

PROJECT: MA12018R ID:

STATE OF NORTH CAROLINA

DEPARTMENT OF TRANSPORTATION

DIVISION OF HIGHWAYS

GEOTECHNICAL UNIT

STRUCTURE  
SUBSURFACE INVESTIGATION

CONTENTS:

PAGE NUMBER:

NC DEPARTMENT OF TRANSPORTATION, DIVISION OF HIGHWAYS, GEOTECHNICAL UNIT, SOIL AND ROCK LEGEND, TERMS AND ABBREVIATIONS	2
GEOTECHNICAL STRUCTURE SUBSURFACE INVESTIGATION REPORT	3 - 4
PROJECT DESCRIPTION	
SITE DESCRIPTION AND GEOLOGY	
FIELD EVALUATION PROCEDURE	
SUBSURFACE AND GROUNDWATER CONDITIONS	
LABORATORY TESTING	
CONCLUSIONS	
FOUNDATION RECOMMENDATIONS	
CLOSURE	
SUMMARY OF FOUNDATION RECOMMENDATIONS	5
DRILLED PIER PAY ITEM QUANTITIES	6
SITE VICINITY MAP	7
BORING LOCATION PLAN	8
PROFILE 12' LEFT OF -L-	9
CROSS SECTION END BENT 1	10
CROSS SECTION END BENT 2	11
FINAL LOGS: BORE LOGS	12 - 23
CORE LOGS	
CORE PHOTOS	
AASHTO SOIL CLASSIFICATION AND GRADATION SHEET	24
LABORATORY SUMMARY SHEET FOR ROCK CORE SAMPLES	24
ROCK CURVES	25
FIELD SCOUR REPORT	26 - 28
CHANNEL BANK MATERIAL SUMMARY	
CHANNEL BANK MATERIAL GRAIN SIZE CURVES	
SITE PHOTOS	29 - 30

STATE	STATE PROJECT REFERENCE NO.	SHEET NO.	TOTAL SHEETS
N.C.	MA12018R	1	30
STATE PROJ. NO.	F.A. PROJ. NO.	DESCRIPTION	
MA12018R		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.

STATE PROJECT MA12018R I.D. NO. \_\_\_\_\_

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

COUNTY GASTON

PROJECT DESCRIPTION BRIDGE #28 ON SR  
2416 (ROBINSON RD.) OVER MILES CREEK

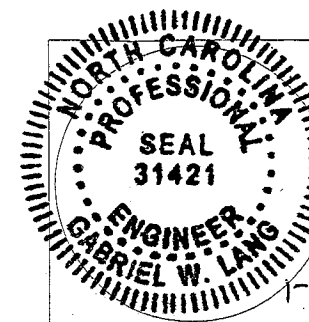
SITE DESCRIPTION \_\_\_\_\_

INVESTIGATED BY J. HOWARD PERSONNEL P. ZHANG  
CHECKED BY G. LANG, P.E.  
SUBMITTED BY TIERRA, INC.  
DATE JANUARY, 2006

DRAWN BY: E. WAGNER

NOTE - THE INFORMATION CONTAINED HEREIN IS NOT IMPLIED OR GUARANTEED BY THE N.C. DEPARTMENT OF TRANSPORTATION AS BEING ACCURATE NOR IS IT 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.

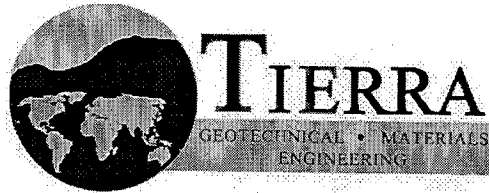


SEAL

1-17-06

SIGNATURE





January 18, 2006

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

**Re: Geotechnical Subsurface Exploration Report**

Project No.: MA-12018R  
County: Gaston County  
Description: Bridge No. 28 on SR 2416 (Robinson Road) over Miles Creek  
Tierra Inc. Proj. No.: 6211-05-028

Dear Mr. Flowe:

As authorized, Tierra, Inc. has completed the geotechnical subsurface exploration for Bridge No. 28 on SR 2416 (Robinson Road) over Miles Creek. Our investigation was performed in general accordance with our proposal number TR-04-071, dated August 2, 2004. The purpose of this report is to present subsurface conditions at the locations tested and foundation design recommendations for the planned structure. Field and laboratory test results, site and boring location plans, and profile/cross-sections depicting subsurface conditions may be found in this report.

**PROJECT DESCRIPTION**

According to the Bridge Survey and Hydraulic Design Report dated July 2005, the referenced project will replace the existing three span bridge, currently spanning Miles Creek. The proposed replacement structure will be a three span, four bent bridge, located at essentially the same alignment as the existing structure. The proposed bridge will be approximately 122 feet long, located between Station 19+01 and Station 20+23, and have a skew angle of 105°. In addition, the bridge embankments will be reconstructed to match the current pavement elevations and are not anticipated to require new fills. The slopes in front of the abutment will be constructed with 4:1 (horizontal: vertical) slopes and Class II Rip Rap. Design scour elevations and structural loads were provided by TGS Engineers on September 26 and October 20, 2005, respectively, and are presented on the attached Summary of Foundation Recommendations.

**SITE DESCRIPTION/GEOLOGY**

The proposed project site is located along SR 2416 in a rural area of Gaston County, approximately 5 miles south of Gastonia, NC. The area has a generally rolling terrain with a relatively well developed flood plain. It is estimated that the floodplain is approximately 190 feet wide at the bridge site. The site appears to be wooded and undeveloped. The depth of water in the creek at the time of drilling was approximately ½ foot along the upstream side.

According to *The Geologic Map of North Carolina* (1985), the project site is part of the Piedmont Physiographic Providence and is located within the Kings Mountain Belt. The map shows that the site is within the Battleground formation (Zbt). Rocks include quartz-sericite schist with metavolcanic rock, quartz-pebble metaconglomerate, kyanite-sillimanite quartzite and garnet-quartz rock.

**FIELD EVALUATION PROCEDURE**

The subsurface exploration consisted of performing six (6) soil test borings near the proposed end bents and interior bents. Some borings were offset due to utility and accessibility issues. Borings were performed with a track-mounted Diedrich D-50 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 (NCDOT) latest Geotechnical Guidelines and Procedures Manual. Rock coring was performed in general conformance with (ASTM) procedure D2113 utilizing HQ size barrels.

Groundwater measurement readings were taken within each borehole with a weighted 100-foot measuring tape from a survey reference location at the top of each boring. Readings were recorded immediately after boring termination and after a 24-hour waiting period. Surveyed borehole elevations are based on a temporary benchmark TBM #3, located at Station 20+51.50, 22.4 feet left of -L-. The elevation at this benchmark is 636.12 feet.

In addition to our subsurface investigation, a visual scour evaluation was performed along the channel and banks of Miles Creek to determine scour impact for foundation design purposes. The scour report is included in the Appendix of this report.

**SUBSURFACE AND GROUNDWATER CONDITIONS**

Subsurface soils penetrated beneath the site consist of roadway embankment, alluvial deposits and residual materials underlain by weathered rock and crystalline rock.

**End Bents**

Soils beneath End Bent 1 consist of roadway embankment, alluvial deposits and residual materials, underlain by weathered rock and crystalline rock. Roadway embankment soils were encountered at or near ground surface and consist of approximately 9 feet of loose silty sand and medium stiff sandy clay (A-2-4, A-7-5). Alluvial deposits were encountered below the roadway embankment soils and consist of approximately 13 to 15 feet of loose to very loose silty sand and soft sandy silt (A-2-4, A-4). Residual soils were encountered below the alluvial deposits and consist of approximately 7 to 12 feet of loose to dense silty sand (A-2-4). Weathered schist was encountered below the residual soils at elevations of approximately 607 and 601 feet. Crystalline rock was encountered below the weathered rock at elevations of approximately 606 and 595 feet.

Soils beneath End Bent 2 consist of roadway embankment, alluvial deposits and residual materials underlain by weathered rock and/or crystalline rock. Roadway embankment soils were encountered at or near ground surface and consist of approximately 4 feet of medium stiff sandy

clay (A-6). Alluvial deposits were encountered either at the ground surface or below the roadway embankment soils and consist of approximately 8 feet of loose to medium dense silty sand and soft to stiff sandy silt (A-2-4, A-4). Residual soils were encountered below the alluvial deposits and consist of approximately 10 to 24 feet of stiff to very stiff sandy silt and loose to dense silty sand (A-4, A-2-4). Weathered rock was encountered below the residual soils at an elevation of approximately 616 feet at EB2B. Crystalline rock was encountered below the weathered rock at EB2B at an elevation of approximately 615 feet, and below the residual soils at EB2A at an elevation of approximately 599 feet.

#### Interior Bents

Soils beneath Interior Bent 1 consist of alluvial deposits and residual materials underlain by weathered rock and crystalline rock. Alluvial deposits were encountered at or near ground surface and consist of approximately 19 feet of very loose to loose silty sand (A-2-4). Residual soils were encountered below alluvial deposits and consist of approximately 8 feet of loose to medium dense silty sand (A-2-4). Weathered schist was encountered below the residual soils at an elevation of approximately 600 feet. Crystalline rock was encountered approximately 6 feet below the top of weathered rock at an elevation of approximately 594 feet.

Soils beneath Interior Bent 2 consist of alluvial deposits and residual materials underlain by weathered rock and crystalline rock. Alluvial deposits were encountered at or near ground surface and consist of approximately 8 feet of loose silty sand and stiff sandy clay (A-2-4, A-6). Residual soils were encountered below alluvial deposits and consist of approximately 5 feet of medium stiff sandy clay (A-6). Weathered schist was encountered below the residual soils at an elevation of approximately 614 feet. Crystalline rock was encountered approximately 4 feet below the top of weathered rock at an elevation of approximately 611 feet.

Groundwater across the site ranges in elevation between approximately 627 and 619 feet. Water level within the creek at the time of our investigation was approximately elevation 619 feet.

#### 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 seven split-spoon samples were analyzed in our laboratory for natural moisture determination, Atterberg limits, and grain size analysis. In addition, representative channel and bank samples were analyzed for grain size distribution. Two rock core samples were also tested for compressive strength. 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-89-02 (As Modified) "Determining the Liquid Limits of Soil"
- AASHTO T-90-00 "Determining the Plastic Limit and Plasticity of Soils"
- AASHTO T-265-93 "Laboratory Determination of Moisture Content of Soils"
- ASTM 2938-95 "Unconfined Compressive Strength of Intact Rock Core"
- ASTM 3148-02 "Elastic Moduli of Intact Rock Core in Uniaxial Compression"

#### CONCLUSIONS

Based on our subsurface investigation, the subsurface conditions consist of loose/medium stiff roadway embankment soils, very loose to medium dense/soft to stiff alluvial soils, and loose to dense/medium stiff to very stiff residual soils, underlain by weathered rock and crystalline rock. The thickness of the alluvial soils ranges from approximately 8 to 19 feet. Weathered rock was encountered at depths ranging from approximately 13 to 35 feet (elevations of 616 to 600 feet). Due to the loose/soft nature of the alluvial soils and deeper depths to weathered rock and crystalline rock, a combination of driven piles and drilled piers bearing on weathered and/or crystalline rock are anticipated for the bridge structure.

#### FOUNDATION RECOMMENDATIONS

Based on the depth to competent bearing material, the end bents for the proposed bridge should be supported by driven HP 12x53 piles. The piles may be designed using an allowable capacity of 45 tons and a safety factor of 2. The interior bents of the bridge should be supported by 42-inch concrete drilled piers. The piers may be designed to bear on crystalline rock with an allowable capacity of 330 tons, based on a safety factor of 2.5. For more information, refer to the attached "Summary of Foundation Recommendations".

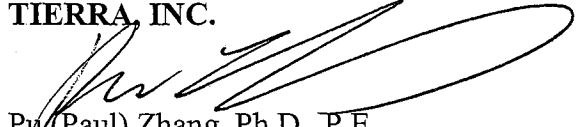
Based upon the information provided, we understand the existing grades at new end bents will not be changed. Construction for the end bents will only require excavation for the abutments and new slopes. Therefore, additional settlement is not anticipated for the bridge approaches. The end bent slopes are proposed to be 4 Horizontal to 1 Vertical (4H:1V). Provided that the embankments are constructed in accordance with NCDOT specifications and suitable slope protection measures are incorporated, the slopes may be constructed at 4H:1V.

