



# ECS Southeast, LLC

Report of Culvert Foundation Design Recommendations

**Culvert No. 522 on 9<sup>th</sup> Street over Tomahawk Branch**

Black Mountain, Buncombe County, North Carolina

WBS No.: 49469.1.1

TIP No: HL-0013

ECS Project No. 31:4437

January 5, 2024





# ECS SOUTHEAST, LLC

Geotechnical • Construction Materials • Environmental • Facilities

NC Engineering License No. F-1519

January 5, 2024

Mr. Ryan Shipman, P.E.  
JMT – Johnson, Mirmiran & Thompson, Inc.  
1318-F Patton Avenue  
Asheville, North Carolina 28806

ECS Project No. 31:4437

Reference: Culvert Foundation Design Recommendations  
**Culvert No. 522 on 9<sup>th</sup> Street over Tomahawk Branch**  
WBS No: 49469.1.1  
TIP No: HL-0013  
County: Buncombe

Dear Mr. Shipman:

ECS Southeast, LLC (ECS) is pleased to submit the attached Culvert Foundation Design Recommendations Report associated with the design and construction of the bridge replacement to box culvert project on 9<sup>th</sup> Street over Tomahawk Branch in Black Mountain, Buncombe County, North Carolina. This work was performed in general accordance with Task Order No. 1 of the Subcontract Agreement between ECS and JMT, executed on March 13, 2023.

Our design is based on project information provided to us by JMT. This report contains the foundation recommendations, the Structure Subsurface Investigation Report, and supporting calculations.

ECS Southeast, LLC appreciates the opportunity to assist you during this phase of the project. If you have questions concerning this report, please contact our office at 704-525-5152.

Respectfully submitted,

**ECS Southeast, LLC**



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ECS New York Engineering, PLLC - An Associate of ECS Group of Companies • [www.ecslimited.com](http://www.ecslimited.com)

"ONE FIRM. ONE MISSION."

# FOUNDATION RECOMMENDATIONS

WBS #	49469.1.1	DESCRIPTION <u>Double 13' x 7' RCBC on 9th Street over</u>
		<u>Tomahawk Branch</u>
TIP NO.	HL-0013	
COUNTY	BUNCOMBE	
STATION	13+21.02	

	INITIALS	DATE
DESIGN	MJW	Jan-24
CHECK	KND	Jan-24
REVISED		



STRUCTURE	STATION	FOUNDATION TYPE	FACTORED RESISTANCE	MISCELLANEOUS DETAILS
2 @ 13' x 7' RCBC	13+21.02 -L-	Reinforced Concrete Box Culvert on Foundation Blanket	3.0 KSF	Invert Elevation at Centerline: 2,356.4 +/- ft

### NOTES ON PLANS:

- 1) FOR BOX CULVERT EXCAVATION, SEE SECTION 414 OF THE STANDARD SPECIFICATIONS.
- 2) THE REINFORCED CONCRETE BOX CULVERT SHALL BE PLACED ON THE STANDARD 1.0 FOOT BLANKET OF FOUNDATION CONDITIONING MATERIAL.
- 3) THE FACTORED BEARING CAPACITY AT THE BASE OF THE CULVERT IS 3.0 KSF. VERIFY A BEARING RESISTANCE OF 6.7 KSF PRIOR TO THE PLACEMENT OF FOUNDATION CONDITIONING MATERIAL. THE ENGINEER SHALL DETERMINE THE NEED FOR UNDERCUTTING AT THE TIME OF CONSTRUCTION.
- 4) AS A CONTINGENCY ITEM, WE RECOMMEND A QUANTITY OF 60 CUBIC YARDS OF UNDERCUT AND AN ADDITIONAL 60 CUBIC YARDS OF FOUNDATION CONDITIONING MATERIAL TO BE USED AS BACKFILL FOR AREAS OF UNDERCUT OF SOFT / ALLUVIAL SOILS, AS DETERMINED BY THE ENGINEER.
- 5) IN LIEU OF UNDERCUTTING, A LAYER OF TYPE V GEOTEXTILE CAN BE PLACED AT THE BOTTOM OF THE EXCAVATION PRIOR TO THE PLACEMENT OF FOUNDATION CONDITIONING MATERIAL. WE RECOMMEND A CONTINGENCY QUANTITY OF 90 SQUARE YARDS OF TYPE V GEOTEXTILE BE INCLUDED IN THE CONTRACT TO BE USED AT THE DISCRETION OF THE ENGINEER.

### COMMENTS:

- 1) RECOMMENDATIONS ARE BASED ON THE BORING INFORMATION OBTAINED AT TWO (2) SOIL TEST BORING ON EITHER SIDE OF THE CULVERT. ACTUAL SUBSURFACE CONDITIONS AT THE TIME OF CONSTRUCTION MAY BE DIFFERENT.
- 2) THE CONTRACTOR SHOULD BE PREPARED TO PROVIDE TEMPORARY DEWATERING DURING CONSTRUCTION.

**CULVERT No. 522 ON 9<sup>th</sup> STREET OVER TOMAHAWK BRANCH**

**FOUNDATION RECOMMENDATIONS  
SUPPORTING DOCUMENTATION**

STATE	STATE PROJECT REFERENCE NO.	SHEET NO.	TOTAL SHEETS
N.C.	HL-0013	1	

**STATE OF NORTH CAROLINA  
DEPARTMENT OF TRANSPORTATION  
DIVISION OF HIGHWAYS  
GEOTECHNICAL ENGINEERING UNIT**

**STRUCTURE  
SUBSURFACE INVESTIGATION**

COUNTY BUNCOMBE  
PROJECT DESCRIPTION REPLACE BRIDGE NO. 522 TO  
BOX CULVERT ON NINTH STREET OVER  
TOMAHAWK BRANCH  
SITE DESCRIPTION -L- STA. 13 + 21.02

**REFERENCE: HL-0013**

**PROJECT: 49469**

**CONTENTS**

<u>SHEET NO.</u>	<u>DESCRIPTION</u>
1	TITLE SHEET
2, 2A	LEGEND (SOIL & ROCK)
3	SITE PLAN
4-5	BORE LOGS
6	SOIL TEST RESULTS

PERSONNEL  
A. BLACKMORE  
C. OSBORNE

INVESTIGATED BY ECS SOUTHEAST, LLC  
DRAWN BY K. DE MONTBRUN, P.E.  
CHECKED BY M. WALKO, P.E.  
SUBMITTED BY ECS SOUTHEAST, LLC  
DATE JANUARY 2024

**CAUTION NOTICE**

THE SUBSURFACE INFORMATION AND THE SUBSURFACE INVESTIGATION ON WHICH IT IS BASED WERE MADE FOR THE PURPOSE OF STUDY, PLANNING AND DESIGN, AND NOT FOR CONSTRUCTION OR PAY PURPOSES. THE VARIOUS FIELD BORING LOGS, ROCK CORES AND SOIL TEST DATA AVAILABLE MAY BE REVIEWED OR INSPECTED IN RALEIGH BY CONTACTING THE N. C. DEPARTMENT OF TRANSPORTATION, GEOTECHNICAL ENGINEERING UNIT AT (919) 707-6850. THE SUBSURFACE PLANS AND REPORTS, FIELD BORING LOGS, ROCK CORES AND SOIL TEST DATA ARE NOT PART OF THE CONTRACT.

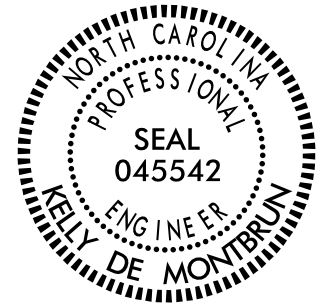
GENERAL SOIL AND ROCK STRATA DESCRIPTIONS AND INDICATED BOUNDARIES ARE BASED ON A GEOTECHNICAL INTERPRETATION OF ALL AVAILABLE SUBSURFACE DATA AND MAY NOT NECESSARILY REFLECT THE ACTUAL SUBSURFACE CONDITIONS BETWEEN BORINGS OR BETWEEN SAMPLED STRATA WITHIN THE BOREHOLE. THE LABORATORY SAMPLE DATA AND THE IN SITU (IN-PLACE) TEST DATA CAN BE RELIED ON ONLY TO THE DEGREE OF RELIABILITY INHERENT IN THE STANDARD TEST METHOD. THE OBSERVED WATER LEVELS OR SOIL MOISTURE CONDITIONS INDICATED IN THE SUBSURFACE INVESTIGATIONS ARE AS RECORDED AT THE TIME OF THE INVESTIGATION. THESE WATER LEVELS OR SOIL MOISTURE CONDITIONS MAY VARY CONSIDERABLY WITH TIME ACCORDING TO CLIMATIC CONDITIONS INCLUDING TEMPERATURES, PRECIPITATION AND WIND, AS WELL AS OTHER NON-CLIMATIC FACTORS.

THE BIDDER OR CONTRACTOR IS CAUTIONED THAT DETAILS SHOWN ON THE SUBSURFACE PLANS ARE PRELIMINARY ONLY AND IN MANY CASES THE FINAL DESIGN DETAILS ARE DIFFERENT. FOR BIDDING AND CONSTRUCTION PURPOSES, REFER TO THE CONSTRUCTION PLANS AND DOCUMENTS FOR FINAL DESIGN INFORMATION ON THIS PROJECT. THE DEPARTMENT DOES NOT WARRANT OR GUARANTEE THE SUFFICIENCY OR ACCURACY OF THE INVESTIGATION MADE, NOR THE INTERPRETATIONS MADE, OR OPINION OF THE DEPARTMENT AS TO THE TYPE OF MATERIALS AND CONDITIONS TO BE ENCOUNTERED. THE BIDDER OR CONTRACTOR IS CAUTIONED TO PERFORM INDEPENDENT SUBSURFACE INVESTIGATIONS AND MAKE INTERPRETATIONS AS NECESSARY TO CONFIRM CONDITIONS ENCOUNTERED ON THE PROJECT. THE CONTRACTOR SHALL HAVE NO CLAIM FOR ADDITIONAL COMPENSATION OR FOR AN EXTENSION OF TIME FOR ANY REASON RESULTING FROM THE ACTUAL CONDITIONS ENCOUNTERED AT THE SITE DIFFERING FROM THOSE INDICATED IN THE SUBSURFACE INFORMATION.

- NOTES:
- THE INFORMATION CONTAINED HEREIN IS NOT IMPLIED OR GUARANTEED BY THE N. C. DEPARTMENT OF TRANSPORTATION AS ACCURATE NOR IS IT CONSIDERED PART OF THE PLANS, SPECIFICATIONS OR CONTRACT FOR THE PROJECT.
  - BY HAVING REQUESTED THIS INFORMATION, THE CONTRACTOR SPECIFICALLY WAIVES ANY CLAIMS FOR INCREASED COMPENSATION OR EXTENSION OF TIME BASED ON DIFFERENCES BETWEEN THE CONDITIONS INDICATED HEREIN AND THE ACTUAL CONDITIONS AT THE PROJECT SITE.



