



August 29, 2018

Office of the County Manager  
215 N. Main Street  
Waynesville, NC 28786

Attention: Mr. David B. Francis  
Program Administrator

Subject: **BORROW MATERIAL EVALUATION**  
Dennis Farm Road Property – Site A  
Jonathan Creek Soil Reclamation Project  
Waynesville, North Carolina  
BLE Project No. J18-12047-01

Dear Mr. Francis:

Bunnell-Lammons Engineering, Inc. (BLE) is pleased to present this report for borrow material evaluation for the Jonathan Creek project. This report has been performed in general accordance with BLE Proposal No. P17-1060 dated April 30, 2018 and change order #2 dated April 30, 2018 and approved on July 20, 2018 by Mr. James W. Kirkpatrick, III. The purpose of this report was to provide information on the soil conditions at Site A that could be used as potential borrow material. Project information was provided to us by correspondence with Mr. David Francis with Haywood County and Andy Alexander, P.G., with BLE and a grading exhibit provided by McGill Associates, our previous exploration report dated April 5, 2018 and our site observations.

#### **PROJECT INFORMATION**

We understand that Haywood County is considering obtaining off-site fill soils to raise the Jonathan Creek site in Waynesville, North Carolina. The Dennis Farm Road property (Site A) in Waynesville, North Carolina is currently being considered as a source for potential fill materials. The proposed borrow site is a cow pasture across Highway 276 from the Johnathan Creek site and is approximately 4 acres in size. The site generally consists of sloping terrain that consist of grass covered ground with scattered underbrush along the edges of the pasture. BLE initially performed eight test pit excavations at the site along with laboratory testing of the soils potential for re-use as fill material. However, due to the limited reach of the provided track-hoe, the exploration was limited to depths of between 6 and 8 feet. Based on this limited data collected, soil test borings were requested to evaluate the deeper soils within the proposed borrow area.

**SURFACE CONDITIONS**

Site conditions were observed by Mr. Sam C. Interlicchia during a site reconnaissance on August 7, 2018. The site is currently being used for agricultural purposes and appears to be mostly used as pasture land for cattle. The site is a vacant, cleared, grassy field. The terrain in the vicinity of the borrow site generally slopes downward from the east to the west. There is approximately 70 feet of elevation relief across the property. There are two slight cross ridges and one valley/swale trending down the principal slope direction. The slope varies, having inclination between 3H:1V and 1½ H:1V. No springs or surface water was observed on the site at the time of our visit. However, the ground surface was noted to be soggy under foot traffic, which was most likely caused by recent precipitation.

**FIELD EXPLORATION**

The site was explored by performing eight (8) soil test borings at the approximate locations shown on the attached Boring Location Plan (reference Figure 1). The soil test borings were performed using a truck-mounted drill rig turning 2-1/4 inch I.D. hollow-stem augers. The soil test borings ranged in depth from 20 feet to 25 feet (boring termination) below the existing ground surface. Soil samples were obtained in accordance with ASTM D 1586 by driving a 1-3/8 inch I.D. split-spoon sampler with a 140-pound safety hammer. The boring locations were established in the field by BLE personnel using point coordinates developed for the provide drawing and a hand-held GPS unit with 3 to 5 meter accuracy. As such, the boring locations referenced in this report and shown on the figures and field records should be considered approximate. The Soil Test Boring Records and a description of our field procedures are attached to this report. Bulk samples were collected at selected depths for laboratory testing. The laboratory results are present in the Appendix.

**SUBSURFACE CONDITIONS**

The descriptions below provide a general summary of the subsurface conditions encountered. The appended test boring records contain detailed information recorded at each boring location. These represent our interpretation of subsurface conditions based on engineering examination of the field samples. The lines designating the interfaces between various strata represent approximate boundaries and the transition between strata may be gradual. It should be noted that the soil conditions will vary between boring locations

The surface materials on-site generally consist of an approximate 6-inch-thick layer of grass and organic-laden topsoil. Beneath this surface material, the soil test borings encountered residual soils. The residual soils were found to consist of loose to very firm residual soil typical of the Blue Ridge Physiographic Province. The residual soils predominantly consisted of sandy silt and silty sands. Standard penetration resistance (blow counts, N values) ranged from 8 to 31 blows per foot, typically becoming firmer with depth. All eight soil test borings were terminated in residual soil.

Groundwater was not encountered by the borings at the time of drilling or when the borings were backfilled. Because the borings were located in an area being currently used as a pasture, the borings were backfilled shortly after drilling, thus precluding 24-hour groundwater level measurements. Groundwater elevations at the site can be expected to fluctuate several feet with seasonal and rainfall variations and may fluctuate due to construction activity. Normally, the highest ground-water levels occur in late winter and spring and the lowest levels occur in late summer and fall. On completion of drilling and after checking for the presence of water, the boreholes were backfilled with auger cuttings, a hole plug inserted.



**LABORATORY RESULTS**

Soil samples were obtained from soil test boring B-2, B-4, B-6 and B-8 and were processed for laboratory testing at the BLE laboratory. Samples were collected from auger cuttings brought to the surface by augers. The laboratory testing performed on the selected soil samples is described below, the results of which are summarized in Table 1 below.

- Natural moisture content: The moisture content of the soil is the ratio, expressed as a percentage, of the weight of water in a given mass of soil to the weight of the soil particles and was determined in accordance with ASTM D 2216.
- A moisture-density relationship test (standard Proctor) was performed to determine compaction characteristics, including the maximum dry density and optimum moisture content. The results are presented on the attached Moisture Density Relationship Test report in the Appendix.

