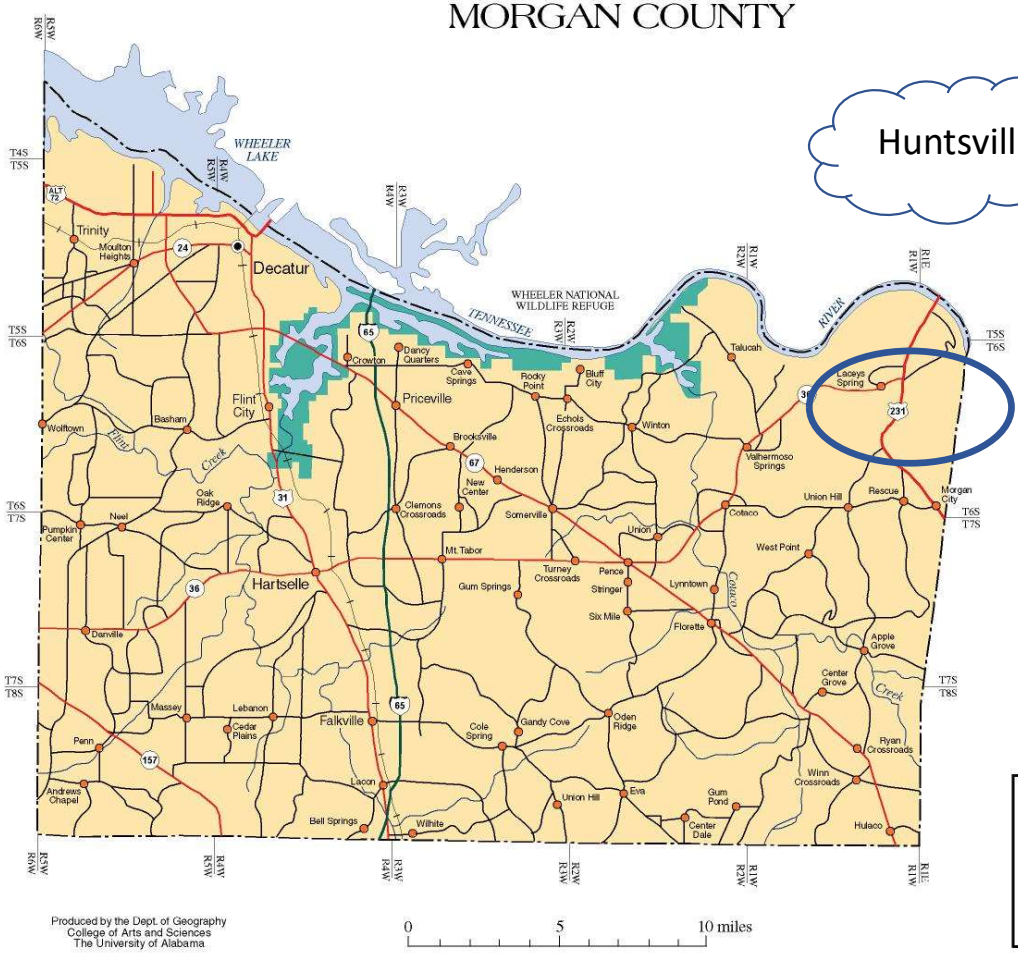
Using a Bridge for Emergency Slide Repair

US 231 near Laceys Spring, Morgan County, AL

Robert Thompson, P.E. - Senior Principal Engineer/CFO

MORGAN COUNTY



Produced by the Dept. of Geography
College of Arts and Sciences
The University of Alabama

Huntsville

Legend

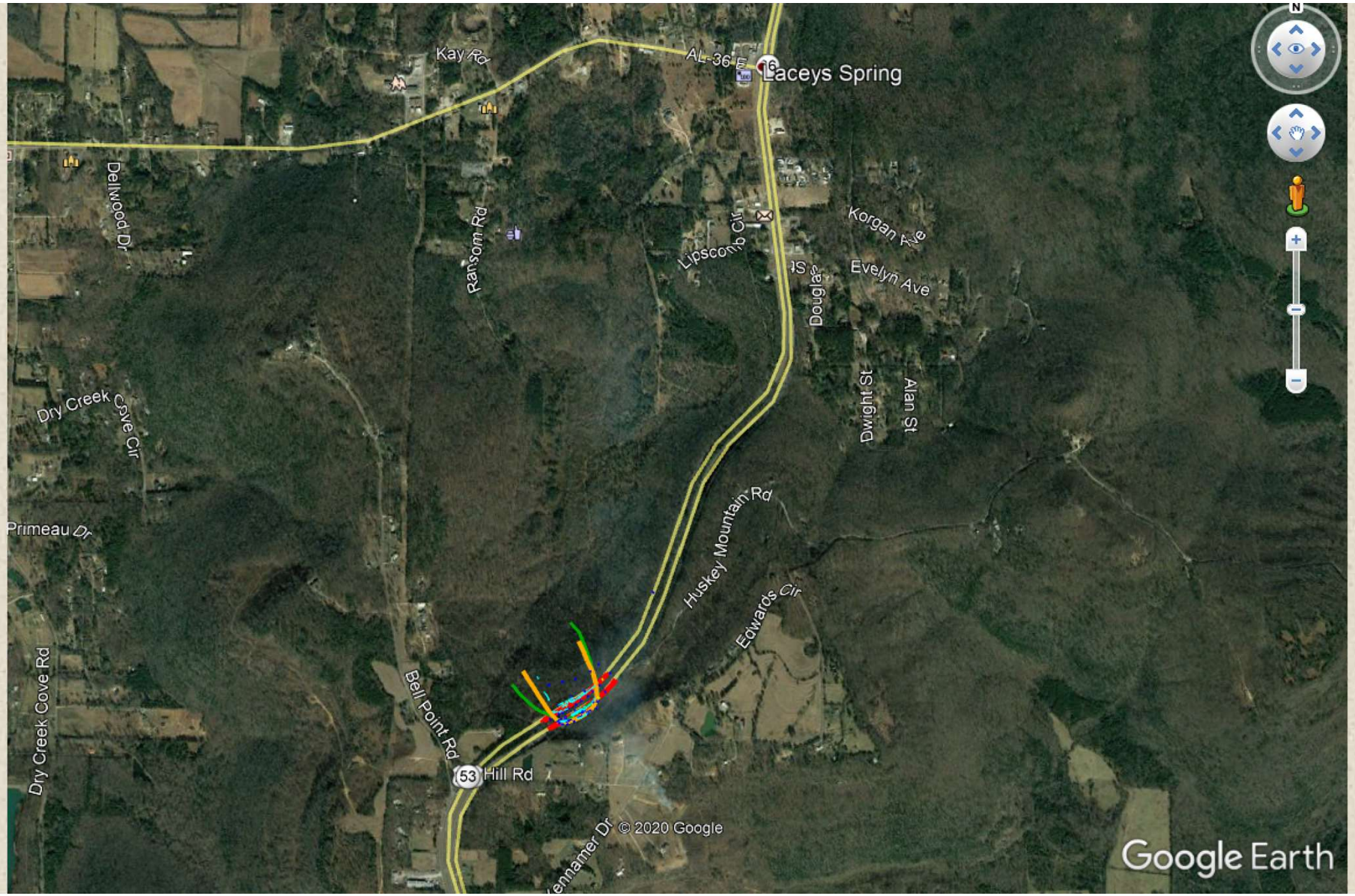
- County seat
- City, town or village
- Primary highway
- Secondary highway
- Other principal roads
- Route marker: Interstate; U.S.; State