**Prepared in the Office of:**  
ECS SOUTHEAST, LLC  
1812 CENTER PARK DRIVE, SUITE D  
CHARLOTTE, NC 28217  
(704) 525-5152 [PHONE]  
(704) 357-0023 [FAX]  
NC REGISTERED  
ENGINEERING  
FIRM # F-1519



DocuSigned by:  
Kelly de Montbrun 1/4/2024  
SIGNATURE DATE  
7BDD9975E22C480

**DOCUMENT NOT CONSIDERED FINAL  
UNLESS ALL SIGNATURES COMPLETED**

**NORTH CAROLINA DEPARTMENT OF TRANSPORTATION**  
**DIVISION OF HIGHWAYS**  
**GEOTECHNICAL ENGINEERING UNIT**  


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**SUBSURFACE INVESTIGATION**  


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**SOIL AND ROCK LEGEND, TERMS, SYMBOLS, AND ABBREVIATIONS**  
**(PAGE 1 OF 2)**

SOIL DESCRIPTION														
SOIL IS CONSIDERED UNCONSOLIDATED, SEMI-CONSOLIDATED, OR WEATHERED EARTH MATERIALS THAT CAN BE PENETRATED WITH A CONTINUOUS FLIGHT POWER AUGER AND YIELD LESS THAN 100 BLOWS PER FOOT ACCORDING TO THE STANDARD PENETRATION TEST (AASHTO T 206, ASTM D1586). SOIL CLASSIFICATION IS BASED ON THE AASHTO SYSTEM. BASIC DESCRIPTIONS GENERALLY INCLUDE THE FOLLOWING: CONSISTENCY, COLOR, TEXTURE, MOISTURE, AASHTO CLASSIFICATION, AND OTHER PERTINENT FACTORS SUCH AS MINERALOGICAL COMPOSITION, ANGULARITY, STRUCTURE, PLASTICITY, ETC. FOR EXAMPLE, VERY STIFF, GRAY, SILTY CLAY, MOIST WITH INTERBEDDED FINE SAND LAYERS, HIGHLY PLASTIC, A-7-6														
SOIL LEGEND AND AASHTO CLASSIFICATION														
GENERAL CLASS.	GRANULAR MATERIALS (≤ 35% PASSING #200)						SILT-CLAY MATERIALS (> 35% PASSING #200)				ORGANIC MATERIALS			
GROUP CLASS.	A-1	A-3	A-2		A-4	A-5	A-6	A-7	A-1, A-2	A-4, A-5				
SYMBOL														
% PASSING #10 #40 #200	50 MX 30 MX 15 MX	50 MX 25 MX	51 MN 10 MX	35 MX	35 MX	35 MX	35 MX	36 MN	36 MN	36 MN	36 MN	GRANULAR SOILS	SILT-CLAY SOILS	MUCK, PEAT
MATERIAL PASSING #40 LL PI	-	-	40 MX 10 MX	41 MN 10 MX	40 MX 11 MN	41 MN 11 MN	40 MX 10 MX	41 MN 10 MX	40 MX 11 MN	41 MN 11 MN		SOILS WITH LITTLE OR MODERATE AMOUNTS OF ORGANIC MATTER	HIGHLY ORGANIC SOILS	
GROUP INDEX	0	0	0	4 MX			8 MX	12 MX	16 MX	NO MX				
USUAL TYPES OF MAJOR MATERIALS	STONE FRAGS, GRAVEL, AND SAND	FINE SAND	SILTY OR CLAYEY GRAVEL AND SAND				SILTY SOILS	CLAYEY SOILS						
GEN. RATING AS SUBGRADE	EXCELLENT TO GOOD						FAIR TO POOR		FAIR TO POOR	POOR	UNSUITABLE			
PI OF A-7-5 SUBGROUP IS ≤ LL - 30 ; PI OF A-7-6 SUBGROUP IS > LL - 30														

GRADATION			
<u>WELL GRADED</u> - INDICATES A GOOD REPRESENTATION OF PARTICLE SIZES FROM FINE TO COARSE.			
<u>UNIFORMLY GRADED</u> - INDICATES THAT SOIL PARTICLES ARE ALL APPROXIMATELY THE SAME SIZE.			
<u>GAP-GRADED</u> - INDICATES A MIXTURE OF UNIFORM PARTICLE SIZES OF TWO OR MORE SIZES.			
ANGULARITY OF GRAINS			
THE ANGULARITY OR ROUNDNESS OF SOIL GRAINS IS DESIGNATED BY THE TERMS: ANGULAR, SUBANGULAR, SUBROUNDED, OR ROUNDED.			
MINERALOGICAL COMPOSITION			
MINERAL NAMES SUCH AS QUARTZ, FELDSPAR, MICA, TALC, KAOLIN, ETC. ARE USED IN DESCRIPTIONS WHEN THEY ARE CONSIDERED OF SIGNIFICANCE.			
COMPRESSIBILITY			
SLIGHTLY COMPRESSIBLE	LL < 31		
MODERATELY COMPRESSIBLE	LL = 31 - 50		
HIGHLY COMPRESSIBLE	LL > 50		
PERCENTAGE OF MATERIAL			
<u>ORGANIC MATERIAL</u>	<u>GRANULAR SOILS</u>	<u>SILT - CLAY SOILS</u>	<u>OTHER MATERIAL</u>
TRACE OF ORGANIC MATTER	2 - 3%	3 - 5%	TRACE 1 - 10%
LITTLE ORGANIC MATTER	3 - 5%	5 - 12%	LITTLE 10 - 20%
MODERATELY ORGANIC	5 - 10%	12 - 20%	SOME 20 - 35%
HIGHLY ORGANIC	> 10%	> 20%	HIGHLY 35% AND ABOVE
GROUND WATER			
	WATER LEVEL IN BORE HOLE IMMEDIATELY AFTER DRILLING		
	STATIC WATER LEVEL AFTER 24 HOURS		
	PERCHED WATER, SATURATED ZONE, OR WATER BEARING STRATA		
	SPRING OR SEEP		

CONSISTENCY OR DENSENESS			
PRIMARY SOIL TYPE	COMPACTNESS OR CONSISTENCY	RANGE OF STANDARD PENETRATION RESISTANCE (N-VALUE)	RANGE OF UNCONFINED COMPRESSIVE STRENGTH (TONS/FT <sup>2</sup> )
GENERALLY GRANULAR MATERIAL (NON-COHESIVE)	VERY LOOSE LOOSE MEDIUM DENSE DENSE VERY DENSE	< 4 4 TO 10 10 TO 30 30 TO 50 > 50	N/A
GENERALLY SILT-CLAY MATERIAL (COHESIVE)	VERY SOFT SOFT MEDIUM STIFF STIFF VERY STIFF HARD	< 2 2 TO 4 4 TO 8 8 TO 15 15 TO 30 > 30	< 0.25 0.25 TO 0.5 0.5 TO 1.0 1 TO 2 2 TO 4 > 4

MISCELLANEOUS SYMBOLS	
	ROADWAY EMBANKMENT (RE) WITH SOIL DESCRIPTION
	SOIL SYMBOL
	ARTIFICIAL FILL (AF) OTHER THAN ROADWAY EMBANKMENT
	INFERRED SOIL BOUNDARY
	INFERRED ROCK LINE
	ALLUVIAL SOIL BOUNDARY
	DIP & DIP DIRECTION OF ROCK STRUCTURES
	TEST BORING
	AUGER BORING
	CORE BORING
	MONITORING WELL
	PIEZOMETER INSTALLATION
	SLOPE INDICATOR INSTALLATION
	CONE PENETROMETER TEST
	SOUNDING ROD
	TEST BORING WITH CORE
	SPT N-VALUE

TEXTURE OR GRAIN SIZE						
U.S. STD. SIEVE SIZE OPENING (MM)	4	10	40	60	200	270
	4.76	2.00	0.42	0.25	0.075	0.053
BOULDER (BLDR.)	COBBLE (COB.)	GRAVEL (GR.)	COARSE SAND (CSE, SD.)	FINE SAND (F SD.)	SILT (SL.)	CLAY (CL.)
	75	3	2.0	0.25	0.05	0.005

RECOMMENDATION SYMBOLS			
	UNDERCUT		
	UNCLASSIFIED EXCAVATION - UNSUITABLE WASTE		UNCLASSIFIED EXCAVATION - ACCEPTABLE, BUT NOT TO BE USED IN THE TOP 3 FEET OF EMBANKMENT OR BACKFILL
	SHALLOW UNDERCUT		UNCLASSIFIED EXCAVATION - ACCEPTABLE DEGRADABLE ROCK

SOIL MOISTURE - CORRELATION OF TERMS		
SOIL MOISTURE SCALE (ATTERBERG LIMITS)	FIELD MOISTURE DESCRIPTION	GUIDE FOR FIELD MOISTURE DESCRIPTION
LL LIQUID RANGE (PI) PL	- SATURATED - (SAT.)	USUALLY LIQUID; VERY WET, USUALLY FROM BELOW THE GROUND WATER TABLE
	- WET - (W)	SEMISOLID; REQUIRES DRYING TO ATTAIN OPTIMUM MOISTURE
OM OPTIMUM MOISTURE SHRINKAGE LIMIT SL	- MOIST - (M)	SOLID; AT OR NEAR OPTIMUM MOISTURE
	- DRY - (D)	REQUIRES ADDITIONAL WATER TO ATTAIN OPTIMUM MOISTURE

ABBREVIATIONS		
AR - AUGER REFUSAL	MED. - MEDIUM	VST - VANE SHEAR TEST
BT - BORING TERMINATED	MICA - MICACEOUS	WEA. - WEATHERED
CL - CLAY	MOD. - MODERATELY	γ - UNIT WEIGHT
CPT - CONE PENETRATION TEST	NP - NON PLASTIC	γ <sub>d</sub> - DRY UNIT WEIGHT
CSE. - COARSE	ORG. - ORGANIC	
DMT - DILATOMETER TEST	PMT - PRESSUREMETER TEST	<b>SAMPLE ABBREVIATIONS</b>
DPT - DYNAMIC PENETRATION TEST	SAP. - SAPROLITIC	S - BULK
e - VOID RATIO	SD. - SAND, SANDY	SS - SPLIT SPOON
F - FINE	SL. - SILT, SILTY	ST - SHELBY TUBE
FOSS. - FOSSILIFEROUS	SLL. - SLIGHTLY	RS - ROCK
FRAC. - FRACTURED, FRACTURES	TCR - TRICONE REFUSAL	RT - RECOMPACTED TRIAXIAL
FRAGS. - FRAGMENTS	w - MOISTURE CONTENT	CBR - CALIFORNIA BEARING RATIO
HI. - HIGHLY	v - VERY	





PLASTICITY	
<u>PLASTICITY INDEX (PI)</u>	<u>DRY STRENGTH</u>
NON PLASTIC 0-5	VERY LOW
SLIGHTLY PLASTIC 6-15	SLIGHT
MODERATELY PLASTIC 16-25	MEDIUM
HIGHLY PLASTIC 26 OR MORE	HIGH
COLOR	
DESCRIPTIONS MAY INCLUDE COLOR OR COLOR COMBINATIONS (TAN, RED, YELLOW-BROWN, BLUE-GRAY). MODIFIERS SUCH AS LIGHT, DARK, STREAKED, ETC. ARE USED TO DESCRIBE APPEARANCE.	

