cl) [a-7-6	Stiff, Browni []	sh Gray, Cl	AY, Some Fine	
-			4 2 1			-										
S-3		21	5 5 6 6				- 5				Sam	ole S-3: St	iff, Reddish	Brown, Trac	e Fine Sand	
- S-4		18	5 5 5 5			-					Samp Sand	ole S-4: St	iff, Reddish	to Yellowish	Brown, Trace Fi	ine
- S-5		12	3 4 4			-					Sam	ole S-5: Re	eddish Brow	n, Trace Fir	e Sand	
_ S-6 _		18	3 4 4				- 10	EL 4	95.3		Sam	ole S-6: Re	eddish Brow	n, Trace Fir	e Sand	Backfilled with auger
						_			.0		ΒΟΙΙΟ		ig @ 11.0 it			cuttings upon completion
						-	- 15									
JOK-																
si Si	AMPL	E IDEN	ITIFICA	TION		DRIL	LING N	METHC	D	BL	.OWS/	FT DE	NSITY	BLOWS/FT	CONSISTENCY	(PERCENT)
2 - S - SPLIT SPOON HSA - HOLLOW STEM AUGER 2 - T - THIN WALL TUBE SSA - SOLID STEM AUGERS 2 - SS - 3" SPLIT SPOON DC - DRIVING CASING 2 - D - DENISON MD - MUD DRILLING 4 - RC - ROCK CORE HA - HAND AUGER										RS O	0-4 5-10 11-30 31-50 VER 5	VER LC MEDIU DI 0 VER	/ LOOSE DOSE IM DENSE ENSE / DENSE	0-2 3-4 5-8 9-15 16-30 OVER 30	VERY SOFT SOFT MEDIUM STIFF STIFF VERY STIFF HARD	TRACE 1 TO 10 LITTLE 11 TO 20 SOME 21 TO 35 AND 36 TO 50

Boring No. SWM-27 Page 1 of 1

	R	K	R,	P	ROJE	CT:	: Prot	fessio	onal	Boul	evaro	d					COMMISSIC	N NC).: 14187-	03.4
1				_		Maa	hinat	on C		., .,	londo	nd					N	ORTH	l: 718116	6
				5	DITE:	vvas	ningi	on C	ount	y,ıv	laryla	ana		Mahill		7 4 T) / /		EAST	Γ: 111746	65
				D	RILL	NG	CO.:	AB				RIG/	HAMME	RSafety	501	/ AIV /	ELEV	ATION	N: 500.5 -	ft
			GRO	UNDV	VATEF	R DA	TA (ft)		EQU	IPME	NT	CASING	SAMPLE	R	CORE	START	DATE	E: 5/17/20	016
	Date	e	Tim	e	Water	(Casing	Ca	ave-In	TYPE			HSA	S			END	DATE	E: 5/17/20	016
_										SIZE,	ID (in)	- /// >	3.25	1.375	_		DR	ILLEF	R: K. Man	IOS
-										HAMI	/IER VI	LL (in)		30	-	-	LOGG	ED B	r: ACR	
	SAMPLE NUMBER	SAMPLE TYPE	SAMPLE RECOVERY (in)	BLOWS/6" (% RQD)	BAL NMC/ Frac. Freq.		ORY INDEX INDEX	DEPTH	ELE DEF	:V. ?TH	GRAPHIC		DES (mois	CRIPTION	I AN ty, c	ID CLASSI	FICATION		NOTE	S:
	S-1 S-2 S-3	$ \begin{array}{c ccccccccccccccccccccccccccccccccccc$							EL 4 5.	00.3 2 95.5 0		3-inc Mois Sam Sam	thes Topso t, Stiff, Rec ple S-2: Me ple S-3: Ve	il/Grass Idish Brow edium Stiff ery Stiff g @ 5.0 ft	n, C	CLAY (cl) [a	[-7-6]	~	Backfilled v cuttings up completion	with auger on
	SA	SAMPLE IDENTIFICATION SAMPLE IDENTIFICATION SAMPLE IDENTIFICATION C S S S S S S S S S S S S S S S S S S							DD	В	OWS/	/FT DE	NSITY	BI	LOWS/FT	CONSISTENCY	SA	MPLE PROF (PERCE)	PORTIONS	
	- S - SPLIT SPOON HSA - HOLLOW STEM AUGI - T - THIN WALL TUBE SSA - SOLID STEM AUGERS - SS - 3" SPLIT SPOON DC - DRIVING CASING - D - DENISON MD - MUD DRILLING - RC - ROCK CORE HA - HAND AUGER								AUGEF GERS	RS 0	0-4 5-10 11-30 31-50 VER 5	VER) LC MEDIU 50 VER)	/ LOOSE DOSE M DENSE ENSE / DENSE	(0-2 3-4 5-8 9-15 16-30 OVER 30	VERY SOFT SOFT MEDIUM STIFF STIFF VERY STIFF HARD	TR LIT SC AN	(PERCE RACE ITLE DME ID	1 TO 10 11 TO 20 21 TO 35 36 TO 50	

