

# STATE OF NORTH CAROLINA

## DEPARTMENT OF TRANSPORTATION

### DIVISION OF HIGHWAYS

### GEOTECHNICAL UNIT

# STRUCTURE SUBSURFACE INVESTIGATION

STATE PROJECT U-4756 I.D. NO. \_\_\_\_\_

F.A. PROJECT \_\_\_\_\_

COUNTY CUMBERLAND

PROJECT DESCRIPTION BRIDGE ON MORGANTON  
ROAD OVER ALL AMERICAN FREEWAY

SITE DESCRIPTION \_\_\_\_\_

STATE	STATE PROJECT REFERENCE NO.	SHEET NO.	TOTAL SHEETS
N.C.	U-4756	1	16
STATE PROJ. NO.	F.A. PROJ. NO.	DESCRIPTION	
U-4756		P.E. CONST.	

### CAUTION NOTICE

THE SUBSURFACE INFORMATION AND THE SUBSURFACE INVESTIGATION ON WHICH IT IS BASED WAS 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 UNIT @ (919) 250-4088. NEITHER THE SUBSURFACE PLANS AND REPORTS, NOR THE FIELD BORING LOGS, ROCK CORES, OR SOIL TEST DATA IS 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 MAKE SUCH INDEPENDENT SUBSURFACE INVESTIGATIONS AS HE DEEMS NECESSARY TO SATISFY HIMSELF AS TO CONDITIONS TO BE ENCOUNTERED ON THIS 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.

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INVESTIGATED BY S. HAN PERSONNEL S. HAN

CHECKED BY G. LANG, P.E. B. SAWASKA

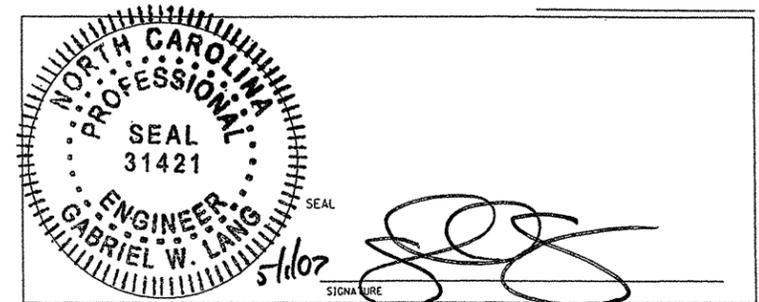
SUBMITTED BY TIERRA, INC.

DATE MAY, 2007

DRAWN BY: P. ZHANG

NOTE - THE INFORMATION CONTAINED HEREIN IS NOT IMPLIED OR GUARANTEED BY THE N. C. DEPARTMENT OF TRANSPORTATION AS BEING ACCURATE NOR IT IS CONSIDERED TO BE PART OF THE PLANS, SPECIFICATIONS, OR CONTRACT FOR THE PROJECT.

NOTE - 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.



PROJECT: U-4756 ID:

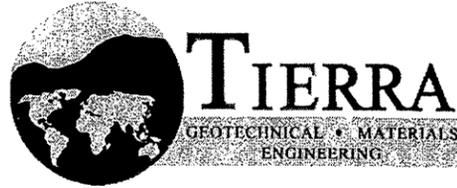
**NORTH CAROLINA DEPARTMENT OF TRANSPORTATION**  
**DIVISION OF HIGHWAYS**  
**GEOTECHNICAL ENGINEERING UNIT**

