STATE	STATE PROJECT REFERENCE NO.	SHEET NO.	TOTAL SHEETS
N.C.	B-5180	1	19
STATE PROJ. NO.	F.A. PROJ. NO.	DESCRIPTION	
MA140138		P.E.	
		CONST.	

STATE OF NORTH CAROLINA

DEPARTMENT OF TRANSPORTATION

DIVISION OF HIGHWAYS

GEOTECHNICAL ENGINEERING UNIT

STRUCTURE SUBSURFACE INVESTIGATION

STATE PROJECT B-5180 I.D. NO. _____

F.A. PROJECT _____

COUNTY HENDERSON

PROJECT DESCRIPTION BRIDGE #205 ON SR 1764 (OLD SPARTANBURG HWY) OVER MUD CREEK

SITE DESCRIPTION _____

CONTENTS: **PAGE NUMBER:**

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FILE COPY

INVESTIGATED BY P. ZHANG PERSONNEL S. HAN

CHECKED BY G. LANG, P.E.

SUBMITTED BY TIERRA, INC.

DATE MAY, 2006

PROJECT: B-5180

DRAWN BY: P. ZHANG

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SEAL

SIGNATURE

ID	STATE PROJECT NO.	SHEET NO.	TOTAL SHEETS
		2	19

NORTH CAROLINA DEPARTMENT OF TRANSPORTATION
DIVISION OF HIGHWAYS
GEOTECHNICAL ENGINEERING UNIT

SUBSURFACE INVESTIGATION

SOIL AND ROCK LEGEND, TERMS, SYMBOLS, AND ABBREVIATIONS

SOIL DESCRIPTION

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:

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-3	A-4, A-5 A-6, A-7	
	A-1-a	A-1-b		A-2-4	A-2-5	A-2-6	A-2-7				A-7-5 A-7-6			
SYMBOL														
% PASSING # 10	50 MX											GRANULAR SOILS	SILT-CLAY SOILS	MUCK, PEAT
# 40	30 MX	50 MX	51 MN											
# 200	15 MX	25 MX	10 MX	35 MX	35 MX	35 MX	35 MX	36 MN	36 MN	36 MN	36 MN			
LIQUID LIMIT	6 MX		N.P.	40 MX	41 MN	40 MX	41 MN	40 MX	41 MN	40 MX	41 MN	SOILS WITH LITTLE OR MODERATE AMOUNTS OF ORGANIC MATTER		HIGHLY ORGANIC SOILS
PLASTIC INDEX				10 MX	10 MX	11 MN	11 MN	10 MX	10 MX	11 MN	11 MN			
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 A SUBGRADE	EXCELLENT TO GOOD							FAIR TO POOR				FAIR TO POOR	POOR	UNSUITABLE

P.I. OF A-7-5 ≤ L.L. - 30 ; P.I. OF A-7-6 > L.L. - 30

CONSISTENCY OR DENSENESS

PRIMARY SOIL TYPE	COMPACTNESS OR CONSISTENCY	RANGE OF STANDARD PENETRATION RESISTENCE (N-VALUE)	RANGE OF UNCONFINED COMPRESSIVE STRENGTH (TONS/FT²)
GENERALLY GRANULAR MATERIAL (NON-COHESIVE)	VERY LOOSE	<4	N/A
	LOOSE	4 TO 10	
	MEDIUM DENSE	10 TO 30	
	DENSE	30 TO 50	
	VERY DENSE	>50	
GENERALLY SILT-CLAY MATERIAL (COHESIVE)	VERY SOFT	<2	<0.25
	SOFT	2 TO 4	0.25 TO 0.5
	MEDIUM STIFF	4 TO 8	0.5 TO 1
	STIFF	8 TO 15	1 TO 2
	VERY STIFF	15 TO 30	2 TO 4
	HARD	>30	>4

TEXTURE OR GRAIN SIZE

U.S. STD. SIEVE SIZE	4	10	40	60	200	270
OPENING (MM)	4.76	2.0	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.)

GRAIN SIZE	MM	305	75	2.0	0.25	0.05	0.005
	IN.	12"	3"				

SOIL MOISTURE - CORRELATION OF TERMS

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

PLASTICITY

	PLASTICITY INDEX (PI)	DRY STRENGTH
NONPLASTIC	0-5	VERY LOW
LOW PLASTICITY	6-15	SLIGHT
MED. PLASTICITY	16-25	MEDIUM
HIGH PLASTICITY	26 OR MORE	HIGH

COLOR

DESCRIPTIONS MAY INCLUDE COLOR OR COLOR COMBINATIONS (TAN, RED, YEL-BRN, BLUE-GRAY) MODIFIERS SUCH AS LIGHT, DARK, STREAKED, ETC. ARE USED TO DESCRIBE APPEARANCE.

GRADATION

WELL GRADED- 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)
GAP-GRADED- INDICATES A MIXTURE OF UNIFORM PARTICLES OF TWO OR MORE SIZES.

ANGULARITY OF GRAINS

THE ANGULARITY OR ROUNDNESS OF SOIL GRAINS ARE 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 WHENEVER THEY ARE CONSIDERED OF SIGNIFICANCE.

COMPRESSIBILITY

SLIGHTLY COMPRESSIBLE	LIQUID LIMIT LESS THAN 30
MODERATELY COMPRESSIBLE	LIQUID LIMIT 31-50
HIGHLY COMPRESSIBLE	LIQUID LIMIT GREATER THAN 50

PERCENTAGE OF MATERIAL

ORGANIC MATERIAL	GRANULAR SOILS	SILT- CLAY SOILS	OTHER MATERIAL	
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.
- PW — PERCHED WATER, SATURATED ZONE OR WATER BEARING STRATA
- SPRING OR SEEPAGE

MISCELLANEOUS SYMBOLS

- ROADWAY EMBANKMENT WITH SOIL DESCRIPTION
- SOIL SYMBOL
- ARTIFICIAL FILL OTHER THAN ROADWAY EMBANKMENTS
- INFERRED SOIL BOUNDARIES
- INFERRED ROCK LINE
- ALLUVIAL SOIL BOUNDARY
- 25/825 — DIP/DIP DIRECTION OF ROCK STRUCTURES
- ● - SOUNDING ROD
- SPT CPT DPT DMT VST PMT — TEST BORING
- AUGER BORING
- CORE BORING
- MONITORING WELL
- PIEZOMETER INSTALLATION
- SLOPE INDICATOR INSTALLATION
- SPT N-VALUE
- REF — SPT REFUSAL

SAMPLE DESIGNATIONS
S- BULK SAMPLE
SS- SPLIT SPOON SAMPLE
ST- SHELBY TUBE SAMPLE
RS- ROCK SAMPLE
RT- RECOMPACTED TRIAXIAL SAMPLE
CBR - CBR SAMPLE

ABBREVIATIONS

AR - AUGER REFUSAL
BT - BORING TERMINATED
CL. - CLAY
CPT - CONE PENETRATION TEST
CSE. - COARSE
C.T. - CORING TERMINATED
DMT - DILATOMETER TEST
DPT - DYNAMIC PENETRATION TEST
e - VOID RATIO
F. - FINE
FOSS. - FOSSILIFEROUS
FRAC. - FRACTURED
FRAGS. - FRAGMENTS
MED. - MEDIUM
PMT - PRESSUREMETER TEST
REF. - REFUSAL
SD. - SAND, SANDY
SL. - SILT, SILTY
SLI. - SLIGHTLY
TCR - TRICONE REFUSAL
γ - UNIT WEIGHT
γ_d - DRY UNIT WEIGHT
W - MOISTURE CONTENT
V. - VERY
VST - VANE SHEAR TEST

EQUIPMENT USED ON SUBJECT PROJECT

DRILL UNITS:
- ☐ MOBILE B-___
- ☐ BK-51
- ☐ CME-45
- ☐ CME-550
- ☐ PORTABLE HOIST
- ☒ OTHER CME-55
- ☐ OTHER _____

ADVANCING TOOLS:
- ☐ CLAY BITS
- ☐ 6" CONTINUOUS FLIGHT AUGER
- ☒ 8" HOLLOW AUGERS
- ☐ HARD FACED FINGER BITS
- ☐ TUNG.-CARBIDE INSERTS
- ☐ CASING ☐ W/ ADVANCER
- ☐ TRICONE ___ 3" STEEL TEETH
- ☐ TRICONE ___ " TUNG.-CARB.
- ☐ CORE BIT
- ☐ OTHER _____

HAMMER TYPE:
- ☒ AUTOMATIC ☐ MANUAL

CORE SIZE:
- ☐ -B-___
- ☐ -N-___
- ☐ -H-___

HAND TOOLS:
- ☐ POST HOLE DIGGER
- ☐ HAND AUGER
- ☐ SOUNDING ROD
- ☐ VANE SHEAR TEST
- ☐ OTHER _____

ROCK DESCRIPTION

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.
ROCK MATERIALS ARE TYPICALLY DIVIDED AS FOLLOWS:

WEATHERED ROCK (WR)	NON-COASTAL PLAIN MATERIAL THAT YIELDS SPT N VALUES > 100 BLOWS PER FOOT.
CRYSTALLINE ROCK (CR)	FINE TO COARSE GRAIN IGNEOUS AND METAMORPHIC ROCK THAT WOULD YIELD SPT REFUSAL IF TESTED. ROCK TYPE INCLUDES GRANITE, GNEISS, GABBRO, SCHIST, ETC.
NON-CRYSTALLINE ROCK (NCR)	FINE TO COARSE GRAIN METAMORPHIC AND NON-COASTAL PLAIN SEDIMENTARY ROCK THAT WOULD YEILD SPT REFUSAL IF TESTED. ROCK TYPE INCLUDES PHYLLITE, SLATE, SANDSTONE, ETC.
COASTAL PLAIN SEDIMENTARY ROCK (CP)	COASTAL PLAIN SEDIMENTS CEMENTED INTO ROCK, BUT MAY NOT YIELD SPT REFUSAL. ROCK TYPE INCLUDES LIMESTONE, SANDSTONE, CEMENTED SHELL BEDS, ETC.