Boring No. SWM-28 Page 1 of 1

F	?;		F	PROJE	ECT:	Pro	fessi	onal	Boul	evar	ď					NNO.: 14187-03.4	
			S	SITE:	Was	hing	ton C	count	v.N	larvl	and					URIH: /1805/	
									, , , , , , , , , , , , , , , , , , ,				Mobil E	57 ATV /		EASI: 1117538	
				DRILL	ING	<u>CO.</u>	: AB				RIG	HAMME	RSafety	-		ATION: 503.0 - π	
		GRO		NATE	R DA	TA (f	t)		EQU	IPME	NT	CASING	SAMPLE	R CORE	START	DATE: 5/17/2016	
D	ate	10:30:0		Water	C	Casing	Ca	ave-In 3.5	TYPE			HSA	S			DATE: 5/17/2016	
0,111	2010	10.00.		Biy				0.0	HAMN	MER W	/T. (lb)	3.25	1.375	-	– DRI	ILLER: K. Manos	
									HAMN	MER FA	ALL (in)		30	-	LOGGE	ED BY: ACR	
SAMPLE		SAMPLE ECOVERY (in)	BLOWS/6" (% RQD)	NMC/ Iac. Freq.			DEPTH	ELE — DEF	EV. — PTH	GRAPHIC		DES	CRIPTION			NOTES:	
S-1		8	6		-			Et 5	02.8		-∖ 3-ind	ches Topso	il/ Grass	y, color, prop			
- - - S-2	2	2	4 5 5 4 3 4 2			-	-	0. <u>EL 5</u> 2.	.2 01.0 .0		FILL Som Mois Little	, Sampled le Coarse t st, Medium e Coarse to	As: Moist, S o Fine Sand Stiff, Yellow Fine Sand	Stiff, Gray to I, Trace Grav vish to Reddi (cl) [a-7-6]	Dark Brown, CLA vel, Trace Roots sh Brown, CLAY,	,	
- -	$\begin{array}{c ccccccccccccccccccccccccccccccccccc$										Sam a Po	ple S-3: Re cket	eddish Brow	n, Trace Fin	e Angular Gravel	lin	
- -	S-4 4 2 - 5 - 5 - 5 5 5 										Sam Grav	ple S-4: St vel in a Poc	iff, Reddish ket	Brown, Trac	e Fine Angular		
- -	S-5 22 3 4 6 $ -$										Sam	ple S-5: Re	eddish Brow	'n		Packfilled with au	gor
	- 10 EL 49 - 10 - 10 - 10 - 10 - 10 - 10								0.0		Bott	om of Borin	g @ 10.0 ft			Backfilled with au cuttings upon completion	ger
s (net	AMP	LE IDEN	NTIFICA	ATION		DRIL	LING I	METHO	DD	В	LOWS	/FT DE	NSITY	BLOWS/FT	CONSISTENCY	SAIVIPLE PROPORTIO (PERCENT)	GNI
	- S - SPLIT SPOON HSA - HOLLOW STEM AUGE - T - THIN WALL TUBE SSA - SOLID STEM AUGERS - SS - 3" SPLIT SPOON DC - DRIVING CASING - D - DENISON MD - MUD DRILLING - RC - ROCK CORE HA - HAND AUGER									25	0-4 5-10 11-30 31-50 OVER \$	VERY LC MEDIU DI 50 VERY	/ LOOSE DOSE M DENSE ENSE / DENSE	0-2 3-4 5-8 9-15 16-30 OVER 30	VERY SOFT SOFT MEDIUM STIFF STIFF VERY STIFF HARD	TRACE1 TOLITTLE11 TOSOME21 TOAND36 TO	10 20 35 50

Boring No. SWM-29 Page 1 of 1

	R	K		P	ROJE	CT:	Pro	fessi	onal	Boul	evard						N NO.: 14187-03.4
				S		Was	hina	ton C	ount	v . M	larvlan	d					DRTH: 717940
				-						,				Mobil B	57 ATV /	E	EAST: 1117557
				D	RILLI	NG	CO.:	AB			R	IG/I	HAMME	RSafety		ELEVA	TION: 500.6 - ft
		(GRO		VATEF	R DA	TA (fl	:)		EQU	IPMENT	•	CASING	SAMPLEF	CORE	START	DATE: 5/17/2016
5/	Date) 16	Time		Water		Casing	Ca	ive-In	TYPE	ID (in)		HSA	S			DATE: 5/17/2016
5/	17/20	10	3.23.00		Diy	-			-	SIZE, HAMN	ID (IN) /IFR WT (I	lb)	3.25	1.375	-	DRIL	LLER: K. Manos
										HAMN	IER FALL	(in)		30	-	LOGGE	DBY: ACR
SAMPLE	NUMBER	AMPLE TYPE	SAMPLE ECOVERY (in)	BLOWS/6" (% RQD)	NMC/ Bac. Freq.		ASTICITY ⁶⁷ AS	DEPTH	ELE DEF	EV. — PTH	GRAPHIC		DES		AND CLASS	IFICATION	NOTES:
	S-1	5	8	2	<u> </u>	_			FI 5	00.1	<u>, 1</u> /, 6·	-inch	nes Topsoi		, 00101, prop		
-		$\left \right\rangle$	12	10 6 7 8			-	-	<u> </u>	5	F A	ILE 3 Ind N	Sampled A Medium to	s: Moist, Vé Fine SAND	ery Stiff, Gra Trace Roo	yish Brown, CLAY s	7,
	5-2 12 11 12 11 12 $ -$											<u></u>					
_	$\begin{array}{c ccccccccccccccccccccccccccccccccccc$										FIS	ine s amp	, very Stiff Sand (cl) [a ble S-3: Litt	, Reddish B a-7-6] le Coarse to	rown, CLAY o Fine Suba	, Some Coarse to ngular Gravel	
-											S	amp	ole S-4: Tra	ace Fine Sa	nd		
-	8-5	X	18	6 5 7			-		EL 4	91.6	s s	amp and	ble S-5: Stit	ff, Reddish	o Yellowish	Brown, Trace Fin	
								- 10 - - - 15	9.	0		ouo	ΠΟΓΡΟΠΙ	J (() 9.0 II			cuttings upon completion
		MPLE - S - 1 - S - C - F	E IDEN 5 - SPI 7 - TH 5S - 3" 0 - DE RC - R0	ITIFICA LIT SP(IIN WAI SPLIT ENISON OCK C(TION DON LL TUBE SPOON N DORE	HSA SSA DC - MD - HA -	DRIL - HOL - SOL - MUD HAND	LING N LOW S ID STE NG CA DRILLI	METHO STEM A MAUC SING ING ER	DD NUGER GERS	BLOV 85 0 5- 11 31 OVE	WS/F -4 -30 -50 ER 50	FT DEN VERY LO MEDIUI DE O VERY	ISITY LOOSE OSE M DENSE NSE DENSE	BLOWS/FT 0-2 3-4 5-8 9-15 16-30 OVER 30	CONSISTENCY VERY SOFT SOFT MEDIUM STIFF STIFF VERY STIFF HARD	SAMPLE PROPORTIONS (PERCENT) TRACE 1 TO 10 LITTLE 11 TO 20 SOME 21 TO 35 AND 36 TO 50