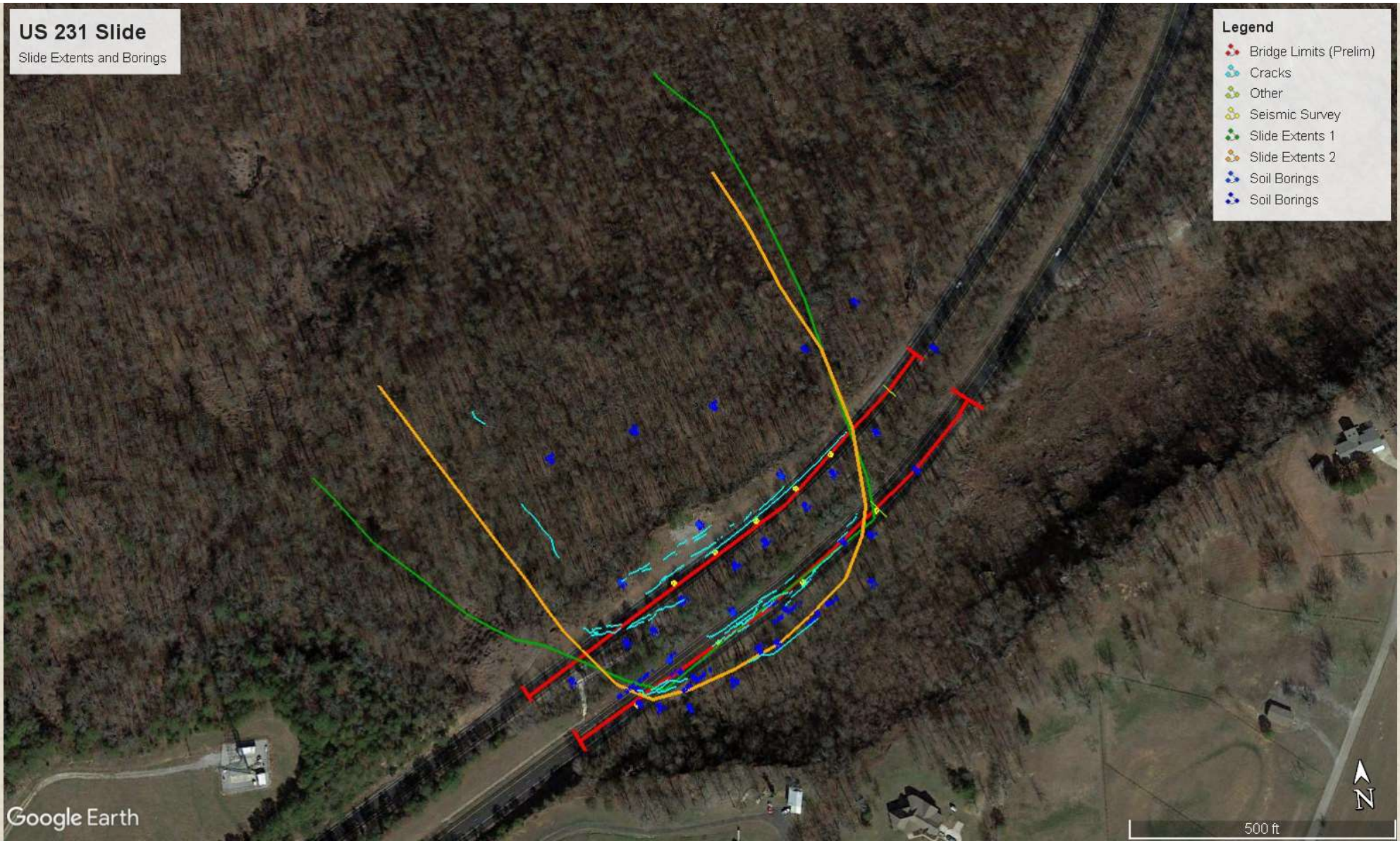
Population Key

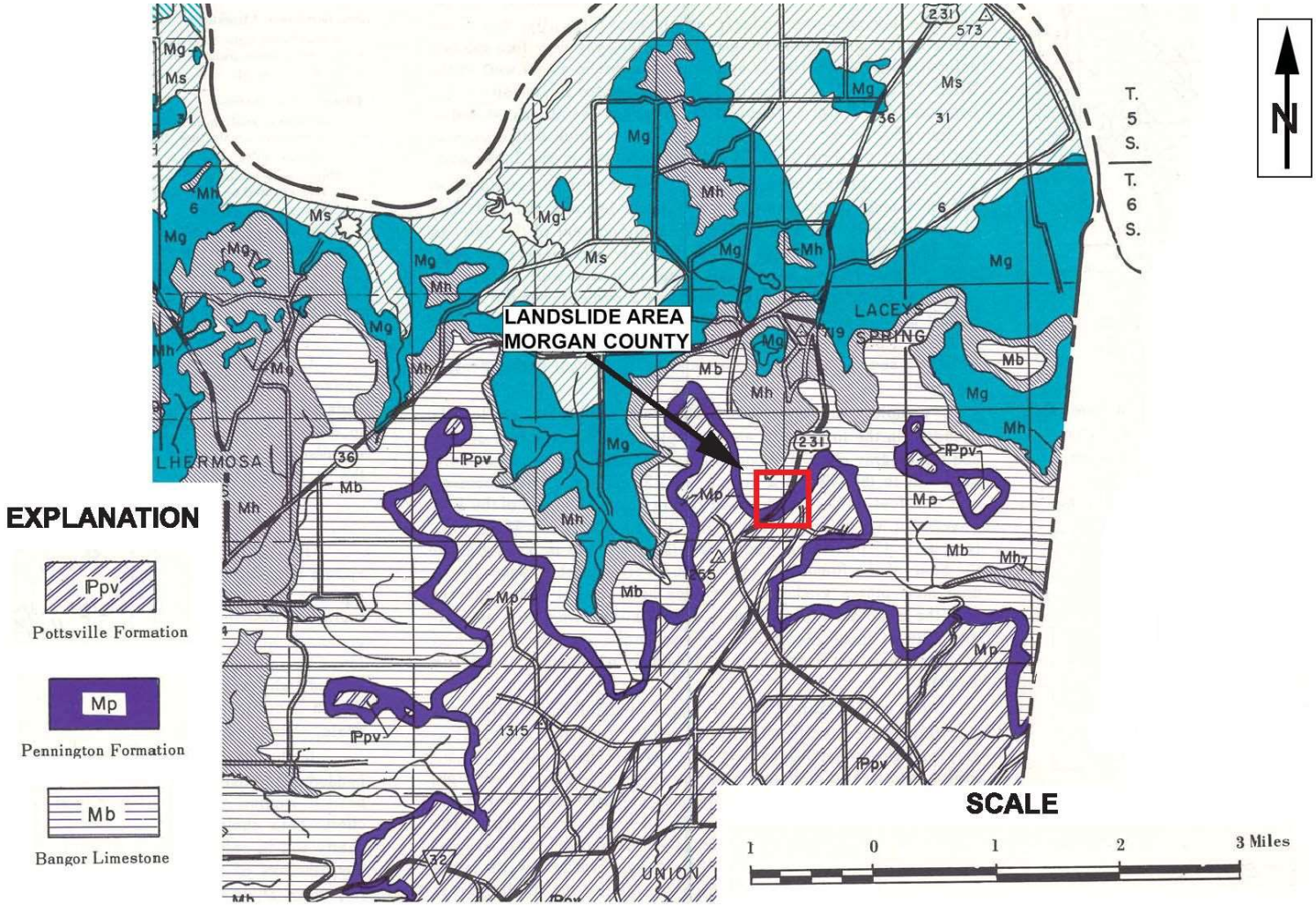
BIRMINGHAM	100,000 to 500,000
Tuscaloosa	50,000 to 100,000
Gadsden	25,000 to 50,000
Albertville	5,000 to 25,000
Foley	1,000 to 5,000
Brilliant	500 to 1,000
Elkmont	up to 500

DBA Design and Construction Timeline

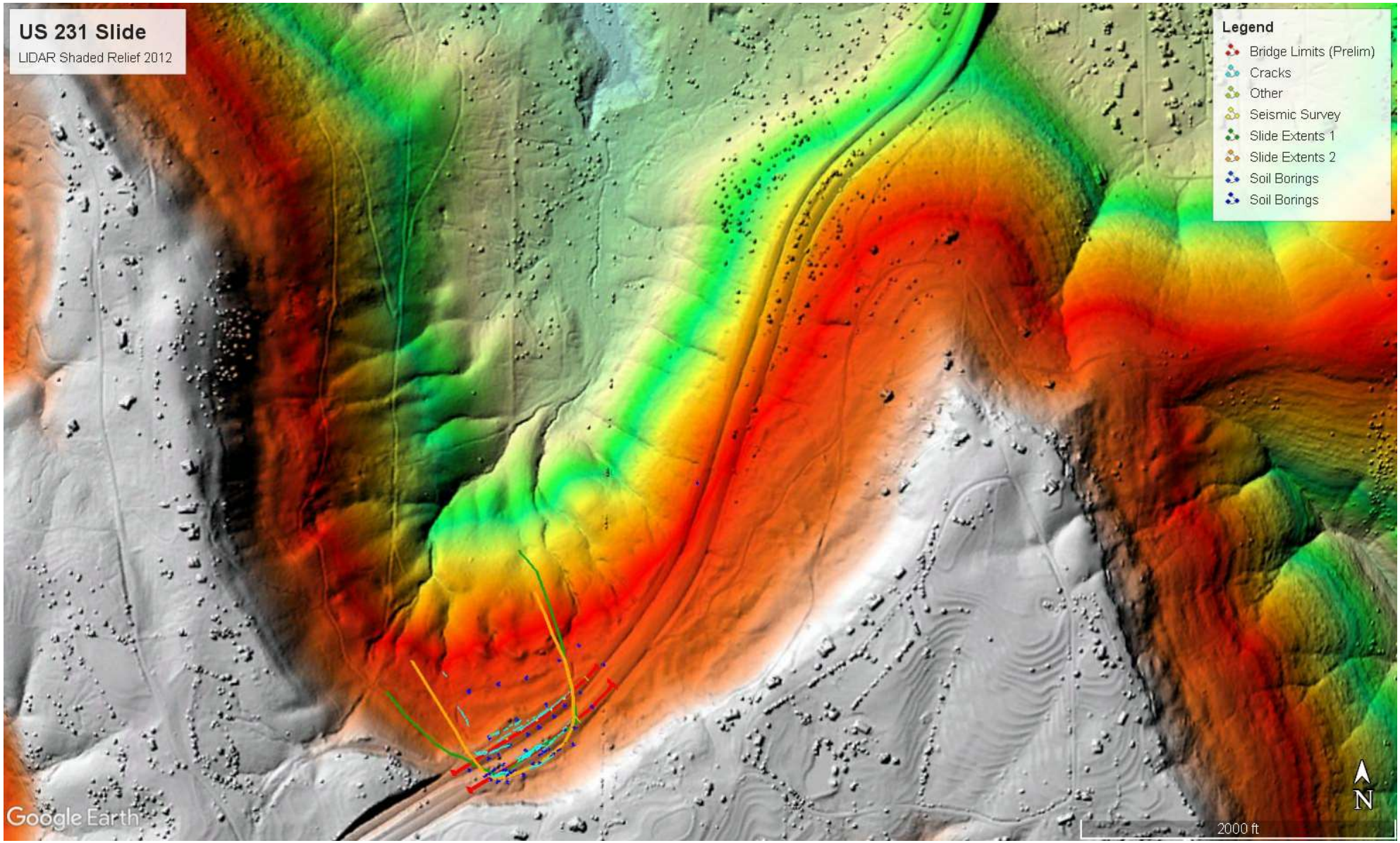
- **Feb 12/13 – Slide Occurs**
- Feb 14 – Get the Call
- Feb 17 – ALDOT mobilizes drills (State Holiday)
- Feb 18-20 – Visit Site, ALDOT drilling
- Mar 5 – Meet w/Director – Bridge is a GO
- Mar 9 – Excavation Underway
- Mar 11 – Bridge Limits Set by DBA/Design Begins
- Apr 15 – Foundation Design Report Delivered
- Apr 20 – Plans Issued
- May 8 – Project Letting and Award
- June 1 12:00am – Begin Construction
- **Sep 28 – Bridge Open to Traffic (7.5 months!)**
- Mid Oct – Post-Construction Instrumentation Installation
- Dec – Collection of instrument readings via remote begins

