

F&ME CONSULTANTS

GEOTECHNICAL • ENVIRONMENTAL • MATERIALS

October 7, 2004

Mr. Russell Howell, P.E.
CECS, Inc.
3020 Devine Street
Columbia, South Carolina 29205

Re.: Report of Preliminary Analysis
SC 41 Bridge Replacement over the Wando River
Berkeley-Charleston Counties, South Carolina
F&ME Project No. G4067

Dear Russell:

The following presents our review of project site geology, the soil stratigraphy as encountered in the soil test borings performed for this phase of investigation, and our conceptual foundation options for bridge support and considerations for roadway approach embankments.

Geology

The bridge site is located in the Lower Coastal Plain Physiographic Province of South Carolina. The Coastal Plain consist of a wedge of sedimentary deposits which overlie basement rocks beginning at the Fall Line and in crease in thickness moving seaward. In the Charleston area this sediment wedge is on the order of 2500 feet thick. The major shallow geological formation in this wedge is the Cooper Group. This formation is locally referred to as "Cooper Marl". The Cooper Group is comprised of several sub-groups or formations which vary in composition depending upon depositional environments. Properties of the Cooper Marl are well documented in Charleston in that it is the predominate support formation for most major structures.

For engineering purposes, Cooper Marl is classified as a sandy silt or clay or silty sand. The formation is over consolidated with plasticity ranging from low to high. Geologically the formation is described as a phosphatic limestone containing calcium carbonates in the range of 60 to 80 percent.

COLUMBIA OFFICE
3112 Devine Street
Columbia, SC 29205
ph (803) 254-4540
fx (803) 254-4542

MYRTLE BEACH OFFICE
1903 Legion Street
Myrtle Beach, SC 29577
ph (843) 626-9253
fx (843) 448-0681

Soil Stratigraphy

During this phase of investigations, four soil test borings (B-1 through B-4) were performed. Borings B-2 and B-3 were performed at the south and north banks, respectively, of the Wando River and were advanced to depths of 120 feet below present ground surface. Boring B-1 was located approximately 125 feet southwest of B-2, and boring B-4 was located approximately 125 feet to the northeast of B-3. Borings B-1 and B-4 were advanced to depths of 100 feet below present ground surface. All borings were off-set approximately 100 feet to the east of existing SC-41 centerline.

As indicated at these boring locations, two major strata were identified. The top strata consisted of alluvial re-worked Coastal Plain soil material which are generally described as firm to stiff, clays (CL) with varying sand constituency. Standard penetration test values (N-values) of this clay layer ranged from 3 blows per foot (bpf) to 16 bpf, with typical values of 8 to 11 bpf. This strata extended to depths of approximately 17 to 22 feet below present ground surface.

Below the initial clay soil strata, the Cooper Marl Formation was encountered. The Cooper Marl is typically described as firm to very stiff, fine sandy silty clay (CL). N-values in the marl generally ranged from 8 to 40 bpf, with consistencies increasing with increasing depths. Borings B-1 and B-4 were terminated in this strata at 100 feet below present ground surface and borings B-2 and B-3 were also terminated in the marl at 120 feet below present ground surface.

Seismic Considerations

No highly liquefiable soils were noted overlying the Cooper Marl at the approach embankments. The Cooper Marl Formation is seismically stable. The river sediment load will probably liquefy under the design earthquake although this will not impact the foundation performance.

A detailed seismic analysis of the foundation system and approach embankments will be performed.

Bridge Foundations

The proposed bridge foundation system is drilled shafts for interior bents and driven steel H-piles for end bents. No subsurface conditions which would preclude drilled shafts or H-piles were noted. Both shafts and H-piles will be supported in the Cooper Marl Formation. Load capacity will be from skin friction in the marl for the H-piles. The drilled shafts will utilize both skin friction and end bearing.

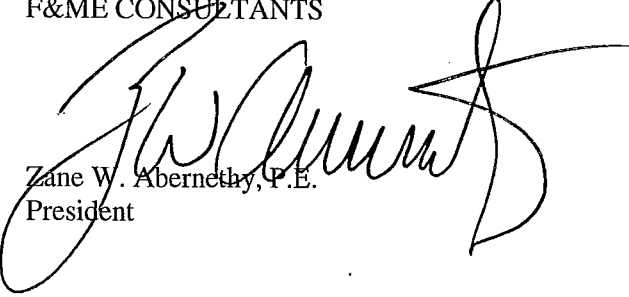
Approach Embankments

The soils encountered overlying the Cooper Marl Formation consisted primarily of firm to stiff clays. No extremely soft or "marsh" type material was encountered. Some settlement will occur under the planned 35 to 38 foot maximum embankment heights. The anticipated settlements can be controlled using standard construction means (i.e. wick drains to accelerate settlement and possibly stone columns at the bridge ends). MSE walls can be utilized to minimize the approach embankment footprints and to minimize the bridge lengths. We do not anticipate any special foundation treatment will be required for MSE walls.

