# Wekiva Parkway Section 6 – Karst Geology Challenges

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WEKIVA PARKWAY
Completing Central Florida's Beltway
TOLL 429

STGEC 2022
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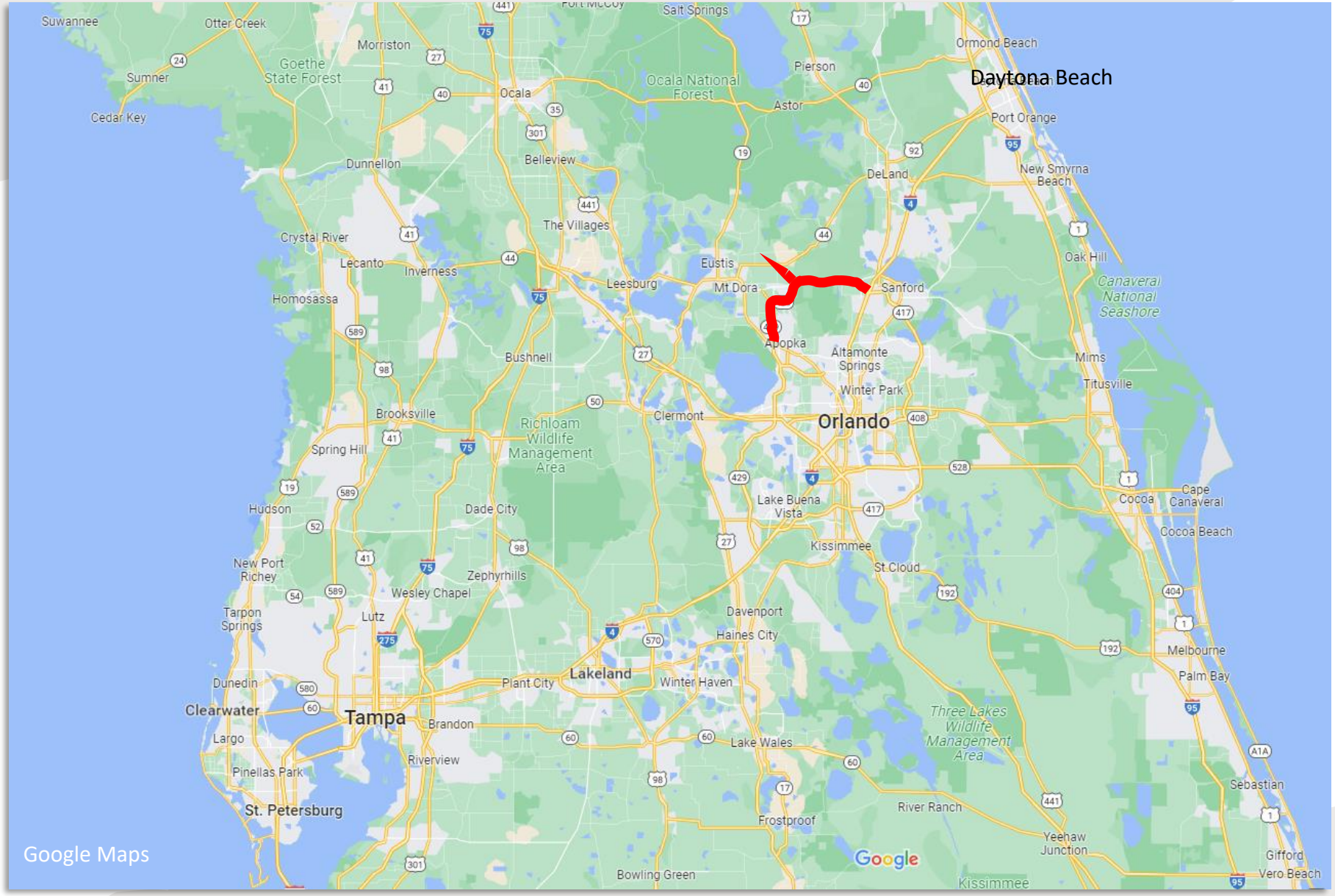
# Project Overview – Wekiva Parkway (SR 429)

- 25-mile, $1.6 billion tolled expressway
- Divided into 13 project sections
- Will complete the beltway around Central Florida
- Cooperative effort between FDOT, Central Florida Expressway Authority (CFX), and the Florida's Turnpike Enterprise
- Entire parkway expected to be open to traffic in 2023

# Wekiva Parkway – Entire Alignment



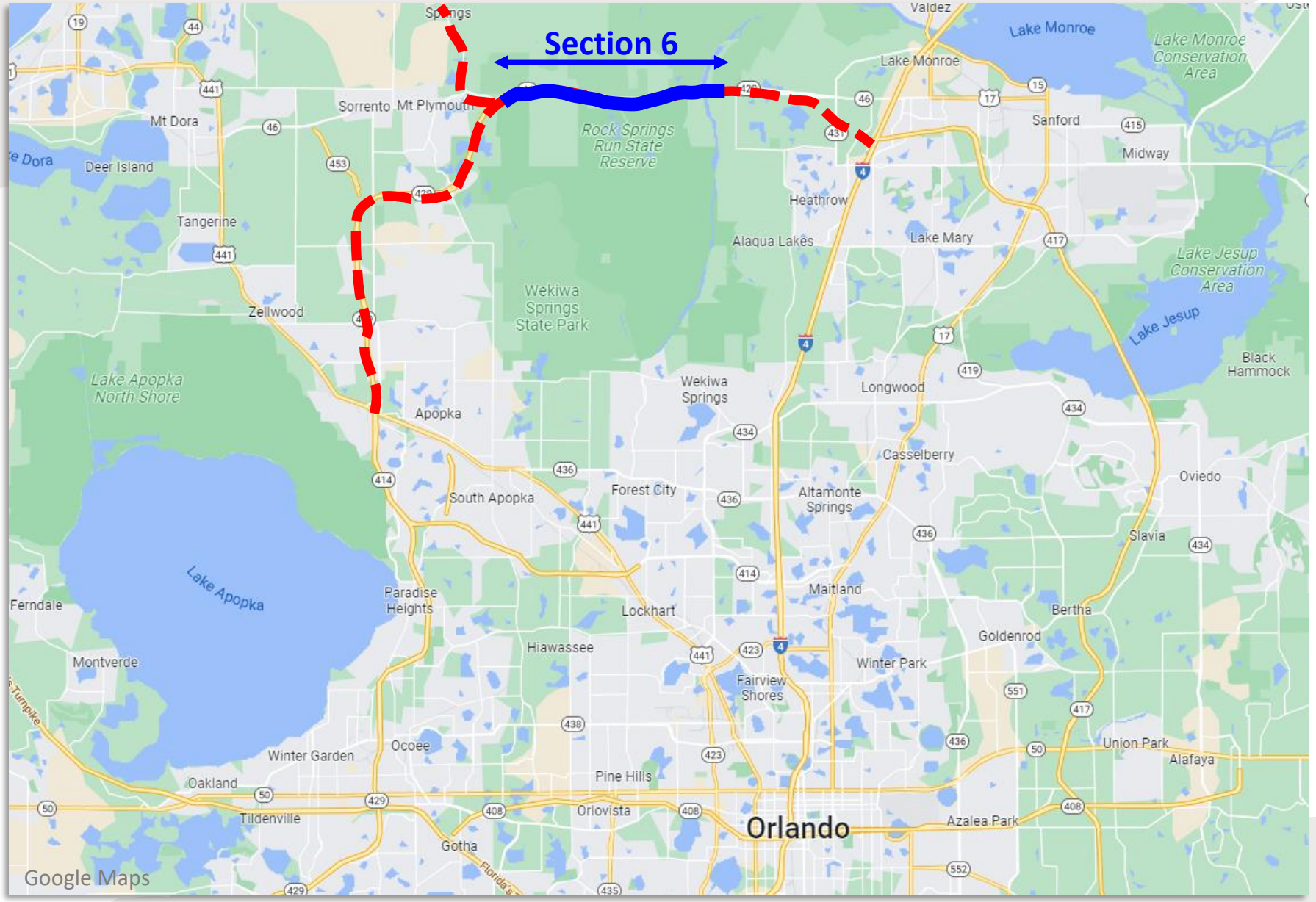
# Project Overview – Section 6

- Section 6 is one of 13 Wekiva Parkway (SR 429) Project Sections
- Cost:  $234 Million
- Project Delivery Method:  Design-Build
- Location:  Lake and Seminole Counties in Central Florida
- Project Length:  Nearly 6 miles of elevated expressway and parallel service road
  Bridges:  18 structures with a total length of 4.7 miles
- Three Wildlife Crossings:

| No. | Length (feet) |
|---|---|
| 1 | 1,800 |
| 2 | 3,860 |
| 3 | 100 |

- Alignment crosses the Wekiva River, a National Wild and Scenic River
- Section 6:  Design-build project began April of 2017; opened May of 2022

# Wekiva Parkway – Section 6



# Section 6 Project Team – Key Members

SUPERIOR CONSTRUCTION

FDOT

GRL Engineers, Inc.

