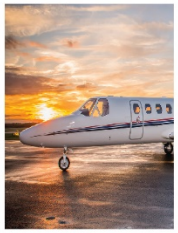
NORTH CAROLINA
Department of Transportation



Borehole Logging & Field Concepts Workshop

Cheryl A. Youngblood, LG, CPG
Christina M. Bruinsma, LG
Jaime L. Love, LG
Nick O. Moore, GIT
D. Clayton Elliott, PG

GEO^{3}T^2 April 10th, 2019

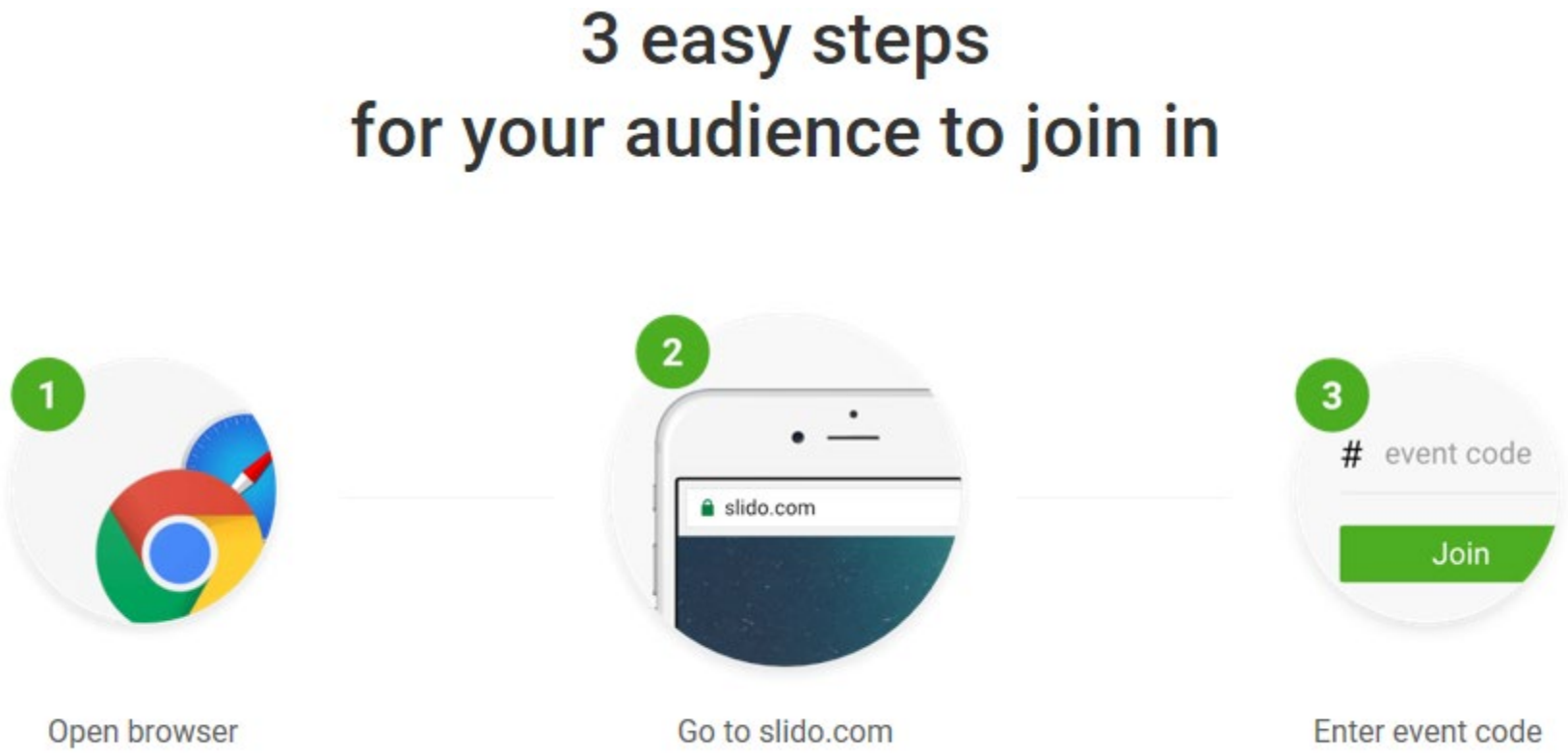
Welcome!

- Housekeeping Items
- Package Contents
  - Borehole Logs
  - Note Sheets
  - Bearing Chart
  - Legend 8.5”x11”
  - Evaluation
  - Miniature Scale
  - Proof of Attendance will be handed out at the end of the Workshop for Licensed Geologists

Sli.do

Slido.com

Event Code: 2410



The Beginning!

- NC Legislature mandate for departmental change causing decentralization.
- Directive to “touch every project.”
- Project schedule acceleration.
- Increase in PEF capacity by hiring recent graduates.

Importance

- The understanding of field practices and data collection is the foundation for Geotechnical Subsurface Inventories and Foundation Recommendations.
  - Field Planning
  - Borehole Logging
  - Rock Core Logging
  - Sampling and Termination
  - Site Clean up

https://saskatoon.ctvnews.ca/new-bridge-collapses-into-river-in-rural-saskatchewan-hours-after-opening-1.4098973

A good day in the field is when

A great day in the field is when

Preliminary Planning for Field Work

Christina M. Bruinsma, LG

April 10, 2019

RFP
(Request for Proposal)

Print it, Read it, Know it!

Includes:
Scope/Purpose of Work
Potential Special Instructions
NCDOT Contract and Project Contacts

Understanding Plans

Roadway vs. Structures

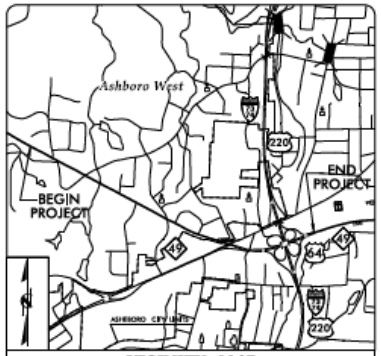
Roadway Plans

Title Sheet
Plan Sheets
Profiles
Cross Sections

TIP PROJECT: U-5813

CONTRACT:

See Sheet 1A For Index of Sheets
See Sheet 1B For Conventional Plan Sheet Symbols
See Sheet 1C For Survey Control Sheet



VICINITY MAP

APPROVED 25% PLAN

STATE OF NORTH CAROLINA
DIVISION OF HIGHWAYS

RANDOLPH COUNTY

LOCATION: US 64 FROM ASHEBORO BYPASS TO EAST OF I-73/I-74/US 220

TYPE OF WORK: GRADING, DRAINAGE, PAVING, STRUCTURES, CULVERT & SIGNALS

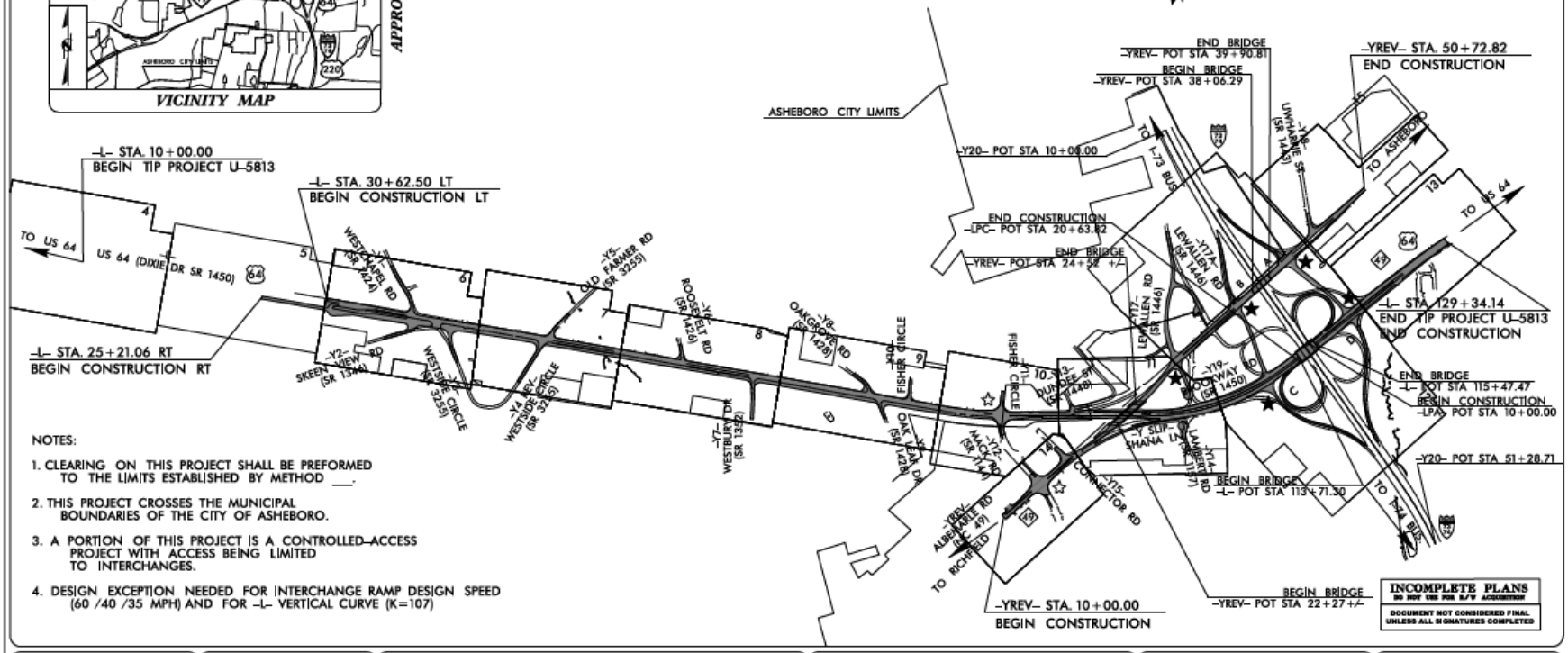
STATE	STATE PROJECT REFERENCE NO.	SHEET NO.	TOTAL SHEETS
N.C.	U-5813	1	

STATE PROJ. NO.	F.A. PROJ. NO.	DESCRIPTION
44385.1.3		PE

NAD 83/NA 2011

☆ EXISTING SIGNAL

★ PROPOSED SIGNAL



NOTES:

1. CLEARING ON THIS PROJECT SHALL BE PREFORMED TO THE LIMITS ESTABLISHED BY METHOD ___.
2. THIS PROJECT CROSSES THE MUNICIPAL BOUNDARIES OF THE CITY OF ASHEBORO.
3. A PORTION OF THIS PROJECT IS A CONTROLLED-ACCESS PROJECT WITH ACCESS BEING LIMITED TO INTERCHANGES.
4. DESIGN EXCEPTION NEEDED FOR INTERCHANGE RAMP DESIGN SPEED (60 /40 /35 MPH) AND FOR -L- VERTICAL CURVE (K=107)

INCOMPLETE PLANS
DO NOT USE FOR R/W ACQUISITION
DOCUMENT NOT CONSIDERED FINAL UNLESS ALL SIGNATURES COMPLETED

GRAPHIC SCALES

PLANS: 50 25 0 50 100
PROFILE (HORIZONTAL): 50 25 0 50 100
PROFILE (VERTICAL): 10 5 0 10 20

DESIGN DATA

ADT 2020 = 32,200
ADT 2040 = 35,700
K = 8%
D = 55%
T = 4 % *
V = 60 MPH
* TTST =3% DUAL 1%
FUNC CLASS = PRINCIPAL ARTERIAL STATEWIDE TIER

PROJECT LENGTH

LENGTH ROADWAY TIP PROJECT U-5813	=	2.227 MILES
LENGTH EXISTING STRUCTURES TIP PROJECT U-5813	=	0.033 MILES
TOTAL LENGTH TIP PROJECT U-5813	=	2.260 MILES

TOTAL LENGTH BASED ON -L- CENTERLINE
EXISTING STRUCTURES LENGTH BASED ON -L- CENTERLINE

Prepared in the Office of:
HNTB NORTH CAROLINA, P.C.
343 E. Six Forks Road, Raleigh NC, 27609

2018 STANDARD SPECIFICATIONS

RIGHT OF WAY DATE: JUNE 21, 2019

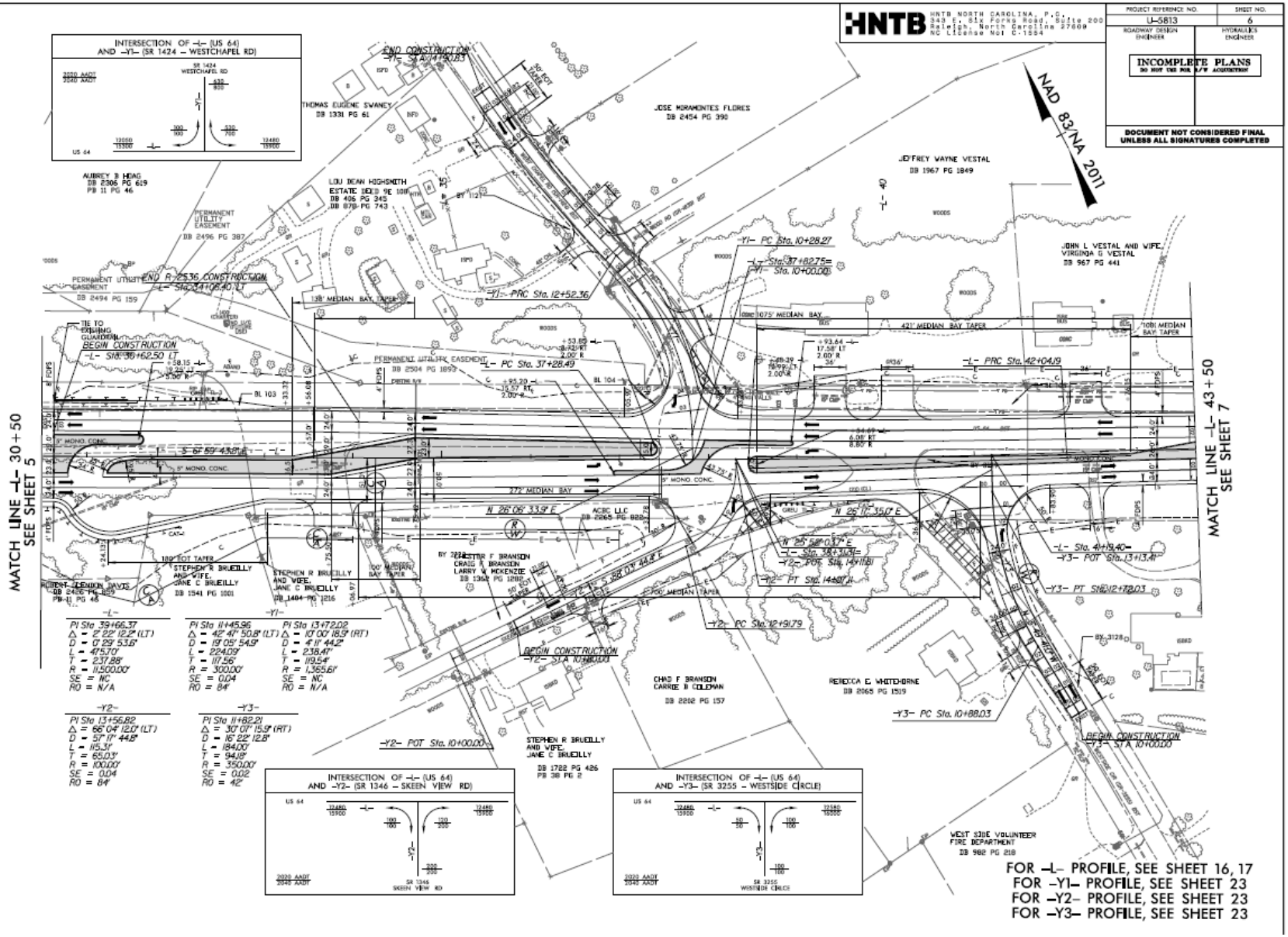
LETTING DATE: JUNE 16, 2020

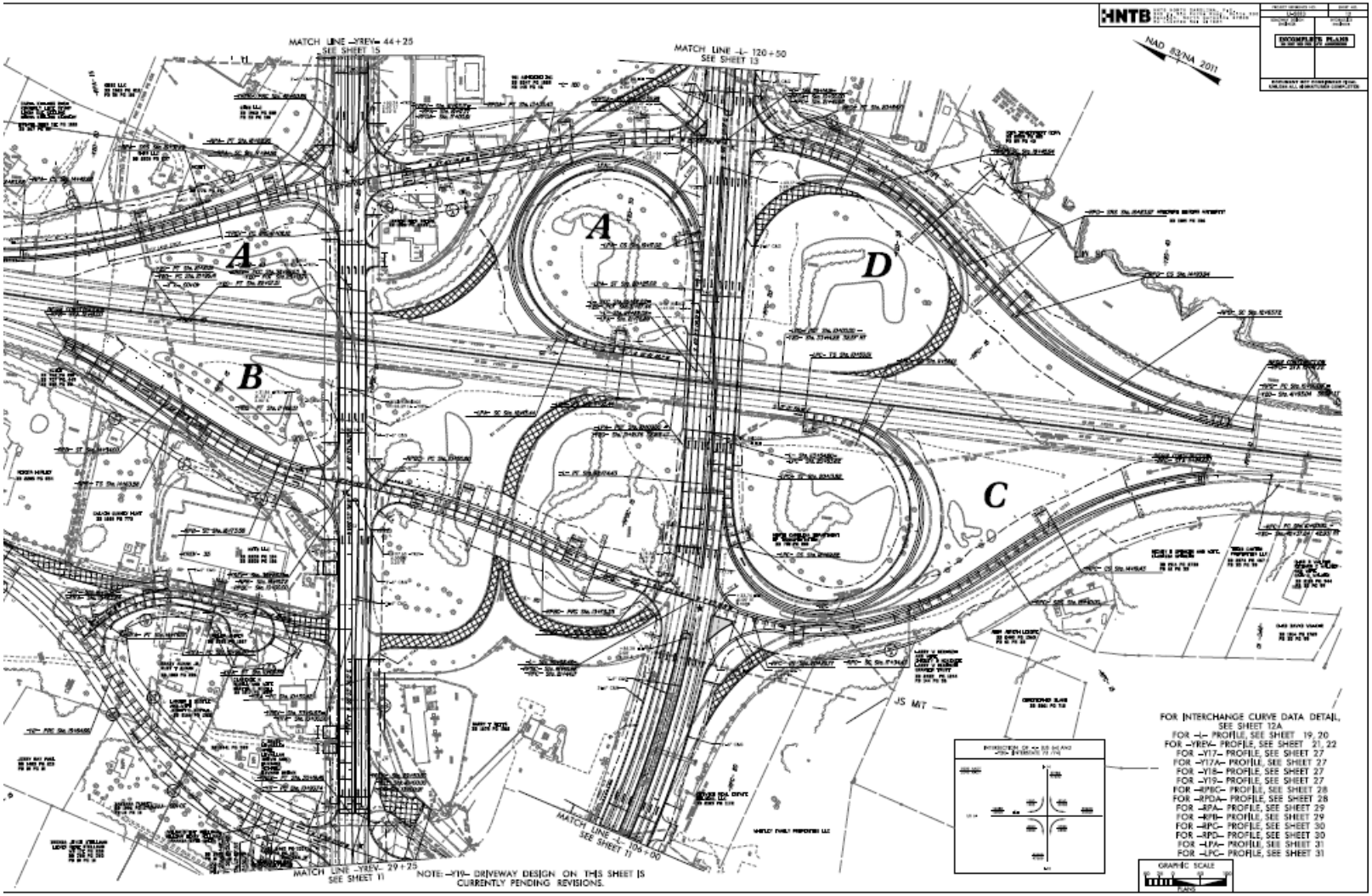
CORY GRELL, PE — PROJECT ENGINEER
TATYANA GIBBS, EI — PROJECT DESIGN ENGINEER
TATIA L. WHITE, PE, PLS — NCDOT CONTACT

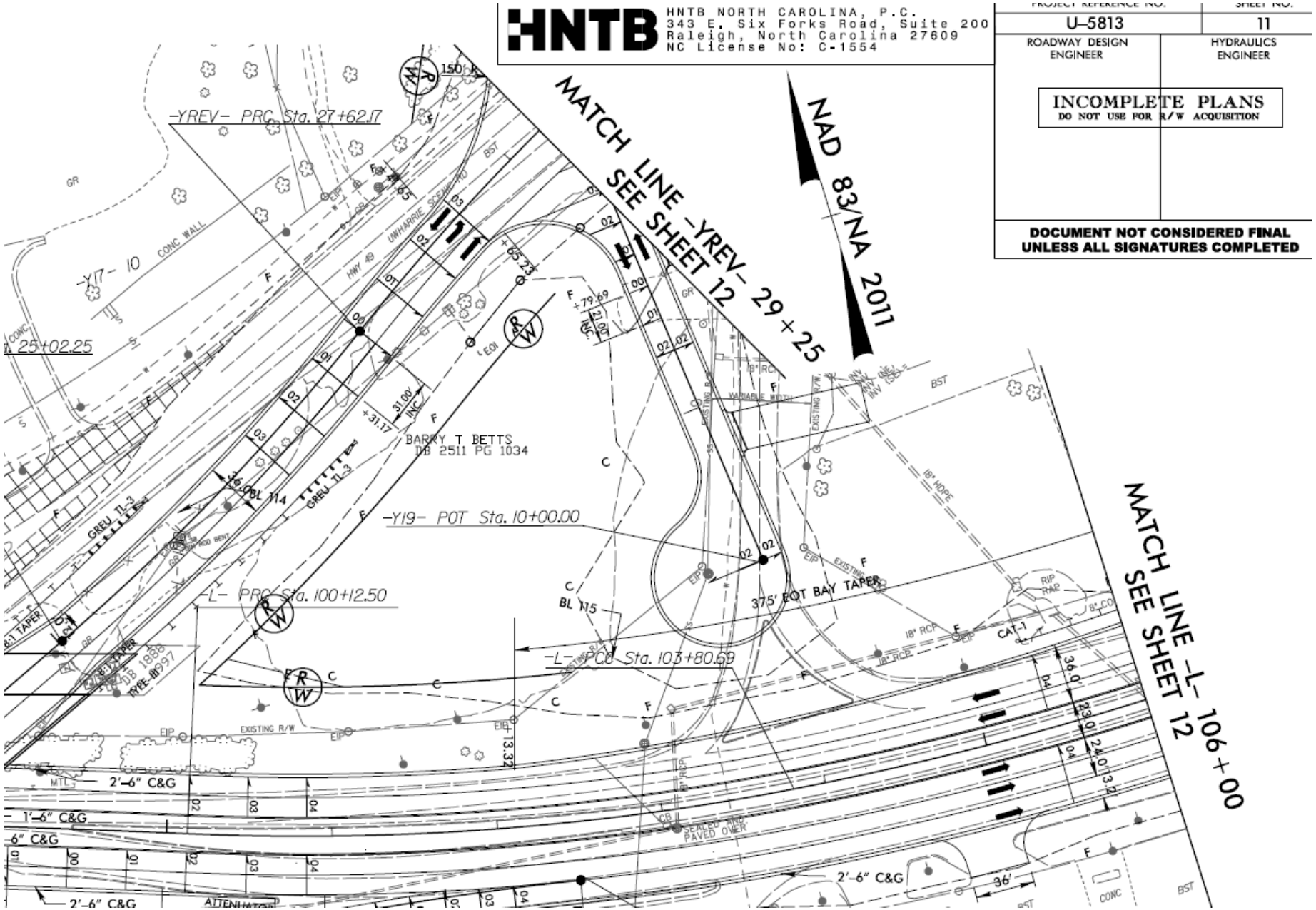
HYDRAULICS ENGINEER
SIGNATURE: P.E.