Boring No. SWM-30

	R	K		P	ROJE	ст:	Pro	fessi	onal	Boul	evar	ď					COMMISSI	ON NC).: 14187-(03.4
				S	ITE: \	Nas	hing	ton C	Count	y, M	1aryl	and							l: 717889	
				-			~~							Mobil I	B57	7 ATV /			I: III/0/	۲ ۲
							CO.	: AB				RIG/							•. 4 93.7 - •. 5/17/20	16
	Date	e	Tim		Water		TA (T Casing		ave-In	TYPE	IPME	:N I		SAMPLE	:R	CORE		DATE	=. 5/17/20 ■. 5/17/20	16
ţ	5/17/20	16	9:40:00) AM	Dry		0		2.0	SIZE,	ID (in)		3.25	1.375					2. 6/17/20 2. K Man	05
										HAMN	MER W	/T. (lb)		140		-		FD B	C: ACR	00
F		Щ	Ē		LAB	ORAT	ORY			HAMIN	/IER F/	ALL (IN)		30		-				
	SAMPLE NUMBER	AMPLE TYF	SAMPLE ECOVERY (i	BLOWS/6" (% RQD)	BNMC/ ac. Freq.			DEPTH		EV. PTH	GRAPHIC		DES	CRIPTION	I AN	ID CLASS			NOTES	S:
┢	S-1	S /	18	2	<u>Ē</u>		4			05.0	<u>, </u>	6-inc	(mols) hes Tops	sture, densi pil	ty, c	color, propo	ortions, etc.)			
	0-1	\mathbb{N}		5 8						.9 <u>5.2</u> .5	ŤΠ	Mois	t, Stiff, Bro	wnish Gray	y, Sī	ILT, Little I	ine Sand (ml) [a-4]		
F		Ň		7				_												
╞	~ ~	\square		5			-	_	EL 4	93.7	<u> </u> ,		t Stiff Do	ddiab Brow	<u> </u>			\		
	5-2	$\mathbb{N}/$	20	7					Z .	.0	\square	[a-7-	6]		n, c	LAT, Hau	e Fille Saliu (C)		
F		Å		8				-												
L		\square	*					_												
	S-3	\mathbb{N}	18	4 5																
┢				5			-	- 5												
	S-4	$\left[\right]$	14	4				_			\square	Sam	ple S-4: V	ery Stiff						
		X		11																
┝		\vdash					-	_	EL 4	88.7 0		Botto	om of Bori	na @ 7 0 ft					Backfilled w	/ith auger
												Dom		ig @ 1.0 it					cuttings upo	on
F								_											completion	
F							-	_												
ŀ							ŀ	— 10												
								_												
9																				
- 1							-	_												
								-												
- האו								_												
Υ Υ																				
ד - ב							-	- 15												
צחיפ																				
EVA.								_												
								_												
NAL																				
								_												
й (-)																				
EFAUL	0.1								 				(FT		_			SA	MPLE PROP	ORTIONS
	SAI	MPLE				ЦСУ				טע אוופיביי	B	LOWS	'FI DE	INSITY	BL	LOWS/FT			(PERCEN	NT)
1/EAS	\square	- 8 - 1	5 - SP [- TH	LIT SPO	LL TUBE	SSA	- HUL - SOL	LOW S		NUGEH GERS	10	0-4 5-10	VER	Y LOOSE		0-2 3-4	VERY SOFT		RACE	1 TO 10
= XO		- 8	SS - 3"	SPLIT	SPOON	DC -	DRIV	ING CA	ASING			11-30	MEDI			5-8 9-15	MEDIUM STIFF		TTLE DMF	11 TO 20 21 TO 35
Z - D - DENISON MD - MUD DRILLING X - RC - ROCK CORE HA - HAND AUGER								0	OVER 5	50 VER	Y DENSE	C	16-30 OVER 30	VERY STIFF HARD	AN	ND	36 TO 50			