EQUIPMENT USED ON SUBJECT PROJECT		
<b>DRILL UNITS:</b>	<b>ADVANCING TOOLS:</b>	<b>HAMMER TYPE:</b>
<input type="checkbox"/> CME-45C	<input type="checkbox"/> CLAY BITS	<input checked="" type="checkbox"/> AUTOMATIC <input type="checkbox"/> MANUAL
<input type="checkbox"/> CME-55	<input type="checkbox"/> 6' CONTINUOUS FLIGHT AUGER	<b>CORE SIZE:</b>
<input type="checkbox"/> CME-550	<input checked="" type="checkbox"/> 8" HOLLOW AUGERS	<input type="checkbox"/> -B _____ <input type="checkbox"/> -H _____
<input type="checkbox"/> VANE SHEAR TEST	<input type="checkbox"/> HARD FACED FINGER BITS	<input type="checkbox"/> -N _____
<input type="checkbox"/> PORTABLE HOIST	<input type="checkbox"/> TUNG-CARBIDE INSERTS	<b>HAND TOOLS:</b>
<input checked="" type="checkbox"/> AMS 9410-D	<input type="checkbox"/> CASING <input type="checkbox"/> W/ ADVANCER	<input type="checkbox"/> POST HOLE DIGGER
<input type="checkbox"/>	<input type="checkbox"/> TRICONE _____ * STEEL TEETH	<input type="checkbox"/> HAND AUGER
<input type="checkbox"/>	<input type="checkbox"/> TRICONE _____ * TUNG-CARB.	<input type="checkbox"/> SOUNDING ROD
<input type="checkbox"/>	<input type="checkbox"/> CORE BIT	<input type="checkbox"/> VANE SHEAR TEST
<input type="checkbox"/>		<input type="checkbox"/>

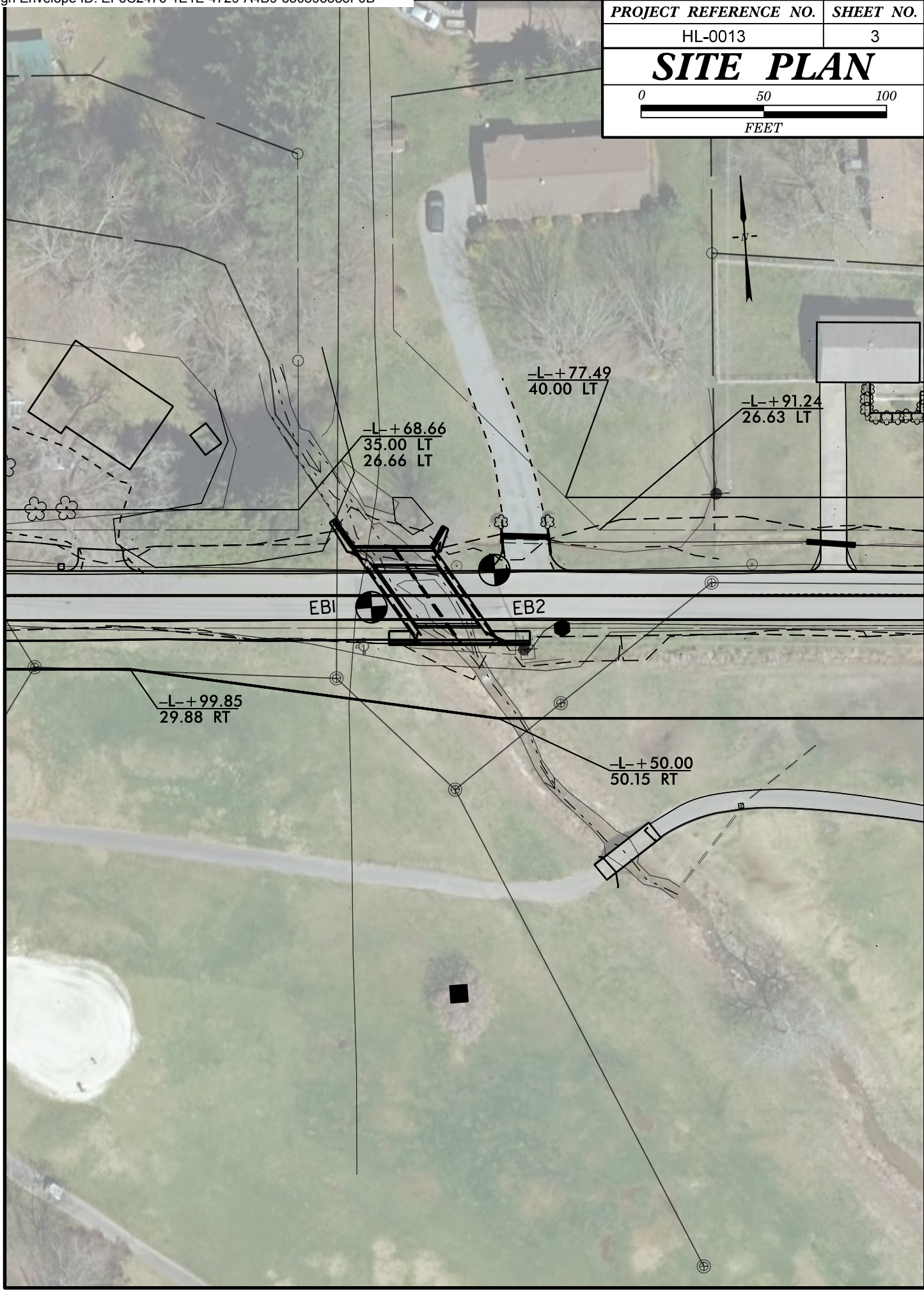
**NORTH CAROLINA DEPARTMENT OF TRANSPORTATION  
DIVISION OF HIGHWAYS  
GEOTECHNICAL ENGINEERING UNIT**