WGI

RS&H

INDEPENDENT DRILLING INC.

wsp

FOUNDATION & GEOTECHNICAL ENGINEERING, LLC

F G E

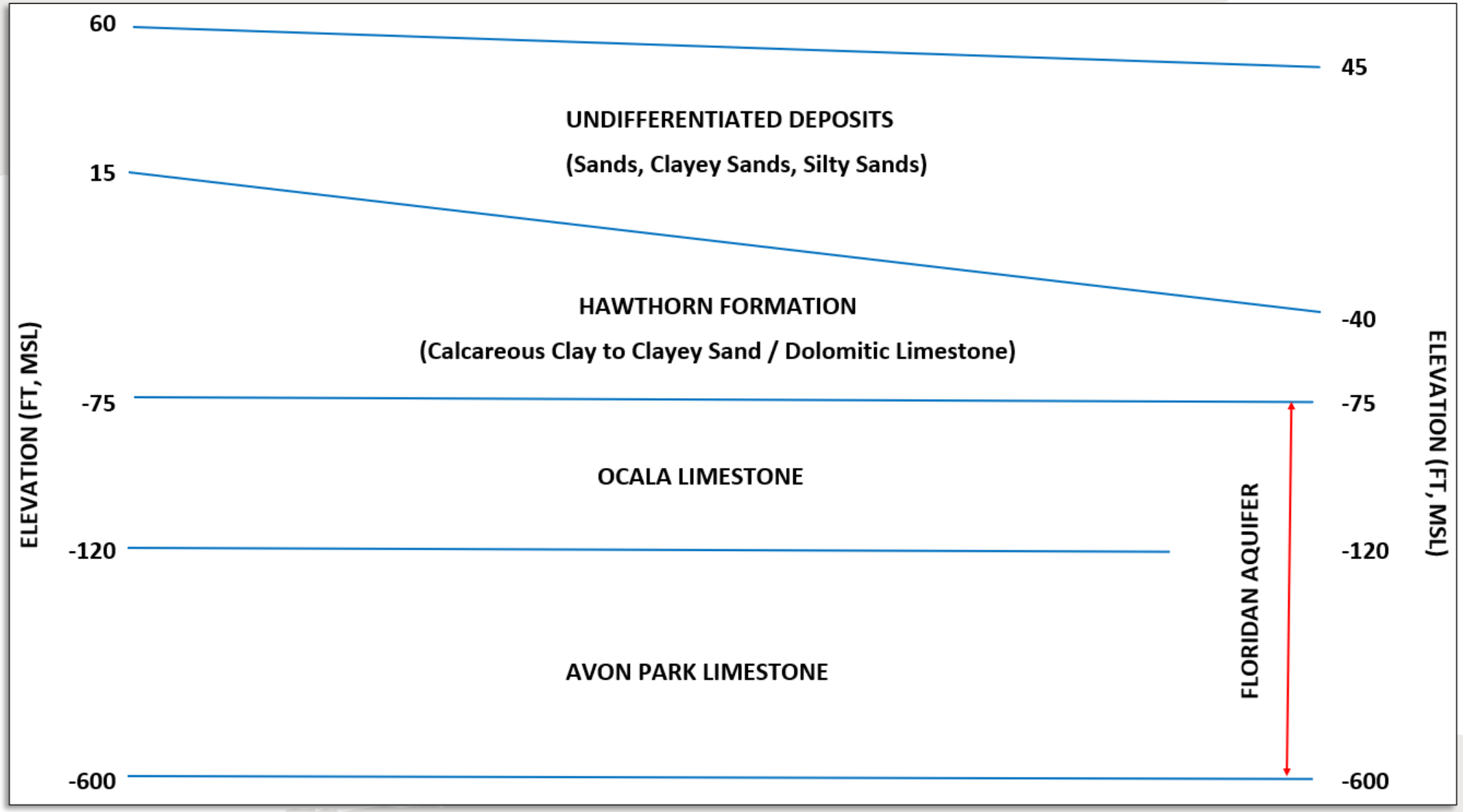
EARTH TECH

# Bridges Over Wekiva River

# Bridges Over Wekiva River

# Bridges Over Wekiva River

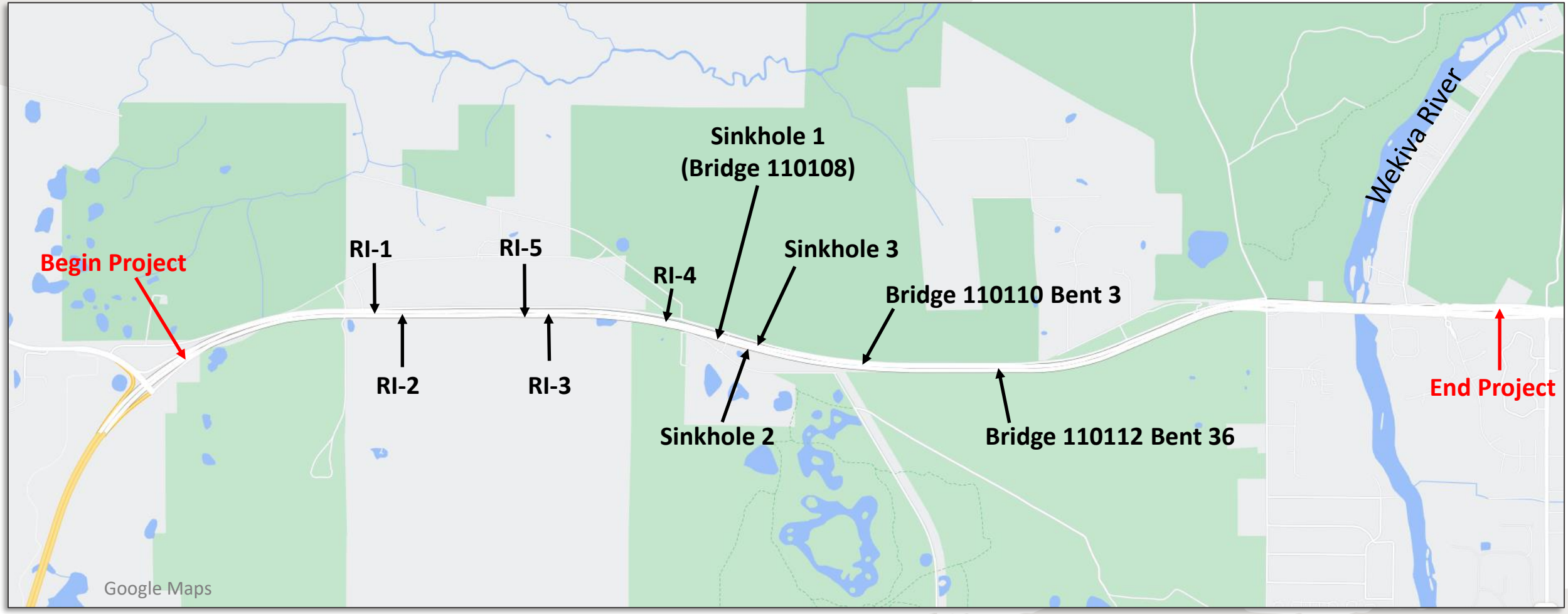
# Geology (West to East)



# Karst Challenges

- Deep Organic Soil Deposits (Relic Sinkholes)
  - Five embankment areas with Low-Mobility Grout Rigid Inclusions (LMG-RI)
- Three New Sinkholes during Project
  - Two locations required compaction grouting
  - Bridge 110108 – Design revised to extend bridge 200 feet
- Unpredictable Pile Driving (Relic Sinkholes)
  - Field-spliced steel and concrete piles

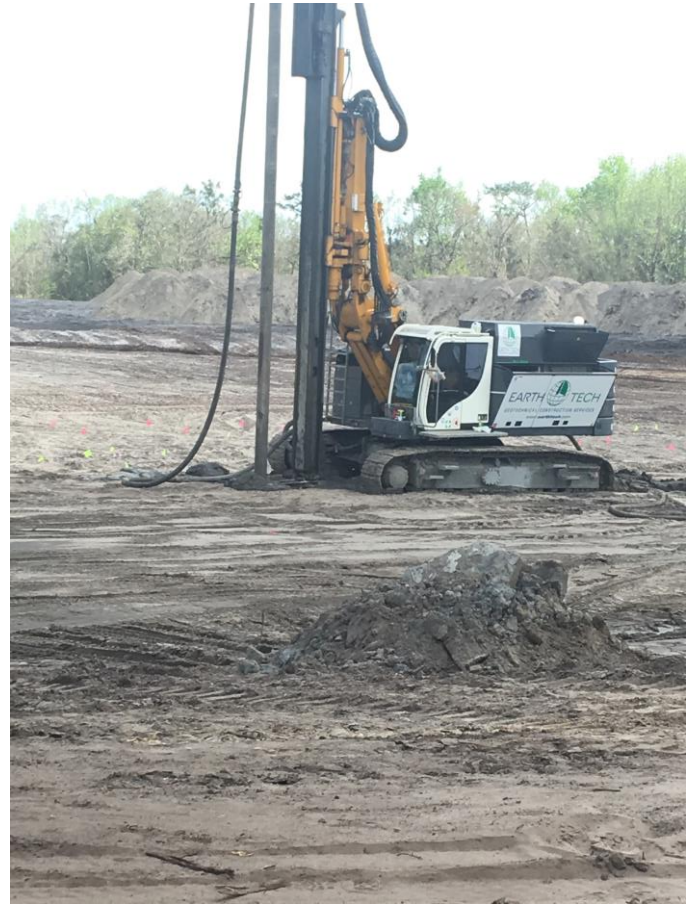
# Karst Feature Locations



# Rigid Inclusions

- Organic soil deposits (PT, typically very soft to soft) ranged from 15 to 45 ft thick, and extended to depths of 45 to 55 ft

| | |
|---|---|
| Specialty Contractor | Earth Tech, LLC (Land O' Lakes, Florida) |
| Method | Low-Mobility Grouted method (LMG-RI) |
| No. of Locations | Five (RI-1 through RI-5) |
| Treatment Areas | ¼ to ¾ acre each (total combined area of 2½ acres) |
| No. of Columns | 121 to 630 columns per treatment area (total of 1,755) |
| Column Diameter | 18 inches |
| Treatment Depths | 42 to 57 feet |
| Column Spacing | 7 to 10 feet |