Appendix C

Professional Bloulevard Bridge and Extension

14187.03-4

Δ	3	AB CONSU 9450 Annapolis I Lanham, Marylar Tel: 301-306-309	LTANTS Road nd 20706 91 Fax: 30	, INC. 01-306-3092	AB JOB NO.: 20 PROJECT: Pr LOCATION: REF. NO.: 14	014117 rofess 4187.0	, io 3-4
				SUMMA	RY OF LABORATORY TEST RES	ULT	S
BORING	SAMPLE	SAMPLE	WATER CONTEN	ATTERBERG	SIEVE ANALYSIS		

			WATER						SIEV	E ANAL	YSIS			MOD	IFIED			COMPRES
BORING NO.	SAMPLE NO.	SAMPLE DEPTH (FT)	CONTEN T	AT		RG			PERCI		SSING			OPT DRY UNIT WTG	OPT MOIST CONTENT	USCS	CALIFORNI A BEARING	SIVE STRENGT
			(%)	LL	PL	PI	3/4"	3/8"	#4	#10	#40	#100	#200	(lb/cu.ft)	(%)		RATIO	Н
AR-01	S-2	3.5-5.0	30.8	67	26	41				100.0	99.2	97.8	95.4					
AR-01	S-5	10.0-11.5	18.2	47	19	28	93.0	90.8	85.7	76.6	67.4	63.4	59.4					
AB-01	S-2	3.5-5.0	20.4	29	15	14				100.0	99.4	89.4	75.1					
AB-01	R-3	16.0-21.0																16660
AB-02	S-2	3.5-5.0	31.0	59	24	35			100.0	99.7	95.5	89.6	85.2					
AB-02	S-3	6.0-7.5	27.3															
AB-02	R-1	9.5-14.5																13540
P-01	S-2	3.5-5.0	30.8	34	21	13			100.0	99.6	95.9	90.2	84.9					
P-01	R-2	12.5-17.5																16400
P-01A	R-1	7.5-12.5																4500
P-02	S-1	1.0-2.5	29.0	31	19	12			100.0	99.6	98.9	92.3	84.9					
P-02	S-2	3.5-5.0	33.0	30	20	10				100.0	99.3	74.3	47.3					
P-02	S-3	6.0-7.5	35.7															
P-02	R-1	9.0-10.5																7130
AB-03	S-1	1.0-2.5	22.7	64	20	44				100.0	99.6	98.7	96.7					
AB-03	R-1	3.0-8.0																9580
AB-04	R-1	3.0-8.0																12080
RB-01	BULK	1.0-6.0	28.4	47	15	32	100.0	97.3	94.1	91.4	87.0	83.5	81.5	116.1	15.9	CL	x	
RB-01	S-2	3.5-5.0	26.7															
RB-01	S-4	8.5-10.0	37.4															
RB-02	BULK	1.0-6.0	29.4	65	21	44	100.0	98.4	97.9	96.3	91.0	86.1	83.8	113.5	14.9	СН	1.7 @ 0.1"	

┞

AB JOB NO.: 2014117

PROJECT: Professional Bloulevard Bridge and Extension LOCATION:

REF. NO.: 14187.03-4

BORING NO.	SAMPLE NO.	SAMPLE DEPTH (FT)	WATER CONTEN T (%)						SIEV	e anal	YSIS			MOD	IFIED			COMPRES
				ATTERBERG LIMIT					PERCI	ENT PA	SSING			OPT DRY UNIT WTG	OPT MOIST CONTENT	USCS		SIVE
				LL	PL	PI	3/4"	3/8"	#4	#10	#40	#100	#200	(lb/cu.ft)	(%)		RATIO	H
RB-02	S-2	3.5-5.0	36.2															
RB-02	S-4	8.5-10.0	37.6															
RB-03	S-1	1.0-2.5	14.0															
RB-03	S-3	6.0-7.5	28.0															
RB-04	BULK	0.0-7.0	33.2	58	21	37		100.0	99.1	98.1	95.8	93.6	90.5	115.4	14.5	СН	x	
RB-04	S-2	3.5-5.0	28.5															
RB-04	S-4	8.5-10.0	29.2															
RB-05	BULK	7.0-12.0	37.1	77	28	49			100.0	99.8	99.2	98.5	97.6	105.3	18.9	СН	1.4 @ 0.1"	
RB-05	S-1	1.0-2.5	32.6															
RB-05	S-3	6.0-7.5	32.2															
RB-06	BULK	0.0-10.0	28.2	43	19	24	100.0	97.0	94.3	90.2	83.3	80.2	77.4	115.8	14.8	CL	3.5 @ 0.2"	
RB-06	S-2	3.5-5.0	33.0															
RB-06	S-4	8.5-10.0	37.5															
RB-07	BULK	0.0-6.0	28.0	72	23	49		100.0	99.5	98.7	96.4	94.0	91.4	110.3	18.2	СН	2.6 @ 0.2"	
RB-07	S-1	1.0-2.5	25.7															
RB-07	S-3	6.0-7.5	29.5															
RB-08	R-1	0.0-5.0																2070

AB CONSULTANTS, INC.