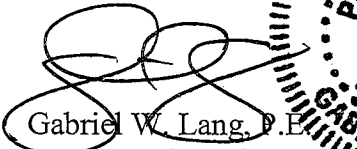
#### CLOSURE

Recommendations and evaluations provided by Tierra, Inc. are based on the Bridge Survey & Hydraulic Design Report dated July 2005. 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.**

  
Pu (Paul) Zhang, Ph.D., P.E.  
Geotechnical Engineer

  
Gabriel W. Lang, P.E.  
Sr. Geotechnical Engineer



1-17-06

**SUMMARY OF FOUNDATION RECOMMENDATIONS**

No. MA12018R, Gaston County  
Bridge # 28 on SR 2416 over Miles Creek  
6211-05-028

**Note on Plans:**

1. Piles for End Bents No. 1 and 2 shall be driven to a minimum bearing capacity of 45 tons each.
2. When driving piles, the maximum blow counts shall not be exceeded.
3. The drilled piers at Bents No. 1 and 2 have been designed for both skin friction and tip bearing. The required tip bearing capacity is 25 tsf.
4. The required tip bearing capacity at Bents No. 1 and 2 shall be verified.
5. Drilled piers for Bents No. 1 and 2 have been designed for an applied load of 330 tons each at the top of the column.
6. Drilled piers at Bent No. 1 shall extend to an elevation no higher than 588 feet and satisfy the required tip bearing capacity.
7. Drilled piers at Bent No. 2 shall extend to an elevation no higher than 588 feet LT and 596 feet RT and satisfy the required tip bearing capacity.
8. Permanent steel casing may be required for drilled piers at Bent No. 1. If required, the casing shall not extend below elevation 600 feet without the engineer's permission. The need for permanent steel casing will be determined by the engineer.
9. Permanent steel casing may be required for drilled piers at Bent No. 2. If required, the casing shall not extend below elevation 600 feet LT, and 607 feet RT without the engineer's permission. The need for permanent steel casing will be determined by the engineer.
10. For permanent steel casing, see special provision for drilled piers.
11. SPT testing is not required to determine the tip bearing capacity of the drilled piers at Bents No. 1 and 2.
12. Slurry construction shall not be used for this project.
13. SID inspections are not required to determine the bottom cleanliness of the drilled piers at Bents No. 1 and 2.
14. For drilled piers, see special provisions.
15. The scour critical elevations for Bents No. 1 and 2 are 606 feet. The scour critical elevations are for use by maintenance forces to monitor possible scour problems during the life of the structure.

**Comments:**

1. The elevation of the point of fixity for Bent No. 1 is 592 ft.
2. The elevations of the point of fixity for Bent No. 2 are 592 ft LT and 600 ft RT.
3. Design scour elevation for Bents No. 1 and 2 is 607 ft.
4. The actual boring location for Bent No. 2 was approximately 18 feet offset from the edge of the road due to accessibility issues. Our recommendation for Bent No. 2 is based on assumed rockline elevations at proposed location through interpolation. It is subjected to change if the revealed subsurface conditions vary from our assumptions during construction.
5. 4:1 (H:V) embankment slope at end bents maybe constructed with suitable slope face protection.
6. A longitudinal shear load of 1.1 kips with a free head condition was assumed for Bents No. 1 and 2.
7. A transverse shear load of 0.1 kips with a fixed head condition was assumed for Bents No. 1 and 2.

NCDOT PROJ. NO.: MA-12018R PROJECT DESCRIPTION: Bridge No. 28 on SR 2416

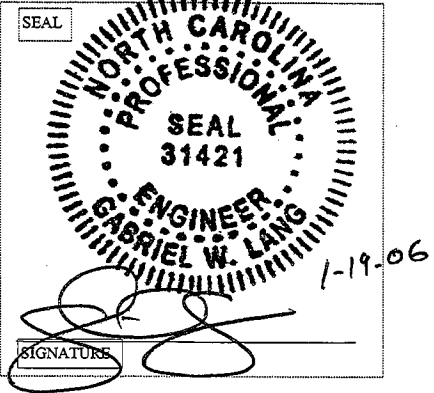
T.I.P. NO.: \_\_\_\_\_ over Miles Creek

COUNTY: Gaston

STATION: 19+62 -L-

PREPARED BY: PZ DATE: 01/18/06

CHECKER: GL DATE: 01/18/06



	STATION	FOUNDATION TYPE	ALLOWABLE LOAD	FOUNDATION DETAILS
END BENT 1	19+01 -L-	Cap on HP 12x53 Steel Pile	45 tons/Pile	Assumed Bottom of Abutment = 631 ft ± Recommended Length of Pile = 35 ft
BENT 1	19+37 -L-	42 inch Drilled Pier	330 tons/Pier	Assumed Bottom of Cap = 632 ft ± Assumed Top of Pier = 625 ft ± Recommended Length of Pier = 37 ft Tip Elevation No Higher Than = 588 ft
BENT 2	19+87 -L-	42 inch Drilled Pier	330 tons/Pier	Assumed Bottom of Cap = 632 ft ± Assumed Top of Pier = 625 ft ± Recommended Length of Pier = 37 ft LT Recommended Length of Pier = 29 ft RT Tip Elevation No Higher Than = 588 ft LT Tip Elevation No Higher Than = 596 ft RT
END BENT 2	20+23 -L-	Cap on HP 12x53 Steel Pile	45 tons/Pile	Assumed Bottom of Abutment = 632 ft ± Recommended Length of Pile = 35 ft

COMMENTS & NOTES (Attached)

DRILLED PIER PAY ITEM QUANTITIES

PROJECT NO.

MA-12018R

DATE

1/18/2006

TIP NO.

DESIGNED BY

PZ

COUNTY

GASTON

CHECKED BY

GL

STATION

19+62 -L-

DESCRIPTION BRIDGE #28 ON SR 2416 (ROBINSON ROAD) OVER MILES CREEK

NUMBER OF BENTS WITH DRILLED PIERS2

NUMBER OF PIERS PER BENT3

BENT #	DRILLED PIER PAY ITEMS					
	PERMANENT STEEL CASING FOR 42 INCH DIA. DRILLED PIER (yes/no/maybe)	42 INCH DIA. DRILLED PIERS NOT IN SOIL (feet)	SPT TESTING (each)	SID INSPECTION (each)	CROSSHOLE SONIC LOGGING* (each)	CSL TUBES* (yes/no)
1	Maybe	27	0	0	0	No
2	Maybe	27	0	0	0	No
3						
4						
5						
6						
7						
8						
9						
10						
TOTALS		54	0	0	0	

\* 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.

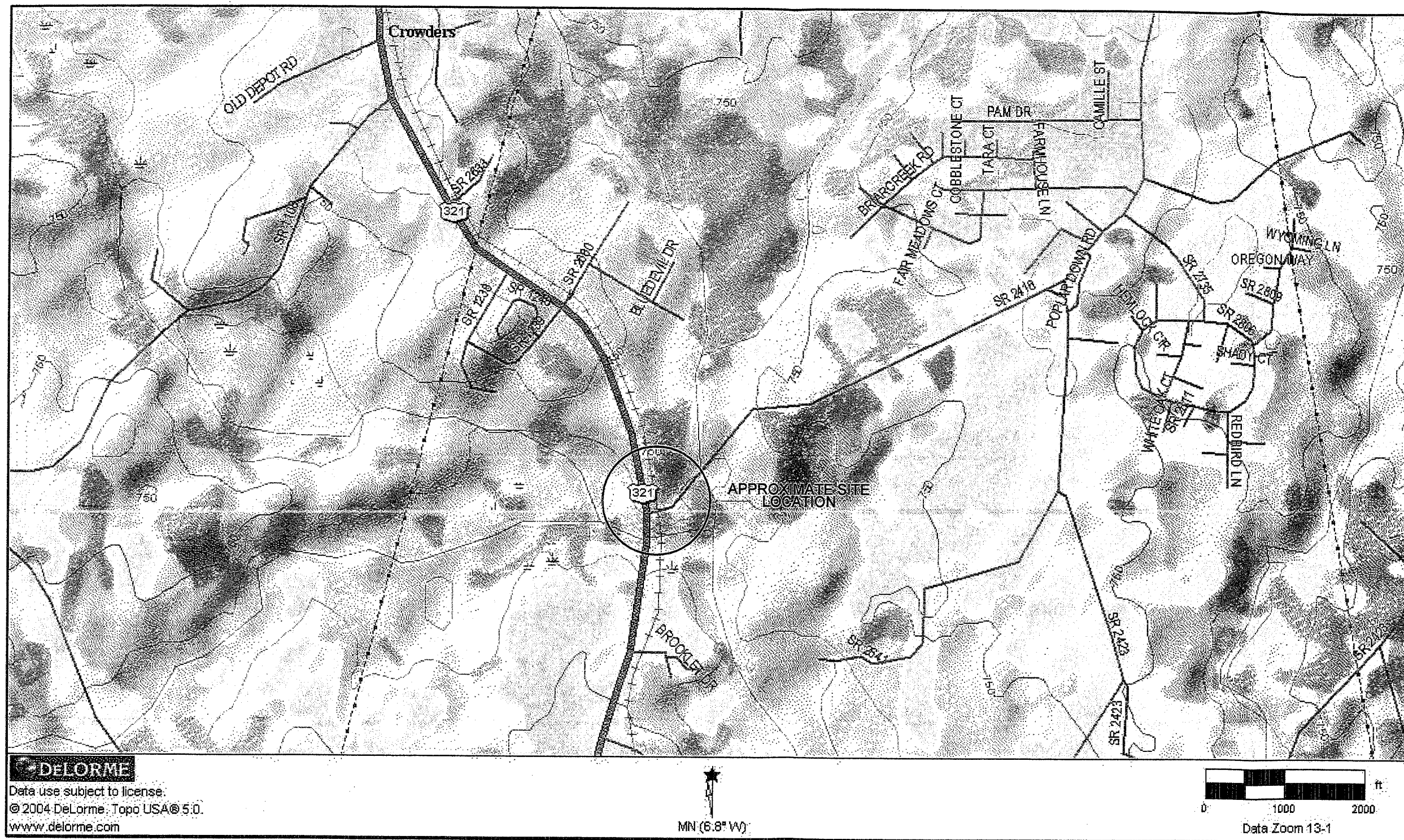
Structure Design should determine the pay item quantity, " \_\_\_ Dia. Drilled Piers in Soil", based upon the total drilled pier length per bent minus the " \_\_\_ Dia. Drilled Piers not in Soil" per bent shown in the table above.

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.



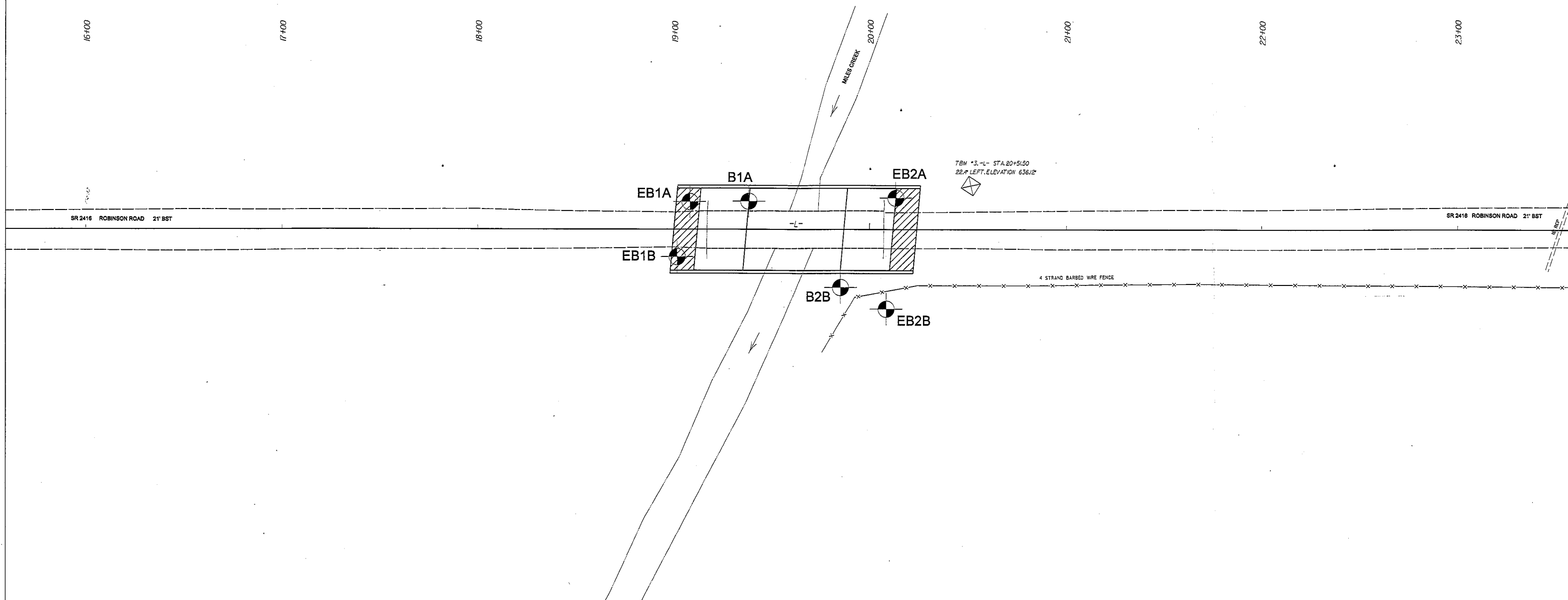
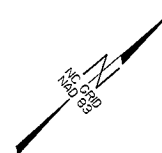


## SITE VICINITY MAP

NCDOT PROJECT #: MA12018R  
GASTON CO., NC  
STRUCTURE #28 ON SR 2416  
(ROBINSON RD.) OVER MILES CREEK



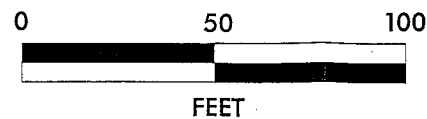
TIERRA, INC.  
2736 ROWLAND RD.  
RALEIGH, NC 27615  
PHONE (919) 871-0300  
FAX (919) 871-0803



**NOTES:**

BENCH MARK: TBM #3, TRAVERSE DISK AT -L-  
STA. 20+51.50, 22.4' LT., ELEVATION 636.12'