ROADWAY DESIGN ENGINEER
SIGNATURE: P.E.

STATE OF NORTH CAROLINA DEPARTMENT OF TRANSPORTATION


HNTB
HNTB NORTH CAROLINA, P.C.
343 E. Six Forks Road, Suite 200
Raleigh, North Carolina 27609
NC License No: C-1554
PROJECT REFERENCE NO.
U-5813
SHEET NO.
6
ROADWAY DESIGN ENGINEER
HYDRAULICS ENGINEER
INCOMPLETE PLANS
DO NOT USE FOR R/W ACQUISITION
DOCUMENT NOT CONSIDERED FINAL UNLESS ALL SIGNATURES COMPLETED
NAD 83/NA 2011
INTERSECTION OF -L- (US 64) AND -Y1- (SR 1424 - WESTCHAPEL RD)
MATCH LINE -L- 30+50 SEE SHEET 5
MATCH LINE -L- 43+50 SEE SHEET 7
BEGIN CONSTRUCTION -L- STA 34+08.40 LT
END R-2536 CONSTRUCTION -L- STA 44+62.50 LT
-Y1- PC Sta. 10+28.27
-Y1- PRC Sta. 12+52.36
-L- PC Sta. 37+28.49
-L- PRC Sta. 42+04.19
-Y2- POT Sta. 10+00.00
-Y2- PC Sta. 12+91.79
-Y3- POT Sta. 13+13.41
-Y3- PT Sta. 12+72.03
-Y3- PC Sta. 10+88.03
BEGIN CONSTRUCTION -Y2- STA 10+00.00
BEGIN CONSTRUCTION -Y3- STA 10+00.00
PI Sta 39+66.37
Δ = 2° 22' 12.2" (LT)
D = 0° 29' 53.6"
L = 475.70'
T = 237.88'
R = 11,500.00'
SE = NC
RO = N/A
PI Sta 11+45.96
Δ = 42° 47' 50.8" (LT)
D = 19° 05' 54.9"
L = 224.09'
T = 117.56'
R = 300.00'
SE = 0.04
RO = 84'
PI Sta 13+72.02
Δ = 10° 00' 18.5" (RT)
D = 4° 11' 44.2"
L = 238.47'
T = 119.54'
R = 1,365.61'
SE = NC
RO = N/A
-Y2-
PI Sta 13+56.82
Δ = 66° 04' 12.0" (LT)
D = 57° 17' 44.8"
L = 115.31'
T = 65.03'
R = 100.00'
SE = 0.04
RO = 84'
-Y3-
PI Sta 11+82.21
Δ = 30° 07' 15.9" (RT)
D = 16° 22' 12.8"
L = 184.00'
T = 94.18'
R = 350.00'
SE = 0.02
RO = 42'
INTERSECTION OF -L- (US 64) AND -Y2- (SR 1346 - SKEEN VIEW RD)
INTERSECTION OF -L- (US 64) AND -Y3- (SR 3255 - WESTSIDE CIRCLE)
FOR -L- PROFILE, SEE SHEET 16, 17
FOR -Y1- PROFILE, SEE SHEET 23
FOR -Y2- PROFILE, SEE SHEET 23
FOR -Y3- PROFILE, SEE SHEET 23


HNTB
NAD 83/NA 2011
MATCH LINE -YREV- 44+25
SEE SHEET 15
MATCH LINE -L- 120+50
SEE SHEET 13
A
B
C
D
JS MIT
MATCH LINE -YREV- 29+25
SEE SHEET 11
NOTE: -Y19- DRIVEWAY DESIGN ON THIS SHEET IS CURRENTLY PENDING REVISIONS.
FOR INTERCHANGE CURVE DATA DETAIL, SEE SHEET 12A
FOR -L- PROFILE, SEE SHEET 19, 20
FOR -YREV- PROFILE, SEE SHEET 21, 22
FOR -Y17- PROFILE, SEE SHEET 27
FOR -Y17A- PROFILE, SEE SHEET 27
FOR -Y18- PROFILE, SEE SHEET 27
FOR -Y19- PROFILE, SEE SHEET 27
FOR -RPBC- PROFILE, SEE SHEET 28
FOR -RPDA- PROFILE, SEE SHEET 28
FOR -RPA- PROFILE, SEE SHEET 29
FOR -RPB- PROFILE, SEE SHEET 29
FOR -RPC- PROFILE, SEE SHEET 30
FOR -RPD- PROFILE, SEE SHEET 30
FOR -LPA- PROFILE, SEE SHEET 31
FOR -LPC- PROFILE, SEE SHEET 31
GRAPHIC SCALE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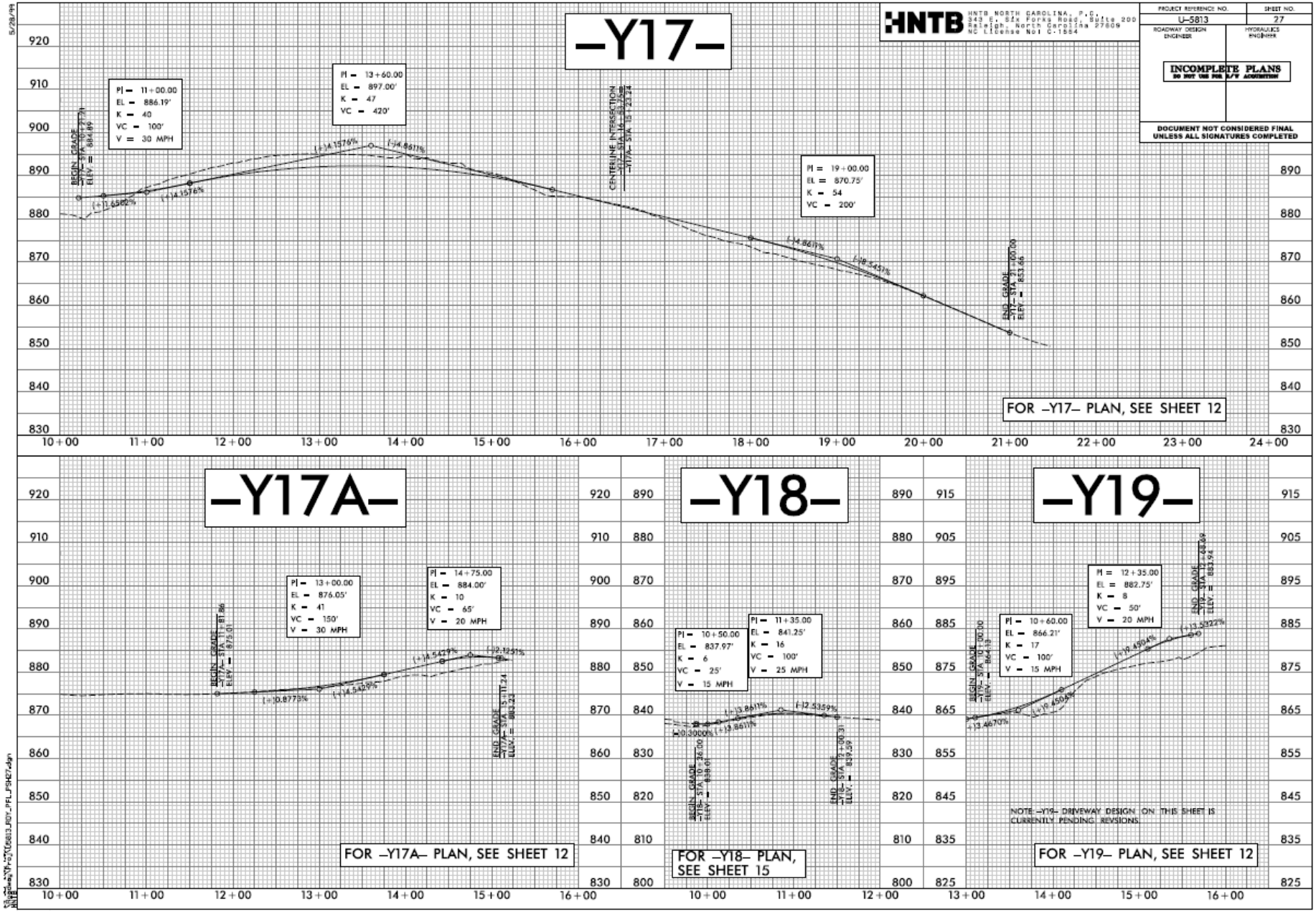
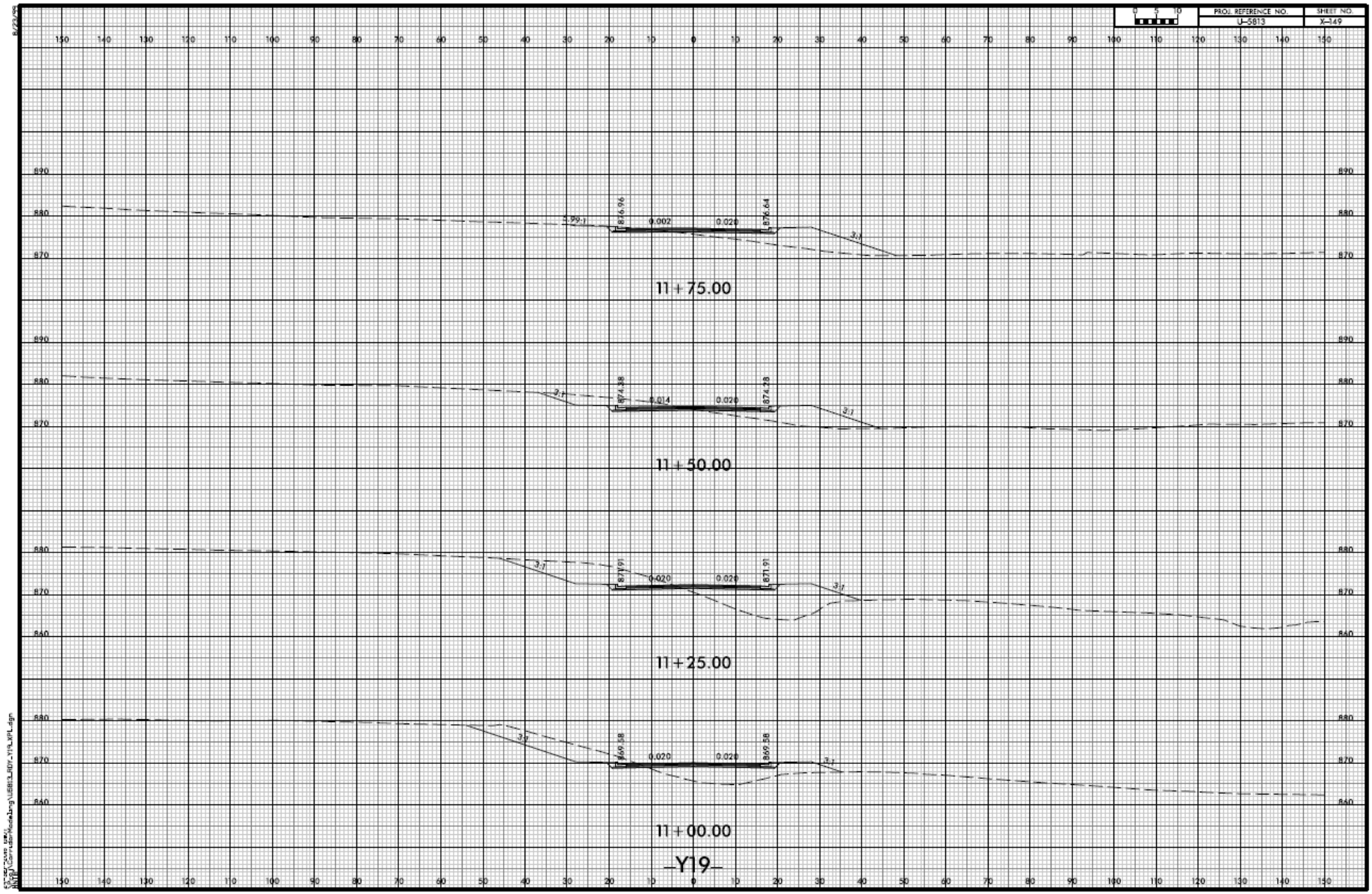
HNTB NORTH CAROLINA, P.C.
343 E. Six Forks Road, Suite 200
Raleigh, North Carolina 27609
NC License No: C-1554
PROJECT REFERENCE NO.
U-5813
SHEET NO.
11
ROADWAY DESIGN ENGINEER
HYDRAULICS ENGINEER
INCOMPLETE PLANS
DO NOT USE FOR R/W ACQUISITION
DOCUMENT NOT CONSIDERED FINAL UNLESS ALL SIGNATURES COMPLETED
MATCH LINE -YREV- 29+25 SEE SHEET 12
NAD 83/NA 2011
MATCH LINE -L- 106+00 SEE SHEET 12
-YREV- PRC Sta. 27+62.17
-Y17- 10
25+02.25
-Y19- POT Sta. 10+00.00
-L- PRC Sta. 100+12.50
-L- PCC Sta. 103+80.69
375' EOT BAY TAPER
BARRY T BETTS
DB 2511 PG 1034
GREU TL-3
HWY 49
UNHARRIE SCENIC RD
CONC WALL
EXISTING R/W
VARIABLE WIDTH
18" HDPE
18" RCP
CAT-1
RIP RAP
2'-6" C&G
1'-6" C&G
6" C&G
36'
SEALED AND PAVED OVER
ATTENUATOR
CONC
BST
GR
EIP
MTL


HNTB
HNTB NORTH CAROLINA, P.C.
343 E. Six Forks Road, Suite 200
Raleigh, North Carolina 27609
NC License No: C-1554
PROJECT REFERENCE NO.
U-5813
SHEET NO.
27
ROADWAY DESIGN ENGINEER
HYDRAULICS ENGINEER
INCOMPLETE PLANS
DO NOT USE FOR R/W ACQUISITION
DOCUMENT NOT CONSIDERED FINAL UNLESS ALL SIGNATURES COMPLETED
–Y17–
PI = 11+00.00
EL = 886.19'
K = 40
VC = 100'
V = 30 MPH
PI = 13+60.00
EL = 897.00'
K = 47
VC = 420'
PI = 19+00.00
EL = 870.75'
K = 54
VC = 200'
CENTERLINE INTERSECTION
–Y17– STA. 16+55.00
–Y17A– STA. 15+23.24
BEGIN GRADE
–Y17– STA. 10+77.71
ELEV. = 884.89
END GRADE
–Y17– STA. 21+00.00
ELEV. = 853.46
(+)7.6582%
(+)14.1576%
(+)14.1576%
(+)4.8611%
(-)4.8611%
(-)18.5455%
FOR –Y17– PLAN, SEE SHEET 12
–Y17A–
PI = 13+00.00
EL = 876.05'
K = 41
VC = 150'
V = 30 MPH
PI = 14+75.00
EL = 884.00'
K = 10
VC = 65'
V = 20 MPH
BEGIN GRADE
–Y17A– STA. 11+81.86
ELEV. = 875.01
END GRADE
–Y17A– STA. 15+11.24
ELEV. = 883.22
(+)10.8775%
(+)14.5429%
(+)14.5429%
(+)12.1251%
FOR –Y17A– PLAN, SEE SHEET 12
–Y18–
PI = 10+50.00
EL = 837.97'
K = 6
VC = 25'
V = 15 MPH
PI = 11+35.00
EL = 841.25'
K = 16
VC = 100'
V = 25 MPH
BEGIN GRADE
–Y18– STA. 10+26.00
ELEV. = 838.01
END GRADE
–Y18– STA. 12+00.31
ELEV. = 839.09
(-)0.3000%
(+)13.8611%
(+)13.8611%
(-)12.5359%
FOR –Y18– PLAN, SEE SHEET 15
–Y19–
PI = 10+60.00
EL = 866.21'
K = 17
VC = 100'
V = 15 MPH
PI = 12+35.00
EL = 882.75'
K = 8
VC = 50'
V = 20 MPH
BEGIN GRADE
–Y19– STA. 10+00.00
ELEV. = 864.13
END GRADE
–Y19– STA. 12+48.39
ELEV. = 883.94
(+)13.4670%
(+)9.4504%
(+)9.4504%
(+)13.5322%
NOTE –Y19– DRIVEWAY DESIGN ON THIS SHEET IS CURRENTLY PENDING REVISIONS.
FOR –Y19– PLAN, SEE SHEET 12
10+00
11+00
12+00
13+00
14+00
15+00
16+00
17+00
18+00
19+00
20+00
21+00
22+00
23+00
24+00


PROJ. REFERENCE NO.
U-5813
SHEET NO.
X-149
11 + 75.00
11 + 50.00
11 + 25.00
11 + 00.00
-Y19-

Structures

BSR (Bridge Survey Report)
PGD (Preliminary General Drawing)
Wall Envelopes

BSR (Bridge Survey Report)

BSR (Bridge Survey Report)

SITE DATA

Drainage Area 148.0 SQUARE MILES Source USGS QUAD MAPS/STREAMSTATS

River Basin CAPE FEAR Character RURAL; PREDOMINANTLY AGRICULTURAL

Stream Classification (Such as Trout, High Quality Water, etc.) CLASS B

Data on Existing Structure 1@21'6", 1@18'1", 1@21'1", 1@19'9" TIMBER DECK ON STEEL GIRDERS AND TIMBER CAPS AND PILES Total Waterway Opening 495 s.f.

Waterway Opening Below 100yr. WS EL. 495 s.f.

Debris Potential: Low ____ Moderate X High ____

Data on Structures Up and Down Stream BRIDGE 1: 1@36'5", 2@34'10", 1@36'5" CONCRETE DECK GIRDERS APPROX. 5.3 MILES UPSTREAM ON US-401 BUSINESS; BRIDGE 47: 1@45'7", 1@45'5", 1@45'7" CORED SLAB APPROX. 3.7 MILES DOWNSTREAM ON SR 1003 (ARABIA ROAD)

Design Control Elev. MAINTAIN OR EXCEED 25 YEAR LOS

Gage Station No. 02104220 Period of Records 1989-2006 yrs.

Max. Discharge 1,750 c.f.s. Date 09/07/2008 Frequency ~5 YR.

Historical Flood Information:

HIGHEST OBSERVED WAS 2' BELOW CAP
Date ____ Elev. ____ ft. Est. Freq. ____ yr. Source THOMAS CHAVIS BRG. MAINT. SUPERVISOR Period of Knowledge 8 yrs.

OVERTOPPING NEVER OBSERVED
Date ____ Elev. ____ ft. Est. Freq. ____ yr. Source CHARLES VICK/STAFF COUNTY MAINT. ENGINEER Period of Knowledge 18 yrs.

Date ____ Elev. ____ ft. Est. Freq. N/A yr. Source N/A Period of Knowledge N/A yrs.

Historical Scour Info. : General N/A ft. Contraction N/A ft. Local N/A ft.

Channel Slope 0.000553 ft/ft Source HEC2 MODEL Normal Water Surface Elev. 137.8 ft.

Manning's n: Left O.B. 0.07-0.35 Channel 0.03-0.66 Right O.B. 0.07-0.35 Source FIS AND FIELD OBSERVATION

Flood Study /Status REDELINEATED DETAILED STUDY (PANEL #9464, 10/17/2006) Floodway Established? YES

Flood Study 100yr. Discharge 8,384 c.f.s. WS Elev.: With Floodway 146.0 ft. Without Floodway 145.0 ft. @ River Station 38,560

DESIGN DATA

Hydrological Method USGS RURAL REGRESSION EQUATIONS (SIR 2009-5158)

Hydraulic Design Method HEC-RAS VERSION 4.1.0

Floods Evaluated: Elevation @ River Station 37919 37' FROM FACE

Freq. (yr.)	Q TOTAL (c.f.s) BRG	Elev. (ft.)	Backwater (ft.)	Bridge Opening Velocity (f.p.s.)
10	2,800 /1,819	140.3	0.3	3.7
25	3,700 /2,419	141.2	0.3	3.9
100 FEMA	8,384 /4,681	145.7		
100	5,000 /2,734	142.5	0.4	3.8
500	6,700 /4,434	144.2	0.6	6.1

Waterway Opening Provided Below Design W.S. Elev. 622 s.f., 100yr W.S. Elev. 730 s.f., Total 730 s.f.,

Average Channel Velocity (Design) 3.6 f.p.s. Average Overbank Velocity (Design) 0.6 f.p.s.

AVERAGE VELOCITIES (CHANNEL AND OVERBANK) TAKEN AT APPROACH RS 38560

Computed Scour : General N/A ft. Contraction 4.3 ft. Local 3.6 & 4.7 ft.