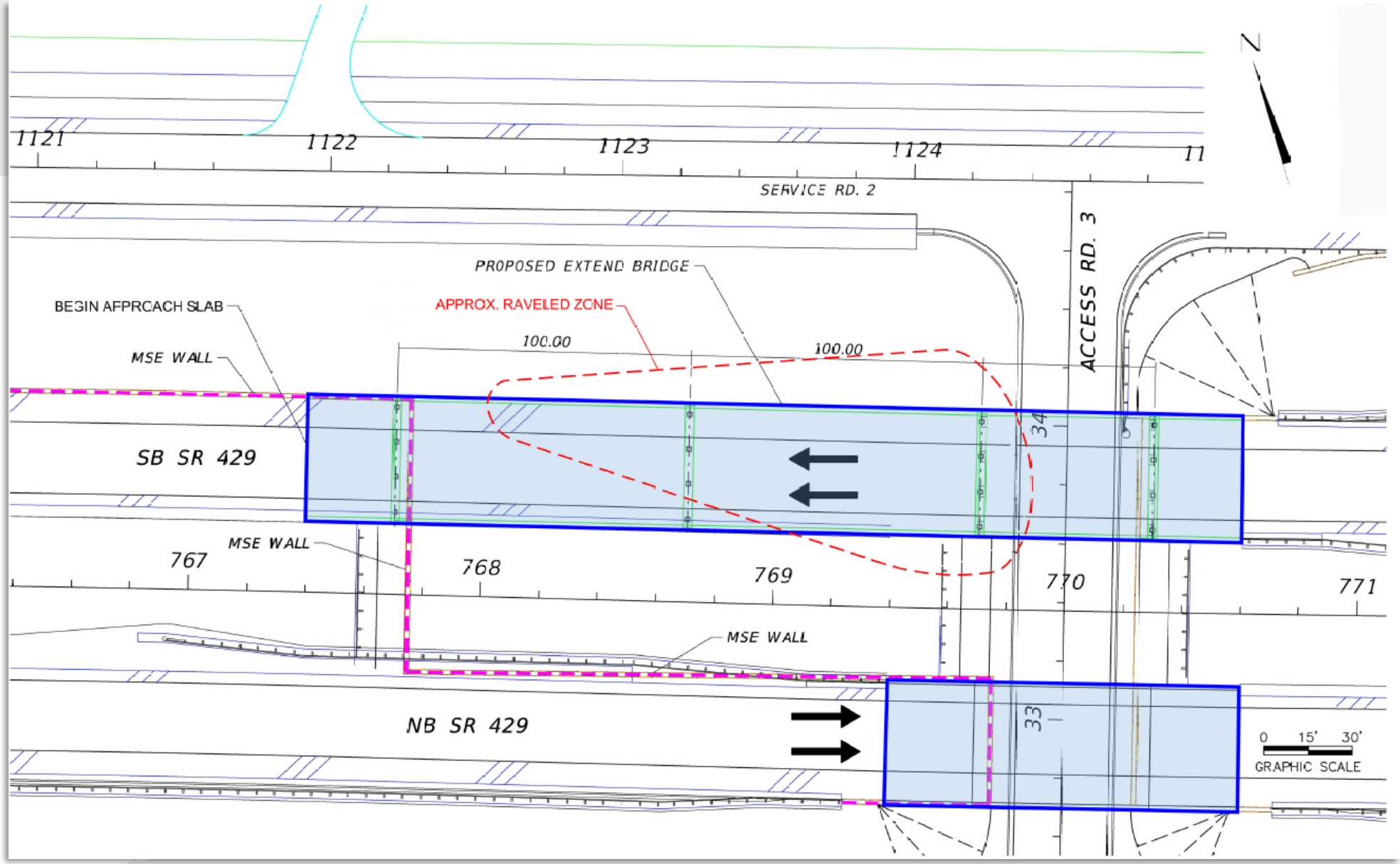

- Settlement monitoring performed following embankment construction
- Measured settlements of  1 to 4.5 inches
- Majority of settlement occurred within 2 to 4 months

# 1… 2… 3… Sinkholes

# Sinkhole No. 1 (During Field Exploration)
# Bridge No. 110108

Photo courtesy of Superior Construction Company

# Bridge No. 110108 - Solution



# Bridge No. 110108

# Bridge No. 110108

Photo courtesy of FDOT.

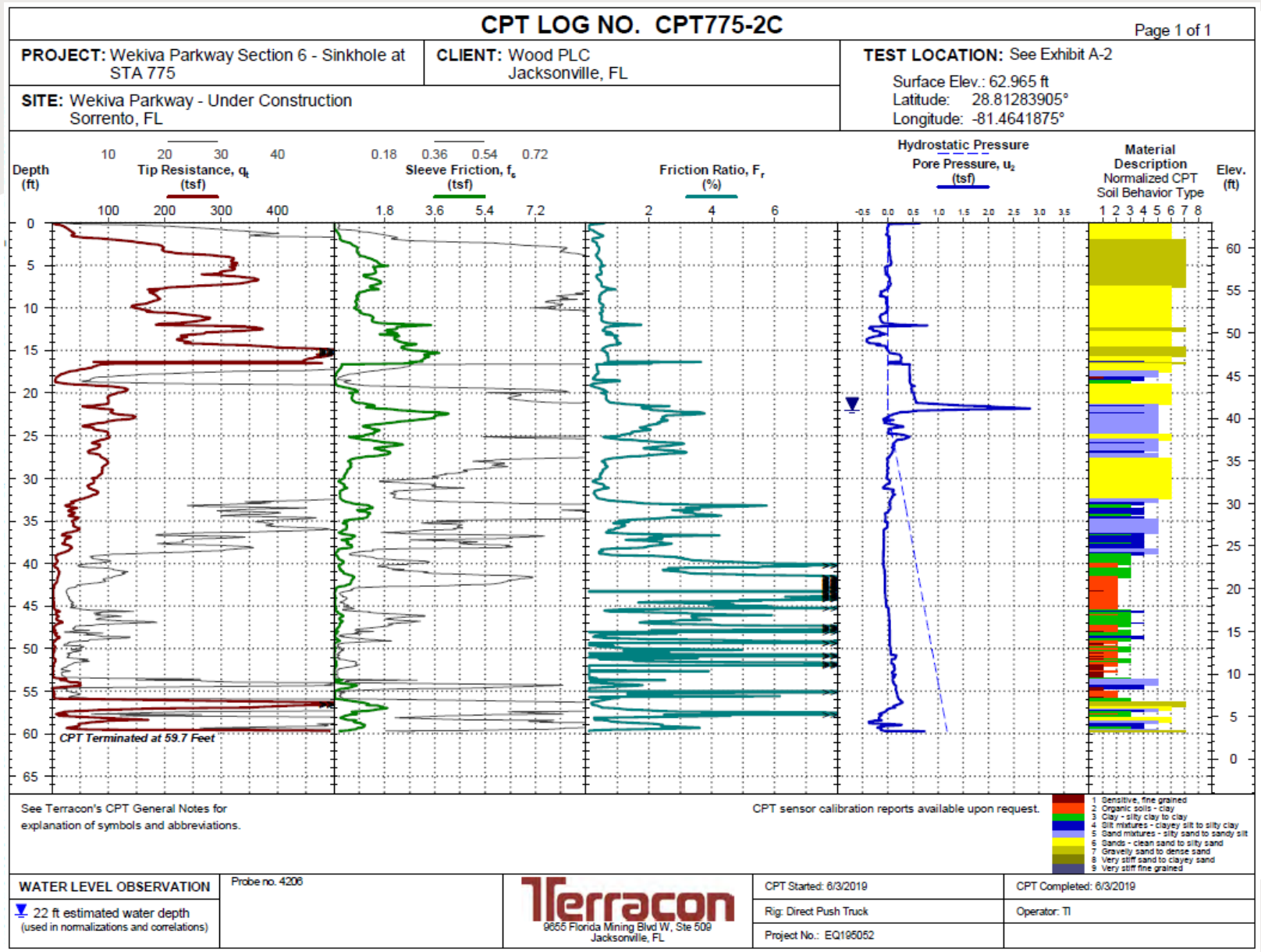
# Sinkhole No. 2

- Dimensions: 10-ft diameter, 12-ft depth
- Occurred at a height of 1/3 of final grade