If you need any additional information for your conceptual design, please do not hesitate to contact us.

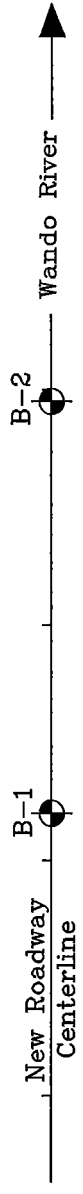
Sincerely,

F&ME CONSULTANTS


Zane W. Abernethy, P.E.
President

cc: Eric Burgess, P.E./TKA

252+00 253+00 254+00 255+00



BRIDGE EAST APPROACH

273+00 274+00 275+00 276+00 277+00

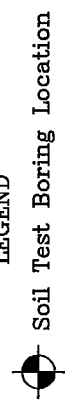


BRIDGE WEST APPROACH

SCALE



LEGEND



Soil Test Boring Location

F&ME
CONSULTANTS

TEST BORING LOCATION PLAN
SC 41 over Wando River
Berkeley/Charleston Counties, SC

Triplett-King & Associates, Inc.

DRAWN BY: <u>JRW</u>	SCALE: <u>As Shown</u>
CHECKED BY: <u>MSM</u>	PROJECT: <u>G4067</u>
APPROVED BY: <u>MSM</u>	Figure: <u>1</u>

SC 41 Replacement Bridge over Wando River
Berkeley/Charleston Counties, South Carolina
G4067

LOG OF BORING No. B-1

Station: 276+50
Offset: CL

Date Drilled: 8/16/04

Supervisor: Ricky Wessinger

Notes:
CME-55 Truck Mounted Drill Rig

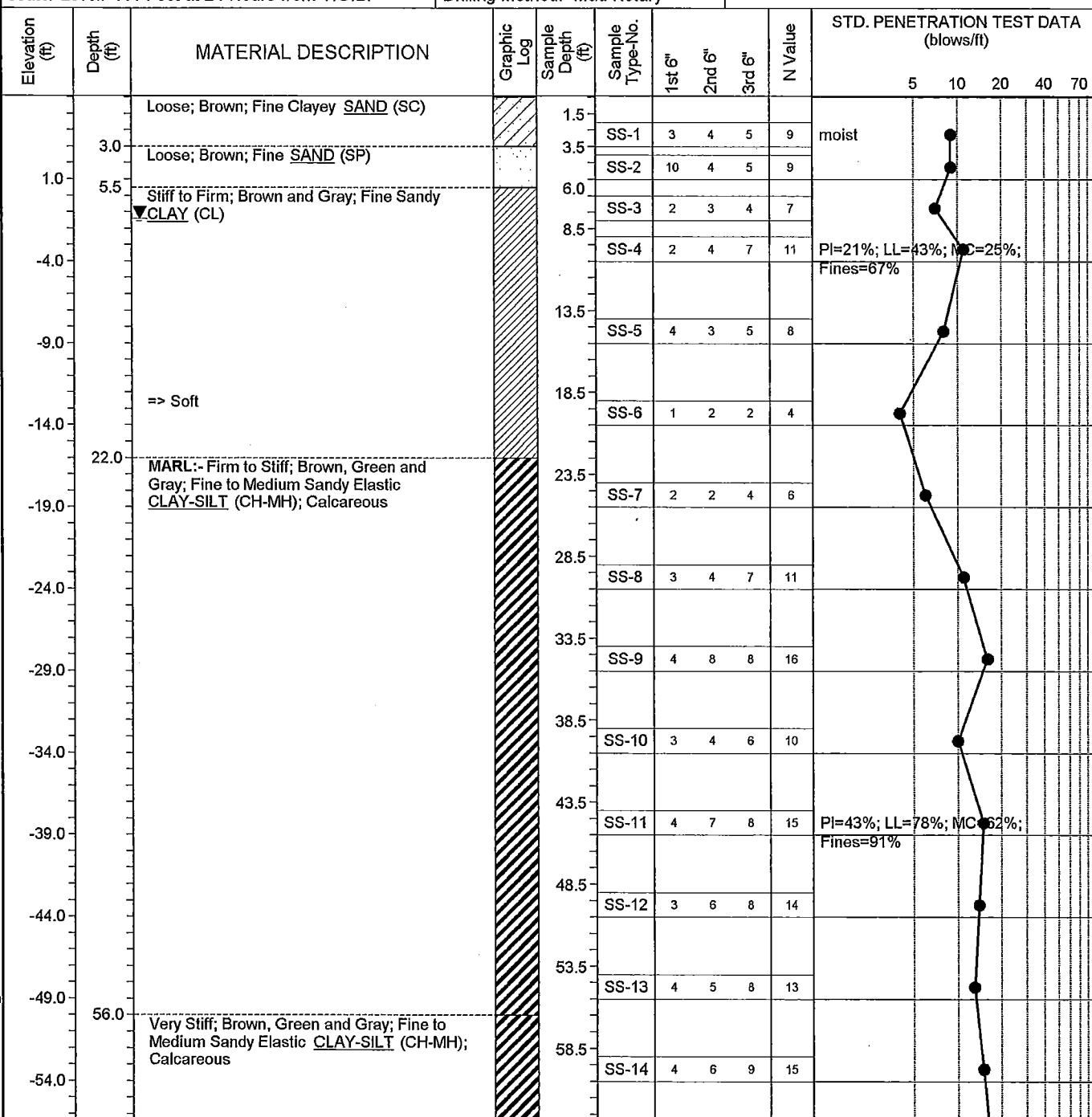
Casing Length (ft):