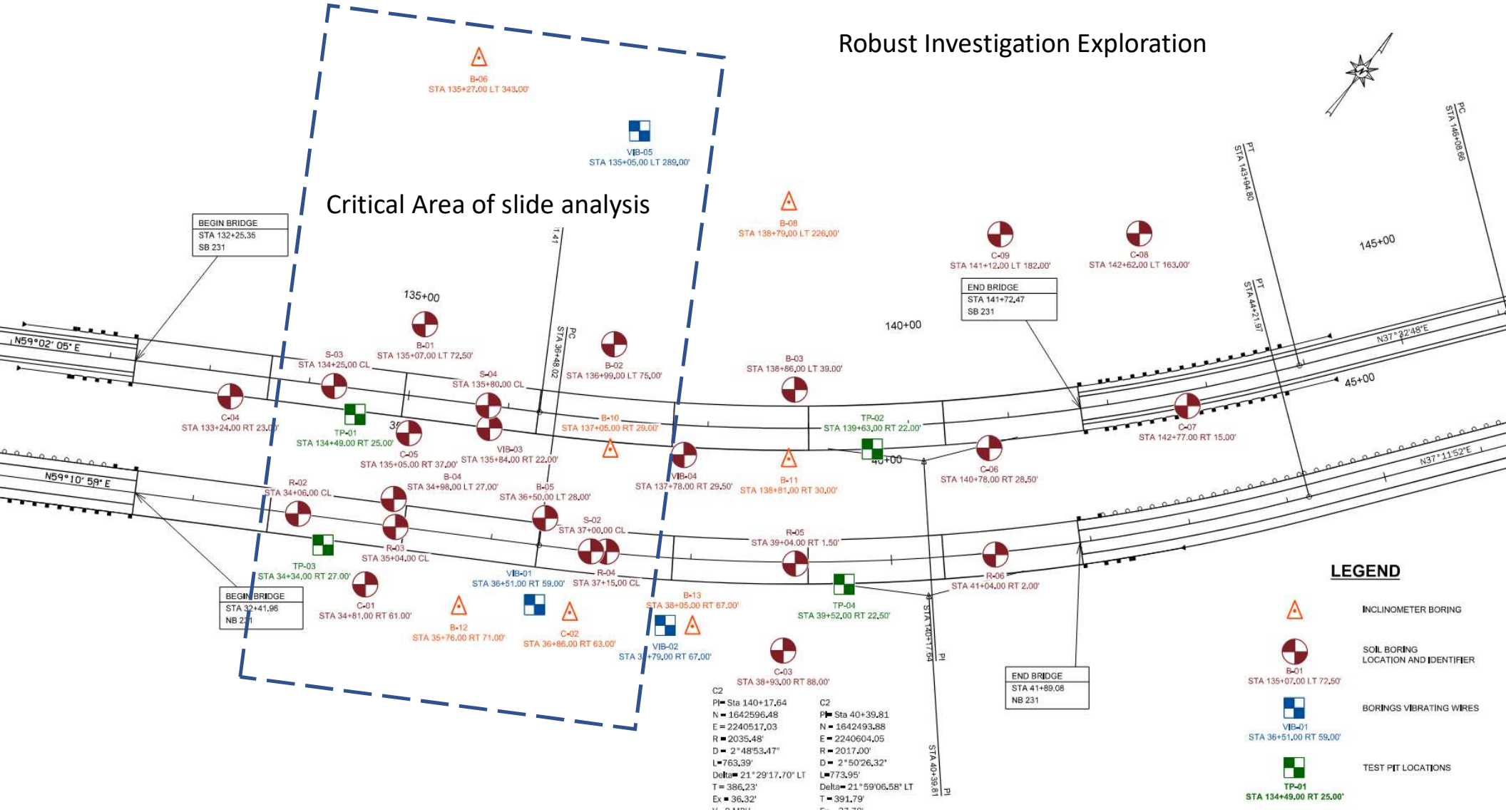

Kay Rd
AL-36
Laceys Spring
Dellwood Dr
Ransom Rd
Lipscomb Cir
Korgan Ave
Douglas St
Evelyn Ave
Dwight St
Alan St
Dry Creek Cove Cir
Primeau Dr
Huskey Mountain Rd
Edwards Cir
Dry Creek Cove Rd
Bell Point Rd
53
Hill Rd
© 2020 Google
Google Earth


US 231 Slide
Slide Extents and Borings
Legend
Bridge Limits (Prelim)
Cracks
Other
Seismic Survey
Slide Extents 1
Slide Extents 2
Soil Borings
Soil Borings
Google Earth
N
500 ft

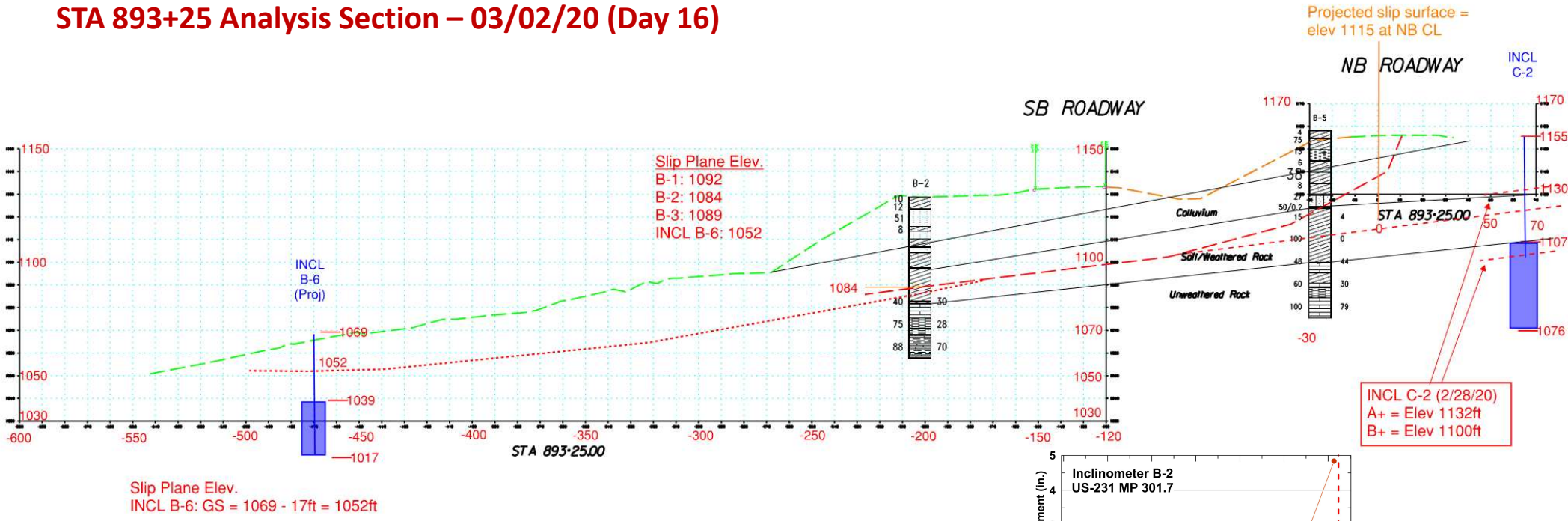


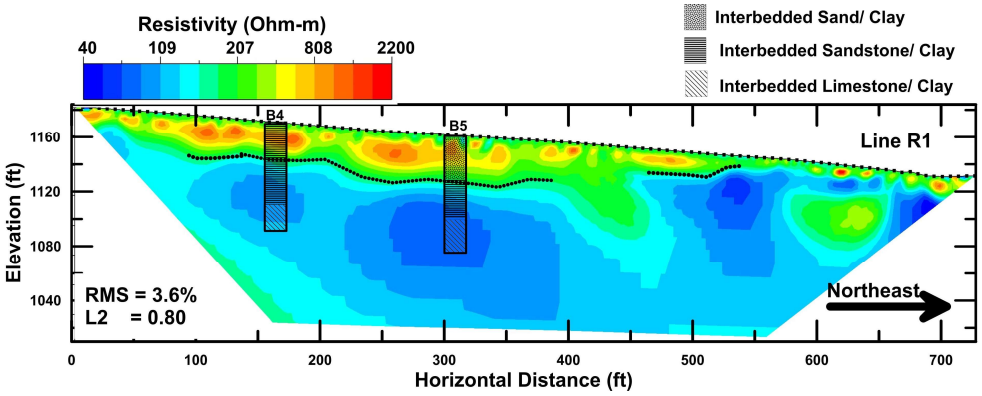
Geologic map of the Laceys Spring area, Morgan County, showing the location of the landslide area on US-231 at MP 301.7 (Dodson, Chester L., and Harris, Jr., Wiley F., 1963, Geologic Map of Morgan County, Alabama: Geological Survey of Alabama Map 23).

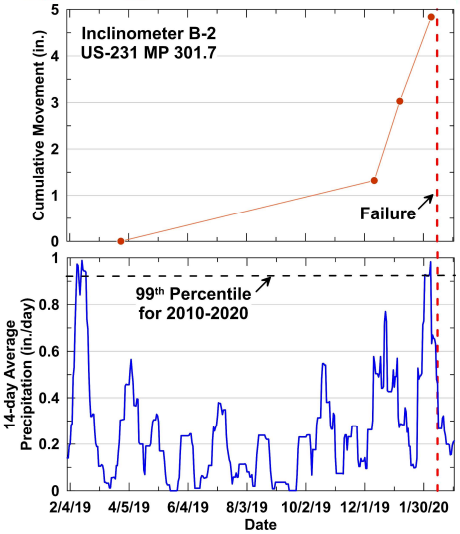

US 231 Slide
LIDAR Shaded Relief 2012
Legend
Bridge Limits (Prelim)
Cracks
Other
Seismic Survey
Slide Extents 1
Slide Extents 2
Soil Borings
Soil Borings
Google Earth
N
2000 ft


Robust Investigation Exploration
Critical Area of slide analysis
B-06
STA 135+27.00 LT 343.00'
VIB-05
STA 135+05.00 LT 289.00'
B-08
STA 138+79.00 LT 226.00'
C-09
STA 141+12.00 LT 182.00'
C-08
STA 142+62.00 LT 163.00'
BEGIN BRIDGE
STA 132+25.35
SB 231
END BRIDGE
STA 141+72.47
SB 231
135+00
140+00
145+00
45+00
B-01
STA 135+07.00 LT 72.50'
B-02
STA 136+99.00 LT 75.00'
B-03
STA 138+86.00 LT 39.00'
S-03
STA 134+25.00 CL
S-04
STA 135+80.00 CL
C-04
STA 133+24.00 RT 23.00'
TP-01
STA 134+49.00 RT 25.00'
C-05
STA 135+05.00 RT 37.00'
VIB-03
STA 135+84.00 RT 22.00'
B-10
STA 137+05.00 RT 29.00'
TP-02
STA 139+63.00 RT 22.00'
C-07
STA 142+77.00 RT 15.00'
C-06
STA 140+78.00 RT 28.50'
VIB-04
STA 137+78.00 RT 29.50'
B-11
STA 138+81.00 RT 30.00'
R-02
STA 34+06.00 CL
B-04
STA 34+98.00 LT 27.00'
B-05
STA 36+50.00 LT 28.00'
S-02
STA 37+00.00 CL
R-05
STA 39+04.00 RT 1.50'
R-03
STA 35+04.00 CL
TP-03
STA 34+34.00 RT 27.00'
VIB-01
STA 36+51.00 RT 59.00'
R-04
STA 37+15.00 CL
R-06
STA 41+04.00 RT 2.00'
BEGIN BRIDGE
STA 32+41.96
NB 231
C-01
STA 34+81.00 RT 61.00'
B-12
STA 35+76.00 RT 71.00'
C-02
STA 36+86.00 RT 63.00'
B-13
STA 38+05.00 RT 67.00'
VIB-02
STA 37+79.00 RT 67.00'
TP-04
STA 39+52.00 RT 22.50'
C-03
STA 38+93.00 RT 88.00'
END BRIDGE
STA 41+89.08
NB 231
N59°02' 05" E
N59°10' 58" E
N37°32'48"E
N37°11'52"E
PC
STA 36+48.02
PT
STA 143+94.80
PC
STA 146+08.66
PT
STA 44+27.97
PI
STA 140+17.64
PI
STA 40+39.81
C2
PI= Sta 140+17.64
N = 1642596.48
E = 2240517.03
R = 2035.48'
D = 2°48'53.47"
L=763.39'
Delta= 21°29'17.70" LT
T = 386.23'
Ex = 36.32'
C2
PI= Sta 40+39.81
N = 1642493.88
E = 2240604.05
R = 2017.00'
D = 2°50'26.32"
L=773.95'
Delta= 21°59'06.58" LT
T = 391.79'
LEGEND
INCLINOMETER BORING
SOIL BORING
LOCATION AND IDENTIFIER
B-01
STA 135+07.00 LT 72.50'
BORINGS VIBRATING WIRES
VIB-01
STA 36+51.00 RT 59.00'
TEST PIT LOCATIONS
TP-01
STA 134+49.00 RT 25.00'