Is a Floodway Revision Required? NO; MOA TYPE-2a; MAX DECREASE=0.12' AT RIVER STATION 37919

Stream ROCKFISH CREEK Struc. Inv. No. 41 I.D. No. B-4550 Project No. 33763.1.2 PDF File 46041 2017 B4550 ROCKFISH CREEK SR1432.pdf

WHE FOR MSL

BRIDGE SURVEY & HYDRAULIC DESIGN REPORT

N. C. DEPARTMENT OF TRANSPORTATION
DIVISION OF HIGHWAYS
HYDRAULICS UNIT
RALEIGH, N. C.

I.D. No. B-4550 Project No. 33763.1.2 Proj. Station 14+75 -L-

County HOKE Bridge Over ROCKFISH CREEK Bridge Inv. No. 41

On Highway SR 1432 (GOLF COURSE ROAD) Between SR 1427 (ELLIS ROAD) and SR 1413 (PITTMAN GROVE CHURCH ROAD)

Recommended Structure 1@50', 1@55', 1@45' 21" CORED SLAB w/4-FOOT CAPS

Recommended Width of Roadway 30'-10" CLEAR ROADWAY Skew 90°

Recommended Location is (Up, (At), Down) Stream from Existing Crossing

Statewide Tier ☐ Regional Tier ☐ Sub-Regional Tier ☒

Bench Mark is (BM#1) RAILROAD SPIKE SET IN BASE OF 18" CYPRESS TREE; -BL- STATION 10+18 AND 96' RIGHT Elev. 140.00 ft. Datum: NAVD 88

Temporary Crossing NOT REQUIRED; OFFSITE DETOUR PROVIDED

Longitude 34.9681356° Latitude -79.1094359°

Designed by: CRAIG J. LEE, PE

Assisted by:

Project Engineer : WILLIAM H. ELAM JR., PE

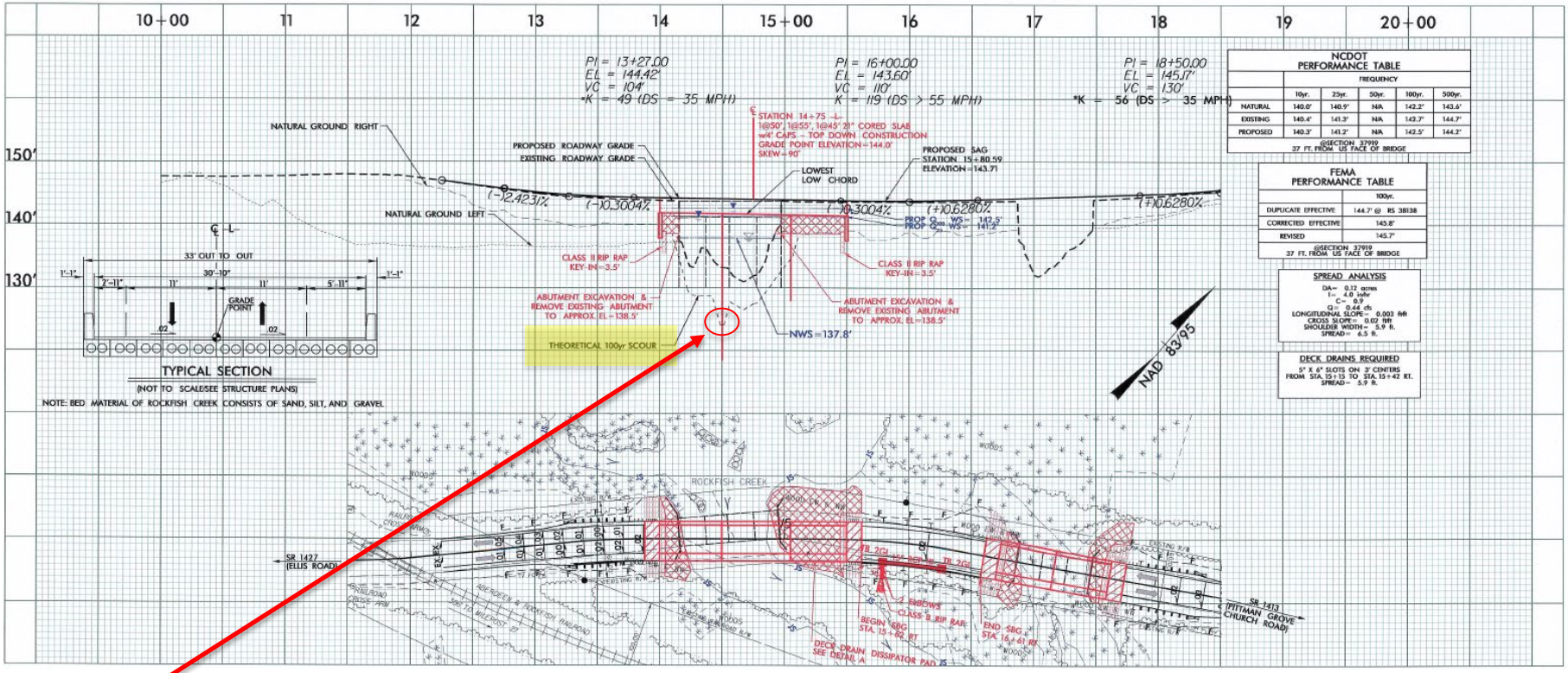
Reviewed by: WHE 2/17/2017

Date 2/17/17

NORTH CAROLINA PROFESSIONAL SEAL 042644 ENGINEER CRAIG J. LEE

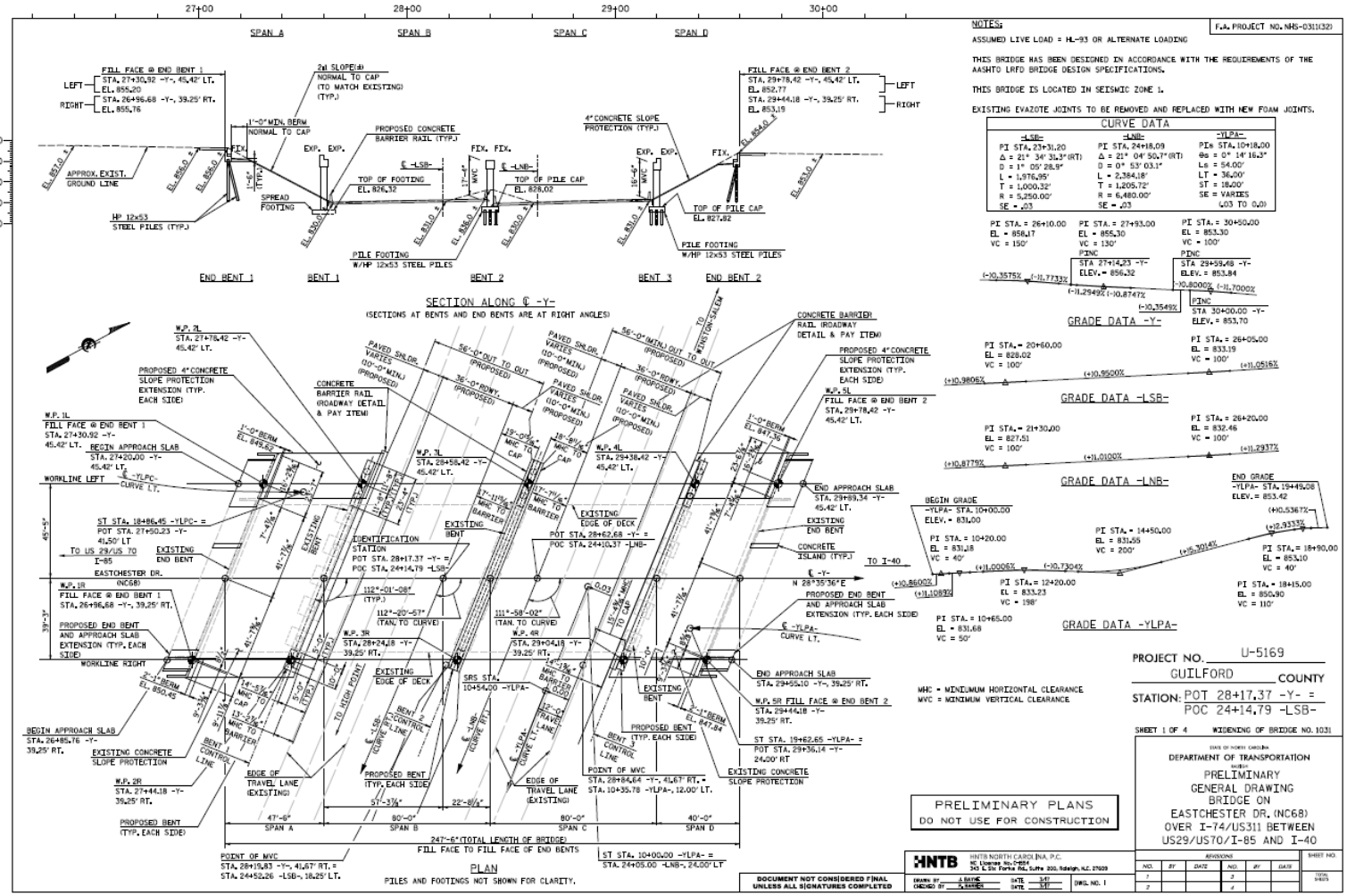
REVISED 02/15/2017
CHANGED FROM
24" CORED SLAB
TO 21" CORED SLAB
PER STRUCTURES UNIT

BSR (Bridge Survey Report)

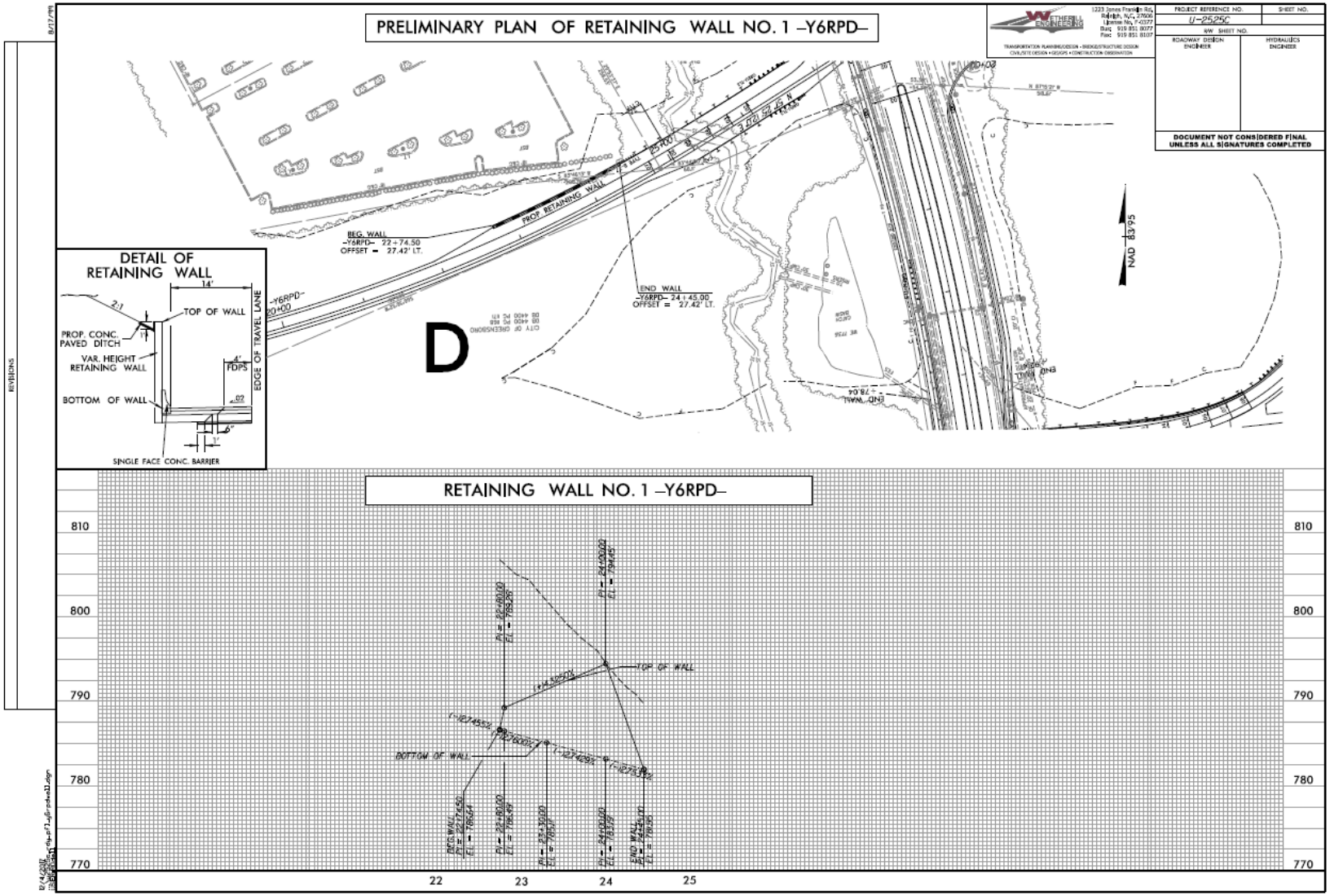


It is important to note the elevation of the 100 year scour. This is represented graphically on this page, but can also be seen as a depth value on the print out Indicating contraction scour (entire streambed) and local scour (scour at the proposed bent). Do not count scour in your bearing calculations!!!

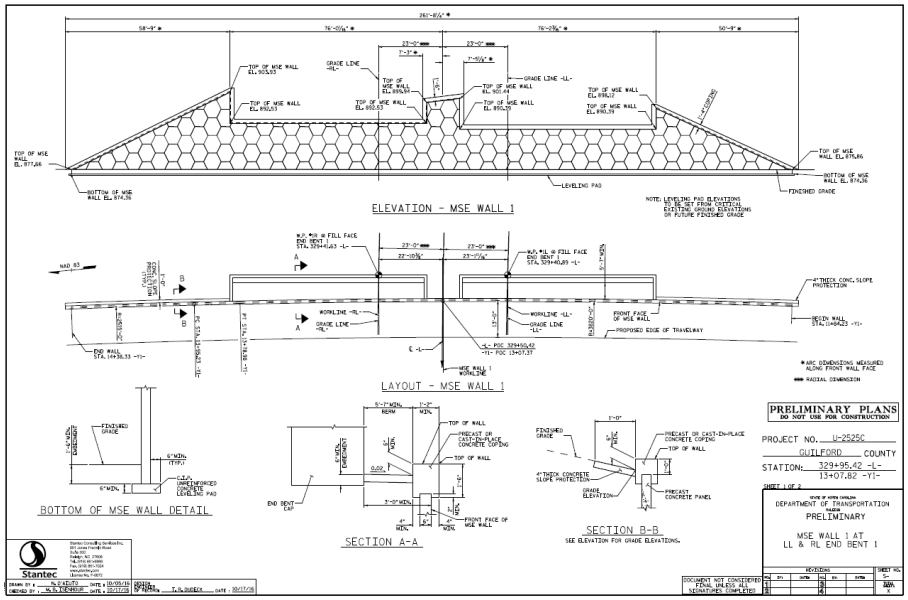
PGD (Preliminary General Drawing)

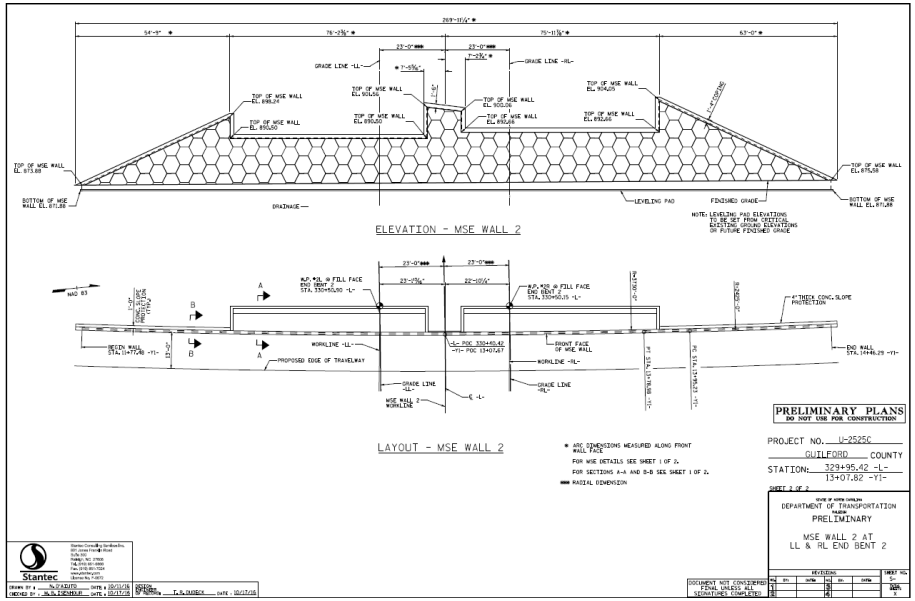


Wall Envelopes (Retaining)



Wall Envelopes (MSE)





When looking at a wall envelope, remember you are looking at the "face" of the wall.

!! An End Bent 1 MSE wall means you are looking DOWNSTATION !!

Special Permitting - Environmental

Environmental Assessment
aka the "Green Sheet"

- State Environmental Assessment
- FONSI (Finding of no Significant Impact)

Special Permitting - Environmental

Nationwide Permits (i.e. NW 6)

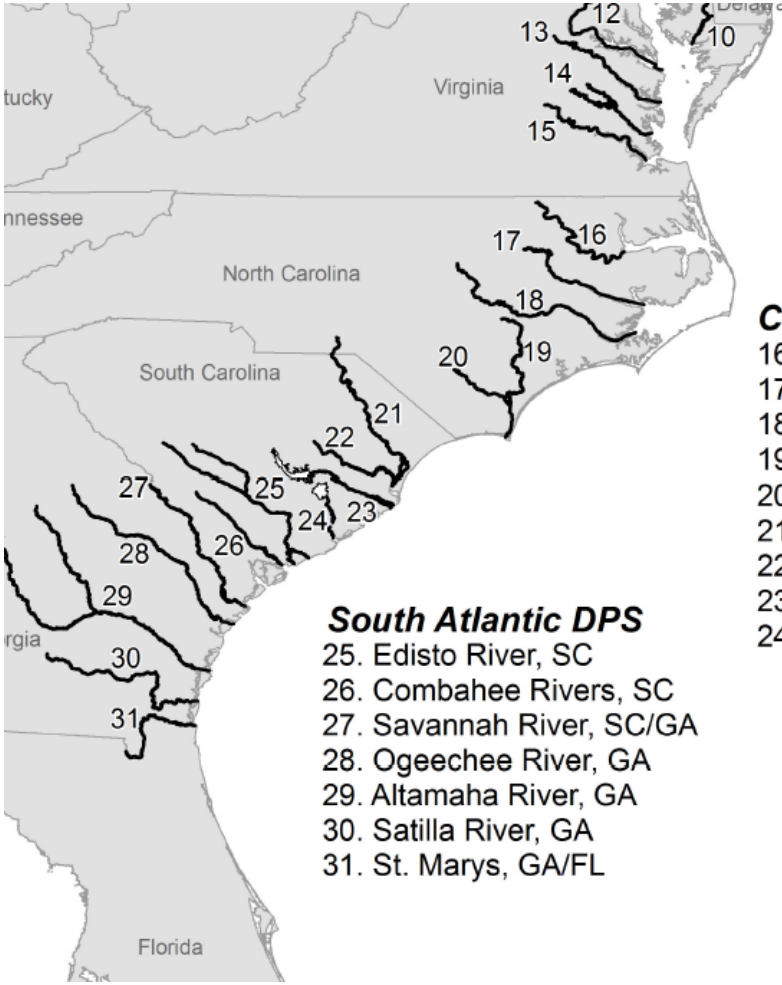
https://www.saw.usace.army.mil/Missions/Regulatory-Permit-Program/Permits/2017-Nationwide-Permits/

Coastal Area Management Act (CAMA)

https://deq.nc.gov/about/divisions/coastal-management/coastal-management-permits

Special Permitting - Environmental

Atlantic Sturgeon



Chesapeake Bay DPS

10. Nanticoke River, MD
11. Marshyhope Creek, MD
12. Potomac River, MD/VA
13. Rappahannock River, VA
14. York/Mattaponi/Pamunkey Rivers, VA
15. James River, VA

Carolina DPS

16. Roanoke River, NC
17. Tar-Pamlico River, NC
18. Neuse River, NC
19. Northeast Cape Fear River, NC
20. Cape Fear River, NC
21. Pee Dee River, NC/SC
22. Black River, SC
23. Santee River, SC
24. Cooper River, SC

South Atlantic DPS

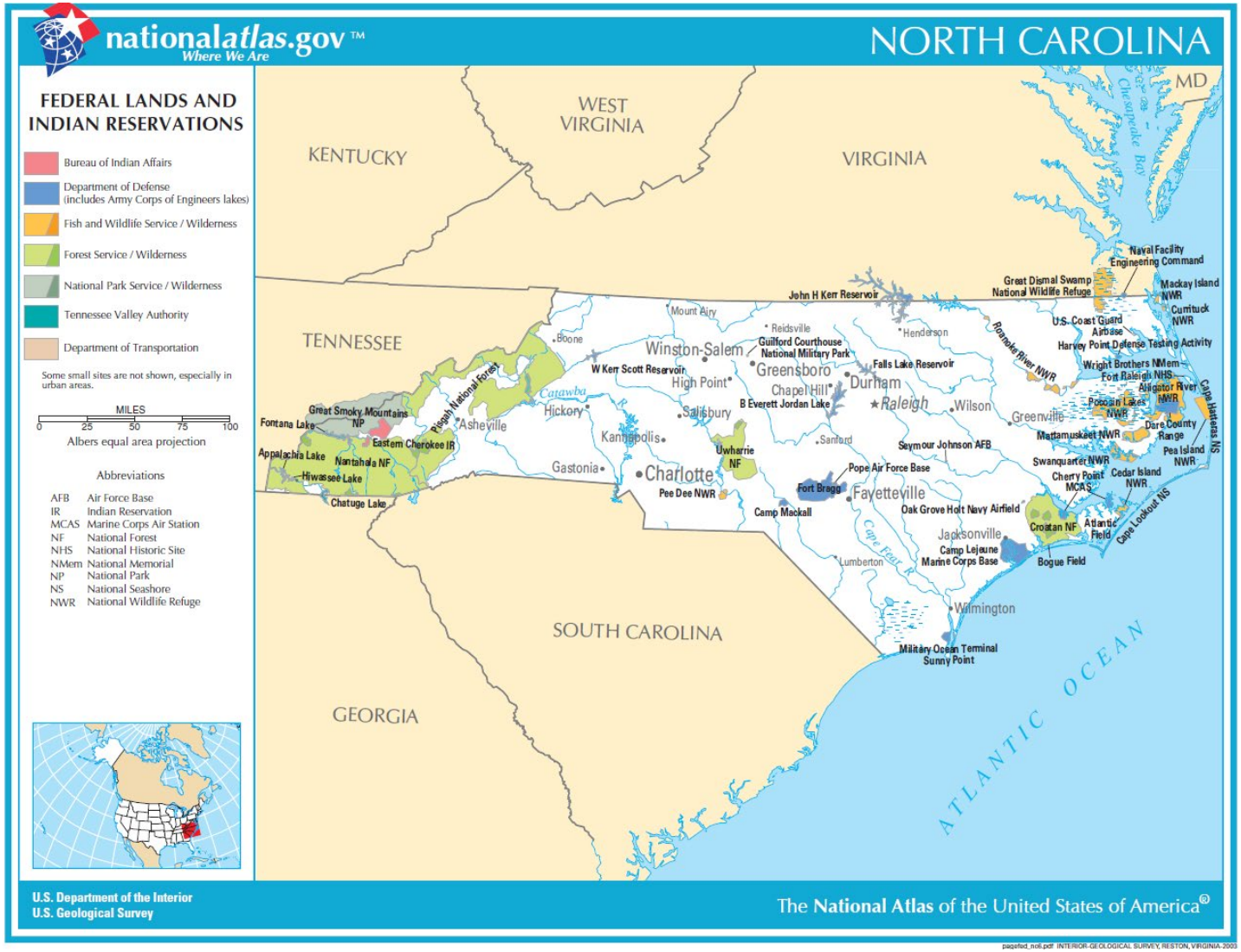
25. Edisto River, SC
26. Combahee Rivers, SC
27. Savannah River, SC/GA
28. Ogeechee River, GA
29. Altamaha River, GA
30. Satilla River, GA
31. St. Marys, GA/FL