Approx. Ground Elevation (ft): 6.0

Hammer Type: ☒ Gravity ☐ Automatic ☐ Other:

Water Level: 7.4 Feet at 24 Hours from T.O.B.

Drilling Method: Mud Rotary



LEGEND

Continued Next Page

SAMPLER TYPE

DRILLING METHOD

SS - Split Spoon
ST - Shelby Tube
AWG - Rock Core, 1-1/8"

NQ - Rock Core, 1-7/8"
CU - Cuttings
CT - Continuous Tube

HSA - Hollow Stem Auger
CFA - Continuous Flight Augers
DC - Driving Casing

RW - Rotary Wash
RC - Rock Core
PHD - Percussion Hammer Drill

SOIL_TEST_BORING G4067.GPJ SC_DOT.GDT 11/24/04

**SC 41 Replacement Bridge over Wando River
Berkeley/Charleston Counties, South Carolina
G4067**

LOG OF BORING No. B-1

Station: 276+50
Offset: CL

Date Drilled: 8/16/04

Supervisor: Ricky Wessinger

Notes:
CME-55 Truck Mounted Drill Rig



Casing Length (ft):

Approx. Ground Elevation (ft): 6.0

Hammer Type: ☒ Gravity ☐ Automatic ☐ Other:

Water Level: 7.4 Feet at 24 Hours from T.O.B.

Drilling Method: Mud Rotary

Elevation (ft)	Depth (ft)	MATERIAL DESCRIPTION	Graphic Log	Sample Depth (ft)	Sample Type-No.	1st 6" 2nd 6" 3rd 6"			N Value	STD. PENETRATION TEST DATA (blows/ft)				
										5	10	20	40	70
-59.0		Very Stiff; Brown, Green and Gray; Fine to Medium Sandy Elastic <u>CLAY-SILT</u> (CH-MH); Calcareous		63.5	SS-15	5	7	10	17					
-64.0				68.5	SS-16	5	9	12	21					
-69.0				73.5	SS-17	6	9	12	21					
-74.0				78.5	SS-18	6	9	12	21					
-79.0				83.5	SS-19	7	13	17	30					
-84.0				88.5	SS-20	6	8	10	18					
-89.0		Boring Terminated at 100 Feet		93.5	SS-21	8	10	13	23	damp				
-94.0	100.0			98.5	SS-22	9	11	15	26					
-99.0														
-104.0														
-109.0														
-114.0														

LEGEND

SAMPLER TYPE

SS - Split Spoon
ST - Shelby Tube
AWG - Rock Core, 1-1/8"

NQ - Rock Core, 1-7/8"
CU - Cuttings
CT - Continuous Tube

DRILLING METHOD

HSA - Hollow Stem Auger
CFA - Continuous Flight Augers
DC - Driving Casing

RW - Rotary Wash
RC - Rock Core
PHD - Percussion Hammer Drill

SC 41 Replacement Bridge over Wando River
Berkeley/Charleston Counties, South Carolina
G4067