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



**BORING LOCATION PLAN**

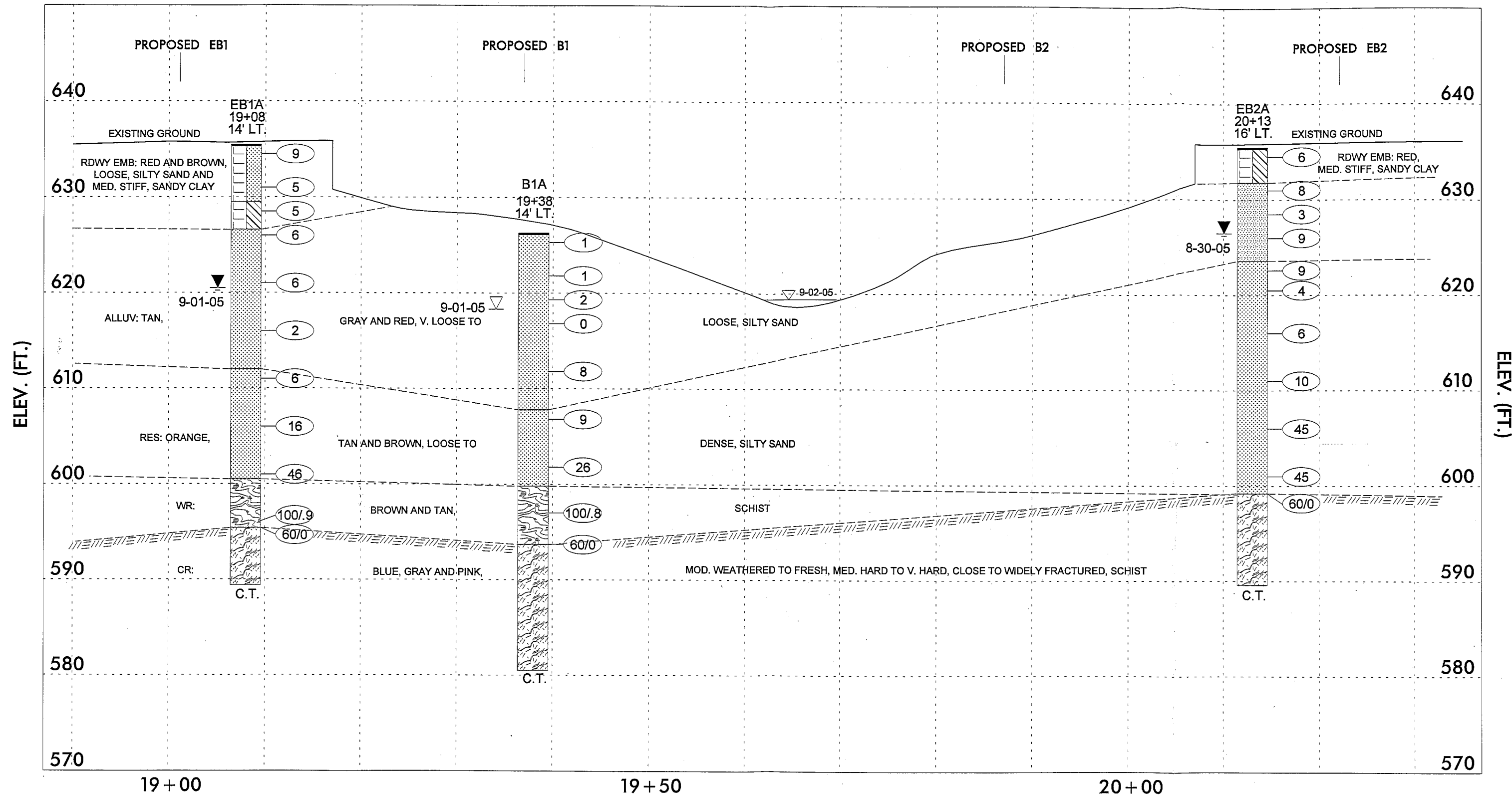
NCDOT PROJECT #: MA 120 18R  
GASTON CO., NC  
BRIDGE #28 ON SR 2416  
(ROBINSON RD.) OVER MILES CREEK



**TIERRA**  
GEOTECHNICAL • MATERIALS  
ENGINEERING

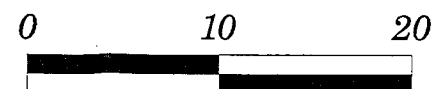
TIERRA, INC.  
2736 ROWLAND RD.  
RALEIGH, NC 27615  
PHONE (919) 871-0800  
FAX (919) 871-0803



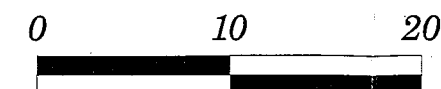


BENCH MARK: TBM #3, TRAVERSE DISK AT -L-  
STA. 20+51.50, 22.4' LT., ELEVATION 636.12'

VERTICAL SCALE



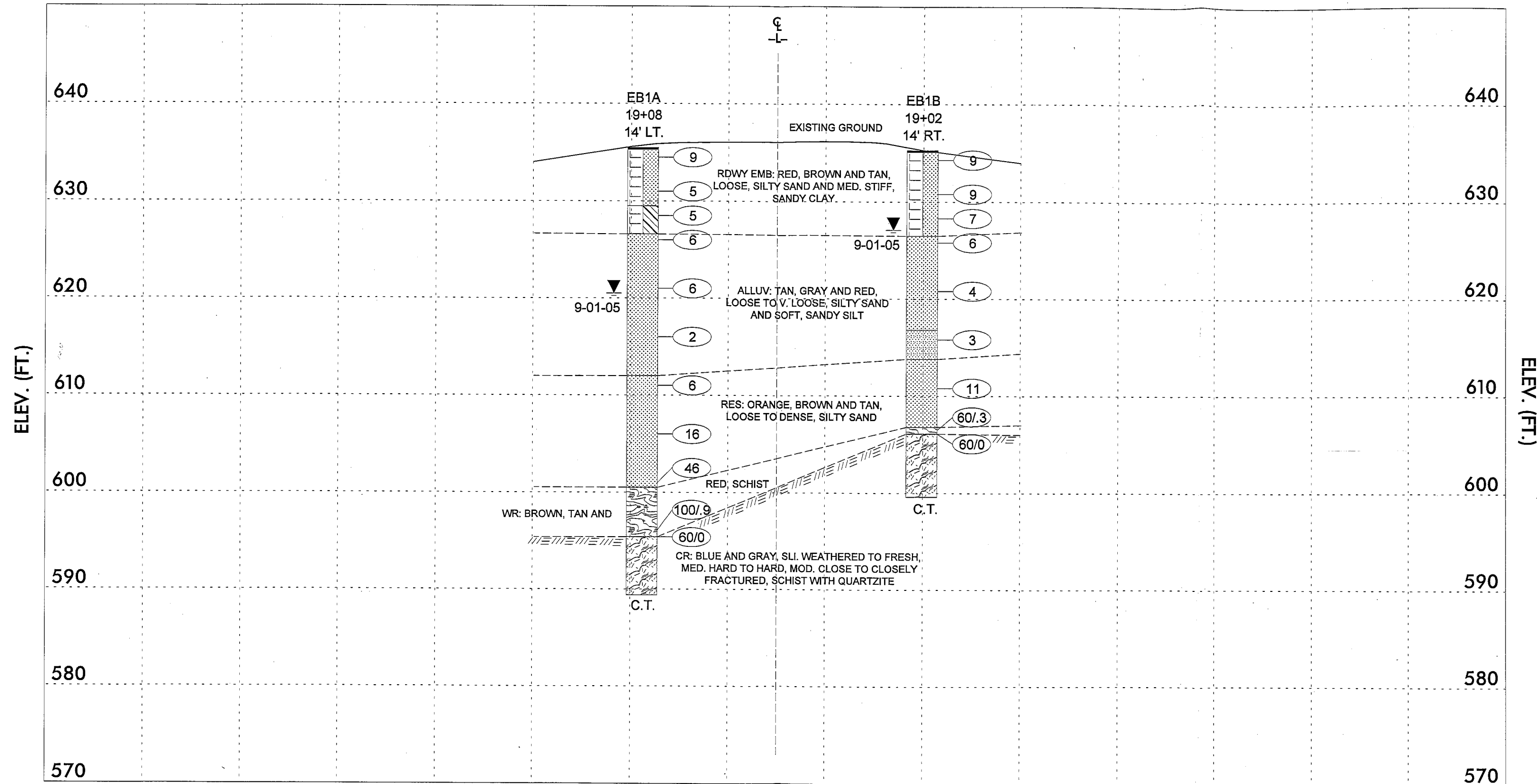
HORIZONTAL SCALE



PROFILE 12' LEFT OF -L-

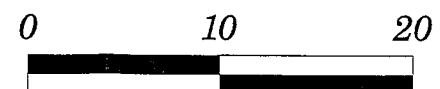
NCDOT PROJECT #: MA12013R  
GASTON CO., NC  
STRUCTURE #28 ON SR 2416  
(ROBINSON RD.) OVER MILES CREEK

**TIERRA**  
INC.  
2736 ROWLAND RD.  
RALEIGH, NC 27615  
PHONE: (919) 871-2800  
FAX: (919) 871-2803

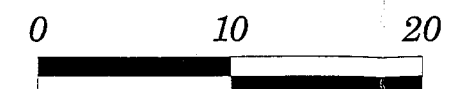


BENCH MARK: TBM #3, TRAVERSE DISK AT -L-  
STA. 20+51.50, 22.4' LT., ELEVATION 636.12'

VERTICAL SCALE



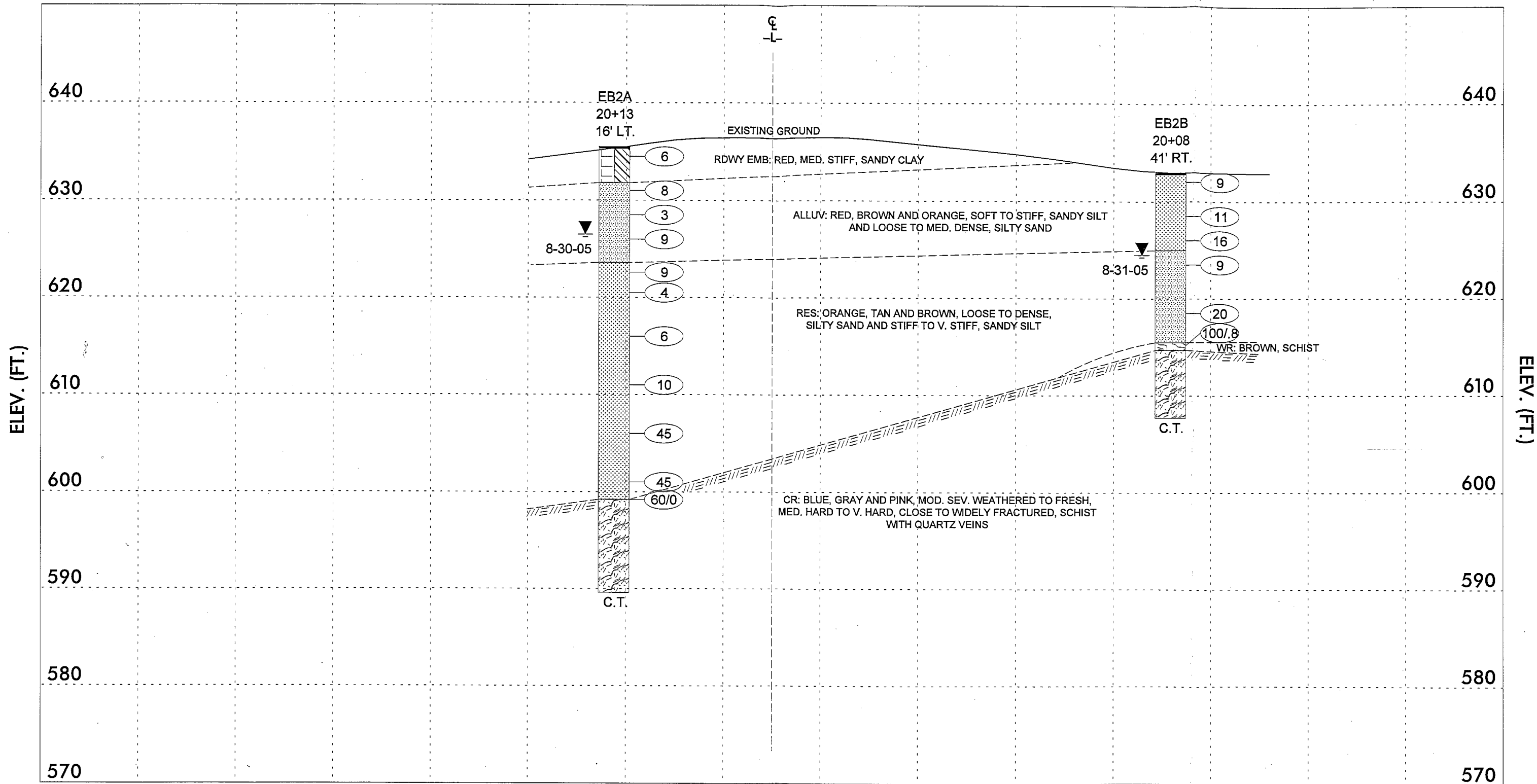
HORIZONTAL SCALE



CROSS SECTION END BENT 1

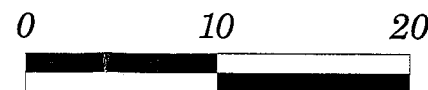
NCDOT PROJECT #: MA12018R  
GASTON CO., NC  
STRUCTURE #28 ON SR 2416  
(ROBINSON RD.) OVER MILES CREEK