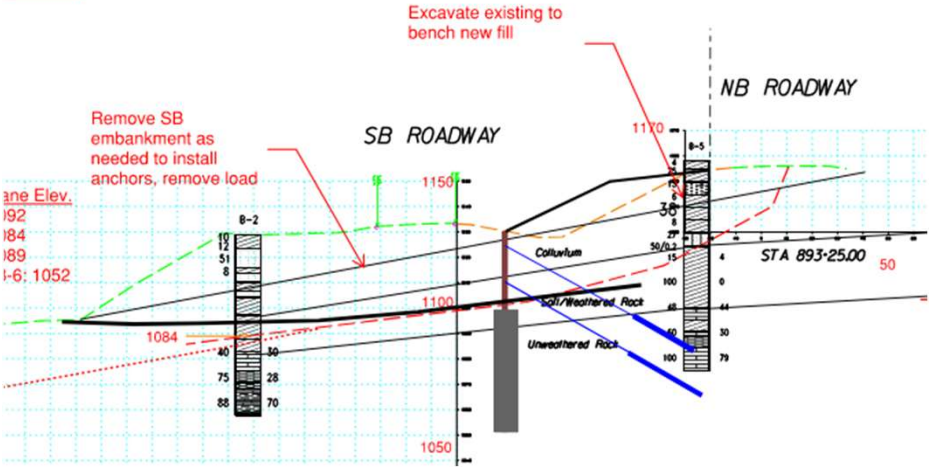
STA 893+25 Analysis Section – 03/02/20 (Day 16)



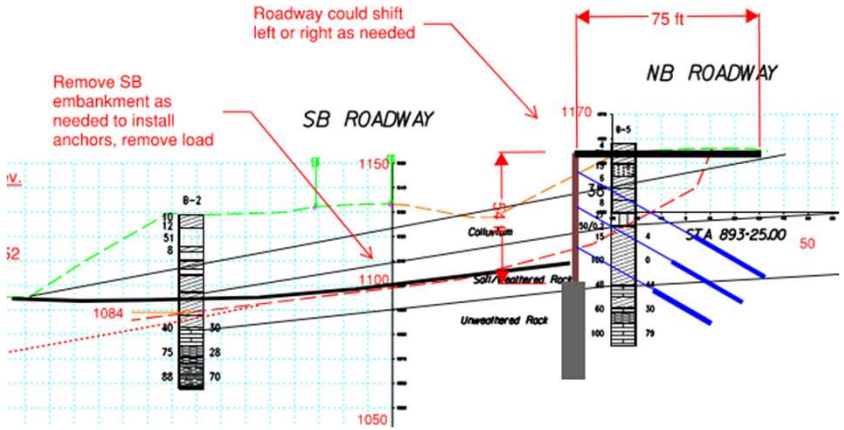


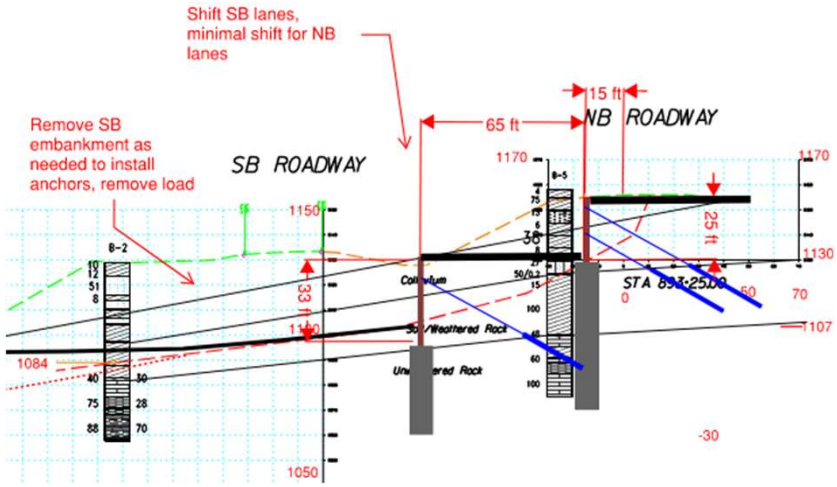


SP Wall

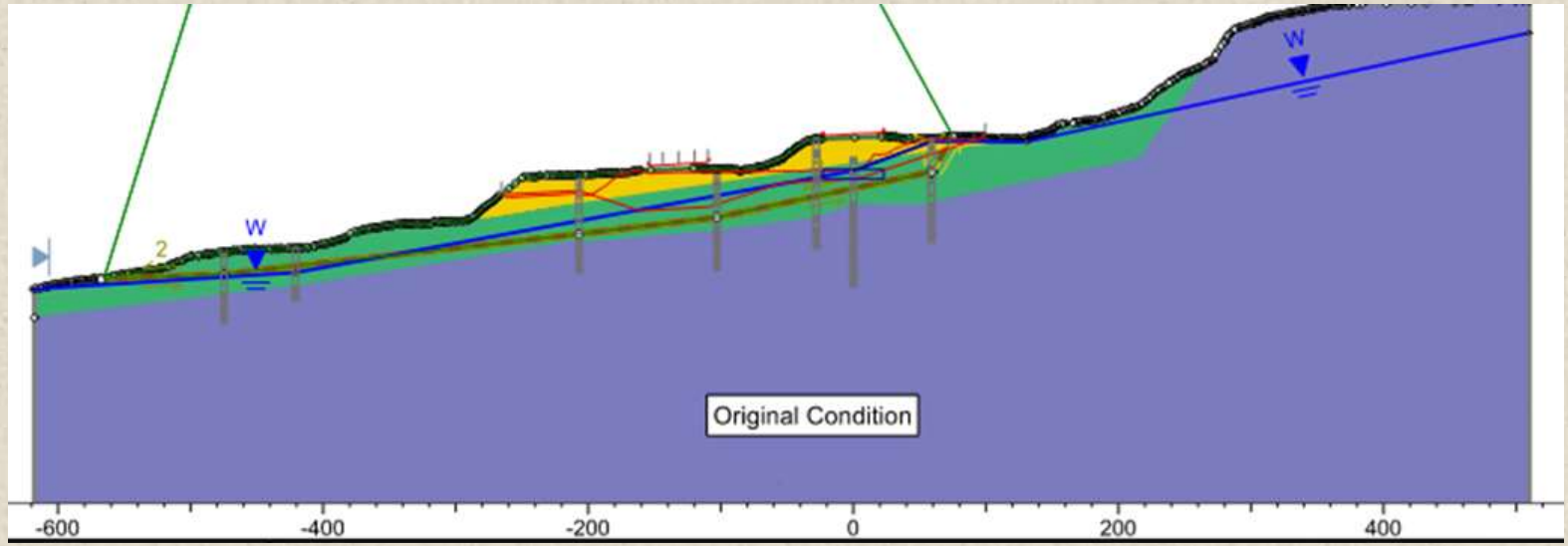

Excavate existing to bench new fill
NB ROADWAY
Remove SB embankment as needed to install anchors, remove load
SB ROADWAY
1170
1150
1100
1084
1050
B-2
B-5
Colluvium
Soil/Weathered Rock
Unweathered Rock
STA 893+25.00
50

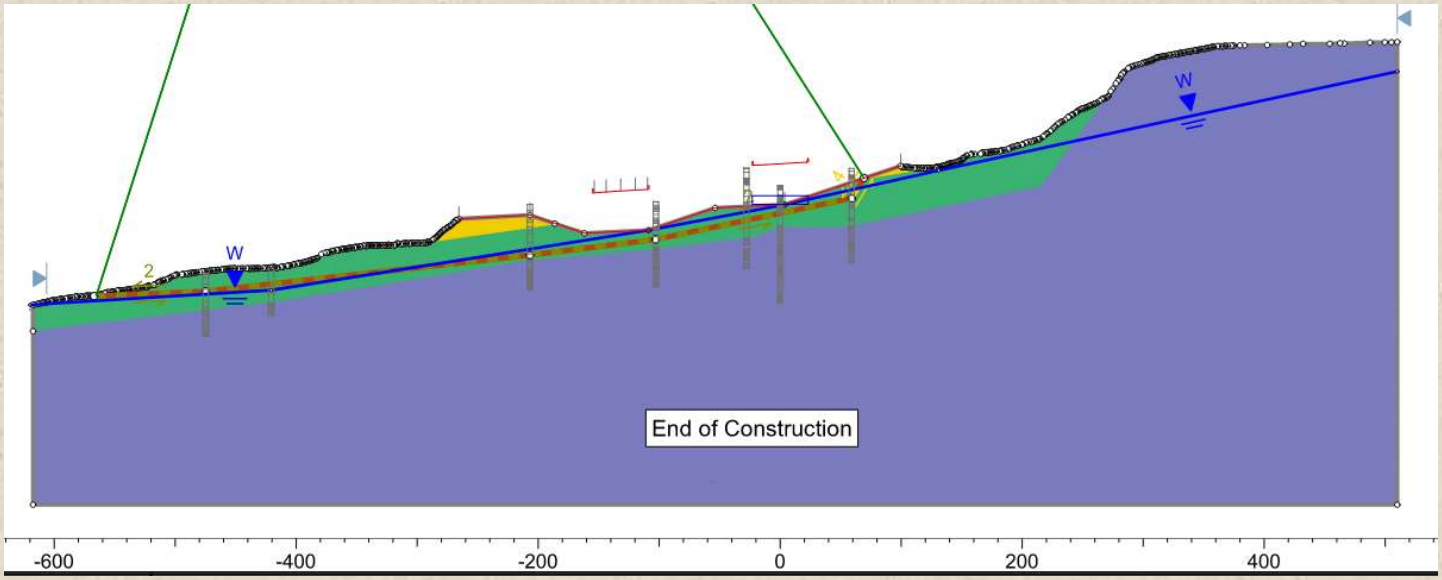
Wall


Roadway could shift left or right as needed
75 ft
NB ROADWAY
Remove SB embankment as needed to install anchors, remove load
SB ROADWAY
1170
1150
1100
1084
1050
B-2
B-5
Colluvium
Soil/Weathered Rock
Unweathered Rock
STA 893+25.00
50