WEATHERING

FRESH	ROCK FRESH, CRYSTALS BRIGHT, FEW JOINTS MAY SHOW SLIGHT STAINING. ROCK RINGS UNDER HAMMER IF CRYSTALLINE.
VERY SLIGHT (V. SLI.)	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.
SLIGHT (SLI.)	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.
MODERATE (MOD.)	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.
MODERATELY SEVERE (MOD. SEV.)	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. *IF TESTED, WOULD YIELD SPT REFUSAL*
SEVERE (SEV.)	ALL ROCKS 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. *IF TESTED, YIELDS SPT N VALUES > 100 BPF*
VERY SEVERE (V. SEV.)	ALL ROCK EXCEPT QUARTZ DISCOLORED OR STAINED, ROCK FABRIC ELEMENTS ARE DISCERNIBLE BUT THE MASS IS EFFECTIVELY REDUCED TO SOIL STATUS, WITH ONLY FRAGMENTS OF STRONG ROCK REMAINING. SAPROLITE IS AN EXAMPLE OF ROCK WEATHERED TO A DEGREE SUCH THAT ONLY MINOR VESTIGES OF THE ORIGINAL ROCK FABRIC REMAIN. *IF TESTED, YIELDS SPT N VALUES < 100 BPF*
COMPLETE	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.

ROCK HARDNESS

VERY HARD	CANNOT BE SCRATCHED BY KNIFE OR SHARP PICK. BREAKING OF HAND SPECIMENS REQUIRES SEVERAL HARD BLOWS OF THE GEOLOGISTS PICK.
HARD	CAN BE SCRATCHED BY KNIFE OR PICK ONLY WITH DIFFICULTY. HARD HAMMER BLOWS REQUIRED TO DETACH HAND SPECIMEN.
MODERATELY HARD	CAN BE SCRATCHED BY KNIFE OR PICK. GOUGES OR GROOVES TO 0.25 INCHES DEEP CAN BE EXCAVATED BY HARD BLOW OF A GEOLOGISTS PICK. HAND SPECIMENS CAN BE DETACHED BY MODERATE BLOWS.
MEDIUM HARD	CAN BE GROOVED OR GOUGED 0.05 INCHES DEEP BY FIRM PRESSURE OF KNIFE OR PICK POINT. CAN BE EXCAVATED IN SMALL CHIPS TO PEICES 1 INCH MAXIMUM SIZE BY HARD BLOWS OF THE POINT OF A GEOLOGISTS PICK.
SOFT	CAN BE GROVED 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.
VERY SOFT	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.

FRACTURE SPACING

TERM	SPACING
VERY WIDE	MORE THAN 10 FEET
WIDE	3 TO 10 FEET
MODERATELY CLOSE	1 TO 3 FEET
CLOSE	0.16 TO 1 FEET
VERY CLOSE	LESS THAN 0.16 FEET

BEDDING

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

INDURATION

FOR SEDIMENTARY ROCKS, INDURATION IS THE HARDENING OF THE MATERIAL BY CEMENTING, HEAT, PRESSURE, ETC.:

FRIABLE	RUBBING WITH FINGER FREES NUMEROUS GRAINS; GENTLE BLOW BY HAMMER DISINTEGRATES SAMPLE.
MODERATELY INDURATED	GRAINS CAN BE SEPARATED FROM SAMPLE WITH STEEL PROBE; BREAKS EASILY WHEN HIT WITH HAMMER.
INDURATED	GRAINS ARE DIFFICULT TO SEPARATE WITH STEEL PROBE; DIFFICULT TO BREAK WITH HAMMER.
EXTREMELY INDURATED	SHARP HAMMER BLOWS REQUIRED TO BREAK SAMPLE; SAMPLE BREAKS ACROSS GRAINS.

TERMS AND DEFINITIONS

ALLUVIUM (ALLUV.) - SOILS WHICH HAVE BEEN TRANSPORTED BY WATER.

AQUIFER - A WATER BEARING FORMATION OR STRATA.

ARENACEOUS - APPLIED TO ROCKS THAT HAVE BEEN DERIVED FROM SAND OR THAT CONTAIN SAND.

ARGILLACEOUS - APPLIED TO ALL ROCKS OR SUBSTANCES COMPOSED OF CLAY MINERALS, OR HAVING A NOTABLE PROPORTION OF CLAY IN THEIR COMPOSITION, AS SHALE, SLATE, ETC.

ARTESIAN - GROUND WATER THAT IS UNDER SUFFICIENT PRESSURE TO RISE ABOVE THE LEVEL AT WHICH IS IS ENCOUNTERED, BUT WHICH DOES NOT NECESSARILY RISE TO OR ABOVE THE GROUND SURFACE.

CALCAREOUS (CALC.) - SOILS WHICH CONTAIN APPRECIABLE AMOUNTS OF CALCIUM CARBONATE.

COLLUVIUM - ROCK FRAGMENTS MIXED WITH SOIL DEPOSITED BY GRAVITY ON SLOPE OR AT BOTTOM OF SLOPE.

CORE RECOVERY (REC.) - TOTAL LENGTH OF ALL MATERIAL RECOVERED IN THE CORE BARREL DIVIDED BY TOTAL LENGTH OF CORE RUN AND EXPRESSED AS A PERCENTAGE.

DIKE - A TABULAR BODY OF IGNEOUS ROCK THAT CUTS ACROSS THE STRUCTURE OF ADJACENT ROCKS OR CUTS MASSIVE ROCK.

DIP - THE ANGLE AT WHICH A STRATUM OR ANY PLANAR FEATURE IS INCLINED FROM THE HORIZONTAL.

DIP DIRECTION (DIP AZIMUTH) - THE DIRECTION OR BEARING OF THE HORIZONTAL TRACE OF THE LINE OF DIP, MEASURED CLOCKWISE FROM NORTH.

FAULT - A FRACTURE OR FRACTURE ZONE ALONG WHICH THERE HAS BEEN DISPLACEMENT OF THE SIDES RELATIVE TO ONE ANOTHER PARALLEL TO THE FRACTURE.

FISSILE - A PROPERTY OF SPLITTING ALONG CLOSELY SPACED PARALLEL PLANES.

FLOAT - ROCK FRAGMENTS ON SURFACE NEAR THEIR ORIGINAL POSITION AND DISLODGED FROM PARENT MATERIAL.

FLOOD PLAIN (F.P.) - LAND BORDERING A STREAM, BUILT OF SEDIMENTS DEPOSITED BY THE STREAM.

FORMATION (FM.) - A MAPPABLE GEOLOGIC UNIT THAT CAN BE RECOGNIZED AND TRACED IN THE FIELD.

JOINT - FRACTURE IN ROCK ALONG WHICH NO APPRECIABLE MOVEMENT HAS OCCURRED.

LEDGE - A SHELF-LIKE RIDGE OR PROJECTION OF ROCK WHOSE THICKNESS IS SMALL COMPARED TO ITS LATERAL EXTENT.

LENS - A BODY OF SOIL OR ROCK THAT THINS OUT IN ONE OR MORE DIRECTIONS.

MOTTLED (MOT.) - IRREGULARLY MARKED WITH SPOTS OF DIFFERENT COLORS. MOTTLING IN SOILS USUALLY INDICATES POOR AERATION AND LACK OF GOOD DRAINAGE.

PERCHED WATER - WATER MAINTAINED ABOVE THE NORMAL GROUND WATER LEVEL BY THE PRESENCE OF AN INTERVENING IMPERVIOUS STRATUM.

RESIDUAL SOIL - SOIL FORMED IN PLACE BY THE WEATHERING OF ROCK.

ROCK QUALITY DESIGNATION (R.Q.D.) - 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.

SAPROLITE (SAP.) - RESIDUAL SOIL WHICH RETAINS THE RELIC STRUCTURE OR FABRIC OF THE PARENT ROCK.

SILL - 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

SLICKENSIDE - POLISHED AND STRIATED SURFACE THAT RESULTS FROM FRICTION ALONG A FAULT OR SLIP PLANE.

STANDARD PENETRATION TEST (PENETRATION RESISTANCE) (SPT) - NUMBER OF BLOWS (N OR B/F.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.

STRATA CORE RECOVERY (SREC.) - TOTAL LENGTH OF STRATA MATERIAL RECOVERED DIVIDED BY TOTAL LENGTH OF STRATUM AND EXPRESSED AS A PERCENTAGE.

STRATA ROCK QUALITY DESIGNATION (S.R.Q.D.) - 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.

TOPSOIL (T.S.) - SURFACE SOILS USUALLY CONTAINING ORGANIC MATTER.

BENCH MARK:

NOTES:

REVISED 09/15/08

May 10, 2007

Mr. Charles L. Flowe, P.E.
TGS Engineers
975 Walnut Street
Suite 141
Cary, NC 27511

Ref: Geotechnical Subsurface Exploration Report
NCMA Project No.: MA14013B
County: Henderson County
Description: Bridge # 205 on SR 1764 over Mud Creek
Tierra Inc. Proj. No.: 6211-05-049

Dear Mr. Flowe:

As authorized, Tierra, Inc. (Tierra) has completed the geotechnical subsurface exploration for Bridge # 205 on SR 1764 (Old Spartanburg HWY) over Mud Creek in Henderson County, North Carolina. Our investigation was performed in general accordance with our proposal number TR-04-121, dated November 18, 2004. The purpose of this report is to present subsurface information 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 the Plans printed on August 8, 2006, the Bridge Survey and Hydraulic Design Report and structural design calculations dated March 29, 2007, we understand the referenced project intends to replace the existing two span bridge supported on timber piles, spanning Mud Creek. The proposed replacement structure is to consist of a single span cored slab, two bent bridge and will be approximately 60 feet long. The structure is planned to be located between Station 13+37 and Station 13+99, and has a skew angle of about 80°. Information provided by TGS Engineers and Consultants (TGS) indicates that the proposed end bents will range from a spill through abutment at End Bent 1 to a vertical abutment at End Bent 2. Both end bents will have bottom of cap elevations of about 2,081 feet. At End Bent 1, the embankment will be reconstructed at 2:1 (Horizontal: Vertical) with Class II Rip Rap. The finished grade of the structure will be at or near the existing grade of the existing bridge. A theoretical overtopping scour elevation of 2,074 feet is indicated on the Bridge Survey and Hydraulic Report, however, scour is not anticipated to impact the single span structure.

It is also our understanding that due to the proximity of End Bent 2 to the existing railroad tracks, it is desired to support the bent with drilled shafts. In addition, temporary shoring is anticipated to support the soils adjacent to the tracks during construction. The shafts are to be designed to resist lateral earth pressures and railroad loading conditions in addition to the bridge structure loads. 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.

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SITE DESCRIPTION/GEOLOGY

The proposed project site is located along SR 1764, approximately 10 feet east of its intersection with the Norfolk Southern Railroad (NS RR) in Henderson County, NC. The area has a generally flat to rolling terrain, sloping downward toward Mud Creek. The area is developed and contains an existing bridge structure, paved roadway, railroad and associated facilities. The depth of standing water below the bridge, at the time of drilling, was approximately 2 to 3 feet.