The soil samples collected were generally classified as silty sands with low plasticity (SM), and were found to have natural moisture contents slightly above the laboratory determined optimum moisture content (see Table 1 below). It should be noted that moisture contents on a large grading project will be dictated to some degree by the prevailing weather at the time of construction.

Table 1 - Laboratory Test Results

Sample ID.	Boring No.	Sample Depth (feet)	Natural Moisture (%)	Maximum Dry Density (pcf)	Optimum Moisture Content (%)
S-1	B-2	10 to 15	18.4	102.1	16.8
S-2	B-4	10 to 15	19.9	101.2	20.5
S-3	B-6	5 to 10	21.3	101.5	19.5
S-4	B-8	1 to 5	21.6	99.8	21.4

**PRELIMINARY RECOMMENDATIONS**

The primary geotechnical considerations for the proposed project were the suitability of the soils for re-use as fill and the potential to encounter rock during excavation. Based on the boring data, the soils encountered in the soil test borings should be excavatable using conventional earthmoving equipment. It was anticipated that the excavated soil would be used to raise the site grade for another nearby site. Based on the soil test boring data, the borrow soil is suitable for use as structural fill material. The laboratory data indicates that the soils are within plus or minus 3 percent of the optimum moisture content. However, it should be noted that moisture contents on a grading project will be dictated to some degree by the prevailing weather at the time of construction.

Engineered Soil Fill

Based upon our visual examination, limited laboratory testing and experience with similar soil types, the on-site residual soils appear to be generally suitable for use as structural fill. Fill should be spread and compacted in horizontal lifts that are 8 inches or less in thickness. Fill should be uniformly compacted in thin lifts to at least 95 percent of the standard Proctor (ASTM D-698) maximum dry density. In addition, the upper 18 inches of subgrade should be compacted to at least 98 percent of the maximum dry density. As a rule, the moisture content of the fill soils should be maintained within plus or minus 3 percent of the optimum moisture content as determined from the standard compaction test.

This provision may require the contractor to dry soils during periods of wet weather or to wet soils during dry periods. The fill soils should have a Plasticity Index (PI) of less than 30, and a standard Proctor maximum dry density (MDD) of no less than 90 pounds per cubic foot (pcf). Fill soils should contain no more than 3 percent organic matter by weight.

### **LIMITATIONS**

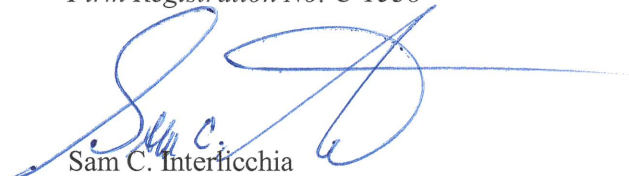
Our evaluation of borrow material has been based on our understanding of the project information and data obtained in our exploration as well as our experience on similar projects. The general subsurface conditions utilized in our evaluation have been based on interpolation of the subsurface data between the widely spaced soil test borings. Subsurface conditions between the borings may differ. If the project information is incorrect or the borrow location has changed, please contact us so that our recommendations can be reviewed. The discovery of any site or subsurface conditions during excavation which deviate from the data obtained in this exploration should be reported to us for our evaluation. All excavations should be in accordance with OSHA regulations. The assessment of site environmental conditions for presence of pollutants in the soil, rock and ground water of the site was beyond the scope of this exploration.

### **CLOSING**

We appreciate the opportunity to provide our professional services on this project. We look forward to providing additional services as the project progresses. If you have any questions regarding this report, please do not hesitate to call us.

