NORTH CAROLINA
Department of Transportation









Breaking Cylinder Piles - Rodanthe Bridge

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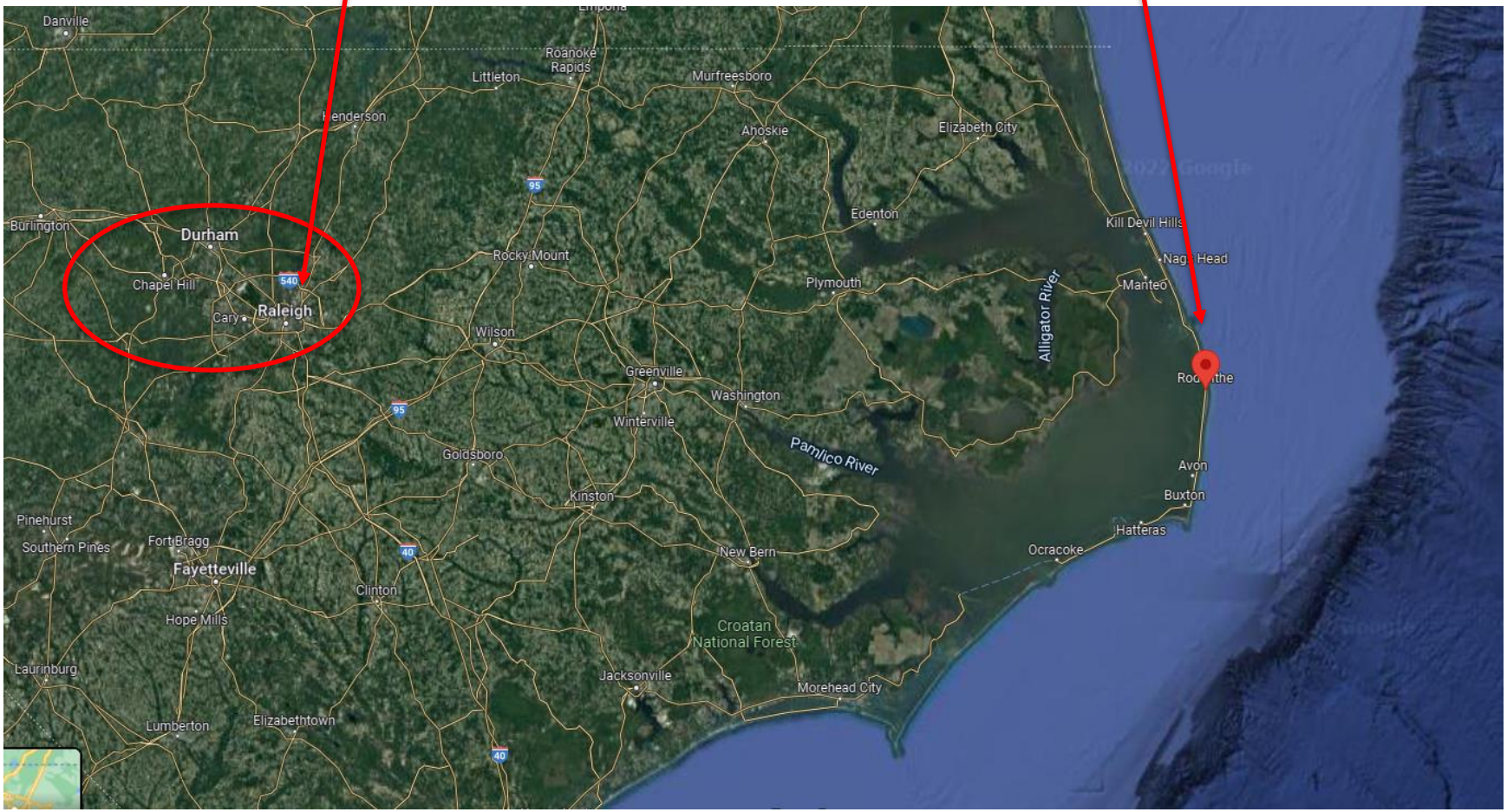
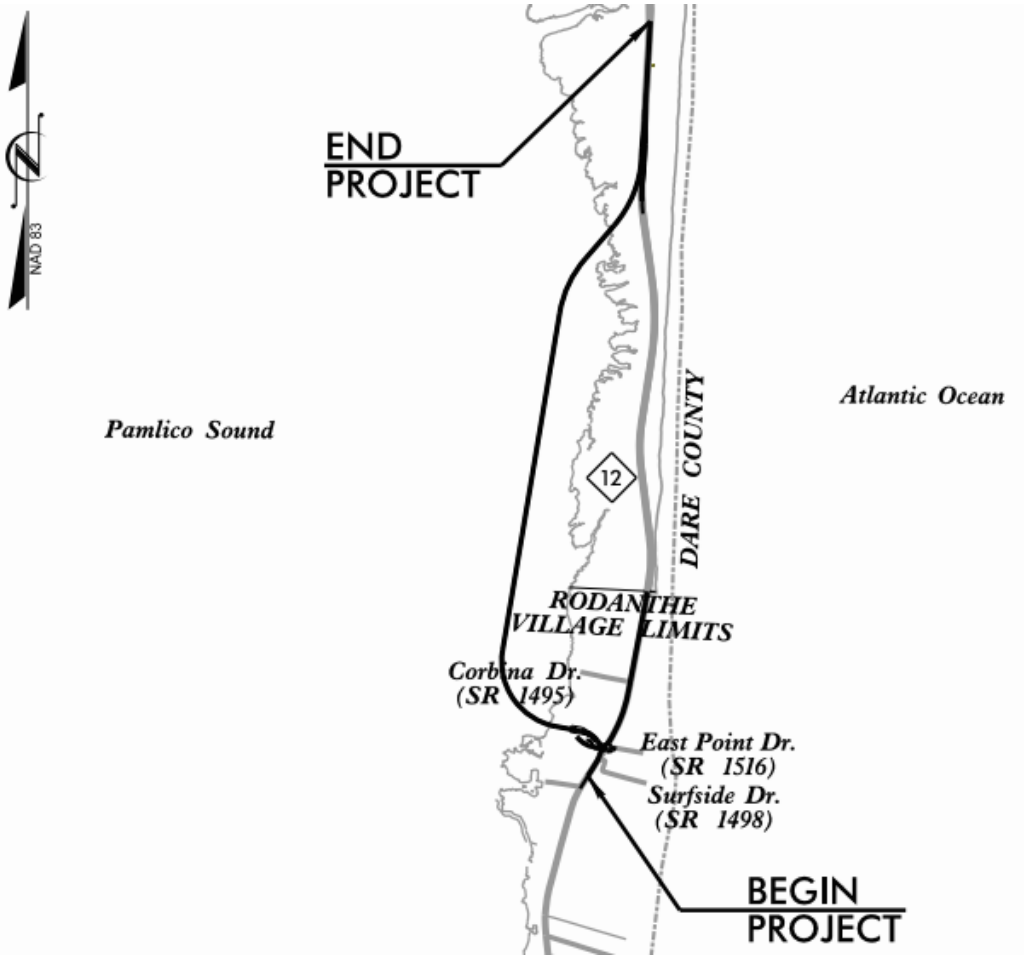
STGEC Daytona Beach - Oct 2022