35°N

30°N

Atlantic Sturgeon Critical Habitat

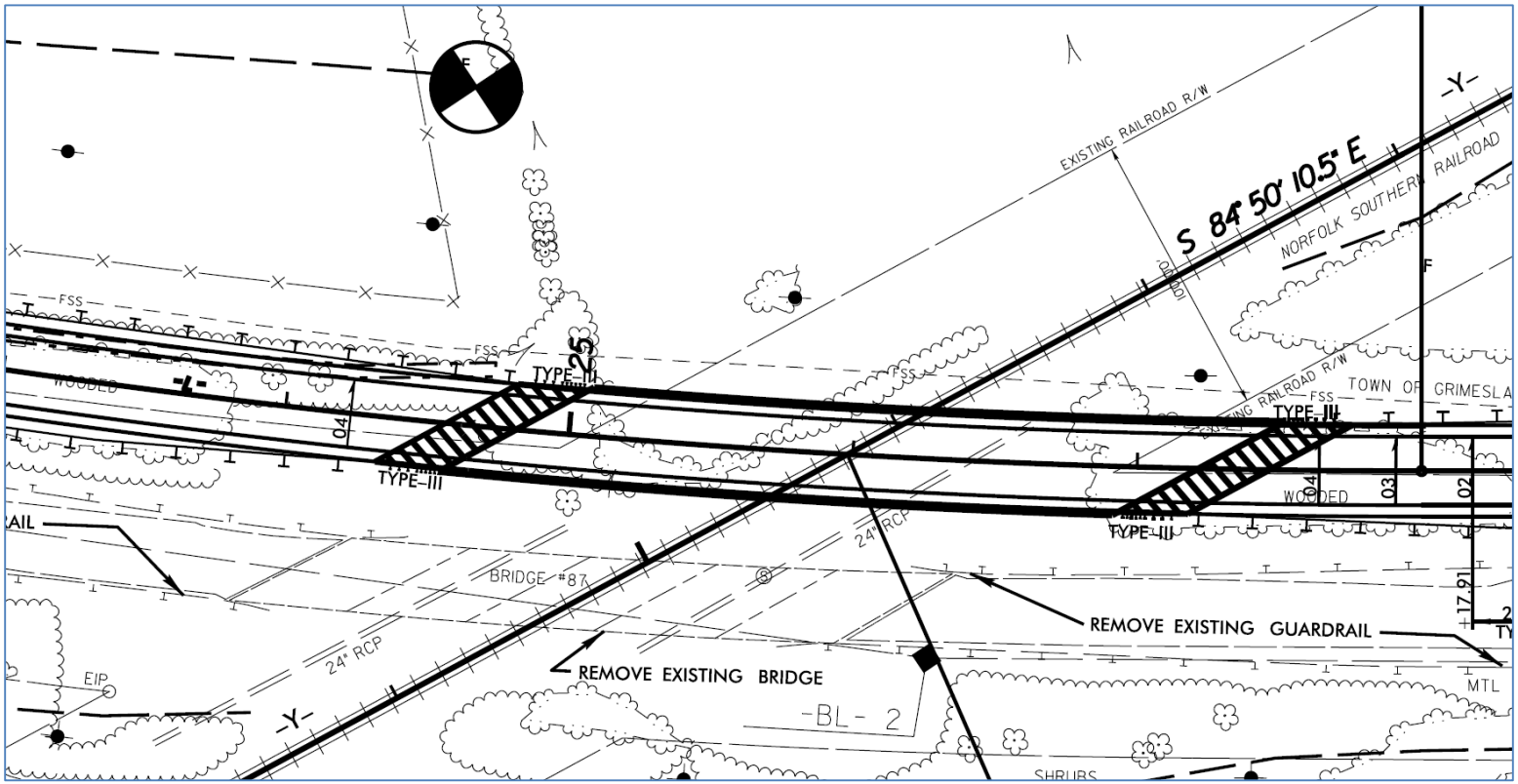
Special Permitting – Federal



Special Permitting – Railroad ROE

North Carolina Railroad (NCRR)
Norfolk Southern (NS)
CSX
Miscellaneous Short Lines

Special Permitting – Railroad ROE



Railroad Right of Way: 100 ft left and right of centerline → Right of Entry permit!
25 ft of centerline → ROE and RR flagman!!
4 ft of centerline → ROE, flagman, closed tracks!!!

Boring Plans

Create Boring Plan

Structures

Bridge

- Number of Bents (EB1, B1,…EB2)
- Left, Center, Right (A, E, C, D , B)
- CP, 1 per bent (under 60 ft width)
- WR, CR, NCR (minimum 2 borings per bent)

Culvert

- Target proposed ends
- Include additional borings if long alignment

Wall

- Noise/Sound Walls
- (100 ft spacing)
- Retaining Walls (50 ft spacing)

Roadway

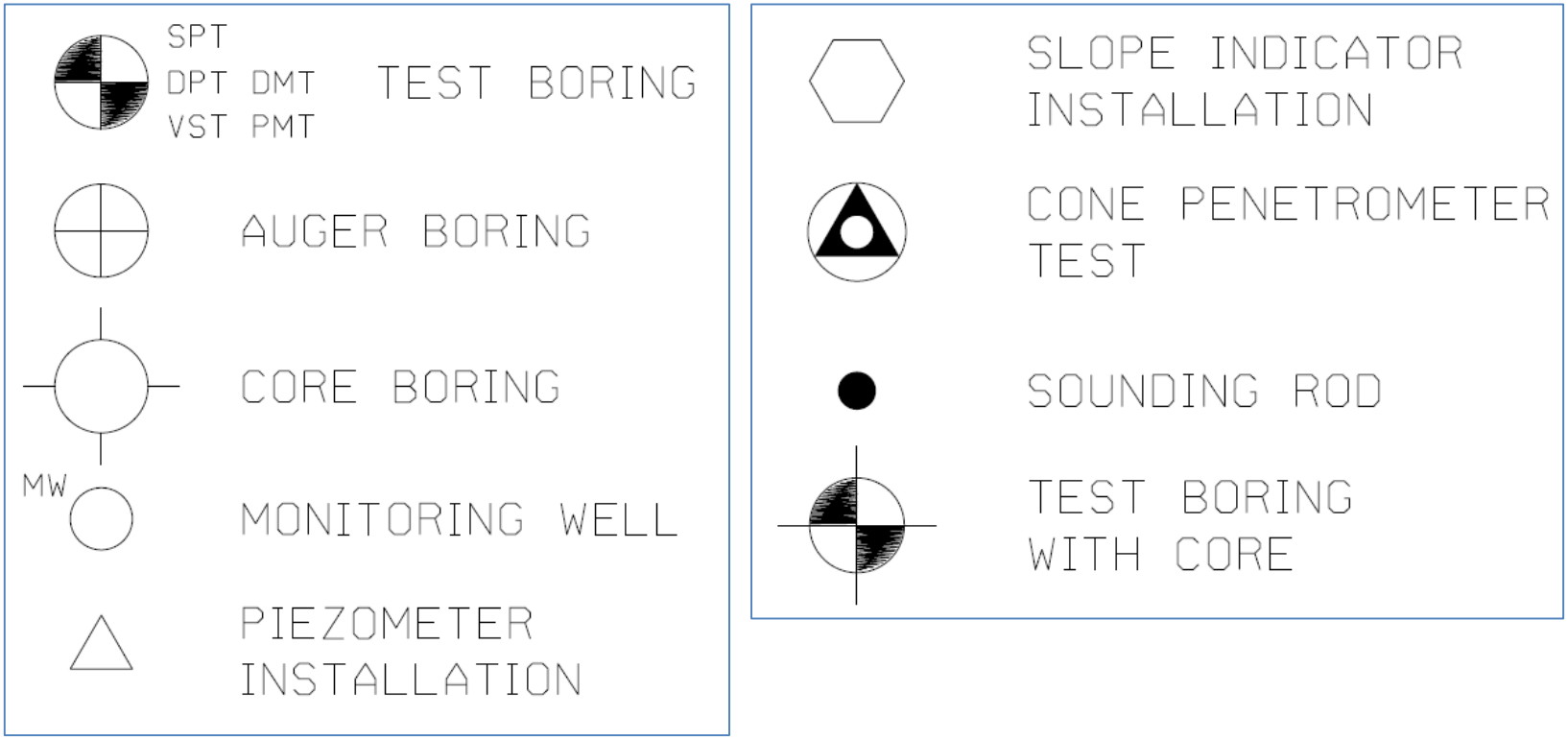
Widening

- Minimum boring spacing 200 ft.
- Pay attention to soils close to subgrade
- Target side with majority of work
- Anticipate culvert extensions

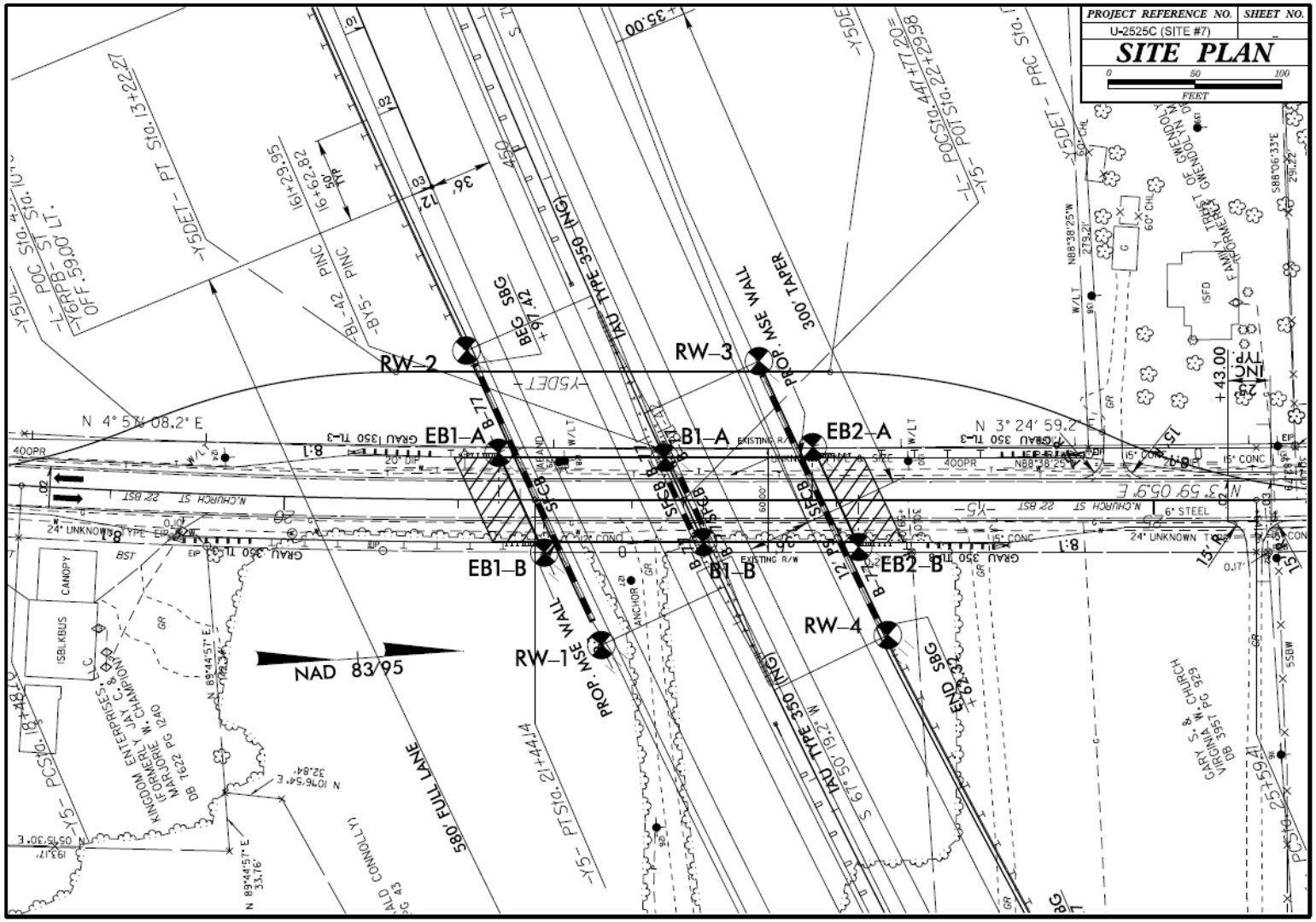
New

- Minimum boring spacing 200 ft.
- Target Cuts
- Target Large Fills
- Target Culverts

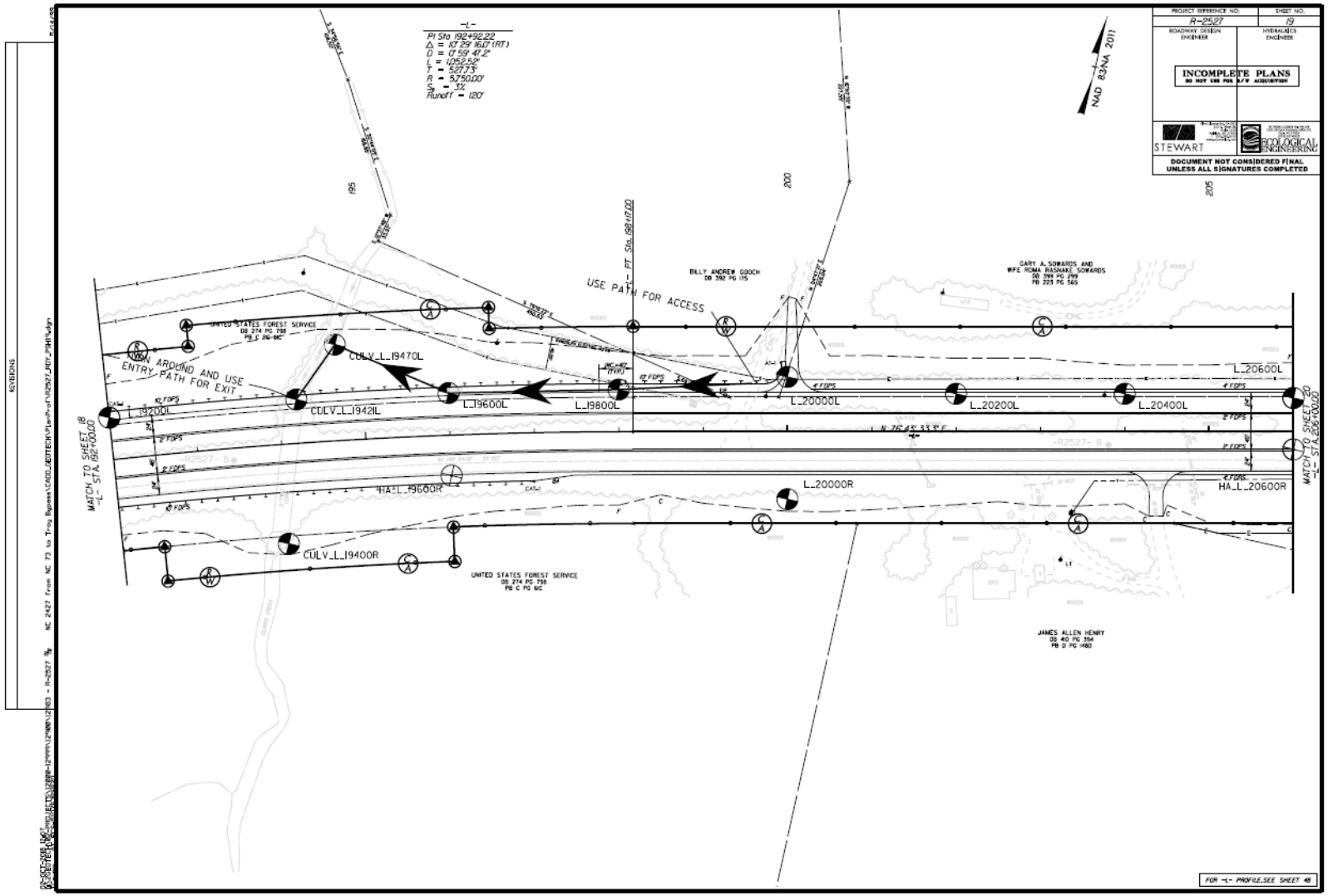
Boring Plans – Type of Borings



Boring Plans – Structure Example



Boring Plans – Roadway Example



Property Owner Contacts

Sources:

Location and Survey Database
County GIS site
Plan Sheets

Methods:

Certified Mail
Phone
In Person

*Make sure to document all contact, dates and responses.
Send in your contact sheets before, during and after drilling!!!

Boring Layout

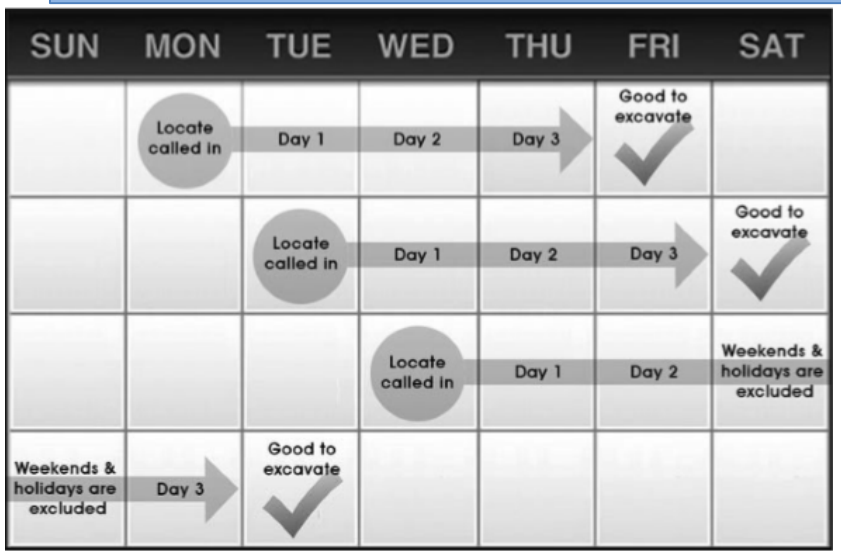
- Mark with WHITE stakes, flags, paint
- Make sure it lasts!
- Flag judiciously, but clearly!
- If using GPS, it must be sub metric accuracy!
- If laying out a structure, it may be more accurate to measure from existing features!