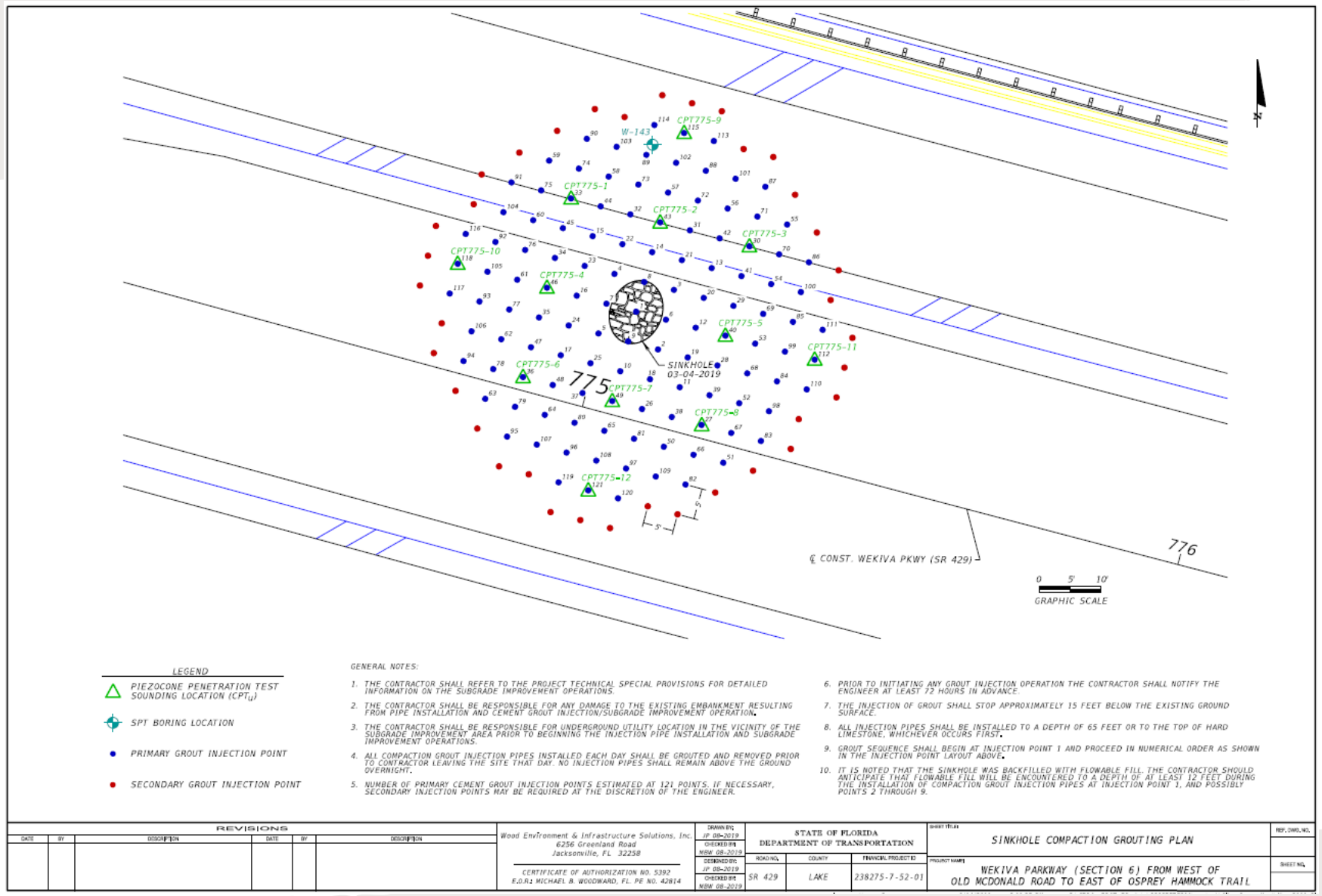
Photo courtesy of FDOT

Photos courtesy of Superior Construction Company and RS&H

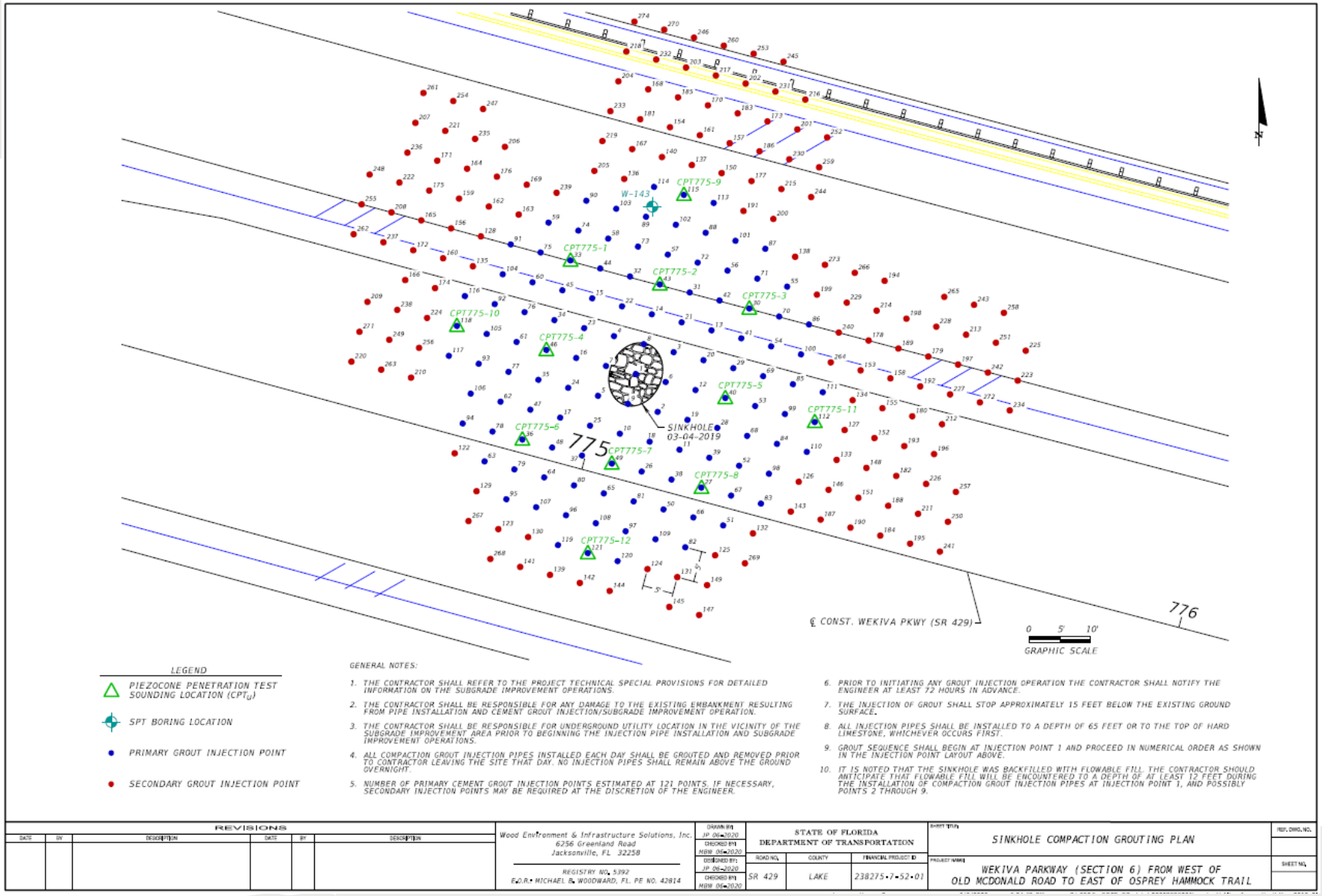
# Sinkhole No. 2 – Typical CPT Log



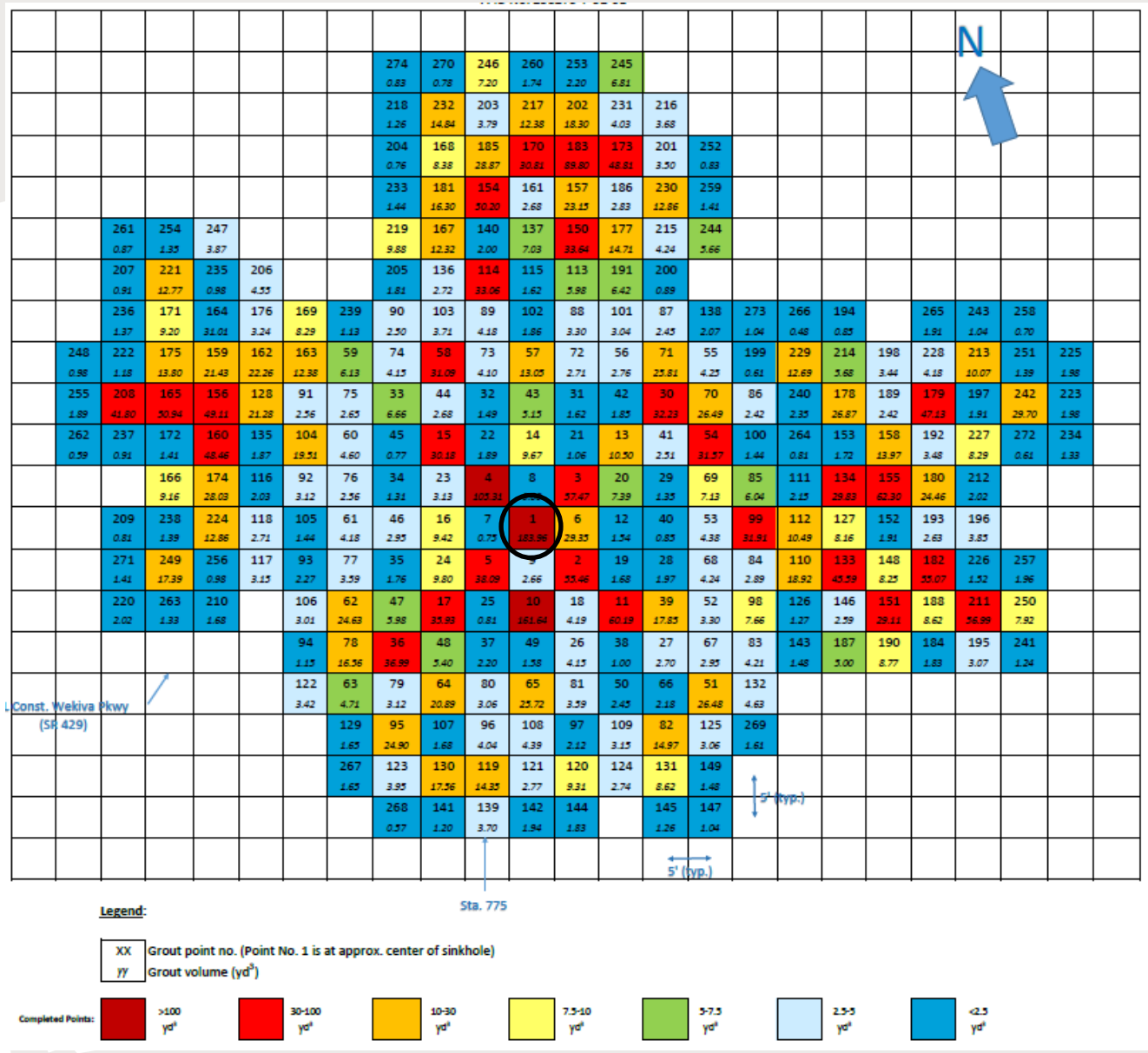
# Sinkhole No. 2 – Compaction Grout Points (planned)