Sincerely,

**BUNNELL-LAMMONS ENGINEERING, INC.**  
*Firm Registration No. C-1538*



Sam C. Interficchia  
Project Manager

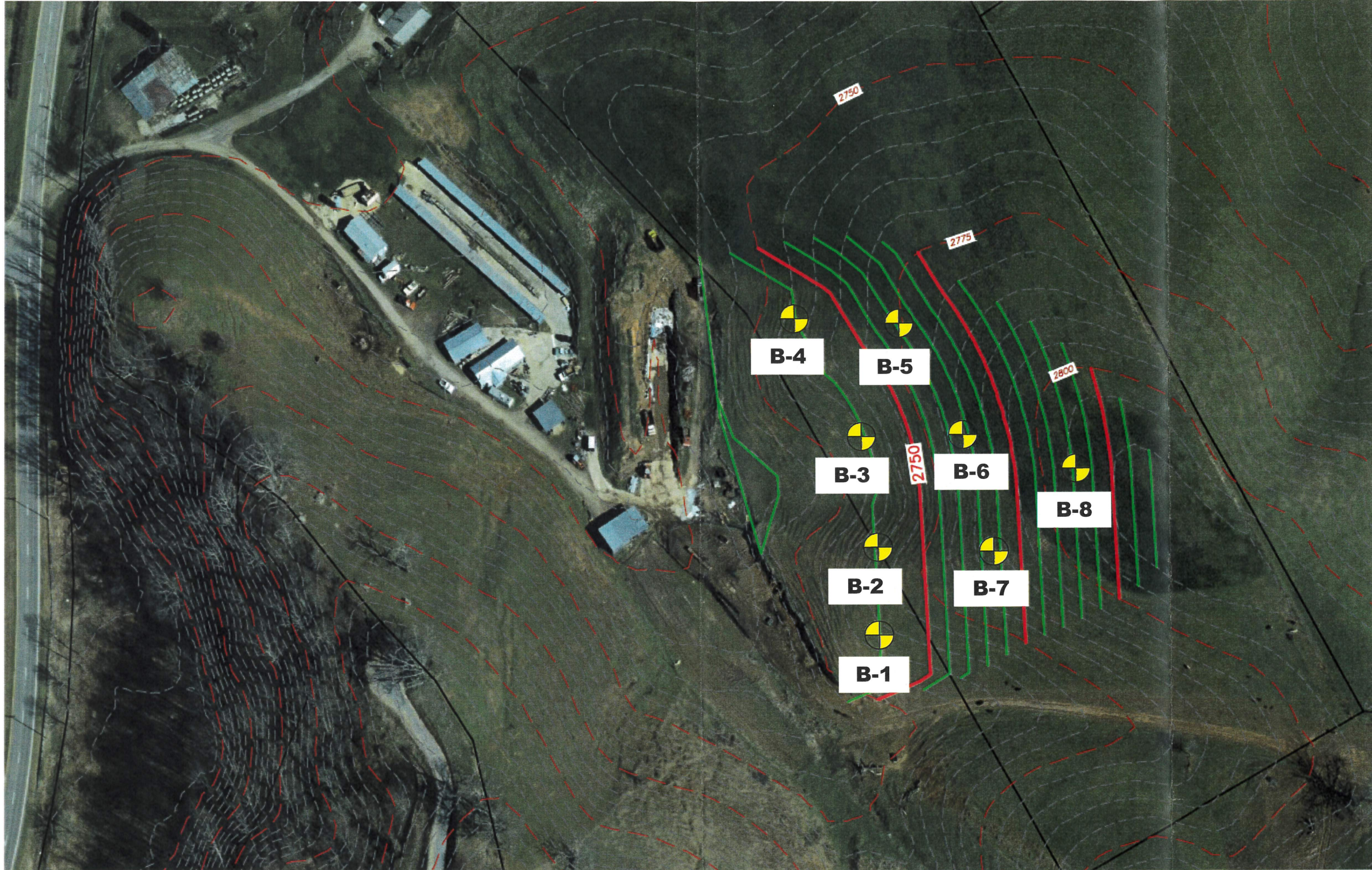



Jesse R. Jacobson, P.E.  
Asheville Branch Manager  
NC Registration No. 030948

### **APPENDIX:**


- Boring Location Plan
- Soil Test Boring Records
- Moisture Density Relationship Test Reports
- Field Exploration Procedures
- Key To Soil Symbols and Classification





 Approximate Soil Test Boring Locations

Reference Drawing: Drawing provided by McGill Associates

Drawn By: SCI	Date: 8/27/2018	Revisions			 <b>BUNNELL-LAMMONS ENGINEERING, INC.</b> <small>GEOTECHNICAL, ENVIRONMENTAL, AND CONSTRUCTION MATERIALS CONSULTANTS</small> <small>130 OVAL ROAD, SUITE 200 • ARDEN, NORTH CAROLINA 28704 • (828) 277-0100</small>	Boring Location Plan Dennis Hall Property Waynesville, North Carolina	Figure No. <b>1</b>
		No.	Description	By			
Checked By: JRJ	Job No: J18-12047-01						





# SOIL BORING NO. B-1

**BUNNELL-LAMMONS  
ENGINEERING, INC.**  
GEOTECHNICAL AND ENVIRONMENTAL  
CONSULTANTS

PROJECT: Dennis Hall Property  
 CLIENT: Haywood County  
 LOCATION: Waynesville, NC  
 DRILLER: METRO DRILL, INC., Tim & Ryan  
 DRILLING METHOD: CME-45, 2 1/2" Hollow Stem Auger  
 DEPTH TO - WATER> INITIAL: ∇ AFTER 24 HOURS: ∇ CAVING> ⊗

PROJECT NO.: J18-12047-01  
 START: 08/08/18 END: 08/08/18  
 ELEVATION: \_\_\_\_\_  
 LOGGED BY: S. Interlicchia

ELEVATION/ DEPTH (FT)	SOIL DESCRIPTION	SOIL TYPE	SAMPLES	STANDARD PENETRATION RESULTS BLOWS/FOOT																
				2	5	10	20	30	40	50	70	90								
5	Firm, light red, slightly micaceous, silty fine to medium SAND (SM) - (residuum)		5 6 6																	
10	Firm to very firm, light red to dark red, micaceous to very micaceous, silty fine to medium SAND (SM)		7 9 11																	
15			9 9 9																	
20			8 11 13																	
25	Boring terminated at 25 feet. No groundwater encountered at time of boring.		9 13 16																	
			10 10 14																	

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# SOIL BORING NO. B-3

**BUNNELL-LAMMONS  
ENGINEERING, INC.**  
GEOTECHNICAL AND ENVIRONMENTAL  
CONSULTANTS

PROJECT: Dennis Hall Property  
 CLIENT: Haywood County  
 LOCATION: Waynesville, NC  
 DRILLER: METRO DRILL, INC., Tim & Ryan  
 DRILLING METHOD: CME-45, 2 1/2" Hollow Stem Auger  
 DEPTH TO - WATER> INITIAL: ▽ AFTER 24 HOURS: ▽

PROJECT NO.: J18-12047-01  
 START: 08/08/18 END: 08/08/18  
 ELEVATION: \_\_\_\_\_  
 LOGGED BY: S. Interlicchia