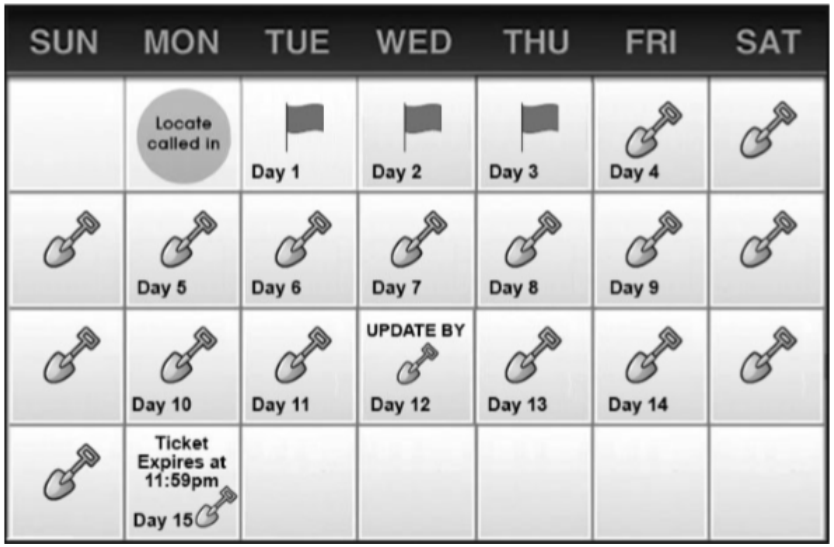
Utilities

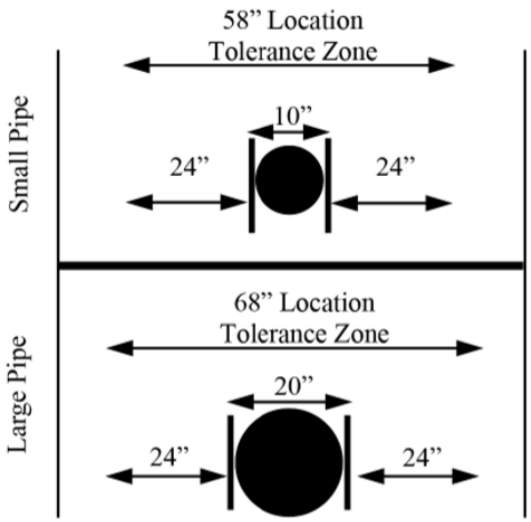
```
EMLCFM 04314 NCOCa 11/20/18 11:21:24 A183173316-00A NORM RESP GRID LR

Thank you for calling North Carolina 811!
This is an automatically generated response from the utilities
who received your notice of excavation.  For your safety,
please respect and protect the marks, and excavate carefully
around the marked utility lines.

This email comes from an automated program that is NOT MONITORED.
DO NOT REPLY BACK TO THIS EMAIL.

Ticket : A183173316 Rev: 00A Taken: 11/13/18 05:09 PM

State: NC Cnty: MOORE Place: WEST END
Address :  NC 211 HWY
Work date: 11/17/18 12:00 AM
Good thru: 12/06/18 11:59 PM  Update by: 12/03/18 11:59 PM

Member      Description                 Response
Code

COF01*      TIME WARNER CABLE-CHARTER
            CABLE TV                    11/20/18 11:21 AM   30
            Not complete
CPL30*      DUKE ENERGY
            POWER                       11/20/18 11:21 AM   30
            Not complete
CTT12*      CTLCL-CENTURYLINK
            PHONE AND FIBER OPTIC       11/20/18 11:21 AM   30
            Not complete
CUB01       CONTERRA ULTRA BROADBAND
            FIBER OPTIC                 11/17/18 12:00 AM   999
            Member has not responded by the required time
MCP01       MOORE COUNTY PUBLIC UTILITIES
            WATER AND SEWER             11/14/18 10:19 AM   20
            Marked


Member      Type     Contact                          Phone

COF01*      Field    DISPATCH                         800-778-9140
            Damage   CAROLINAS REGIONAL OPERATIONS   855-272-2862
CPL30*      Field    DISPATCH                         800-778-9140
            Damage   DUKE ENERGY REPRESENTATIVE       800-452-2777
CTT12*      Field    DISPATCH                         800-778-9140
            Damage   GENERAL NUMBER                   800-788-3600
CUB01       Field    BRIAN WIDMER                     803-446-0580
            Damage   NETWORK OPERATIONS CENTER        888-581-0811
MCP01       Field    1 - ROBBIE BAKER                 910-947-6315x4313
            Field    2 - JUSTIN BOYD (CELL)           910-690-1561
            Field    2 - JUSTIN BOYD (OFFICE)         910-947-6315
            Damage   CUSTOMER SERVICE                 910-947-6315

If any damage involves a release of product or injury, please call 911
before contacting the owner.

Water, sewer and storm drain lines are marked within the right of way or
to the meter, and not on private property. Lines from the right of way or
meter to the residence or business are private lines and you will need to
contact a private line locator to have these lines located. Member facility
owners are not responsible for marking private lines. For a listing of
private line locators, please visit our website, www.nc811.org.  You must
contact any non-member facility owners not listed on your location request
directly to request their facilities to be located and marked.
```

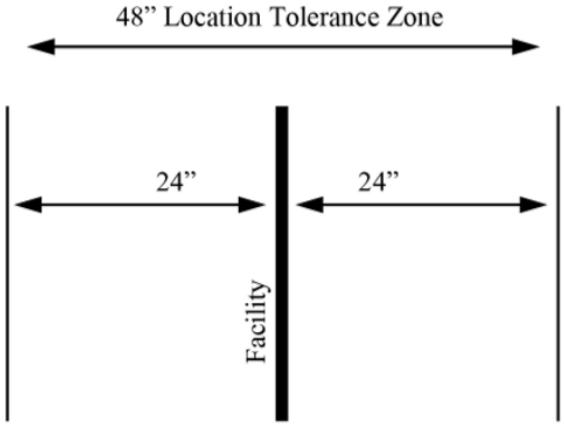
https://www.nc811.org/brochures-and-manuals.html

Utilities


SUN
MON
TUE
WED
THU
FRI
SAT
Locate called in
Day 1
Day 2
Day 3
Good to excavate
Locate called in
Day 1
Day 2
Day 3
Good to excavate
Locate called in
Day 1
Day 2
Weekends & holidays are excluded
Weekends & holidays are excluded
Day 3
Good to excavate


SUN
MON
TUE
WED
THU
FRI
SAT
Locate called in
Day 1
Day 2
Day 3
Day 4
Day 5
Day 6
Day 7
Day 8
Day 9
Day 10
Day 11
UPDATE BY
Day 12
Day 13
Day 14
Ticket Expires at 11:59pm
Day 15


58" Location Tolerance Zone
Small Pipe
10"
24"
24"
68" Location Tolerance Zone
Large Pipe
20"
24"
24"


48" Location Tolerance Zone
24"
24"
Facility

Site Reconnaissance

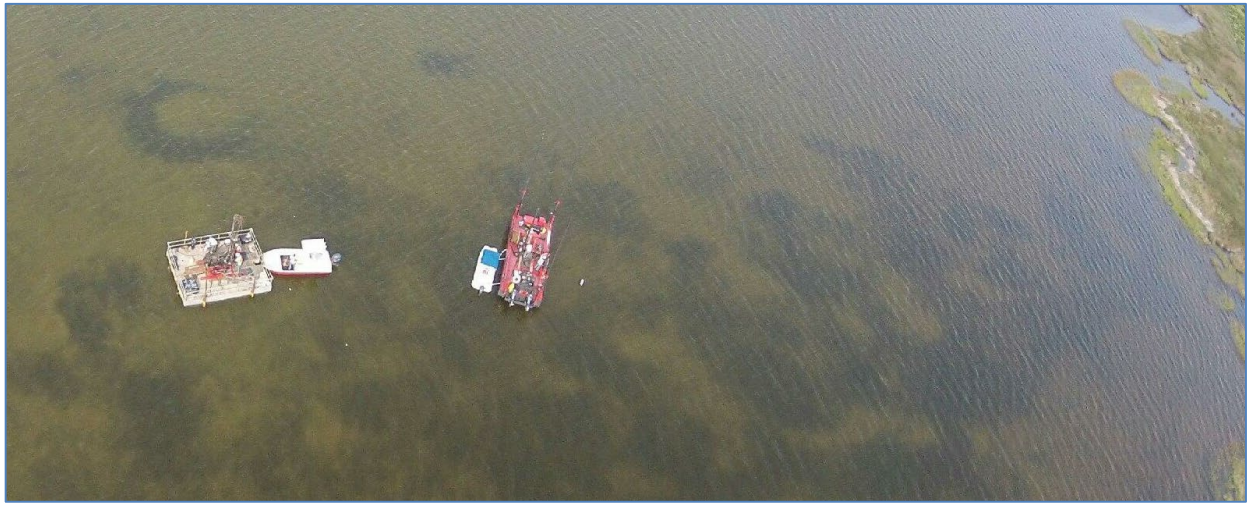
https://youtu.be/tZbuMpqWiSk

Clearing?
Hand vs. Hydraulic Mulching/Clearing

Route Restrictions?
Weight limits, difficult access, offloading rigs

Site Reconnaissance

Difficult Access?
Rock outcrop?
Barge?
Marsh buggy?
Track rig?
Utility issues?



Traffic Control

MUTCD
(Manual on Uniform Traffic Control Devices)

TIMS/Drive NC
(Traffic Information Management System)

Divisions 1-14, Municipalities
(May provide restrictions to traffic control operations)

Safety

Know your PPE

Tailgate Meetings

- Slips, Trips, Falls
- Poison Ivy
- Sun
- Extreme Temperatures
- Traffic
- ALL THE CRITTERS

Nearest Medical Facility

Field Forms

- Boring Logs (roadway half and full)
- Boring Logs (structure)
- Coring Logs
- Survey Notes Sheet
- Daily Activity Log

C:\NCDOT_V8_WORKSPACE\GEOTECHNICAL_STDS\Standards\appl\GeoForms\English

Borehole Logging

Jaime L. Love, L.G.

April 10, 2019

Filling Out the Boring Log

All data fields must be completed.
Blank data fields suggest they have been overlooked.

NORTH CAROLINA DEPARTMENT OF TRANSPORTATION
GEOTECHNICAL UNIT BORING LOG

SHEET 1 OF 1

PROJECT NO. 35516.1.TA2	ID. R-2828	COUNTY WAKE	GEOLOGIST N. Moore
SITE DESCRIPTION NC-540 from US-401 to I-40			
BORING NO. 39-RL-B6-A	STATION 838+16	OFFSET 25' RT	LINE -1-
COLLAR ELEV.	NORTHING	EASTING	
TOTAL DEPTH 53.7'	DRILL MACHINE CME 55 551	DRILL METHOD Mud Rotary	HAMMER TYPE Auto
DATE START 9-29-17	DATE COMPLETE 9-30-17	CORE BARREL TYPE N/A	SURFACE WATER DEPTH N/A

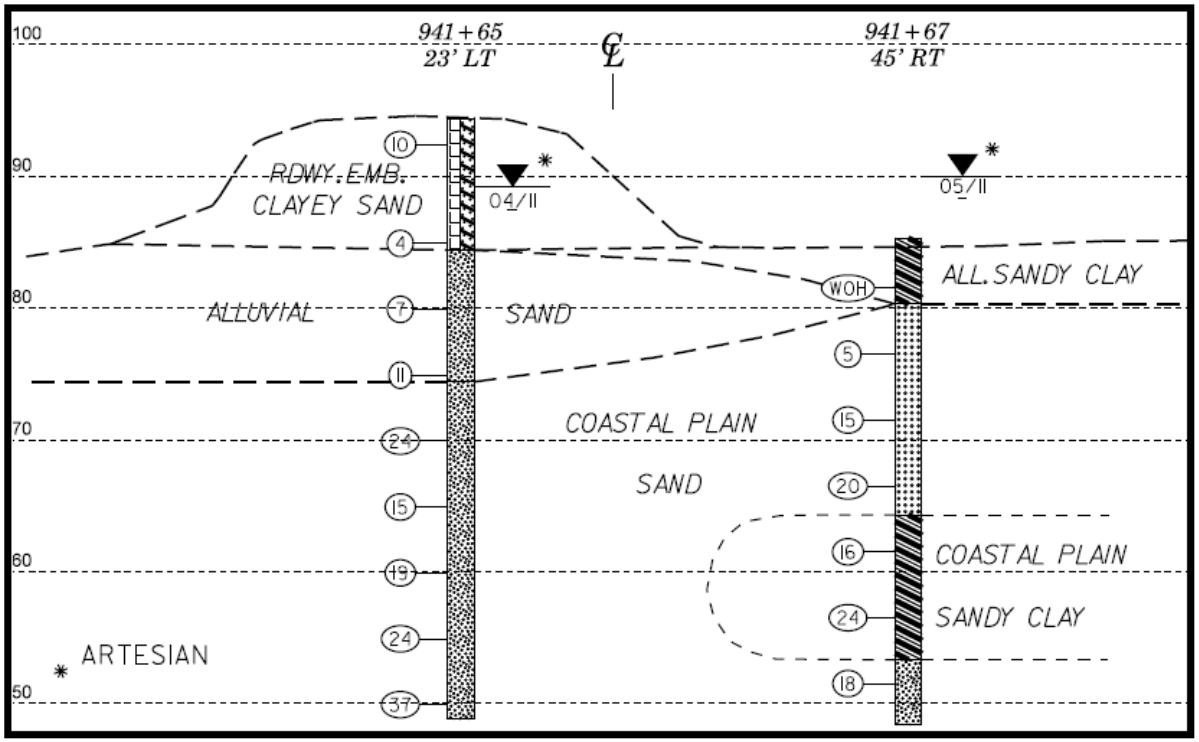
GROUND WATER
0 HR. 25' @ 31.0'
24 HR. 3.8' @ 35.8'

These fields can be completed during redline stage

0-hour water measurement should be taken after drilling implements are removed from boring

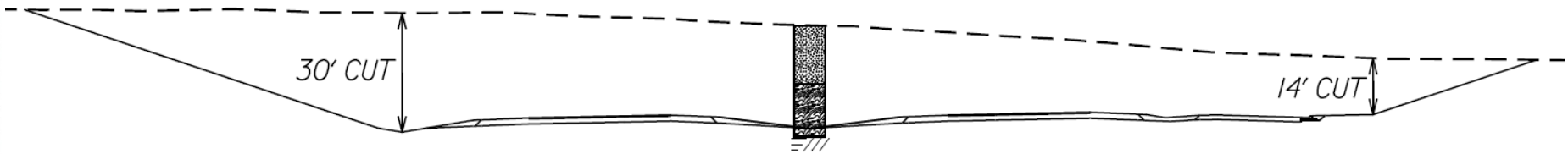
Artesian

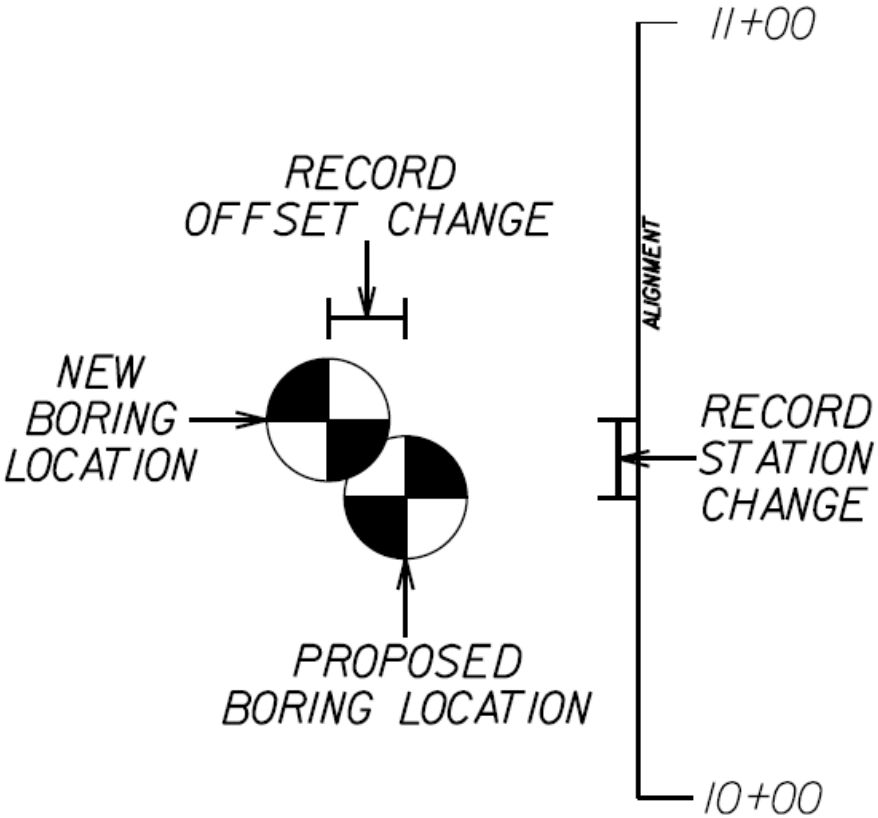
When artesian conditions are encountered in the field, they should be noted on the boring logs.



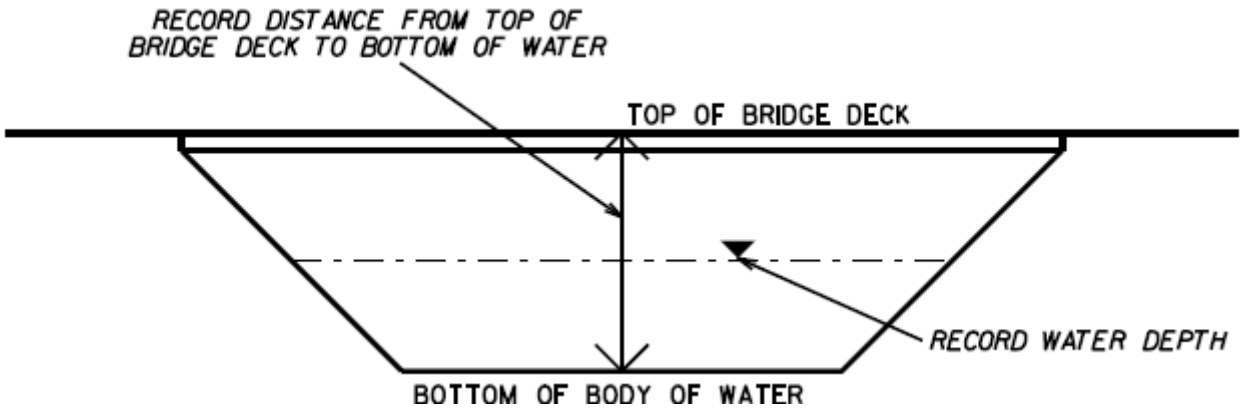
What to Do When a Boring is Added or Moved

Every field professional must carry cross sections and plans for the project





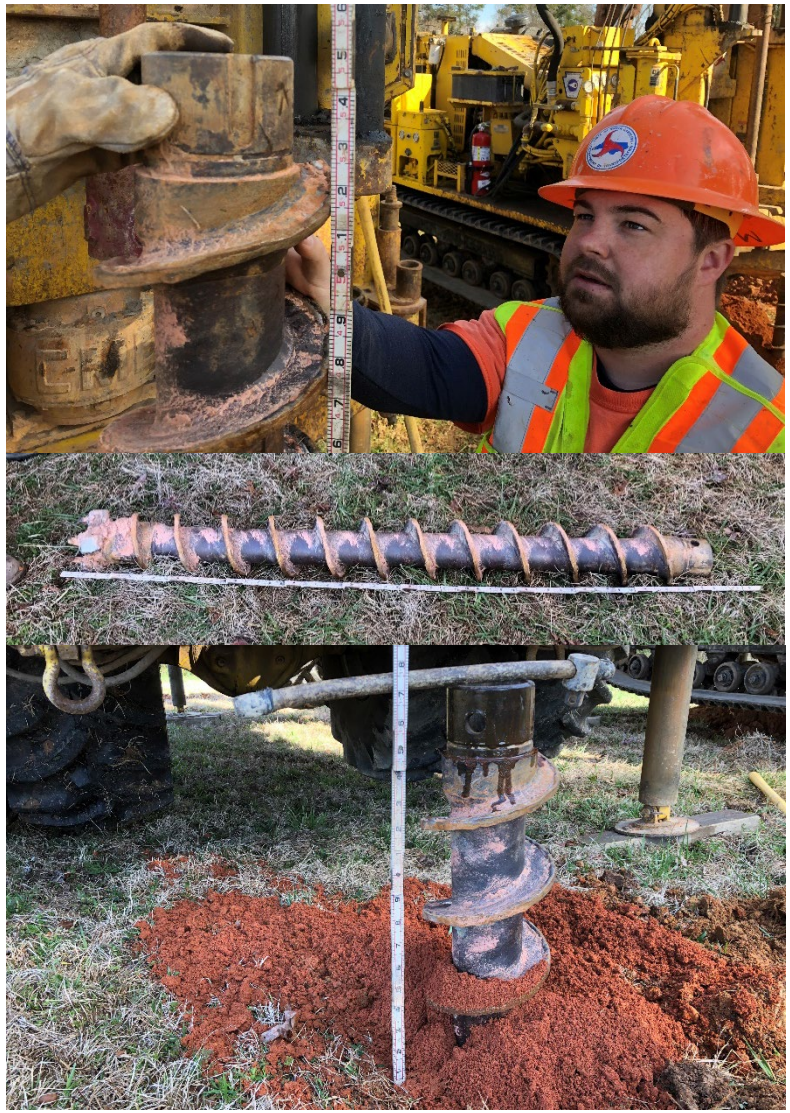
Drilling Through a Bridge Deck



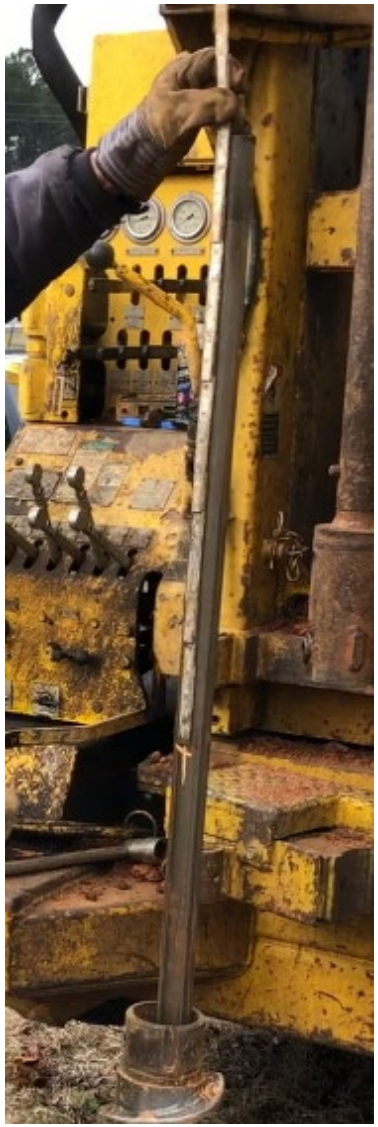
DO NOT DRILL THROUGH CORED SLABS OR BOX BEAM BRIDGE DECKS WITHOUT PRIOR APPROVAL FROM NCDOT

https://www.forconstructionpros.com/pavement-maintenance/preservation-maintenance/article/12070735/cold-patch-helps-heat-up-asphalt-repairs

Measuring Stick-Up to Calculate Initial Sample Depth



Running and Recording the Standard Penetration Test

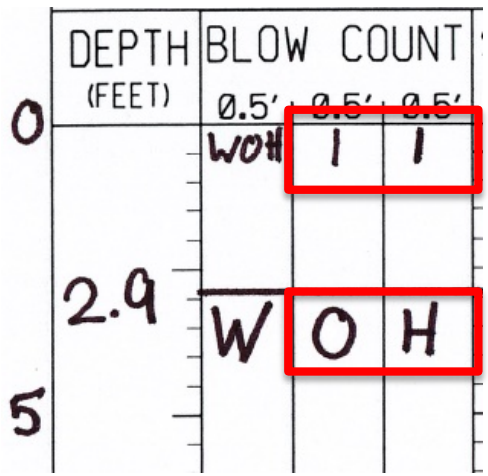


Lead = 5.5’ Stick up = 2.5’
First drive is at 3.0’

Sampler (2.8’)+ rod (5.0’)=7.8

Running and Recording the Standard Penetration Test

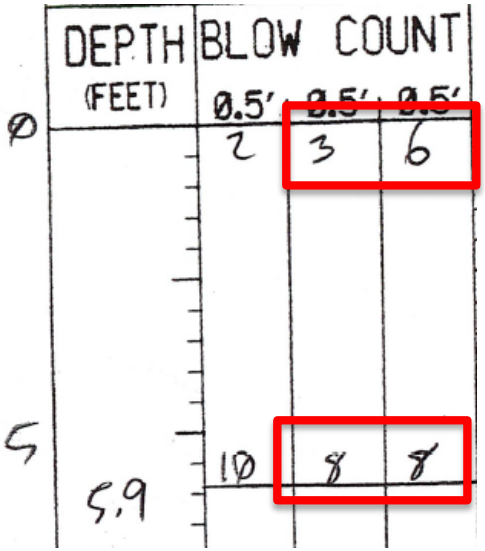
Running and Recording the Standard Penetration Test



N=2

N=0

The last foot is the N-value



N=9

N=16

Describing Soils

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 #40 #200	50 MX 30 MX 15 MX	50 MX 25 MX	51 MN 10 MX	35 MX	35 MX	35 MX	35 MX	36 MN	36 MN	36 MN	36 MN	GRANULAR SOILS	SILT-CLAY SOILS	MUCK, PEAT
MATERIAL PASSING #40 LL PI	— 6 MX		— NP	40 MX 10 MX	41 MN 10 MX	40 MX 11 MN	41 MN 11 MN	40 MX 10 MX	41 MN 10 MX	40 MX 11 MN	41 MN 11 MN	SOILS WITH LITTLE OR MODERATE AMOUNTS OF ORGANIC MATTER		HIGHLY ORGANIC SOILS
GROUP INDEX	0		0	0		4 MX		[illegible]	[illegible]	16 MX	NO MX			
USUAL TYPES OF MAJOR MATERIALS	STONE FRAGS. GRAVEL, AND SAND		FINE SAND	SILTY OR CLAYEY GRAVEL AND SAND				SILTY SOILS		CLAYEY SOILS				
GEN. RATING AS SUBGRADE	EXCELLENT TO GOOD							FAIR TO POOR				FAIR TO POOR	POOR	UNSUITABLE

PI OF A-7-5 SUBGROUP IS ≤ LL - 30 ; PI OF A-7-6 SUBGROUP IS > LL - 30

PERCENTAGE OF MATERIAL

ORGANIC MATERIAL	GRANULAR SOILS	SILT - CLAY SOILS
TRACE OF ORGANIC MATTER	2 - 3%	3 - 5%
LITTLE ORGANIC MATTER	3 - 5%	5 - 12%
MODERATELY ORGANIC	5 - 10%	12 - 20%
HIGHLY ORGANIC	> 10%	> 20%

OTHER MATERIAL	
TRACE	1 - 10%
LITTLE	10 - 20%
SOME	20 - 35%
HIGHLY	35% AND ABOVE

Examples:

CP, gray, soft, silty clay (A-7-6) with trace lignite (Black Creek Formation)

Residual, orange-tan, medium dense, silty sand (A-2-4) with trace mica

Encountering Contaminated Soils

When drilling operations encounter any abnormal conditions that indicate the presence of hazardous, contaminated or toxic material, such operations shall be discontinued immediately and the GeoEnvironmental section of GEU shall be contacted.