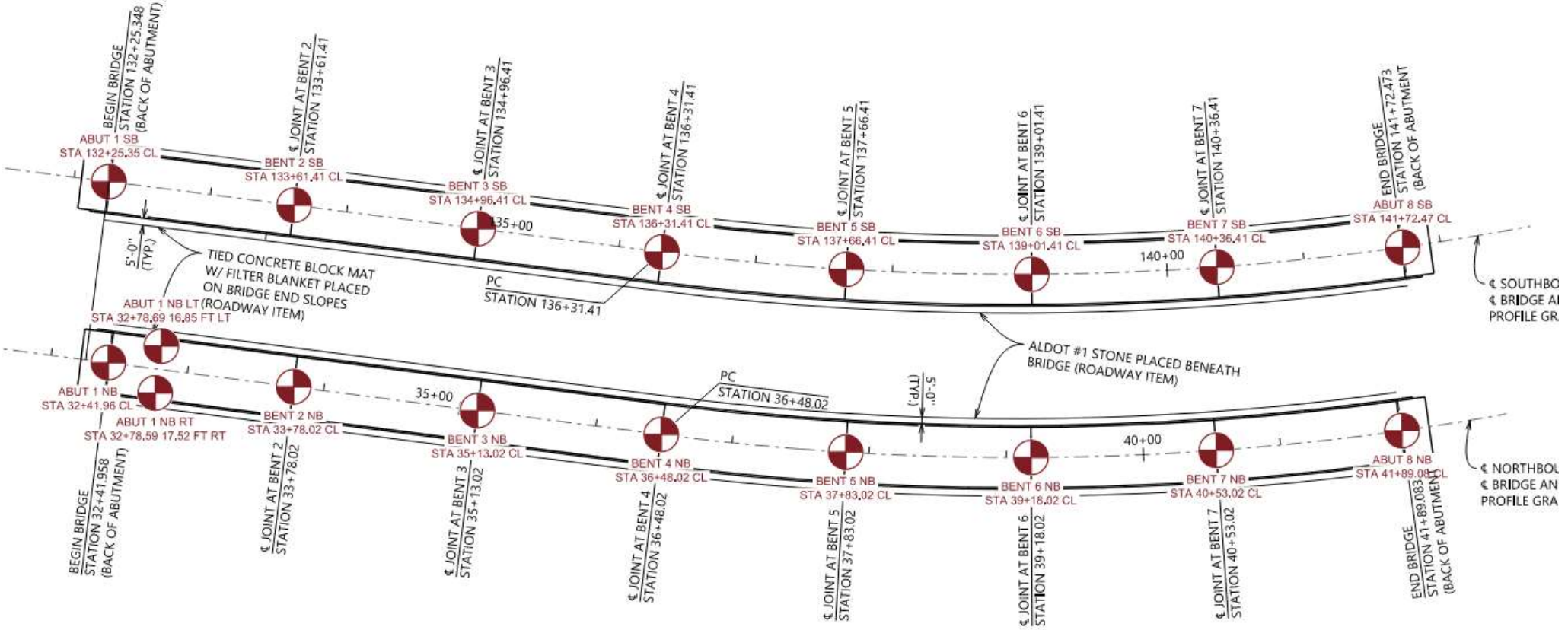

Shift SB lanes, minimal shift for NB lanes
15 ft
65 ft
NB ROADWAY
Remove SB embankment as needed to install anchors, remove load
SB ROADWAY
1170
1150
1084
1050
B-2
B-5
25 ft
33 ft
STA 893+25.00
50
70
0
-30
1130
1107


VOLVO

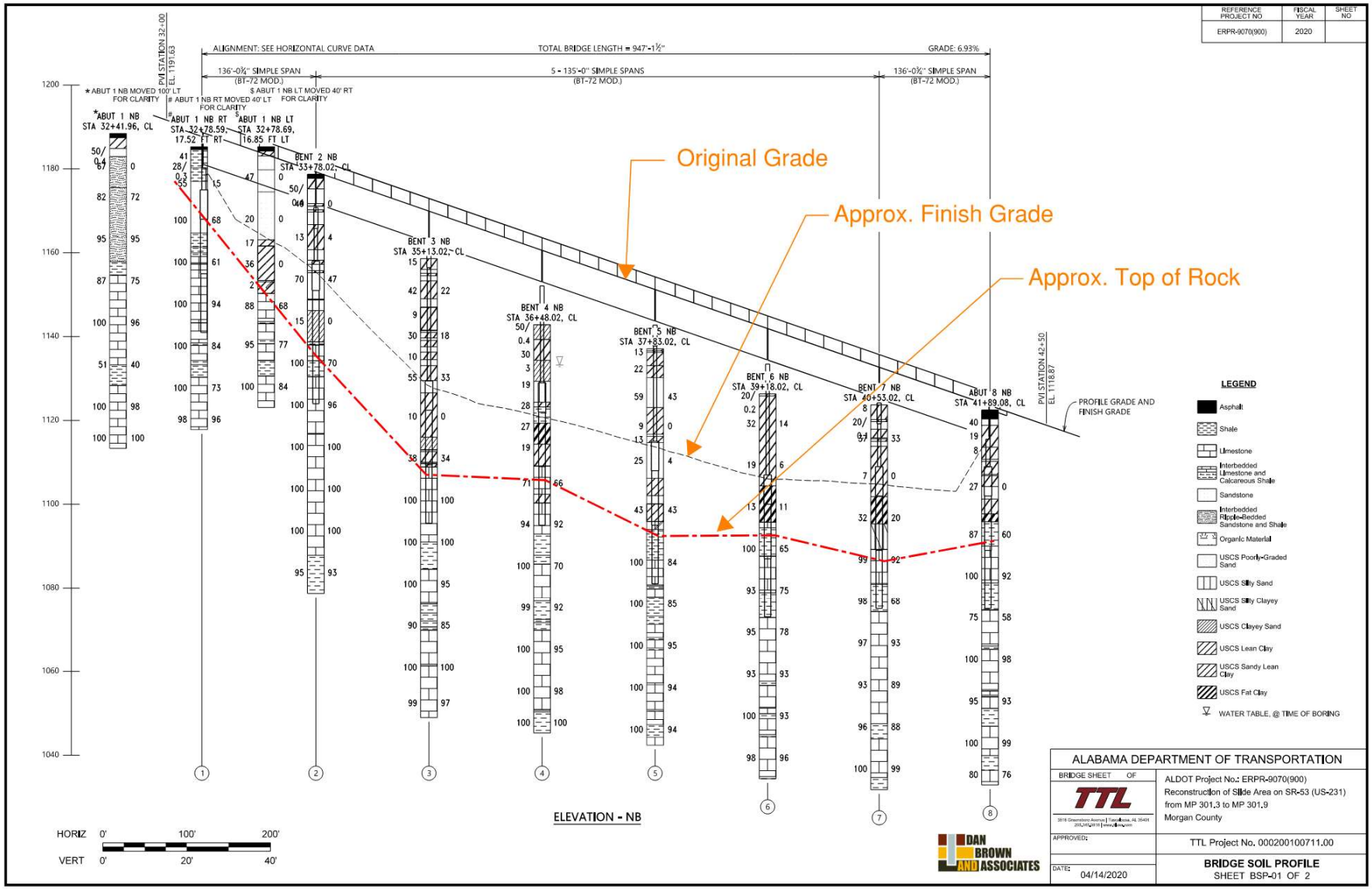

W
2
W
Original Condition
-600
-400
-200
0
200
400


W
2
W
End of Construction
-600
-400
-200
0
200
400

- 1 boring per abutment/bent during grading – used for design and in report
- 1 boring each bent shaft (not abutments) between grading and start of bridge to finalize Top of Rock, shaft tips, grade beam elevations



PLAN

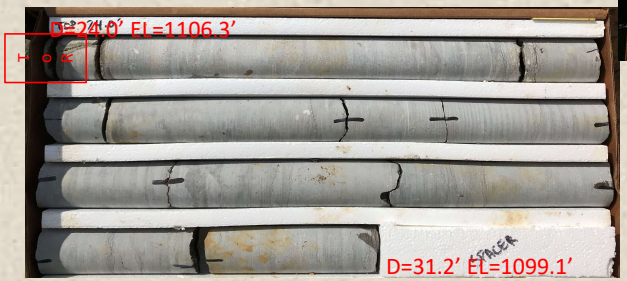

REFERENCE PROJECT NO
ERPR-9070(900)
FISCAL YEAR
2020
SHEET NO
ALIGNMENT: SEE HORIZONTAL CURVE DATA
TOTAL BRIDGE LENGTH = 947'-1½"
GRADE: 6.93%
136'-0⅞" SIMPLE SPAN (BT-72 MOD.)
5 - 135'-0" SIMPLE SPANS (BT-72 MOD.)
136'-0⅞" SIMPLE SPAN (BT-72 MOD.)
PVI STATION 32+00 EL. 1191.63
★ABUT 1 NB MOVED 100' LT FOR CLARITY
ABUT 1 NB RT MOVED 40' LT FOR CLARITY
$ ABUT 1 NB LT MOVED 40' RT FOR CLARITY
★ABUT 1 NB STA 32+41.96, CL
#ABUT 1 NB RT STA 32+78.59, 17.52 FT RT
$ABUT 1 NB LT STA 32+78.69, 16.85 FT LT
BENT 2 NB STA 33+78.02, CL
BENT 3 NB STA 35+13.02, CL
BENT 4 NB STA 36+48.02, CL
BENT 5 NB STA 37+83.02, CL
BENT 6 NB STA 39+18.02, CL
BENT 7 NB STA 40+53.02, CL
ABUT 8 NB STA 41+89.08, CL
PVI STATION 42+50 EL. 1118.87
PROFILE GRADE AND FINISH GRADE
Original Grade
Approx. Finish Grade
Approx. Top of Rock
1200
1180
1160
1140
1120
1100
1080
1060
1040
1
2
3
4
5
6
7
8
ELEVATION - NB
HORIZ 0' 100' 200'
VERT 0' 20' 40'
LEGEND
Asphalt
Shale
Limestone
Interbedded Limestone and Calcareous Shale
Sandstone
Interbedded Ripple-Bedded Sandstone and Shale
Organic Material
USCS Poorly-Graded Sand
USCS Silty Sand
USCS Silty Clayey Sand
USCS Clayey Sand
USCS Lean Clay
USCS Sandy Lean Clay
USCS Fat Clay
WATER TABLE, @ TIME OF BORING
DAN BROWN AND ASSOCIATES
ALABAMA DEPARTMENT OF TRANSPORTATION
BRIDGE SHEET OF
TTL
APPROVED:
DATE: 04/14/2020
ALDOT Project No.: ERPR-9070(900)
Reconstruction of Slide Area on SR-53 (US-231) from MP 301.3 to MP 301.9
Morgan County
TTL Project No. 000200100711.00
BRIDGE SOIL PROFILE
SHEET BSP-01 OF 2

NB Bent 3

NB3 Uphill
GS EL = +1140.012 ft
Depth to Top of Rock = 10.2 ft
Top of Rock Elevation = +1129.812

NB3 Center
GS EL = +1158.60 ft
Depth to Top of Rock = 49.6 ft
Top of Rock Elevation = +1109.00 ft

NB3 Downhill
GS EL = +1130.271 ft
Depth to Top of Rock = 24.0 ft
Top of Rock Elevation = +1106.271 ft



NB Bent 4

NB4 Center
GS EL = +1142.82 ft
Depth to Top of Rock = 33.7 ft
Top of Rock Elevation = +1109.12 ft

NB4 Downhill
GS EL = +1125.333 ft
Depth to Top of Rock = 25.0 ft
Top of Rock Elevation = +1100.333 ft