**TIERRA**  
TIERRA, INC.  
2736 ROWLAND RD.  
RALEIGH, NC 27605  
PHONE (919) 871-0800  
FAX (919) 871-0801

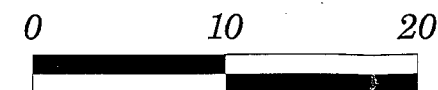


BENCH MARK: TBM #3, TRAVERSE DISK AT -L- STA. 20+51.50, 22.4' LT., ELEVATION 636.12'

VERTICAL SCALE



HORIZONTAL SCALE



CROSS SECTION END BENT 2

NCDOT PROJECT #: MA12018R  
GASTON CO., NC  
STRUCTURE #28 ON SR 2416  
(ROBINSON RD.) OVER MILES CREEK

**TIERRA**  
GEOTECHNICAL - MATERIALS  
ENGINEERING

TIERRA, INC.  
2735 ROWLAND RD.  
RALEIGH, NC 27608  
PHONE 919 871-0800  
FAX 919 871-0803

NCDOT BORE 05-028 BR 28 - GASTON CO.GP.I NCDOT.GDT 1/18/06

DATE: 9/01/05

PROJECT: MA12018R      I.D. NO.:      BORING NO: EB1A      GEOLOGIST: J. HOWARD

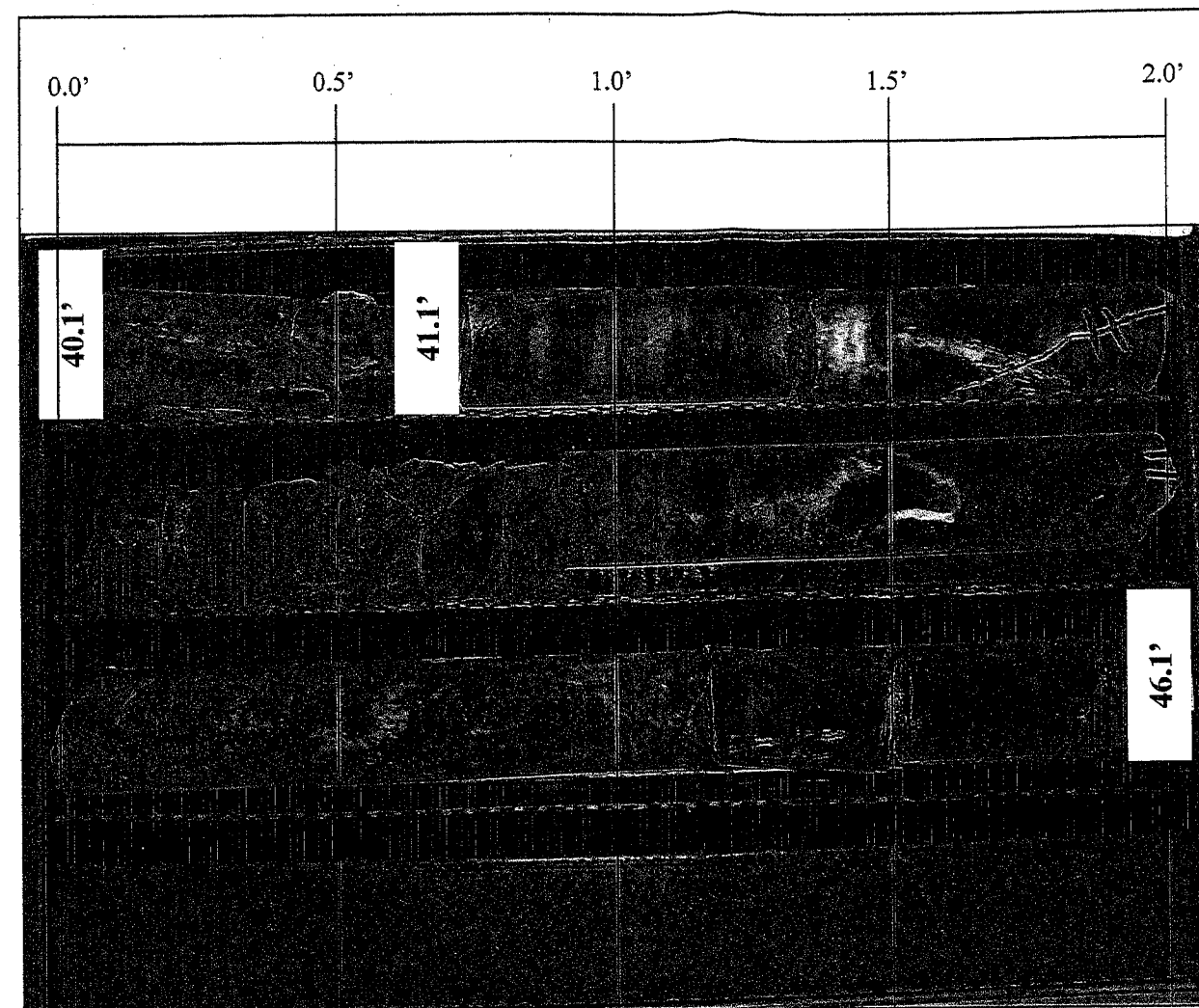
DESCRIPTION: BRIDGE #28 ON SR 2416 (ROBINSON RD.) OVER MILES CREEK

COUNTY: GASTON COLLAR ELEV.: 635.5 FT TOTAL DEPTH: 46.1 FT

[illegible]

CORING TERMINATED AT 46.1 FT  
ELEVATION 589.4 FT

DRILLER: F. COX CORE SIZE: HQ EQUIPMENT: D-50



Boring EB1A, Box 1 of 1, 40.1 feet to 46.1 feet.

SCALE 1:40 (1"=4")

# **ROCK CORE PHOTOGRAPHS**

NCDOT PROJECT #: MA12018R  
 GASTON CO., NC  
 STRUCTURE #28 ON SR 2416  
 (ROBINSON RD.) OVER MILES CREEK



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





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

SHEET 1 OF 1

PROJECT NO. 6211-05-028			ID. MA12018R			COUNTY GASTON			GEOLOGIST J. HOWARD				
SITE DESCRIPTION BRIDGE #28 ON SR 2416 (ROBINSON RD.) OVER MILES CREEK								GROUND WATER (ft)					
BORING NO. EB1B		BORING LOCATION 19+02			OFFSET 14' RT.		ALIGNMENT -L-		0 HR. 8.2				
COLLAR ELEV. 635.3 ft		NORTHING			EASTING				24 HR. 8.2				
TOTAL DEPTH 35.7 ft		DRILL MACHINE D-50			DRILL METHOD MUD ROTARY			HAMMER TYPE AUTO					
DATE STARTED 8-31-05			COMPLETED 8-31-05			SURFACE WATER DEPTH N/A							
ELEV. (ft)	DEPTH (ft)	BLOW COUNT			BLOWS PER FOOT					SAMP. NO.	▼ MOI	L O G	SOIL AND ROCK DESCRIPTION
		0.5ft	0.5ft	0.5ft	0	20	40	60	80	100			
635.3					EXISTING GROUND								
635	0.0	4	4	5									635.3 0.0
	3.5		3	4									635.1 0.0
630	6.0		3	3									
	8.5		4	3									
625													626.5 8.0
	13.5		1	2									
620													
	18.5	WOH	1	2						SS-2	46%		616.8 18.0
615													
	23.5		3	4									613.8 21.0
610													
	28.5												606.8 28.0
	29.2	60/3											606.1 29.0
605		60/0											
600													599.6 35.0
	</												

## CORE BORING REPORT

DATE: 8-31-05

PROJECT: MA12018R      I.D. NO.:      BORING NO: EB1B      GEOLOGIST: J. HOWARD

DESCRIPTION: BRIDGE #28 ON SR 2416 (ROBINSON RD.) OVER MILES CREEK

COUNTY: GASTON COLLAR ELEV.: 635.3 FT TOTAL DEPTH: 35.7 FT

[illegible]

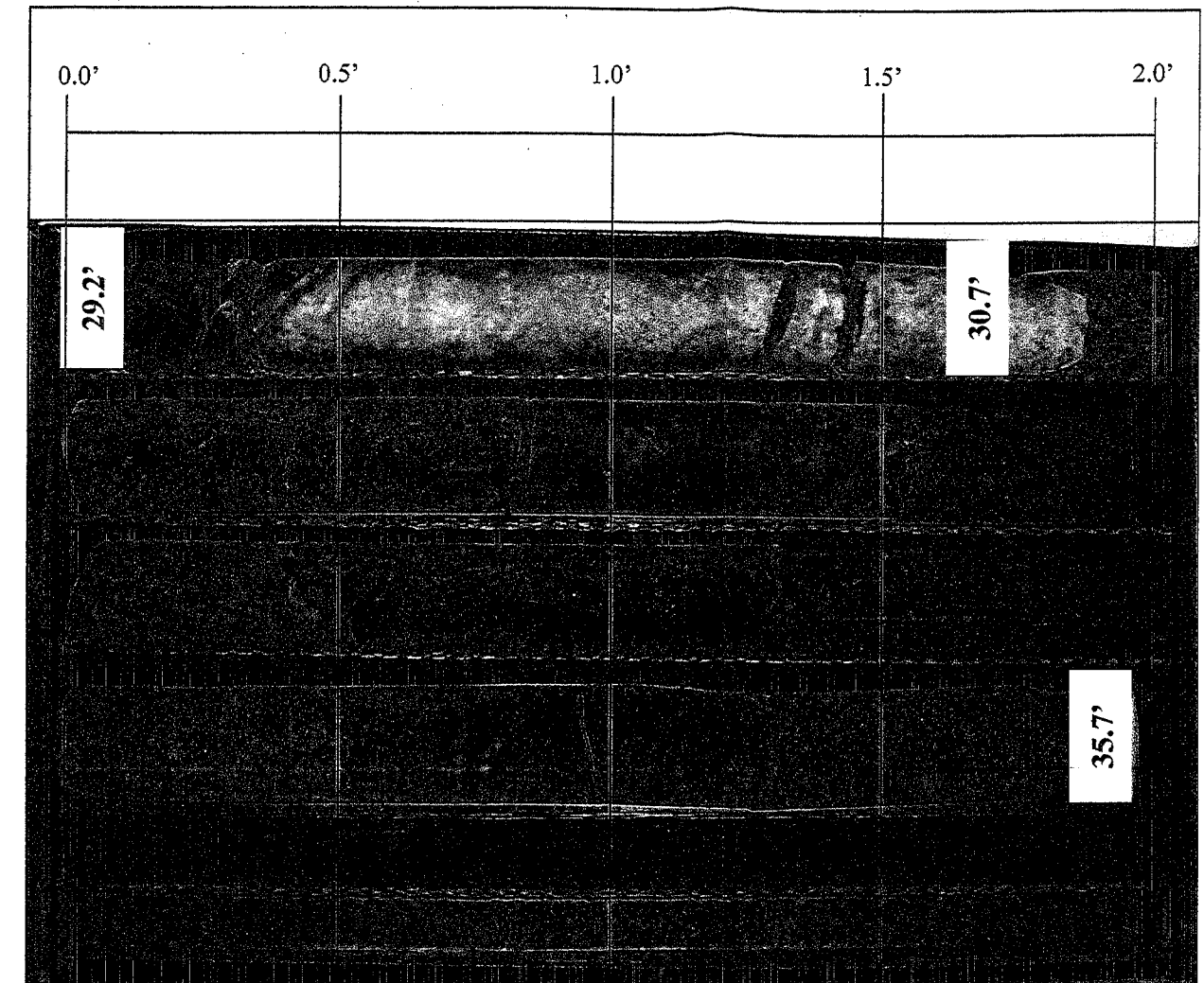
CORING TERMINATED AT 35.7 FT  
ELEVATION 599.6 FT

DRILLER: F. COX

CORE SIZE: HQ

EQUIPMENT: D-50

NCDOT\_BORE 05-028 BR 28 - GASTON CO.GPJ NCDOT.GDT 1/18/06



Boring EB1B, Box 1 of 1, 29.2 feet to 35.7 feet.