DEPTH TO - WATER> INITIAL: ▽ AFTER 24 HOURS: ▽ CAVING>

ELEVATION/ DEPTH (FT)	SOIL DESCRIPTION	SOIL TYPE	SAMPLES		STANDARD PENETRATION RESULTS BLOWS/FOOT														
			4-5	5-6	2	5	10	20	30	40	50	70	90						
5	Loose to firm, reddish brown, slightly micaceous, silty fine to medium SAND (SM) - (residuum)		4	5															
			5	6															
			6	8															
			8	9															
10	Loose to firm, reddish brown, slightly micaceous, silty fine to medium SAND (SM) - (residuum)		6	9															
			6	6															
15	Loose to firm, reddish brown, slightly micaceous, silty fine to medium SAND (SM) - (residuum)		6	9															
			6	7															
			7	9															
20	Very firm, light tan, very micaceous, silty fine to medium SAND (SM)		8	11															
			11	13															
25	Very firm, light tan, very micaceous, silty fine to medium SAND (SM)		9	14															
			14	13															
	Boring terminated at 25 feet. No groundwater encountered at time of boring.																		



# SOIL BORING NO. B-4

**BUNNELL-LAMMONS  
ENGINEERING, INC.**  
GEOTECHNICAL AND ENVIRONMENTAL  
CONSULTANTS

PROJECT: Dennis Hall Property  
 CLIENT: Haywood County  
 LOCATION: Waynesville, NC  
 DRILLER: METRO DRILL, INC., Tim & Ryan  
 DRILLING METHOD: CME-45, 2 1/2" Hollow Stem Auger  
 DEPTH TO - WATER> INITIAL: ▽ AFTER 24 HOURS: ▽ CAVING> ⊗

PROJECT NO.: J18-12047-01  
 START: 08/08/18 END: 08/08/18  
 ELEVATION: \_\_\_\_\_  
 LOGGED BY: S. Interlicchia

ELEVATION/ DEPTH (FT)	SOIL DESCRIPTION	SOIL TYPE	SAMPLES	STANDARD PENETRATION RESULTS BLOWS/FOOT																				
				2	5	10	20	30	40	50	70	90												
5	Firm, reddish brown, slightly micaceous to micaceous, silty fine to medium SAND (SM) - (residuum)		6 6 7																					
10	Firm to very firm, light reddish brown, very micaceous, silty fine to medium SAND (SM)		7 8 10																					
15			8 8 9																					
20			4 5 6																					
25	Boring terminated at 25 feet. No groundwater encountered at time of boring.		5 6 6																					
25			9 10 12																					

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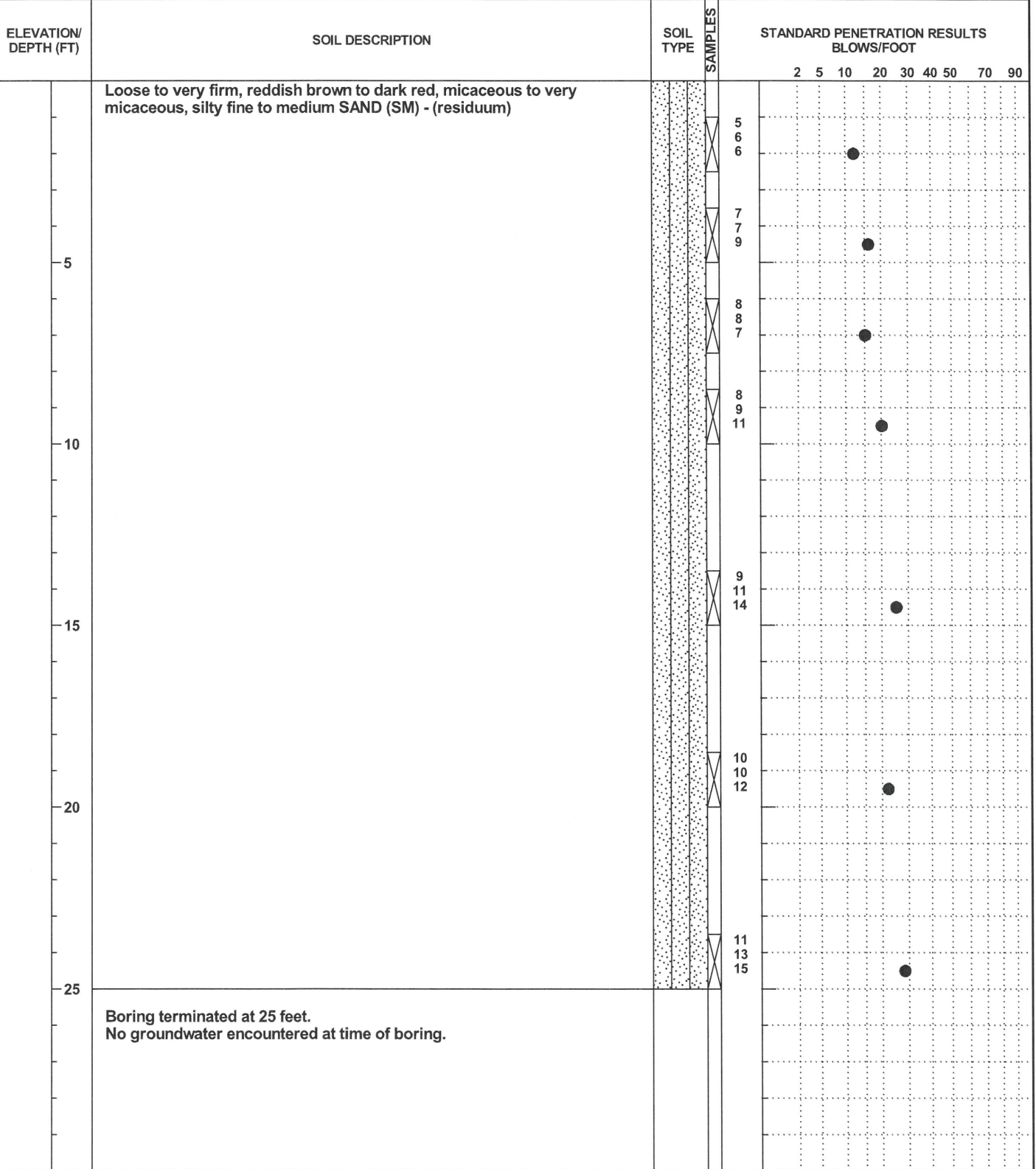
# SOIL BORING NO. B-5