Project Overview

Raleigh

Rodanthe





Design Build Procurement

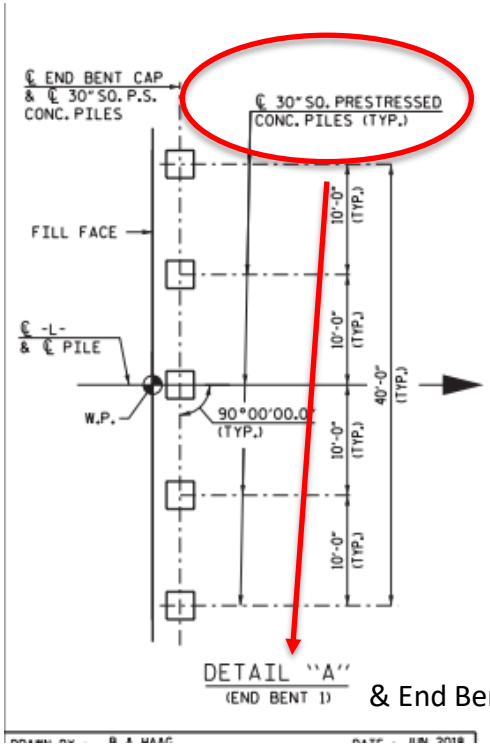
2.5 Mile Long Bridge

Crossing over Pamlico Sound

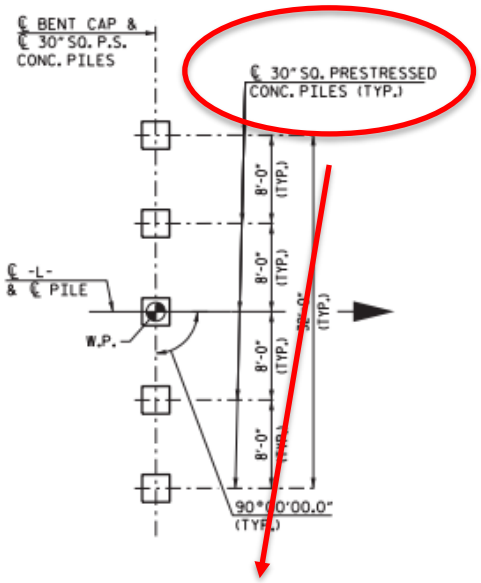
Roadway Elevation 25.5 feet

106 Interior Bents

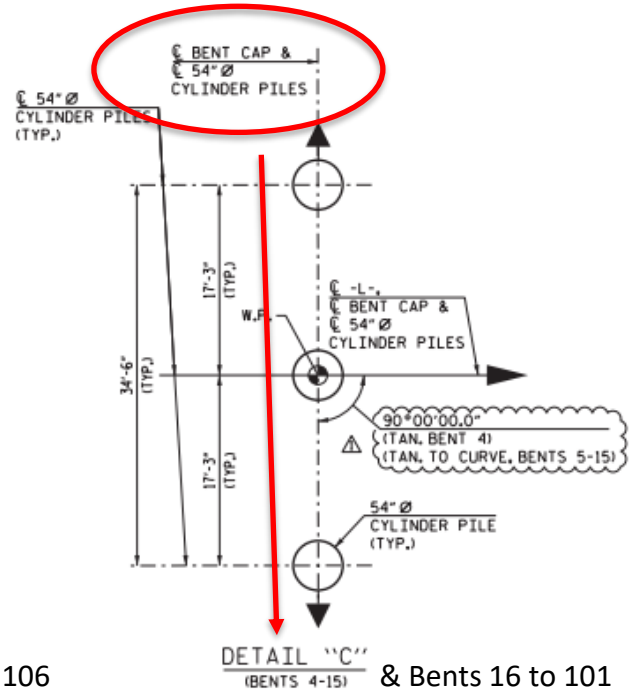
AASHTO Girders – Spans at 60 feet, 100 feet +-, and 136 feet +-



