Buck O’Neil Bridge Design-Build Project

Don Hammond, PE

Lead Project Geotechnical Engineer

John Szturo, PG

HNTB Geotechnical Task Leader

November 9th, 2023

BUCK O’NEIL BRIDGE US 169

MoDOT

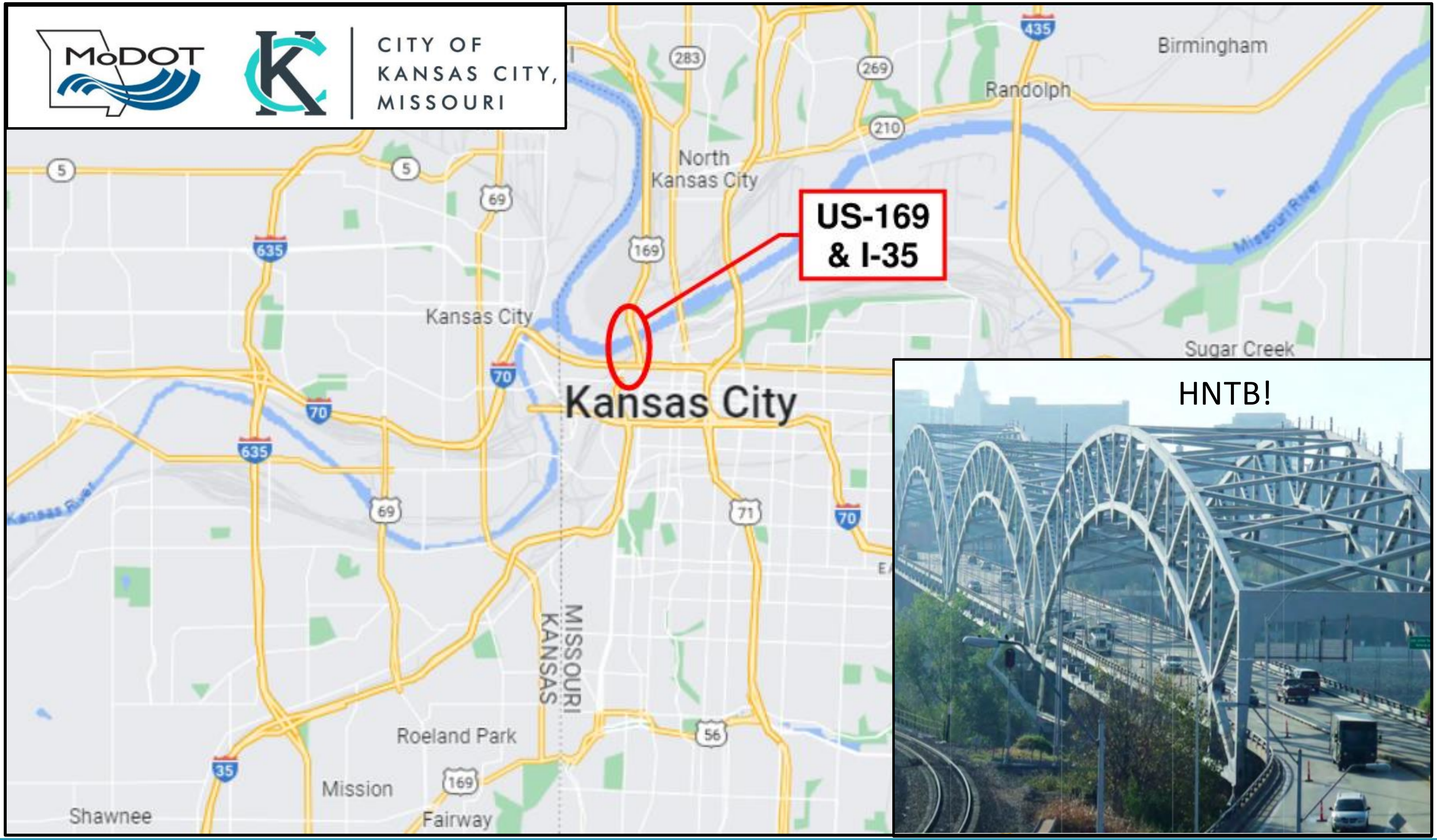
CITY OF KANSAS CITY, MISSOURI

MASSMAN CONSTRUCTION CO. | CLARKSON CONSTRUCTION COMPANY

A JOINT VENTURE

HNTB

Location Map



Bridge History

The Original Bridge was:

- Designed by HNTB
- Constructed by the City of KC, MO
- Built at a cost of $12 million
- Opened as a toll bridge
- Opened on September 9, 1956 as "The Broadway Bridge"
- Renamed 60 years later on June 24, 2016 to "The Buck O' Neil Bridge"

Buck O’Neil

- First Baseman and Manager for the Negro League KC Monarchs
- Long time employee and scout for the KC Royals
- Honored with the “Buck O’Neil” Legacy Seat at the K
- Inducted into the MLB Hall of fame class of 2022

Pre-award Work - Schedule

Advertise – April 2020

Shortlist - July 2020

- Massman Clarkson HNTB
- Lunda Construction
- American Bridge Parsons
- Traylor Ames
- Walsh

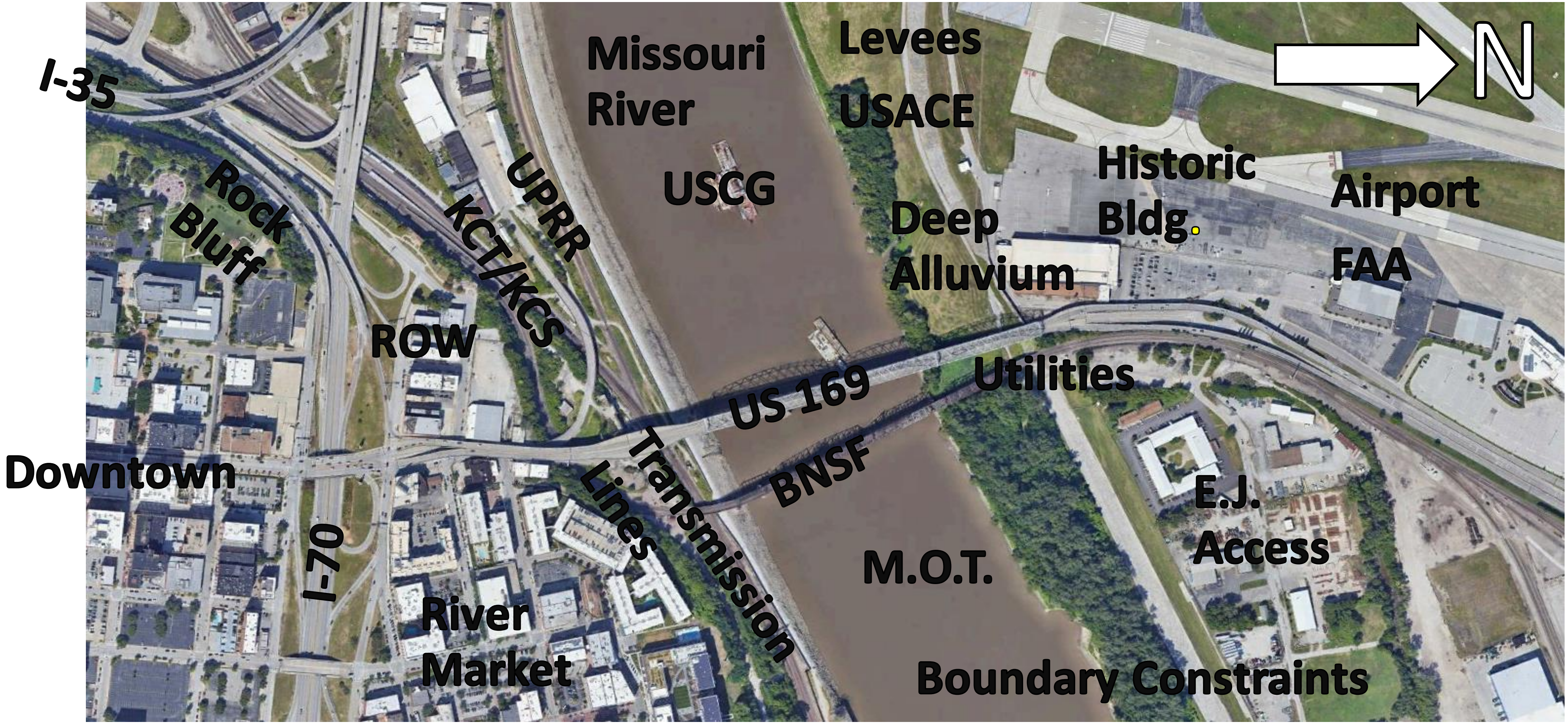
Proposals Due - December 2020

Project Award - February 2021

MoDOT Design-Build Goals

- Construct an innovative, low maintenance Missouri River Bridge that will provide a century of service within a program budget of $247.5 million.
  - Split between MoDOT and KCMO
- Provide a safe, connective and accessible transportation facility that improves regional and local system performance.
- Manage the impact to the traveling public during construction.
- Complete the project by December 1, 2024, utilizing a diverse workforce.