NCDOT Standard Specifications for Roads and Structures, January 2018, Section 107-25

Contact:
Cyrus Parker, L.G., P.E.
cfparker1@ncdot.gov
(919) 707-6868

Then contact the project manager and make him/her aware of the possibility of contaminates.

https://www.goldfm.co.nz/general/residents-warned-about-contaminated-soil

Advancing the Borehole

Example:

Next drive at 28.4’

Drill chatter at -1.3’

Assumed contact at 27.1’

Weathered Rock & SPT Refusal Blow Counts

- When 100 blows are applied to the sampler and less than 1.0’ of penetration is accomplished, record the number of blows and the penetration achieved to the nearest 0.1’ (i.e. 99/1.0’ or 100/0.9’)

- SPT Refusal is defined as ≤0.1’ of penetration less after 60 hammer blows.
  The exception is Coastal Plain or Triassic borings

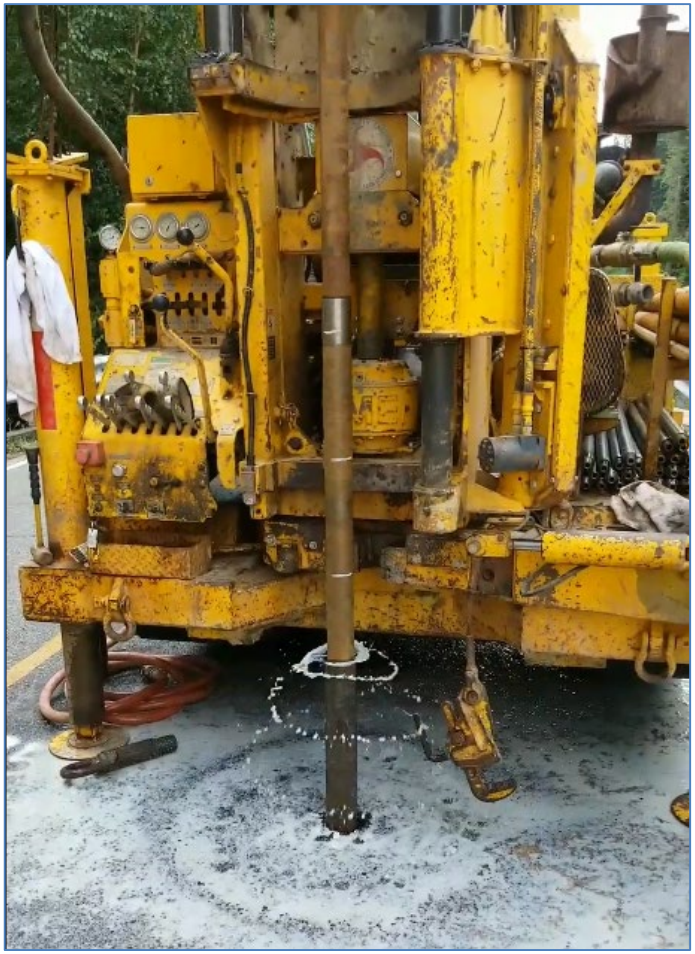
- In Coastal Plain sedimentary rock, SPT refusal is defined as 0.1’ of penetration or less after 60 hammer blows **within the first 0.1’**. After 0.1’ has been penetrated, 100 blows must be achieved. If after the first 0.5’ of penetration, 100 blows has not been achieved, then blow counts start over at 1 and continue until 100.

Rock Core Logging

Christina M. Bruinsma, LG

April 10, 2019

Before Coring



- Measure core barrel
- Measure stickup
- Confirm rock depth*
- Mark your 1 foot increments

*If you begin coring at 60/0.1' penetration, the beginning of the run is at the bottom of the spoon sample!

Coring Tools

Typical core barrels in geotechnical engineering are:

- N-size (2” diameter core) or H-size (3” diameter core)
- Conventional or Wireline (pictured above)
- Solid barrel or split inner barrel (pictured above)
- Series core bit based on hardness of rock in area
  i.e. Series 2, Series 6 (most common), Series 10

During Coring Drilling Observations

What this tells you about the rock below:

Drilling water color → Color can indicate weathering i.e. white vs. brown

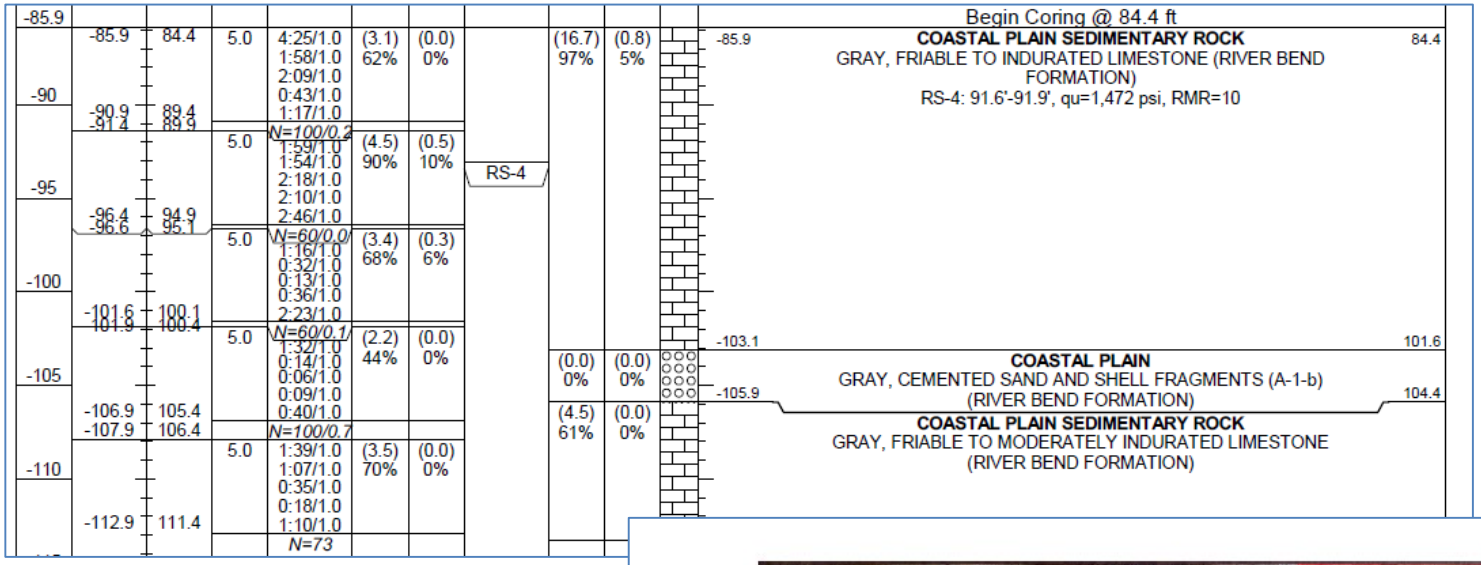
Circulation Loss → Could indicate large or frequent fracturing

"Blocking off" → Could indicate clay or high angled fracturing

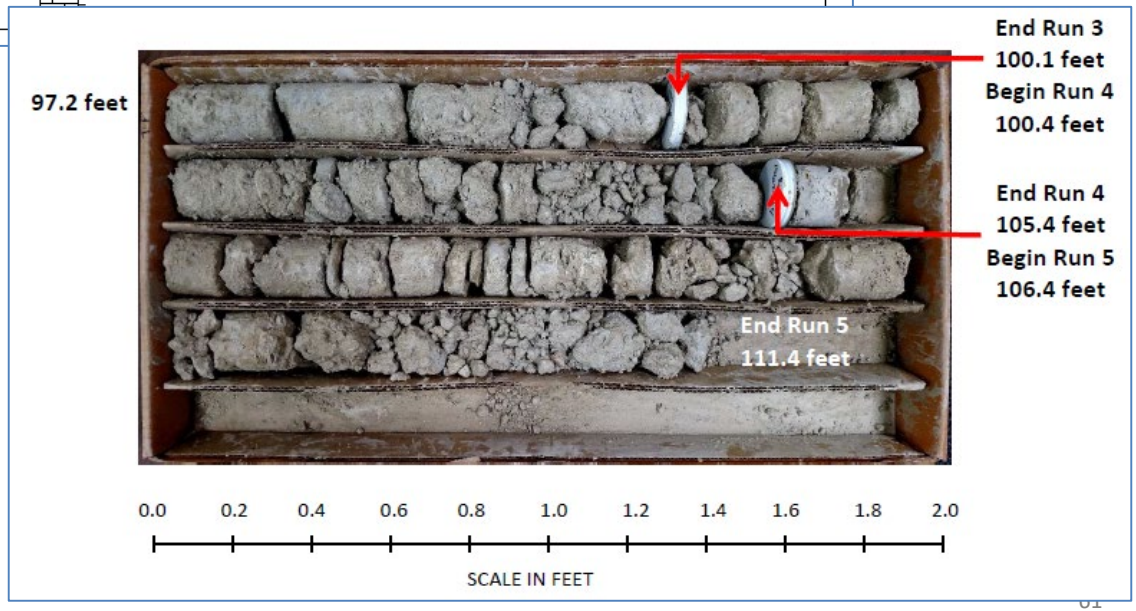
Drilling times → Fast times could mean weathered seams, or bit issues.

*Talk to your drillers about down pressure, water pressure, or drilling conditions. They may have insight from how their equipment is working that can help!

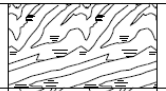
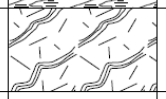
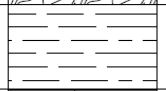
When to SPT Between Core Runs



- Coastal Plain Rock
- Weathered rock/soil seams in Piedmont
- Roadway Embankment, artificial fill, colluvial or alluvial boulders in Mountains



Rock Description

ROCK DESCRIPTION		
HARD ROCK IS NON-COASTAL PLAIN MATERIAL THAT WOULD YIELD SPT REFUSAL IF TESTED. AN INFERRED ROCK LINE INDICATES THE LEVEL AT WHICH NON-COASTAL PLAIN MATERIAL WOULD YIELD SPT REFUSAL. SPT REFUSAL IS PENETRATION BY A SPLIT SPOON SAMPLER EQUAL TO OR LESS THAN 0.1 FOOT PER 60 BLOWS IN NON-COASTAL PLAIN MATERIAL. THE TRANSITION BETWEEN SOIL AND ROCK IS OFTEN REPRESENTED BY A ZONE OF WEATHERED ROCK. ROCK MATERIALS ARE TYPICALLY DIVIDED AS FOLLOWS:		
WEATHERED ROCK (WR)		NON-COASTAL PLAIN MATERIAL THAT WOULD YIELD SPT N VALUES > 100 BLOWS PER FOOT IF TESTED.
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.

Rock Description - Weathering

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 ROCK EXCEPT QUARTZ DISCOLORED OR STAINED. ROCK FABRIC CLEAR AND EVIDENT BUT REDUCED IN STRENGTH TO STRONG SOIL. IN GRANITOID ROCKS ALL FELDSPARS ARE KAOLINIZED TO SOME EXTENT. SOME FRAGMENTS OF STRONG ROCK USUALLY REMAIN. *IF TESTED, WOULD YIELD SPT N VALUES > 100 BPF*
VERY SEVERE (V SEV.)	ALL ROCK EXCEPT QUARTZ DISCOLORED OR STAINED. ROCK FABRIC ELEMENTS ARE DISCERNIBLE BUT MASS IS EFFECTIVELY REDUCED TO SOIL STATUS, WITH ONLY FRAGMENTS OF STRONG ROCK REMAINING. SAPROLITE IS AN EXAMPLE OF ROCK WEATHERED TO A DEGREE THAT ONLY MINOR VESTIGES OF ORIGINAL ROCK FABRIC REMAIN. *IF TESTED, WOULD YIELD 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 Description - Weathering

Moderately severely weathered

Severely weathered (Weathered Rock)

Very Severely weathered (Soil, A-4, often this material is not recovered)

slightly weathered

Fresh

Very slightly weathered

Rock Description - Hardness

ROCK HARDNESS	
VERY HARD	CANNOT BE SCRATCHED BY KNIFE OR SHARP PICK. BREAKING OF HAND SPECIMENS REQUIRES SEVERAL HARD BLOWS OF THE GEOLOGIST'S 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 GEOLOGIST'S 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 GEOLOGIST'S 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.

Keep your rock hammer and knife handy to perform scratch tests on rock core.

Rock Description
Fracture Spacing

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 FOOT
VERY CLOSE	LESS THAN 0.16 FEET

Double line hash mark indicates "mechanical break"

Rock Description
Bedding

BEDDING

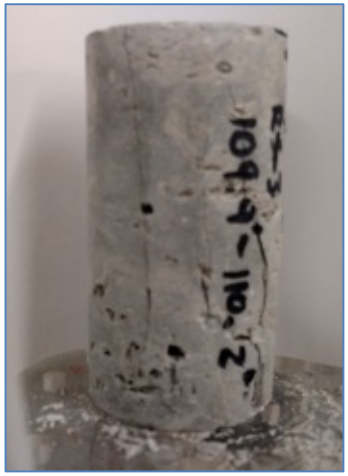
TERM	THICKNESS
VERY THICKLY BEDDED	4 FEET
THICKLY BEDDED	1.5 - 4 FEET
THINLY BEDDED	0.16 - 1.5 FEET
VERY THINLY BEDDED	0.03 - 0.16 FEET
THICKLY LAMINATED	0.008 - 0.03 FEET
THINLY LAMINATED	< 0.008 FEET

Rock Description
Induration

INDURATION

FOR SEDIMENTARY ROCKS, INDURATION IS THE HARDENING OF 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.



Rock Description on Logs

- Origin (WR, CR, NCR, CP Rock)
- Color (keep it fairly simple)
- Weathering (all rock)
- Hardness (all rock)
- Fracture Spacing (all rock)
- Bedding (NCR, CP Rock)
- Induration (NCR, CP Rock)
- Rock type (all rock)

For weathered rock, only give full rock description if material was recovered. No recovery can just be marked as WR: and color and type of rock. Recovery can be recorded, but **RQD will be N/A.**

Rock Core Recovery (REC)

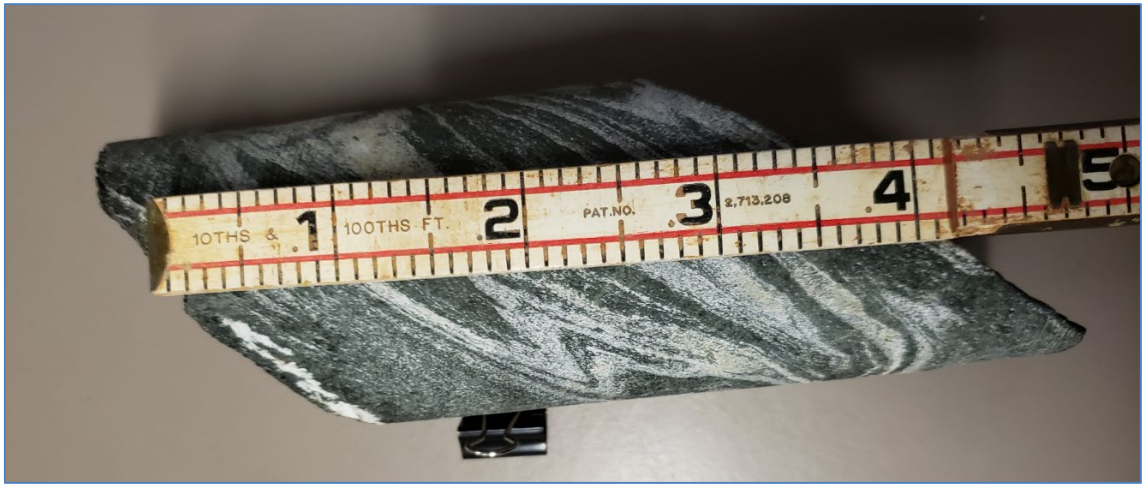
$$CR = \frac{total\ length\ of\ core\ recovered}{total\ length\ of\ core\ run} \times 100\%$$

Measure total amount of recovery over length of run.

Be aware, sometimes rock can slip out of the barrel. Check times and rock quality to be sure.

Rock Quality Designation (RQD)

$$RQD = \frac{\sum \text{length of sound pieces} > 4 \text{ inches}}{\text{Total length of core run}} \times 100\%$$



Measure from midpoint to midpoint of fracture. Make sure breaks are natural.

This is considered a full piece, since the breaks observed were mechanical.

Strata Recovery and RQD

$$CR = \frac{total\ length\ of\ core\ recovered}{total\ length\ of\ core\ run} \times 100\%$$

$$RQD = \frac{\sum length\ of\ sound\ pieces > 4\ inches}{Total\ length\ of\ core\ run} \times 100\%$$

Strata Recovery is the overall measurement of recovery divided by the strata length.

Strata RQD is the total amount of sound pieces divided by the strata length.

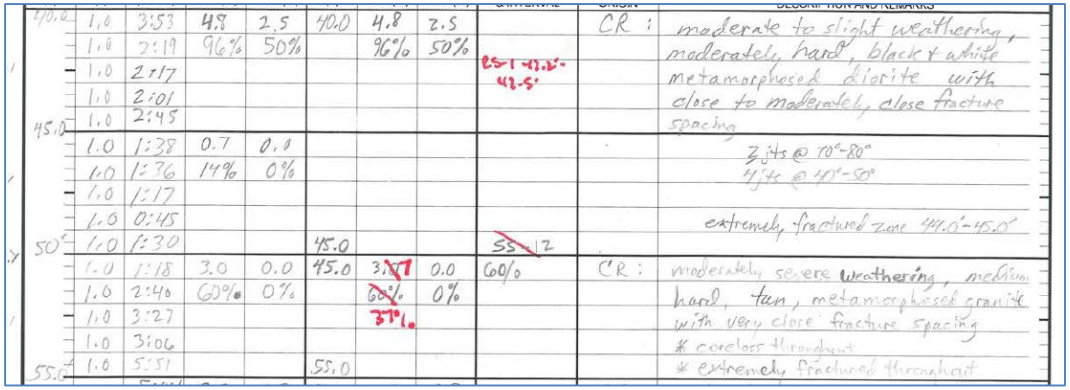
Table 4-12 Rock quality based on *RQD* (from Deere and Deere, 1988).

RQD	Rock Mass Quality
0 – 25	Very Poor
25 – 50	Poor
50 – 75	Fair
75 – 90	Good
90-100	Excellent

Strata RQD is often used to determine coring termination.