& End Bent 2

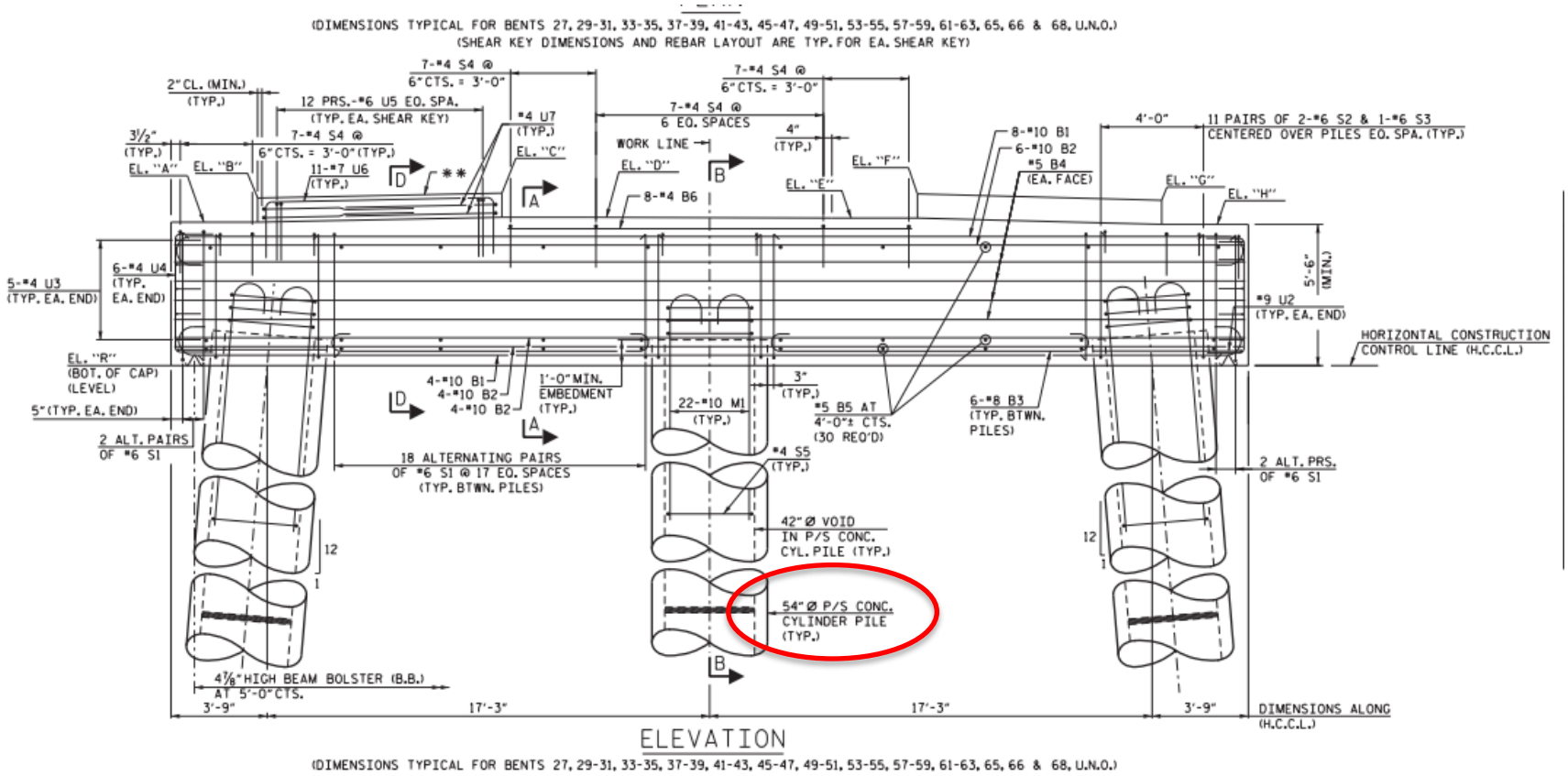


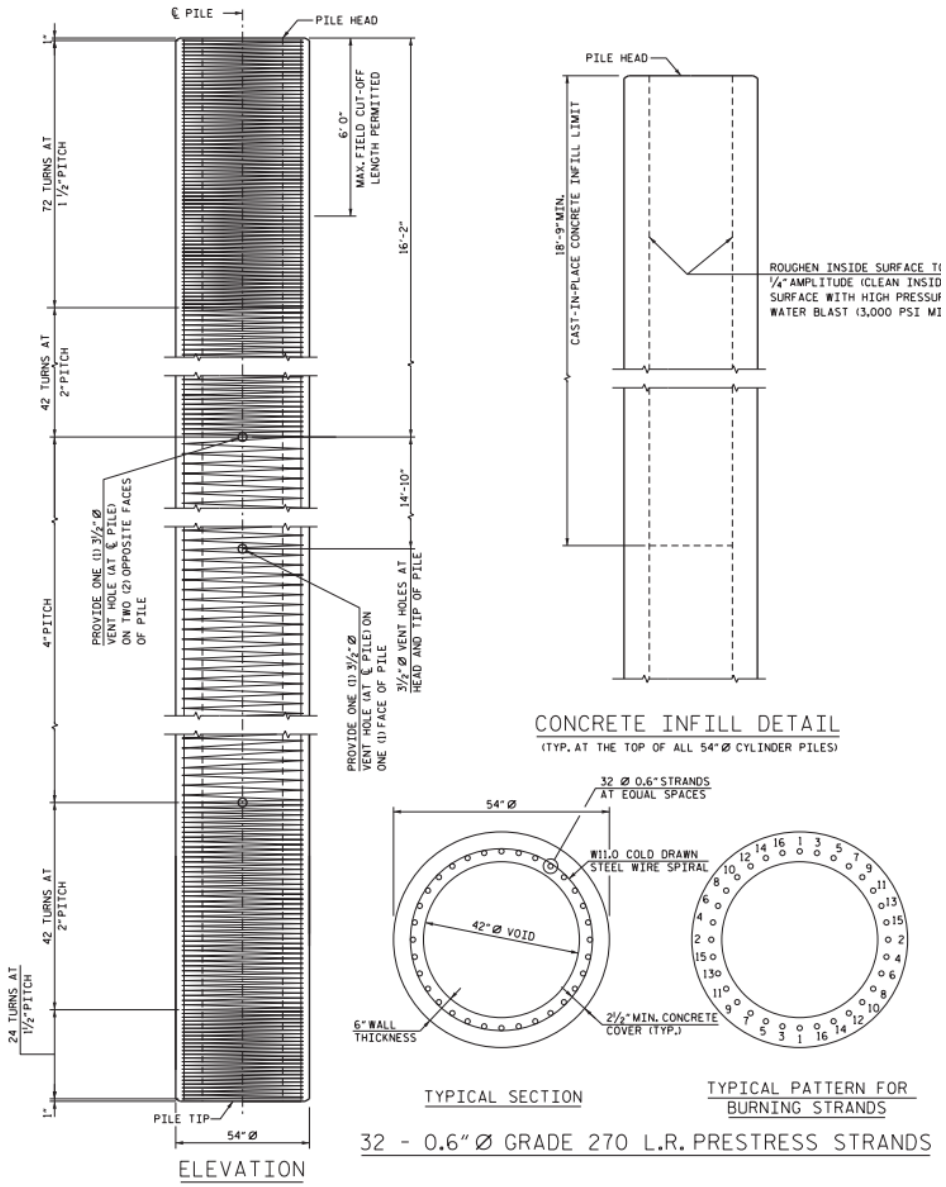
& Bents 102 to 106



& Bents 16 to 101

Typical 54 Inch Diameter Cylinder Pile Bent



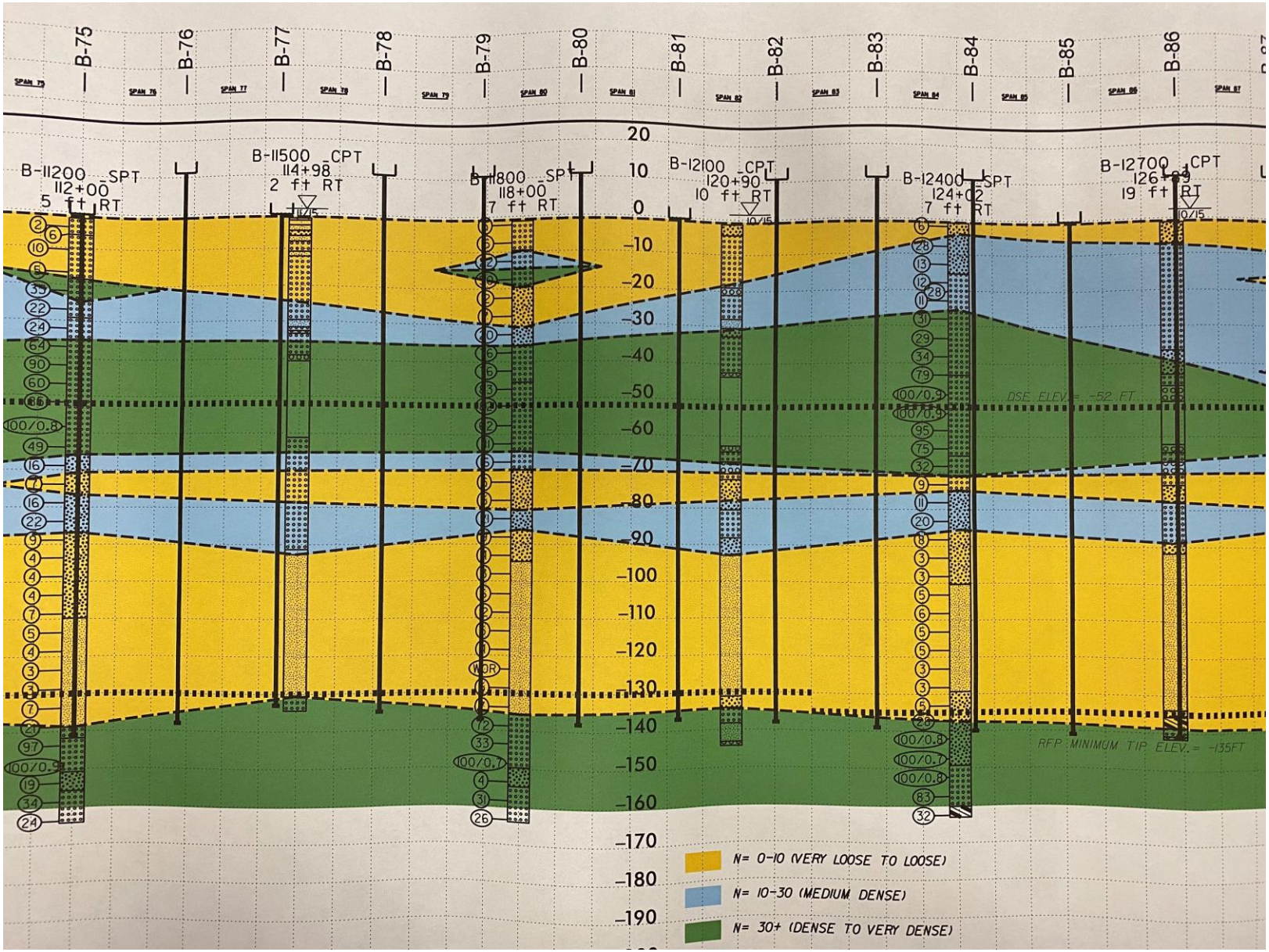


Cast at **Coastal Precast Systems** in Chesapeake, VA

Pre-stressed (cast in a single segment)

Lengths varied – generally 150 feet +-

- Dynamic Pile Testing performed at each bent
- Factored Design Loads ranged from 665 to 815 tons (1330 to 1630 kips)
- Required driving resistances – generally around 2250 to 2500 kips
- Typical final tip elevations -125 to -135 feet
- Long drive times (4000 blows +-)