**SUBSURFACE INVESTIGATION**

**SOIL AND ROCK LEGEND, TERMS, SYMBOLS, AND ABBREVIATIONS  
(PAGE 2 OF 2)**

ROCK DESCRIPTION		TERMS AND DEFINITIONS																											
<p>HARD ROCK IS NON-COASTAL PLAIN MATERIAL THAT WOULD YIELD SPT REFUSAL IF TESTED. AN INFERRED ROCK LINE INDICATES THE LEVEL AT WHICH NON-COASTAL PLAIN MATERIAL WOULD YIELD SPT REFUSAL. SPT REFUSAL IS PENETRATION BY A SPLIT SPOON SAMPLER EQUAL TO OR LESS THAN 0.1 FOOT PER 60 BLOWS IN NON-COASTAL PLAIN MATERIAL. THE TRANSITION BETWEEN SOIL AND ROCK IS OFTEN REPRESENTED BY A ZONE OF WEATHERED ROCK. ROCK MATERIALS ARE TYPICALLY DIVIDED AS FOLLOWS:</p>		<p><b>ALLUVIUM (ALLUV.)</b> - SOILS THAT HAVE BEEN TRANSPORTED BY WATER.  <b>AQUIFER</b> - A WATER BEARING FORMATION OR STRATA.  <b>ARENACEOUS</b> - APPLIED TO ROCKS THAT HAVE BEEN DERIVED FROM SAND OR THAT CONTAIN SAND.  <b>ARGILLACEOUS</b> - APPLIED TO ALL ROCKS OR SUBSTANCES COMPOSED OF CLAY MINERALS, OR HAVING A NOTABLE PROPORTION OF CLAY IN THEIR COMPOSITION, SUCH AS SHALE, SLATE, ETC.  <b>ARTESIAN</b> - GROUND WATER THAT IS UNDER SUFFICIENT PRESSURE TO RISE ABOVE THE LEVEL AT WHICH IT IS ENCOUNTERED, BUT WHICH DOES NOT NECESSARILY RISE TO OR ABOVE THE GROUND SURFACE.  <b>CALCAREOUS (CALC.)</b> - SOILS THAT CONTAIN APPRECIABLE AMOUNTS OF CALCIUM CARBONATE.  <b>COLLUVIUM</b> - ROCK FRAGMENTS MIXED WITH SOIL DEPOSITED BY GRAVITY ON SLOPE OR AT BOTTOM OF SLOPE.  <b>CORE RECOVERY (REC.)</b> - TOTAL LENGTH OF ALL MATERIAL RECOVERED IN THE CORE BARREL DIVIDED BY TOTAL LENGTH OF CORE RUN AND EXPRESSED AS A PERCENTAGE.  <b>DIKE</b> - A TABULAR BODY OF IGNEOUS ROCK THAT CUTS ACROSS THE STRUCTURE OF ADJACENT ROCKS OR CUTS MASSIVE ROCK.  <b>DIP</b> - THE ANGLE AT WHICH A STRATUM OR ANY PLANAR FEATURE IS INCLINED FROM THE HORIZONTAL.  <b>DIP DIRECTION (DIP AZIMUTH)</b> - THE DIRECTION OR BEARING OF THE HORIZONTAL TRACE OF THE LINE OF DIP, MEASURED CLOCKWISE FROM NORTH.  <b>FAULT</b> - A FRACTURE OR FRACTURE ZONE ALONG WHICH THERE HAS BEEN DISPLACEMENT OF THE SIDES RELATIVE TO ONE ANOTHER PARALLEL TO THE FRACTURE.  <b>FISSILE</b> - A PROPERTY OF SPLITTING ALONG CLOSELY SPACED PARALLEL PLANES.  <b>FLOAT</b> - ROCK FRAGMENTS ON SURFACE NEAR THEIR ORIGINAL POSITION AND DISLODGED FROM PARENT MATERIAL.  <b>FLOOD PLAIN (FP)</b> - LAND BORDERING A STREAM, BUILT OF SEDIMENTS DEPOSITED BY THE STREAM.  <b>FORMATION (FM.)</b> - A MAPPABLE GEOLOGIC UNIT THAT CAN BE RECOGNIZED AND TRACED IN THE FIELD.  <b>JOINT</b> - FRACTURE IN ROCK ALONG WHICH NO APPRECIABLE MOVEMENT HAS OCCURRED.  <b>LEDGE</b> - A SHELF-LIKE RIDGE OR PROJECTION OF ROCK WHOSE THICKNESS IS SMALL COMPARED TO ITS LATERAL EXTENT.  <b>LENS</b> - A BODY OF SOIL OR ROCK THAT THINS OUT IN ONE OR MORE DIRECTIONS.  <b>MOTTLED (MOT.)</b> - IRREGULARLY MARKED WITH SPOTS OF DIFFERENT COLORS. MOTTLING IN SOILS USUALLY INDICATES POOR AERATION AND LACK OF GOOD DRAINAGE.  <b>PERCHED WATER</b> - WATER MAINTAINED ABOVE THE NORMAL GROUND WATER LEVEL BY THE PRESENCE OF AN INTERVENING IMPERVIOUS STRATUM.  <b>RESIDUAL (RES.) SOIL</b> - SOIL FORMED IN PLACE BY THE WEATHERING OF ROCK.  <b>ROCK QUALITY DESIGNATION (ROD)</b> - A MEASURE OF ROCK QUALITY DESCRIBED BY TOTAL LENGTH OF ROCK SEGMENTS EQUAL TO OR GREATER THAN 4 INCHES DIVIDED BY THE TOTAL LENGTH OF CORE RUN AND EXPRESSED AS A PERCENTAGE.  <b>SAPROLITE (SAP.)</b> - RESIDUAL SOIL THAT RETAINS THE RELIC STRUCTURE OR FABRIC OF THE PARENT ROCK.  <b>SILL</b> - AN INTRUSIVE BODY OF IGNEOUS ROCK OF APPROXIMATELY UNIFORM THICKNESS AND RELATIVELY THIN COMPARED WITH ITS LATERAL EXTENT, THAT HAS BEEN EMPLACED PARALLEL TO THE BEDDING OR SCHISTOSITY OF THE INTRODUCED ROCKS.  <b>SLICKENSIDE</b> - POLISHED AND STRIATED SURFACE THAT RESULTS FROM FRICTION ALONG A FAULT OR SLIP PLANE.  <b>STANDARD PENETRATION TEST (PENETRATION RESISTANCE) (SPT)</b> - NUMBER OF BLOWS IN OR BPF) OF A 140 LB. HAMMER FALLING 30 INCHES REQUIRED TO PRODUCE A PENETRATION OF 1 FOOT INTO SOIL WITH A 2 INCH OUTSIDE DIAMETER SPLIT SPOON SAMPLER. SPT REFUSAL IS PENETRATION EQUAL TO OR LESS THAN 0.1 FOOT PER 60 BLOWS.  <b>STRATA CORE RECOVERY (SREC.)</b> - TOTAL LENGTH OF STRATA MATERIAL RECOVERED DIVIDED BY TOTAL LENGTH OF STRATUM AND EXPRESSED AS A PERCENTAGE.  <b>STRATA ROCK QUALITY DESIGNATION (SROD)</b> - A MEASURE OF ROCK QUALITY DESCRIBED BY TOTAL LENGTH OF ROCK SEGMENTS WITHIN A STRATUM EQUAL TO OR GREATER THAN 4 INCHES DIVIDED BY THE TOTAL LENGTH OF STRATA AND EXPRESSED AS A PERCENTAGE.  <b>TOPSOIL (TS.)</b> - SURFACE SOILS USUALLY CONTAINING ORGANIC MATTER.</p>																											
<p><b>WEATHERED ROCK (WR)</b></p>  <p>NON-COASTAL PLAIN MATERIAL THAT WOULD YIELD SPT N VALUES &gt; 100 BLOWS PER FOOT IF TESTED.</p>	<p><b>CRYSTALLINE ROCK (CR)</b></p>  <p>FINE TO COARSE GRAIN IGNEOUS AND METAMORPHIC ROCK THAT WOULD YIELD SPT REFUSAL IF TESTED. ROCK TYPE INCLUDES GRANITE, GNEISS, GABBRO, SCHIST, ETC.</p>	<p><b>NON-CRYSTALLINE ROCK (NCR)</b></p>  <p>FINE TO COARSE GRAIN METAMORPHIC AND NON-COASTAL PLAIN SEDIMENTARY ROCK THAT WOULD YIELD SPT REFUSAL IF TESTED. ROCK TYPE INCLUDES PHYLLITE, SLATE, SANDSTONE, ETC.</p>	<p><b>COASTAL PLAIN SEDIMENTARY ROCK (CP)</b></p>  <p>COASTAL PLAIN SEDIMENTS CEMENTED INTO ROCK, BUT MAY NOT YIELD SPT REFUSAL. ROCK TYPE INCLUDES LIMESTONE, SANDSTONE, CEMENTED SHELL BEDS, ETC.</p>																										
<b>WEATHERING</b>																													
<p><b>FRESH</b></p> <p>ROCK FRESH, CRYSTALS BRIGHT, FEW JOINTS MAY SHOW SLIGHT STAINING. ROCK RINGS UNDER HAMMER IF CRYSTALLINE.</p>	<p><b>VERY SLIGHT (V SL.)</b></p> <p>ROCK GENERALLY FRESH, JOINTS STAINED, SOME JOINTS MAY SHOW THIN CLAY COATINGS IF OPEN. CRYSTALS ON A BROKEN SPECIMEN FACE SHINE BRIGHTLY. ROCK RINGS UNDER HAMMER BLOWS IF OF A CRYSTALLINE NATURE.</p>	<p><b>SLIGHT (SL.)</b></p> <p>ROCK GENERALLY FRESH, JOINTS STAINED AND DISCOLORATION EXTENDS INTO ROCK UP TO 1 INCH. OPEN JOINTS MAY CONTAIN CLAY. IN GRANITOID ROCKS SOME OCCASIONAL FELDSPAR CRYSTALS ARE DULL AND DISCOLORED. CRYSTALLINE ROCKS RING UNDER HAMMER BLOWS.</p>	<p><b>MODERATE (MOD.)</b></p> <p>SIGNIFICANT PORTIONS OF ROCK SHOW DISCOLORATION AND WEATHERING EFFECTS. IN GRANITOID ROCKS, MOST FELDSPARS ARE DULL AND DISCOLORED, SOME SHOW CLAY. ROCK HAS DULL SOUND UNDER HAMMER BLOWS AND SHOWS SIGNIFICANT LOSS OF STRENGTH AS COMPARED WITH FRESH ROCK.</p>																										
<p><b>MODERATELY SEVERE (MOD. SEV.)</b></p> <p>ALL ROCK EXCEPT QUARTZ DISCOLORED OR STAINED. IN GRANITOID ROCKS, ALL FELDSPARS DULL AND DISCOLORED AND A MAJORITY SHOW KAOLINIZATION. ROCK SHOWS SEVERE LOSS OF STRENGTH AND CAN BE EXCAVATED WITH A GEOLOGIST'S PICK. ROCK GIVES "CLUNK" SOUND WHEN STRUCK. <u>IF TESTED, WOULD YIELD SPT REFUSAL</u></p>	<p><b>SEVERE (SEV.)</b></p> <p>ALL ROCK EXCEPT QUARTZ DISCOLORED OR STAINED. ROCK FABRIC CLEAR AND EVIDENT BUT REDUCED IN STRENGTH TO STRONG SOIL. IN GRANITOID ROCKS ALL FELDSPARS ARE KAOLINIZED TO SOME EXTENT. SOME FRAGMENTS OF STRONG ROCK USUALLY REMAIN. <u>IF TESTED, WOULD YIELD SPT N VALUES &gt; 100 BPF</u></p>	<p><b>VERY SEVERE (V SEV.)</b></p> <p>ALL ROCK EXCEPT QUARTZ DISCOLORED OR STAINED. ROCK FABRIC ELEMENTS ARE DISCERNIBLE BUT MASS IS EFFECTIVELY REDUCED TO SOIL STATUS, WITH ONLY FRAGMENTS OF STRONG ROCK REMAINING. SAPROLITE IS AN EXAMPLE OF ROCK WEATHERED TO A DEGREE THAT ONLY MINOR VESTIGES OF ORIGINAL ROCK FABRIC REMAIN. <u>IF TESTED, WOULD YIELD SPT N VALUES &lt; 100 BPF</u></p>	<p><b>COMPLETE</b></p> <p>ROCK REDUCED TO SOIL. ROCK FABRIC NOT DISCERNIBLE, OR DISCERNIBLE ONLY IN SMALL AND SCATTERED CONCENTRATIONS. QUARTZ MAY BE PRESENT AS DIKES OR STRINGERS. SAPROLITE IS ALSO AN EXAMPLE.</p>																										
<b>ROCK HARDNESS</b>																													
<p><b>VERY HARD</b></p> <p>CANNOT BE SCRATCHED BY KNIFE OR SHARP PICK. BREAKING OF HAND SPECIMENS REQUIRES SEVERAL HARD BLOWS OF THE GEOLOGIST'S PICK.</p>	<p><b>HARD</b></p> <p>CAN BE SCRATCHED BY KNIFE OR PICK ONLY WITH DIFFICULTY. HARD HAMMER BLOWS REQUIRED TO DETACH HAND SPECIMEN.</p>	<p><b>MODERATELY HARD</b></p> <p>CAN BE SCRATCHED BY KNIFE OR PICK. GOUGES OR GROOVES TO 0.25 INCHES DEEP CAN BE EXCAVATED BY HARD BLOW OF A GEOLOGIST'S PICK. HAND SPECIMENS CAN BE DETACHED BY MODERATE BLOWS.</p>	<p><b>MEDIUM HARD</b></p> <p>CAN BE GROOVED OR GOUGED 0.05 INCHES DEEP BY FIRM PRESSURE OF KNIFE OR PICK POINT. CAN BE EXCAVATED IN SMALL CHIPS TO PIECES 1 INCH MAXIMUM SIZE BY HARD BLOWS OF THE POINT OF A GEOLOGIST'S PICK.</p>																										
<p><b>SOFT</b></p> <p>CAN BE GROOVED OR GOUGED READILY BY KNIFE OR PICK. CAN BE EXCAVATED IN FRAGMENTS FROM CHIPS TO SEVERAL INCHES IN SIZE BY MODERATE BLOWS OF A PICK POINT. SMALL, THIN PIECES CAN BE BROKEN BY FINGER PRESSURE.</p>	<p><b>VERY SOFT</b></p> <p>CAN BE CARVED WITH KNIFE. CAN BE EXCAVATED READILY WITH POINT OF PICK. PIECES 1 INCH OR MORE IN THICKNESS CAN BE BROKEN BY FINGER PRESSURE. CAN BE SCRATCHED READILY BY FINGERNAIL.</p>																												
<b>FRACTURE SPACING</b>		<b>BEDDING</b>																											
<table border="1"> <thead> <tr> <th>TERM</th> <th>SPACING</th> </tr> </thead> <tbody> <tr> <td>VERY WIDE</td> <td>MORE THAN 10 FEET</td> </tr> <tr> <td>WIDE</td> <td>3 TO 10 FEET</td> </tr> <tr> <td>MODERATELY CLOSE</td> <td>1 TO 3 FEET</td> </tr> <tr> <td>CLOSE</td> <td>0.16 TO 1 FOOT</td> </tr> <tr> <td>VERY CLOSE</td> <td>LESS THAN 0.16 FEET</td> </tr> </tbody> </table>	TERM	SPACING	VERY WIDE	MORE THAN 10 FEET	WIDE	3 TO 10 FEET	MODERATELY CLOSE	1 TO 3 FEET	CLOSE	0.16 TO 1 FOOT	VERY CLOSE	LESS THAN 0.16 FEET	<table border="1"> <thead> <tr> <th>TERM</th> <th>THICKNESS</th> </tr> </thead> <tbody> <tr> <td>VERY THICKLY BEDDED</td> <td>4 FEET</td> </tr> <tr> <td>THICKLY BEDDED</td> <td>1.5 - 4 FEET</td> </tr> <tr> <td>THINLY BEDDED</td> <td>0.16 - 1.5 FEET</td> </tr> <tr> <td>VERY THINLY BEDDED</td> <td>0.03 - 0.16 FEET</td> </tr> <tr> <td>THICKLY LAMINATED</td> <td>0.008 - 0.03 FEET</td> </tr> <tr> <td>THINLY LAMINATED</td> <td>&lt; 0.008 FEET</td> </tr> </tbody> </table>	TERM	THICKNESS	VERY THICKLY BEDDED	4 FEET	THICKLY BEDDED	1.5 - 4 FEET	THINLY BEDDED	0.16 - 1.5 FEET	VERY THINLY BEDDED	0.03 - 0.16 FEET	THICKLY LAMINATED	0.008 - 0.03 FEET	THINLY LAMINATED	< 0.008 FEET		
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<b>INDURATION</b>																													
<p><b>FRIABLE</b></p> <p>RUBBING WITH FINGER FREES NUMEROUS GRAINS; GENTLE BLOW BY HAMMER DISINTEGRATES SAMPLE.</p>	<p><b>MODERATELY INDURATED</b></p> <p>GRAINS CAN BE SEPARATED FROM SAMPLE WITH STEEL PROBE; BREAKS EASILY WHEN HIT WITH HAMMER.</p>	<p><b>INDURATED</b></p> <p>GRAINS ARE DIFFICULT TO SEPARATE WITH STEEL PROBE; DIFFICULT TO BREAK WITH HAMMER.</p>	<p><b>EXTREMELY INDURATED</b></p> <p>SHARP HAMMER BLOWS REQUIRED TO BREAK SAMPLE; SAMPLE BREAKS ACROSS GRAINS.</p>																										
<p><b>BENCH MARK:</b> N/A</p>		<p><b>ELEVATION:</b> FEET</p>																											
<p><b>NOTES:</b>                  FIAD = FILLED IN AFTER DRILLING                  DESIGN FILES, .TIN AND .GPK FILE PROVIDED BY JMT.</p>																													
DATE: 8-15-14																													