# Sinkhole No. 2 – Compaction Grout Points (actual)

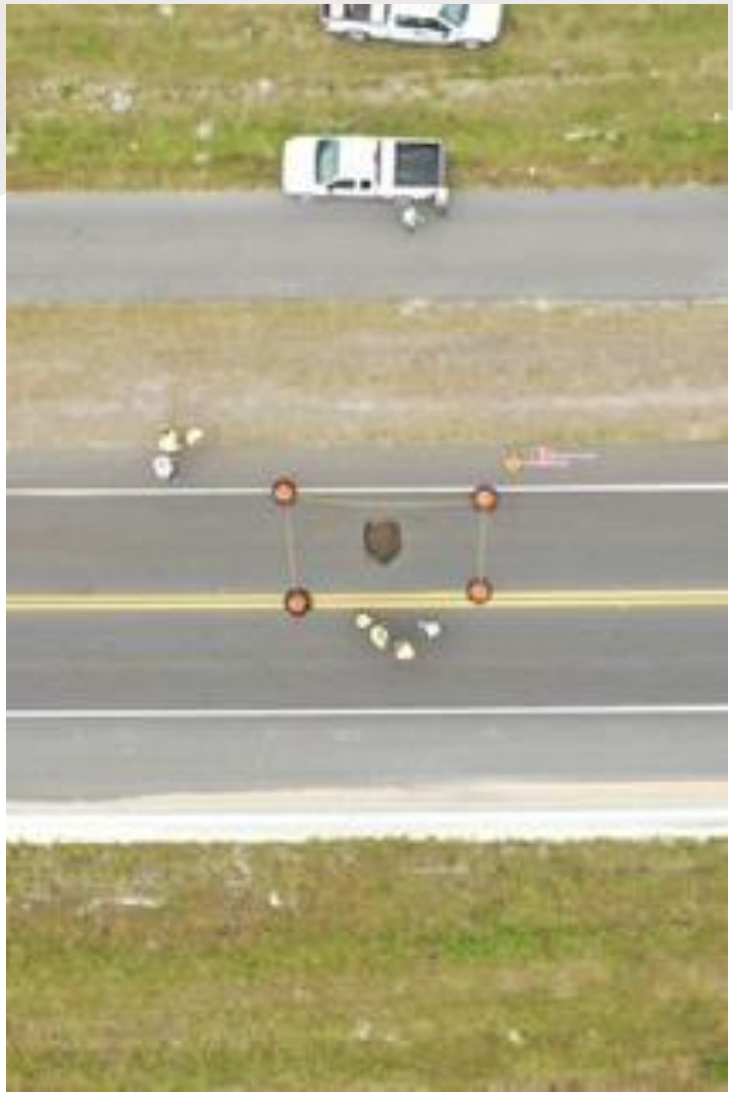


# Sinkhole No. 2 – Compaction Grouting Quantities



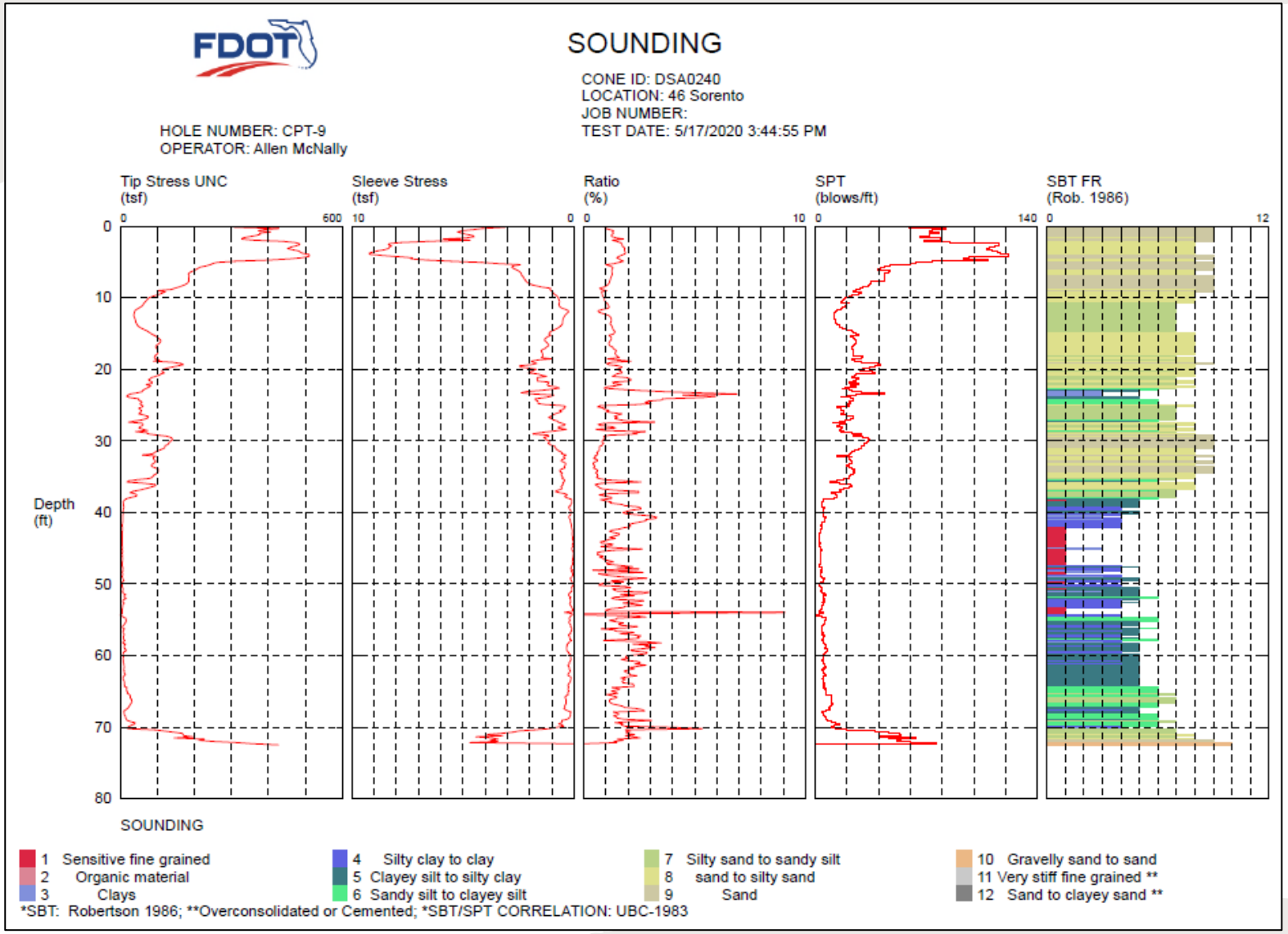
# Sinkhole No. 3

- Dimensions: 6-ft diameter, 10-ft depth
- Service Road recently opened to traffic