FHWA NHI-16-072
GEOTECHNICAL SITE CHARACTERIZATION GEOTECHNICAL ENGINEERING CIRCULAR NO.5
https://www.fhwa.dot.gov/engineering/geotech/pubs/nhi16072.pdf

Core Hole Logging



40.0	1.0	3:53	4.8	2.5	40.0	4.8	2.5		CR :	moderate to slight weathering,
	1.0	2:19	96%	50%		96%	50%			moderately hard, black & white
	1.0	2:17						RS-1 42.2-42.5'		metamorphosed diorite with
	1.0	2:01								close to moderately close fracture
45.0	1.0	2:45								spacing
	1.0	1:38	0.7	0.0						2 jts @ 70°-80°
	1.0	1:36	14%	0%						4 jts @ 40°-50°
	1.0	1:17								
	1.0	0:45								extremely fractured zone 44.0'-45.0'
50	1.0	1:30			45.0			~~55~~ 12		
	1.0	1:18	3.0	0.0	45.0	3.~~77~~	0.0	60%	CR :	moderately severe weathering, medium
	1.0	2:40	60%	0%		~~60%~~ 37%	0%			hard, tan, metamorphosed granite
	1.0	3:27								with very close fracture spacing
	1.0	3:06								* core loss throughout
55.0	1.0	5:51			55.0					* extremely fractured throughout

Rock Core Box Labeling

LID

B1-B

tape

45678.1.1 (B-1234)
WAKE CO.
Brdg #99 on SR 2345 over Mud Ck

(Run 3 continued from Box 1)
Run 3: 39.4 - 42.5

Run 4: 42.5 - 47.5

Run 5: 47.5 - 52.5

(Run 5 continued in Box 3)

tape

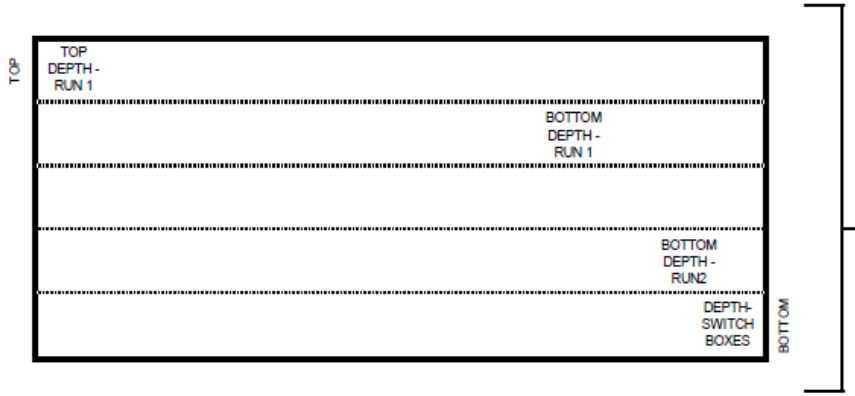
Box 2 of 3

ENDS OF TOP AND BOTTOM

COMPANY	45678.1.1 (B-1234)	PROPERTY	Wake, #99
HOLE NO.	B1-B	BOX NO.	2 of 3
FROM	40.3	TO	50.1

*This blank space can be used to label firm name or project geo. and month/yr.

****REMEMBER TO LABEL "TOP" AND "BOTTOM" ON ENDS OF BOTTOM BOX**



Place core into box from top right corner to left bottom, which will allow the boxes to be stacked for photographing and the core can be viewed from left to right from start to finish.

Sampling and Boring Termination

Nick Moore, GIT

April 10, 2019

Outline

- **Importance of Appropriate Sampling**
- **Background**
  1. Stratigraphic Rules
  2. Soil Origins
  3. Geotechnical Implications of Different Origins
- **Sampling Criteria and Methods**
  1. Quality
  2. Moisture Content
  3. Organic Content
  4. Percentage of Other Material
  5. California Bearing Ratio (CBR)
  6. Shelby Tubes (ST)
  7. Rock Core
  8. Roadway vs. Structures
- **Boring Termination Criteria**
  1. When to Terminate a Borehole
  2. Boring Termination Statement

Importance of Appropriate Sampling

Job of Field Professional:

1. Take accurate and concise notes
2. Determine when, where, and what to sample
3. Determine borehole termination depth

Importance:

- Integral part of the planning, design, construction, and maintenance of bridges, roadways, and other transportation facilities
- Field conditions are often complex
  - Field Professional is engaged in project
- Saves time and money
  - Not oversampling competent soils
  - Not under sampling poor soils
  - Can prevent re-drilling
  - Can prevent cost overruns during construction

- Better quality data = better engineering design

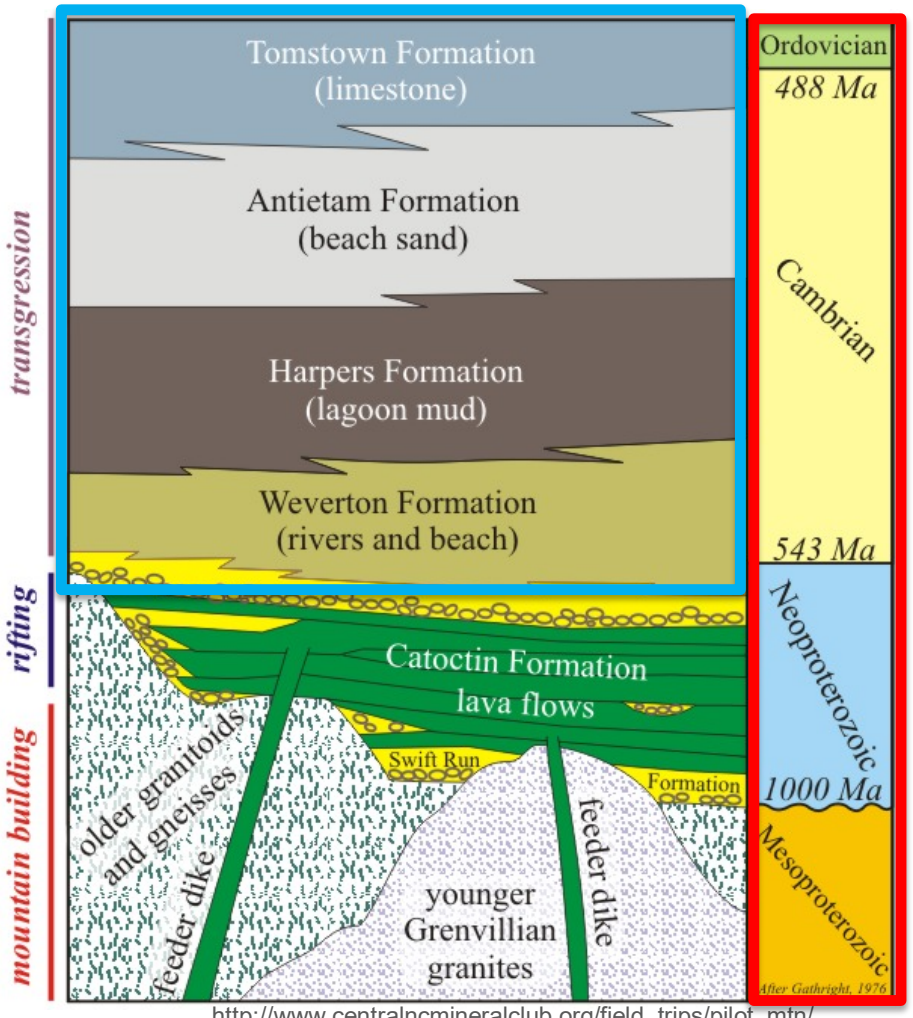
Stratigraphic Rules

Law of Original Horizontality

"…sediments are deposited strata that are horizontal or nearly horizontal." (Skinner and Porter, 200)

Principle of Stratigraphic Superposition

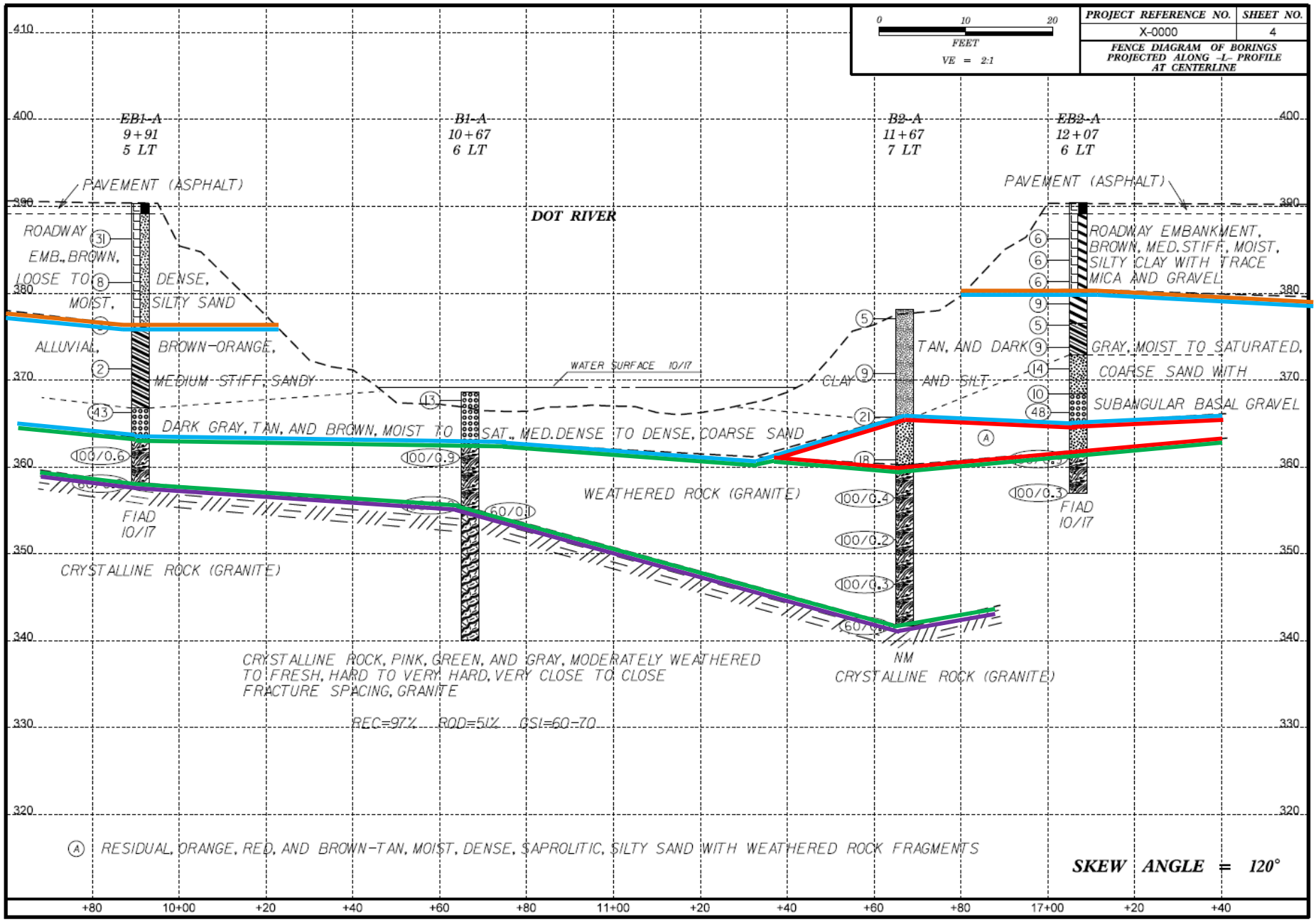
"…in any succession of strata, not subsequently disturbed or overturned since deposition, younger rocks lie above older rocks." (Boggs Jr., 451)



http://www.centralncmineralclub.org/field_trips/pilot_mtn/

Skinner, Brian J., and Stephen C. Porter. Geologic Time. *The Dynamic Earth: An Introduction to Physical Geology*, Fourth Edition. New York: John Wiley & Sons, Inc., 2000. Print.

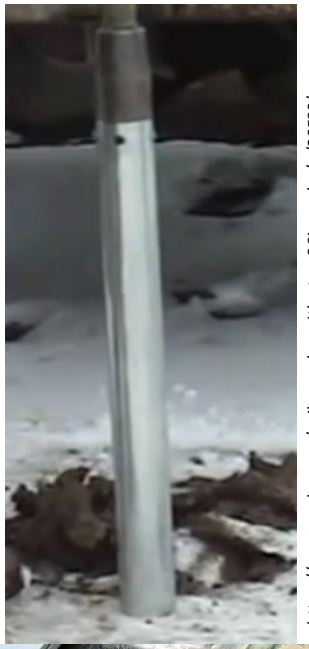
Boggs Jr., Sam. *Principles of Sedimentology and Stratigraphy*, Third Edition. New Jersey: Prentice-Hall, Inc., 2001. Print.


0 10 20
FEET
VE = 2:1
PROJECT REFERENCE NO.
X-0000
SHEET NO.
4
FENCE DIAGRAM OF BORINGS PROJECTED ALONG -L- PROFILE AT CENTERLINE
EB1-A
9+91
5 LT
B1-A
10+67
6 LT
B2-A
11+67
7 LT
EB2-A
12+07
6 LT
PAVEMENT (ASPHALT)
DOT RIVER
ROADWAY EMB., BROWN, LOOSE TO DENSE, MOIST, SILTY SAND
ALLUVIAL, BROWN-ORANGE, MEDIUM STIFF, SANDY
WATER SURFACE 10/17
DARK GRAY, TAN, AND BROWN, MOIST TO SAT., MED.DENSE TO DENSE, COARSE SAND
WEATHERED ROCK (GRANITE)
CRYSTALLINE ROCK (GRANITE)
FIAD 10/17
TAN, AND DARK CLAY AND SILT
ROADWAY EMBANKMENT, BROWN, MED.STIFF, MOIST, SILTY CLAY WITH TRACE MICA AND GRAVEL
GRAY, MOIST TO SATURATED, COARSE SAND WITH SUBANGULAR BASAL GRAVEL
NM
CRYSTALLINE ROCK, PINK, GREEN, AND GRAY, MODERATELY WEATHERED TO FRESH, HARD TO VERY HARD, VERY CLOSE TO CLOSE FRACTURE SPACING, GRANITE
REC=97% RQD=51% GSI=60-70
(A) RESIDUAL, ORANGE, RED, AND BROWN-TAN, MOIST, DENSE, SAPROLITIC, SILTY SAND WITH WEATHERED ROCK FRAGMENTS
SKEW ANGLE = 120°
410
400
390
380
370
360
350
340
330
320
+80
10+00
+20
+40
+60
+80
11+00
+20
+40
+60
+80
17+00
+20
+40

Origin	Geotechnical Implications
Roadway Embankment	Generally acceptable material, can be highly plastic
Artificial Fill	Likely uncompacted and uncontrolled material
Colluvial	Unstable, unconsolidated, poorly-sorted, can trap water
Alluvial	Under-consolidated, typically has low density, can have high moisture and organic content, can be highly plastic
Undivided Coastal Plain/Coastal Plain	Shrinkage, can have low density, can be highly plastic, moisture content
Triassic Residual	Shrink/swell, can be highly plastic
Residual	Low blow counts are a concern in areas of high embankment, can be highly plastic, can have high mica content
Weathered Rock	Problematic if above proposed grade, can have perched water table
Non-Crystalline Rock	Triassic non-crystalline rock can degrade when in contact with water, areas of limestone can form dissolution voids
Crystalline Rock	Problematic if within 6 feet of proposed grade, can have perched water table, can cause higher project costs

Sampling Methods

Field Professional's Tool Box



https://www.youtube.com/watch?v=6HWi6iZKciU

https://www.amleo.com/soil-sampler-with-step-36in-probe/p/36FSS/

Sampling Criteria

Decisions must be made in the field to ensure that an adequate number of borings and in situ testing are performed to determine the site engineering properties.

Quality

AASHTO Classification											
A-1-a	A-1-b	A-3	A-2-4	A-2-5	A-2-6	A-2-7	A-4	A-5	A-6	A-7-5	A-7-6
Coarse Sand		Fine Sand	Silty Sand		Clayey Sand		Sandy Silt	Clayey Silt	Sandy Clay	Silty Clay	

Sample numbering should be sequential throughout project

Criteria:

- Classify all soils on project using AASHTO designation
- Cohesive soils
  - Increase frequency for soils with high clay content and/or high plasticity, especially for surficial soils or soils at proposed subgrade

Method:

- Collect representative sample in zip-lock bag
  - Bottom 1.5' in split spoon
- Label bag with date, TIP #, boring number, sample #, and sample depth

Moisture Content

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) PL — PLASTIC LIMIT	- WET - (W)	SEMISOLID; REQUIRES DRYING TO ATTAIN OPTIMUM MOISTURE
OM — OPTIMUM MOISTURE SL — SHRINKAGE LIMIT	- MOIST - (M)	SOLID; AT OR NEAR OPTIMUM MOISTURE
	- DRY - (D)	REQUIRES ADDITIONAL WATER TO ATTAIN OPTIMUM MOISTURE

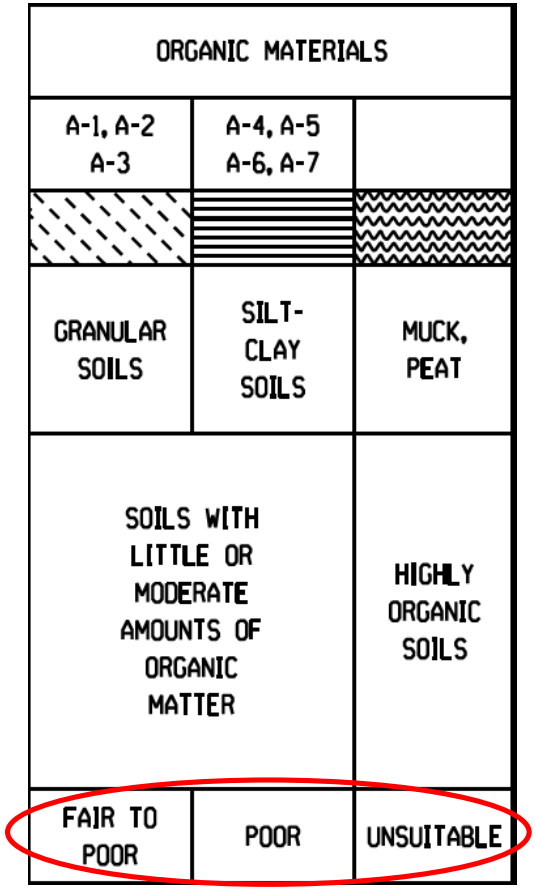
Criteria:

- Collected in fine-grained, cohesive soils
  - Minimal moisture sample for granular soils
- Important to collect for soils at-grade or within 3' of grade
  - Especially wet-saturated soils

Method:

- Collect representative sample from split spoon or hand auger and fill moisture can
- Seal moisture can with tape while in the field
- Glass and/or metal containers are acceptable
- Label moisture container with date, TIP #, boring number, sample #, and sample depth
- Needs a corresponding quality sample (e.g. SS-5 and M-5)

Organic Content



Problematic for construction

PERCENTAGE OF MATERIAL

ORGANIC MATERIAL	GRANULAR SOILS	SILT - CLAY SOILS
TRACE OF ORGANIC MATTER	2 - 3%	3 - 5%
LITTLE ORGANIC MATTER	3 - 5%	5 - 12%
MODERATELY ORGANIC	5 - 10%	12 - 20%
HIGHLY ORGANIC	> 10%	> 20%

OTHER MATERIAL	
TRACE	1 - 10%
LITTLE	10 - 20%
SOME	20 - 35%
HIGHLY	35% AND ABOVE

Criteria:

- Collected when material is classified >3% by weight in soil regardless of AASHTO classification
  - All suspected muck or peat soils should be submitted for organic test

Methods:

- Collect representative sample in container
  - Bottom 1.5' in split spoon
- Label with date, TIP #, boring number, sample #, and sample depth
- Needs a corresponding quality sample (e.g. SS-8 and O-8)

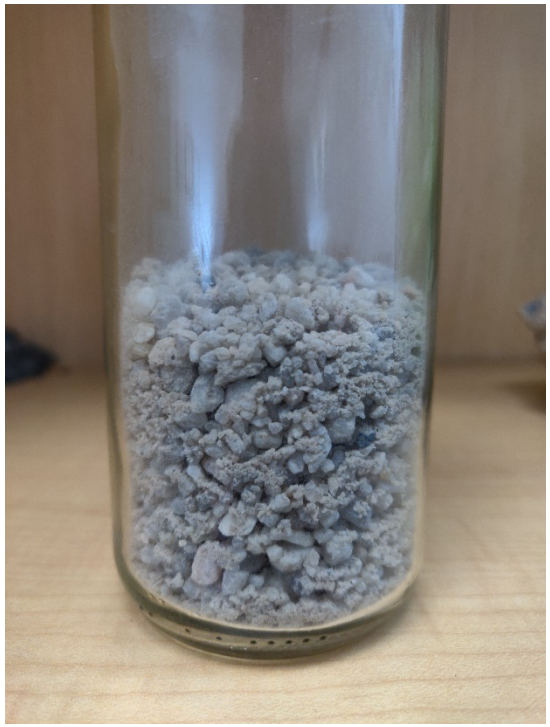
Sampling Criteria: Percentage of Other Material

PERCENTAGE OF MATERIAL

ORGANIC MATERIAL	GRANULAR SOILS	SILT - CLAY SOILS
TRACE OF ORGANIC MATTER	2 - 3%	3 - 5%
LITTLE ORGANIC MATTER	3 - 5%	5 - 12%
MODERATELY ORGANIC	5 - 10%	12 - 20%
HIGHLY ORGANIC	> 10%	> 20%

OTHER MATERIAL	
TRACE	1 - 10%
LITTLE	10 - 20%
SOME	20 - 35%
HIGHLY	35% AND ABOVE

Micaceous soils:
Planar mineral habit facilitates water transport and slope failure



Coarse Sand with trace gravel:
Compacts well

Sampling Criteria: CBR

Large-scale representation of cut sections and for Pavement design support

Criteria:

- Collected in cut or at-grade sections
  - 1 sample to represent every major soil type to be used at subgrade

Method:

- Collect ~ 75 lbs. of material from auger cuttings
- Label with date, TIP #, boring number, sample #, and sample depth
- CBR have their own successive numbers independent of quality samples

Sampling Criteria: Shelby Tube (ST)

Triaxial and consolidation testing

Criteria: (Coastal Plain and Piedmont)

- 1 ST per 10' of cohesive material <15 BPF within 20' of ground surface (typically for bridge approaches and large embankments)

Criteria: (Mountains)