**BUNNELL-LAMMONS  
ENGINEERING, INC.**  
GEOTECHNICAL AND ENVIRONMENTAL  
CONSULTANTS

PROJECT: Dennis Hall Property  
CLIENT: Haywood County  
LOCATION: Waynesville, NC  
DRILLER: METRO DRILL, INC., Tim & Ryan  
DRILLING METHOD: CME-45, 2 1/2" Hollow Stem Auger  
DEPTH TO - WATER> INITIAL: ▽ \_\_\_\_\_ AFTER 24 HOURS: ▽ \_\_\_\_\_

PROJECT NO.: J18-12047-01  
START: 08/08/18 END: 08/08/18  
ELEVATION: \_\_\_\_\_  
LOGGED BY: S. Interlicchia

CAVING> ☒ \_\_\_\_\_



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### SOIL BORING NO. B-6

**BUNNELL-LAMMONS  
ENGINEERING, INC.**  
GEOTECHNICAL AND ENVIRONMENTAL  
CONSULTANTS

PROJECT: Dennis Hall Property  
 CLIENT: Haywood County  
 LOCATION: Waynesville, NC  
 DRILLER: METRO DRILL, INC., Tim & Ryan  
 DRILLING METHOD: CME-45, 2 1/2" Hollow Stem Auger  
 DEPTH TO - WATER> INITIAL: ▽ AFTER 24 HOURS: ▽

PROJECT NO.: J18-12047-01  
 START: 08/08/18 END: 08/08/18  
 ELEVATION: \_\_\_\_\_  
 LOGGED BY: S. Interlicchia

DEPTH TO - WATER> INITIAL: ▽ AFTER 24 HOURS: ▽ CAVING> ⊗

ELEVATION/ DEPTH (FT)	SOIL DESCRIPTION	SOIL TYPE	SAMPLES	STANDARD PENETRATION RESULTS BLOWS/FOOT													
				2	5	10	20	30	40	50	70	90					
5	Firm, light reddish brown, slightly micaceous to micaceous, silty fine to medium SAND (SM) - (residuum)		6 7 7														
10			6 6 7														
15			6 7 9														
20	Very firm, dark red, very micaceous, silty fine to medium SAND (SM)		10 12 15														
25	Boring terminated at 25 feet. No groundwater encountered at time of boring.		10 13 16														



# SOIL BORING NO. B-7

**BUNNELL-LAMMONS  
ENGINEERING, INC.**  
GEOTECHNICAL AND ENVIRONMENTAL  
CONSULTANTS

PROJECT: Dennis Hall Property  
CLIENT: Haywood County  
LOCATION: Waynesville, NC  
DRILLER: METRO DRILL, INC., Tim & Ryan  
DRILLING METHOD: CME-45, 2 1/2" Hollow Stem Auger  
DEPTH TO - WATER> INITIAL: ▽ AFTER 24 HOURS: ▽

PROJECT NO.: J18-12047-01  
START: 08/08/18 END: 08/08/18  
ELEVATION: \_\_\_\_\_  
LOGGED BY: S. Interlicchia

DEPTH TO - WATER> INITIAL: ▽ AFTER 24 HOURS: ▽ CAVING> ⊗

ELEVATION/ DEPTH (FT)	SOIL DESCRIPTION	SOIL TYPE	SAMPLES	STANDARD PENETRATION RESULTS BLOWS/FOOT																
				2	5	10	20	30	40	50	70	90								
4	Loose, brown, slightly clayey, silty fine to medium SAND (SM) - (residuum)		4																	
5	Firm to very firm, reddish brown, very micaceous, silty fine to medium SAND (SM)		6																	
8			8																	
10			5																	
15			8																	
20			8																	
25	Boring terminated at 25 feet. No groundwater encountered at time of boring.		9																	