LOG OF BORING No. B-2

Station: 273+90
Offset: CL

Date Drilled: 8/16/04

Supervisor: Ricky Wessinger

Notes:
CME-55 Truck Mounted Drill Rig

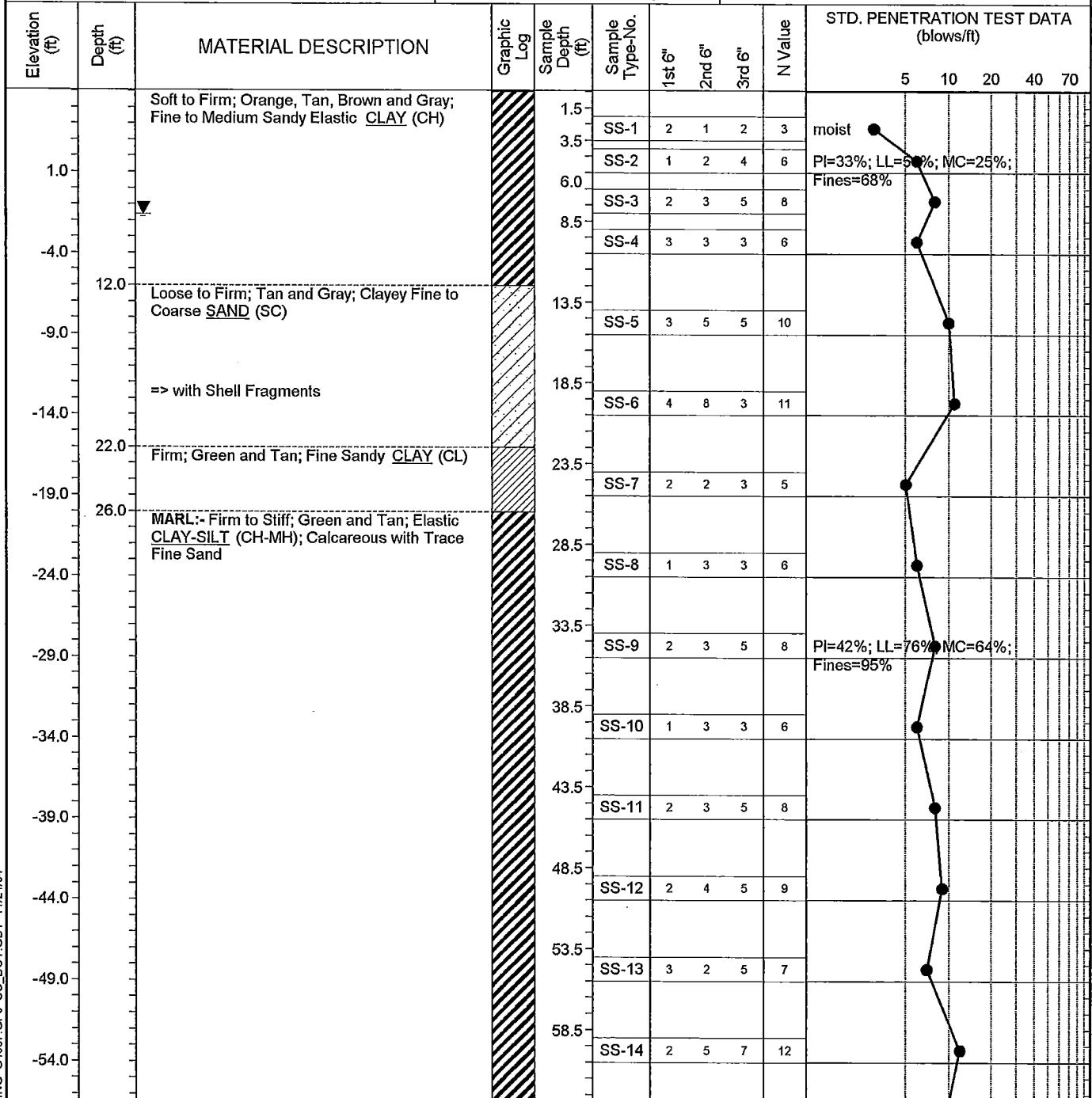
Casing Length (ft):

Approx. Ground Elevation (ft): 6.0

Hammer Type: ☒ Gravity ☐ Automatic ☐ Other:

Water Level: 7.6 Feet at 24 Hours from T.O.B.

Drilling Method: Mud Rotary



LEGEND

Continued Next Page

SAMPLER TYPE

DRILLING METHOD

SS - Split Spoon
ST - Shelby Tube
AWG - Rock Core, 1-1/8"

NQ - Rock Core, 1-7/8"
CU - Cuttings
CT - Continuous Tube

HSA - Hollow Stem Auger
CFA - Continuous Flight Augers
DC - Driving Casing

RW - Rotary Wash
RC - Rock Core
PHD - Percussion Hammer Drill

**SC 41 Replacement Bridge over Wando River
Berkeley/Charleston Counties, South Carolina
G4067**

LOG OF BORING No. B-2

Station: 273+90
Offset: CL

Date Drilled: 8/16/04

Supervisor: Ricky Wessinger

Notes:
CME-55 Truck Mounted Drill Rig




Casing Length (ft):

Approx. Ground Elevation (ft): 6.0

Hammer Type: ☒ Gravity ☐ Automatic ☐ Other:

Water Level: 7.6 Feet at 24 Hours from T.O.B.