Tel: 301-306-3091 Fax: 301-306-3092

9450 Annapolis Road

Lanham, Maryland 20706



AB CONSULTANTS, INC. 9450 Annapolis Road Lanham, Maryland 20706 Tel: 301-306-3091 Fax: 301-306-3092

AB JOB NO.:	2014117
PROJECT:	Professional Bloulevard Bridge and Extension
LOCATION:	
REF. NO.:	14187.03-4

BORING NO.	SAMPLE NO.	SAMPLE DEPTH (FT)	WATER CONTENT (%)	ATTERBERG LIMIT					SIEV PERC	'E ANAL ENT PA	YSIS SSING			MODIFIED OPT DRY OPT MOIST UNIT WTG CONTENT		USCS		COMPRES
				LL	PL	PI	3/4"	3/8"	#4	#10	#40	#100	#200	(lb/cu.ft)	(%)		RATIO	STRENGTH
SWM-01	S-2	2 - 3.5	9.9	20	13	7	100.0	96.9	93.6	89.9	82.4	77.8	73.6					
SWM-01	S-6	10 - 11.5	15.9															
SWM-02	S-3	4 - 5.5	32.9															
SWM-02	S-6	10 - 11.5	27.8	61	22	39				100.0	99.8	99.6	99.0					
SWM-02	S-8	14 - 15.5	37.7															
SWM-03	S-3	4 - 5.5	26.7															
SWM-03	S-7	12 - 13.5	28.4	48	20	28			100.0	98.1	96.0	94.5	92.5					
SWM-03	S-9	16 - 17.5	30.1															
SWM-13	S-3	4 - 5.5	25.9															
SWM-13	S-5	8 - 9.5	29.1	65	23	42			100.0	99.4	94.9	93.6	93.1					
SWM-14	S-1	6 - 7.5	26.5	<u>60</u>	20	40		100.0	98.0	96.1	93.7	92.5	91.1					
SWM-15	S-2	2 - 3.5	20.7	48	18	30			100.0	99.1	96.2	93.9	91.7					
SWM-15	S-4	6 - 7.5	32.1															
SWM-15	S-17	12 - 13.5	31.8															
























Professional Boulevard Extension Washington County, Maryland RKK PROJECT NO. 14187-03.4

Summary of Rock Mass Rating (RMR) Professional Boulevard

ROCK MASS RATING

BORING	ROCK CORE	ROCK TYPE	- STRENGTH OF ROCK				RQD		SPACING OF JOINTS		JOINT CONDITION	GROUNDWA	TER	STRIKE & DIP		SUM	RMR
NUMBER RUN P	RUN NUMBER		(psi)	(ksf)	(MPa)	Rating	%	RATING	(mm)	RATING	RATING		RATING	FOR FOUNDATIONS	RATING		
AB-01	R-1	LIMESTONE			114	12	100	20	60 to 200	8	25	COMPLETELY DRY	15	VERY FAVOURABLE	0	80	
AB-01	R-2	LIMESTONE			114	12	93	20	60 to 200	8	25	COMPLETELY DRY	15	VERY FAVOURABLE	0	80	I
AB-01	R-3	LIMESTONE	16660	2399	114	12	91	20	60 to 200	8	12	COMPLETELY DRY	15	VERY FAVOURABLE	0	67	Ш
AB-01	R-4	LIMESTONE			114	12	93	20	60 to 200	8	6	COMPLETELY DRY	15	VERY FAVOURABLE	0	61	=
AB-02	R-1	LIMESTONE	13540	1950	93	7	85	17	60 to 200	8	12	COMPLETELY DRY	15	VERY FAVOURABLE	0	59	
AB-02	R-2	LIMESTONE			93	7	98	20	200 to 600	10	25	COMPLETELY DRY	15	VERY FAVOURABLE	0	77	=
AB-02	R-3	LIMESTONE			93	7	98	20	60 to 200	8	25	COMPLETELY DRY	15	VERY FAVOURABLE	0	75	=
AB-02	R-4	LIMESTONE			93	7	63	13	60 to 200	8	12	COMPLETELY DRY	15	VERY FAVOURABLE	0	55	III
AB-03	R-1	LIMESTONE	9580	1380	66	7	98	20	60 to 200	8	12	COMPLETELY DRY	15	VERY FAVOURABLE	0	62	II
AB-03	R-2	LIMESTONE			66	7	98	20	60 to 200	8	20	COMPLETELY DRY	15	VERY FAVOURABLE	0	70	II
AB-03	R-3	LIMESTONE			66	7	100	20	200 to 600	10	12	COMPLETELY DRY	15	VERY FAVOURABLE	0	64	II
AB-03	R-4	LIMESTONE			66	7	100	20	60 to 200	8	12	COMPLETELY DRY	15	VERY FAVOURABLE	0	62	
AB-04	R-1	LIMESTONE	12080	1740	83	7	53	13	60 to 200	8	0	COMPLETELY DRY	15	VERY FAVOURABLE	0	43	
AB-04	R-2	LIMESTONE			83	7	92	20	60 to 200	8	6	COMPLETELY DRY	15	VERY FAVOURABLE	0	56	III
AB-04	R-3	LIMESTONE			83	7	100	20	60 to 200	8	6	COMPLETELY DRY	15	VERY FAVOURABLE	0	56	111
AB-04	R-4	LIMESTONE			83	7	100	20	200 to 600	10	20	COMPLETELY DRY	15	VERY FAVOURABLE	0	72	
P-01	R-1	LIMESTONE			113	12	100	20	60 to 200	8	6	WET	7	VERY FAVOURABLE	0	53	
P-01	R-2	LIMESTONE	16400	2362	113	12	63	13	60 to 200	8	12	WET	7	VERY FAVOURABLE	0	52	Ξ
P-01A	R-1	LIMESTONE	4500	648	31	4	75	13	60 to 200	8	6	WET	7	FAIR	-7	31	IV
P-01A	R-2	LIMESTONE			31	4	67	13	60 to 200	8	6	WET	7	UNFAVOURABLE	-15	23	IV
P-01A	R-3	LIMESTONE			31	4	98	20	60 to 200	8	12	WET	7	VERY FAVOURABLE	0	51	
P-01A	R-4	LIMESTONE			31	4	83	17	200 to 600	10	20	WET	7	VERY FAVOURABLE	0	58	=
P-02	R-1	LIMESTONE	7130	1027	49	4	27	8	60 to 200	8	6	WET	7	VERY FAVOURABLE	0	33	IV
P-02	R-2	LIMESTONE				0	0	3	0 to 60	5	6	WET	7	VERY FAVOURABLE	0	21	IV
P-02	R-3	LIMESTONE			49	4	100	20	60 to 200	8	20	WET	7	FAVOURABLE	-2	57	
P-02	R-4	LIMESTONE			49	4	100	20	60 to 200	8	20	WET	7	VERY FAVOURABLE	0	59	