ID	STATE PROJECT NO.	SHEET NO.	TOTAL SHEETS
	U-4756	2	16

## SUBSURFACE INVESTIGATION

### SOIL AND ROCK LEGEND, TERMS, SYMBOLS, AND ABBREVIATIONS

SOIL DESCRIPTION		GRADATION		ROCK DESCRIPTION		TERMS AND DEFINITIONS																																																																																																																																													
<p>SOIL IS CONSIDERED TO BE THE UNCONSOLIDATED, SEMI-CONSOLIDATED OR WEATHERED EARTH MATERIALS WHICH CAN BE PENETRATED WITH A CONTINUOUS FLIGHT POWER AUGER, AND WHICH YIELDS LESS THAN 100 BLOWS PER FOOT ACCORDING TO STANDARD PENETRATION TEST (AASHTO T206, ASTM D-1586). SOIL CLASSIFICATION IS BASED ON THE AASHTO SYSTEM AND BASIC DESCRIPTIONS GENERALLY SHALL INCLUDE: CONSISTENCY, COLOR, TEXTURE, MOISTURE, AASHTO CLASSIFICATION, AND OTHER PERTINENT FACTORS SUCH AS MINERALOGICAL COMPOSITION, ANGULARITY, STRUCTURE, PLASTICITY, ETC. EXAMPLE:</p> <p style="text-align: center;"><i>VERY STIFF, GRAY SILTY CLAY, MOIST WITH INTERBEDDED FINE SAND LAYERS, HIGHLY PLASTIC, A-7-6</i></p>		<p><b>WELL GRADED:</b> INDICATES A GOOD REPRESENTATION OF PARTICLE SIZES FROM FINE TO COARSE UNIFORM. INDICATES THAT SOIL PARTICLES ARE ALL APPROXIMATELY THE SAME SIZE. (ALSO POORLY GRADED)</p> <p><b>GAP-GRADED:</b> INDICATES A MIXTURE OF UNIFORM PARTICLES OF TWO OR MORE SIZES.</p> <p style="text-align: center;"><b>ANGULARITY OF GRAINS</b></p> <p>THE ANGULARITY OR ROUNDNESS OF SOIL GRAINS ARE DESIGNATED BY THE TERMS: <u>ANGULAR</u>, <u>SUBANGULAR</u>, <u>SUBROUNDED</u>, OR <u>ROUNDED</u>.</p>		<p>HARD ROCK IS NON-COASTAL PLAIN MATERIAL THAT WHEN TESTED, WOULD YIELD SPT REFUSAL, 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.</p> <p>ROCK MATERIALS ARE TYPICALLY DIVIDED AS FOLLOWS:</p>		<p><b>ALLUVIUM (ALLUV.)</b> - SOILS WHICH HAVE BEEN TRANSPORTED BY WATER.</p> <p><b>AQUIFER</b> - A WATER BEARING FORMATION OR STRATA.</p> <p><b>ARENACEOUS</b> - APPLIED TO ROCKS THAT HAVE BEEN DERIVED FROM SAND OR THAT CONTAIN SAND.</p> <p><b>ARGILLACEOUS</b> - APPLIED TO ALL ROCKS OR SUBSTANCES COMPOSED OF CLAY MINERALS, OR HAVING A NOTABLE PROPORTION OF CLAY IN THEIR COMPOSITION, AS SHALE, SLATE, ETC.</p> <p><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.</p> <p><b>CALCAREOUS (CALC.)</b> - SOILS WHICH CONTAIN APPRECIABLE AMOUNTS OF CALCIUM CARBONATE.</p> <p><b>COLLUVIUM</b> - ROCK FRAGMENTS MIXED WITH SOIL DEPOSITED BY GRAVITY ON SLOPE OR AT BOTTOM OF SLOPE.</p> <p><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.</p> <p><b>DIKE</b> - A TABULAR BODY OF IGNEOUS ROCK THAT CUTS ACROSS THE STRUCTURE OF ADJACENT ROCKS OR CUTS MASSIVE ROCK.</p> <p><b>DIP</b> - THE ANGLE AT WHICH A STRATUM OR ANY PLANAR FEATURE IS INCLINED FROM THE HORIZONTAL.</p> <p><b>DIP DIRECTION (DIP AZIMUTH)</b> - THE DIRECTION OR BEARING OF THE HORIZONTAL TRACE OF THE LINE OF DIP, MEASURED CLOCKWISE FROM NORTH.</p> <p><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.</p> <p><b>FISSILE</b> - A PROPERTY OF SPLITTING ALONG CLOSELY SPACED PARALLEL PLANES.</p> <p><b>FLOAT</b> - ROCK FRAGMENTS ON SURFACE NEAR THEIR ORIGINAL POSITION AND DISLODGED FROM PARENT MATERIAL.</p> <p><b>FLOOD PLAIN (F.P.)</b> - LAND BORDERING A STREAM, BUILT OF SEDIMENTS DEPOSITED BY THE STREAM.</p> <p><b>FORMATION (FM.)</b> - A MAPPABLE GEOLOGIC UNIT THAT CAN BE RECOGNIZED AND TRACED IN THE FIELD.</p> <p><b>JOINT</b> - FRACTURE IN ROCK ALONG WHICH NO APPRECIABLE MOVEMENT HAS OCCURRED.</p> <p><b>LEDGE</b> - A SHELF-LIKE RIDGE OR PROJECTION OF ROCK WHOSE THICKNESS IS SMALL COMPARED TO ITS LATERAL EXTENT.</p> <p><b>LENS</b> - A BODY OF SOIL OR ROCK THAT THINS OUT IN ONE OR MORE DIRECTIONS.</p> <p><b>MOTTLED (MOT.)</b> - IRREGULARLY MARKED WITH SPOTS OF DIFFERENT COLORS, MOTTLING IN SOILS USUALLY INDICATES POOR AERATION AND LACK OF GOOD DRAINAGE.</p> <p><b>PERCHED WATER</b> - WATER MAINTAINED ABOVE THE NORMAL GROUND WATER LEVEL BY THE PRESENCE OF AN INTERVENING IMPERVIOUS STRATUM.</p> <p><b>RESIDUAL SOIL</b> - SOIL FORMED IN PLACE BY THE WEATHERING OF ROCK.</p> <p><b>ROCK QUALITY DESIGNATION (R.Q.D.)</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.</p> <p><b>SAPROLITE (SAP.)</b> - RESIDUAL SOIL WHICH RETAINS THE RELIC STRUCTURE OR FABRIC OF THE PARENT ROCK.</p> <p><b>SILL</b> - AN INTRUSIVE BODY OF IGNEOUS ROCK OF APPROXIMATELY UNIFORM THICKNESS AND RELATIVELY THIN COMPARED WITH ITS LATERAL EXTENT, WHICH HAS BEEN EMPLACED PARALLEL TO THE BEDDING OR SCHISTOSITY OF THE INTRUDED ROCKS.</p> <p><b>SLICKENSIDE</b> - POLISHED AND STRIATED SURFACE THAT RESULTS FROM FRICTION ALONG A FAULT OR SLIP PLANE.</p> <p><b>STANDARD PENETRATION TEST (PENETRATION RESISTANCE) (SPT)</b> - NUMBER OF BLOWS IN OR B.P.F. 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 LESS THAN 0.1 FOOT PENETRATION WITH 60 BLOWS.</p> <p><b>STRATA CORE RECOVERY (SREC.)</b> - TOTAL LENGTH OF STRATA MATERIAL RECOVERED DIVIDED BY TOTAL LENGTH OF STRATUM AND EXPRESSED AS A PERCENTAGE.</p> <p><b>STRATA ROCK QUALITY DESIGNATION (S.R.Q.D.)</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.</p> <p><b>TOPSOIL (T.S.)</b> - SURFACE SOILS USUALLY CONTAINING ORGANIC MATTER.</p>																																																																																																																																													
<p style="text-align: center;"><b>SOIL LEGEND AND AASHTO CLASSIFICATION</b></p> <table border="1" style="width: 100%; border-collapse: collapse;"> <tr> <th rowspan="2">GENERAL CLASS.</th> <th colspan="4">GRANULAR MATERIALS (35% PASSING #200)</th> <th colspan="4">SILT-CLAY MATERIALS (35% PASSING #200)</th> <th colspan="4">ORGANIC MATERIALS</th> </tr> <tr> <th>A-1</th> <th>A-3</th> <th>A-2</th> <th>A-4</th> <th>A-5</th> <th>A-6</th> <th>A-7</th> <th>A-1, A-2</th> <th>A-4, A-5</th> <th>A-6, A-7</th> <th>A-1, A-2</th> <th>A-4, A-5</th> <th>A-6, A-7</th> </tr> <tr> <td>GROUP CLASS.</td> <td>A-1-a</td> <td>A-1-b</td> <td>A-2-4</td> <td>A-2-5</td> <td>A-2-6</td> <td>A-2-7</td> <td>A-4-1</td> <td>A-4-2</td> <td>A-4-3</td> <td>A-4-4</td> <td>A-4-5</td> <td>A-4-6</td> <td>A-4-7</td> </tr> <tr> <td>SYMBOL</td> <td></td> </tr> <tr> <td>% PASSING</td> <td>50 MX</td> <td>30 MX</td> <td>15 MX</td> <td>10 MX</td> <td>10 MN</td> </tr> <tr> <td>LIQUID LIMIT</td> <td>6 MX</td> <td>N.P.</td> <td>40 MX</td> <td>40 MN</td> </tr> <tr> <td>PLASTIC INDEX</td> <td>6 MX</td> <td>N.P.</td> <td>10 MX</td> <td>10 MN</td> </tr> <tr> <td>GROUP INDEX</td> <td>0</td> <td>0</td> <td>0</td> <td>4 MX</td> <td>8 MX</td> <td>12 MX</td> <td>16 MX</td> </tr> <tr> <td>USUAL TYPES OF MAJOR MATERIALS</td> <td>STONE FRAGS. GRAVEL AND SAND</td> <td>FINE SAND</td> <td>SILTY OR CLAYEY GRAVEL AND SAND</td> <td>SILTY SOILS</td> <td>CLAYEY SOILS</td> </tr> <tr> <td>GENERATING AS A SUBGRADE</td> <td colspan="4">EXCELLENT TO GOOD</td> <td colspan="4">FAIR TO POOR</td> <td>FAIR TO POOR</td> <td>POOR</td> <td>UNSATURABLE</td> <td></td> <td></td> </tr> </table> <p style="text-align: center;">P.I. OF A-7-5 ≤ L.L. - 30 ; P.I. OF A-7-6 &gt; L.L. - 30</p>		GENERAL CLASS.	GRANULAR MATERIALS (35% PASSING #200)				SILT-CLAY MATERIALS (35% PASSING #200)				ORGANIC MATERIALS				A-1	A-3	A-2	A-4	A-5	A-6	A-7	A-1, A-2	A-4, A-5	A-6, A-7	A-1, A-2	A-4, A-5	A-6, A-7	GROUP CLASS.	A-1-a	A-1-b	A-2-4	A-2-5	A-2-6	A-2-7	A-4-1	A-4-2	A-4-3	A-4-4	A-4-5	A-4-6	A-4-7	SYMBOL														% PASSING	50 MX	30 MX	15 MX	10 MX	10 MN	10 MN	10 MN	10 MN	10 MN	10 MN	10 MN	10 MN	10 MN	LIQUID LIMIT	6 MX	N.P.	40 MX	40 MN	PLASTIC INDEX	6 MX	N.P.	10 MX	10 MN	GROUP INDEX	0	0	0	4 MX	8 MX	12 MX	16 MX	USUAL TYPES OF MAJOR MATERIALS	STONE FRAGS. GRAVEL AND SAND	FINE SAND	SILTY OR CLAYEY GRAVEL AND SAND	SILTY SOILS	CLAYEY SOILS	GENERATING AS A SUBGRADE	EXCELLENT TO GOOD				FAIR TO POOR				FAIR TO POOR	POOR	UNSATURABLE			<p style="text-align: center;"><b>MINERALOGICAL COMPOSITION</b></p> <p>MINERAL NAMES SUCH AS QUARTZ, FELDSPAR, MICA, TALC, KAOLIN, ETC. ARE USED IN DESCRIPTIONS WHENEVER THEY ARE CONSIDERED OF SIGNIFICANCE.</p>		<p style="text-align: center;"><b>COMPRESSIBILITY</b></p> <p>SLIGHTLY COMPRESSIBLE      LIQUID LIMIT LESS THAN 30          MODERATELY COMPRESSIBLE      LIQUID LIMIT 31-50          HIGHLY COMPRESSIBLE      LIQUID LIMIT GREATER THAN 50</p>		<p style="text-align: center;"><b>WEATHERED ROCK (WR)</b></p> <p>NON-COASTAL PLAIN MATERIAL THAT YIELDS SPT N VALUES &gt; 100 BLOWS PER FOOT.</p>		<p style="text-align: center;"><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>																																	
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May 1, 2007

Mr. Kevin Austin, P.E.  
Mulkey Engineers and Consultants  
6750 Tryon Road  
Cary, NC 27511

**Re: Geotechnical Subsurface Exploration Report**

Project ID.: U-4756  
County: Cumberland County  
Description: Bridge on Morganton Road over All American Freeway  
Tierra Inc. Proj. No.: 6211-07-018

Dear Mr. Austin:

As authorized, Tierra, Inc. (Tierra) has completed the geotechnical subsurface exploration for Bridge on Morganton Road over All American Freeway in Cumberland County, North Carolina. Our investigation was performed in general accordance with our proposal number TR-07-017, dated March 29, 2007. The purpose of this report is to present subsurface conditions and foundation design recommendations for the planned structure. Field and laboratory test results, site and boring location plans, and profiles depicting subsurface conditions may be found in this report.

**PROJECT DESCRIPTION**

According to a general drawing provided by Mulkey Engineers and Consultants, dated February 2007, the referenced project intends to replace and widen the existing two span, three bent bridge structure on Morganton Road over All American Freeway. Based upon the plans prepared by NCDOT, it is our understanding that the existing structure is supported by driven HP 12x53 steel piles at end bents and footings on driven 12 inch prestressed concrete piles at interior bent. These foundations are to be reutilized to support the proposed structure. The existing piles were designed for an allowable capacity of 30 tons each. However, construction records indicating production piles lengths, capacities and tip elevations were not available at the time of this report. We also understand that a previous subsurface investigation was performed by NCDOT and included a total of six (6) SPT borings, two (2) borings per bent.

The proposed structure is to consist of a two span, three bent bridge with a length of approximately 240 feet and a skew angle of approximately 73 degree. The structure is planned to be located along the same alignment as the existing structure but will be widened to the north and south. From our conversation with Mulkey Engineers and Consultants, we understand that due to existing utilities located immediately adjacent to the widening portion of the interior bent, drilled shaft foundations are desired. In addition, use of HP 12x53 piles at end bents in widened areas is also preferred. The end bent caps will be at an elevation of approximately 241 feet and interior bent at an elevation of 240 feet.

If any of the above information is incorrect or has changed, please inform Tierra so that we may amend the recommendations presented in this report if appropriate.

**SITE DESCRIPTION/GEOLOGY**

The proposed project site is located at intersection of Morganton Road and All American Freeway in Fayetteville, North Carolina. In general, the area is developed and contains an existing bridge structure, paved roadway and grassed shoulders and medians.