According to ***The Geologic Map of North Carolina*** (1985), the project site is located between the Blue Ridge and Inner Piedmont Physiographic Province. Hendersonville lies within the Chauga Belt. Bedrock generally consists of rocks of the Henderson Gneiss **(Chg)**, which are typically granodioritic and inequigranular gneisses.

FIELD EVALUATION PROCEDURE

The subsurface exploration consisted of performing four Standard Penetration Test (SPT) borings along the two proposed end bents. Borings were offset from proposed bent lines as indicated on the Boring Location Plan of this report, due to accessibility issues and utilities. Borings were performed with a trailer-mounted CME 55 drill rig with an automatic hammer. Standard Penetration Tests (SPT) and soil sampling were performed in general accordance with American Association of State Highway Transportation Officials (AASHTO T-206-87), and North Carolina Department of Transportation's (NCDOT) latest Geotechnical Guidelines and Procedures Manual.

Groundwater measurements 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 TGS.

In addition to our subsurface investigation, a visual scour evaluation was performed along the channel and banks of Mud Creek and is included in the Appendix of this report.

SUBSURFACE AND GROUNDWATER CONDITIONS

Subsurface soils encountered at the borings performed consist of man-placed fill, alluvial deposits, residual soils and weathered rock (in descending order). The subsurface conditions encountered at each end bent are described below:

Borings near End Bent 1 encountered fill materials in the upper 4.5 to 7 feet, consisting of loose silty sand with gravel (A-2-4) and very soft sandy clay (A-6). Below the fill materials, alluvial deposits were encountered to depths ranging from 19 to 19.5 feet below ground surface

(elevation of 2,067), consisting of very loose to dense silty sand and gravelly sand (A-2-4 and A-1-b) and very soft to medium stiff sandy silt and clay (A-4 and A-7-5). Residual soils composed of very loose to very dense silty sand (A-2-4) were encountered below the alluvial deposits and extended to depths ranging from 59.5 to 79 feet (elevations of 2,026 to 2,007 feet). Weathered rock (Gneiss) was encountered below the residual soil and extended to the boring termination depths ranging from 69 to 79 feet (elevations of 2,017 to 2,007 feet).

Borings near End Bent 2 encountered fill materials in the upper 3 to 6 feet, consisting of very loose to loose silty sand with gravel (A-2-4). Below these fill materials, alluvial deposits were encountered to depths ranging from 19 to 24 feet below ground surface (elevations of 2,066 to 2,061 feet), consisting of very loose to medium dense silty sand and gravelly sand (A-2-4 and A-1-b) and very soft sandy clay (A-6 and A-7-5). Residual soils composed of loose to very dense silty sand (A-2-4) were encountered below the alluvial deposits and extended to depths ranging from 59 to 76 feet (elevations of 2,026 to 2,000 feet). Weathered rock (Gneiss) was encountered in boring EB2B below the residual soils and extended to the boring termination depth of 69 feet (elevation 2,016 feet). Auger refusal was encountered in boring EB2A immediately below the residual soil at a depth of 76 feet (elevation 2,009 feet).

Groundwater levels encountered at the borings ranged from 7 to 8 feet below existing grade (elevations of 2,077 to 2,078 feet). In addition, 2 to 3 feet of standing water was observed in Mud Creek.

LABORATORY TESTING

Representative split-spoon samples were selected from soil test borings to verify visual field classification and determine soil index properties. A total of nine split-spoon 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) as modified and/or (AASHTO) procedures:

- AASHTO T-88-00 (As Modified) "Particle Size Analysis of Soil"
- AASHTO T-89-02 (As Modified) "Determining the Liquid Limits of Soil"
- AASHTO T-90-00 "Determining the Plastic Limit and Plasticity of Soils"
- AASHTO T-265-93 (2000) "Laboratory Determination of Moisture Content of Soils"

CONCLUSIONS

The results of our subsurface investigation indicate that the subsurface conditions consist predominately of loose/soft man-placed fills and alluvial soils extending to depths ranging from 19 to 24 feet below ground surface (elevations of 2,061 to 2,067 feet). Weathered Gneiss was encountered at depths ranging from 59 to 79 feet below ground surface (elevations of 2,026 to 2,007 feet). Considering the depth of competent bearing materials, it is anticipated that driven HP steel piles will be suitable for support of End Bent 1. In addition, due to the close proximity of End Bent 2 to the existing NS railroad tracks, we understand that drilled piers will be utilized. The drilled piers will be designed to resist lateral earth pressures and railroad loading conditions in addition to the bridge structure loads. Due to the close proximity of the railroad tracks, temporary shoring is also anticipated at End Bent 2.

FOUNDATION RECOMMENDATIONS

Based on the subsurface conditions and our analysis, End Bent 1 for the proposed bridge may be supported by driven HP 12x53 steel piles and End Bent 2 by 48 inch diameter drilled piers. The piles for the End Bent 1 may be designed using an allowable capacity of 45 tons. The allowable pile capacity was 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 End Bent 2 should be designed to bear in weathered rock or rock at elevations ranging from 2,009 to 2,026 feet and have a tip elevation no higher than 2,007 feet (LT) and 2,025 (RT). The piers should also be designed using an allowable capacity of 230 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 pile cap at End Bent 1, the embankment soils should be laid back at no steeper than (2H:1V) or as required by OSHA. Temporary shoring is anticipated for the construction of End Bent 2 adjacent to the railroad tracks. The design of the shoring should be based upon the soil parameters provided in the Appendix of this report. Backfill behind the end bent caps shall be replaced in accordance with Section 410-8 and 410-9 of the Standard Specifications.

It should be noted that demolition of the existing bridge structure will require cutting off the existing timber piles. There is a potential for the proposed piles and piers to encounter the existing piles during construction. In such cases, the proposed piles or piers may need to be offset to reach the desired bearing material.

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, Inc. are based on the Plans printed on August 8, 2006, Bridge Survey & Hydraulic Design Report and structural design calculations dated March 29, 2007. 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 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, Inc. 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

SOIL PARAMETERS FOR TEMPORARY SHORING
BRIDGE NO. 205 ON SR 1764 OVER MUD CREEK
NCMA PROJECT NO. : MA14013B
TIERRA, INC. PROJECT NO.: 6211-05-049

Soil Parameters for Temporary Shoring							
Boring Location	Approximate Groundwater Elev. (ft)	Material Type	Approximate Elevation (feet)	Approximate Soil Unit Weight (pcf)		Soil Angle of Internal Friction (degrees)	Cohesion (psf)
				γ_{sat}	$\gamma_{effective}$		
EB2A (*Elev. 2,085 ft*)	2,077	FILL: V. Loose Sand	2,085-2,079	120	57.6	25	0
		ALLUV: V. Soft Clay	2,079-2,075.5	115	52.6	0	50
		ALLUV: Loose to Medium Dense *Gravelly Sand*	2,075.5-2,066	120	57.6	29	0
		RES: V. Loose to Loose Sand	2,066-2,035	120	57.6	26	0
		RES: M. Dense to Dense Sand	2,035-2,009	120	57.6	32	0
EB2B (*Elev. 2,085 ft*)		FILL: V. Loose Sand	2,085-2,082	120	57.6	25	0
		ALLUV: V. Soft Clay	2,082-2,079	115	52.6	0	50
		ALLUV: V. Loose to Loose Sand	2,079-2,061	120	57.6	25	0
		RES: Loose to M. Dense Sand	2,061-2,045	120	57.6	30	0
		RES: M. Dense to V. Dense Sand	2,045 – 2,026	120	57.6	34	0

Notes: Refer to the test boring logs in the report for additional information. Ground surface elevation based upon Topographic Maps provided

SUMMARY OF FOUNDATION RECOMMENDATIONS

NCDOT PROJ. NO.: MA14013B PROJECT DESCRIPTION: Bridge # 205 on SR 1764

T.I.P. NO.: (Old Spartanburg HWY) over Mud Creek

COUNTY: Henderson

STATION: 13+68 -L-

SEAL

PREPARED BY: SWH DATE: 05/7/06

CHECKER: GL DATE: 5/10/07

SIGNATURE

	STATION	FOUNDATION TYPE	ALLOWABLE LOAD	FOUNDATION DETAILS
END BENT 1	13+37 -L-	Cap on HP 12x53 Steel Pile	50 tons/Pile	Assumed Bottom of Cap = 2,081 ft ± Recommended Length of Pile = 65 ft (LT) Recommended Length of Pile = 60 ft (RT)
END BENT 2	13+99 -L-	48" Drilled Pier	230 tons/Pier	Assumed Bottom of Cap = 2,081 ft ± Assumed Top of Pier = 2,080 ft Tip Elevation No Higher Than = 2,007 ft (LT) Recommended Length of Pier = 74 ft (LT) Tip Elevation No Higher Than = 2,025 ft (RT) Recommended Length of Pier = 56 ft (RT)

COMMENTS & NOTES (Attached)

MA14013, Henderson County
Bridge # 205 on SR 1764 over Mud Creek
6211-05-049

Note on Plans:

1. Drive piles at End Bent No. 1 to a required bearing capacity of 100 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 Bent No. 1 is 50 tons per pile.
3. Steel pile points (with teeth) are required for steel piles at End Bent No. 1. See Section 450 of the Standard Specifications.
4. Drilled piers at End Bent No. 2 are designed for both skin friction and end bearing. Check field conditions for the required end bearing capacity of 20 tsf.
5. Drilled piers at End Bent No.2 are designed for an applied load of 195 tons at the top of the column.
6. Drilled piers at End Bent No. 2 shall extend to an elevation no higher than 2,007 ft (LT) and 2,025 ft (RT), satisfy the required end bearing capacity, and have a minimum penetration of 1 ft into rock or weathered rock as defined by the Drilled Piers Special Provision.
7. SPT testing is not required to determine the end bearing capacity of the drilled piers at End Bent No. 2.
8. Slurry construction is required for drilled piers at End Bent No. 2. See Drilled Piers Special Provision.
9. Do not use polymer slurry for drilled piers at End Bent No. 2.
10. SID inspections are required to inspect the bottom cleanliness of the drilled piers at End Bent No.2. See Drilled Piers Special Provision.
11. 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.
12. For drilled piers, see Drilled Piers Special Provision.