Drilling Method: Mud Rotary

Elevation (ft)	Depth (ft)	MATERIAL DESCRIPTION	Graphic Log	Sample Depth (ft)	Sample Type-No.	STD. PENETRATION TEST DATA (blows/ft)				
						1st 6"	2nd 6"	3rd 6"	N Value	
-59.0		MARL :- Firm to Stiff; Green and Tan; Elastic CLAY-SILT (CH-MH); Calcareous with Trace Fine Sand		63.5	SS-15	2	3	6	9	
-64.0				68.5	SS-16	3	6	9	15	
-69.0				73.5	SS-17	3	6	8	14	
-74.0				78.5	SS-18	4	4	9	13	
-79.0				83.5	SS-19	5	5	7	12	
	87.0	=> Sandy Very Firm to Dense; Tan and Green; Silty Fine SAND (SM); Calcareous		88.5	SS-20	12	16	19	35	PI=N.P.; MC=32%; Fines=16%
-84.0				93.5	SS-21	7	9	14	23	
-89.0				98.5	SS-22	14	14	25	39	
-94.0				103.5	SS-23	2	4	12	16	
-99.0				108.5	SS-24	5	8	14	22	PI=46%; LL=84%; MC=57%; Fines=96%
-104.0		Very Stiff ; Green and Gray; Elastic CLAY-SILT (CH-MH); Calcareous with Trace Fine Sand		113.5	SS-25	6	7	15	22	
-109.0				118.5	SS-26	7	10	16	26	
-114.0	120.0									
		Boring Terminated at 120 Feet								

LEGEND

SAMPLER TYPE

SS - Split Spoon
ST - Shelby Tube
AWG - Rock Core, 1-1/8"

NQ - Rock Core, 1-7/8"
CU - Cuttings
CT - Continuous Tube

DRILLING METHOD

HSA - Hollow Stem Auger
CFA - Continuous Flight Augers
DC - Driving Casing

RW - Rotary Wash
RC - Rock Core
PHD - Percussion Hammer Drill

SOIL TEST BORING G4067.GPJ SC_DOT.GDT 11/24/04

**SC 41 Replacement Bridge over Wando River
Berkeley/Charleston Counties, South Carolina
G4067**

LOG OF BORING No. B-3

Station: 254+95
Offset: 10' LT CL

Date Drilled: 9/13/2004

Supervisor: Ricky Wessinger

Notes:
CME-550 ATV Mounted Drill Rig

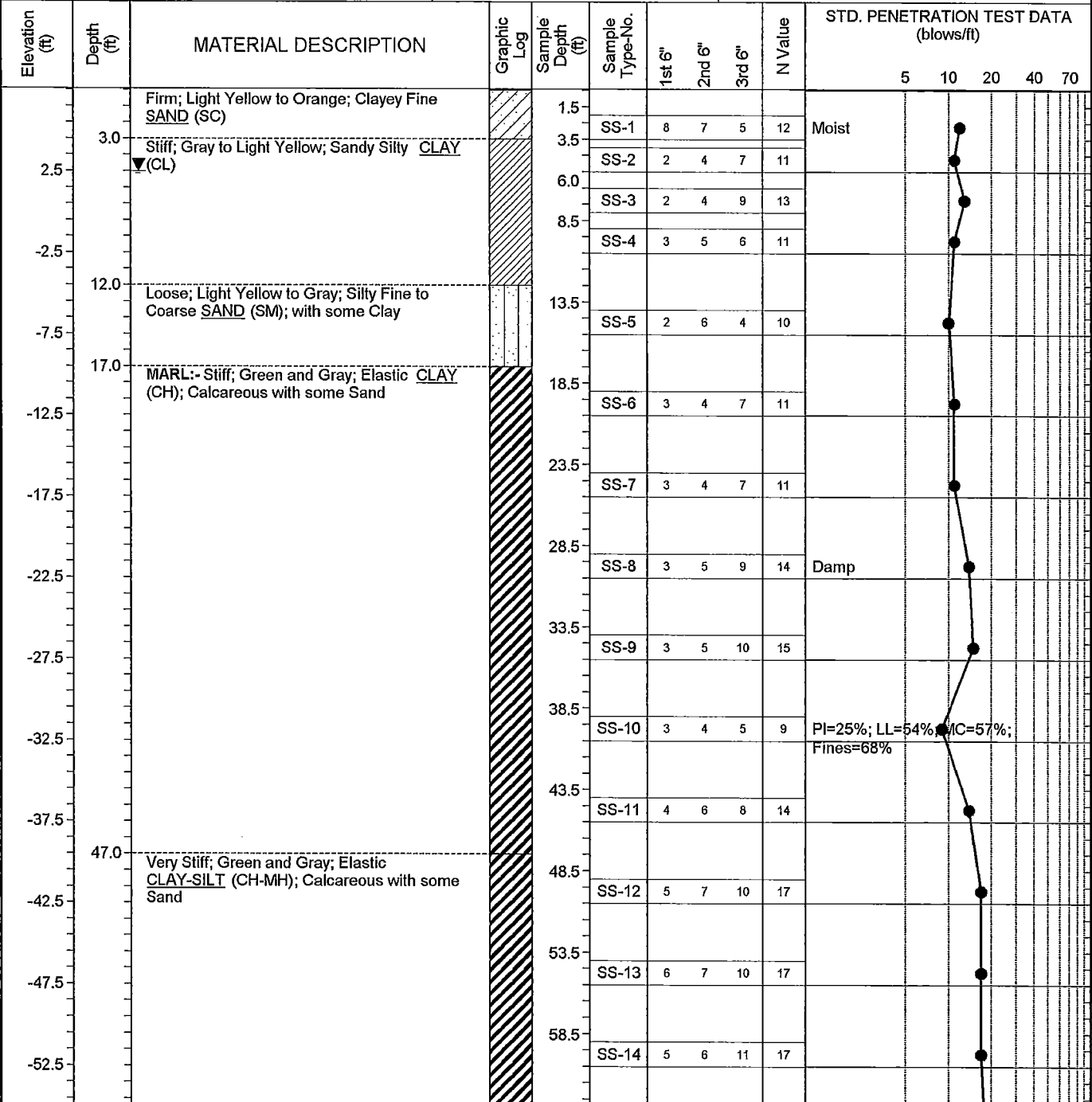
Casing Length (ft):