PROJECT REFERENCE NO.	SHEET NO.
HL-0013	3
<b>SITE PLAN</b>	
0                      50                      100 ————— FEET	



# GEOTECHNICAL BORING REPORT

## BORE LOG

WBS 49469.1.1	TIP HL-0013	COUNTY BUNCOMBE	GEOLOGIST A. Blackmore
SITE DESCRIPTION Replace Buncombe Bridge #0522 on Ninth Street over Tomahawk Creek			GROUND WTR (ft)
BORING NO. EB1	STATION 12+98	OFFSET 5 ft RT	ALIGNMENT -L-
COLLAR ELEV. 2,364.8 ft	TOTAL DEPTH 30.0 ft	NORTHING 698,853	EASTING 1,010,112
DRILL RIG/HAMMER EFF./DATE ECS1390 AMS PowerProbe 9410:D 97% 12/20/2022		DRILL METHOD H.S. Augers	HAMMER TYPE Automatic
DRILLER C. Osborne	START DATE 09/29/23	COMP. DATE 09/29/23	SURFACE WATER DEPTH N/A

ELEV (ft)	DRIVE ELEV (ft)	DEPTH (ft)	BLOW COUNT			BLOWS PER FOOT					SAMP. NO.	LOG MOI	SOIL AND ROCK DESCRIPTION	DEPTH (ft)	
			0.5ft	0.5ft	0.5ft	0	25	50	75	100					
2365														GROUND SURFACE	0.0
	2,364.1	0.7												<b>ROADWAY EMBANKMENT</b> 0.4' Asphalt 0.3' Stone Base	0.7
	2,361.3	3.5												Very Soft to Medium Stiff, Brown-Gray, Fine to Coarse Sandy SILT (A-4), with trace gravel	
2360	2,358.8	6.0	WOH	WOH	WOH										
	2,356.3	8.5												<b>ALLUVIAL</b> Very Loose to Loose, Gray, Silty Fine to Coarse SAND (A-2-4), with trace cobbles	
2355	2,351.3	13.5													
	2,346.3	18.5												<b>RESIDUAL</b> Loose to Medium Dense, Brown-Orange-Red, Silty Fine to Coarse SAND (A-2-4(0)), with trace mica	
2350	2,341.3	23.5													
	2,336.3	28.5												Boring Terminated at Elevation 2,334.8 ft In Residual Silty SAND (A-2-4)	
2345															
2340															
2335															

NCDOT BORE SINGLE HL0013\_GEO\_GTM.GPJ NC\_DOT.GDT 10/20/23

# GEOTECHNICAL BORING REPORT

## BORE LOG

WBS 49469.1.1		TIP HL-0013		COUNTY BUNCOMBE		GEOLOGIST A. Blackmore										
SITE DESCRIPTION Replace Buncombe Bridge #0522 on Ninth Street over Tomahawk Creek							GROUND WTR (ft)									
BORING NO. EB2		STATION 13+48		OFFSET 10 ft LT		ALIGNMENT -L-	0 HR. 9.8									
COLLAR ELEV. 2,364.8 ft		TOTAL DEPTH 30.0 ft		NORTHING 698,865		EASTING 1,010,163	24 HR. FIAD									
DRILL RIG/HAMMER EFF./DATE ECS1390 AMS PowerProbe 9410:D 97% 12/20/2022				DRILL METHOD H.S. Augers		HAMMER TYPE Automatic										
DRILLER C. Osborne		START DATE 09/29/23		COMP. DATE 09/29/23		SURFACE WATER DEPTH N/A										
ELEV (ft)	DRIVE ELEV (ft)	DEPTH (ft)	BLOW COUNT			BLOWS PER FOOT					SAMP. NO.	LOG MOI	SOIL AND ROCK DESCRIPTION	DEPTH (ft)		
			0.5ft	0.5ft	0.5ft	0	25	50	75	100						
2365														2,364.8	GROUND SURFACE	0.0
	2,363.9	0.9											M	2,363.9	<b>ROADWAY EMBANKMENT</b>	0.9
	2,361.3	3.5											W	2,361.8	0.6' Asphalt 0.3' Stone	3.0
2360	2,358.8	6.0	WOH	WOH	1									2,358.3	Medium Dense, Gray-Brown, Silty Fine to Coarse SAND (A-2-4), with trace gravel	
	2,356.3	8.5	WOH	2	5								SS-3	23%	Very Soft, Gray-Brown, Fine to Coarse Sandy SILT (A-4)	6.5
2355															<b>ALLUVIAL</b>	
	2,351.3	13.5													Loose to Medium Dense, Gray, Silty Fine to Coarse SAND (A-2-4), with trace cobbles	
2350													W	2,350.8		14.0
	2,346.3	18.5											M		<b>RESIDUAL</b>	
2345															Loose, Tan-Gray-Orange-Red, Silty Fine to Coarse SAND (A-2-4(0)), with trace mica	
	2,341.3	23.5											M			
2340																
	2,336.3	28.5											M			
2335														2,334.8		30.0
															Boring Terminated at Elevation 2,334.8 ft In Residual Silty SAND (A-2-4)	

NCDOT BORE SINGLE HL0013\_GEO\_GTM.GPJ NC\_DOT.GDT 10/20/23

PROJECT REFERENCE NO.

SHEET NO.

HL-0013

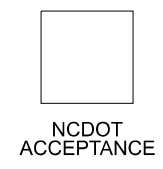
6

**SOIL TEST RESULTS**

BORING NO.	SAMPLE NO.	OFFSET	STATION	DEPTH INTERVAL	AASHTO CLASS.	L.L.	P.I.	% BY WEIGHT				% PASSING (SIEVES)			% MOISTURE	% ORGANIC
								C. SAND	F. SAND	SILT	CLAY	10	40	200		
EB1	SS-13	5' RT	-L- 12+98	13.5-15.0'	A-2-4(0)	35	NP	34.3	42.2	14.8	8.6	94.0	71.3	29.4	23.2	-
EB2	SS-3	10' LT	-L- 13+48	6.0-7.5'	A-2-4(0)	25	NP	40.7	39.3	11.4	8.5	73.7	56.9	18.4	22.8	-

TESTED BY: DILLON KESTNER

CERTIFICATION NO.: 135-01-0816



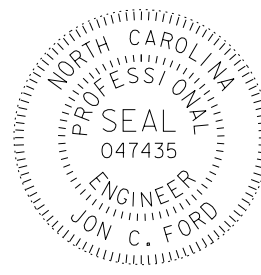
# CULVERT SURVEY & HYDRAULIC DESIGN REPORT

NC DEPARTMENT OF TRANSPORTATION  
DIVISION OF HIGHWAYS  
HYDRAULICS UNIT  
RALEIGH, NC

State Proj Reference No HL-0013 WBS Proj No 49469.1.1 Proj Station L-13+21.02  
County BUNCOMBE Bridge over TOMAHAWK BRANCH Struc Inv No 100522  
On Highway 9TH STREET between SR-2495 (HIAWASSEE AVE) and N CHEROKEE AVE  
Recommended Structure 2@ 13' X 7' REINFORCED CONCRETE BOX CULVERTS WITH HEADWALLS/WINGWALLS WITH 6" TOP BEVEL  
Recommended Width of Roadway 20'-0" CLEAR ROADWAY Skew 55°  
Recommended Location is (A) Upstream of, (B) Downstream of Existing Crossing  
Latitude 35.624586 Longitude -82.331525  
Statewide Tier  Regional Tier  Sub-Regional Tier   
Bench Mark is BM280, STA. L-10+79.32 98.03 RT  
Northing 698776.3750 Easting 1009886.7030 Elevation 2377.7230 ft Datum NAVD 88  
Temporary Crossing OFFSITE DETOUR



Designed by JON FORD, PE  
Assisted by ARTHUR WILLIAMS



Date \_\_\_\_\_ Reviewed by \_\_\_\_\_ Date \_\_\_\_\_



## SITE DATA

Drainage Area 1.2 SQ. MI Source USGS-STREAMSTATS  
River Basin FRENCH BROAD Character REGION 2-BLUE RIDGE (RURAL)  
Stream Classification (e.g., Trout, High Quality Water) B  
Data on Existing Structure 1@28', TIMBER FLOOR ON I-BEAMS AND CHANNELS, E.BTS:TIMBER CAPS/TIMBER PILES  
Total Waterway Opening 137.2 ft<sup>2</sup>  
Debris Potential: Low  Moderate  High  Waterway Opening Below 100-yr WS Elev 117.0 ft<sup>2</sup>  
Data on Structures Up and Down Stream UPSTREAM: 1 @ 24'-9" TIMBER FLOOR ON I-BEAMS, ABUTS:REINFORCED CONCRETE W/SPREAD FTGS ON SR-2495. DOWNSTREAM: 2@ 48" CMP, 1 @ 12' X 4' ARCH CULVERTS ON LAUREL CR DR.  
Gage Station No N/A Period of Records N/A  
Max Discharge N/A cfs Date N/A Frequency N/A

Historical Flood Information:  
Date N/A Just Below Bridge Ele Beams ft Est Freq N/A yr Source LLOYD DAVIS Period of Knowledge 44 yrs  
Date Elev ft Est Freq yr Source Period of Knowledge yrs  
Date Elev ft Est Freq yr Source Period of Knowledge yrs  
Allowable HW Elev 2365.04 (Corrected 100-YR @ RS 7594) ft Normal Water Surface Elev 2358.3 ft  
Manning's n: Left OB 0.200 Channel 0.055 Right OB 0.2000 Source FIS REPORT  
Flood Study / Status LIMITED DETAILED STUDY(effective:01/06/2010)  
Flood Study 100-yr Discharge 1330 cfs WS Elev: With 2367.97 ft Without 2367.66 ft River Station 7606

## DESIGN DATA

Hydrological Method USGS STREAMSTAT - SIR 2009-5158  
Hydraulic Design Method HEC-RAS V 6.20 HL-0013 Tomahawk Br 9th St  
Design Tailwater: Q<sub>10</sub> 4.0 ft Q<sub>25</sub> 4.4 ft Q<sub>50</sub> 4.6 ft Q<sub>100</sub> 4.8 ft Q<sub>500</sub> 5.1 ft