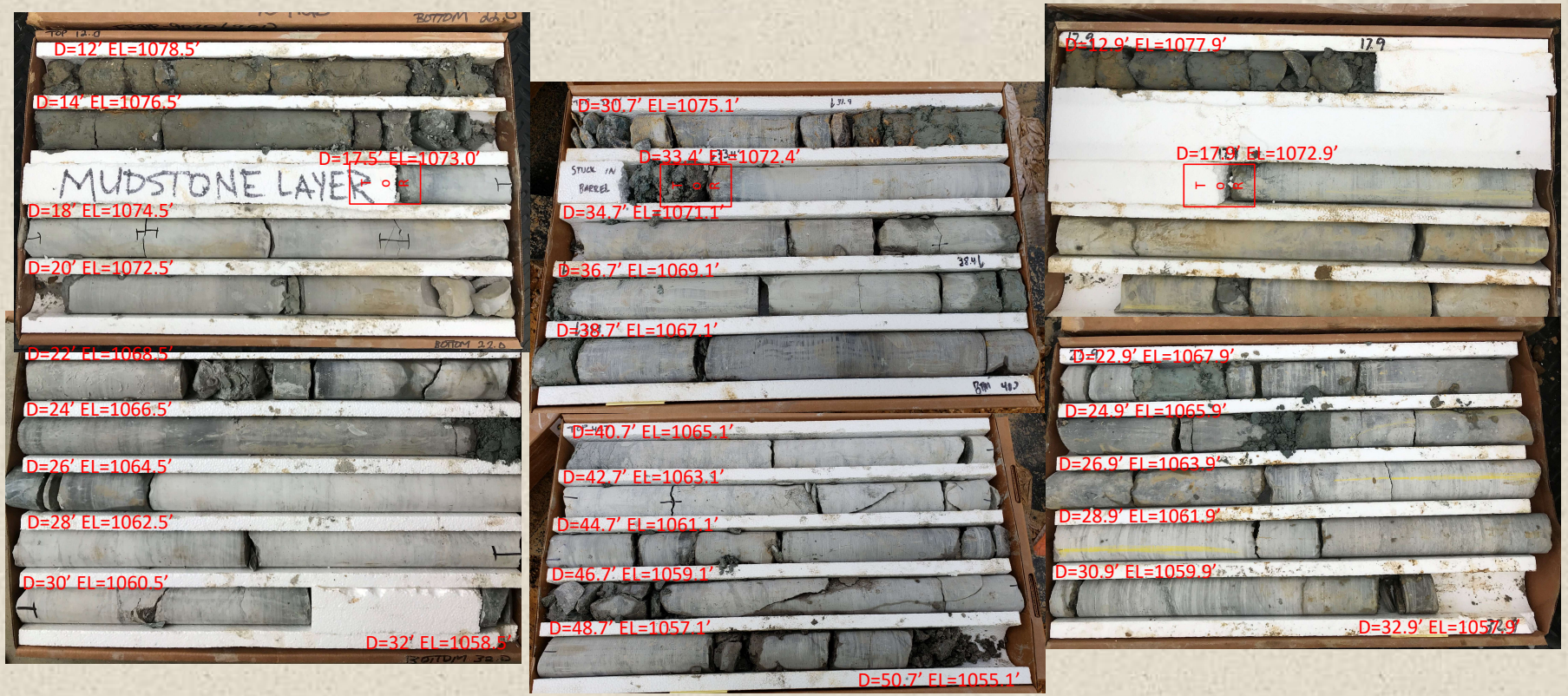
NB4 Uphill
GS EL = +1131.760 ft
Depth to Top of Rock = 31.0 ft
Top of Rock Elevation = +1100.76 ft

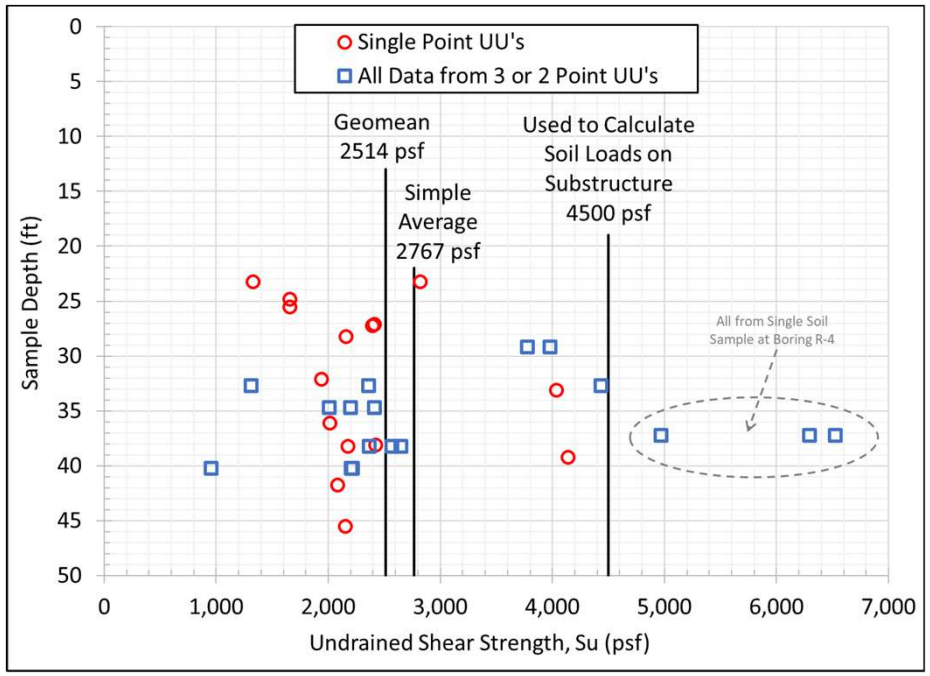
SB Bent 7

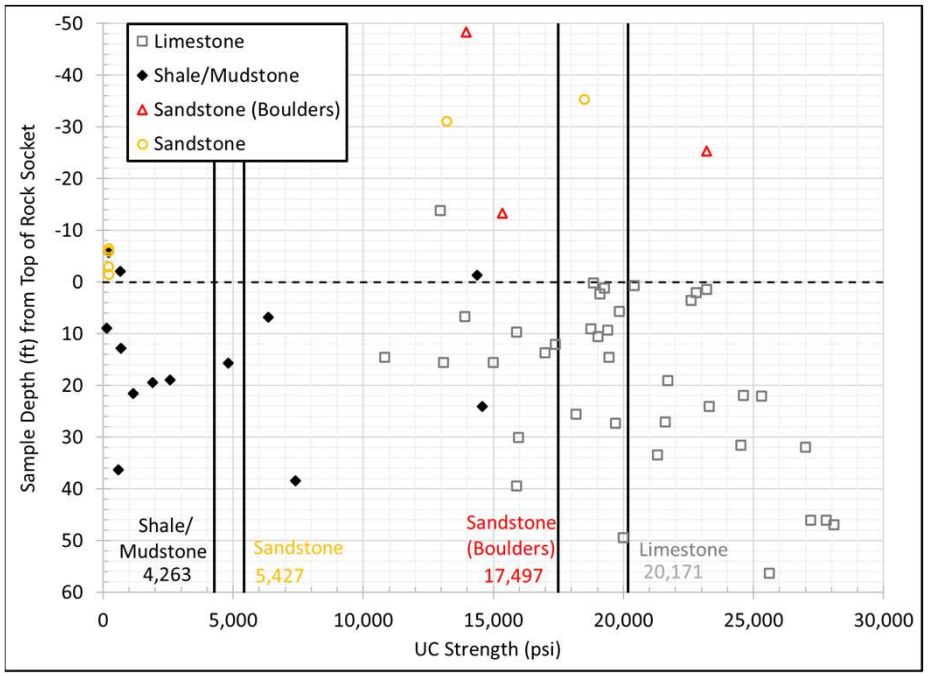
SB7 Downhill
GS EL = +1090.454 ft
Depth to Top of Rock = 17.5 ft
Top of Rock Elevation = +1073.0 ft

SB7 Center
GS EL = +1105.8 ft
Depth to Top of Rock = 33.4 ft
Top of Rock Elevation = +1072.4 ft

SB7 Uphill
GS EL = +1090.777 ft
Depth to Top of Rock = 17.9ft
Top of Rock Elevation = +1072.9 ft



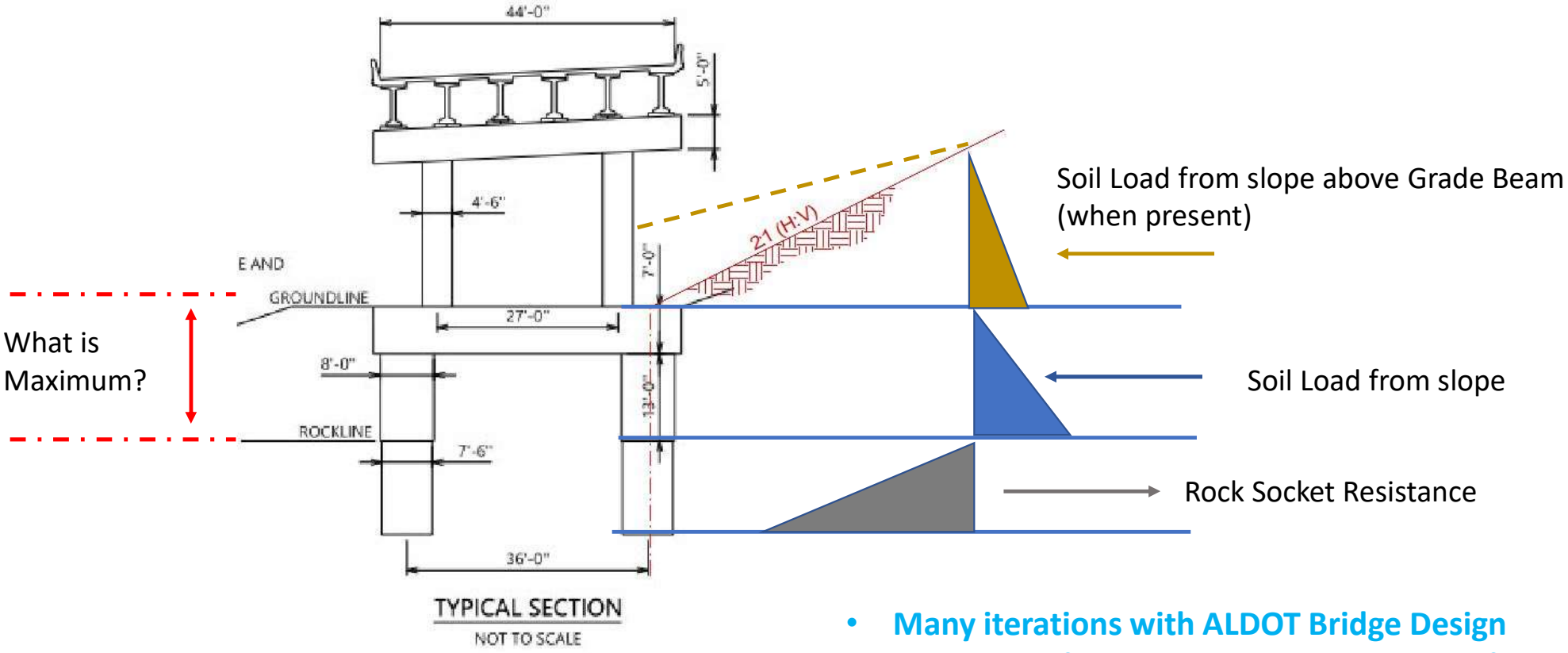

Single Point UU's
All Data from 3 or 2 Point UU's
Geomean
2514 psf
Simple
Average
2767 psf
Used to Calculate
Soil Loads on
Substructure
4500 psf
All from Single Soil
Sample at Boring R-4
Sample Depth (ft)
Undrained Shear Strength, Su (psf)
0
5
10
15
20
25
30
35
40
45
50
0
1,000
2,000
3,000
4,000
5,000
6,000
7,000


Limestone
Shale/Mudstone
Sandstone (Boulders)
Sandstone
Shale/
Mudstone
4,263
Sandstone
5,427
Sandstone
(Boulders)
17,497
Limestone
20,171
Sample Depth (ft) from Top of Rock Socket
UC Strength (psi)
-50
-40
-30
-20
-10
0
10
20
30
40
50
60
0
5,000
10,000
15,000
20,000
25,000
30,000

Questions to Answer:

Where is Top of Rock?