The project site is located in the Coastal Plain Physiographic Province of North Carolina. *The Geologic Map of North Carolina* (1985) indicates the bridge site is located within the Cape Fear Formation (Kc). The Cretaceous materials of this formation typically consist of sandstone, mudstone and continuous beds of micaceous and feldspar rich sands and blocky mottled red and yellow clays.

**FIELD EVALUATION PROCEDURE**

The subsurface exploration consisted of performing two (2) soil test borings along the proposed interior bent line. In addition, Tierra has reviewed previous test boring information obtained by NCDOT. Tierra's borings were performed with a CME 45 trailer mounted drill rig with a manual hammer. Due to the presence of subsurface and overhead utilities, the borings were offset approximately 20 to 25 feet from the proposed shaft locations. Standard Penetration Tests (SPT) and soil sampling were performed in general accordance with American Association of State Highway Transportation Officials (AASHTO T-206-87).

Groundwater measurement readings were taken within each borehole with a weighted 100-foot measuring tape from a reference location at the top of each boring. Readings were recorded immediately after boring termination and after a 24-hour waiting period. Test boring elevations were approximated from topographic information provided by Mulkey Engineers and Consultants.

**SUBSURFACE AND GROUNDWATER CONDITIONS**

Based upon the results of our subsurface exploration and the previous test borings drilled by NCDOT, subsurface soils penetrated beneath the site generally consist of roadway embankment soil underlain by coastal plain deposited materials to the boring termination depths.

**End Bents**

A total of four (4) borings (EB1-A, EB1-B, EB2-A and EB2-B) were drilled prior to the construction of the end bents. Copies of the original test boring logs are included in this report and our interpretation of their profiles is presented as well. The soils are noted to consist of very soft to hard silty/sandy clay (A-6, A-7-5) and very loose to very dense silty/clayey sand and fine to coarse sand (A-2-4, A-2-6, A-3, A-1-b). The borings were extended to depths of approximately 60 to 65 feet (elevations of approximately 160 feet to 166 feet).

### Interior Bent

The results of our subsurface investigation indicate that soils beneath Interior Bent No. 1 consist of roadway embankment underlain by coastal plain materials. Roadway embankment soils were encountered at the ground surface and consist of approximately 3 feet of loose to medium dense silty sand and fine sand (A-2-4, A-3). Coastal plain soils were encountered below the roadway embankment and extended to the boring termination depths of approximately 79 to 80 feet (elevations of 146 to 147 feet). These soils consist of very soft to very stiff sandy/silty clay (A-6, A-7-5, A-7-6) and very loose to very dense silty/clayey sand and fine to coarse sand (A-2-4, A-2-6, A-3, A-1-b).

Groundwater across the site ranged from elevations of approximately 218 to 220 feet. In addition, a loss of drilling fluids occurred in boring B1A between the depths of 50 to 60 feet below ground surface.

### LABORATORY TESTING

Representative split-spoon samples were selected from soil test borings to verify visual field classifications and determine soil index properties. A total of four (4) samples were analyzed in our laboratory for natural moisture determination, Atterberg limits, and grain size analysis. All testing was performed in accordance with the following American Society for Testing and Materials (ASTM), (NCDOT) Modified and/or (AASHTO) procedures:

- AASHTO T-88-00 (As Modified) "Particle Size Analysis of Soil"
- AASHTO T-89-902 (As Modified) "Determining the Liquid Limits of Soil"
- AASHTO T-90-00 "Determining the Plastic Limit and Plasticity of Soils"
- AASHTO T-265-93 "Laboratory Determination of Moisture Content of Soils"

The results of the laboratory testing indicate that the site soils tested ranged from sandy clay (A-6) to silty sand (A-2-4).

### CONCLUSIONS

The results of our subsurface investigation and review of previous subsurface investigation by NCDOT indicate that the subsurface conditions consist predominately of coastal plain deposits of very soft to hard clay and very loose to very dense sand. The coastal plain deposited soils extended to the boring termination depths ranging from approximately 60 to 80 feet. Considering the depth of competent bearing materials and close proximity of existing utilities, it is anticipated that driven HP steel piles will be suitable for support of the bridge end bents and are anticipated to have reduced vibration impacts in comparison to driven concrete piles. In addition, due to potential utility issues and vibrations, drilled piers bearing in very dense sandy material will be utilized for the interior bent.

### FOUNDATION RECOMMENDATIONS

Based on the subsurface conditions and our analysis, the end bents for the proposed bridge may be supported by driven HP 12x53 steel piles and interior bent by 42 inch diameter drilled piers. The piles for the end bents may be designed using an allowable capacity of 45 tons. The allowable pile capacities were estimated utilizing static methods and a safety factor of 2. The actual capacity of the piles should be verified during installation using pile driving criteria, from wave equation analysis, established by the Geotechnical Engineer. The piers for the interior bent should be designed to bear in very dense sandy material beginning at elevations of approximately 168 to 169 feet and have a tip elevation no higher than 151 feet. The piers should also be designed using an allowable capacity of 310 tons with a safety factor of 2.5. For more information, refer to the attached "Summary of Foundation Recommendations".

The piles and piers shall be spaced at a minimum of three times the pile diameter to prevent reductions due to group effects. During construction of the end bent caps, the embankment soils should be laid back at no steeper than (2H:1V) or as required by OSHA. Temporary shoring may also be required. Backfill behind the end bent caps shall be replaced in accordance with Section 410-8 and 410-9 of the Standard Specifications.

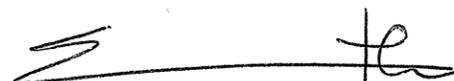
From the information provided, we understand the structure will be constructed at or near existing site grades. Provided that the embankments are constructed in accordance with NCDOT specifications and suitable slope protection measures are incorporated, the slopes may be reconstructed as planned.

### CLOSURE

Recommendations and evaluations provided by Tierra are based upon previous subsurface information prepared by NCDOT, the General Drawing dated February 2007, and information provided by Mulkey Engineers and Consultants. Modifications of our recommendations and evaluations may be required if there are changes to the design or location of the structure. Recommendations in this report are based on data obtained from current and previous soil borings. The nature and extent of variations between borings may not become evident until construction.

Our professional services for this project have been performed in accordance with generally accepted engineering practices. No other warranty, expressed or implied, is made. Tierra appreciates this opportunity to have provided you with geotechnical engineering services for this project. If you have any questions regarding this report, please contact our office.

Sincerely,  
**TIERRA, INC.**

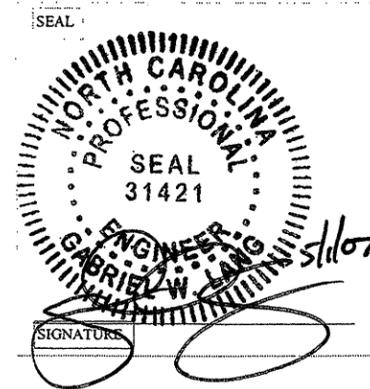
  
Seungwoon (Sean) Han, Ph.D., P.E.  
Geotechnical Engineer

  
Gabriel W. Lang, P.E.  
Sr. Geotechnical Engineer Manager 5/1/07

## SUMMARY OF FOUNDATION RECOMMENDATIONS

NCDOT PROJ. NO.: U-4756 PROJECT DESCRIPTION: Bridge on Morganton Road  
 T.I.P. NO.: \_\_\_\_\_ over All American Freeway  
 COUNTY: Cumberland  
 STATION: 44+88 -L-