INLET INVERT ELEVATION = 2356.60, OUTLET INVERT ELEVATION = 2356.20  
SIZE & TYPE: 2@13' x 7' RCBC STATION 7594 APPROXIMATELY 20 FEET UPSTREAM OF CULVERT

FREQUENCY	Q (cfs)	INLET CONTROL		OUTLET CONTROL		REMARKS	
		HW/D	HW	WSEL	HW		WSEL
10-YEAR	330	0.4	2.3	2360.0	3.3	2360.9	OUTLET CONTROL
25-YR (DESIGN)	460	0.5	3.0	2360.6	3.8	2361.4	OUTLET CONTROL
100-YEAR	660	0.6	3.8	2361.4	4.5	2362.1	OUTLET CONTROL
500-YEAR	910	0.9	5.2	2362.8	5.7	2363.3	OUTLET CONTROL

Total Proposed Waterway Opening 142 sf  
Outlet Velocity (V<sub>o</sub>) 4.4 fps Natural Channel Velocity (V<sub>nc</sub>) 4.4 fps  
Required Outlet Protection CLASS II RIPRAP  
State Floodway Compliance Type B; MAX DECREASE IN BFE=1.21 @ SECTION 7594

## INFORMATION TO BE SHOWN ON PLANS

HYDRAULIC DATA	
DESIGN DISCHARGE	= 460 C.F.S.
FREQUENCY OF DESIGN FLOOD	= 25 YRS.
DESIGN HIGH WATER ELEVATION	= 2361.4
DRAINAGE AREA	= 1.2 SQ. MI.
BASIC DISCHARGE (Q100)	= 660 C.F.S.
BASIC HIGH WATER ELEVATION	= 2362.1

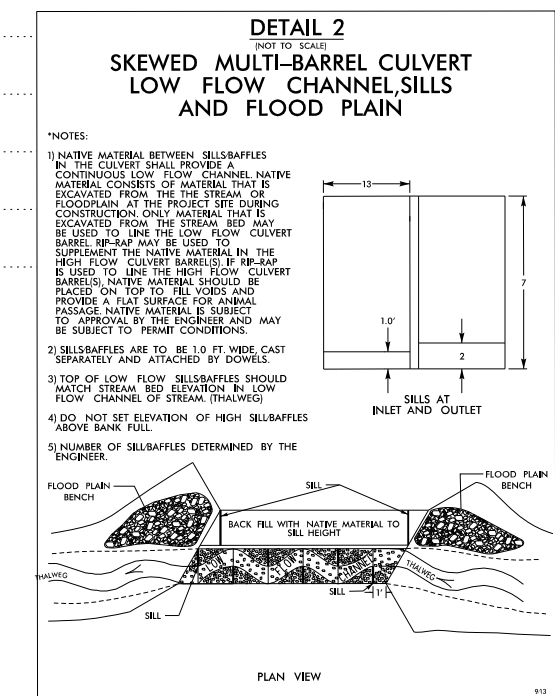
OVERTOPPING FLOOD DATA	
OVERTOPPING DISCHARGE	= 1330 C.F.S.
FREQUENCY OF OVERTOPPING FLOOD	= 500 YRS.
OVERTOPPING FLOOD ELEVATION	= 2365.8

\*NOTE: LOCATION OF OVERTOPPING WS EL. Taken @ River Station 7594

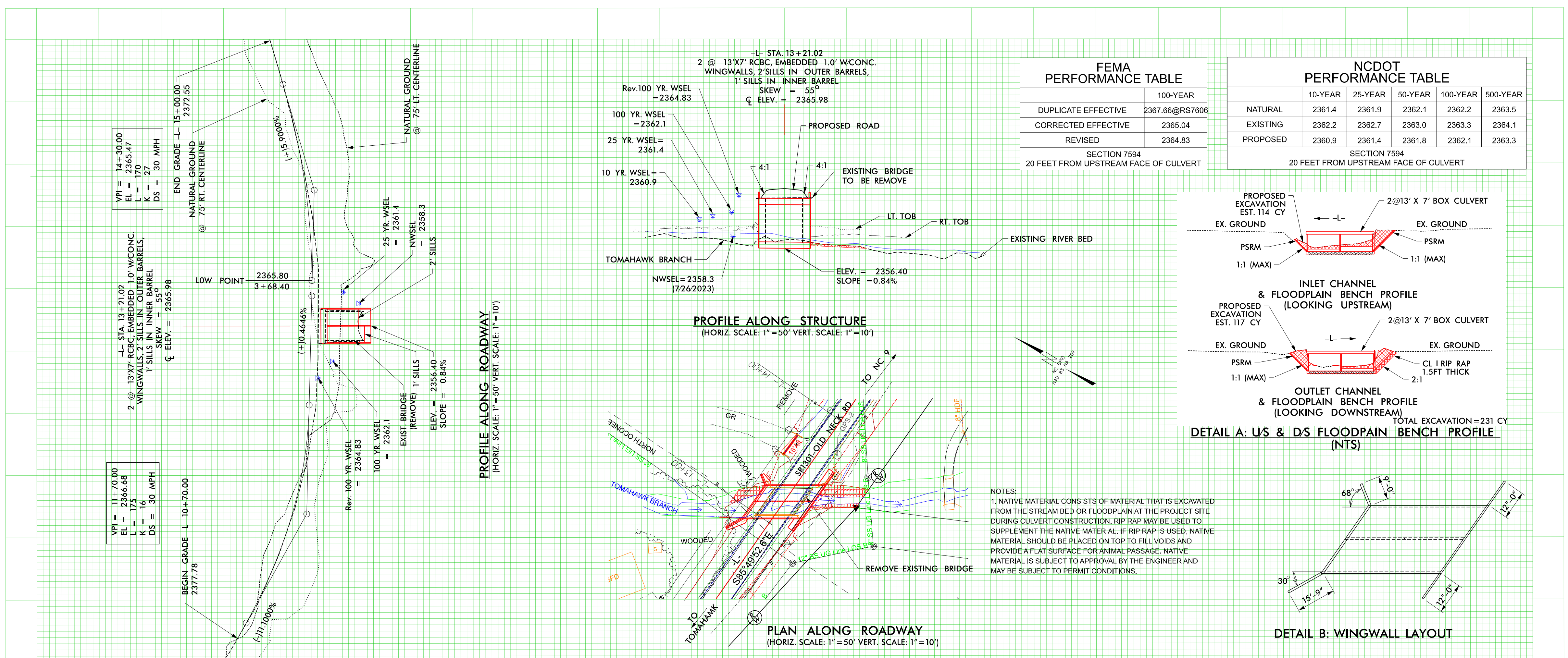
## ADDITIONAL INFORMATION AND COMPUTATIONS

HYDROLOGIC REGION=2; DRAINAGE AREA:1.2 SQ. MI.  
USGS REGRESSION EQUATIONS SOURCE: BLUE RIDGE SIR 2009-5158  
Q<sub>10</sub> = 288 (DA)<sup>0.724</sup> = 330 => 330  
Q<sub>25</sub> = 398 (DA)<sup>0.718</sup> = 445 => 460  
Q<sub>50</sub> = 479 (DA)<sup>0.713</sup> = 546 => 550  
Q<sub>100</sub> = 575 (DA)<sup>0.704</sup> = 655 => 660  
Q<sub>500</sub> = 794 (DA)<sup>0.704</sup> = 903 => 910  
FEMA DISCHARGES  
Q<sub>10</sub> = 600  
Q<sub>25</sub> = N/A  
Q<sub>50</sub> = 1110  
Q<sub>100</sub> = 1330  
Q<sub>500</sub> = 1900

NOTE: REGRESSION EQUATIONS USED FOR NCDOT DESIGN. FIS DISCHARGES USED FOR FEMA COMPLIANCE.  
THIS PROJECT FOLLOWS SUB-REGIONAL TIER GUIDELINES.  
NO STRUCTURES WILL BE ADVERSELY AFFECTED BY THIS PROJECT.



NATIVE MATERIAL SPECIFICATION FOR BACKFILLING NOTE  
The Engineer, in consultation with DEO staff, shall review all material to be used as backfill prior to conducting the backfill activity. Backfill shall consist of native material only unless the Engineer, in consultation with DEO staff, determines that (1) the native material is unsuitable, or (2) additional material is required to supplement the native material. The chosen backfill material shall not have adverse effects to aquatic life, aquatic life passage, or water quality. Native material consists of material that is excavated from the stream bed or floodplain at the project site during culvert construction.



# GEOTECHNICAL BORING REPORT BORE LOG

WBS 49469.1.1	TIP HL-0013	COUNTY BUNCOMBE	GEOLOGIST A. Blackmore
SITE DESCRIPTION Replace Buncombe Bridge #0522 on Ninth Street over Tomahawk Creek			GROUND WTR (ft)
BORING NO. EB1	STATION 12+88	OFFSET CL	ALIGNMENT -L-
COLLAR ELEV. 2,365.0 ft	TOTAL DEPTH 30.0 ft	NORTHING 698,859	EASTING 1,010,102
DRILL RIG/HAMMER EFF./DATE ECS1390 AMS PowerProbe 9410-D 97% 12/20/2022		DRILL METHOD H.S. Augers	HAMMER TYPE Automatic
DRILLER C. Osborne	START DATE 09/29/23	COMP. DATE 09/29/23	SURFACE WATER DEPTH N/A

ELEV (ft)	DRIVE ELEV (ft)	DEPTH (ft)	BLOW COUNT			BLOWS PER FOOT					SAMP. NO.	LOG MOI	L O G	SOIL AND ROCK DESCRIPTION		
			0.5ft	0.5ft	0.5ft	0	25	50	75	100				ELEV. (ft)	DEPTH (ft)	
2365	2,364.3	0.7												2,365.0	0.0	GROUND SURFACE
	2,364.3		3	4	1							M		2,364.3	0.7	ROADWAY EMBANKMENT 0.4' Asphalt 0.3' Stone Base
2360	2,361.5	3.5	woh	woh	woh							M		2,358.5	6.5	Very Soft to Medium Stiff, Brown-Gray, Fine to Coarse Sandy SILT (A-4), with trace gravel
	2,359.0	6.0	4	4	4											ALLUVIAL
2355	2,356.5	8.5	4	1	1							Sat				Very Loose to Loose, Gray, Silty Fine to Coarse SAND (A-2-4), with trace cobbles
	2,351.5	13.5	4	6	2									2,352.0	13.0	RESIDUAL
2350	2,346.5	18.5	1	2	4							SS-13	23%			Loose to Medium Dense, Brown-Orange-Red, Silty Fine to Coarse SAND (A-2-4(0)), with trace mica
2345	2,341.5	23.5	10	13	9							M				
2340	2,336.5	28.5	6	7	8							M				
2335												M		2,335.0	30.0	Boring Terminated at Elevation 2,335.0 ft in Residual Silty SAND (A-2-4)

Approximate bottom of excavation EL 2355.4'

Some undercutting may be required. Include a contingency quantity

For Wings  
 $4'(w) \times 15'(L) \times 2'(D) = 4.4 \text{ cyd}$   
 2 wings  $\approx 9 \text{ cyd}$

For Box  
 $13'(w) \times 50'(L) \times 2'(D) = 48 \text{ cyd}$   
 Round up to 60 cyd.