Design: JR Updated: JR Check: Date: 6/16/16 Date: 6/24/16 Date:

Appendix D



Final Report Geophysical Survey Pinnacles and Sinkholes beneath Proposed Roadway 4300 Lineal Feet of Proposed Roadway Hagerstown, MD Enviroscan Project Number 061423

Prepared For: RK & K Prepared By: Enviroscan, Inc. March 24, 2016





March 24, 2016

Mr. Richard Adams, Jr., P.E. **RK&K** 81 Mosher Street Baltimore, MD 21217

> RE: Geophysical Survey Pinnacles and Sinkholes beneath Proposed Roadway 4300 Lineal Feet of Proposed Roadway Hagerstown, MD Enviroscan Project Number 061423

Dear Mr. Goins:

Pursuant to our proposal dated June 9, 2014, Enviroscan, Inc. ("Enviroscan") has completed a geophysical investigation at the above-referenced site. The purpose of the survey was to provide reconnaissance detection and delineation of incipient sinkholes and sinkhole-prone areas beneath the site. Fieldwork for the survey was completed on March 3, 2016.

Site Description

The site is located along the proposed Professional Boulevard road extension, which is a currently open field with a semi-accessible wooded section. The survey alignment was based on drawings provided by the client prior to the field survey. Please note that portions of the alignment were inaccessible due to dense vegetation (Figure 1).

According to the Geologic Map of Maryland (Cleaves, E.T., Edwards, J., Jr., Glaser, J.D., 1968) the site is primarily underlain by the Ordovician-aged Stonehenge and Conococheague Limestones. Figure 1, lower right panel, shows the relative site location within the limestone formations. Common surface features seen in carbonate rocks are sinkholes and closed depressions. Both of these features form from the dissolution of carbonate bedrock (forming cavities and conduits) and the downward movement of surface material and groundwater into these voids. Note that the main difference between a sinkhole and a closed depression is that a sinkhole may appear suddenly as a break in the ground surface revealing a hole, whereas a closed depression typically subsides slowly with no break at the surface.



Karst Processes

Pinnacled bedrock, depressions, and sinkholes are among the geologic features characteristic of karst terranes — i.e. terranes underlain by soluble carbonate (limestone or dolomite) bedrock in wet climates. In karst terranes, infiltrating precipitation dissolves the carbonate bedrock surface, causing the top-of-rock to retreat downward leaving behind a soil mantle of the insoluble clay and/or silica particles formerly bonded in the rock (see Appendix A, panels I and II). Within the bedrock, percolating water enlarges fractures, bedding planes, etc. to produce solution openings ranging in size from minor seams to scenic caverns.

Sinkholes form where particularly enhanced infiltration into a sufficiently wide solution opening (often called a throat or chimney) washes the soil mantle down into cavities in the underlying rock — a process commonly called soil piping. In areas where the residual soil mantle is clay-rich and cohesive, incipient sinkholes may not display any surficial topographic expression, and are present only as air-, water-, or mud-filled voids which may grow or "stope" upward (see Appendix A, panel III). Eventually, the overlying soil arch collapses under its own weight or under the weight of an overlying structure or passing vehicle. The resulting collapse sink, or "sinkhole," is commonly filled with the remains of the soil arch and may display rock at its base (see Appendix A, panel IV). In some cases, surficial subsidence may keep pace with soil piping at depth such that a sinkhole forms by progressive deepening of a surficial depression (sometimes called a subsidence sink), rather than by catastrophic collapse of a stoping void.

Note that the dissolution of bedrock occurs on a time scale measured in thousands to tens of thousands of years. Therefore, the natural occurrence of new sinkholes is a rare occurrence on a human time scale (see Newton, 1987). However, concentration of storm water and excess infiltration due to man's activities can trigger man-made sinkholes virtually anywhere in a karst terrane - even on topographic highs or beneath paved streets or buildings.