PREPARED BY: SWH DATE: 4/27/07  
 CHECKER: GWL DATE: 5/1/07



### Note on Plans:

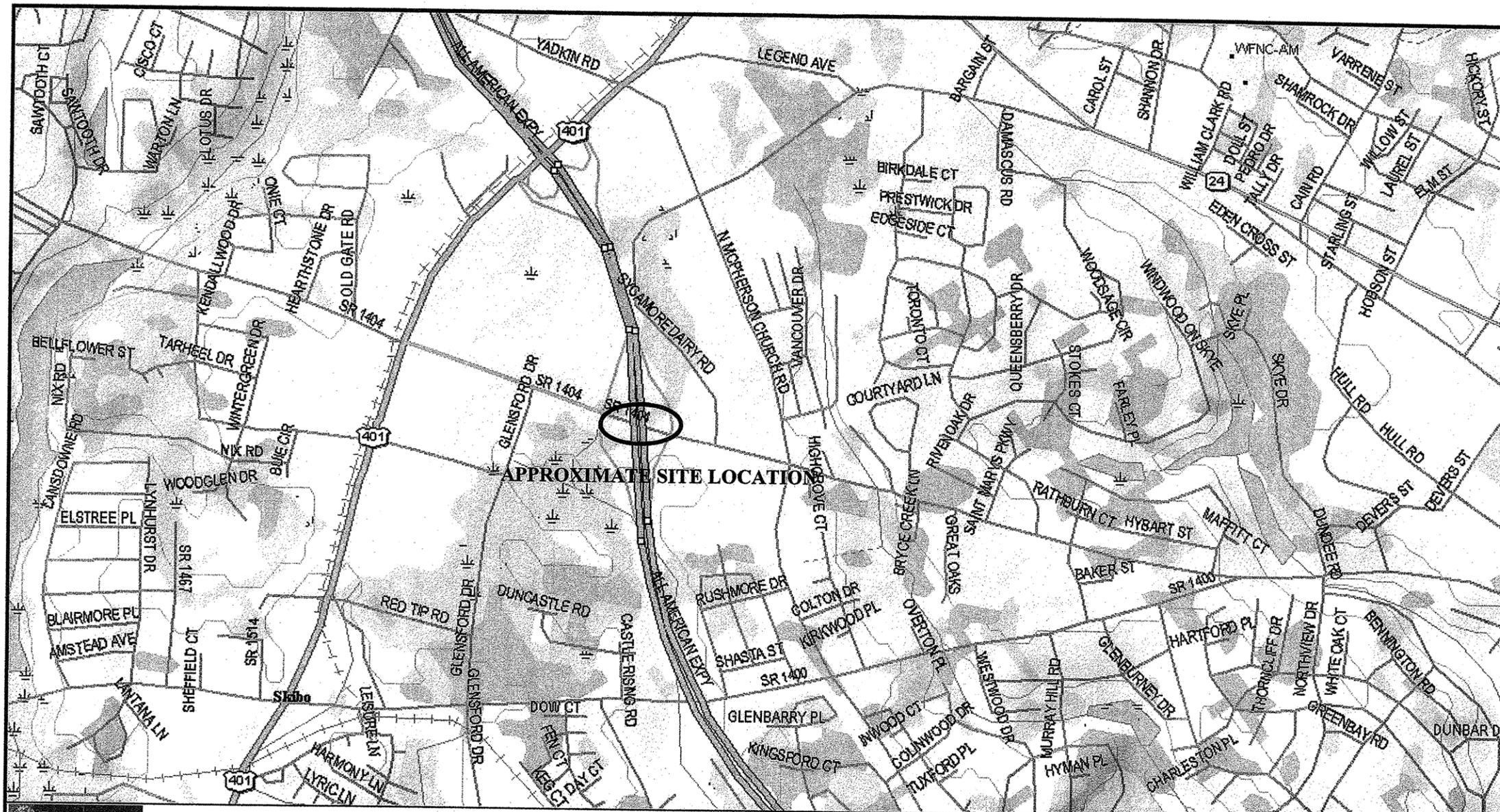
1. Drive piles at End Bents No. 1 and 2 to a required bearing capacity of 90 tons per pile. The required bearing capacity is equal to the allowable bearing capacity with a minimum factor of safety of two.
2. The allowable bearing capacity for piles at End Bents No. 1 and 2 is 45 tons per pile.
3. Drilled piers at Bent No. 1 are designed for both skin friction and end bearing. Check field conditions for the required end bearing capacity of 30 tsf.
4. Drilled piers at Bent No.1 are designed for an applied load of 265 tons at the top of the column.
5. Drilled piers at Bent No. 1 shall extend to an elevation no higher than 151 ft and satisfy the required end bearing capacity.
6. SPT testing is required to determine the end bearing capacity of the drilled piers at Bent No. 1.
7. Slurry construction is required for drilled piers at Bent No. 1. See Drilled Piers Special Provision.
8. Do not use polymer slurry for drilled piers at Bent No. 1.
9. SID inspections are required to inspect the bottom cleanliness of the drilled piers at Bent No.1. See Drilled Piers Special Provision.
10. CSL tubes are required and CSL testing may be required for the drilled piers. The Engineer will determine the need for CSL testing. See Crosshole Sonic Logging Special Provision.
11. For drilled piers, see Drilled Piers Special Provision.

### Comments:

1. Considering a maximum lateral force of 8.1 kips, the elevation of the point of fixity for Bent No. 1 is 208 ft.
2. Pile recommendations are based upon previous subsurface information at site by NCDOT as presented in their plans, Sheet S-31, Project No. 8.2326309; and our assumptions on the embankment fill.
3. A loss of drilling fluids occurred in boring B1A between the depths of 50 to 60 feet.

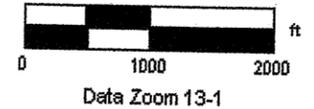
	STATION	FOUNDATION TYPE	ALLOWABLE LOAD	FOUNDATION DETAILS
END BENT 1	43+67 -L-	Cap on HP 12x53 Steel Pile	45 tons/Pile	Assumed Bottom of Cap = 241 ft ± Recommended Length of Pile = 75 ft
BENT 1	44+88 -L-	42" Drilled Pier	310 tons/Pier	Assumed Bottom of Cap = 240 ft ± Assumed Top of Pier = 224 ft Tip Elevation No Higher Than = 151 ft Recommended Length of Pier = 73 ft
END BENT 2	46+10 -L-	Cap on HP 12x53 Steel Pile	45 tons/Pile	Assumed Bottom of Cap = 241 ft ± Recommended Length of Pile = 75 ft

COMMENTS & NOTES (Attached)



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MN (8.4" W)

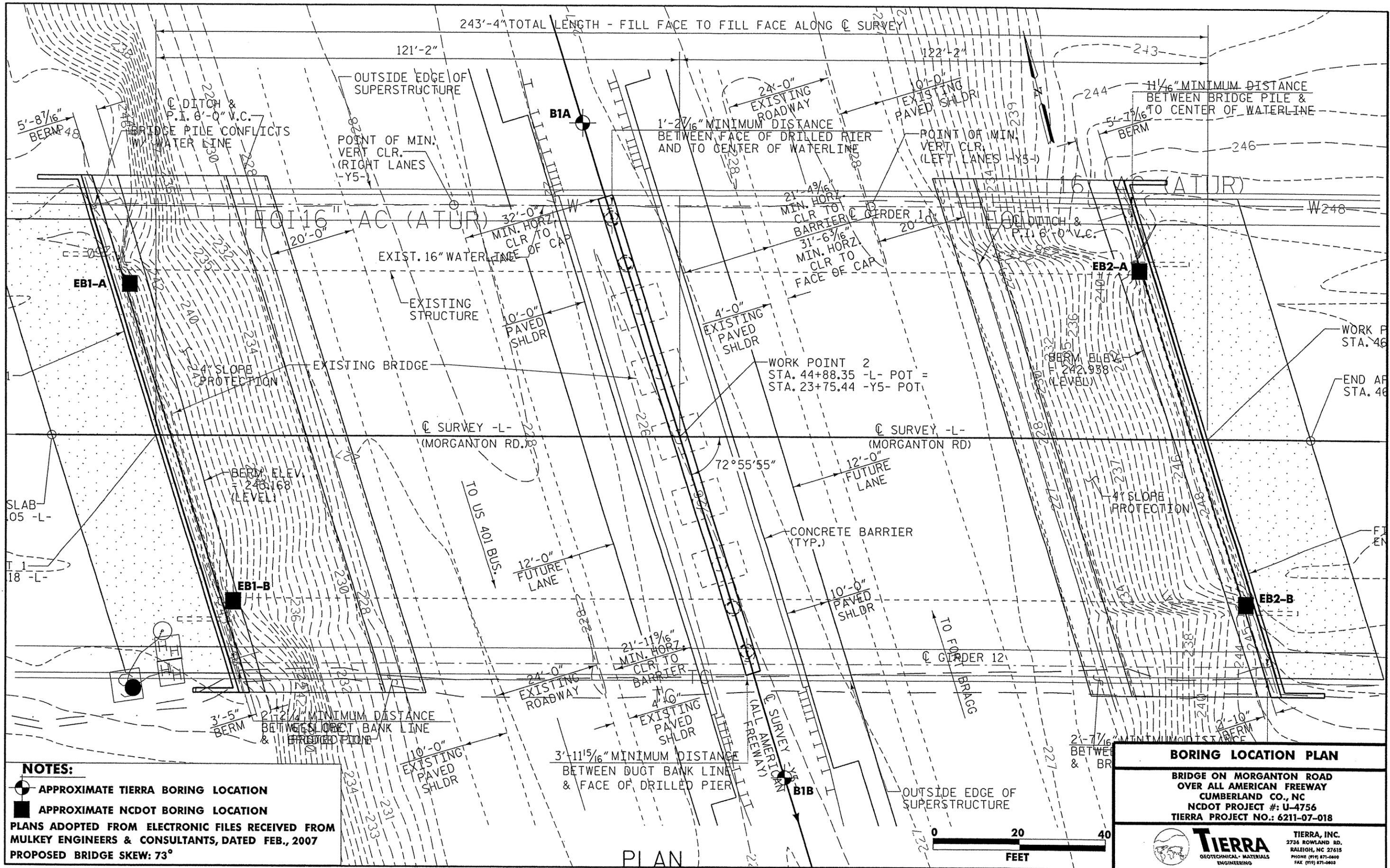


**SITE VICINITY MAP**

**BRIDGE ON MORGANTON ROAD  
 OVER ALL AMERICAN FREEWAY  
 CUMBERLAND CO., NC  
 NCDOT PROJECT #: U-4756  
 TIERRA PROJECT #: 6211-07-018**



TIERRA, INC.  
 2736 ROWLAND RD.  
 RALEIGH, NC 27615  
 PHONE (919) 871-0800  
 FAX (919) 871-0803



**NOTES:**

- APPROXIMATE TIERRA BORING LOCATION
- APPROXIMATE NCDOT BORING LOCATION

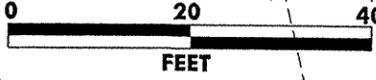
PLANS ADOPTED FROM ELECTRONIC FILES RECEIVED FROM MULKEY ENGINEERS & CONSULTANTS, DATED FEB., 2007  
 PROPOSED BRIDGE SKEW: 73°