B-75
B-76
B-77
B-78
B-79
B-80
B-81
B-82
B-83
B-84
B-85
B-86
B-11200 SPT
112+00
5 ft RT
B-11500 CPT
114+98
2 ft RT
B-11800 SPT
118+00
7 ft RT
B-12100 CPT
120+90
10 ft RT
B-12400 SPT
124+02
7 ft RT
B-12700 CPT
126+99
19 ft RT
20
10
0
-10
-20
-30
-40
-50
-60
-70
-80
-90
-100
-110
-120
-130
-140
-150
-160
-170
-180
-190
DSE ELEV. = -52 FT
RFP MINIMUM TIP ELEV. = -135FT
N= 0-10 (VERY LOOSE TO LOOSE)
N= 10-30 (MEDIUM DENSE)
N= 30+ (DENSE TO VERY DENSE)

Means and Methods

- Temporary Work Platform
  - Rail System
  - Overhead Gantry Cranes
  - Platforms for Crawler Cranes
  - Remove at back and reinstall at front
- Start at South Terminus – Move North
- Later add second temporary work platform at North Terminus – Move South

Breaking Cylinder Piles - Rodanthe Bridge

Breaking Cylinder Piles - Rodanthe Bridge

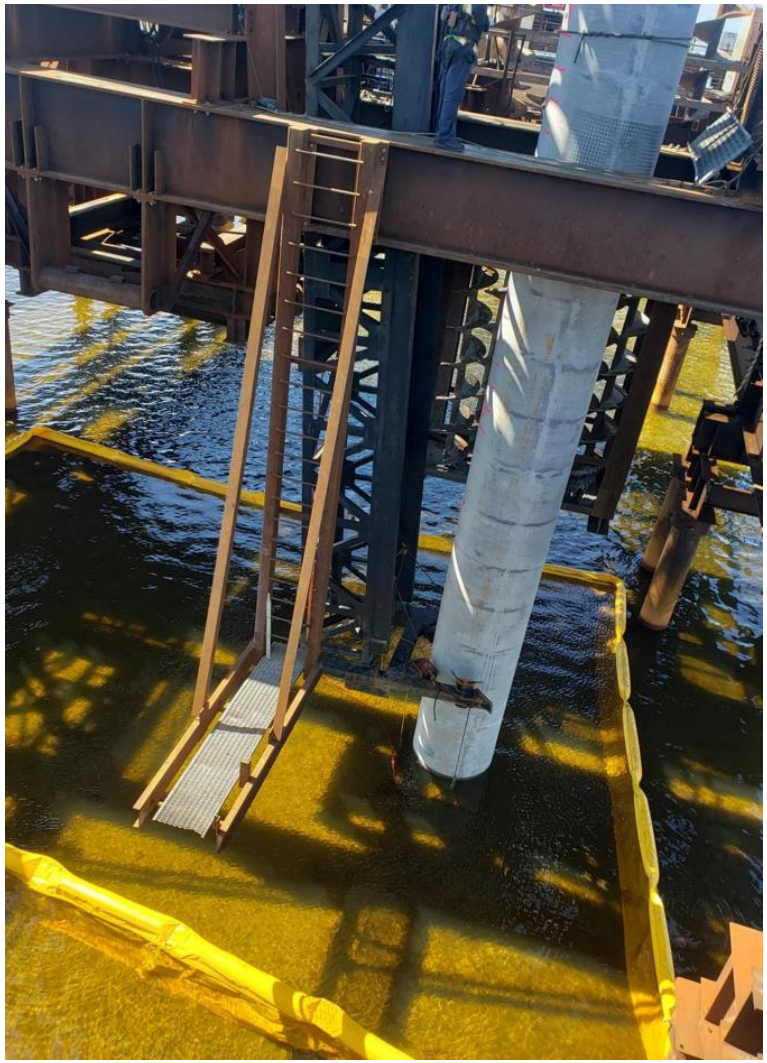
- Use Overhead Gantry Cranes to unload and transport cylinder piles
- Place in “Flipper”
- Attach and lift to vertical with crawler crane
- Set in template and drive
- Drive remaining cylinder piles
- Jump to next bent and repeat
- Set girders/pour deck 2 to 4 spans behind


OVERSIZE
LOAD


PRO-HAUL
OVERSIZE
PRO-HAUL
LOAD

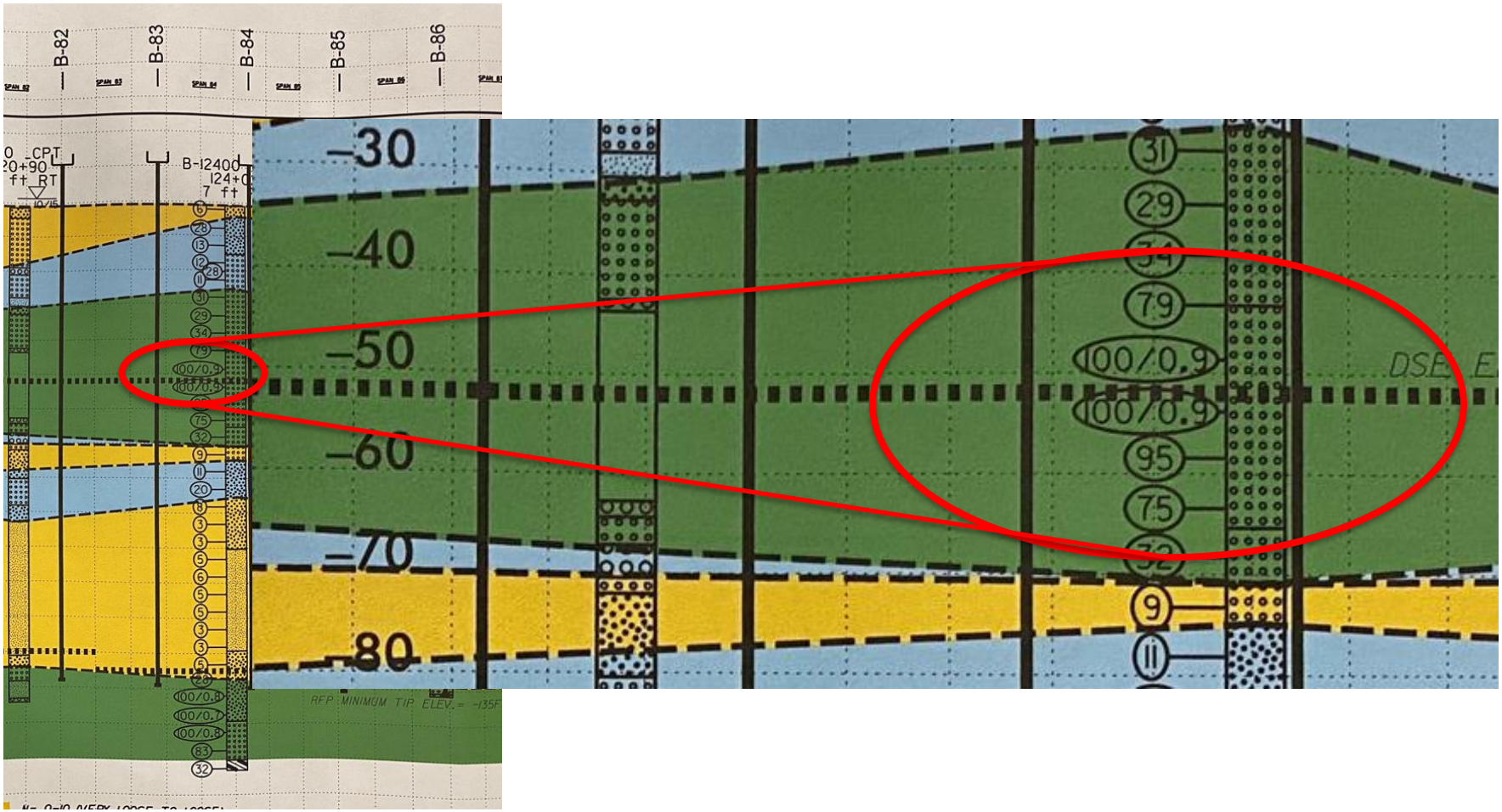

SWL 70 US TON

Breaking Cylinder Piles - Rodanthe Bridge



Breaking Cylinder Piles - Rodanthe Bridge

Means and Methods



Getting through D to VD soil stratum

- Plan #1 – Steel casings and excavation
  - Set pile in casing
  - Drive
  - Remove and reuse casing
  - Abandoned concept early after award

Getting through D to VD soil stratum

- Plan #2
  - Jet
  - Revised permits
  - Abandoned after a few attempts
  - Could not meet permit requirements economically and/or in a timely fashion (?????)