Comments:

1. Considering a maximum lateral force of 27.9 kips, the elevation of the point of fixity for End Bent No. 1 is 2,052 ft.
2. Cutting off of the existing timber piles below the proposed pile cap levels will be required.
3. The proposed piles/piers may encounter the existing timber piles and need to be offset.

DRILLED PIER PAY ITEM QUANTITIES

PROJECT NO. _____ DATE 5/10/2007

TIP NO. _____ DESIGNED BY SWH

COUNTY HENDERSON CHECKED BY GWL

STATION _____

DESCRIPTION Br. # 205 on SR 1764 over Mud Creek

NUMBER OF BENTS WITH DRILLED PIERS 1
NUMBER OF PIERS PER BENT 4

	DRILLED PIER PAY ITEMS					
END BENT #	PERMANENT STEEL CASING FOR 48". DIA. DRILLED PIER (yes/no/maybe)	48" DIA. DRILLED PIERS NOT IN SOIL (feet)	SPT TESTING (each)	SID INSPECTION (each)	CROSSHOLE SONIC LOGGING* (each)	CSL TUBES* (yes/no)
2	No	4		4	4	YES
TOTALS		4	0	4	4	

* Pay items, "Crosshole Sonic Logging" and "CSL Tubes" are not required unless CSL testing is required with a Note on Plans.

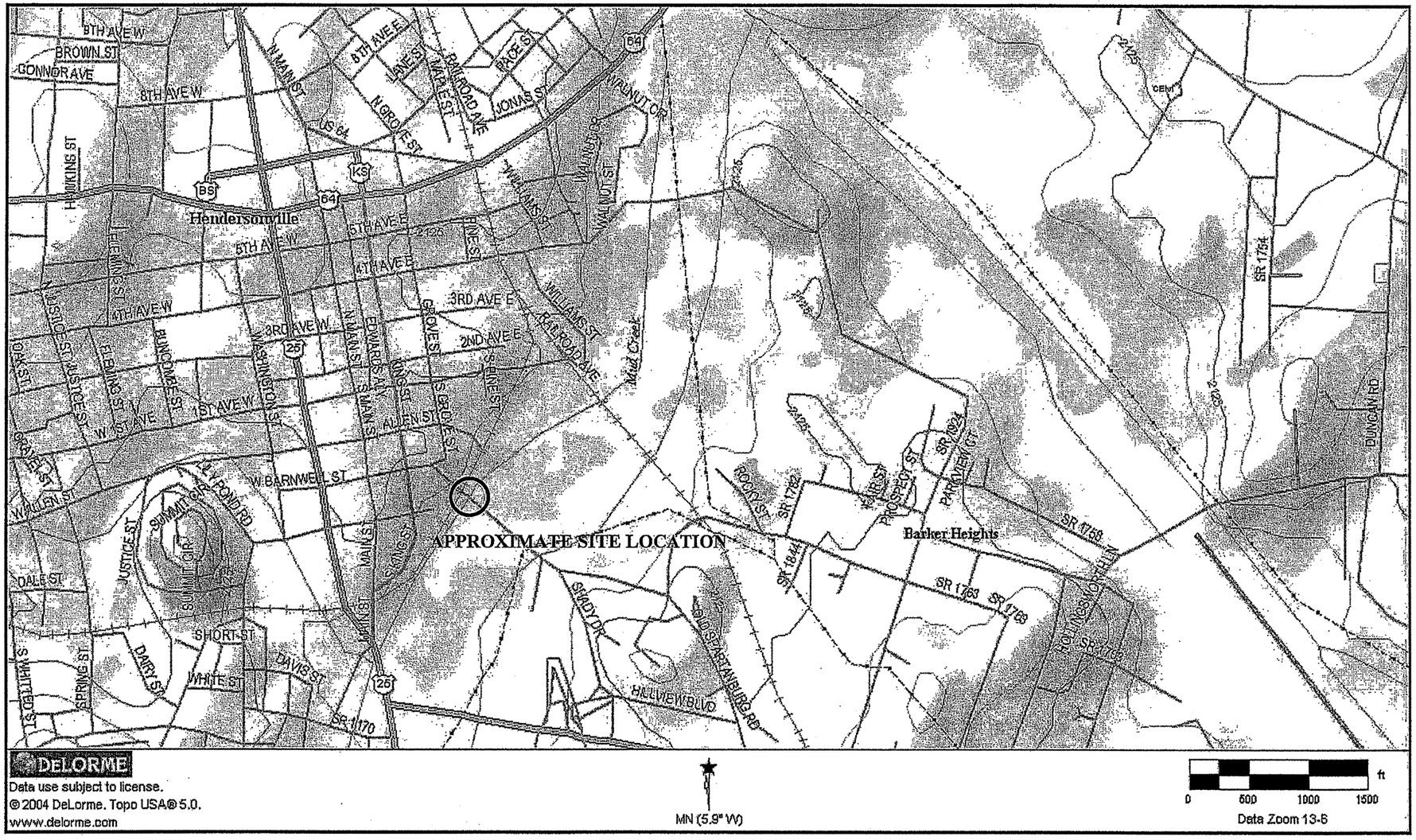
Notes:

Blanks or no represent quantity of zero.

If permanent steel casing is required or may be required, Structure Design should calculate the pay item quantity, "Permanent Steel Casing for ___ Dia. Drilled Pier", as the difference between the top of drilled pier elevation or the top of permanent steel casing elevation (whichever is lower) and the elevation the permanent steel casing can not extend below as shown with a Note on Plans.

Structure Design should determine the pay item quantity, "___ Dia. Drilled Piers in Soil", based upon the total drilled pier length per bent minus the "___ Dia. Drilled Piers not in Soil" per bent shown in the table above.

If CSL tubes are required, Structure design should calculate the pay item quantity, "CSL Tubes", as follows:
"CSL Tubes" per bent = (drilled pier length + 2.5 feet) x number of CSL tubes per pier
The number of CSL tubes per pier is dependent upon the drilled pier diameter. For drilled piers with a diameter of 5 feet or less, use 4 tubes. For drilled piers with a diameter greater than 5 feet, use 6 tubes.



SITE VICINITY MAP

NCDOT PROJECT #:
HENDERSON CO., NC
BRIDGE # 205 ON SR 1764 (OLD SPARTANBURG HWY)
OVER MUD CREEK

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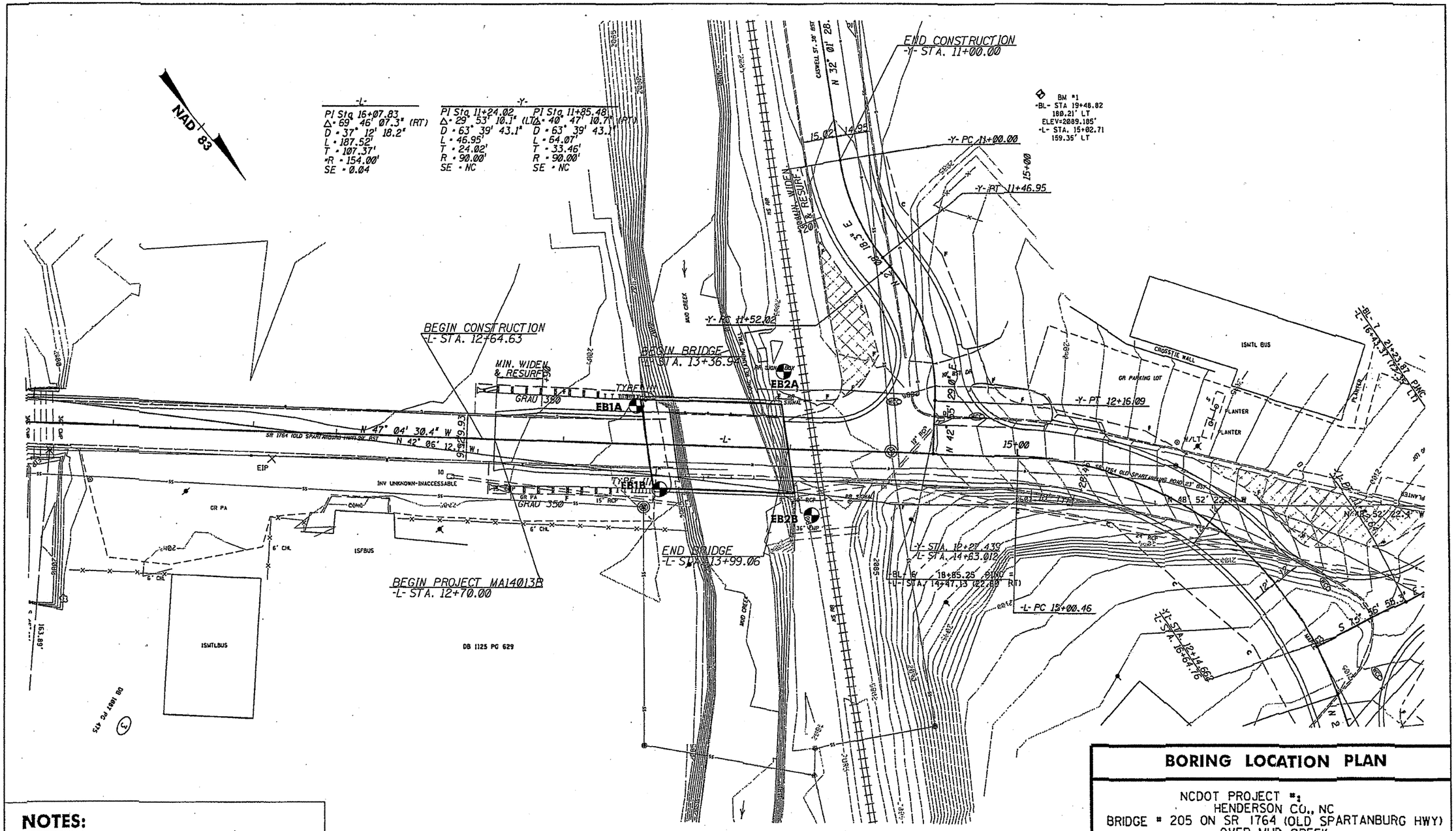

NOTES:

PLANS ADOPTED FROM ELECTRONIC FILES RECEIVED FROM TGS ENGINEERS, DATED OCTOBER, 2005

PROPOSED BRIDGE SKEW: 80°

BORING LOCATION PLAN

NCDOT PROJECT #:
HENDERSON CO., NC
BRIDGE # 205 ON SR 1764 (OLD SPARTANBURG HWY)
OVER MUD CREEK

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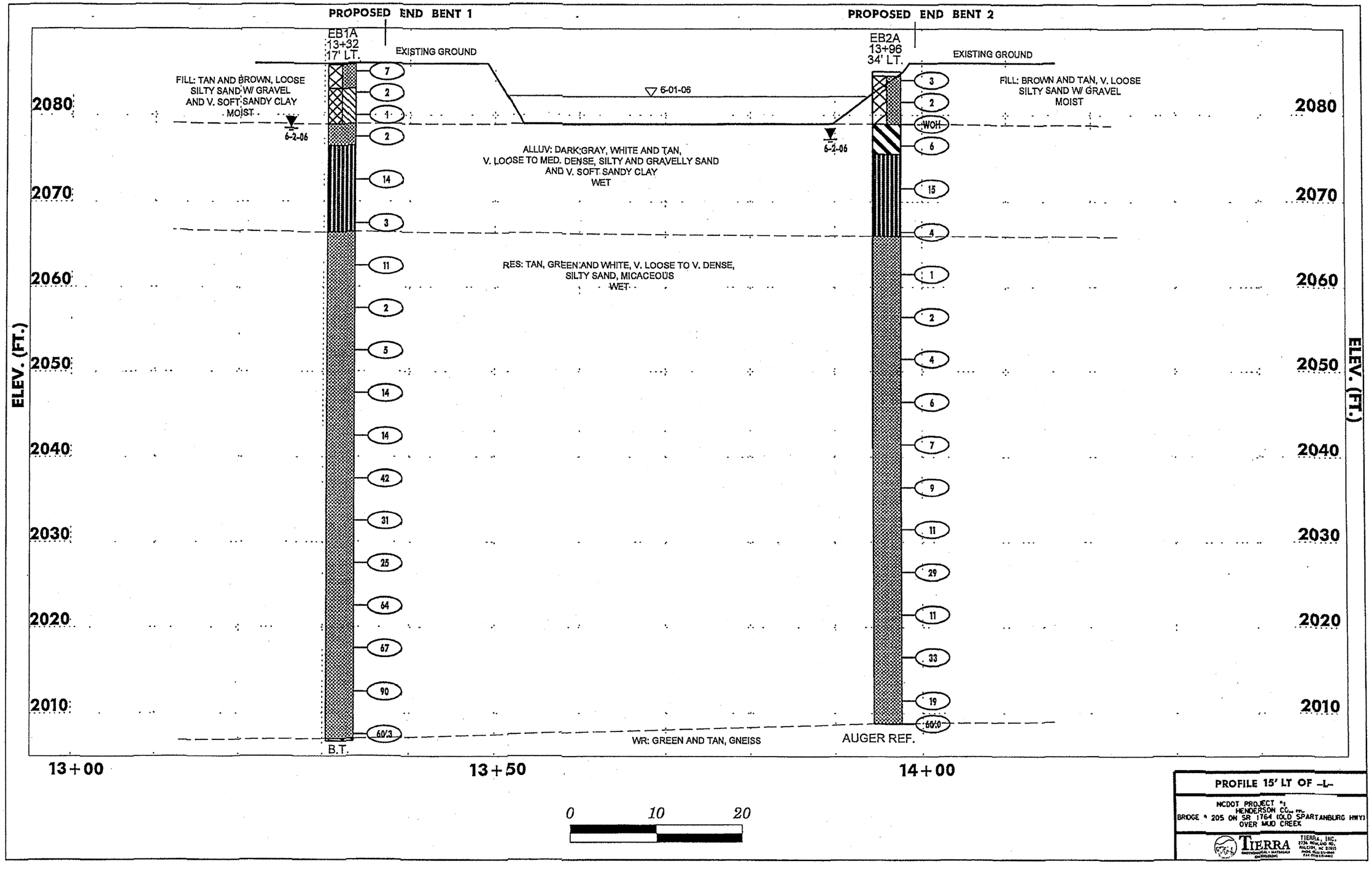
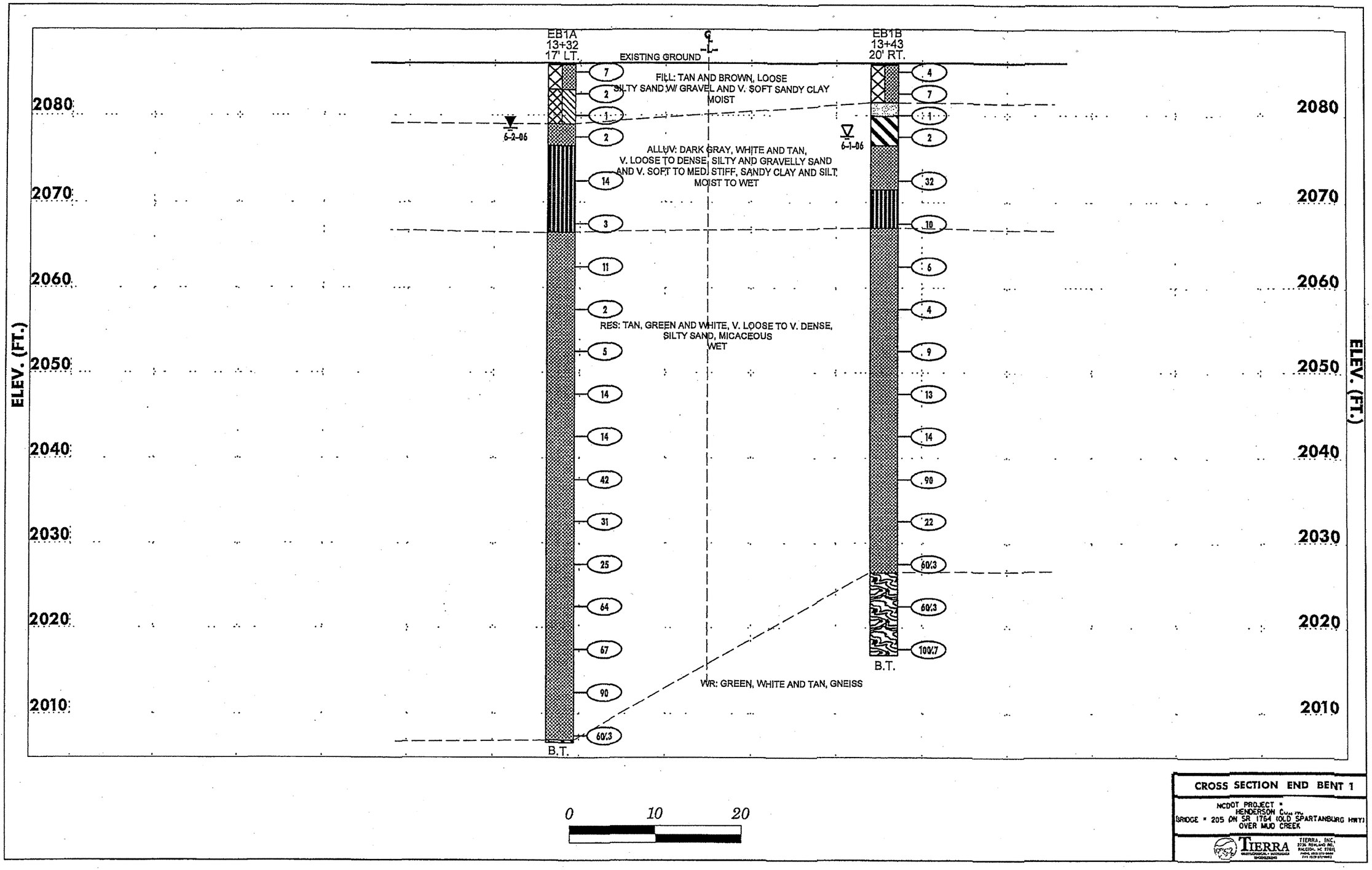

PROPOSED END BENT 1
PROPOSED END BENT 2
EB1A
13+32
17' LT.
EB2A
13+96
34' LT.
EXISTING GROUND
EXISTING GROUND
FILL: TAN AND BROWN, LOOSE SILTY SAND W/ GRAVEL AND V. SOFT SANDY CLAY MOIST
6-2-06
6-01-06
6-2-06
ALLUV: DARK GRAY, WHITE AND TAN, V. LOOSE TO MED. DENSE, SILTY AND GRAVELLY SAND AND V. SOFT SANDY CLAY WET
FILL: BROWN AND TAN, V. LOOSE SILTY SAND W/ GRAVEL MOIST
RES: TAN, GREEN AND WHITE, V. LOOSE TO V. DENSE, SILTY SAND, MICACEOUS WET
WR: GREEN AND TAN, GNEISS
B.T.
AUGER REF.
ELEV. (FT.)
2080
2070
2060
2050
2040
2030
2020
2010
7
2
1
2
14
3
11
2
5
14
14
42
31
25
64
67
90
50/3
3
2
WOH
6
15
4
1
2
4
6
7
9
11
29
11
33
19
50/0
13+00
13+50
14+00
0
10
20
PROFILE 15' LT OF -L-
NCDOT PROJECT #
HENDERSON CO.
BRIDGE # 205 ON SR 1764 (OLD SPARTANBURG HWY)
OVER MUD CREEK
TIERRA
TIERRA, INC.