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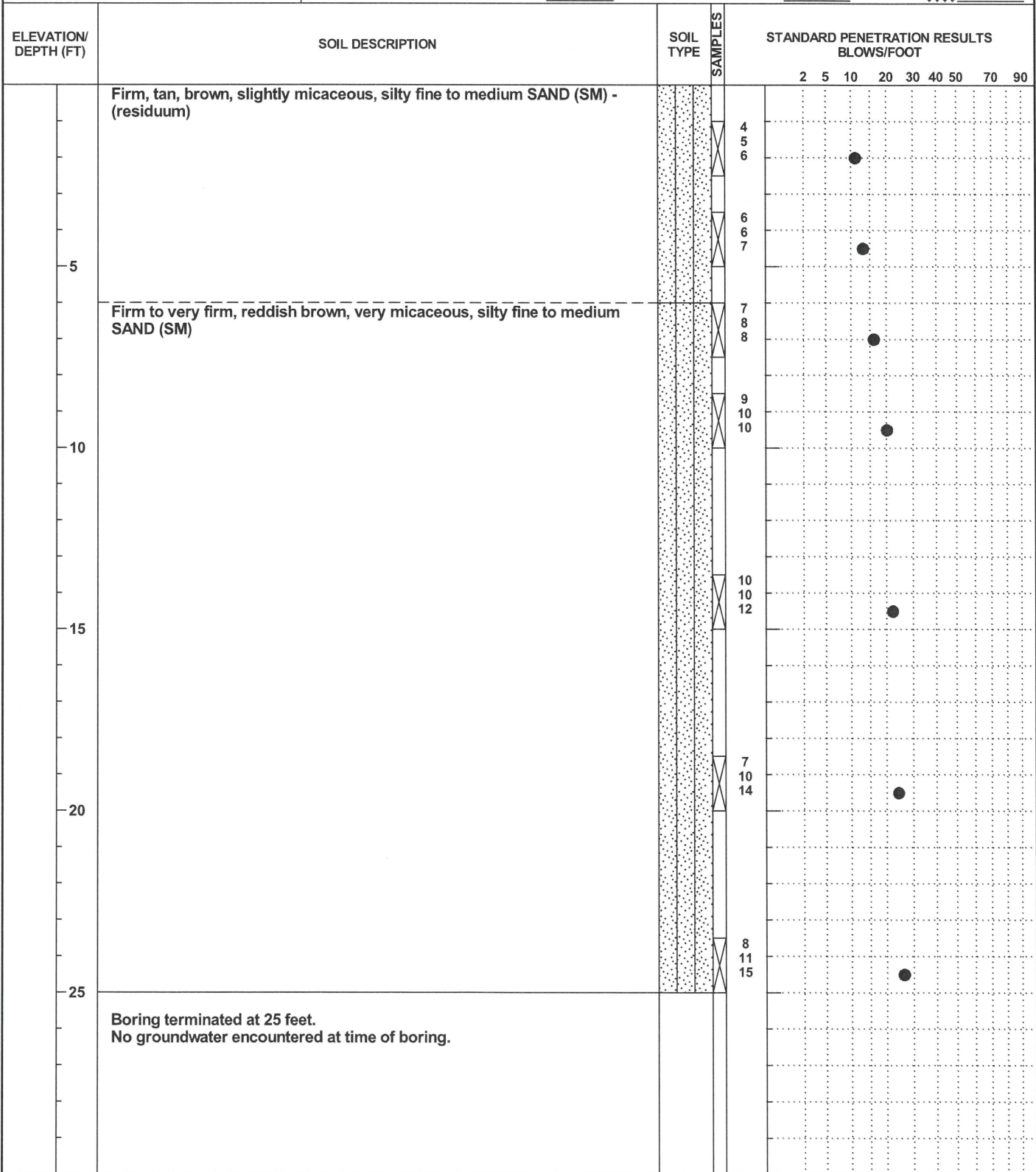


# SOIL BORING NO. B-8

**BUNNELL-LAMMONS  
ENGINEERING, INC.**  
GEOTECHNICAL AND ENVIRONMENTAL  
CONSULTANTS

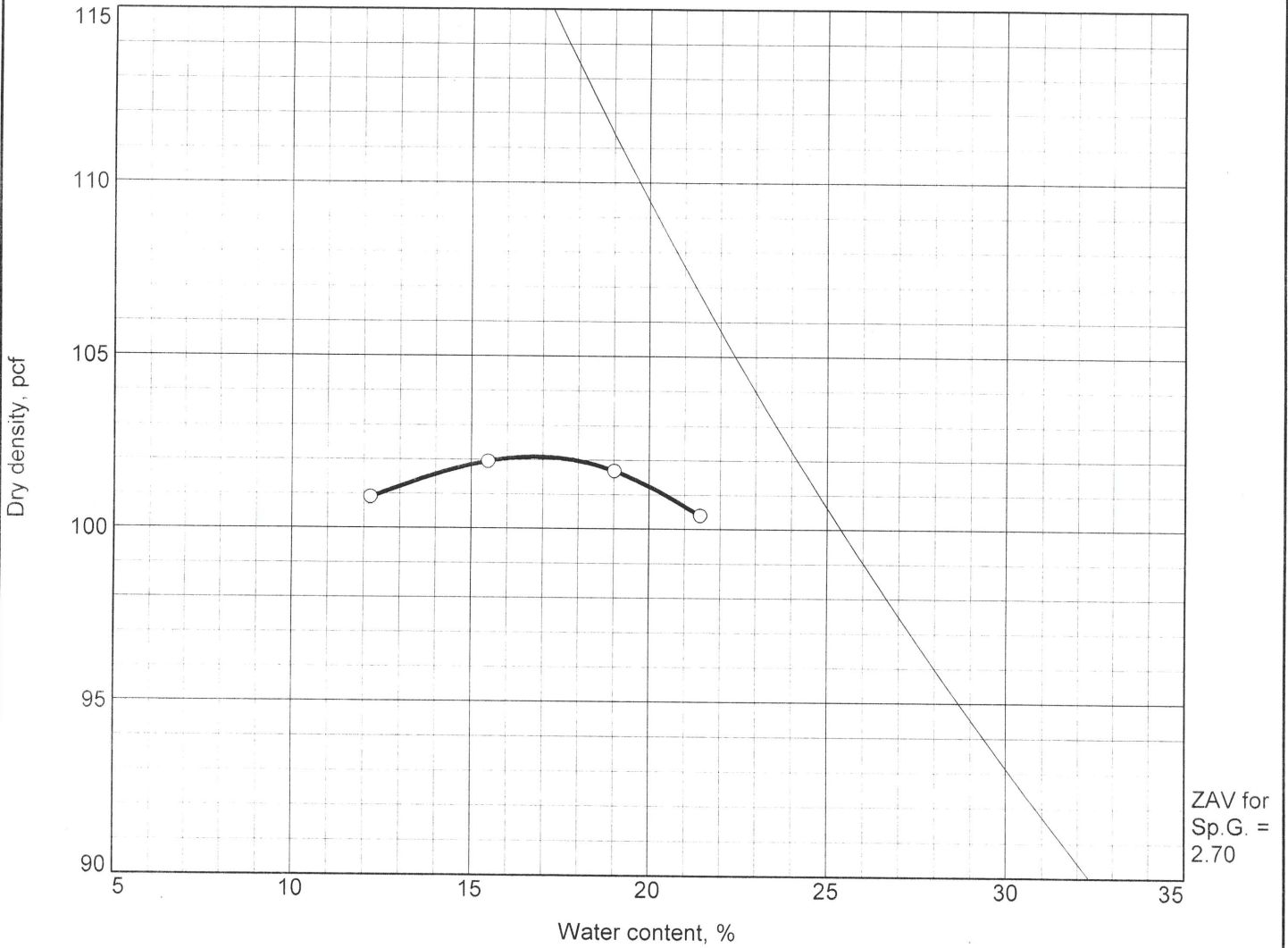
PROJECT: Dennis Hall Property  
 CLIENT: Haywood County  
 LOCATION: Waynesville, NC  
 DRILLER: METRO DRILL, INC., Tim & Ryan  
 DRILLING METHOD: CME-45, 2 1/2" Hollow Stem Auger  
 DEPTH TO - WATER> INITIAL: ▽ AFTER 24 HOURS: ▽ CAVING> ⊗