Approx. Ground Elevation (ft): 7.5

Hammer Type: ☒ Gravity ☐ Automatic ☐ Other:

Water Level: 5.0 Feet at 24 Hours from T.O.B.

Drilling Method: Mud Rotary



LEGEND

Continued Next Page

SAMPLER TYPE

SS - Split Spoon
ST - Shelby Tube
AWG - Rock Core, 1-1/8"

NQ - Rock Core, 1-7/8"
CU - Cuttings
CT - Continuous Tube

DRILLING METHOD

HSA - Hollow Stem Auger
CFA - Continuous Flight Augers
DC - Driving Casing

RW - Rotary Wash
RC - Rock Core
PHD - Percussion Hammer Drill

SOIL TEST BORING G4067.GPJ SC_DOT.GDT 11/24/04

SC 41 Replacement Bridge over Wando River
Berkeley/Charleston Counties, South Carolina
G4067

LOG OF BORING No. B-3

Station: 254+95
Offset: 10' LT CL

Date Drilled: 9/13/2004

Supervisor: Ricky Wessinger

Notes:
CME-550 ATV Mounted Drill Rig

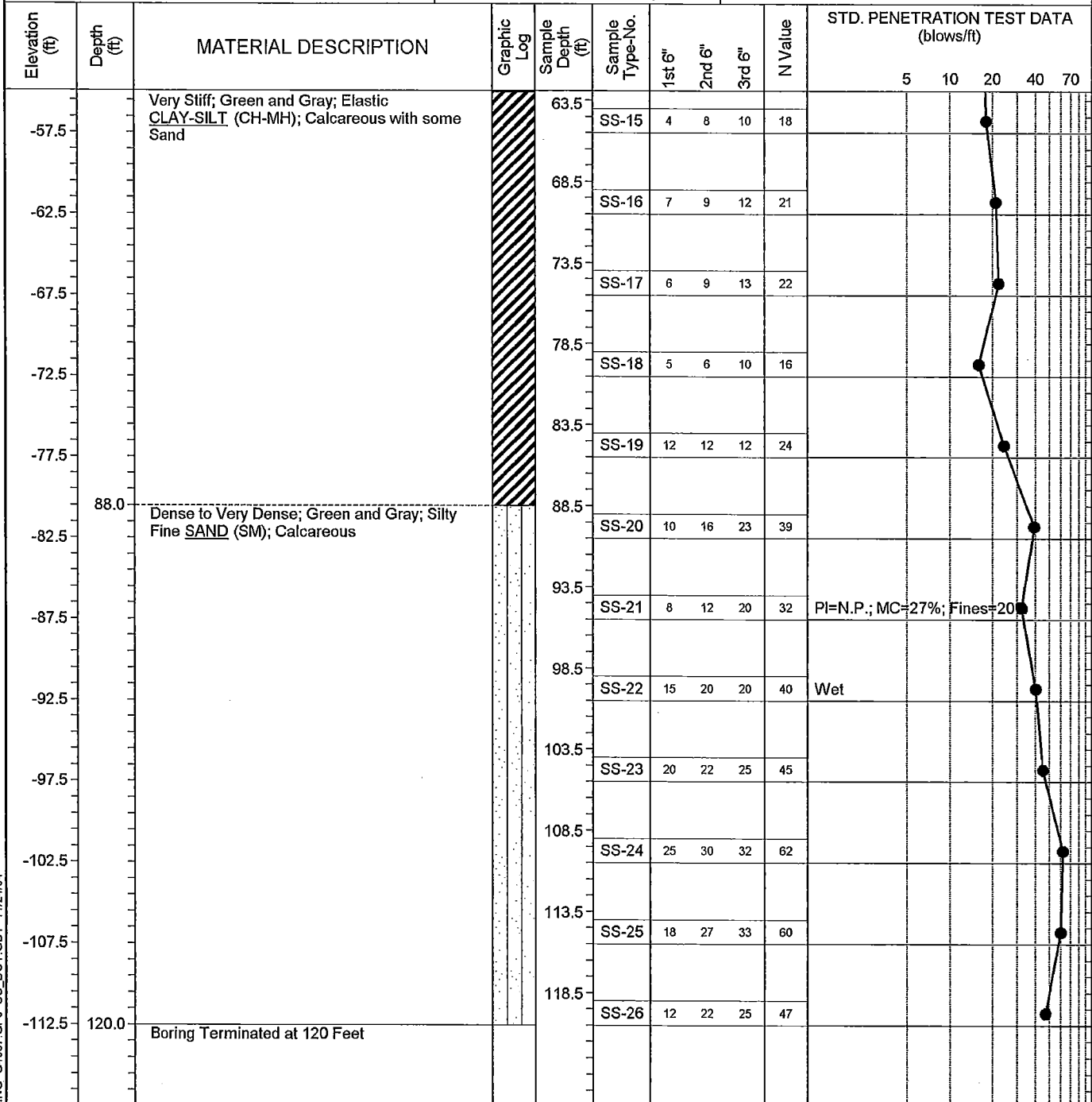
Casing Length (ft):