Since sinkhole activity is allowed by bedrock cavities and triggered/driven by infiltrating water, hydraulically-active geologic features can act as foci for sinkhole activity. In particular, where open faults, fractures, bedding planes or contacts act as preferred pathways for groundwater infiltration or flow, the water can dissolve networks of solution openings along the fault/fracture/bedding plane/contact. The enhanced infiltration also encourages movement of soil or soil fines into the solution openings, which may cause surficial subsidence and enhanced capture and infiltration of storm water, etc. in a positive-feedback process.

Survey Methods

Electrical Imaging

Surface resistivity measurements involve driving an electrical current in the ground using two current electrodes at the ground surface. The apparent resistivity of the subsurface (essentially the mathematical inverse of terrain conductivity) is determined by measuring the potential difference or voltage between two potential electrodes with a known separation and position/orientation relative to the current electrodes. The depth and volume of the subsurface zone represented by the measured apparent resistivity is a function of the geometry of the current and potential electrodes located at the surface. The principles of electrical imaging are described in the accompanying Introduction to Electrical Imaging (Appendix B).

Using an AGI Super Sting R8/IP resistivity meter, apparent resistivity readings were collected along the four profiles (see Figure 1). Along each profile, electrodes were spaced at 10-foot intervals. To collect electrical imaging data, a dipole-dipole array was used. The locations of profile endpoints were surveyed using a Topcon GMS-110 global positioning system (GPS) receiver. The GPS positions were collected with real-time differential correction, using the corrections from the Satellite-Based Augmentation Service (SBAS). The resulting differential GPS (DGPS) positions have an accuracy of better than two feet. The measured apparent resistivities (ρ_a 's) were plotted, after each line was completed, as resistivity pseudo-sections depicting the apparent resistivity versus nominal survey depth for each profile, in order to confirm data quality.

In post-field processing, the apparent resistivity pseudo-sections were mathematically inverted using EarthImager2D software by AGI, Inc., to provide color-contoured electrical images of true resistivity versus depth along each profile, as depicted in Figures 2 and 3. On these images, low-resistivity (high-conductivity) material is depicted in shades of blue to yellow, with high-resistivity (low-conductivity) material in shades of orange to red and moderately resistive/conductive materials in shades of yellow. Note that clay-rich and/or wet materials are typically represented by local resistivity lows (conductivity highs – shades of blue), while competent rock, and dry sands, gravels or other well-drained porous materials are typically represented by areas of resistivity highs (low conductivity – orange to red).

Survey Results

Figure 1 depicts the locations of Profiles 1 through 4, and the corresponding resistivity cross sections are depicted in Figure 2. The yellow- to red-shaded contours represent inferred dry soil/rock, and the green- to blue-shaded contours represent moist or conductive soil/rock. Alternating high- and low-resistivity values are a common feature in karst terrain and are evident along all four profiles.

The conductive anomalies of the type expected for water- or soil-filled fractures (low resistivity) are identified in Figures 2 and 3 with blue arrows. Please note that Profile 3 contains numerous alternating high/low anomalies indicative of highly karstified terrain. Any of these anomalies could be typical sinkhole "throats" through which water infiltrates into deeper voids or solution cavities. Figure 4 depicts the plan-view location of the significant conductive anomalies identified in Figures 2 and 3.

Enviroscan recommends that any future geotechnical investigations include direct testing of each of these anomalies to determine the extent and source of the conductive feature.

Limitations

The geophysical survey described above was completed using standard and/or routinely accepted practices of the geophysical industry and equipment representing the best available technology. Enviroscan does not accept responsibility for survey limitations due to inherent technological limitations or unforeseen site-specific conditions. However, we make every effort to identify and notify the client of such limitations or conditions.

We have enjoyed and appreciated the opportunity to work with you. If you have any questions, please do not hesitate to contact the undersigned.

Sincerely, **Enviroscan, Inc.**

Ch H K

Charles H. Rhine, M.Sc., P.G. Senior Geophysics Project Manager

Technical Review By: **Enviroscan, Inc.**

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Felicia Kegel Bechtel, M.Sc., P.G. President

enc.: Figure 1: Resistivity Profile Location Map
Figure 2: Electrical Imaging Profiles 1 & 2
Figure 3: Electrical Imaging Profiles 3 & 4
Figure 4: Electrical Resistivity Survey Results
Appendix A: Schematic Karst Processes
Appendix B: Introduction to Electrical Imaging









Note: The information depicted on this drawing represents survey results on the date surveyed and can only be considered to be indicative of the general conditions existing on the survey date.

Figure composed using aerial image from Google Earth and RTK survey by Enviroscan, Inc. personnel.

Geologic Map of Maryland (Cleaves, E.T., Edwards, J., Jr., Glaser, J.D., 1968)





EI data from AGI SuperSting R8 system, models from EarhImager 2D inversions.

Electrical Resistivity (Ohm-ft)



	Project Location:	Figure			
al Imaging es 1 & 2	Professional Bridge and Hagersto		2		
	Project Number 061423	Revision/Issue 03/24/2016			
	Original Scale	Survey Ending Date	Drawn by:	Approved by:	
	1"= 50'	03/03/2016	MEG	FKB	





Geophysical Survey Legend					
	Profile 1				
	Profile 2				
	Profile 3				
	Profile 4				
0	Low Resistivity Area				



Note: The information depicted on this drawing represents survey results on the date surveyed and can only be considered to be indicative of the general conditions existing on the survey date.

Figure composed using aerial image from Google Earth and RTK survey by Enviroscan, Inc. personnel.