Getting through D to VD soil stratum

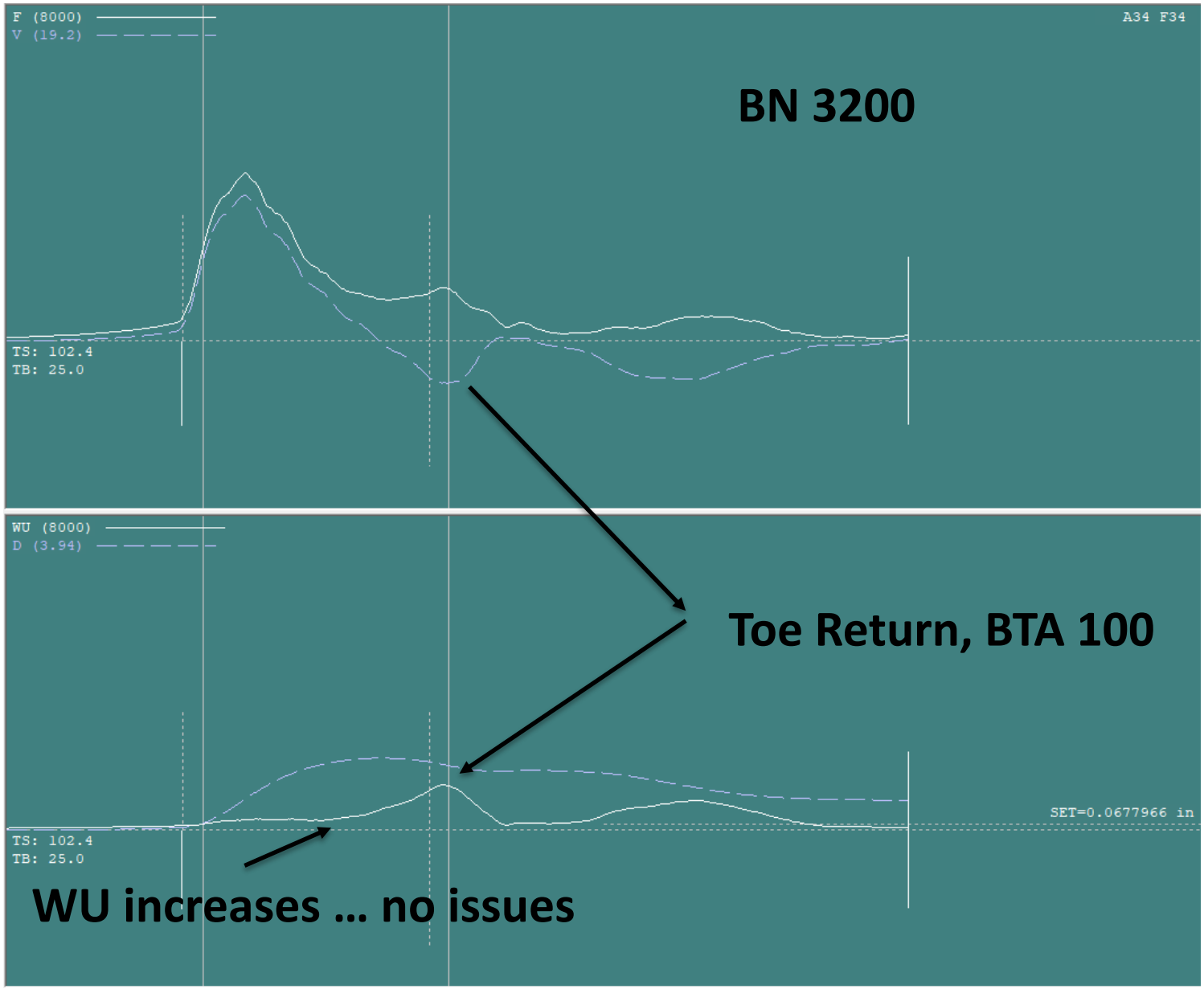
- Plan #3 – Just stand them and drive them
  - At South Terminus
    - Success
  - At North Terminus
    - Almost immediately broke a production pile