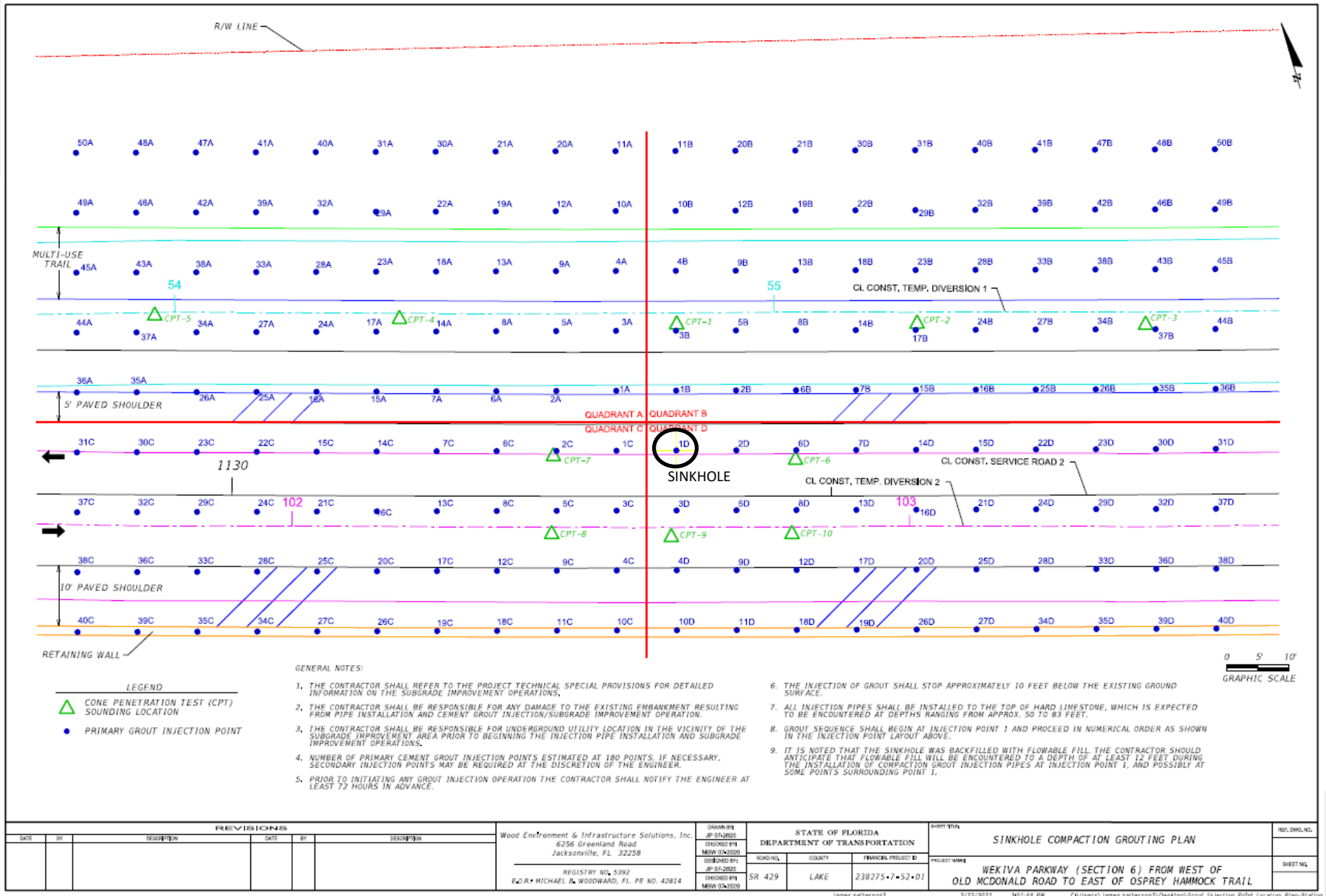


Photos courtesy of Superior Construction Company

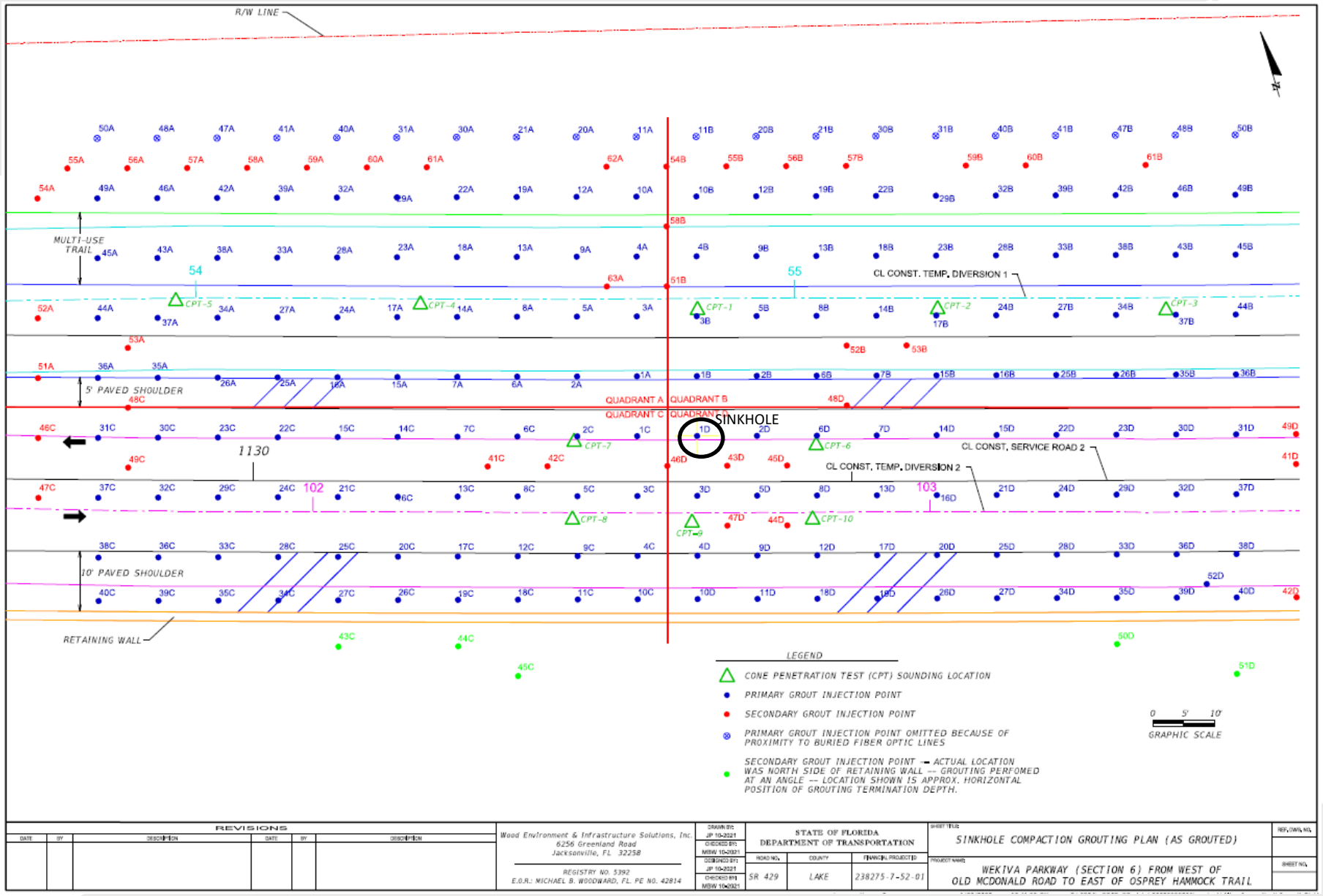
# Sinkhole No. 3 – Typical CPT Log



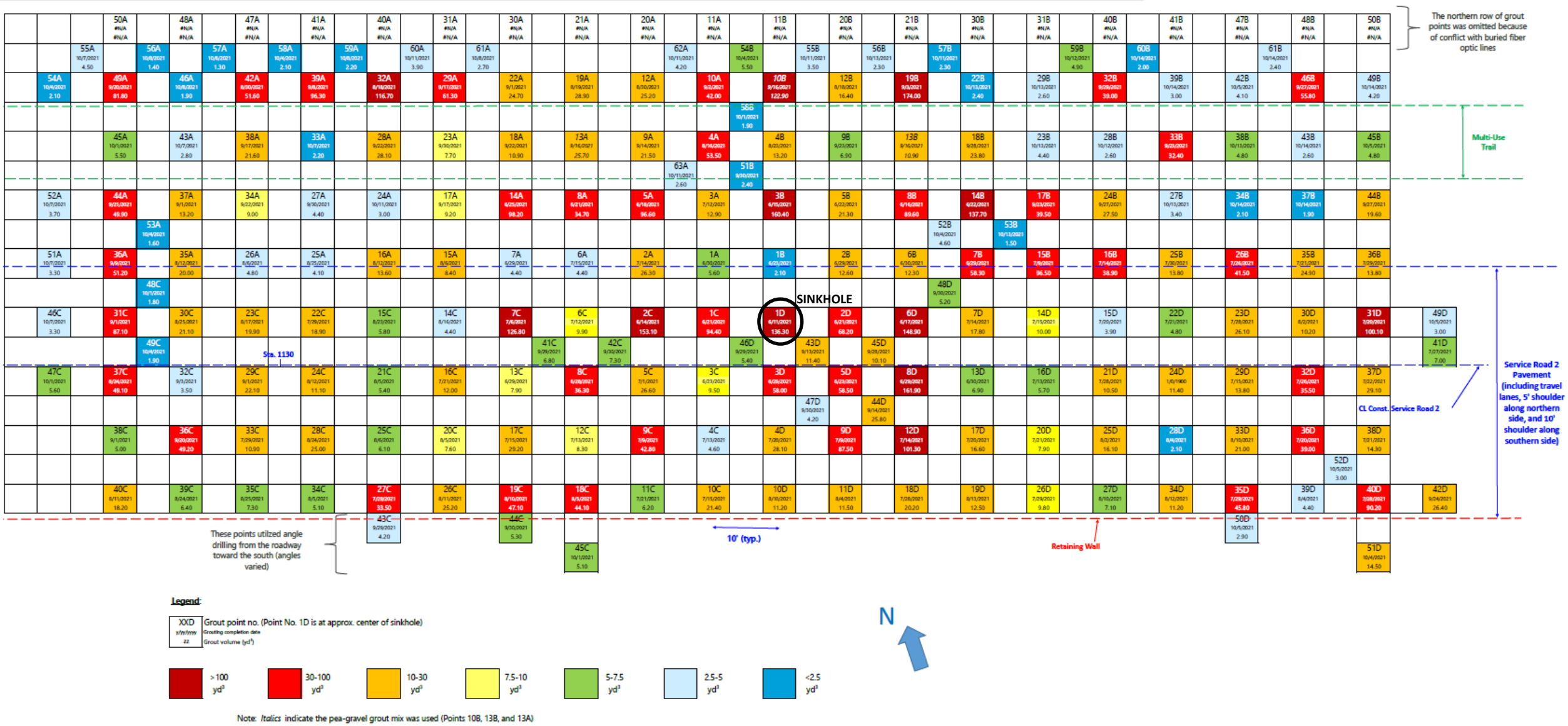
# Sinkhole No. 3 – Compaction Grout Points (planned)



# Sinkhole No. 3 – Compaction Grout Points (actual)



# Sinkhole No. 3 – Compaction Grouting Quantities



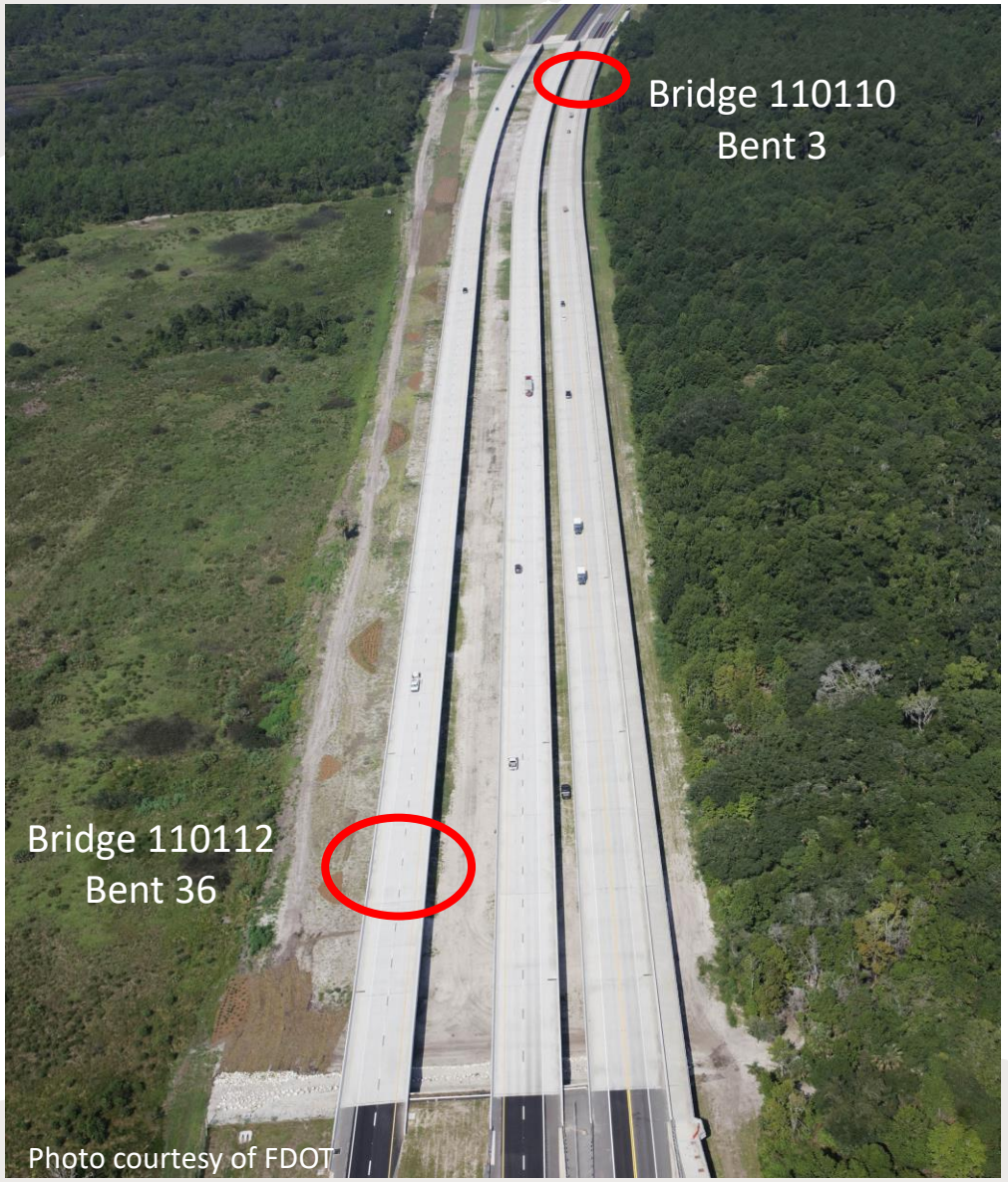
# Compaction Grouting Program Summary

| | Sinkhole No. 2 | Sinkhole No. 3 |
|---|---|---|
| Grout Points | 274 | 207 |
| Lin. Ft. of Casing | 13,962 ft | 14,088 ft |
| Depths (min / max / avg) | 31 / 74 / 51 ft | 41 / 130 / 69 ft |
| Grout Quantity Range/Point | <1 to 184 cy | 1.5 to 174 cy |
| Total Grout Quantity | 3,140 cy | 5,370 cy |
| Duration | 4½ months | 4 months |
| Approx. Area Covered | 7,100 sf | 16,000 sf |