CROSS SECTION END BENT 1

NCDOT PROJECT #
HENDERSON Co...
BRIDGE # 205 ON SR 1764 (OLD SPARTANBURG HWY)
OVER MUD CREEK

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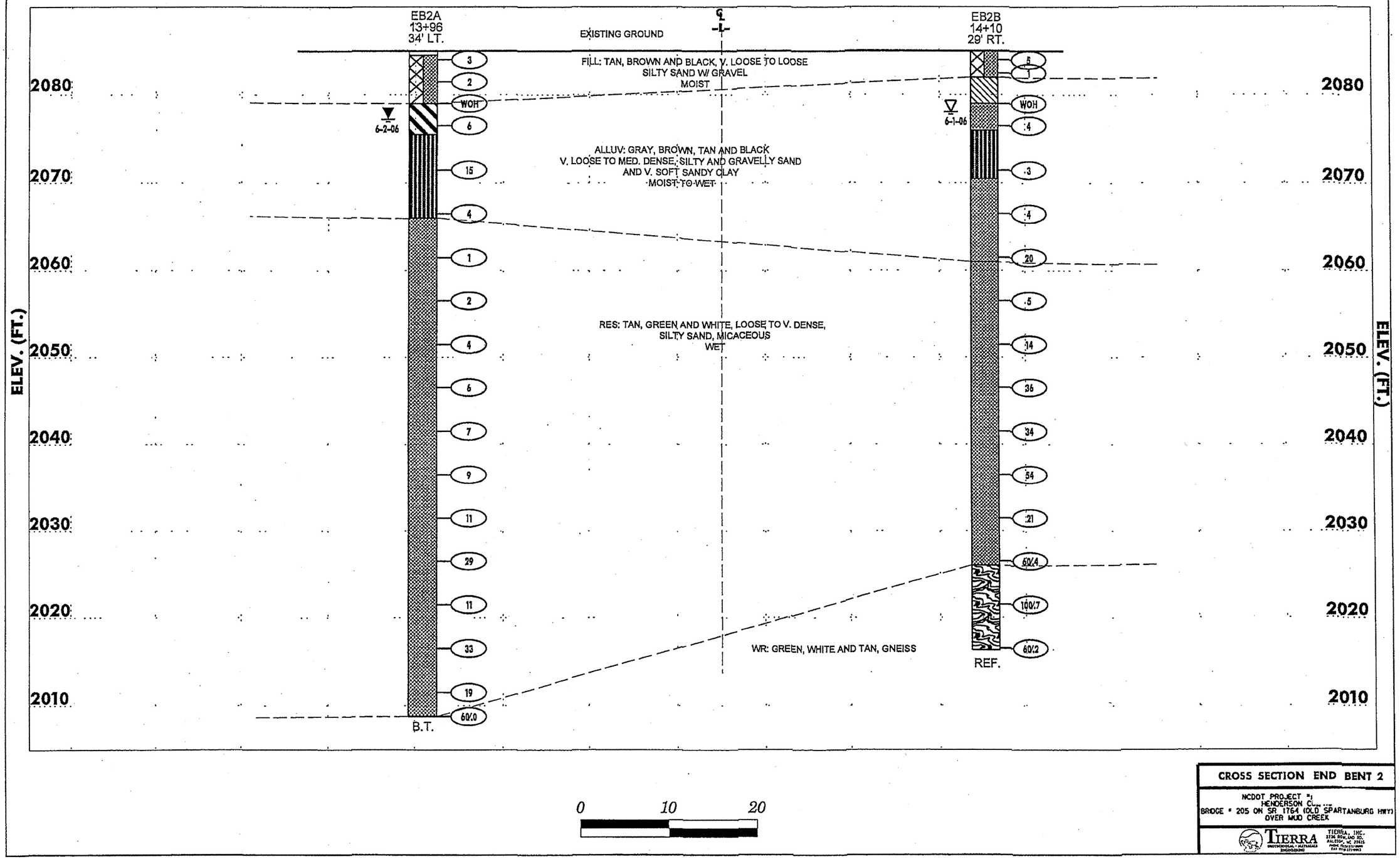

0 10 20

CROSS SECTION END BENT 2

NCDOT PROJECT #:
HENDERSON Co.
BRIDGE # 205 ON SR 1764 (OLD SPARTANBURG HWY)
OVER MUD CREEK

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N.C.D.O.T. GEOTECHNICAL UNIT
BORING LOG

SHEET 1 OF 1

PROJECT NO. 6211-05-049	ID.	COUNTY HENDERSON	GEOLOGIST P. ZHANG
SITE DESCRIPTION BRIDGE #205 ON SR 1764 (OLD SPARTANBURG HWY) OVER MUD CREEK			GROUND WATER (ft)
BORING NO. EB1A	BORING LOCATION 13+32	OFFSET 17' LT ALIGNMENT -L-	0 HR. 8.0
COLLAR ELEV. 2086 ft	NORTHING	EASTING	24 HR. 7.5
TOTAL DEPTH 79.3 ft	DRILL MACHINE CME 55	DRILL METHOD HSA	HAMMER TYPE AUTO
DATE STARTED 6-1-06	COMPLETED 6-1-06	SURFACE WATER DEPTH N/A	

ELEV. (ft)	DEPTH (ft)	BLOW COUNT 0.5ft	0.5ft	0.5ft	BLOWS PER FOOT 0 20 40 60 80 100	SAMP. NO.	MOI	LOG	SOIL AND ROCK DESCRIPTION
2086.0									
2085	1.0	7	5	2	EXISTING GROUND 7		M		2086.6 ROOTMAT 0.6
	3.5								2083.0 FILL: TAN AND BROWN, LOOSE, SILTY SAND (A-2-4) WITH GRAVEL 3.0
2080	6.0	1	1	1	2		M		FILL: BROWN, V. SOFT, SANDY CLAY (A-6)
	8.5	WOH	WOH	1	1				2079.0 7.0
2075	13.5	1	1	1	2		W		ALLUV: DARK GRAY, V. LOOSE, SILTY SAND (A-2-4) 9.5
2070	18.5	5	6	8	14	SS-1	W		2076.5 ALLUV: WHITE AND TAN, V. LOOSE TO MED. DENSE, GRAVELLY SAND (A-1-b)
2065	23.5	2	2	1	3		W		2066.5 19.5
2060	28.5	1	5	6	11		W		RES: TAN, GREEN AND WHITE, V. LOOSE TO V. DENSE, SILTY SAND (A-2-4), MICACEOUS
2055	33.5	1	1	1	2		W		
2050	38.5	1	2	3	5		W		
2045	43.5	11	7	7	14		W		
2040	48.5	4	5	9	14		W		
2035	53.5	10	19	23	42	SS-2	W		
2030	58.5	6	11	20	31		W		
2025	63.5	7	10	15	25		W		
2020	68.5	18	24	40	64		W		
2015	73.5	15	26	41	67		W		
2010	78.5	10	36	54	90		W		
		35	60/.3		60/.3		M		2007.0 79.0
									2006.7 WR: GREEN AND TAN, GNEISS 79.3
									BORING TERMINATED AT 79.3' IN WR: GNEISS

NCDOT_BORE 05-049.GPJ NCDOT.GDT 5/10/07

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N.C.D.O.T. GEOTECHNICAL UNIT
BORING LOG

SHEET 1 OF 1

PROJECT NO. 6211-05-049	ID.	COUNTY HENDERSON	GEOLOGIST P. ZHANG
SITE DESCRIPTION BRIDGE #205 ON SR 1764 (OLD SPARTANBURG HWY) OVER MUD CREEK			GROUND WATER (ft)
BORING NO. EB1B	BORING LOCATION 13+43	OFFSET 20' RT ALIGNMENT -L-	0 HR. 8.4
COLLAR ELEV. 2086 ft	NORTHING	EASTING	24 HR. BACKFILL
TOTAL DEPTH 69.2 ft	DRILL MACHINE CME 55	DRILL METHOD HSA	HAMMER TYPE AUTO
DATE STARTED 6-1-06	COMPLETED 6-1-06	SURFACE WATER DEPTH N/A	

ELEV. (ft)	DEPTH (ft)	BLOW COUNT 0.5ft	0.5ft	0.5ft	BLOWS PER FOOT 0 20 40 60 80 100	SAMP. NO.	MOI	LOG	SOIL AND ROCK DESCRIPTION
2086.0									
2085	1.0	2	2	2	EXISTING GROUND 4		M		2086.6 GRAVEL 0.6
	3.5								FILL: BROWN AND TAN, LOOSE, SILTY SAND (A-2-4), MICACEOUS
2080	6.0	2	4	3	7		M		2081.5 4.5
	8.5	WOH	WOH	1	1	SS-3	56.3%		2080.0 ALLUV: BLACK, MED. STIFF, SANDY SILT (A-4) 6.0
2075	13.5	WOH	WOH	2	2		M		ALLUV: BLACK, V. SOFT, SANDY CLAY (A-7-5)
2070	18.5	5	16	16	32		W		2076.5 9.5
2065	23.5	1	4	6	10		W		ALLUV: GRAY, V. LOOSE TO DENSE, SILTY SAND (A-2-4)
2060	28.5	WOH	WOH	6	8	SS-4	W		2071.5 14.5
2055	33.5	2	1	3	4		W		ALLUV: TAN AND WHITE, DENSE, GRAVELLY SAND (A-1-b)
2050	38.5	5	4	5	9		W		2067.0 19.0
2045	43.5	3	4	9	13		W		RES: TAN, GREEN AND WHITE, LOOSE TO V. DENSE, SILTY SAND (A-2-4), MICACEOUS
2040	48.5	3	5	9	14		M		
2035	53.5	20	34	56	90		M		
2030	58.5	7	8	14	22		W		
2025	63.5	16	34	60/.3	60/.3		M		2026.5 59.5
2020	68.5	35	60/.3		60/.3		M		WR: GREEN AND WHITE, GNEISS
		55	45/.2		100/.7		M		2016.8 69.2
									BORING TERMINATED AT 69.2' IN WR: GNEISS

NCDOT_BORE 05-049.GPJ NCDOT.GDT 5/10/07

N.C.D.O.T. GEOTECHNICAL UNIT
BORING LOG

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GEOTECHNICAL • MATERIALS ENGINEERING
2736 ROWLAND ROAD
RALEIGH, NORTH CAROLINA 27615
Phone (919) 871-0800 Fax (919) 871-0803

SHEET 1 OF 1

PROJECT NO. 6211-05-049	ID.	COUNTY HENDERSON	GEOLOGIST P. ZHANG
SITE DESCRIPTION BRIDGE #205 ON SR 1764 (OLD SPARTANBURG HWY) OVER MUD CREEK			GROUND WATER (ft)
BORING NO. EB2A	BORING LOCATION 13+96	OFFSET 34' LT ALIGNMENT -L-	0 HR. 8.0
COLLAR ELEV. 2085 ft	NORTHING	EASTING	24 HR. 7.8
TOTAL DEPTH 76.2 ft	DRILL MACHINE CME 55	DRILL METHOD HSA	HAMMER TYPE AUTO
DATE STARTED 6-1-06	COMPLETED 6-1-06	SURFACE WATER DEPTH N/A	