**BORING LOCATION PLAN**

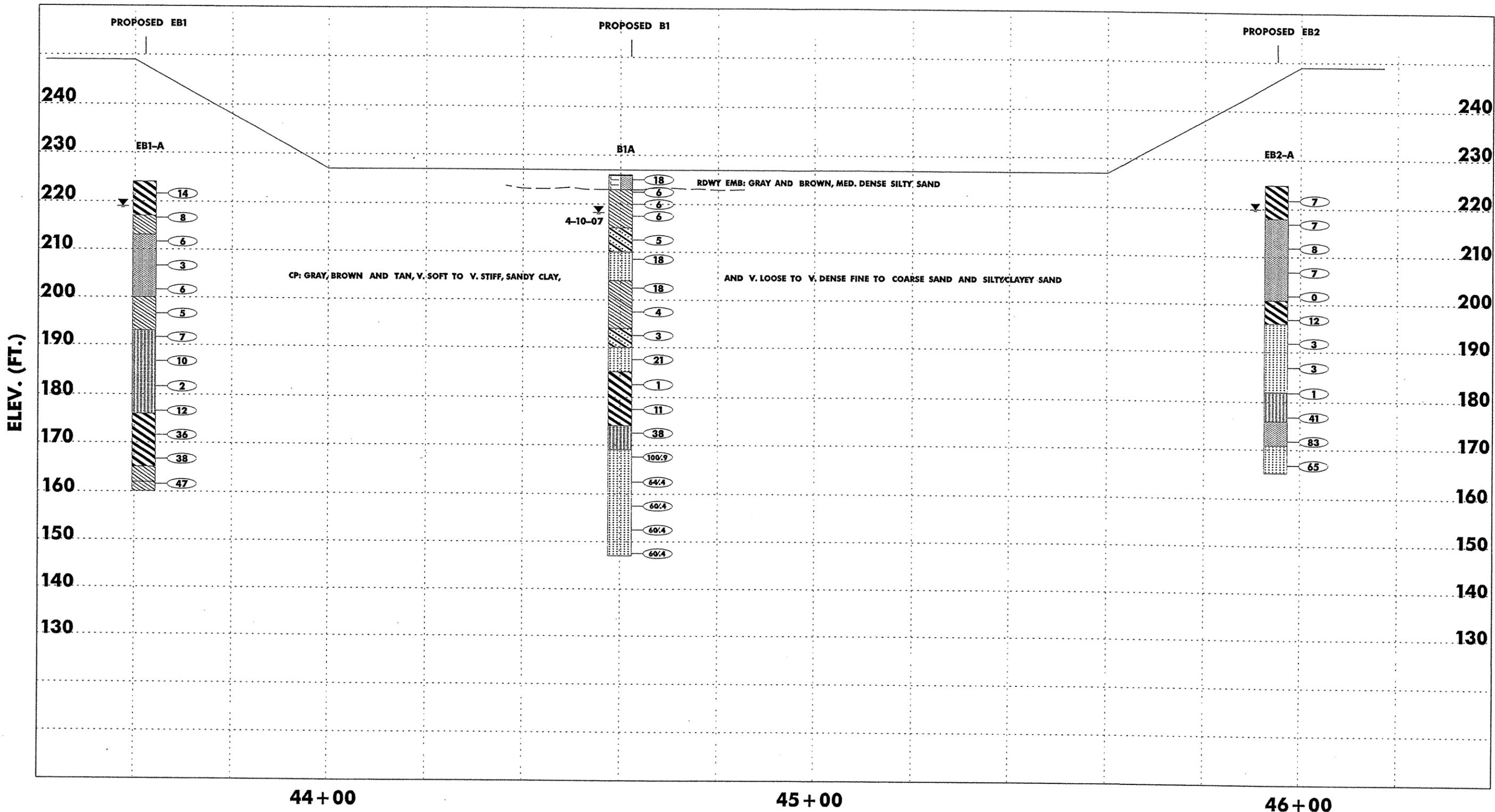
BRIDGE ON MORGANTON ROAD  
 OVER ALL AMERICAN FREEWAY  
 CUMBERLAND CO., NC  
 NCDOT PROJECT #: U-4756  
 TIERRA PROJECT NO.: 6211-07-018


**TIERRA**  
 GEOTECHNICAL MATERIALS  
 ENGINEERING

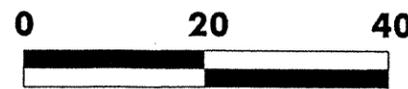
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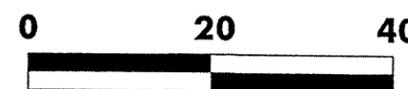
PLAN



VERTICAL SCALE



HORIZONTAL SCALE

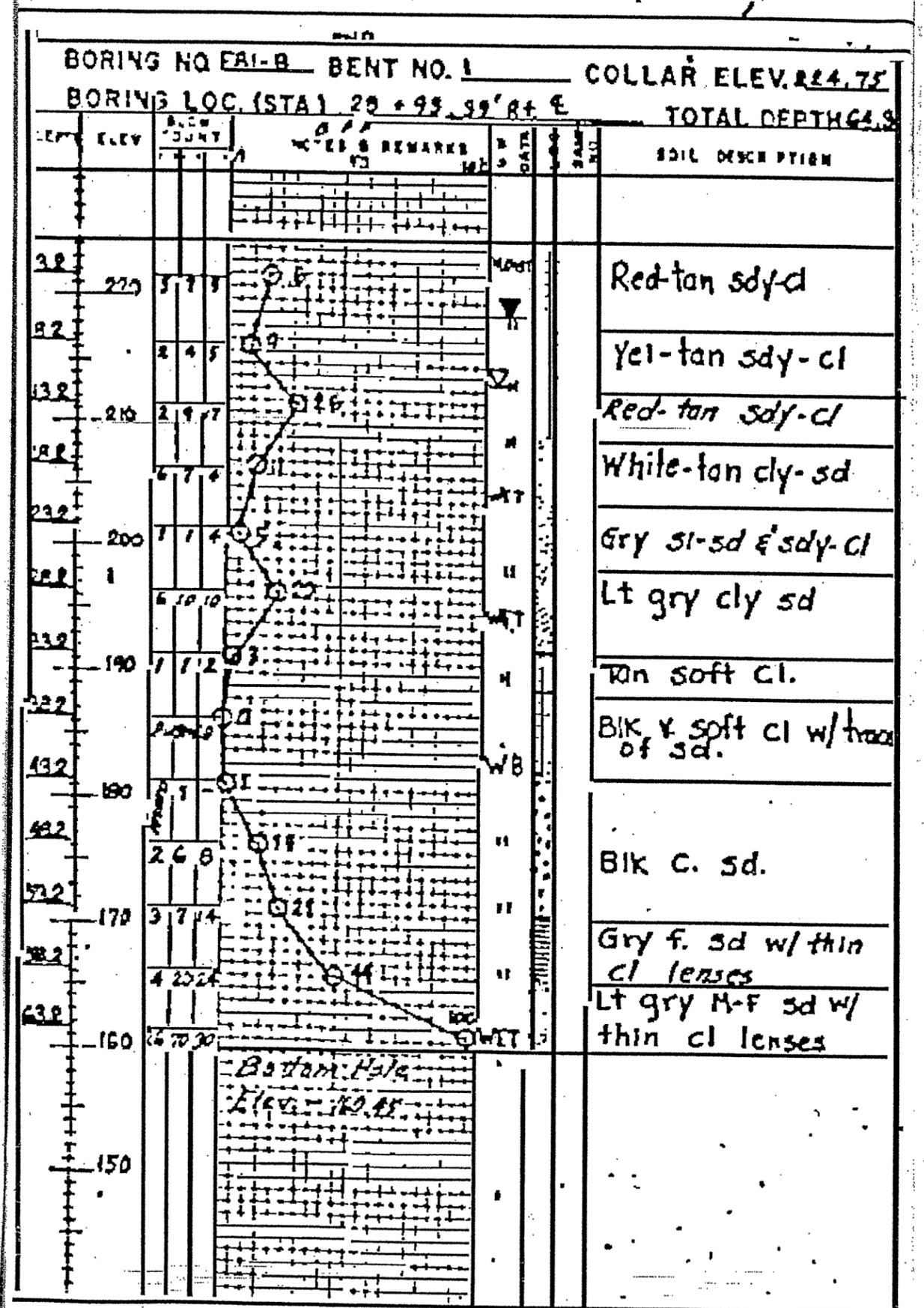
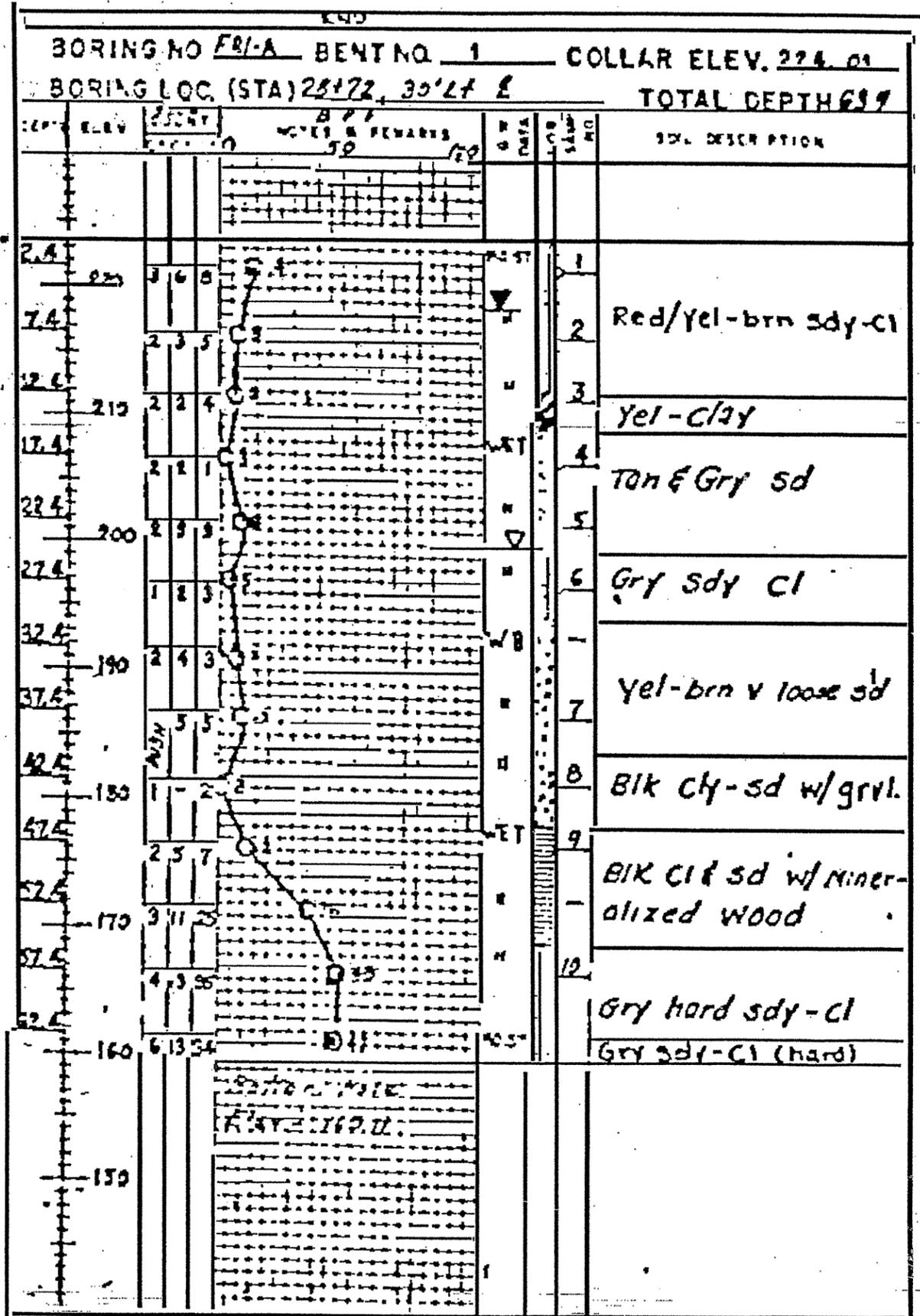