# Wildlife Crossing 2 Challenges

## Three Parallel Bridges:

| | |
|---|---|
| Bridge Nos. | 110110, 110111, 110112 |
| Length | 3,860 feet |
| No. of Spans | 38 per bridge |
| Pile Size/Type | 24-inch Square Prestressed Concrete |
| No. of Piles/Bent | 5 to 7 |
| Typical NBR | 720 to 774 kips |




Looking west along Wildlife Crossing 2

# Bridge No. 110112 Bent 36 - Solution

- Original Design
  - 5 Piles
  - NBR = 774 kips
- Re-Design
  - 6 Piles (2 spliced)
  - 2 Piles Abandoned
  - NBR ranged from 502 kips to 774 kips

Bent 37

Bent 36

Photos courtesy of FDOT

# And then there was Bridge No. 110110 Bent 3…

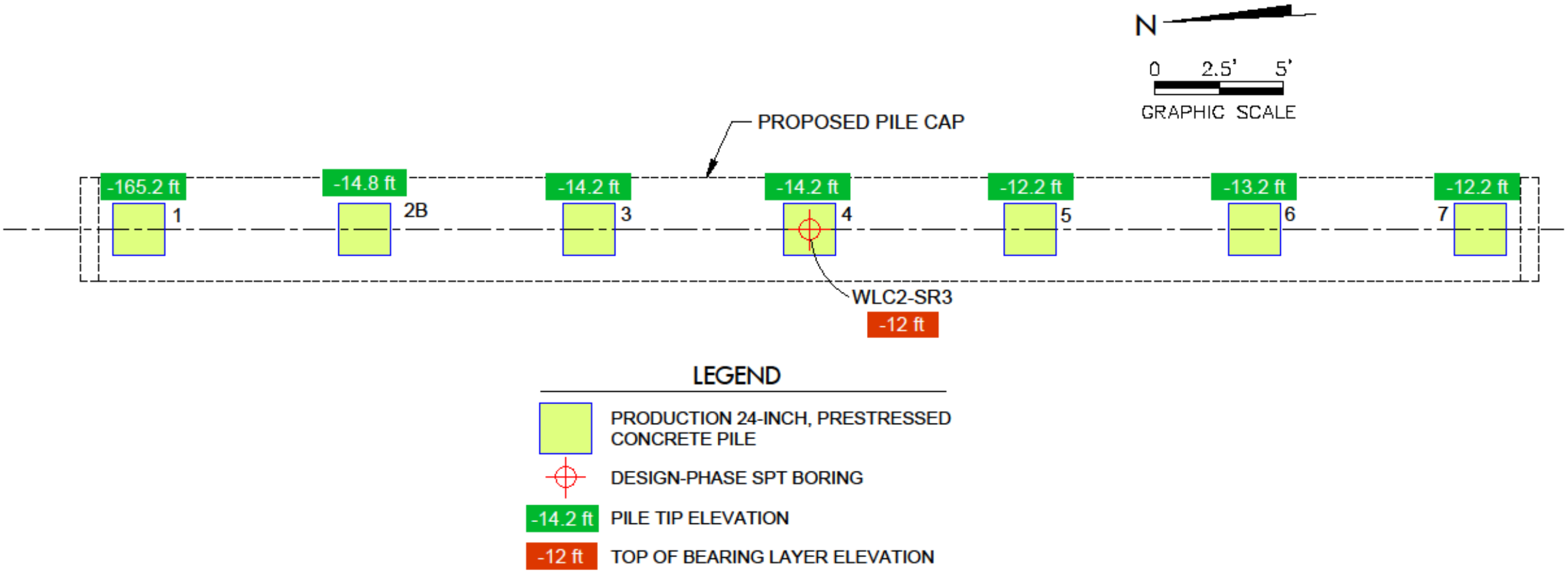
Original design:  seven piles total

- Six installed to consistent tip elevations
- One…not so much

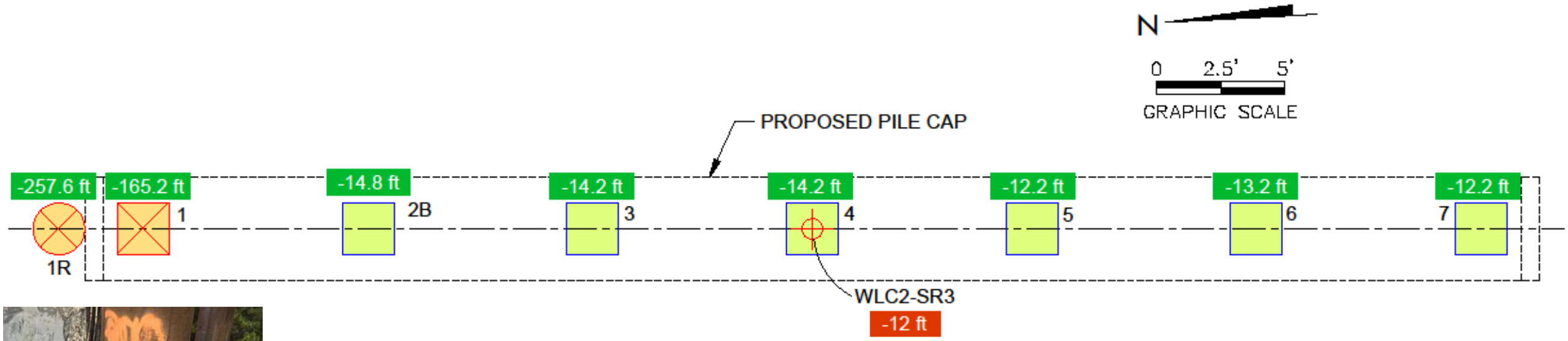
Photos courtesy of FDOT

# Original Design

## Boring data, pile driving results, configuration



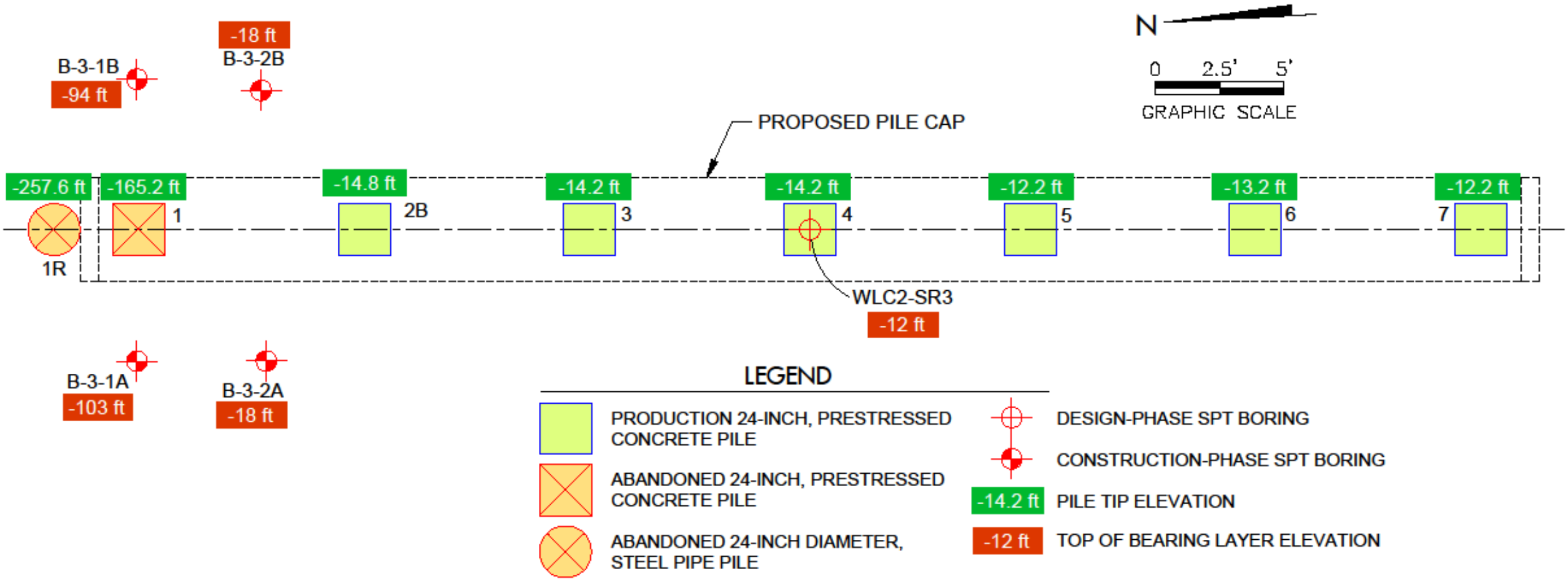
# 1st Design Revision
## Configuration, pile driving results