Where is Bottom of Grade Beam?



- **Many iterations with ALDOT Bridge Design**
- **Varying shaft diameter, length, 2 or 3 shafts**
- **Varying rock strength, soil strength (slope)**

Drilled Shaft and Grade Beam Design

Stem wall for selected bents

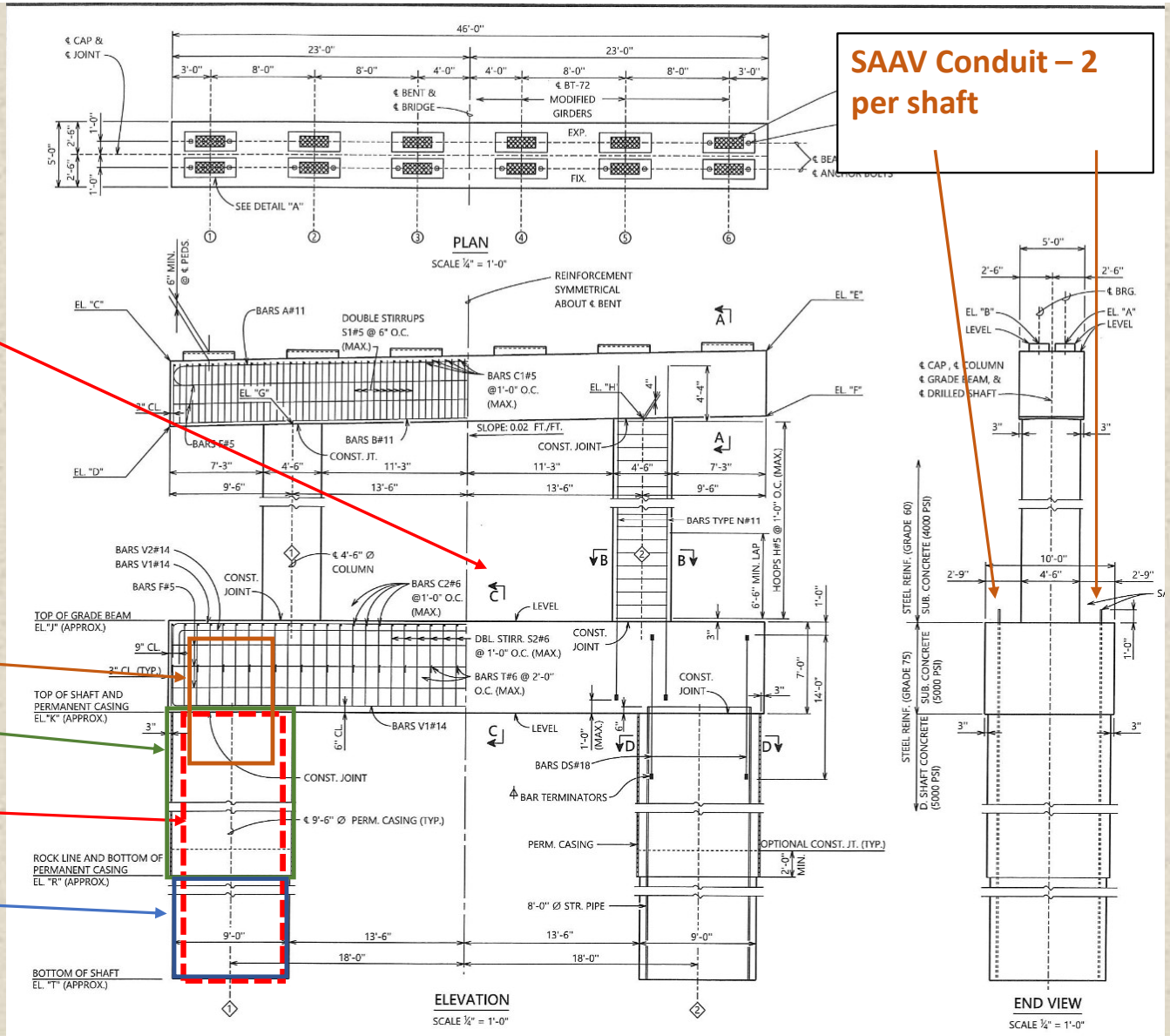
28 - #18 bars, 75ksi

9.5ft x 5/8in Permanent Casing

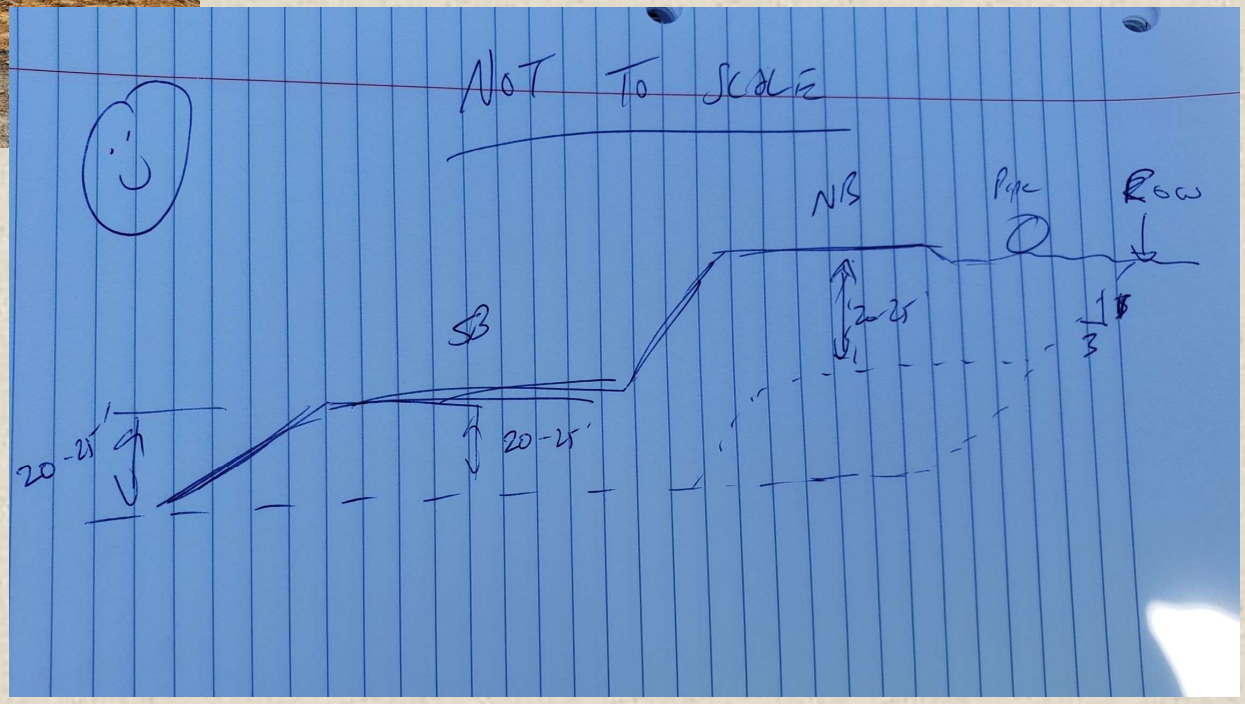
8ft x 1.5in Structural pipe

9ft Dia Rock Socket

SAAV Conduit – 2 per shaft



Preliminary Grading Plan to begin work – March 6, 2020




REED
SellersPhoto.com

- 220,000 cubic yards removed prior to bridge construction
- Additional excavation at each bent for grade beams

For later:
NB7 Inclinometer and VW Piezometer

Bent 7 NB Shaft 2 (uphill)

8ft x 1.5in pipe

FAVOR STEEL & FABRICATING INC
205.426.3288 favorsteel.com

9.5ft perm casing

NUCOR® SKYLINE

SSAB

A.H. BECK FOUNDATION CO. Inc. SINCE 1932

- 2 slick lines delivered concrete between Casing and Structural Pipe
- Pump boom or free fall inside Structural Pipe
- All shafts in the dry
- Specified maximum differential of concrete in/out of Structural Pipe

BRASFIELD & GORRIE
GENERAL CONTRACTORS

VOLKERT


SENSERA
SYSTEMS
HELLO
231

Post-Construction Instrumentation

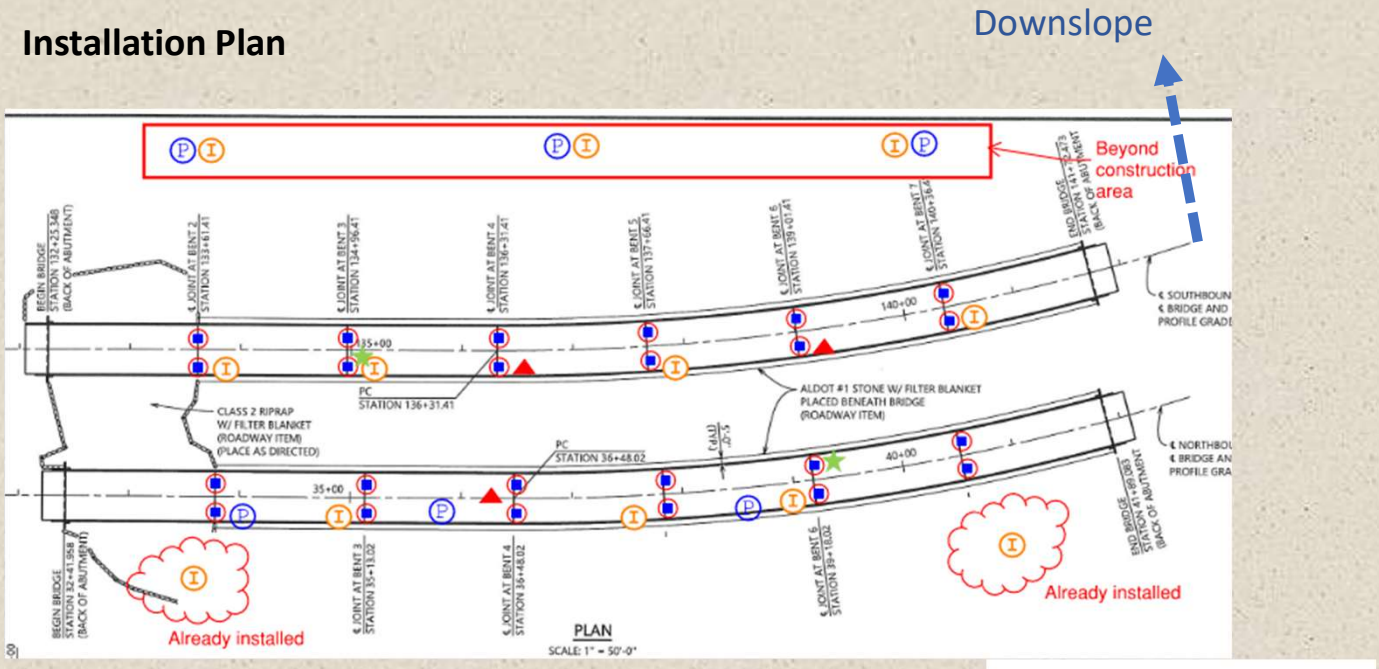
To allow load in the shafts to be characterized, should ground movement occur, so that the condition of the bridge foundations, and their suitability to resist additional movement, can be established at any given time

- DETAILS:
  - Monitor slope movement and water pressures, deflection of the drilled shafts.
  - Comparison of the measured responses with predicted values.
  - Assess risk of damage of the bridge in near real-time, at least qualitatively.