PROFILE 39' LEFT OF -L-

BRIDGE ON MORGANTON ROAD  
OVER ALL AMERICAN FREEWAY  
CUMERLAND CO., NC  
NCDOT PROJECT #: U-4756  
TIERRA PROJECT NO.: 6211-07-018

TIERRA, INC.  
2756 ROWLAND RD.  
RALEIGH, NC 27615  
PHONE 919 875-4666  
FAX 919 875-4663





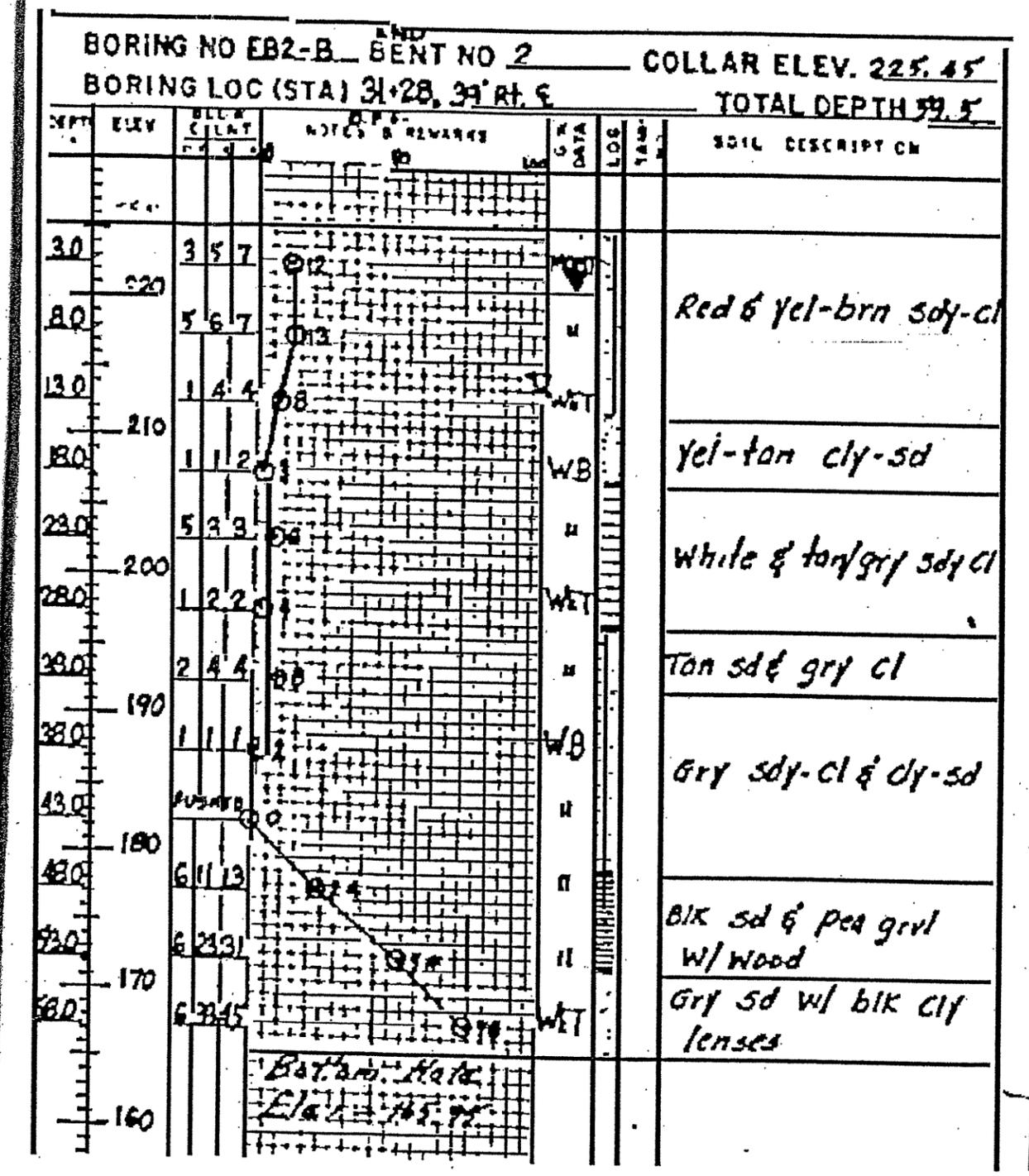
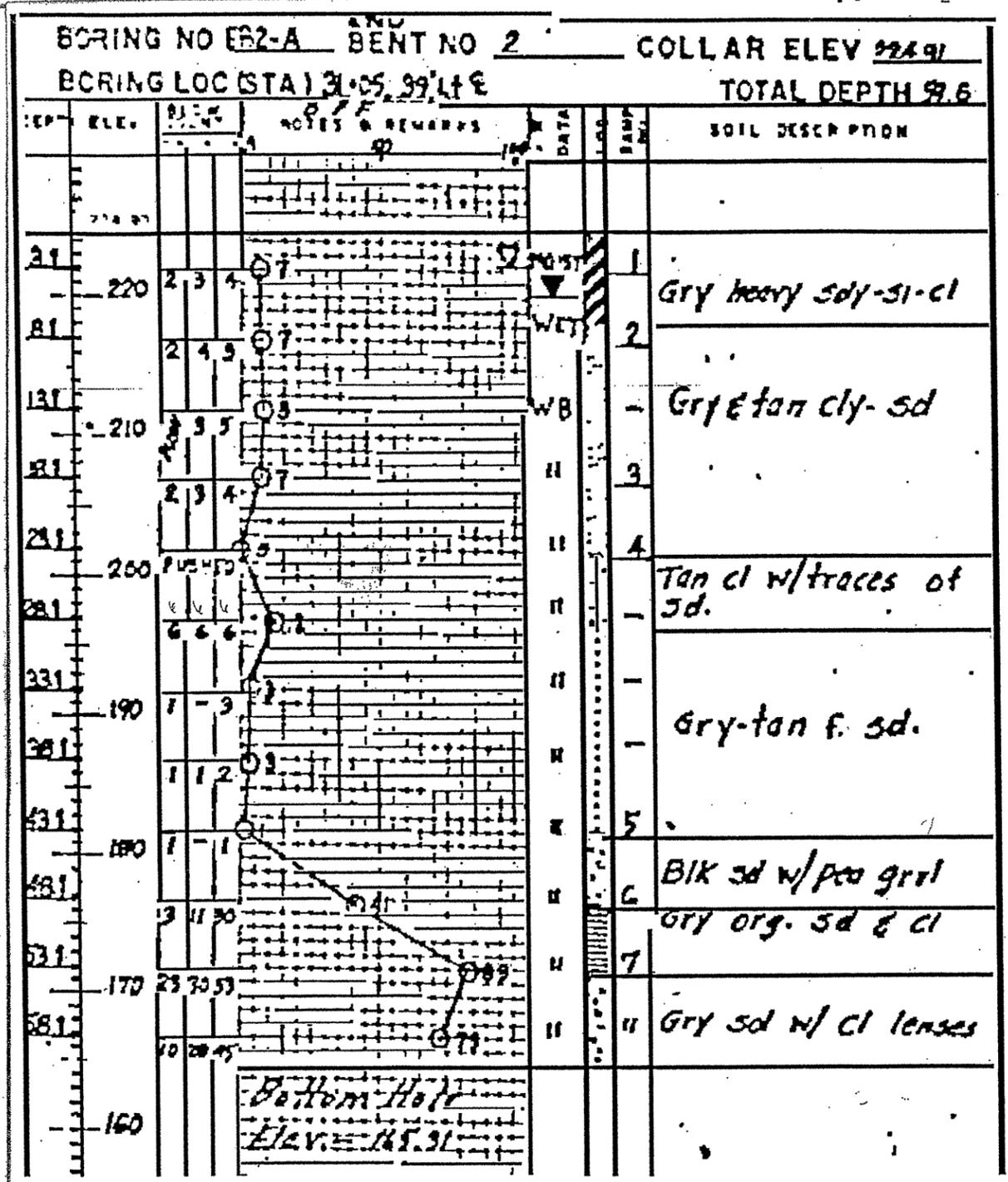
PROJECT NO. U-4756		ID.		COUNTY CUMBERLAND, NC		GEOLOGIST S. HAN							
SITE DESCRIPTION BRIDGE ON MORGANTON ROAD OVER ALL AMERICAN FREEWAY						GROUND WATER (ft)							
BORING NO. B1A		BORING LOCATION 44+60		OFFSET 73' LT		ALIGNMENT							
COLLAR ELEV. 226 ft		NORTHING		EASTING		0 HR. 12							
TOTAL DEPTH 79.0 ft		DRILL MACHINE CME 45		DRILL METHOD MUD ROTARY		HAMMER TYPE MANUAL							
DATE STARTED 4-9-07		COMPLETED 4-9-07		SURFACE WATER DEPTH N/A									
ELEV. (ft)	DEPTH (ft)	BLOW COUNT			BLOWS PER FOOT					SAMP. NO.	LOG	SOIL AND ROCK DESCRIPTION	
		0.5ft	0.5ft	0.5ft	0	20	40	60	80				100
226.0													EXISTING GROUND
225.0	1.0	12	9	9								M	225.8 ROOTMAT
	3.5												223.0 RDWY EMB: GRAY AND BROWN, MED. DENSE, SILTY SAND (A-2-4)
	6.0	2	3	3								SS-1 23.5%	CP: GRAY, MED. STIFF, SANDY CLAY (A-6)
	8.5	3	3	3								M	
	13.5	2	3	3								W	215.0 CP: GRAY, LOOSE, CLAYEY SAND (A-2-6)
	17.5	5	6	12								W	210.0 CP: GRAY, MED. DENSE, SAND (A-3)
	23.5	3	8	10								SS-2 24.4%	204.0 CP: GRAY, V. STIFF TO SOFT, SANDY CLAY (A-6)
	28.5	1	1	3								W	194.0 CP: GRAY, V. LOOSE, CLAYEY SAND (A-2-6)
	33.5	2	2	1								W	190.0 CP: GRAY, MED. DENSE, SAND (A-3)
	38.5	9	10	11								W	185.0 CP: GRAY AND TAN, V. SOFT TO STIFF, SANDY CLAY (A-7-5)
	43.5	WOH	WOH	1								W	
	48.5	4	5	6								W	174.0 CP: GRAY, DENSE, COARSE SAND (A-1-b)
	53.5	6	10	28								W	169.0 CP: GRAY AND BROWN, V. DENSE, SAND (A-3)
	58.5	31	57	43/4								W	
	63.5	36	64/4									W	
	68.5	60/4										W	
	73.5	60/4										W	
	78.5	60/4										W	
													147.0 BORING TERMINATED AT 79.0' IN CP: SAND