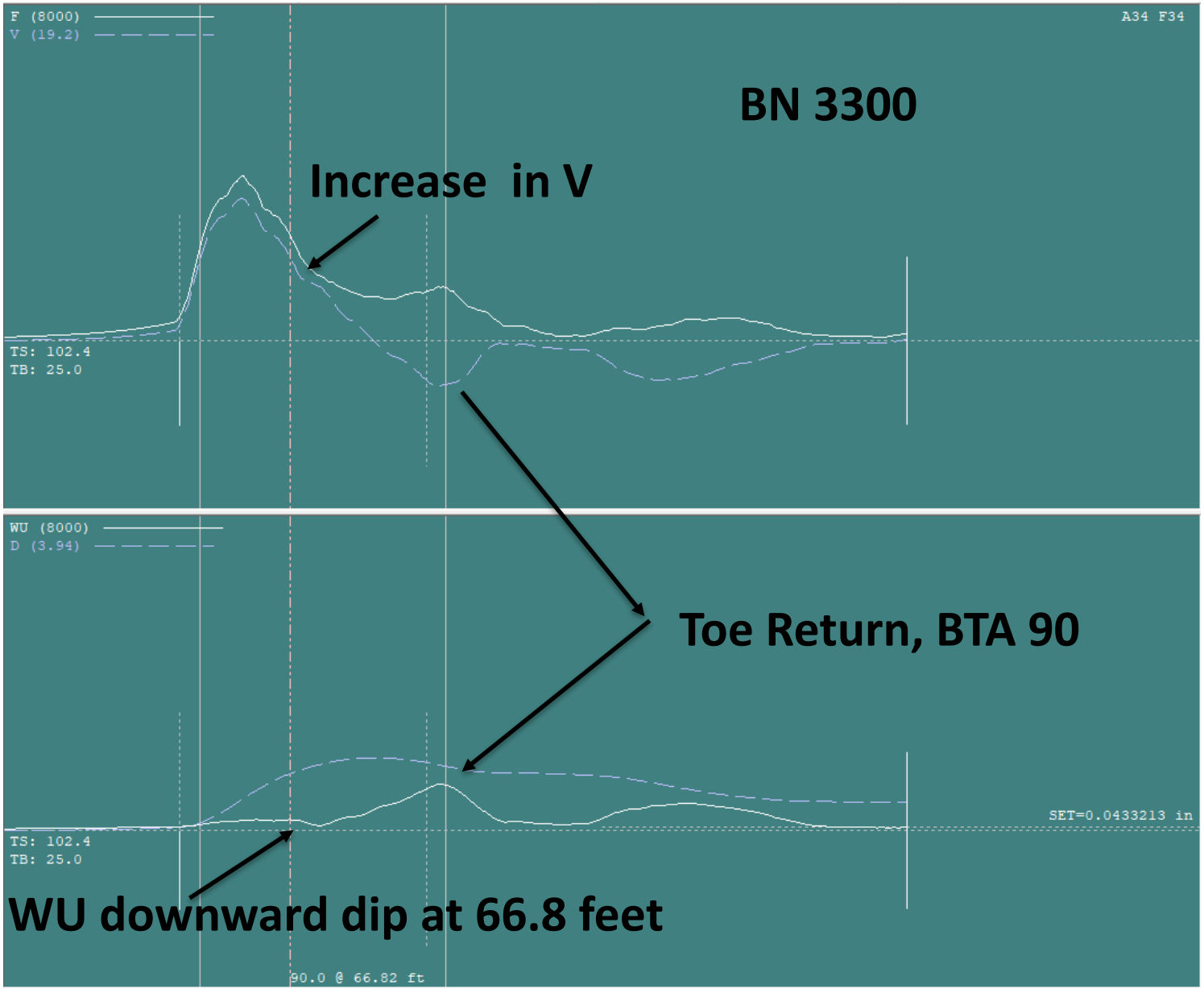

Pileco D180-32
OED
40 kip Ram
18 inch Ply PC

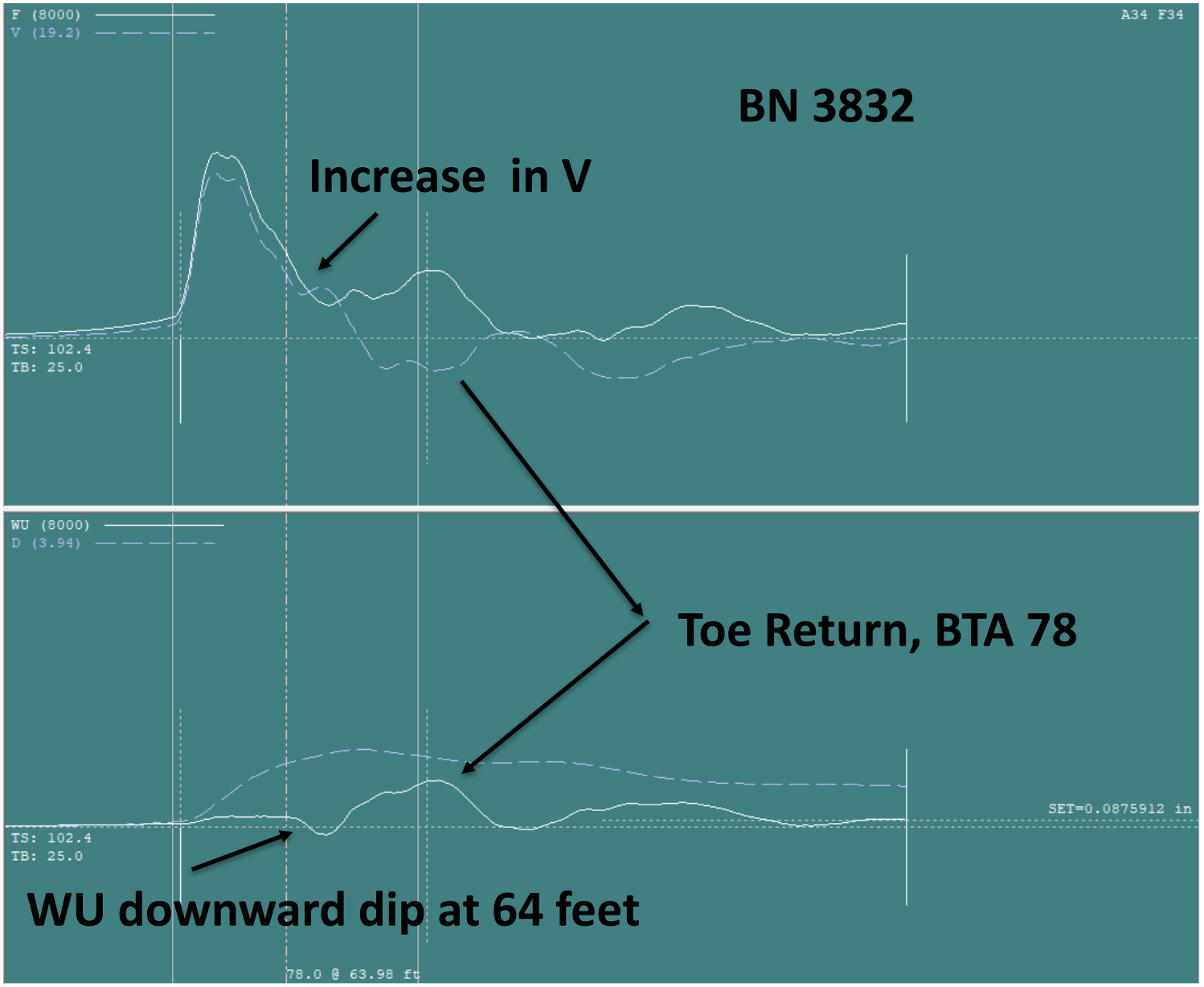
Bent 101, Pile 1

Bent 101, Pile 1

- Drove to tip elevation of –98.7 feet
- Damage noted by PDA at elevation -14 to -18 feet during last 6 inches of drive
- BTA values 78 to 82%

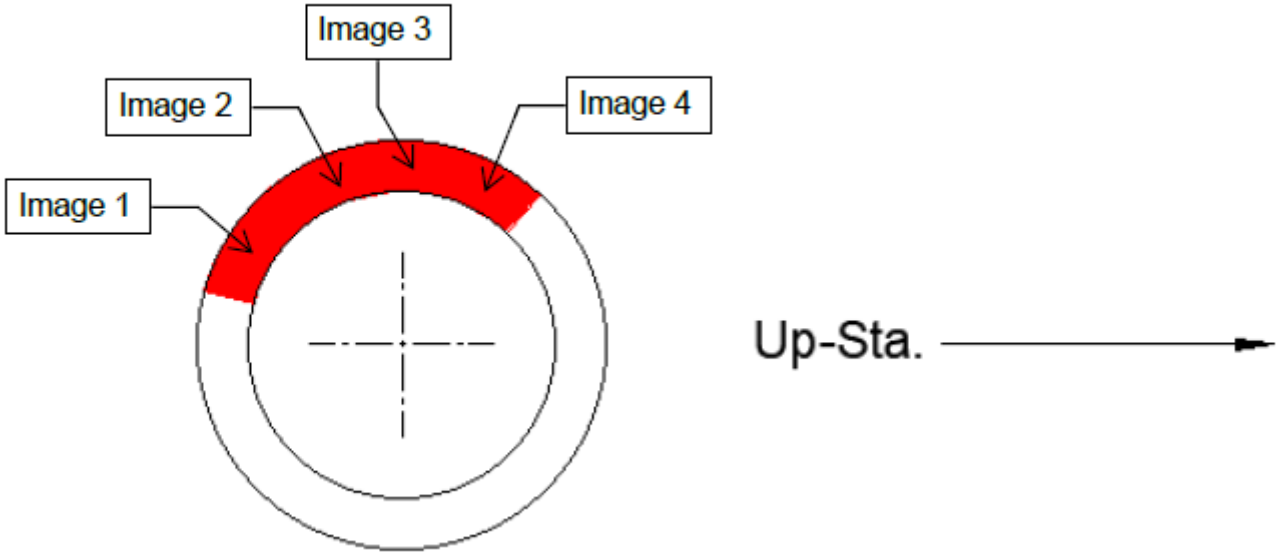

F (8000)
V (19.2)
A34 F34
BN 3200
TS: 102.4
TB: 25.0
WU (8000)
D (3.94)
Toe Return, BTA 100
SET=0.0677966 in
TS: 102.4
TB: 25.0
WU increases … no issues


F (8000)
V (19.2)
A34 F34
BN 3300
Increase in V
TS: 102.4
TB: 25.0
WU (8000)
D (3.94)
Toe Return, BTA 90
SET=0.0433213 in
TS: 102.4
TB: 25.0
WU downward dip at 66.8 feet
90.0 @ 66.82 ft


F (8000)
V (19.2)
A34 F34
BN 3832
Increase in V
TS: 102.4
TB: 25.0
WU (8000)
D (3.94)
Toe Return, BTA 78
SET=0.0875912 in
TS: 102.4
TB: 25.0
WU downward dip at 64 feet
78.0 @ 63.98 ft

Bent 101, Pile 1

- Is it really damaged?
- Can we salvage it?
- DB Team elected to visually inspect



Cleaned out inside and dropped down a camera

Image 1 taken at approximate elevation -14ft. Vertical and horizontal cracking with . Water intrusion is evident.