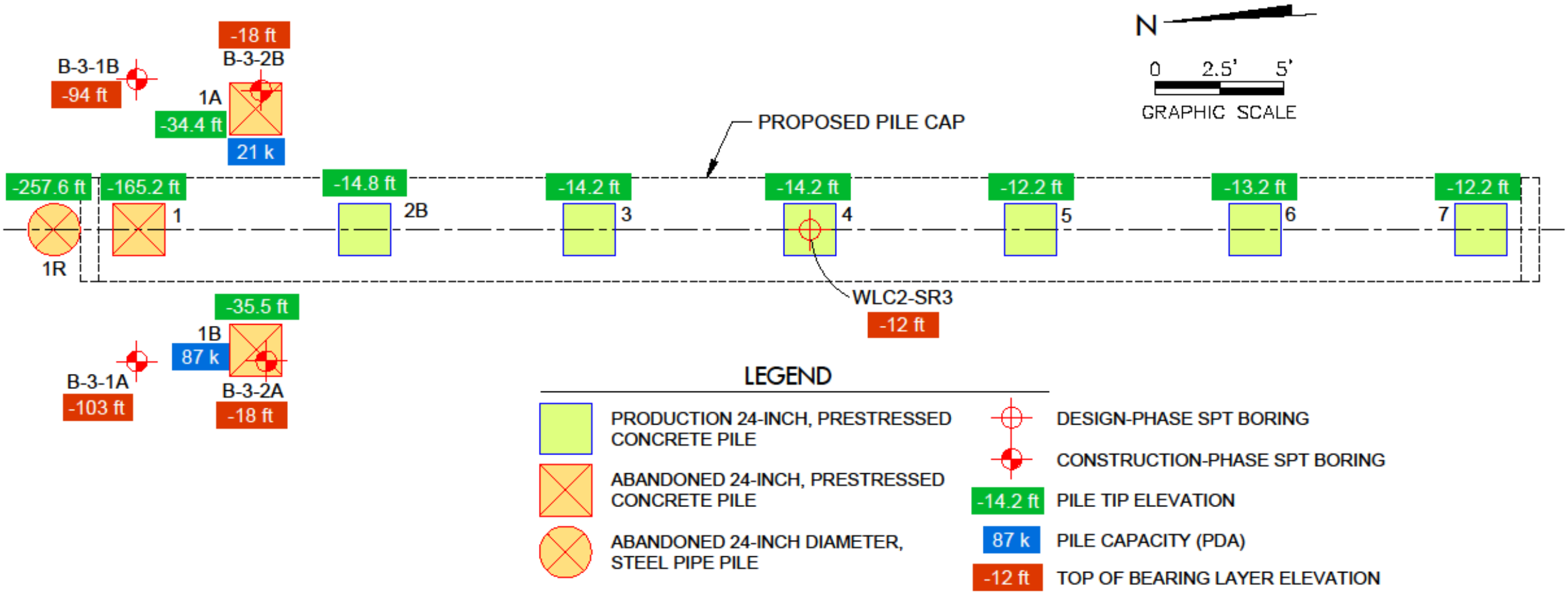

LEGEND

- PRODUCTION 24-INCH, PRESTRESSED CONCRETE PILE
- ABANDONED 24-INCH, PRESTRESSED CONCRETE PILE
- ABANDONED 24-INCH DIAMETER, STEEL PIPE PILE
- DESIGN-PHASE SPT BORING
- -14.2 ft PILE TIP ELEVATION
- -12 ft TOP OF BEARING LAYER ELEVATION

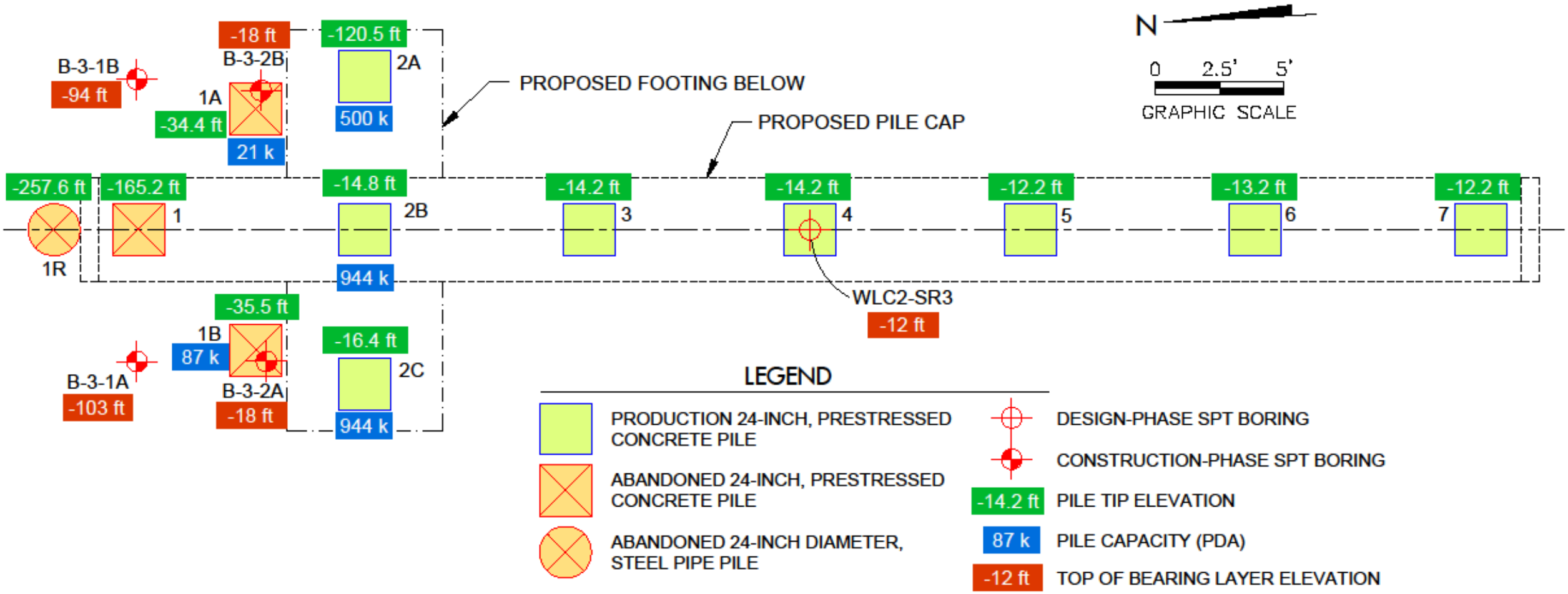
# Construction-phase borings drilled



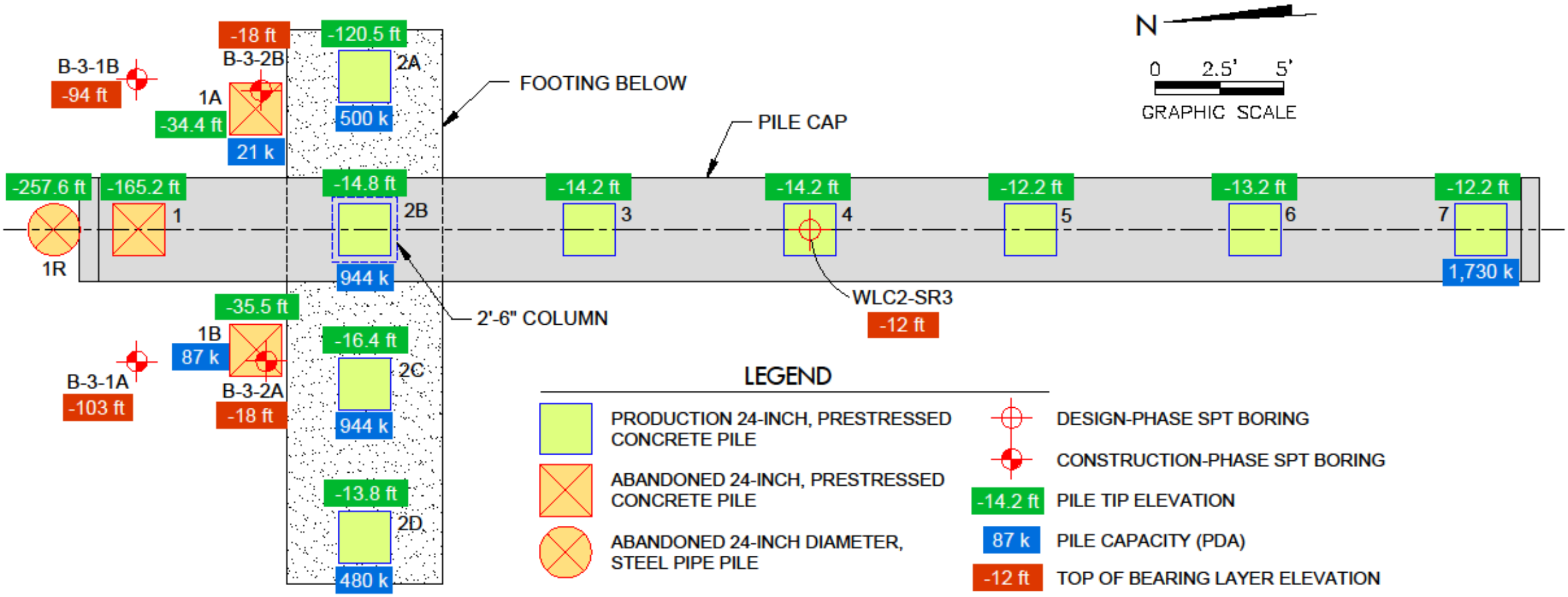
# 2nd Design Revision
# Boring data, configuration, pile-driving results



# 3rd Design Revision
# Configuration, pile-driving results



# 4th Design Revision
## Final configuration, pile driving results



# Bridge 110110 Bent 3
# Design and Construction Summary

- 6 Additional Piles Driven
- 4 Piles Abandoned
- 3 Piles Spliced in the Field (2 Concrete, 1 Steel)
- Pile Installation Took 14 Months Instead of 1-2 Days
- Pile Cap Redesigned to Accommodate Cantilever

# Bridge 110110 Bent 3

# Bridge 110110 Bent 3

# Bridge 110110 Bent 3
# (An early redesign option that was rejected)

# Summary of Unanticipated Impacts

- Design and Construction Changes
  - Multiple Bridges Required Unplanned Spliced Piles
  - Two Sinkholes Required Compaction Grouting
  - Bridge 110108 was Lengthened 200 feet
  - Bridge 110112 Bent 36 was Re-Designed One Time
  - Bridge 110110 Bent 3 was Re-Designed Four Times
- Additional Cost: $6.023M (+2.57%)
- Additional Time: 208 Days (+10.99%)

# Conclusions

- Solutions do not involve quick fixes
- Additional subsurface exploration needed when dealing with unforeseen conditions
- Redesign may be needed
- Extreme variability in subsurface conditions can make it difficult to predict pile lengths
- Such uncertainties can result in time delays that impact costs and construction schedule
- Close collaboration between team members is needed to develop appropriate solutions
- Expect surprises

# Unintended Use of a Wildlife Crossing???

# Acknowledgements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- James Horton, P.E.

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