For Fabric (Type V)  
 $[(4 \times 15) \times 2 = 120 \text{ ft}^2 + (13 \times 50) = 650 \text{ ft}^2] / 9 = 85.6 \text{ yd}^2$   
 Round up to 90 yd.

NCDOT BORE SINGLE HL0013\_GEO\_GTM.GPJ NC\_DOT.GDT 10/20/23

# GEOTECHNICAL BORING REPORT BORE LOG

WBS 49469.1.1	TIP HL-0013	COUNTY BUNCOMBE	GEOLOGIST A. Blackmore
SITE DESCRIPTION Replace Buncombe Bridge #0522 on Ninth Street over Tomahawk Creek			GROUND WTR (ft)
BORING NO. EB2	STATION 13+48	OFFSET 10 ft LT	ALIGNMENT -L-
COLLAR ELEV. 2,365.0 ft	TOTAL DEPTH 30.0 ft	NORTHING 698,865	EASTING 1,010,163
DRILL RIG/HAMMER EFF./DATE ECS1390 AMS PowerProbe 9410-D 97% 12/20/2022		DRILL METHOD H.S. Augers	HAMMER TYPE Automatic
DRILLER C. Osborne	START DATE 09/29/23	COMP. DATE 09/29/23	SURFACE WATER DEPTH N/A

ELEV (ft)	DRIVE ELEV (ft)	DEPTH (ft)	BLOW COUNT			BLOWS PER FOOT					SAMP. NO.	MOI	LOG	SOIL AND ROCK DESCRIPTION				
			0.5ft	0.5ft	0.5ft	0	25	50	75	100				ELEV (ft)	DEPTH (ft)			
2365															2,365.0	GROUND SURFACE	0.0	
	2,364.1	0.9	10	14	5										2,364.1	ROADWAY EMBANKMENT	0.9	
	2,361.5	3.5	woh	woh	1										2,362.0	0.6' Asphalt 0.3' Stone	3.0	
2360																		
	2,359.0	6.0	woh	2	5										2,358.5	Medium Dense, Gray-Brown, Silty Fine to Coarse SAND (A-2-4), with trace gravel Very Soft, Gray-Brown, Fine to Coarse Sandy SILT (A-4)	6.5	
	2,356.5	8.5	5	7	4													
<del>2355</del>																		
	2,351.5	13.5	3	1	2													
2350																		
	2,346.5	18.5	3	4	4													
2345																		
	2,341.5	23.5	4	4	6													
2340																		
	2,336.5	28.5	3	4	5													
2335																		

Approximate bottom of excavation EL 2355.4'

No undercutting is anticipated

Boring Terminated at Elevation 2,335.0 ft in Residual Silty SAND (A-2-4)

General Bearing Capacity - Box Culvert  
AASHTO LRFD Evaluation

ECS Project No. 31-4437  
Date: JANUARY 5, 2024  
Calc By: MJW Rev By: KND

Purpose: To evaluate the general bearing capacity using AASHTO LRFD Bridge Design Method. (Section 10.6.3.1.2).

Soil/WR Parameters:

Soil Friction Angle: Worst Case N = 3 bpf, A-2-4

$$\phi_s := 28 \text{ deg}$$

Soil Cohesion:

$$c_s := 0 \text{ psf}$$

Soil Unit Weight:

$$\gamma_s := 110 \text{ pcf}$$

Foundation Geometry:

Footing Width: 2 @ 13' x 7' RCBC ~ 28 feet

$$B_{ftg} := 28 \text{ ft}$$

Footing Length: Total Length of Culvert ~ 50 feet

$$L_{ftg} := 50 \text{ ft}$$

Footing Embedment: Buried Depth 1' + 1.5' Rip Rap

$$D_f := 2.5 \text{ ft}$$

Bearing Capacity Factors (Table 10.6.3.1.2a-1):

Cohesion Term:

$$N_c := 25.8$$

Surcharge (Embedment) Term:

$$N_q := 14.7$$

Unit Weight (Footing Width) Term:

$$N_\gamma := 16.7$$

Groundwater Correction Factors:

Depth to Groundwater: Assume Bottom of Box Elevation  $z_{gw} := 0 \text{ ft}$

$$C_{wq} := \text{if} \left( z_{gw} > D_f, 1, 0.5 + \frac{0.5 \cdot z_{gw}}{D_f} \right) = 0.5$$

$$C_{w\gamma} := \text{if} \left( z_{gw} > 1.5 B_{ftg} + D_f, 1, \text{if} \left( z_{gw} < D_f, 0.5, 0.5 + \frac{0.5 \cdot z_{gw}}{1.5 \cdot B_{ftg} + D_f} \right) \right) = 0.5$$

Shape Factors (Table 10.6.3.1.2a-3):

Cohesion Term:  $s_c := \text{if} \left( \phi_s > 0, 1 + \frac{B_{ftg}}{L_{ftg}} \cdot \frac{N_q}{N_c}, 1 + \frac{B_{ftg}}{5 \cdot L_{ftg}} \right) = 1.32$

Unit Weight Term:  $s_\gamma := \text{if} \left( \phi_s > 0, 1 - 0.4 \cdot \frac{B_{ftg}}{L_{ftg}}, 1 \right) = 0.78$

Surcharge Term:  $s_q := \text{if} \left( \phi_s > 0, 1 + \frac{B_{ftg}}{L_{ftg}} \cdot \tan(\phi_s), 1 \right) = 1.3$

Depth Correction Factor (Table 10.6.3.1.2a-4):

$$d_q := 1.0$$

Load Inclination Factors:

Unfactored Vertical Load (1 kip minimum required):  $V_{uf} := 50 \text{ kip}$

Unfactored Horizontal Load:  $H_{uf} := 0 \text{ kip}$

Projected Direction of Load:  $\theta_l := 0 \text{ deg}$

$$n := \frac{2 + \frac{L_{ftg}}{B_{ftg}}}{1 + \frac{L_{ftg}}{B_{ftg}}} \cdot (\cos(\theta_l))^2 + \frac{2 + \frac{B_{ftg}}{L_{ftg}}}{1 + \frac{B_{ftg}}{L_{ftg}}} \cdot (\sin(\theta_l))^2 = 1.359$$

## Unit Weight Term:

$$i_\gamma := \text{if} \left( \phi_s > 0, \left( 1 - \frac{H_{uf}}{V_{uf} + c_s \cdot B_{ftg} \cdot L_{ftg} \cdot \cot(\phi_s)} \right)^{(n+1)}, 1 \right) = 1$$

## Surcharge Term:

$$i_q := \text{if} \left( \phi_s > 0, \left( 1 - \frac{H_{uf}}{V_{uf} + c_s \cdot B_{ftg} \cdot L_{ftg} \cdot \cot(\phi_s)} \right)^n, 1 \right) = 1$$

Cohesion Term:

$$i_c := \text{if} \left( \phi_s > 0, i_q - \frac{1 - i_q}{N_q - 1}, 1 - \frac{n \cdot H_{uf}}{c_s \cdot B_{ftg} \cdot L_{ftg} \cdot N_c} \right) = 1$$

Bearing Resistance:

$$\text{Cohesion Term (eq. 10.6.3.1.2a-2):} \quad N_{cm} := N_c \cdot s_c \cdot i_c = 34$$

$$\text{Surcharge Term (eq. 10.6.3.1.2a-3):} \quad N_{qm} := N_q \cdot s_q \cdot d_q \cdot i_q = 19.1$$

$$\text{Unit Weight Term (eq. 10.6.3.1.2a-4):} \quad N_{\gamma m} := N_\gamma \cdot s_\gamma \cdot i_\gamma = 13$$

Nominal Bearing Resistance

$$q_n := c_s \cdot N_{cm} + \gamma_s \cdot D_f \cdot N_{qm} \cdot C_{wq} + 0.5 \cdot \gamma_s \cdot B_{ftg} \cdot N_{\gamma m} \cdot C_{w\gamma} = 13 \text{ ksf}$$

$$\text{Bearing Capacity Resistance Factor:} \quad \phi_{bc} := 0.45$$

$$\text{Factored Bearing Resistance:} \quad \phi_{bc} \cdot q_n = 6 \text{ ksf}$$