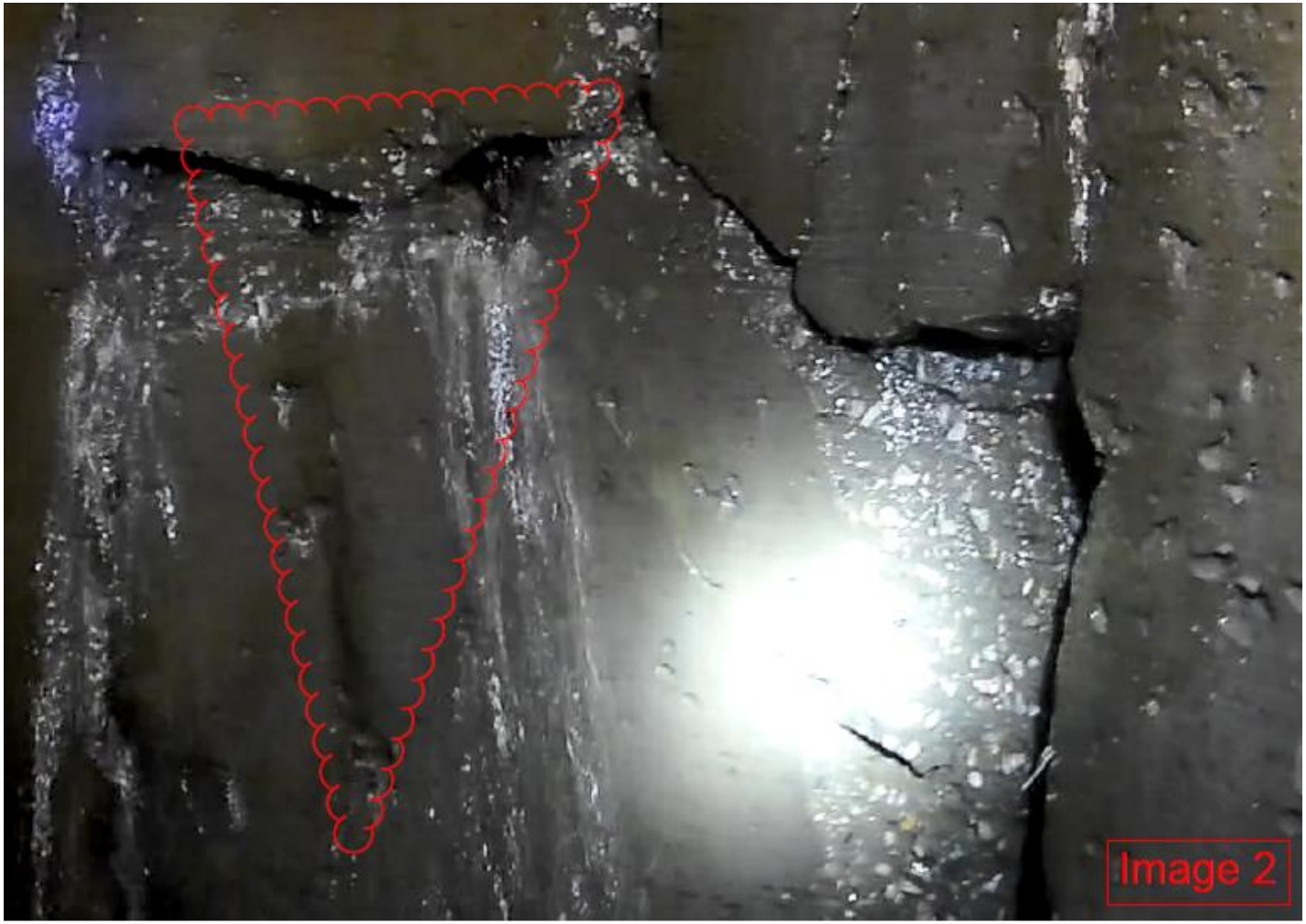


Image 2 taken at approximate elevation -15ft to -16ft. Multiple reinforcing strands are exposed. Strands appear to have shallow cover. Water intrusion evident.

Image 3 taken at approximate elevation -17ft.

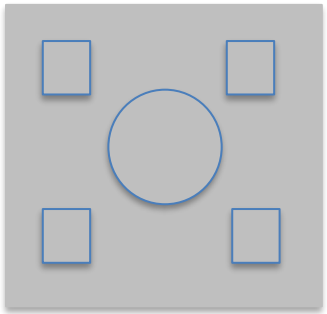
Image 4 taken at approximate elevation -18ft to -19ft.

Multiple reinforcing strands and spirals exposed.

Unable to excavate lower than this elevation with current equipment setup.

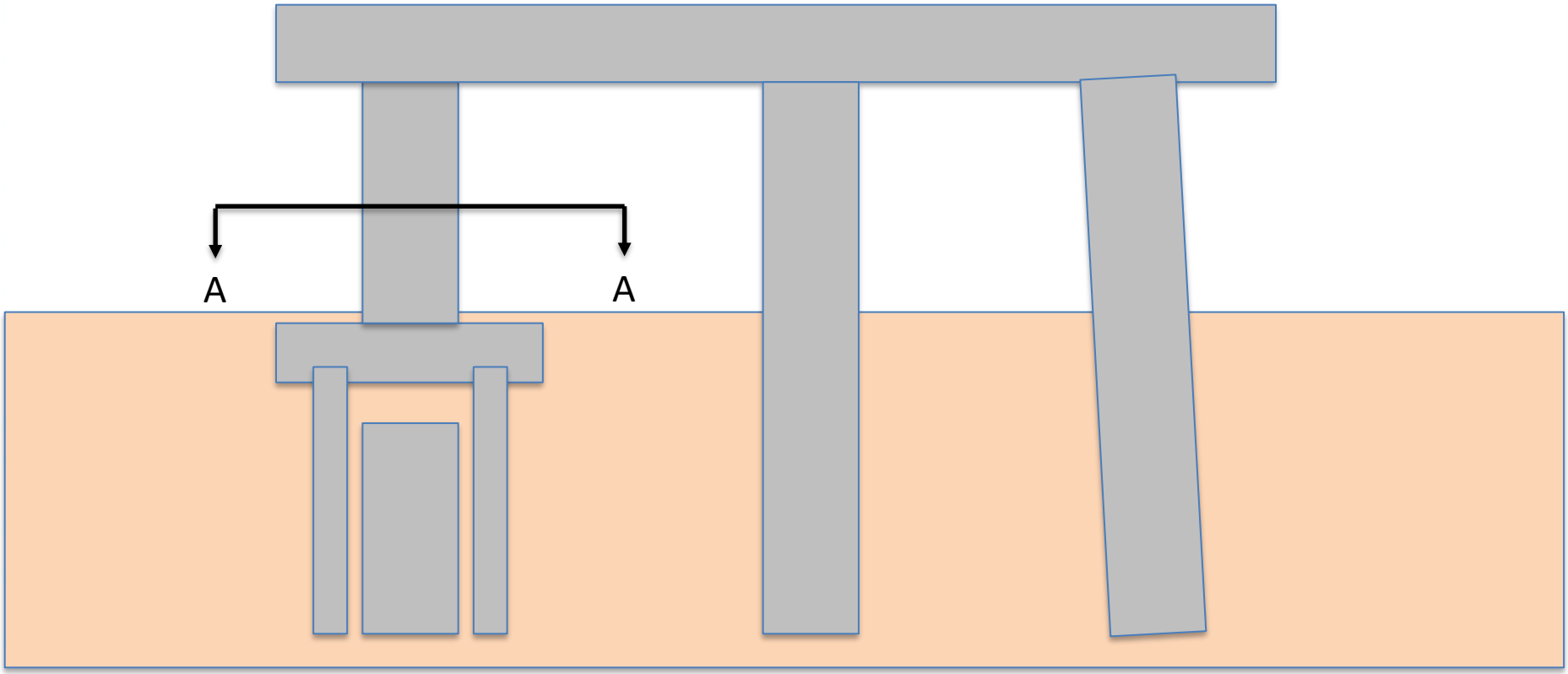
Bent 101, Pile 1

- The fix…this pile was on land
  - Dug a hole
  - Cut off the pile
  - Drove 30 inch square PCP
  - Built pile footing
  - Added a column to the bent cap