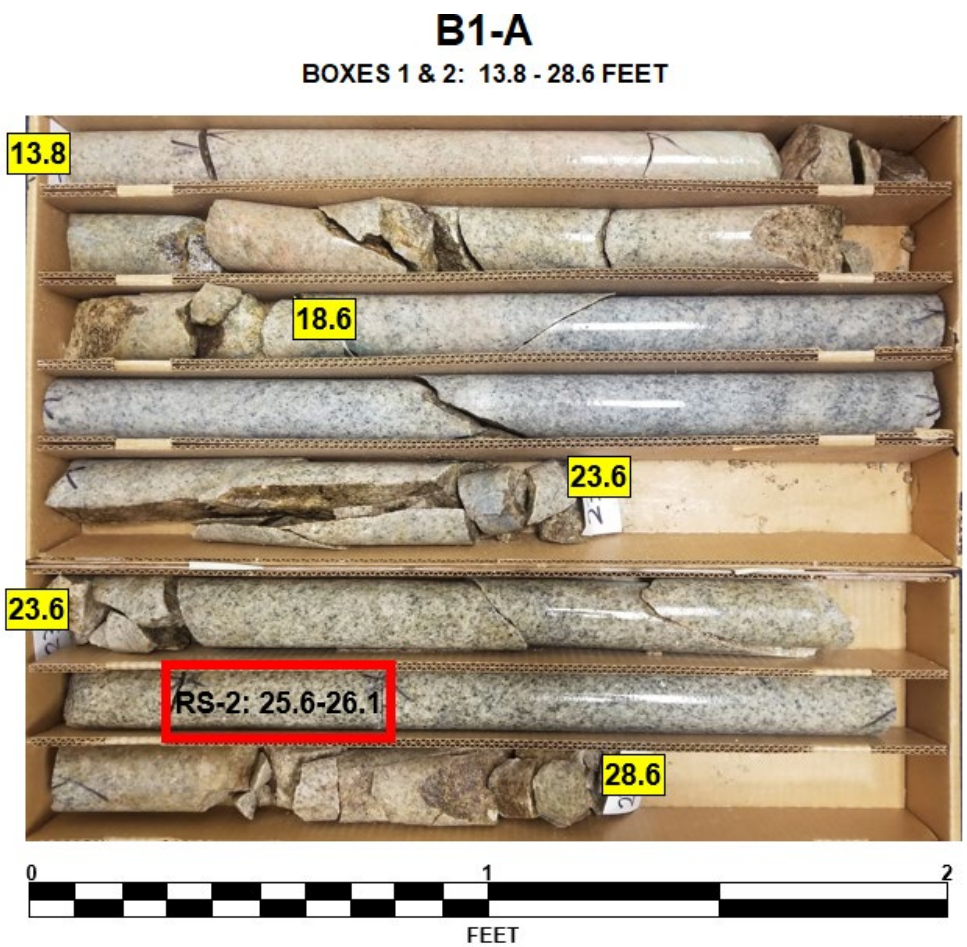
- 1 ST per 10' of any wet or saturated <3 BPF within 20' of ground surface (proposed embankments)

Method:

- Always run clean-out tube prior to pushing sample tube
- Continuous push
- Seal with wax at top and bottom
- Fill with material to prevent disturbance
- Store and transport in upright position
- Do NOT expose to extreme heat/cold
- ST have their own successive numbers independent of quality samples

Sampling Criteria Rock Core Sampling

Provides unconfined compressive strength



Core Photograph

- Spray water on core to reveal true colors
- Lay core box flat and take photo from directly above
- Photo needs to be scalable
- Mark sample area and run depths on photo

Choosing Samples

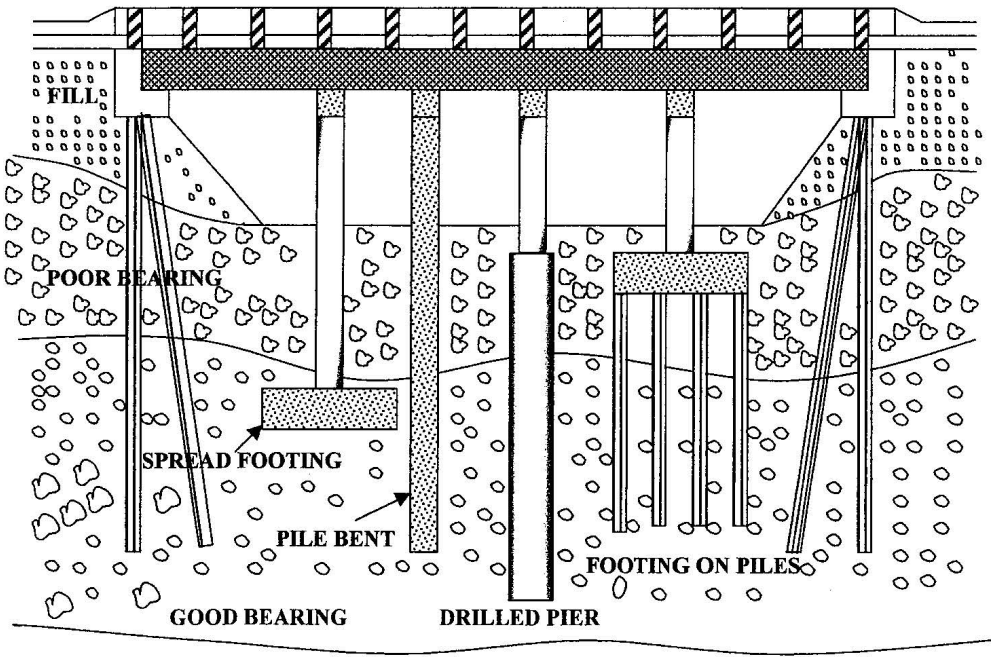
- Select a competent representative sample with a length that is twice the diameter
- Attempt to test samples within the rock socket for drill shafts, especially near the probable tip elevation
- RS have their own successive numbers independent of quality samples

Sampling: Roadway vs. Structures

Roadway	Structures
Quality -AASHTO -Provides PI and LL	Rock Core -Young's Modulus -Unconfined compressive strength
Moisture content	Quality -AASHTO
Organic Content	Organic Content
Shelby Tube -Triaxial Consolidated Undrained -Consolidation	Shelby Tube -Triaxial Consolidated Undrained -Consolidation
California Bearing Ratio (CBR) -For pavement design support	Recompacted Triaxial (RT) -For remolded strength of soil
Vane Shear Test (VST) -Undrained shear strength of soils	Proctor -Maximum dry density and optimum moisture
Cone Penetration Test (CPT) -Density, friction, and pore pressure	

*Testing methods should be determined on a case by case basis.

Boring Termination Criteria



- No exact recipe for termination
- Requires sound geotechnical judgement by Field Professional based on:
  - Knowledge of engineering design criteria
  - Engineering properties of soil and rock

Do NOT terminate in:

- Muck and highly organic material
- WOH/WOR material
- Substantially decreasing blow count material

Borehole Termination Criteria: Bridges

NORTH CAROLINA DEPARTMENT OF TRANSPORTATION
GEOTECHNICAL ENGINEERING UNIT
Estimated Driven Pile Axial Resistance Table

SPT-N	Estimated Resistance (tons/ft)		SPT-N	Estimated Resistance (tons/ft)		SPT-N	Estimated Resistance (tons/ft)	
(bpf)	HP 12 x 53 Steel Piles	12" P/S Concrete Piles	(bpf)	HP 12 x 53 Steel Piles	12" P/S Concrete Piles	(bpf)	HP 12 x 53 Steel Piles	12" P/S Concrete Piles
1			44	10.34	12.86	87	39.10	49.72
2			45	10.71	13.24	88	40.71	51.51
3			46	10.98	13.64	89	42.40	53.38
4			47	11.25	14.06	90	44.17	55.32
5	1.00	0.96	48	11.54	14.52	91	46.03	57.34
6	1.13	1.17	49	11.84	15.00	92	47.97	59.44
7	1.24	1.41	50	12.16	15.52	93	50.01	61.62
8	1.36	1.59	51	12.50	15.79	94	52.14	63.88
9	1.49	1.76	52	12.86	16.36	95	54.37	66.23
10	1.62	1.94	53	13.24	16.98	96	56.69	68.66
11	1.76	2.12	54	13.43	17.65	97	59.12	71.19
12	1.91	2.34	55	13.85	18.00	98	61.66	73.82
13	2.07	2.57	56	14.29	18.37	99	64.31	76.54
14	2.25	2.81	57	14.52	18.75	100	67.08	79.36
15	2.48	3.10	58	15.00	19.57			
16	2.73	3.45	59	15.25	20.00			
17	2.95	3.70	60	15.79	20.45			
18	3.21	4.00	61	16.07	20.93			
19	3.46	4.29	62	16.67	21.95			
20	3.67	4.57	63	16.98	22.50			
21	3.91	4.84	64	17.65	23.08			
22	4.13	5.14	65	18.00	23.68			
23	4.39	5.49	66	18.37	24.32			
24	4.62	5.70	67	19.15	25.00			
25	4.86	6.00	68	19.57	26.47			
26	5.14	6.43	69	20.45	27.27			
27	5.42	6.72	70	20.93	28.13			
28	5.70	7.03	71	21.95	29.03			
29	6.00	7.38	72	22.50	30.00			
30	6.29	7.69	73	23.08	30.83			
31	6.52	8.11	74	23.68	31.85			
32	6.87	8.26	75	25.00	32.92			
33	7.14	8.57	76	25.71	34.03			
34	7.44	9.00	77	26.47	35.19			
35	7.69	9.28	78	27.27	36.39			
36	8.04	9.68	79	29.03	37.64			
37	8.33	10.00	80	30.00	38.95			
38	8.57	10.34	81	30.90	40.31			
39	9.00	10.84	82	32.11	41.73			
40	9.18	11.25	83	33.37	43.20			
41	9.47	11.54	84	34.70	44.73			
42	9.78	12.00	85	36.09	46.33			
43	10.00	12.33	86	37.56	47.99			

References

1. "NCDOT Geotechnical Unit Engineering Analysis Manual", Keane, 1978
2. "Some Practical Aspects of Foundation Studies for Highway Bridges", Harned, 1959

Notes

1. N values less than 5 will be ignored.
2. The required axial resistance should be determined during project initiation, but should not be less than 180 tons plus
   - 2 additional drives or auger refusal in the Piedmont
   - 4 additional drives in the Coastal Plain
3. The original tables presented by Keane did not list factors for N values greater than 80 for HP 12 x 53 steel piles or greater than 72 for 12 inch concrete piles. Factors for N values greater than 80 for HP 12 x 53 piles and N values greater than 72 for 12 inch concrete piles are based on regression analysis and extrapolation of the tables presented by Keane.

Last Updated: 10/2/2015

2. The required axial resistance should be determined during project initiation, but should not be less than 180 tons plus:
   - 2 consecutive 100-blow drives or auger refusal in the Piedmont
   - 4 additional drives in the Coastal Plain

- Only start calculating bearing at Historical Scour Elevation
  - (contact between alluvial soils and residual or formational material)

Borehole Termination Criteria: Rock Core

Termination Criteria is determined by RQD

CORE DEPTHS FOR DRILLED SHAFTS, BASED ON RQD

% RQD	Core to greater of:		
	feet	meters	Diamtr
>75	10 - 15	3.0 - 4.5	4 times
50-75	15 - 20	4.5 - 6.0	6 times
25-50	20 - 25	6.0 - 7.5	8 times
<25	30 - 35	9.0 - 10.5	10 times

DRILL DEPTHS FOR DRILLED SHAFTS W/ 100% SOIL BEARING

Drill to greater of bearing or 10 x diameter.

Boring Termination Statement

Examples:

Boring Terminated at 63.4 ft in Residual (Sandy Silt)

Boring Terminated at 107.4 ft in Coastal Plain, Silty Sand (Black Creek Formation)

Boring Terminated at 47.2 ft with SPT refusal in Crystalline Rock (Chlorite Biotite Schist)

Boring Terminated at 83.4 ft with SPT refusal on Non-Crystalline Rock (Triassic Sandstone)

Boring Terminated at 32.9 ft with Auger and SPT refusal on Crystalline Rock (Amphibolite)

Site Restoration

D. Clayton Elliott, PG

April 10, 2019

Geotechnical Engineering Unit: Site Clean-Up

Backfilling/Abandoning Boreholes

- Typically Backfilled following the 24-Hour Water Level Measurement (but not always, see below).

- Done for safety concerns & to prevent possible contamination of groundwater.

- When a Borehole is left open overnight, or longer, the top of any & all borings MUST be covered in some way; to prevent injury to people & animals.

Think lawsuit. It's bad, mmmkay.

3 Major Issues if a Borehole is NOT Properly Backfilled

- 1) The area around the Borehole may settle excessively, or even cave. And that settlement, can be a safety hazard to humans & animals alike.

- 2) An improperly Backfilled/Sealed Borehole can act as a conduit for water &/or contaminants; either into porous strata at varying depths, or into an aquifer itself. Ideal to restore the Hydrogeological conditions to pre-drill conditions.

- 3) For slope boreholes, water entering the Borehole can affect the slope adversely; possibly encouraging landslide mobility; e.g., increasing of pore pressures.

Prior to Backfill Boreholes

- Borings without Groundwater: backfill with drill cuttings & soil; tamp down the top few feet, top off, tamp again.

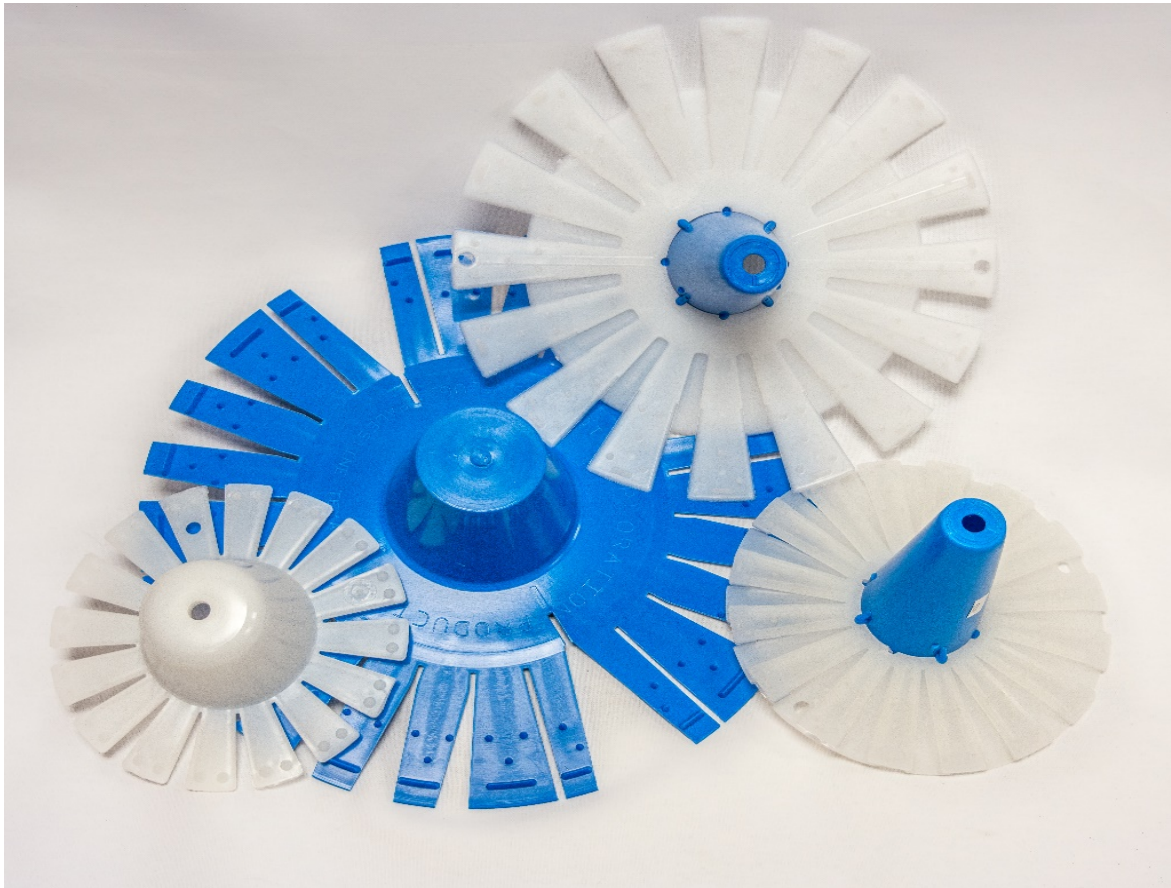
--Do NOT throw trash in the hole!!--

- Borings with Groundwater: backfill with a minimum of 1 foot of Bentonite plug, somewhere above groundwater, but below the collar. Plug should be covered with min. 0.5' to 1.0' of soil to allow for revegetation.

- If actually drilling in/thru inner coastal waters, a lake, or a stream/river, do not attempt to backfill or seal; allow natural material to fill the opening. Basically a no-brainer.

The GeoTech version of a Cow Catcher:

Can be inserted with Drill-Rod: typically 3'-5', cover with Bentonite, then Soil to the top



Encountering Artesian Conditions

- If Artesian conditions encountered & prior to backfill: measure the Artesian Head – add pipe above ground surface (the drill collar) to achieve the Potentiometric Surface: note this on the borelog; that elevation is “artesian”.

- In the Coastal Plain: typically holes are plugged from the bottom-up, with a pre-bagged product called “HolePlug”; push w/ drill-rod, then add more till the last foot, finish with soil.

Encountering Artesian Conditions: Cont'd

- Occasionally: full depth grout is needed to fully plug the hole: with a combination of Portland Cement & Bentonite Powder (not chips or gravels); pumped in through the drill rods or a tremie, from the bottom up, to seal the hole in its entirety.

- Parting word on Artesians: part of the reason to plug an Artesian from **the bottom-up**, a plug only few feet down can be opened up during construction. This can be difficult to plug once that happens.

IF Artesian : Plug from the bottom-up.

IMPORTANT

If some type of contamination is encountered in the borehole:

- **First:** CALL Cyrus Parker, LG, PE w/ the NCDOT Geoenvironmental group: 919.707.6868

- **Second:** call your designated Project Geological Engineer

Do not proceed drilling. Do fill the hole.

Patching Bridge Deck Holes:
Drilling through the Deck

2 primary options to patch said hole:

- 1) Call the local Division/District Bridge Maint. Dept. office to patch on your behalf. Especially if a “Snooper” or a Platform Truck is needed. This depends on Bridge Girder-Web Depths or if it has Arches.

- 2) Patch w/ QuikCrete: using some type of form to hold the patch in place. Allow to set before turning traffic.

Novel Method to Patch Bridge Deck Holes

- Use the smaller version of the Cow-Catcher, carefully push into the hole to fill the cavity: backfill w/ Quikcrete, or some other approved material, plug the hole. Let set.

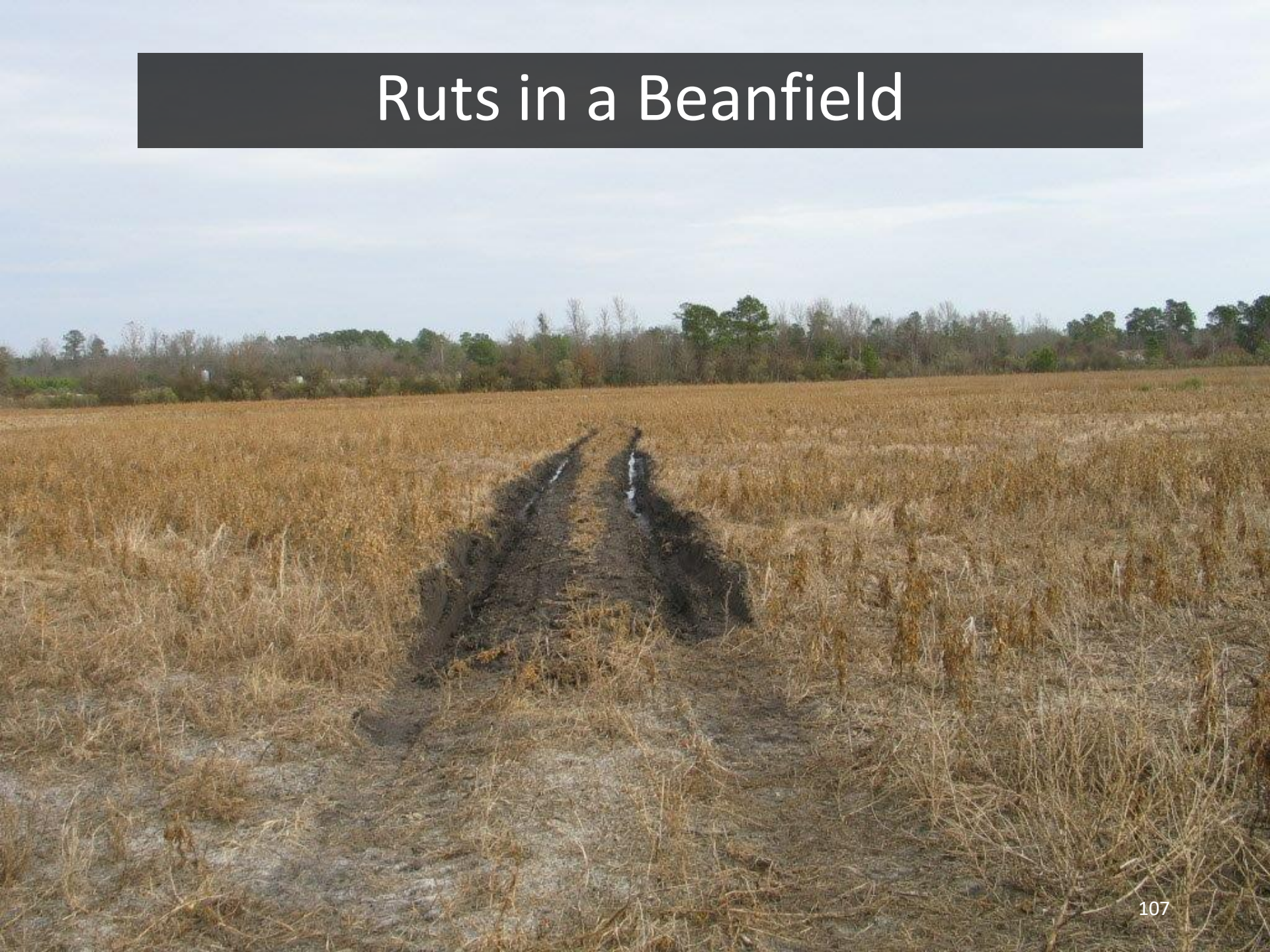
Site Restoration

- Ideally, restore any work-site to pre-investigation conditions, including (but not limited to):

- Trash: come on man!! (or woman!!) **PICK IT UP !!!**

  Do NOT put trash in your borehole !!
- Ruts: fill & smooth, maybe more. *Spread out some grass seed?? If so, check & use a locally approved species: **In the Mtns Kentucky-31 Tall Fescue**
- Clean up the site generally: spread any excess soils, don't leave piles
- If excess damage has occurred, **DOCUMENT**; photos (in general, pre- & post-drilling photos aren't a bad idea either).
- Other possible considerations: e.g., cut downed trees up to smaller pieces; spray mud off the pavements or bridges; AND always close (and lock?) gates. Say thank you to landowners, be courteous.

Ruts in a Beanfield



Lastly…
Watch out for these guys !!!!!

Geotechnical Engineering Unit Questions?

(video embedded)