SCALE 1:40 (1"=4")

### ROCK CORE PHOTOGRAPHS

NCDOT PROJECT #: MA12018R  
GASTON CO., NC  
STRUCTURE #28 ON SR 2416  
(ROBINSON RD.) OVER MILES CREEK



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



PROJECT NO. 6211-05-028					ID. MA12018R					COUNTY GASTON					GEOLOGIST J. HOWARD									
SITE DESCRIPTION BRIDGE #28 ON SR 2416 (ROBINSON RD.) OVER MILES CREEK															GROUND WATER (ft)									
BORING NO. B1A					BORING LOCATION 19+38					OFFSET 14' LT.					ALIGNMENT -L-					0 HR. 8.0				
COLLAR ELEV. 626.3 ft					NORTHING					EASTING					24 HR. BACKFILL									
TOTAL DEPTH 45.8 ft					DRILL MACHINE D-50					DRILL METHOD MUD ROTARY					HAMMER TYPE AUTO									
DATE STARTED 9-01-05					COMPLETED 9-02-05					SURFACE WATER DEPTH N/A														
ELEV. (ft)	DEPTH (ft)	BLOW COUNT			BLOWS PER FOOT					SAMP. NO.	MOI	L O G	SOIL AND ROCK DESCRIPTION											
		0.5ft	0.5ft	0.5ft	0	20	40	60	80	100														
EXISTING GROUND																								
626.3	0.0	1	WOH	1	1								626.3	0.0	ROOTMAT									
625	3.5	1	WOH	1	1								626.1	0.2	ALLUV: TAN TO GRAY, V. LOOSE TO LOOSE, SILTY SAND (A-2-4)									
620	6.0	1	1	1	2																			
615	8.5	WOH	WOH	WOH	0																			
610	13.5	9	4	4	8																			
605	18.5	6	5	4	9										RES: TAN AND BROWN, LOOSE TO MED. DENSE, SILTY SAND (A-2-4)									
600	23.5	6	8	18	28																			
595	28.5	31	69/3		100/8										WR: BROWN AND TAN, SCHIST									
590	32.6	60/0			60/0										CR: BLUE, GRAY AND PINK, SLI. WEATHERED TO FRESH, HARD TO V. HARD, CLOSE TO MOD. CLOSELY FRACTURED, SCHIST WITH QUARTZITE									
585															CORING TERMINATED AT ELEV. 580.5' IN CR: BLUE, GRAY AND PINK, SCHIST WITH QUARTZITE									

# CORE BORING REPORT

DATE: 9-02-05

PROJECT: MA12018R      I.D. NO.:      BORING NO: B1A      GEOLOGIST: J. HOWARD

DESCRIPTION: BRIDGE #28 ON SR 2416 (ROBINSON RD.) OVER MILES CREEK

COUNTY: GASTON COLLAR ELEV.: 626.3 FT TOTAL DEPTH: 45.8 FT

[illegible]

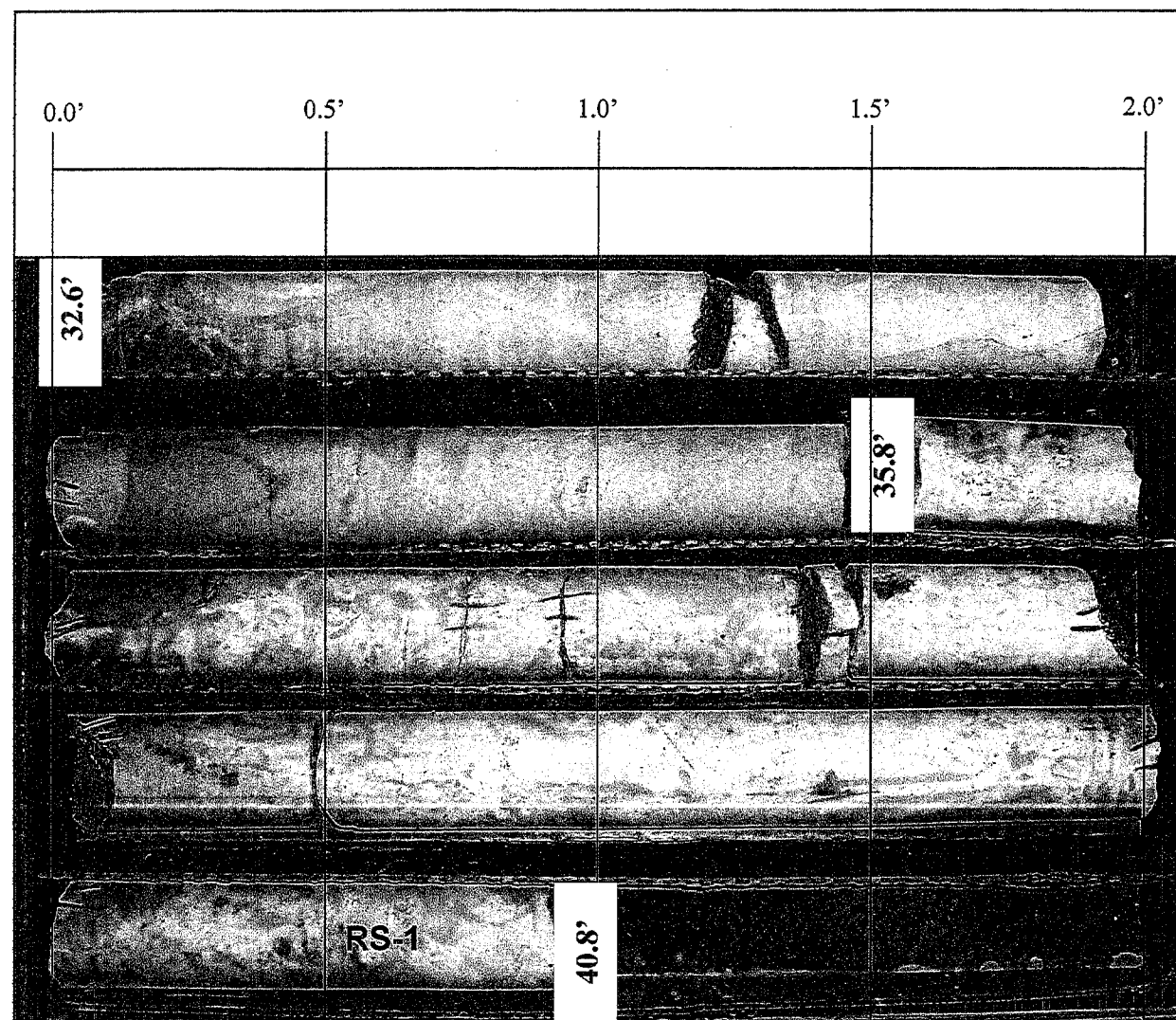
CORING TERMINATED AT 45.8 FT  
ELEVATION 580.5 FT

DRILLER: F. COX

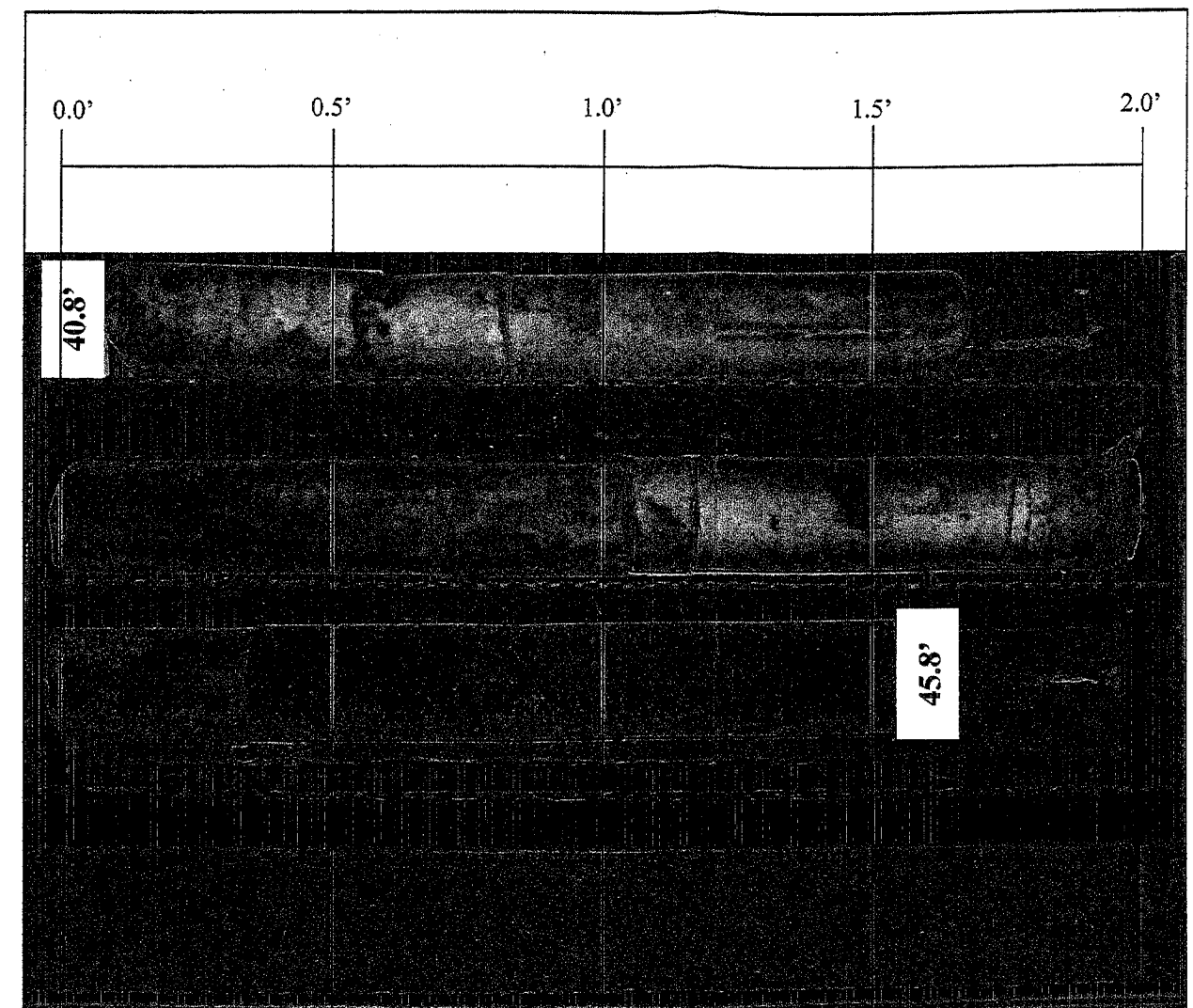
CORE SIZE: HQ

EQUIPMENT: D-50

NCDOT\_BORE 05-028 BR 28 - GASTON CO.GPJ NCDOT.GDT 1/18/06



Boring B1A, Box 1 of 2, 32.6 feet to 40.8 feet.



Boring B1A, Box 2 of 2, 40.8 feet to 45.8 feet.

SCALE 1:40 (1"=4")