ELEV. (ft)	DEPTH (ft)	BLOW COUNT 0.5ft	0.5ft	0.5ft	BLOWS PER FOOT 0 20 40 60 80 100	SAMP. NO.	MOI	LOG	SOIL AND ROCK DESCRIPTION
2085.0									
	1.0				EXISTING GROUND				
	3.5	2	1	2	3		M		2086.0 BALLAST 0.0
2080	6.0	1	1	1	2		M		FILL: BROWN AND TAN, V. LOOSE, SILTY SAND (A-2-4) WITH GRAVEL
	8.5	WOH	WOH	WOH		SS-5	50%		2079.0 6.0
		1	3	3	6		W		ALLUV: BLACK, V. SOFT, SANDY CLAY (A-7-5)
2075	13.5								2075.5 9.5
		7	8	7	15		W		ALLUV: TAN AND WHITE, LOOSE TO MED. DENSE, GRAVELLY SAND (A-1-b)
2070	18.5								
		1	2	2	4		W		
2065	23.5								2066.0 19.0
		WOH	WOH	1	1		W		RES: GREEN, WHITE AND TAN, V. LOOSE TO V. DENSE, SILTY SAND (A-2-4), MICACEOUS
2060	28.5								
		WOH	1	1	2		W		
2055	33.5								
		3	3	1	4	SS-6	W		
2050	38.5								
		2	2	4	6		W		
2045	43.5								
		2	3	4	7		W		
2040	48.5								
		1	4	5	9		W		
2035	53.5								
		3	4	7	11		W		
2030	58.5								
		3	10	19	29		W		
2025	63.5								
		3	4	7	11		W		
2020	68.5								
		19	19	14	33		W		
2015	73.5								
		3	4	15	19		W		
2010	76.2	60/.0			60/.0				2008.8 76.2
									AUGER REFUSAL AT 76.2' BELOW EXISTING GROUND

NCDOT_BORE 05-049.GPJ NCDOT.GDT 5/10/07

N.C.D.O.T. GEOTECHNICAL UNIT
BORING LOG

TIERRA
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SHEET 1 OF 1

PROJECT NO. 6211-05-049	ID.	COUNTY HENDERSON	GEOLOGIST P. ZHANG
SITE DESCRIPTION BRIDGE #205 ON SR 1764 (OLD SPARTANBURG HWY) OVER MUD CREEK			GROUND WATER (ft)
BORING NO. EB2B	BORING LOCATION 14+10	OFFSET 29' RT ALIGNMENT -L-	0 HR. 7.0
COLLAR ELEV. 2085 ft	NORTHING	EASTING	24 HR. BACKFILL
TOTAL DEPTH 68.7 ft	DRILL MACHINE CME 55	DRILL METHOD HSA	HAMMER TYPE AUTO
DATE STARTED 6-1-06	COMPLETED 6-1-06	SURFACE WATER DEPTH N/A	

ELEV. (ft)	DEPTH (ft)	BLOW COUNT 0.5ft	0.5ft	0.5ft	BLOWS PER FOOT 0 20 40 60 80 100	SAMP. NO.	MOI	LOG	SOIL AND ROCK DESCRIPTION
2085.0									2085.0 0.0
	1.0				EXISTING GROUND				FILL: TAN AND BLACK, LOOSE, SILTY SAND (A-2-4), MICACEOUS
	2.5	3	2	3	5	SS-7	M		2082.0 3.0
2080	6.0	WOH	WOH	1	1		W		ALLUV: TAN AND BROWN, V. SOFT, SANDY CLAY (A-6)
	8.5	WOH	WOH	WOH			W		2079.0 6.0
		1	2	2	4		W		ALLUV: TAN AND GRAY, V. LOOSE, SILTY SAND (A-2-4), MICACEOUS
2075	13.5								2076.0 9.0
		2	2	1	3		W		ALLUV: TAN AND WHITE, LOOSE, GRAVELLY SAND (A-1-b)
2070	18.5								2070.5 14.5
		2	2	2	4	SS-8	W		ALLUV: TAN AND GRAY, V. LOOSE TO LOOSE, SILTY SAND (A-2-4), MICACEOUS
2065	23.5								
		3	9	11	20		W		2061.0 24.0
2060	28.5								RES: TAN, GRAY, AND WHITE, LOOSE TO V. DENSE, SILTY SAND (A-2-4), MICACEOUS
		2	2	3	5	SS-9	W		
2055	33.5								
		5	6	8	14		M		
2050	38.5								
		7	14	22	36		M		
2045	43.5								
		11	13	21	34		M		
2040	48.5								
		13	20	34	54		M		
2035	53.5								
		5	8	13	21		M		
2030	58.5								
		28	60/.4		60/.4		M		
2025	63.5								
		56	44/.2		100/.7				
2020	68.5	60/.2			60/.2				2026.0 59.0
									WR: WHITE, GREEN AND GRAY, GNEISS
									2016.3 68.7
									BORING TERMINATED AT 68.7' IN WR: GNEISS

NCDOT_BORE 05-049.GPJ NCDOT.GDT 5/10/07

TIERRA, INC. 2736 ROWLAND RD. RALEIGH, NORTH CAROLINA 27615

SOIL CLASSIFICATION AND GRADATION SHEET

BRIDGE #205 ON SR 1764 OVER MUD CREEK
NCDOT PROJECT NO:

HENDERSON COUNTY

TIERRA, INC. PROJECT NO: 6211-05-049

BORING #		SAMPLE #	NATURAL MOISTURE CONTENT	TOTAL SAMPLE PERCENT PASSING			ATTERBERG LIMIT		
AASHTO Classification									
STATION #	OFFSET (FEET)	DEPTH (FEET)		#10	#40	#200	LIQUID LIMIT	PLASTIC LIMIT	PLASTIC INDEX
EB1A		SS-1	N/A	53	23	6	NP	NP	NP
A-1-b									
13+32	17' LT	13.5-15.0							
EB1A		SS-2	N/A	98	76	29	NP	NP	NP
A-2-4									
13+32	17' LT	48.5-50.0							
EB1B		SS-3	56.3%	100	98	88	82	47	35
A-7-5									
13+43	20' RT	6.0-7.5							
EB1B		SS-4	N/A	91	72	31	NP	NP	NP
A-2-4									
13+43	20' RT	23.5-25.0							
EB2A		SS-5	58.1%	100	98	72	67	40	27
A-7-5									
13+96	34' LT	6.0-7.5							
EB2A		SS-6	N/A	92	75	33	NP	NP	NP
A-2-4									
13+96	34' LT	33.5-35.0							
EB2B		SS-7	N/A	92	73	33	NP	NP	NP
A-2-4									
14+10	29' RT	1.0-2.5							
EB2B		SS-8	N/A	73	54	27	NP	NP	NP
A-2-4									
14+10	29' RT	18.5-20.0							
EB2B		SS-9	N/A	85	64	18	NP	NP	NP
A-2-4									
14+10	29' RT	28.5-30.0							

NORTH CAROLINA DEPARTMENT OF TRANSPORTATION
GEOTECHNICAL ENGINEERING UNIT

FIELD SCOUR REPORT

WBS: __ _____ TIP: _____ COUNTY: HENDERSON

DESCRIPTION(1): BR # 205 ON SR 1764 OVER MUD CREEK

EXISTING BRIDGE

Information from: Field Inspection X Microfilm ____ (reel _____ pos: _____)
Other (explain) _____

Bridge No.: 205 Length: 46 Total Bents: 3 Bents in Channel: 1 Bents in Floodplain: 2
Foundation Type: TIBER PILES

EVIDENCE OF SCOUR(2)

Abutments or End Bent Slopes: VISABLE @ EB2B

Interior Bents: VISABLE

Channel Bed: VISABLE

Channel Bank: VISABLE

EXISTING SCOUR PROTECTION

Type(3): RIPRAP @EB1B AND EB2B

Extent(4): 5 TO 20' DOWNSTREAM

Effectiveness(5): FAIRLY GOOD

Obstructions(6): SOME DEBRIS IN THE CHANNEL

INSTRUCTIONS

1 Describe the specific site's location, including route number and body of water crossed.
2 Note scour evidence at existing end bents or abutments (e.g. undermining, sloughing, degradations).
3 Note existing scour protection (e.g. rip rap).
4 Describe extent of existing scour protection.
5 Describe whether or not the scour protection appears to be working.
6 Note obstructions such as dams, fallen trees, debris at bents, etc.
7 Describe the channel bed material based on observation and/or samples. Include any lab results with report.
8 Describe the channel bank material based on observation and/or samples. Include any lab results with report.
9 Describe the material covering the banks (e.g. grass, trees, rip rap, none).
10 Determine the approximate floodplain width from field observation or a topographic map.
11 Describe the material covering the floodplain (e.g. grass, trees, crops).
12 Use professional judgement to specify if the stream is degrading, aggrading, or static.
13 Describe potential and direction of the stream to migrate laterally during the bridge's life (approx. 100 years).
14 Give the design scour elevation (DSE) expected over the life of the bridge (approx. 100 years). This elevation can be given as a range across the site, or for each bent. Discuss the relationship between the Hydraulics Unit theoritical scour and the DSE. If the DSE is dependent on scour counter measures, explain (e.g. rip rap armoring on slopes). The DSE is based on the erodability of materials, giving consideration to the influence of joints, foliation, bedding characteristics, % core recovery, % RQD, differential weathering, shear strength, observations at existing structures, other tests deemed appropriate, and overall geologic conditions at the site.

DESIGN INFORMATION

Channel Bed Material(7): SAND

Channel Bank Material(8): SAND

Channel Bank Cover(9): TREES, BUSHES AND GRASS

Floodplain Width(10): APPROXIMATELY 200 FEET

Floodplain Cover(11): TREES, BUSHES AND GRASS

Stream is(12): Aggrading ____ Degrading X Static ____

Channel Migration Tendency(13): TOWARDS EAST

Observations and Other Comments: NONE

Reported by: PAUL ZHANG, TIERRA, INC. **Date:** 6/1/2006

DESIGN SCOUR ELEVATIONS(14) Feet ____ Meters ____

	BENTS B1	B2	B3	B4							
SB Lanes, Lt											
SB Lanes, Rt											
NB Lanes, Lt											
NB Lanes, Rt											

Comparison of DSE to Hydraulics Unit theoretical scour:

DSE determined by: _____ **Date:** _____

SOIL ANALYSIS RESULTS FROM CHANNEL BED AND BANK MATERIAL

Bed or Bank	Channel	Bank					
Sample No.	SS-8	SS-7					
Retained #4	31	3					
Passed #10	53	92					
Passed #40	23	73					
Passed #200	6	33					
Coarse Sand	30	19					
Fine Sand	17	40					
Silt							
Clay	6	33					
LL	NP	NP					
PI	NP	NP					
AASHTO	A-1-b	A-2-4					
Station	13+32	14+10					
Offset	17' LT	29' RT					
Depth	13.5-15.0	1.0-2.5					