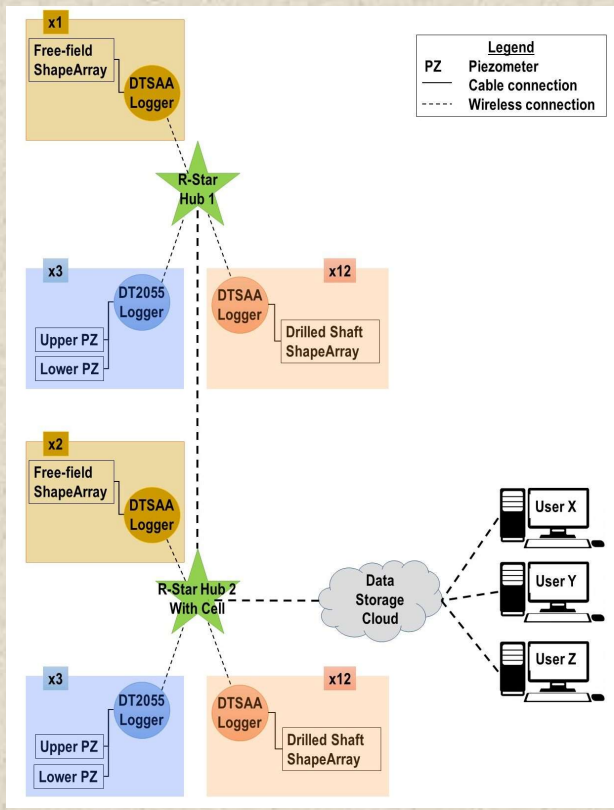
Challenges with Instrumentation Plan and Installation

- Time
- Access
  - Completion of grading NOT part of incentive – delayed access for free-field locations
  - Incentive/Disincentive contract – Additional steps out of the norm for bridge construction had potential for delays
- Details of getting components to talk to each other, for hubs to talk to cloud, etc.

Installation Plan



Conceptual Communication Layout



<u>As of 01/12/21:</u>

All 24 Shaft ShapeArrays installed

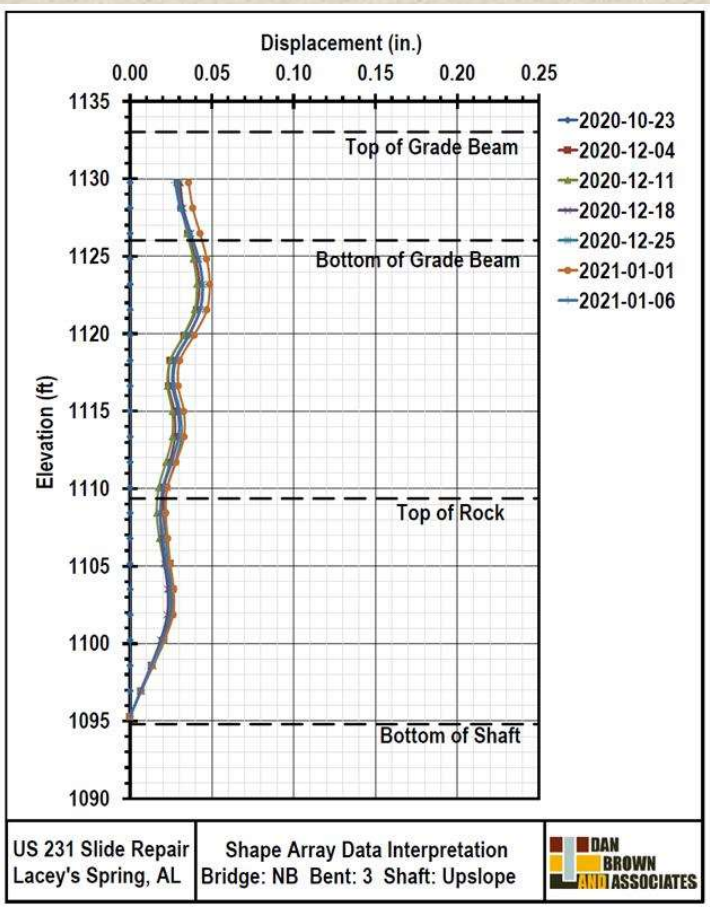
All NB free-field instruments installed (1 SA, 3 INC, 3 VWP)

SB free-field ShapeArrays installed

Utilizing 2 existing upslope and 2 downslope inclinometers from construction


GEO
INSTRUMENTS
800-477-2506
GEO-INSTRUMENTS.COM
GEO


MEASURAND

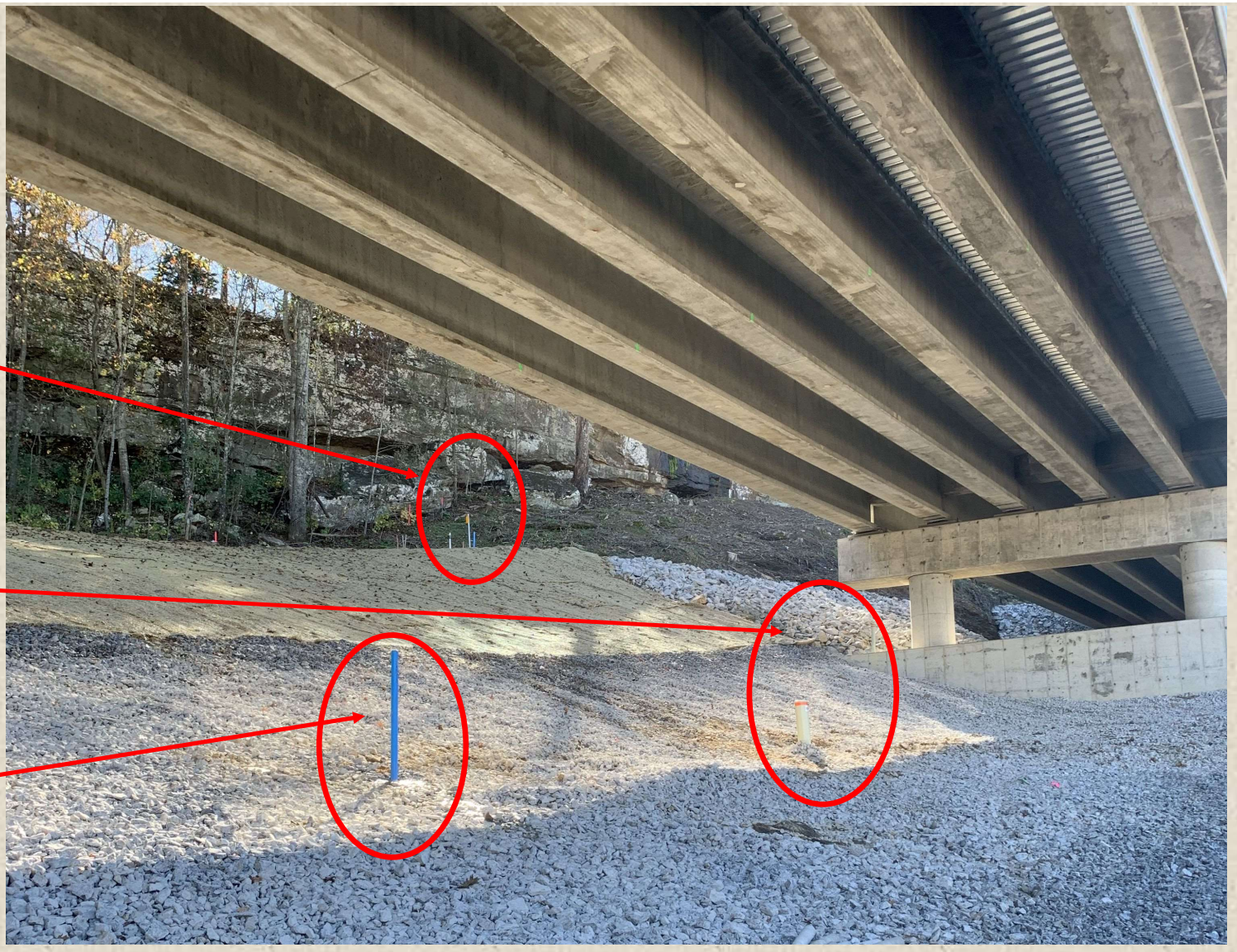

Displacement (in.)
0.00
0.05
0.10
0.15
0.20
0.25
Elevation (ft)
1135
1130
1125
1120
1115
1110
1105
1100
1095
1090
Top of Grade Beam
Bottom of Grade Beam
Top of Rock
Bottom of Shaft
2020-10-23
2020-12-04
2020-12-11
2020-12-18
2020-12-25
2021-01-01
2021-01-06
US 231 Slide Repair
Lacey's Spring, AL
Shape Array Data Interpretation
Bridge: NB Bent: 3 Shaft: Upslope
DAN
BROWN
AND ASSOCIATES


Shaft Shape Array
Vibrating Wire Piezometer
Inclinometer
Shaft Shape Array

Inclinometer and
Vibrating Wire Piezometer
(Construction)

Vibrating Wire Piezometer

Inclinometer




Vibrating Wire
Piezometer
Free Field
Shape Array
Shaft Shape Array

Star Hub and Solar Panel

Completed Shaft Install

Free Field Shape Array Installation

What's Next?...or….The Story Continues……

- All installed instruments are gathering data and we can download it!
- Installation of Southbound Free-Field Instruments (INC, VWP)
- Installation of Downslope Instruments (INC, VWP)
- ALDOT reads Inclinometers every week to two weeks
- Analysis of data – slope movements, groundwater, shaft movements, estimating loads in the shafts
- Establish protocol for comparing measured to design
- Draft Action Levels Plan submitted to ALDOT for review
- DBA monitor for first year (or so), develop training for ALDOT Geotechnical Section for future

Thanks For Listening!!!