# **ROCK CORE PHOTOGRAPHS**

NCDOT PROJECT #: MA12018R  
 GASTON CO., NC  
 STRUCTURE #28 ON SR 2416  
 (ROBINSON RD.) OVER MILES CREEK



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



SHEET 1 OF 1

NCDOT BORE 05-028 BR 28 - GASTON CO.GPJ NCDOT.GDT 1/18/06

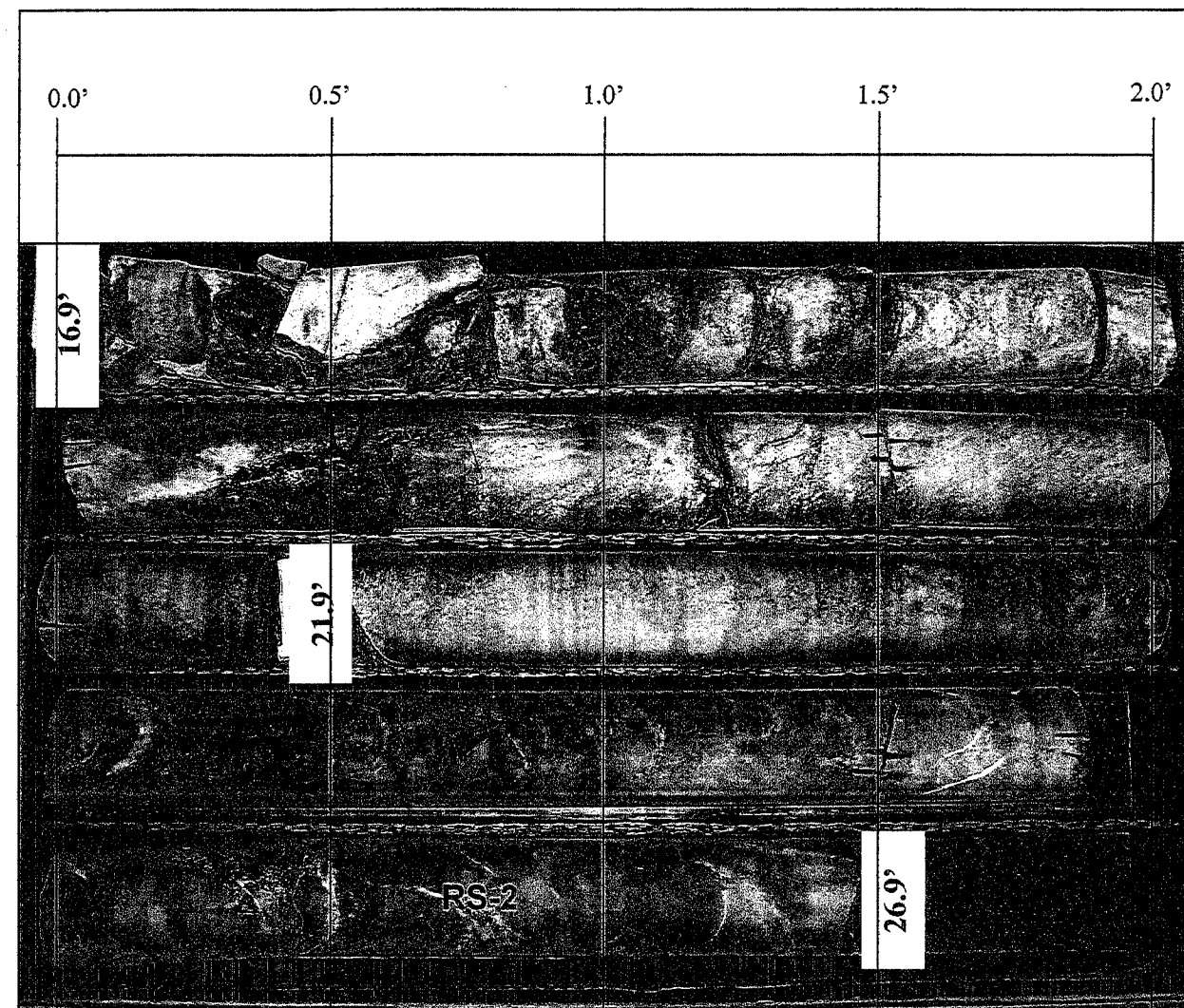
DATE: 8-30-05

COUNTY: GASTON COLLAR ELEV.: 627.4 FT TOTAL DEPTH: 31.9 FT

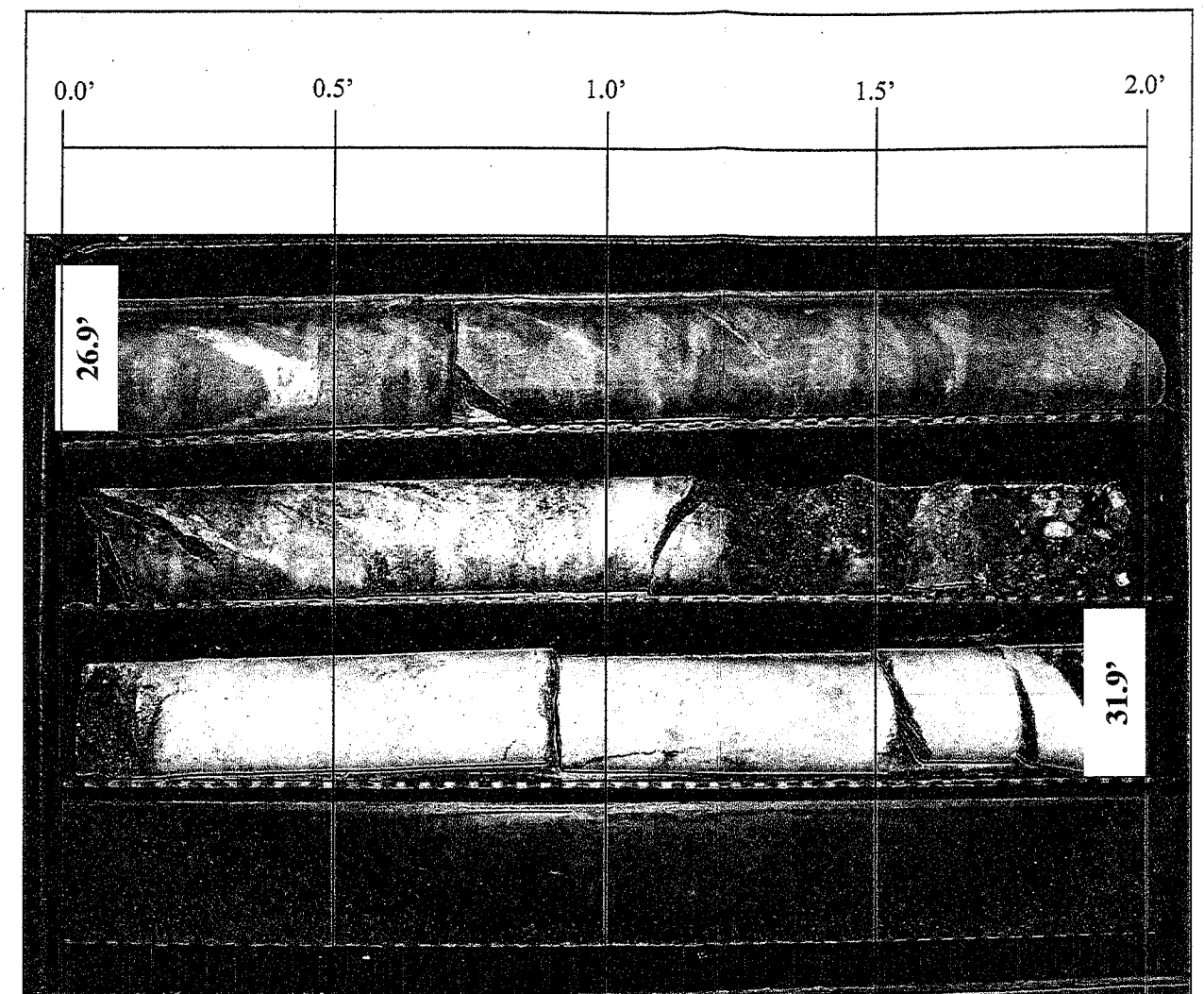
CORING TERMINATED AT 31.9 FT  
ELEVATION 595.5 FT

EQUIPMENT: D-50





Boring B2B, Box 1 of 2, 16.9 feet to 26.9 feet.



Boring B2B, Box 2 of 2, 26.9 feet to 31.9 feet.

SCALE 1:40 (1"=4")

## ROCK CORE PHOTOGRAPHS

NCDOT PROJECT #: MA12018R  
GASTON CO., NC  
STRUCTURE #28 ON SR 2416  
(ROBINSON RD.) OVER MILES CREEK



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

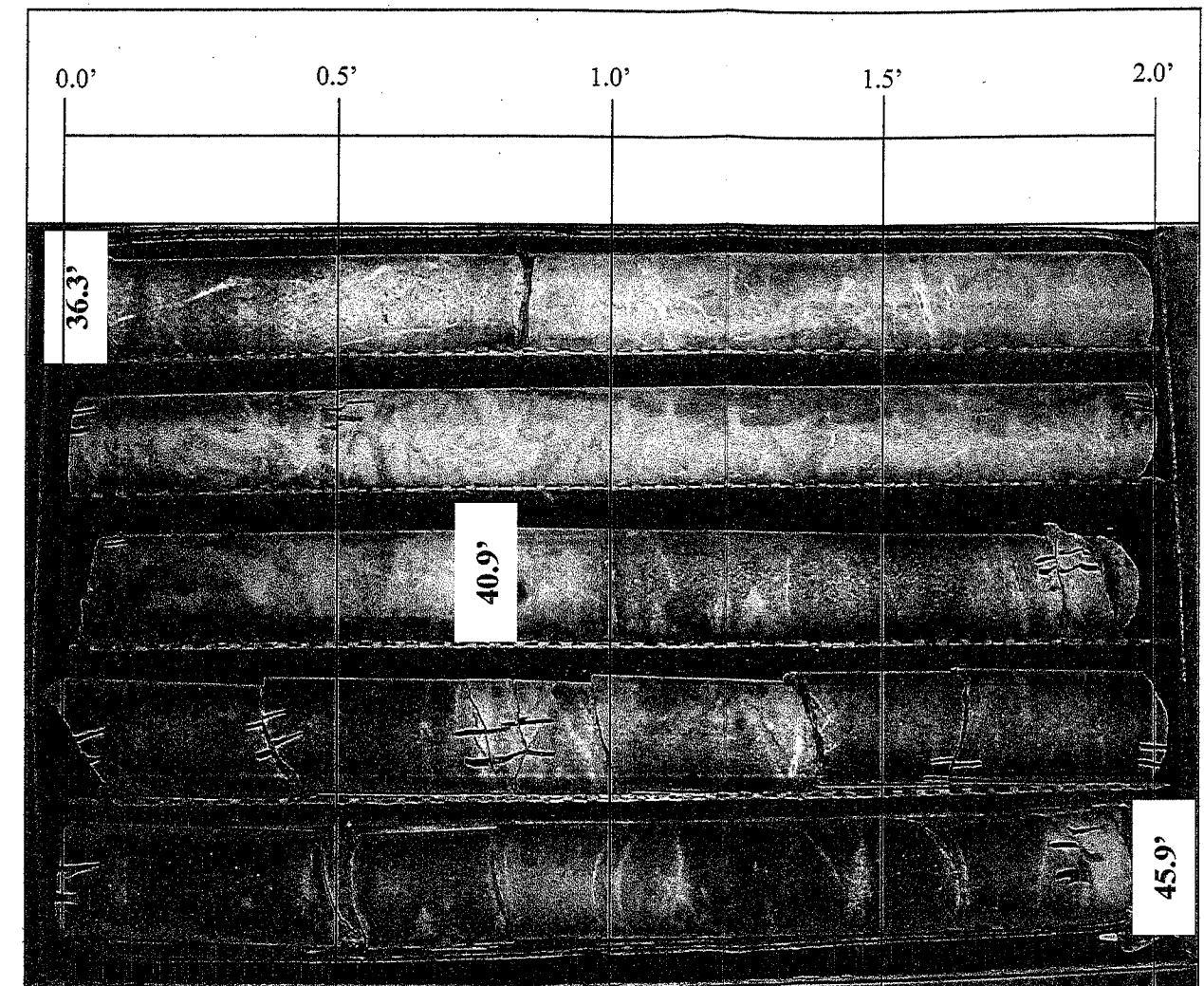
NCDOT\_BORE 05-028 BR 28 - GASTON CO.GPJ NCDOT.GDT 1/18/06

DATE: 8-30-05

COUNTY: GASTON COLLAR ELEV.: 635.5 FT TOTAL DEPTH: 45.9 FT

CORING TERMINATED AT 45.9 FT  
ELEVATION: 589.6 FT

DRILLER: F. COX CORE SIZE: HQ EQUIPMENT: D-50



Boring EB2A, Box 1 of 1, 36.3 feet to 45.9 feet.

SCALE 1:40 (1"=4")

# **ROCK CORE PHOTOGRAPHS**

NCDOT PROJECT #: MA12018R  
 GASTON CO., NC  
 STRUCTURE #28 ON SR 2416  
 (ROBINSON RD.) OVER MILES CREEK



TIERRA, INC.  
 2736 ROWLAND RD.  
 RALEIGH, NC 27615  
 PHONE (919) 871-4080  
 FAX (919) 871-0803



## CORE BORING REPORT

DATE: 8-30-05

PROJECT: MA12018R      I.D. NO.:      BORING NO: EB2B      GEOLOGIST: J. HOWARD

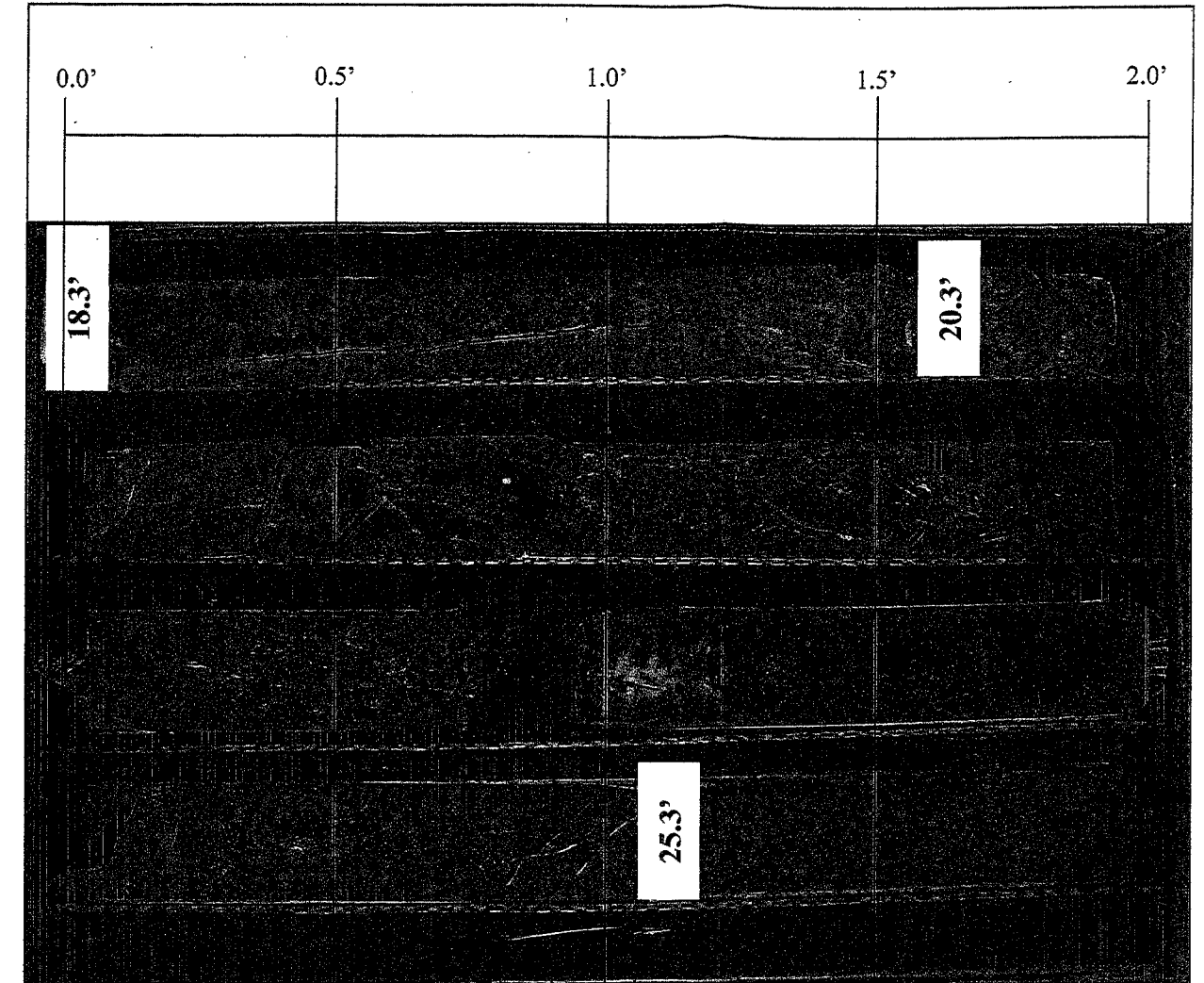
DESCRIPTION: BRIDGE #28 ON SR 2416 (ROBINSON RD.) OVER MILES CREEK

COUNTY: GASTON COLLAR ELEV.: 633.0 FT TOTAL DEPTH: 25.3 FT

[illegible]

CORING TERMINATED AT 25.3 FT  
ELEVATION 607.7 FT

DRILLER: F. COX CORE SIZE: HQ EQUIPMENT: D-50



Boring EB2B, Box 1 of 1, 18.3 feet to 25.3 feet.