PROJECT NO.: J18-12047-01  
 START: 08/08/18 END: 08/08/18  
 ELEVATION: \_\_\_\_\_  
 LOGGED BY: S. Interlicchia





# MOISTURE DENSITY RELATIONSHIP TEST REPORT



Test specification: ASTM D 698-00a Method A Standard

Elev/ Depth	Classification		Nat. Moist.	Sp.G.	LL	PI	% > #4	% < No.200
	USCS	AASHTO						
10' - 15'	SM		18.4					

TEST RESULTS	MATERIAL DESCRIPTION
Maximum dry density = 102.1 pcf Optimum moisture = 16.8 %	Reddish brown, very silty fine to medium SAND (SM)

<b>Project No.</b> J17-12047-01 <b>Client:</b> Haywood County <b>Project:</b> Dennis Hall Property Date: 08/17/18 <input type="radio"/> <b>Source of Sample:</b> On Site <b>Sample Number:</b> S-1	<b>Remarks:</b> Boring B-2
<b>BUNNELL-LAMMONS ENGINEERING, INC.</b>  <b>Asheville, North Carolina</b>	

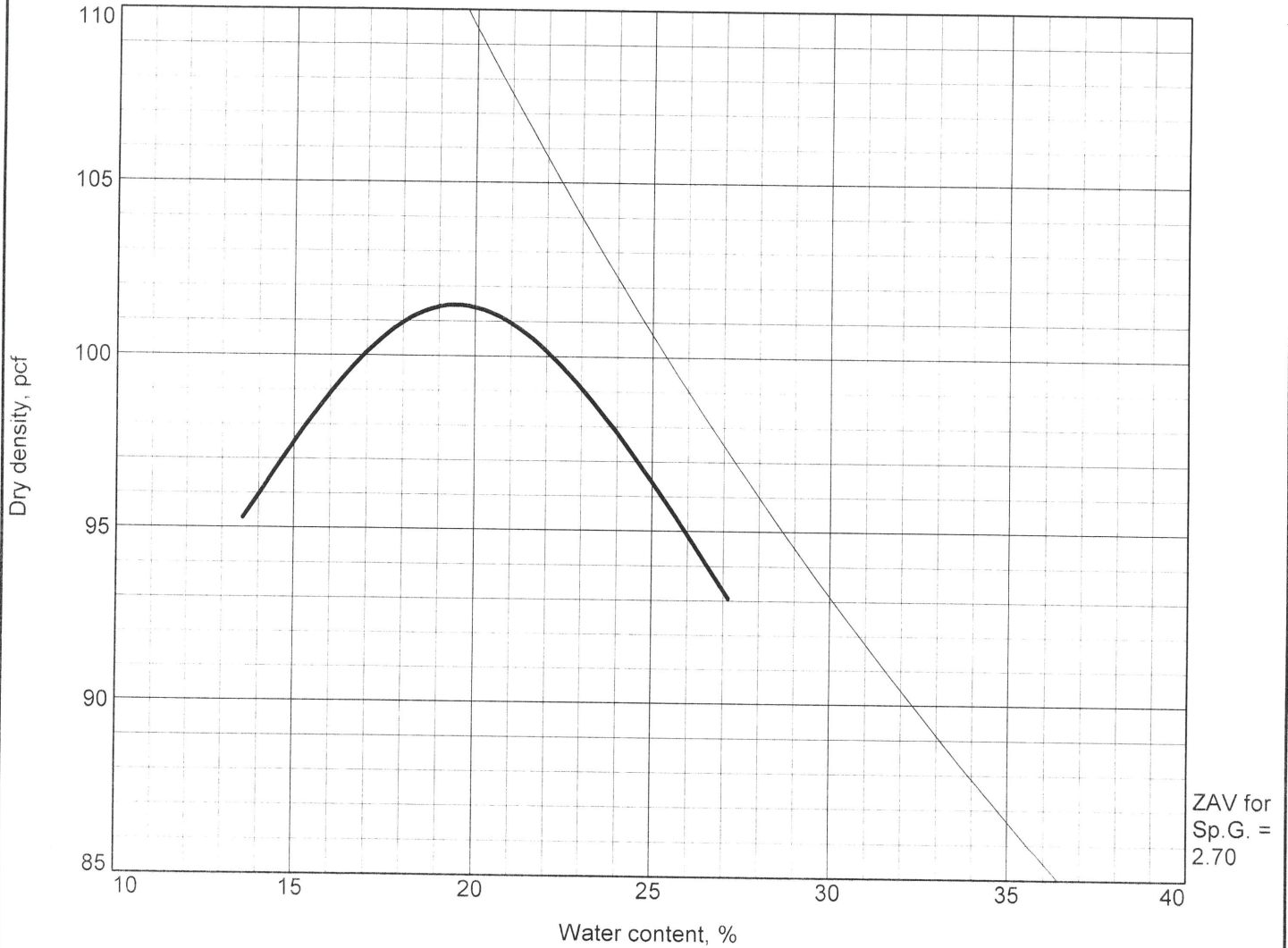
Plate

Tested By: AD

Checked By: PY



# MOISTURE DENSITY RELATIONSHIP TEST REPORT



Test specification: ASTM D 698-00a Method A Standard

Elev/ Depth	Classification		Nat. Moist.	Sp.G.	LL	PI	% > #4	% < No.200
	USCS	AASHTO						
5' - 10'	SM		21.3					

TEST RESULTS	MATERIAL DESCRIPTION
Maximum dry density = 101.5 pcf Optimum moisture = 19.5 %	Reddish brown, silty fine to medium SAND (SM)
Project No. J17-12047-01    Client: Haywood County Project: Dennis Hall Property Date: 8/17/18 Source of Sample: On Site    Sample Number: S-3	Remarks: Boring B-6
<b>BUNNELL-LAMMONS ENGINEERING, INC.</b> Asheville, North Carolina	
	Plate

Tested By: AD \_\_\_\_\_ Checked By: PY \_\_\_\_\_





## **Field Exploration Procedures**

### ***SOIL TEST BORINGS***

The borings were made by mechanically twisting a continuous flight steel auger into the soil. Soil sampling and penetration testing were performed in accordance with ASTM D-1586. At assigned intervals, soil samples were obtained with a standard 1.4-inch I.D., 2-inch O.D., split-tube sampler. The sampler was first seated 6 inches to penetrate any loose cuttings, and then driven an additional 12 inches with blows of a 140-pound hammer falling 30 inches. The number of hammer blows required to drive the sampler the final 12 inches was recorded and is designated the "standard penetration