NCDOT\_BORE 07-018.GPJ NCDOT.GDT 5/1/07

NOTE: A LOSS OF DRILLING FLUIDS OCCURRED BETWEEN 50 TO 60 FEET.

PROJECT NO. U-4756		ID.		COUNTY CUMBERLAND, NC		GEOLOGIST S. HAN							
SITE DESCRIPTION BRIDGE ON MORGANTON ROAD OVER ALL AMERICAN FREEWAY						GROUND WATER (ft)							
BORING NO. B1B		BORING LOCATION 45+13		OFFSET 80' RT		ALIGNMENT							
COLLAR ELEV. 226 ft		NORTHING		EASTING		0 HR. 9.8							
TOTAL DEPTH 79.9 ft		DRILL MACHINE CME 45		DRILL METHOD MUD ROTARY		HAMMER TYPE MANUAL							
DATE STARTED 4-10-07		COMPLETED 4-10-07		SURFACE WATER DEPTH N/A									
ELEV. (ft)	DEPTH (ft)	BLOW COUNT			BLOWS PER FOOT					SAMP. NO.	LOG	SOIL AND ROCK DESCRIPTION	
		0.5ft	0.5ft	0.5ft	0	20	40	60	80				100
226.0													EXISTING GROUND
225.0	1.0	1	2	5									225.8 ROOTMAT
	3.1	1	3	5									223.0 RDWY EMB: BROWN, LOOSE, SAND (A-3)
	6.0	5	7	8									CP: ORANGE AND GRAY, MED. STIFF TO STIFF, SILTY CLAY (A-7-5)
	8.1	5	6	7									218.0 CP: BROWN, STIFF, SANDY CLAY (A-6)
	13.1	3	4	5									214.0 CP: TAN AND GRAY, STIFF, SANDY CLAY (A-7-5)
	18.4	18	13	5									209.0 CP: RED AND TAN, MED. DENSE, CLAYEY SILTY SAND (A-2-4)
	23.4	7	4	9									204.0 CP: WHITE AND TAN, STIFF TO SOFT, SANDY SILTY CLAY (A-7-5)
	28.4	1	1	3									196.5 CP: BROWN, GRAY WHITE AND RED, LOOSE TO V. LOOSE, SILTY SAND (A-2-4)
	33.4	1	2	3									
	38.4	4	3	5									
	43.4	1	1	1									
	48.4	15	20	17									179.0 CP: DARK GRAY, DENSE, COARSE SAND (A-1-b)
	53.4	10	9	14									174.0 CP: DARK GRAY, V. STIFF, SANDY SILTY CLAY (A-7-6)
	58.4	23	25	24									171.5 CP: DARK GRAY, MED. DENSE, CLAYEY SILTY SAND (A-2-4)
	63.4	24	33	27									167.5 CP: LIGHT GRAY, DENSE TO V. DENSE, SAND (A-3) WITH CLAY SEAMS
	68.4	21	38	60									
	73.4	40	44	38									155.0 CP: GRAY, V. DENSE, MED. TO COARSE SAND (A-1-b)
	78.4	30	46	49									146.1 BORING TERMINATED AT 79.9' IN CP: SAND