Approx. Ground Elevation (ft): 7.5

Hammer Type: ☒ Gravity ☐ Automatic ☐ Other:

Water Level: 5.0 Feet at 24 Hours from T.O.B.

Drilling Method: Mud Rotary



LEGEND

SAMPLER TYPE

SS - Split Spoon
ST - Shelby Tube
AWG - Rock Core, 1-1/8"

NQ - Rock Core, 1-7/8"
CU - Cuttings
CT - Continuous Tube

DRILLING METHOD

HSA - Hollow Stem Auger
CFA - Continuous Flight Augers
DC - Driving Casing

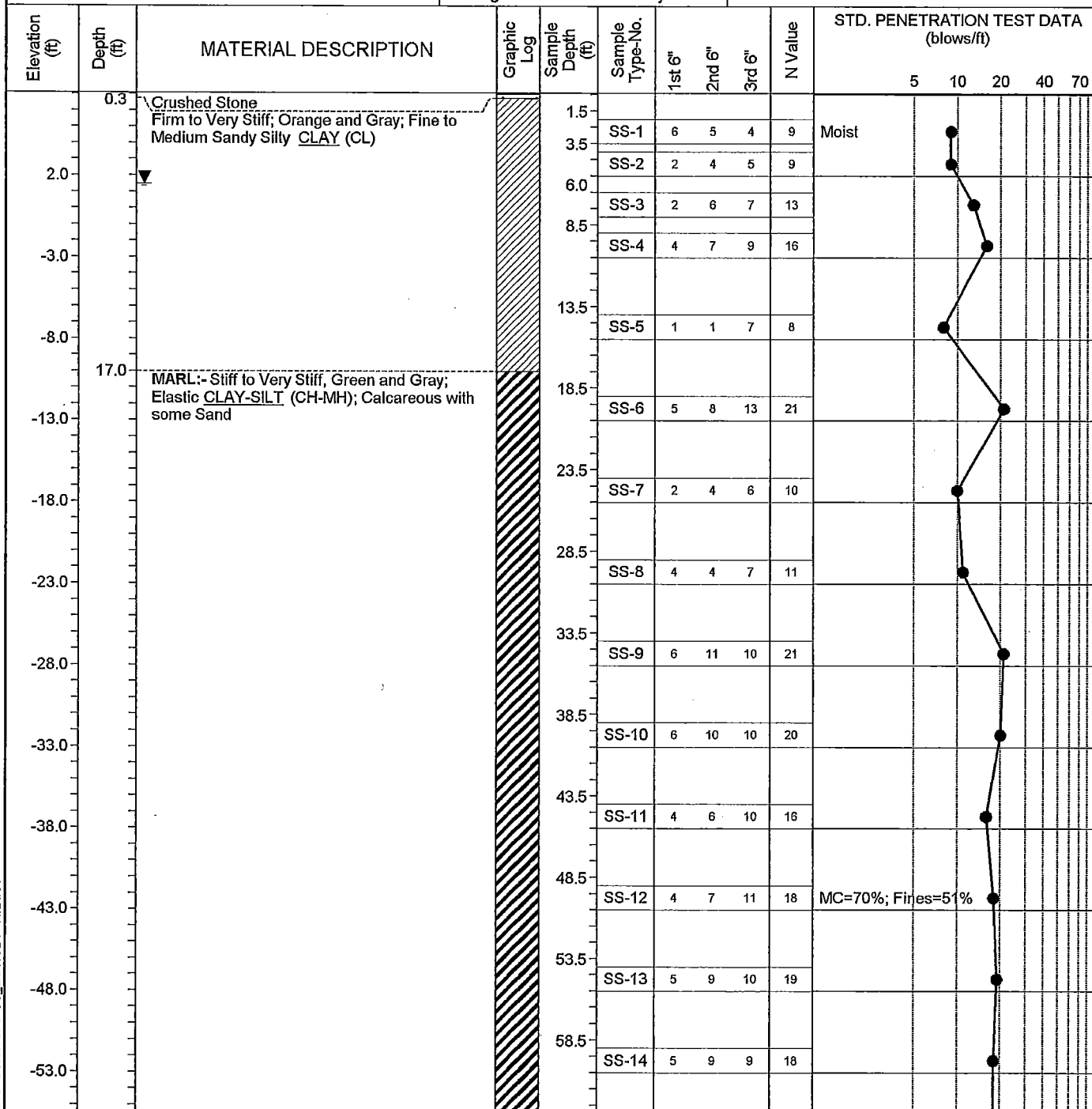
RW - Rotary Wash
RC - Rock Core
PHD - Percussion Hammer Drill