resistance." The penetration resistance, once properly evaluated, is an index to the strength of the soil and foundation supporting capability. Representative portions of the soil samples, thus obtained, were placed in glass jars and transported to the laboratory. In the laboratory, the samples were examined by a geotechnical engineer and visually classified. Soil Test Boring Records are attached showing the soil descriptions and penetration resistance.



# KEY TO SOIL CLASSIFICATIONS AND CONSISTENCY DESCRIPTIONS

BUNNELL-LAMMONS ENGINEERING, INC.  
ASHEVILLE, NORTH CAROLINA

## Penetration Resistance\* Blows per Foot

SANDS

0 to 4  
5 to 10  
11 to 20  
21 to 30  
31 to 50  
over 50

## Relative Density

Very Loose  
Loose  
Firm  
Very Firm  
Dense  
Very Dense

## Particle Size Identification

Boulder: Greater than 300 mm  
Cobble: 75 to 300 mm  
Gravel:  
Coarse - 19 to 75 mm  
Fine - 4.75 to 19 mm  
Sand:  
Coarse - 2 to 4.75 mm  
Medium - 0.425 to 2 mm  
Fine - 0.075 to 0.425 mm  
Silt & Clay: Less than 0.075 mm

## Penetration Resistance\* Blows per Foot

SILTS and CLAYS

0 to 2  
3 to 4  
5 to 8  
9 to 15  
16 to 30  
31 to 50  
over 50

## Consistency

Very Soft  
Soft  
Firm  
Stiff  
Very Stiff  
Hard  
Very Hard

12 Number of blows in first 6-inches  
15 Number of blows in second 6-inches  
16 Number of blows in third 6-inches

\*ASTM D 1586

## KEY TO DRILLING SYMBOLS



Grab Sample



Split Spoon Sample



Undisturbed Sample



Groundwater Table at Time of Drilling

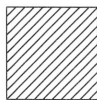


Groundwater Table 24 Hours after Completion of Drilling

## KEY TO SOIL CLASSIFICATIONS



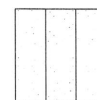
Well-graded Gravel  
GW



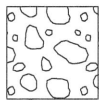
Low Plasticity Clay  
CL



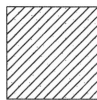
Clayey Silt  
MH



Silty Sand  
SM



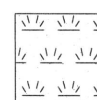
Poorly-graded Gravel  
GP



Sandy Clay  
CLS



Sandy Silt  
MLS



Topsoil  
TOPSOIL



Partially Weathered Rock  
BLDRCBBL



Silty Clay  
CL-ML



Sand  
SW



Bedrock  
BEDROCK



High Plasticity Clay  
CH



Silt  
ML



Clayey Sand  
SC



Concrete  
A5