SCALE 1:40 (1"=4")

### ROCK CORE PHOTOGRAPHS

NCDOT PROJECT #: MA12018R  
GASTON CO., NC  
STRUCTURE #28 ON SR 2416  
(ROBINSON RD.) OVER MILES CREEK



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



2736 ROWLAND RD. RALEIGH, NORTH CAROLINA 27615

**BRIDGE #28 ON SR 2416 (ROBINSON ROAD) OVER MILES CREEK**  
**NCMA PROJECT NO: MA12018R**

**TIERRA, INC. PROJECT NO: 6211-05-028**

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			
EB1A		SS-1	30.5%	99	95	81	48	33	15
A-7-5									
19+08	14' LT	6.0-7.5							
EB1B		SS-2	45.6%	96	84	48	26	21	5
A-4									
19+02	14' RT	18.5-20.0							
B1A		SS-3	N/A	100	96	23	NP	NP	NP
A-2-4									
19+38	14' LT	8.5-10.0							
B2B		SS-4	23.9%	88	70	40	38	26	12
A-6									
19+85	30' RT	6.0-7.5							
B2B		SS-5	23.6%	100	94	70	39	28	11
A-6									
19+85	30' RT	8.5-10.0							
EB2A		SS-6	22.4%	99	95	72	35	25	10
A-4									
20+13	16' LT	6.0-7.5							
EB2B		SS-7	45.9%	99	95	52	NP	NP	NP
A-4									
20+08	41' RT	8.5-10.0							

LABORATORY SUMMARY SHEET FOR ROCK CORE SAMPLES  
Bridge No. 28 on SR 2416 Over Miles Creek  
Gaston County, North Carolina  
MA 12018 R  
TIERRA No: 6211-05-028

[illegible]

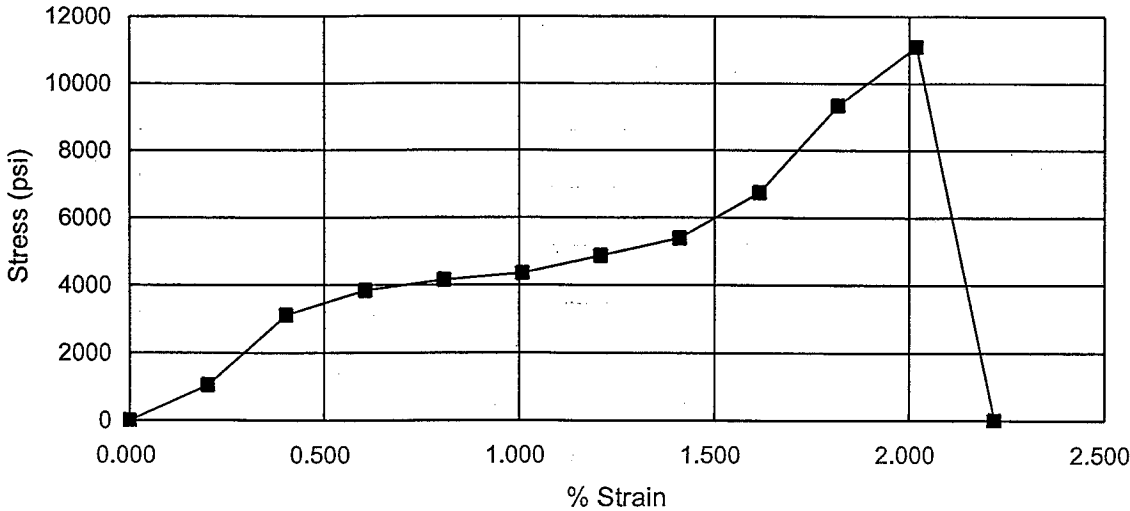
ROCK CORE UNIAXIAL COMPRESSIVE STRENGTH TEST

Job No.: 6211-05-028 Job Name: Bridge 28 on SR 2416 Over Miles Creek  
Gaston County, North Carolina

Project No. MA 12018 R  
Date: 9/9/2005 Sample No.: RS - 1  
Boring No.: B1A Depth (ft): 40.0 - 40.8  
Description: Blue, gray and pink slightly weathered to fresh, hard to very hard, close to moderately closely fractured schist with quartzite  
Length (in.): 4.955  
Diameter (in.): 2.478  
Area (sq. in.): 4.823

Compressive Strength (psi): 11093

Deflection (in.)	Strain (%)	Corrected Load (lbf)	Compressive Strength (psi)	Young's Modulus (psi)
0.000	0.000	0	0.0	
0.010	0.202	5000	1036.8	513,714
0.020	0.404	15000	3110.3	770,571
0.030	0.605	18500	3836.0	633,580
0.040	0.807	20000	4147.0	513,714
0.050	1.009	21000	4354.4	431,520
0.060	1.211	23500	4872.8	402,409
0.070	1.413	26000	5391.1	381,616
0.080	1.615	32500	6738.9	417,392
0.090	1.816	45000	9330.8	513,714
0.100	2.018	53500	11093.3	549,674
0.110	2.220	0	0.0	0



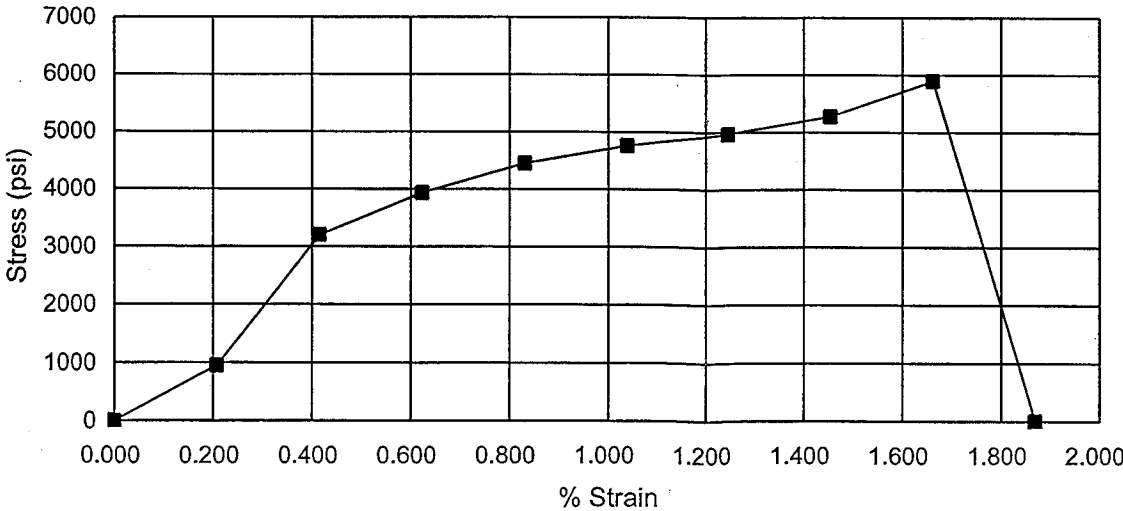
ROCK CORE UNIAXIAL COMPRESSIVE STRENGTH TEST

Job No.: 6211-05-028 Job Name: Bridge 28 on SR 2416 Over Miles Creek  
Gaston County, North Carolina

Project No. MA 12018 R  
Date: 9/9/2005 Sample No.: RS - 2  
Boring No.: B2B Depth (ft): 25.9 - 26.9  
Description: Blue, gray and white moderately weathered to fresh, hard to very hard, close to moderately closely fractured schist with quartz veins and pyrite  
Length (in.): 4.813  
Diameter (in.): 2.476  
Area (sq. in.): 4.815

Compressive Strength (psi): 5895

Deflection (in.)	Strain (%)	Corrected Load (lbf)	Compressive Strength (psi)	Young's Modulus (psi)
0.000	0.000	0	0.0	
0.010	0.208	4580	951.2	457,815
0.020	0.416	15396	3197.5	769,489
0.030	0.623	18924	3930.3	630,545
0.040	0.831	21414	4447.4	535,134
0.050	1.039	22908	4757.7	457,975
0.060	1.247	23904	4964.5	398,239
0.070	1.454	25398	5274.8	362,682
0.080	1.662	28386	5895.4	354,682
0.090	1.870	0	0.0	0



# GEOTECHNICAL UNIT FIELD SCOUR REPORT

PROJECT: 6211-05-028 ID: MA12018R COUNTY: GASTON

DESCRIPTION(1): BRIDGE #28 ON SR 2416 (ROBINSON ROAD) OVER MILES CREEK

INFORMATION ON EXISTING BRIDGES Information obtained from: ☒ field inspection  
☐ microfilm(Reel: Pos: )  
☒ other hydro report

COUNTY BRIDGE NO. 28 BRIDGE LENGTH 90 NO. BENTS IN: CHANNEL 0 FLOOD PLAIN 4

FOUNDATION TYPE: TIMBER DECKING AND TIMBER ABUTMENTS

## EVIDENCE OF SCOUR(2):

ABUTMENTS OR END BENT SLOPES: NONE

INTERIOR BENTS: BOTH BENTS SHOW MODERATE SIGNS OF SCOUR

CHANNEL BED: NONE VISIBLE

CHANNEL BANKS: DOWNSTREAM HAS LITTLE VEGETATION ON CHANNEL WALLS

## EXISTING SCOUR PROTECTION:

TYPE(3): RIPRAP AT UPSTREAM, WING WALLS

EXTENT(4): WING WALLS EXTEND 10 FEET IN ALL DIRECTIONS

EFFECTIVENESS(5): FAIR, MANY PIECES OF RIPRAP ARE NOW IN THE STREAM BEAD

OBSTRUCTIONS(6) (DAMS, DEBRIS, ETC.): NONE

## DESIGN INFORMATION

CHANNEL BED MATERIAL(7) (SAMPLE RESULTS ATTACHED): BROWN SAND (A-1-b)

CHANNEL BANK MATERIAL(8) (SAMPLE RESULTS ATTACHED): BROWN SILTY SAND (A-2-4)

CHANNEL BANK COVER(9): GRASS

FLOOD PLAIN WIDTH(10): 90 FEET ON EAST SIDE; 100 FEET ON WEST SIDE

FLOOD PLAIN COVER(11): GRASS, SHRUBS AND TREES

## DESIGN INFORMATION CONT.

PAGE 2

STREAM IS X DEGRADING AGGRADING (12)

OTHER OBSERVATIONS AND COMMENTS:

CHANNEL MIGRATION TENDENCY (13): TOWARD EAST

REPORTED BY: [Signature] for Jim Howard DATE: 9/2/2005  
TIERRA, INC

GEOTECHNICALLY ADJUSTED SCOUR ELEVATION (14):

REPORTED BY: DATE:

NCDOT GEOTECHNICAL UNIT

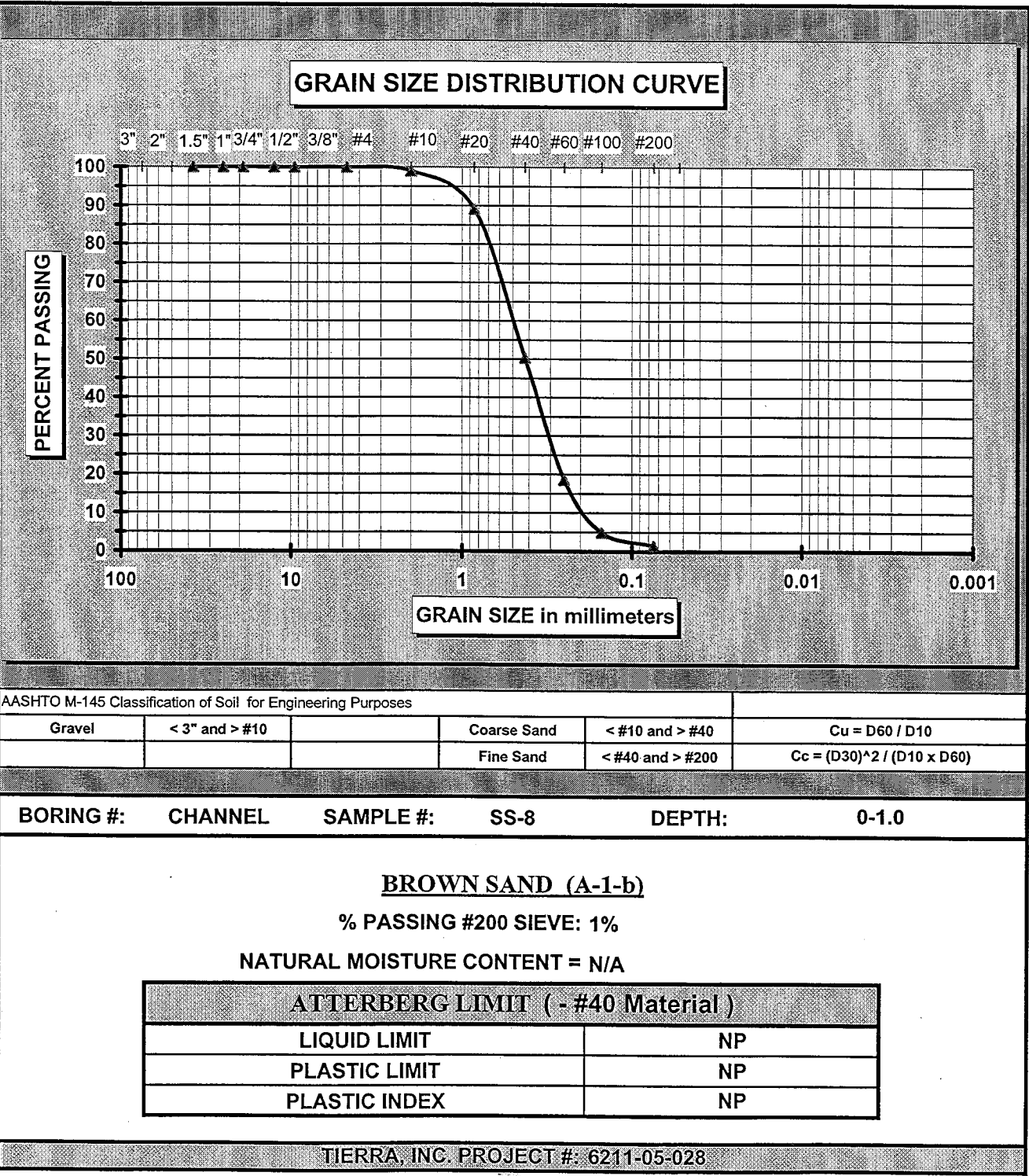
### INSTRUCTIONS

- (1) GIVE THE DESCRIPTION OF THE SPECIFIC SITE GIVING ROUTE NUMBER AND BODY OF WATER CROSSED.
- (2) NOTE ANY EVIDENCE OF SCOUR AT THE EXISTING END BENTS OR ABUTMENTS (UNDERMINING, SLOUGHING, SCOUR LOCATIONS, DEGRADATIONS, ETC.)
- (3) NOTE ANY EXISTING SCOUR PROTECTION (RIP RAP, ETC.)
- (4) DESCRIBE THE EXTENT OF ANY EXISTING SCOUR PROTECTION.
- (5) DESCRIBE WHETHER OR NOT THE SCOUR PROTECTION APPEARS TO BE WORKING.
- (6) NOTE ANY DAMS, FALLEN TREES, DEBRIS AT BENTS, ETC.
- (7) DESCRIBE THE CHANNEL BED MATERIAL: A SAMPLE SHOULD BE TAKEN FOR GRAIN SIZE DISTRIBUTION, ATTACH LAB RESULTS.
- (8) DESCRIBE THE CHANNEL BANK MATERIAL: A SAMPLE SHOULD BE TAKEN FOR GRAIN SIZE DISTRIBUTION, ATTACH LAB RESULTS.
- (9) DESCRIBE THE BANK COVERING (GRASS, TREES, RIP RAP, NONE, ETC.)
- (10) GIVE THE APPROXIMATE FLOOD PLAIN WIDTH (ESTIMATE).
- (11) DESCRIBE THE FLOOD PLAIN COVERING (GRASS, TREES, CROPS, ETC.)
- (12) CHECK THE APPROPRIATE SPACE AS TO WHETHER THE STREAM IS DEGRADING OR AGGRADING
- (13) DESCRIBE THE POTENTIAL OF THE BODY OF WATER TO MIGRATE Laterally DURING THE LIFE OF THE BRIDGE (APPROXIMATELY 100 YEARS).
- (14) GIVE THE GEOTECHNICALLY ADJUSTED SCOUR ELEVATION EXPECTED OVER THE LIFE OF THE BRIDGE (APPROXIMATELY 100 YEARS). THIS CAN BE GIVEN AS AN ELEVATION RANGE ACROSS THE SITE, OR ON A BENT BY BENT BASIS WHERE VARIATIONS EXIST. DISCUSS RELATIONSHIP BETWEEN THE HYDRAULICS THEORETICAL SCOUR AND THE GEOTECHNICALLY ADJUSTED SCOUR ELEVATION. THE GEOTECHNICALLY ADJUSTED SCOUR ELEVATION IS BASED ON THE ERODABILITY OF MATERIALS WITH CONSIDERATION FOR JOINTING, FOLIATION, BEDDING ORIENTATION AND FREQUENCY; CORE RECOVERY PERCENTAGE; PERCENTAGE RQD; DIFFERENTIAL WEATHERING, SHEAR STRENGTH; OBSERVATIONS AT EXISTING STRUCTURES; OTHER TESTS DEEMED APPROPRIATE; AND OVERALL GEOLOGIC CONDITIONS AT THE SITE.

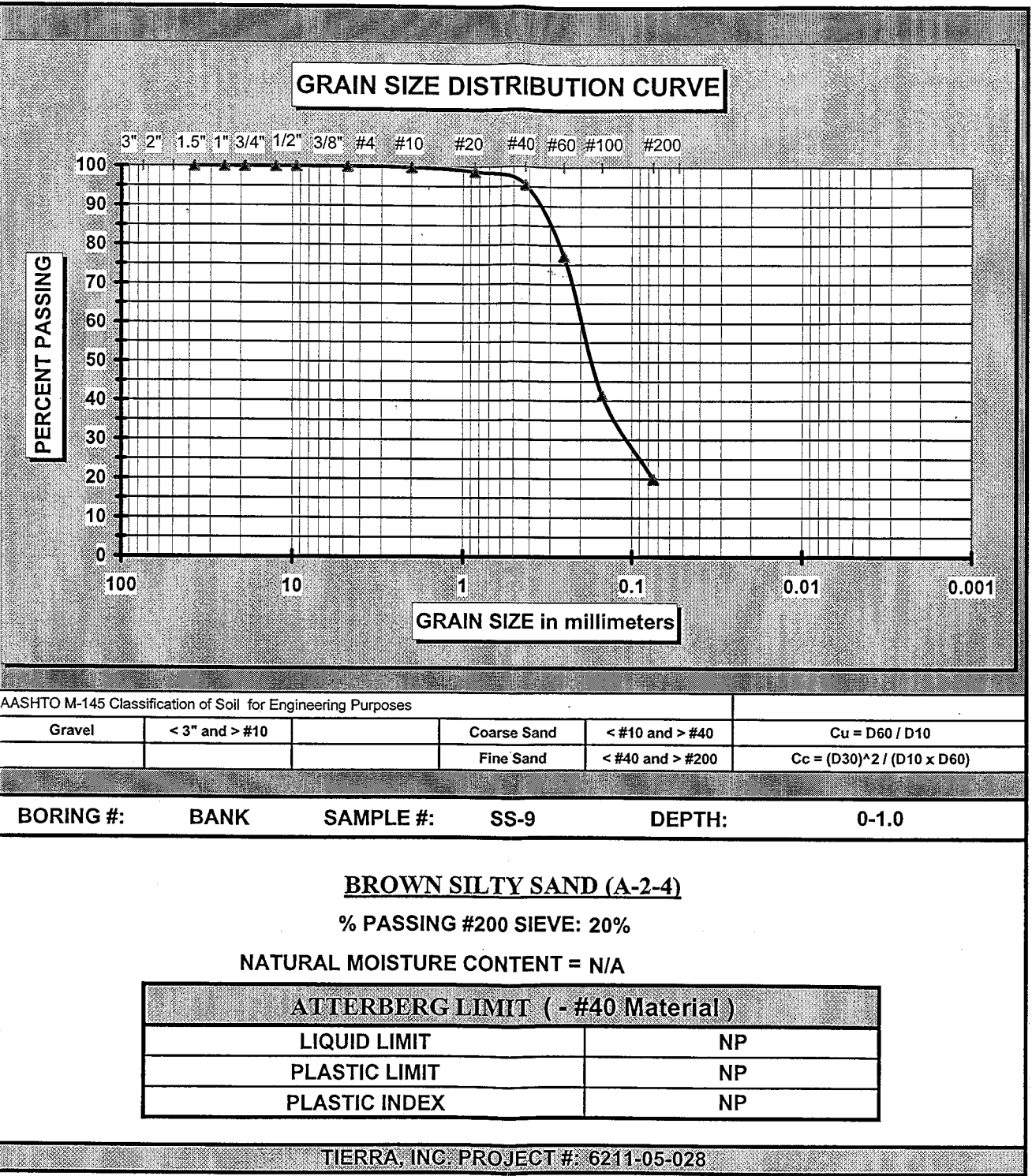
PROJECT #: 6211-05-028  
COUNTY: GASTON  
DESCRIPTION: BRIDGE #28 ON SR 2416 (ROBINSON ROAD) OVER MILES CREEK

	CHANNEL BED MATERIAL			CHANNEL BANK MATERIAL			
SAMPLE #	SS-8			SS-9			
RETAINED #4	0			0			
PASSING #10	99			100			
PASSING #40	50			95			
PASSING #200	1			20			
SAND	99			80			
SILT/CLAY	1			20			
LL	NP			NP			
PL	NP			NP			
AASHTO	A-1-b			A-2-4			
STATION	19+70			19+68			
OFFSET	CL			CL			
DEPTH	0-1.0			0-1.0			

BRIDGE #28 ON SR 2416 (ROBINSON ROAD) OVER MILES CREEK  
GASTON COUNTY  
NCMA PROJECT NO: MA12018R



BRIDGE #28 ON SR 2416 (ROBINSON ROAD) OVER MILES CREEK  
GASTON COUNTY  
NCMA PROJECT NO: MA12018R





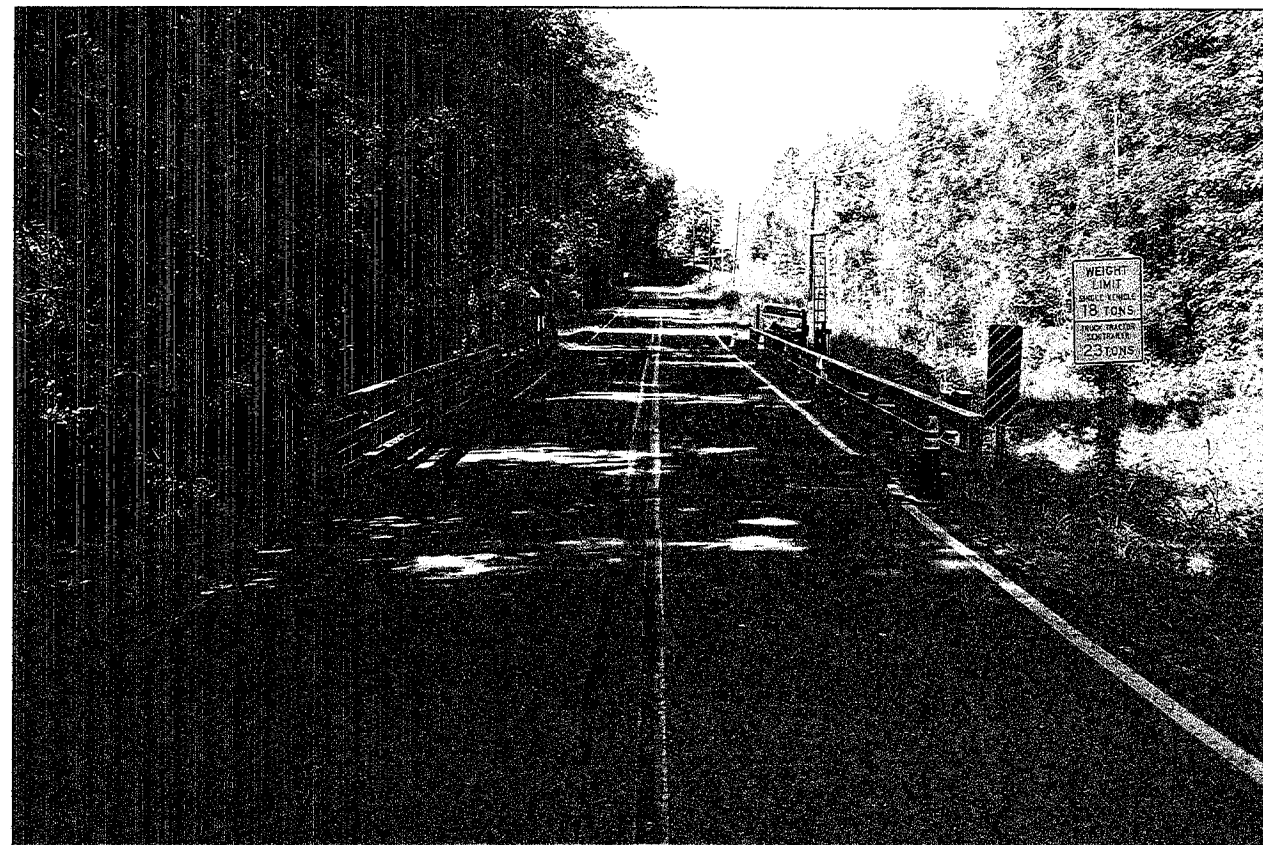


PHOTO 1: CENTERLINE PROFILE (-L-), LOOKING DOWNSTATION



PHOTO 2: MILES CREEK, LOOKING UPSTREAM

## SITE PHOTOS

NCDOT PROJECT #: MA12018R  
GASTON CO., NC  
STRUCTURE #28 ON SR 2416  
(ROBINSON RD.) OVER MILES CREEK



**TIERRA**  
GEOTECHNICAL • MATERIALS  
ENGINEERING

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



PHOTO 3: END BENT 1, LOOKING FROM EB1B TO EB1A



PHOTO 4: END BENT 2, LOOKING FROM EB2A TO EB2B

## SITE PHOTOS

NCDOT PROJECT #: MA12018R  
 GASTON CO., NC  
 STRUCTURE #28 ON SR 2416  
 (ROBINSON RD.) OVER MILES CREEK



**TIERRA**  
 GEOTECHNICAL • MATERIALS  
 ENGINEERING

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