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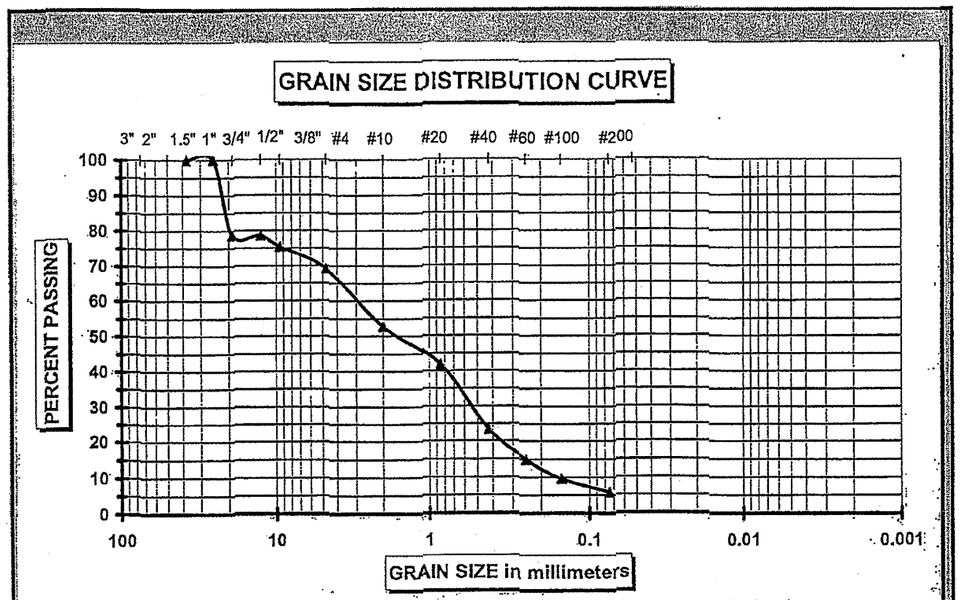
BRIDGE #205 ON SR 1764 OVER MUD CREEK
HENDERSON COUNTY
NCDOT PROJECT NO:



AASHTO M-145 Classification of Soil for Engineering Purposes					
Gravel	< 3" and > #10		Coarse Sand	< #10 and > #40	Cu = D60 / D10
			Fine Sand	< #40 and > #200	Cc = (D30)^2 / (D10 x D60)

BORING #: EB1A SAMPLE #: SS-1 DEPTH: 13.5-15.0

WHITE AND TAN SAND (A-1-b)

% PASSING #200 SIEVE: 6%

NATURAL MOISTURE CONTENT = N/A

ATTERBERG LIMIT (- #40 Material)	
LIQUID LIMIT	NP
PLASTIC LIMIT	NP
PLASTIC INDEX	NP

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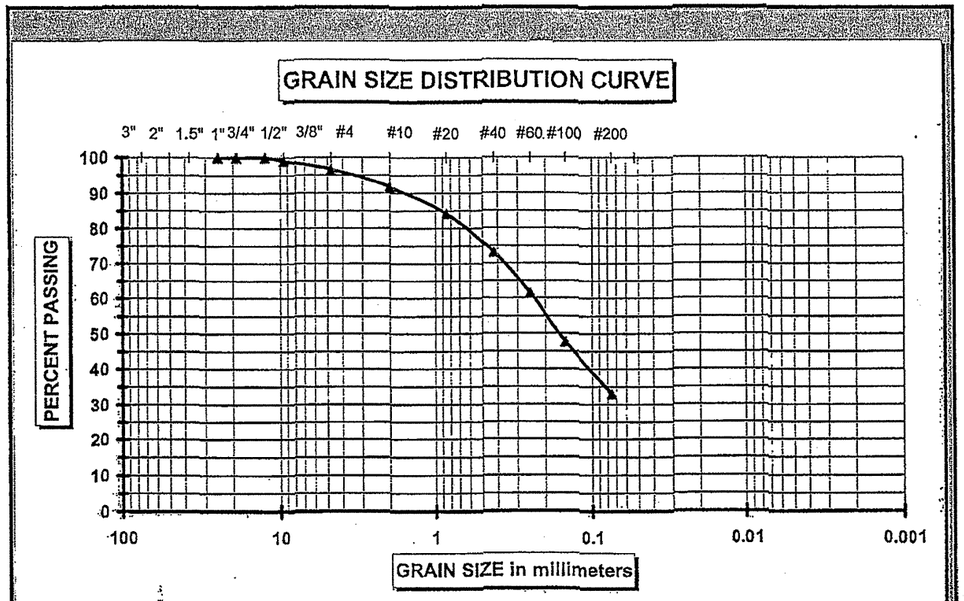

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BORING #: EB2B SAMPLE #: SS-7 DEPTH: 1.0-2.5

TAN AND GRAY SILTY SAND (A-2-4)

% PASSING #200 SIEVE: 33%

NATURAL MOISTURE CONTENT = N/A

ATTERBERG LIMIT (- #40 Material)	
LIQUID LIMIT	NP
PLASTIC LIMIT	NP
PLASTIC INDEX	NP

PHOTO 1: CENTERLINE PROFILE (-L-), LOOKING UPSTATION.

PHOTO 2: MUD CREEK, LOOKING UPSTREAM.

SITE PHOTOGRAPHS

NCDOT PROJECT #:
HENDERSON CO., NC
BRIDGE # 205 ON SR 1764 (OLD SPARTANBURG HWY)
OVER MUD CREEK

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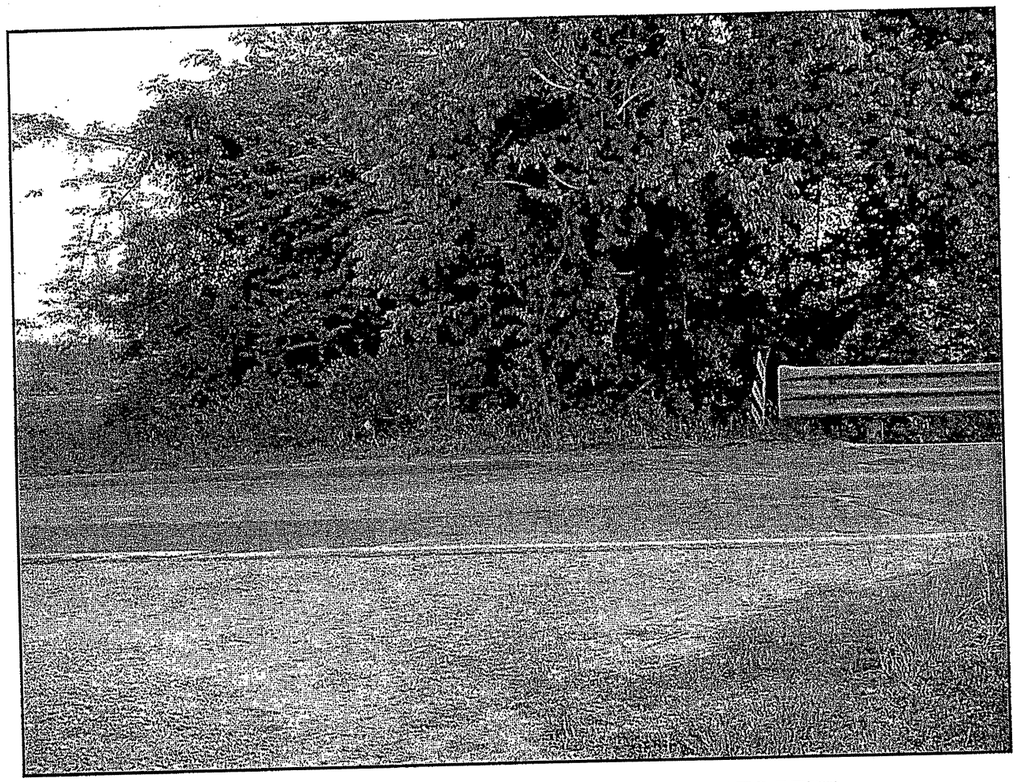

PHOTO 3: END BENT 1, LOOKING FROM RIGHT TO LEFT.

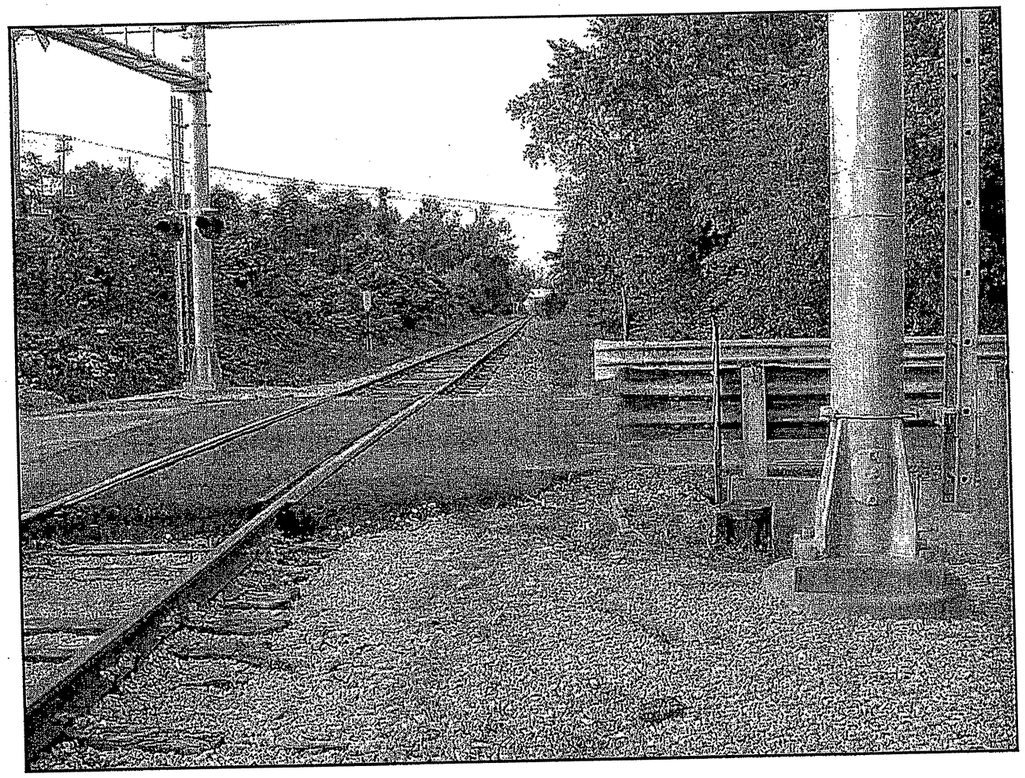

PHOTO 4: END BENT 2, LOOKING FROM LEFT TO RIGHT.

SITE PHOTOGRAPHS

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