Section A-A

Not to Scale - Conceptual



And then…

- Broke Bent 100, Pile 1
  - Similar to Bent 101, Pile 1
  - Same Fix
- Started to consider modifications to installation procedure
  - Slickcoat inside of cylinder pile – No noticeable difference seen in driving
  - Settled on a Pre-drill Methodology

Pre-drill Methodology

- Stand and drive each pile
- If blows per foot and stroke exceed specified limit
  - Pre-drill (36 inch diameter flight auger) through pile to loosen plug
  - Continue below pile tip 15 feet +-
- Continue driving the pile
- Repeat pre-drilling as needed

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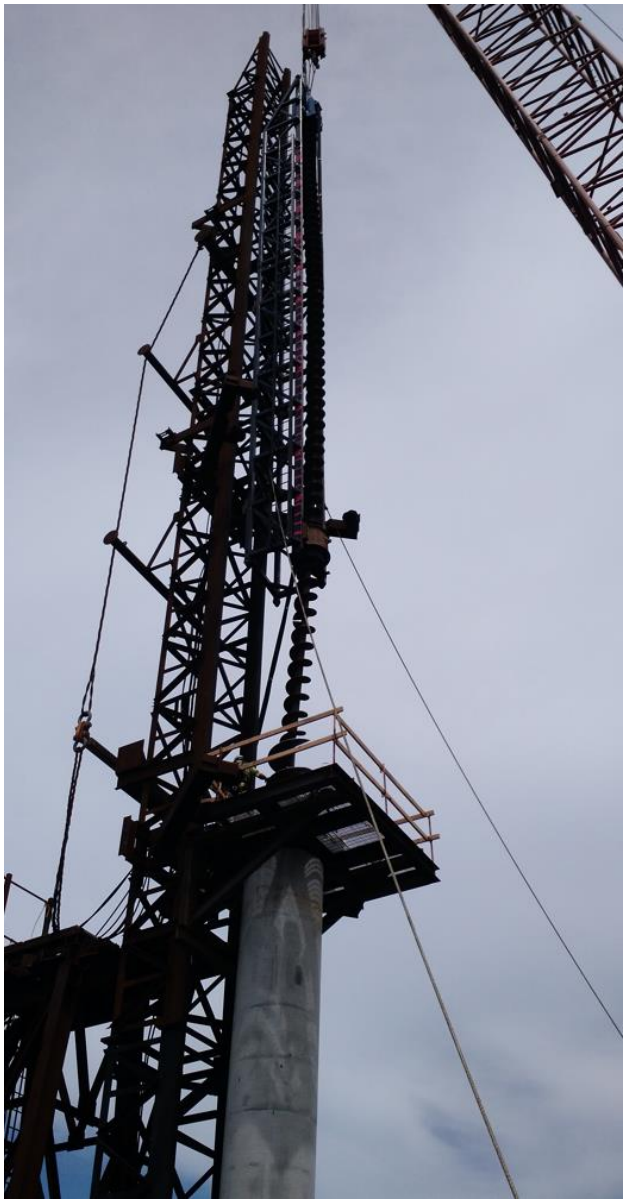
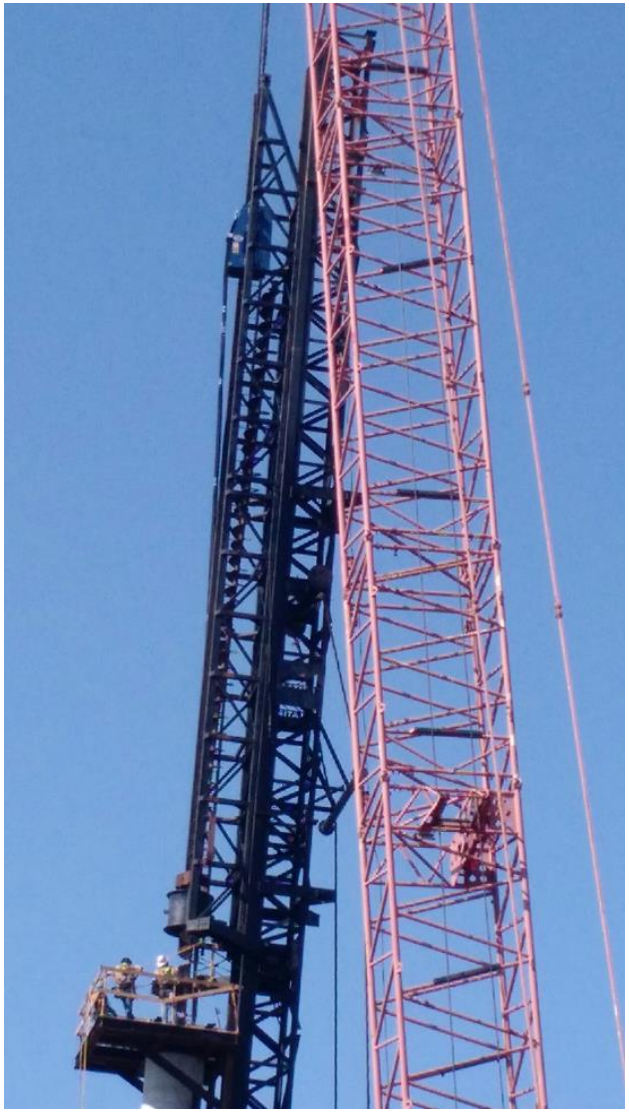




Cutting Head

Typical 36 inch diameter flight

Cutting head with steel wire and pre-stress strand

Pre-drill Methodology

- There was a learning curve
- Modifications to blows per foot (reduction in limits) occurred
- Lost augers/snapped connections
- Added significant time to installation
- Not all piles needed pre-drilling

Summary

Bent No.	Pile No.	54 CCP Inch Approx. Tip Elev. (ft)	36x1.25 SPP Approx. Tip Elevation (ft)	
37	2	-72	-145	
39	1	-87	-143	
68	1	-95	-144	
77	3	-124	-174	
94	2	-108	-149	
94	3	-73	-143	
96	1	-90	-151	
96	2	-73	-150	
100	1	-95	N/A	30 inch sq PCP and footing
101	1	-99	N/A	30 inch sq PCP and footing

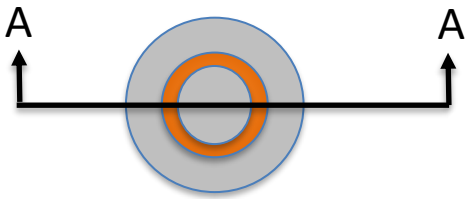
10 total with breaks in middle third

Some others had apparent damage near the toe - accepted based on further analysis

The fix for the bents in the water

- Drove 36x1.25 open end steel pipe pile through center of the concrete cylinder pile
- Steel pipe pile driven out the bottom and achieved the RDR
- Cylinder pile left in place
- Annulus between two piles was grouted to required elevation
- Pour concrete plug and reinforcing steel in steel pipe pile to required elevation


EDWARDS
EDWARDS
CK



Section A-A

1 - Cut off Cylinder Pile at PCO Elev.

Set Rebar and Pour Concrete Plug to Required Elevation

Grout Annulus to Required Elevation

2 - Drive Steel Pipe Pile to RDR

Not to Scale - Conceptual

Thank you…