Geologic Map of Maryland (Cleaves, E.T., Edwards, J., Jr., Glaser, J.D., 1968)





Appendix A

Schematic Karst Processes





Schematic Karst Processes



Rev. 01/2009



Appendix A

Introduction to Electrical Imaging





Introduction to Electrical Imaging

by

Timothy D. Bechtel, Ph.D., P.G.

<u>Energy</u>

Electrical currents injected into the subsurface between electrodes pushed into the ground surface or non-intrusive, protected capacitors.

Sensitivity

Detects changes in electrical resistivity (the inverse of conductivity).

Basic Equipment

Either (traditional "steel spike electrode" method):

Steel spike electrodes (called current electrodes) connected by wires to a current source (to inject current), and steel spike electrodes (called voltage electrodes) connected to a microvolt meter (to measure the surficial distribution of electrical potentials). Note that current and voltage electrodes differ only by that to which they are connected (i.e. current source or microvolt meter, respectively.) Modern systems use arrays of electrodes (connected to multi-channel cables and an automated electrode-switching/recording system) to take measurements from electrodes at different locations and spacings (which adjusts the survey depth and resolution). Electrodes are hand-pushed into the ground surface along desired survey profiles.

Or (innovative "capacitively-coupled electrode" method):

Straight-wire capacitors which are capable of driving subsurface electrical currents and measuring surface potentials. The wire lengths and the distance between wires can be varied to adjust the survey depth and resolution. Capacitors are encased in torpedo-like protectors between the wire lengths, and the entire array (similar to a swimming rope with flotation buoys) is hand- or vehicle-towed along desired survey profiles.



Introduction to Electrical Imaging Page 2

Common Applications

Electrical imaging produces color-contour cross sections (commonly called electrical images) of subsurface electrical resistivity variations. These images can depict a target that has a different electrical resistivity from its surroundings, such as: buried wastes (pits, trenches, etc.); conductive groundwater plumes; resistive hydrocarbon plumes; foundation elements; water-bearing or mineralized faults or fractures; clay seams in bedrock; soil moisture anomalies; soil voids; clay layers bounded by sand or sand lenses bounded by clay; the top of competent (non-water-bearing) rock.

Principles

Electrical imaging can be performed by driving a harmless, very low amperage (e.g. 1 milliamp) DC electrical current in the ground between two steel spike electrodes. The depth to which the current flows is dictated by the separation of the two electrodes, and by the resistivity of subsurface materials. The flow of electrical current is mapped by measuring the electrical potential at various points of the ground surface using a very high impedance microvolt meter. Data suitable for determining a cross-sectional electrical image can be collected by taking many voltage readings with differing current electrode separations (i.e. different effective measurement depths) using different current electrode positions and voltage electrode positions (i.e. different locations along a profile). A two-dimensional image or cross-section is produced by employing electrodes in a linear array. Three-dimensional images (or color-contoured blocks of data) can be calculated using multiple linear arrays or grids of electrodes. The field-measured voltages, together with associated electrode positions, are mathematically inverted to provide the statistically best-fitting model of the subsurface resistivity distribution.

Electrical imaging can also be performed using straight-wire capacitors to drive currents and measure voltages. In this case, the length of the transmitter wire and the separation between the transmitter and receiver wires dictate the effective survey depth. Two- or three-dimensional data is collected by varying the lengths and separations of the transmitter and receiver capacitor wires for a given survey profile (i.e. the same profile is traversed several times using different wire lengths and separations). Introduction to Electrical Imaging Page 3

Capabilities

Electrical imaging can detect and delineate a target that has a different electrical resistivity from its surroundings. Particularly good targets for electrical imaging include: electrically conductive clay seams, and water-bearing or mineralized faults or fractures in resistive bedrock; electrically resistive hydrocarbon plumes in moist electrically conductive soils; highly conductive electrolytic groundwater plumes (e.g. leachate or saltwater intrusion); highly conductive or resistive wastes buried in "normal" soils; soil moisture anomalies (e.g. dam seepage or incipient sinkholes).

Where site conditions allow, capacitively-coupled electrode systems can collect greater quantities of data in a given time (or at a given cost) than the traditional steel spike systems. The capacitive systems can also be used on asphalt pavement (where steel spike systems would require drilling many electrode holes).

Limitations

Electrical resistivities of differing materials have wide and overlapping ranges, making it impossible to positively identify a subsurface material based on its resistivity alone. For instance, profiling of the top-of-rock can be done by electrical imaging, but it is often difficult to specify exactly what resistivity contour corresponds with the top of rock (particularly where there is a weathering or saprolite zone). Since electrical resistivity (unlike seismic velocity) does not correlate with rippability or density, it is not typically the method of choice for rock profiling.

Based largely on a single well-publicized incident, electrical imaging has been promoted (by others) as a method for detecting bedrock cavities. However, since an air-filled cavity and competent rock are both electrical resistors, many cavities are not detectable using electrical methods (in this case, gravity would be the method of choice since air and competent rock have very different densities).

Electrical imaging data is susceptible to interference from underground utilities that capture and channel the subsurface current flow. This can be minimized in twodimensional surveys by orienting the trace of an image perpendicular to any existing utilities.

Capacitively-coupled electrode systems suffer loss of signal penetration depth in highly conductive terranes. In addition, they are difficult to use in rugged or brushy terrain.

Survey depths using steel spike electrode systems can be limited by high contact resistances between the spikes and highly resistive surficial material.