SC 41 Replacement Bridge over Wando River
Berkeley/Charleston Counties, South Carolina
G4067

LOG OF BORING No. B-4

Station: 253+20
Offset: 80' LT CL

Date Drilled: 9/14/2004 Supervisor: Ricky Wessinger Notes: CME-550 ATV Mounted Drill Rig
Casing Length (ft): Approx. Ground Elevation (ft): 7.0
Hammer Type: ☒ Gravity ☐ Automatic ☐ Other:
Water Level: 5.5 Feet at 24 Hours from T.O.B. Drilling Method: Mud Rotary



LEGEND

Continued Next Page

SAMPLER TYPE
SS - Split Spoon NQ - Rock Core, 1-7/8"
ST - Shelby Tube CU - Cuttings
AWG - Rock Core, 1-1/8" CT - Continuous Tube

DRILLING METHOD
HSA - Hollow Stem Auger RW - Rotary Wash
CFA - Continuous Flight Augers RC - Rock Core
DC - Driving Casing PHD - Percussion Hammer Drill

**SC 41 Replacement Bridge over Wando River
Berkeley/Charleston Counties, South Carolina
G4067**

LOG OF BORING No. B-4

Station: 253+20
Offset: 80' LT CL

Date Drilled: 9/14/2004

Supervisor: Ricky Wessinger

Notes:
CME-550 ATV Mounted Drill Rig



Casing Length (ft):

Approx. Ground Elevation (ft): 7.0

Hammer Type: ☒ Gravity ☐ Automatic ☐ Other:

Water Level: 5.5 Feet at 24 Hours from T.O.B.

Drilling Method: Mud Rotary

Elevation (ft)	Depth (ft)	MATERIAL DESCRIPTION	Graphic Log	Sample Depth (ft)	Sample Type-No.	1st 6" 2nd 6" 3rd 6"			N Value	STD. PENETRATION TEST DATA (blows/ft)				
						1st 6"	2nd 6"	3rd 6"		5	10	20	40	70
-58.0		MARL:- Stiff to Very Stiff, Green and Gray; Elastic <u>CLAY-SILT</u> (CH-MH); Calcareous with some Sand		63.5	SS-15	4	6	12	18					
-63.0				68.5	SS-16	4	5	12	17					
-68.0				73.5	SS-17	6	12	14	26					
-73.0				78.5	SS-18	6	9	14	23					
-78.0	82.0	Very Stiff to Hard; Green and Gray; Fine Sandy Elastic <u>SILT</u> (MH); Calcareous		83.5	SS-19	9	17	27	44					
-83.0				88.5	SS-20	9	13	17	30	PI=27%; LL=59%; MC=52%; Fines=57%				
-88.0				93.5	SS-21	6	11	15	26					
-93.0	100.0			98.5	SS-22	11	15	25	40	Wet				
		Boring Terminated at 100 Feet												
-98.0														
-103.0														
-108.0														
-113.0														

LEGEND

SAMPLER TYPE		DRILLING METHOD	
SS - Split Spoon	NQ - Rock Core, 1-7/8"	HSA - Hollow Stem Auger	RW - Rotary Wash
ST - Shelby Tube	CU - Cuttings	CFA - Continuous Flight Augers	RC - Rock Core
AWG - Rock Core, 1-1/8"	CT - Continuous Tube	DC - Driving Casing	PHD - Percussion Hammer Drill