NCDOT\_BORE 07-018.GPJ NCDOT.GDT 5/1/07



SOIL CLASSIFICATION AND GRADATION SHEET

BRIDGE ON MORGANTON ROAD OVER ALL AMERICAN FREEWAY  
 NCDOT PROJECT NO.: U-4756

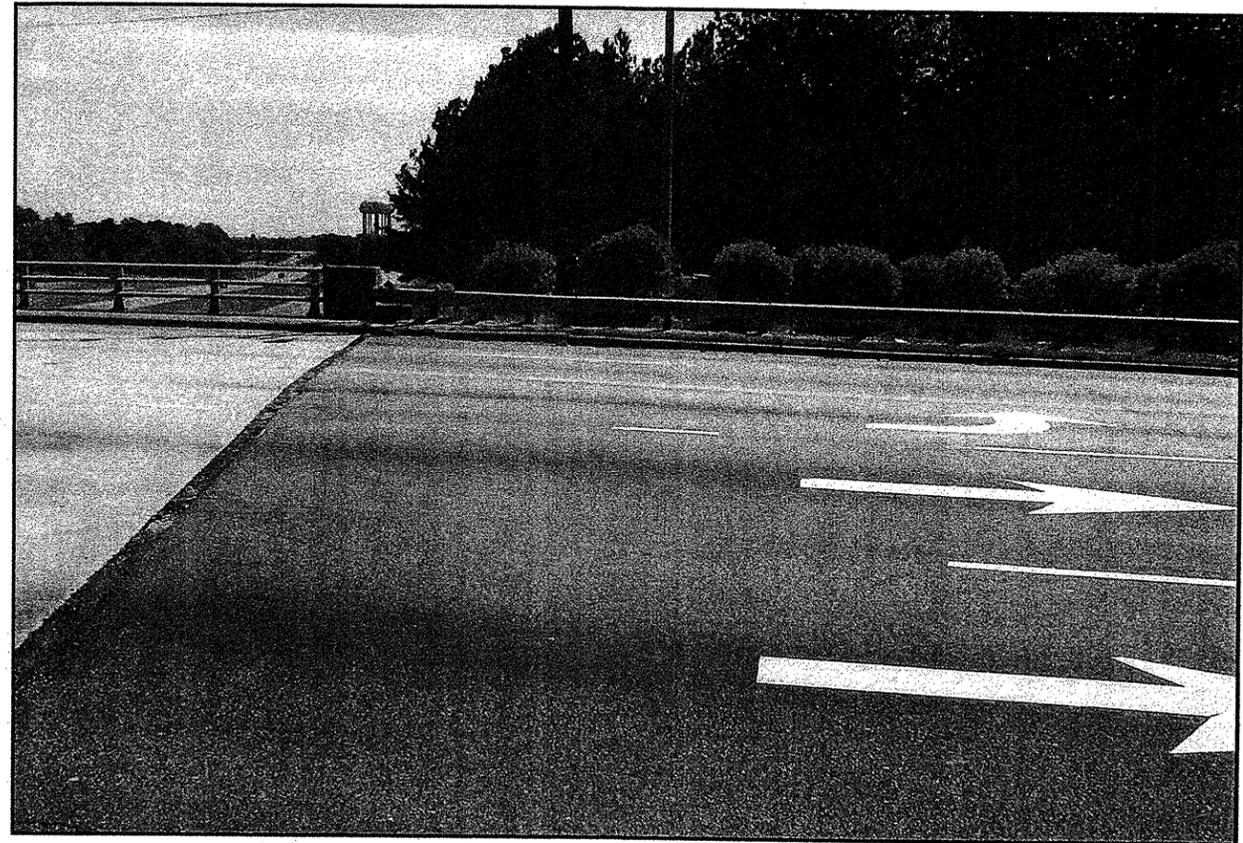
CUMBERLAND COUNTY

TIERRA, INC. PROJECT NO: 6211-07-018

BORING #		SAMPLE #	NATURAL MOISTURE CONTENT	TOTAL SAMPLE			ATTERBERG LIMIT		
AASHTO Classification				PERCENT PASSING			LIQUID LIMIT	PLASTIC LIMIT	PLASTIC INDEX
STATION #	OFFSET (FEET)	DEPTH (FEET)		#10	#40	#200			
B1A		SS-1	23.5%	99	84	50	38	18	20
A-6									
44+60	73 LT	3.5-5.0							
B1A		SS-2	24.4%	100	90	50	34	14	20
A-6									
44+60	73 LT	23.5-25.0							
B1B		SS-3	21.4%	100	75	36	31	12	19
A-6									
45+13	80 RT	8.1-9.6							
B1B		SS-4	33.9%	92	56	14	NP	NP	NP
A-2-4									
45+13	80 RT	43.4-44.9							



**PHOTO 1: PROFILE 39' LEFT OF -L-, LOOKING UPSTATION**



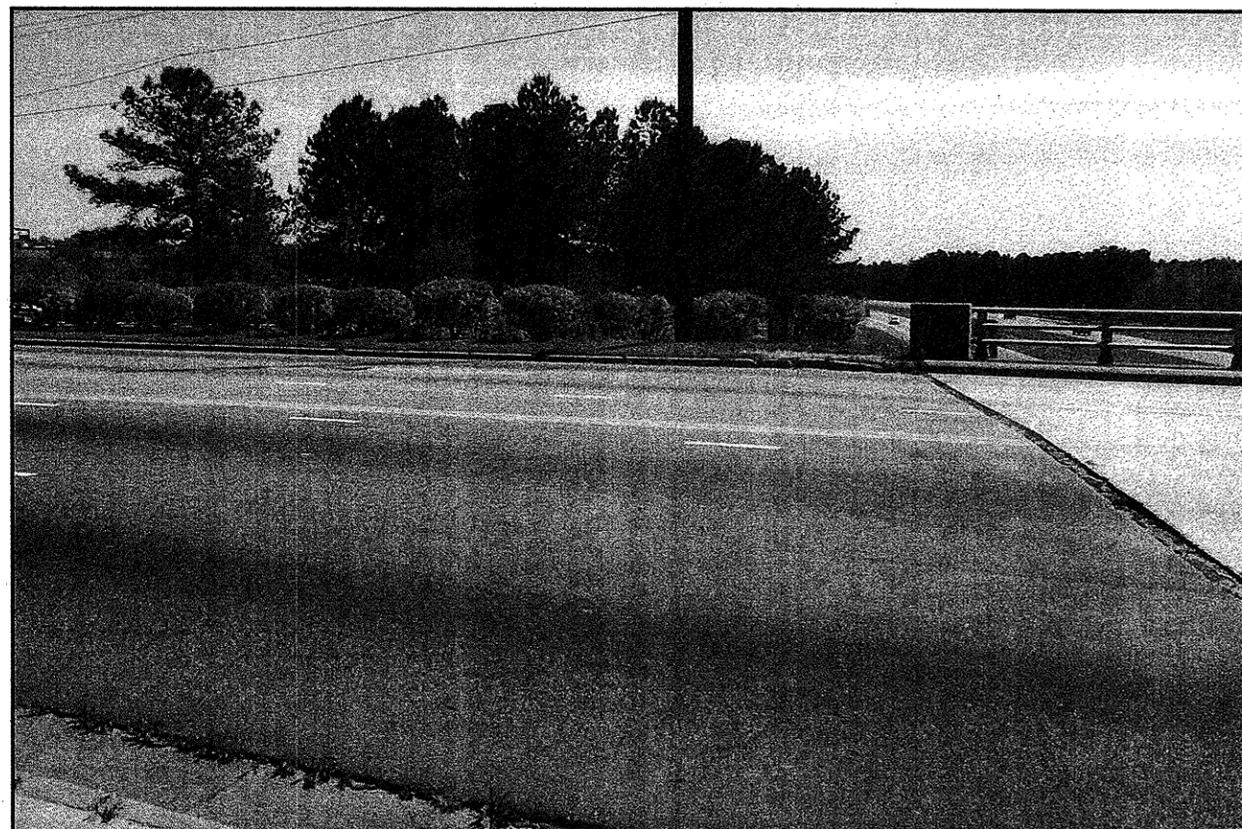
**PHOTO 2: END BENT 1, LOOKING FROM LEFT TO RIGHT**

**SITE PHOTOGRAPHS**

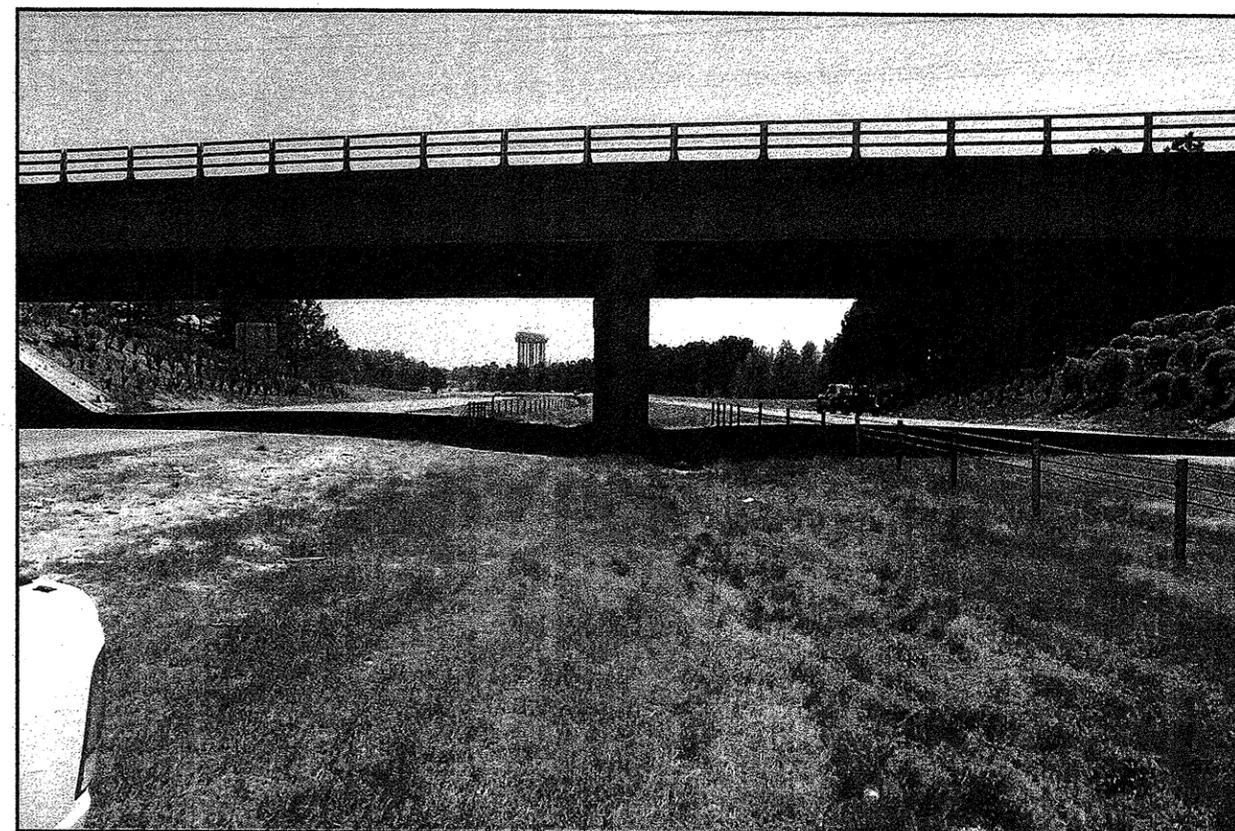
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OVER ALL AMERICAN FREEWAY  
CUMBERLAND CO., NC  
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TIERRA PROJECT #: 6211-07-018**



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2736 ROWLAND RD.  
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PHONE (919) 871-0800  
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**PHOTO 3: END BENT 2, LOOKING FROM LEFT TO RIGHT**



**PHOTO 4: BENT 1, LOOKING SOUTH TOWARD BORING B1A**

**SITE PHOTOGRAPHS**

**BRIDGE ON MORGANTON ROAD  
OVER ALL AMERICAN FREEWAY  
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