$$\text{Bearing Capacity Required:} \quad 3.0 \text{ ksf}$$

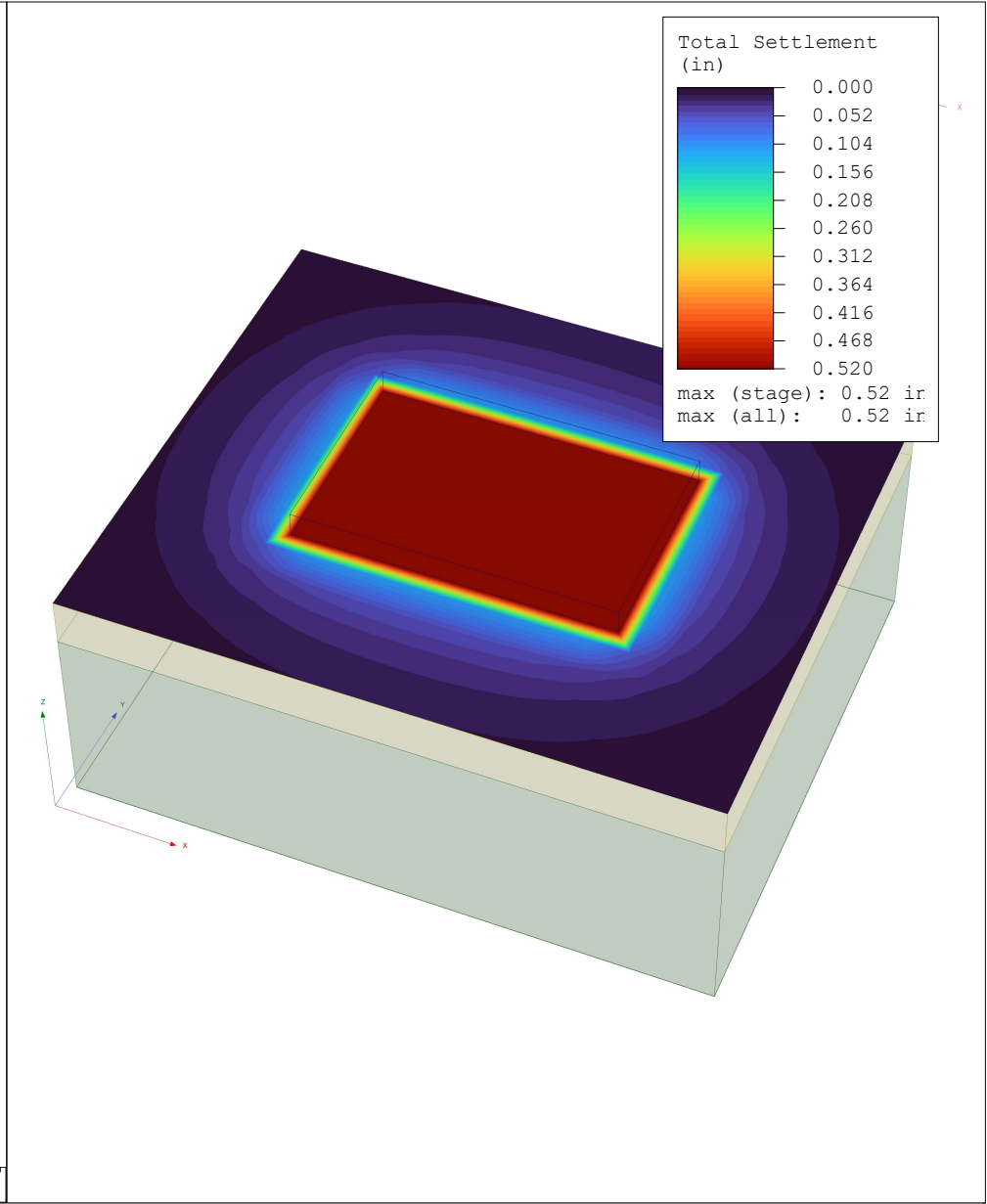
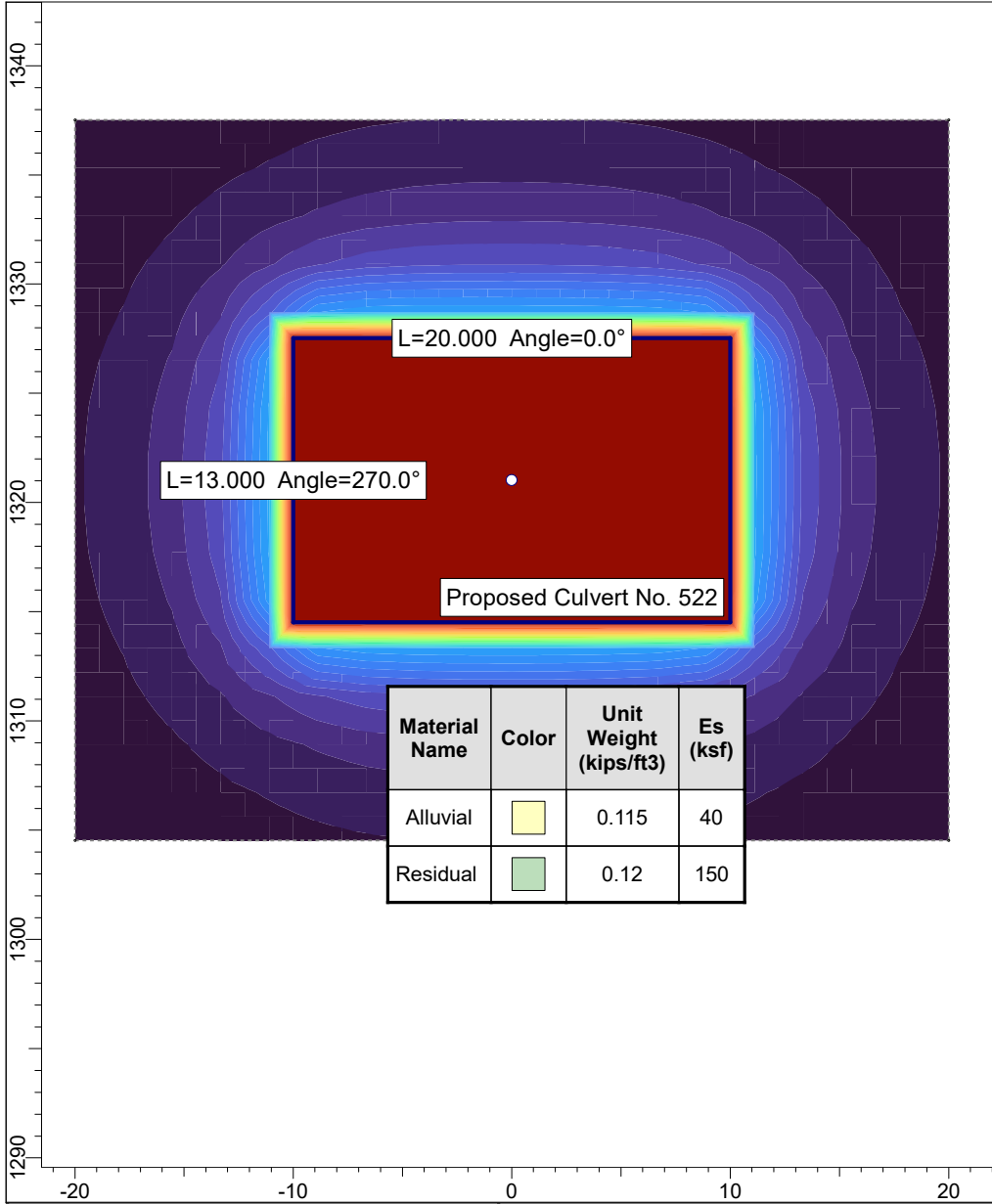
(per JMT)

Since 6 ksf > 3.0 ksf, Bearing Resistance is OK.

Use Factored Resistance to 3.0 ksf (1.5 tsf) for Design.

Some undercutting of very loose / alluvial soils in the vicinity of the culvert and wing wall foundations may be required during construction. As a contingency item, include an additional 60 cubic yards of undercut and 60 cubic yards of additional foundation conditioning material in the contract.

In lieu of undercutting, a layer of Type V Geotextile can be placed at the bottom of the excavation prior to the placement of foundation conditioning material. We recommend a contingency quantity of 90 square yards of Type V Geotextile be included in the contract to be used at the discretion of the Engineer.



	Project Culvert No. 522 on 9th Street over Tomahawk Branch		
	Analysis Description		
	Drawn By KN	Company ECS Southeast, LLC	
	Date 1/4/2024, 8:24:27 AM	File Name Culvert No. 522.s3z	



Culvert No. 522 on 9th Street over Tomahawk Branch  
ECS Southeast, LLC  
Report Creation Date: 2024/01/04, 08:56:56

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# Settle3 Analysis Information

## Culvert No. 522 on 9th Street over Tomahawk Branch

### Project Settings

---

Document Name	Culvert No. 522
Project Title	Culvert No. 522 on 9th Street over Tomahawk Branch
Author	KND
Company	ECS Southeast, LLC
Date Created	1/4/2024, 8:24:27 AM
Stress Computation Method	Boussinesq
Stress Units	Imperial, stress as ksf
Settlement Units	inches

### Advanced Settings

---

Start of secondary consolidation (% of primary)	95
Min. stress for secondary consolidation (% of initial)	1
Reset time when load changes for secondary consolidation	No
Minimum settlement ratio for subgrade modulus	0.9
Use average poisson's ratio to calculate layered stresses	
Update Cv in each time step (improves consolidation accuracy)	
Ignore negative effective stresses in settlement calculations	
Add field points to load edges	

### Soil Profile

---

Layer Option	Horizontal Soil Layers
Vertical Axis	Elevation
Ground Elevation (ft)	0

## Stage Settings

---

Stage #	Name
1	Stage 1

# Results

Time taken to compute: 4.00657 seconds

## Stage: Stage 1

Data Type	Minimum	Maximum
Total Settlement [in]	0	0.516623
Total Consolidation Settlement [in]	0	0
Virgin Consolidation Settlement [in]	0	0
Recompression Consolidation Settlement [in]	0	0
Immediate Settlement [in]	0	0.516623
Loading Stress ZZ [ksf]	6.90406e-10	0.423503
Loading Stress XX [ksf]	-1.16619	0.915759
Loading Stress YY [ksf]	-1.17438	0.915425
Total Stress ZZ [ksf]	6.90406e-10	1.86536
Total Stress XX [ksf]	-0.806781	2.36917
Total Stress YY [ksf]	-0.701964	2.34311
Modulus of Subgrade Reaction (Total) [ksf/ft]	0	19.3142
Modulus of Subgrade Reaction (Immediate) [ksf/ft]	0	19.3142
Modulus of Subgrade Reaction (Consolidation) [ksf/ft]	0	0
Total Strain	1.88115e-09	0.0104985
Degree of Consolidation [%]	0	0
Pre-consolidation Stress [ksf]	0.0172501	1.86468
Over-consolidation Ratio	1	1
Void Ratio	0	0
Hydroconsolidation Settlement [in]	0	0
Undrained Shear Strength	0	0.00759748

# Loads

---

## **1. Rectangular Load: "Proposed Culvert No. 522"**

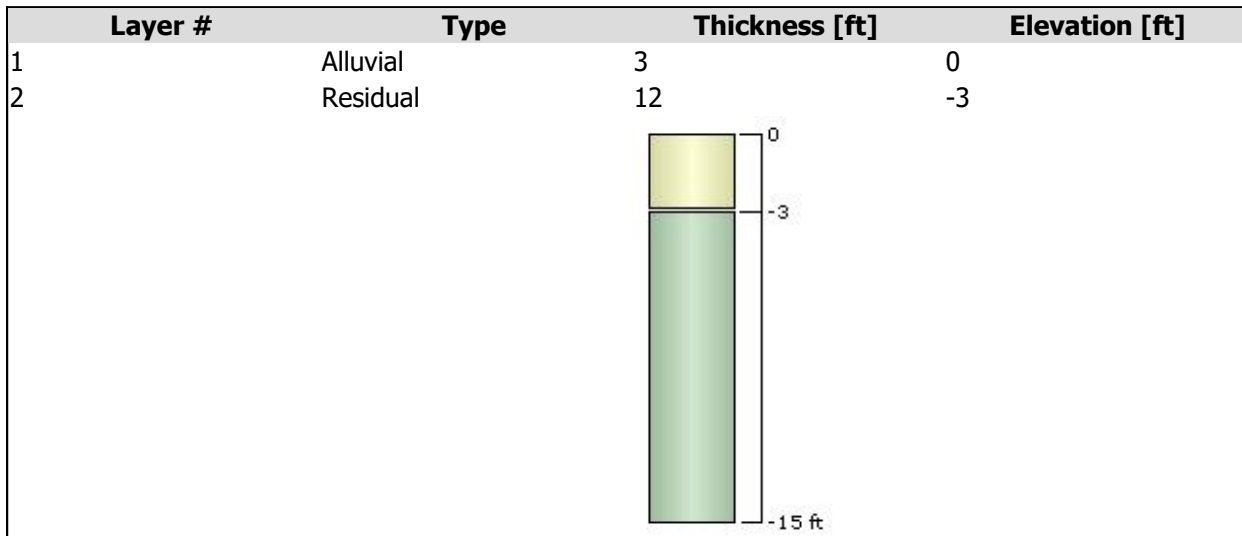
Length	20 ft
Width	13 ft
Rotation angle	0 degrees
Load Type	Rigid
Area of Load	260 ft <sup>2</sup>
Load	0.25 ksf
Elevation	0 ft
Installation Stage	Stage 1

## **Coordinates**



---

	X [ft]	Y [ft]
-10	1314.52	
10	1314.52	
10	1327.52	
-10	1327.52	

# Soil Layers



# Soil Properties

Property	Alluvial	Residual
Color		
Unit Weight [kips/ft3]	0.115	0.12
K0	1	1
Immediate Settlement	Enabled	Enabled
Es [ksf]	40	150
Esur [ksf]	40	150
Undrained Su A [kips/ft2]	0	0
Undrained Su S	0.2	0.2
Undrained Su m	0.8	0.8

# Query

---

## Field Point Grid

---

Number of points 338  
Expansion Factor 2

### **Grid Coordinates**

	X [ft]	Y [ft]
20	1337.52	
20	1304.52	
-20	1304.52	
-20	1337.52	