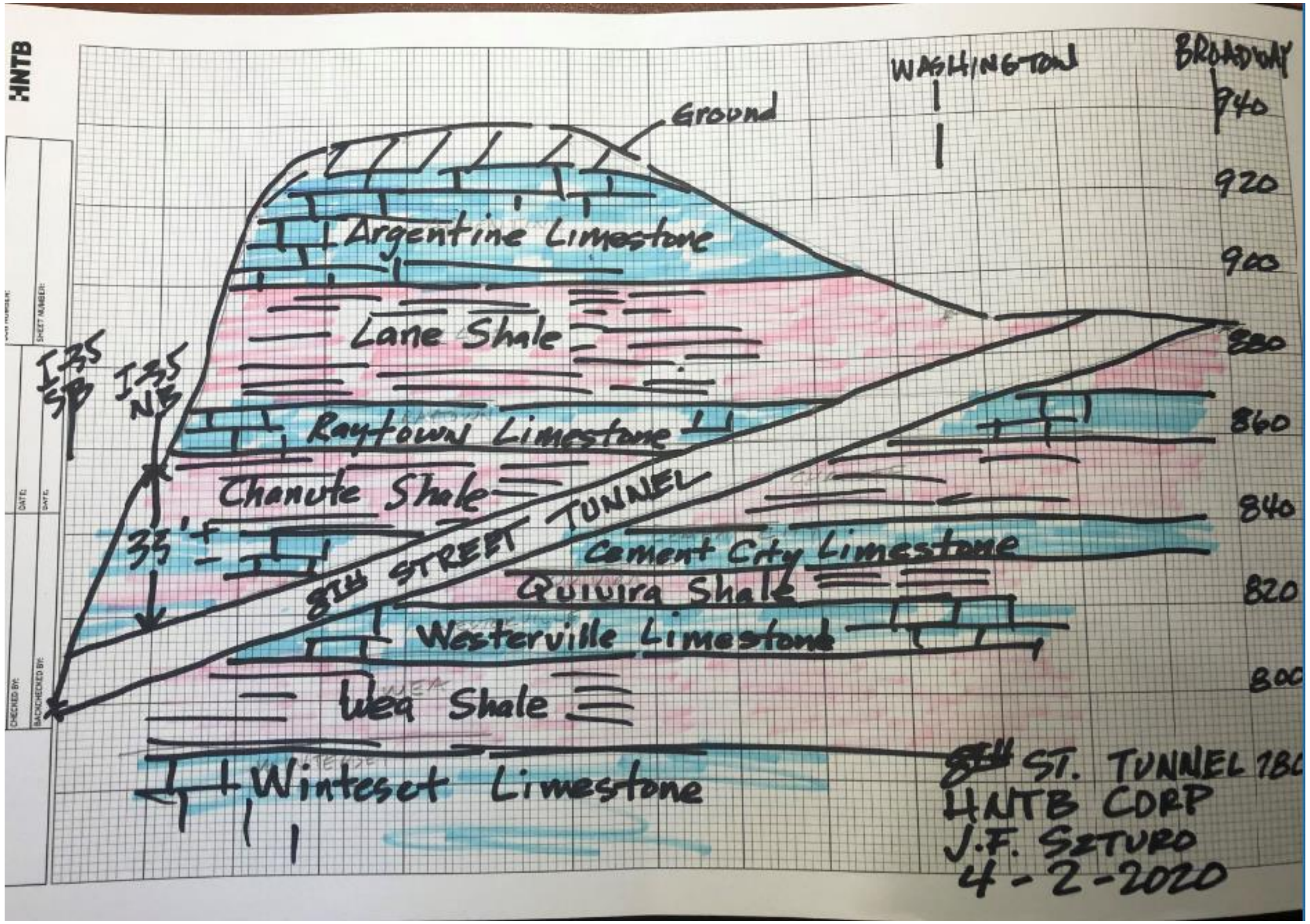
Site Challenges



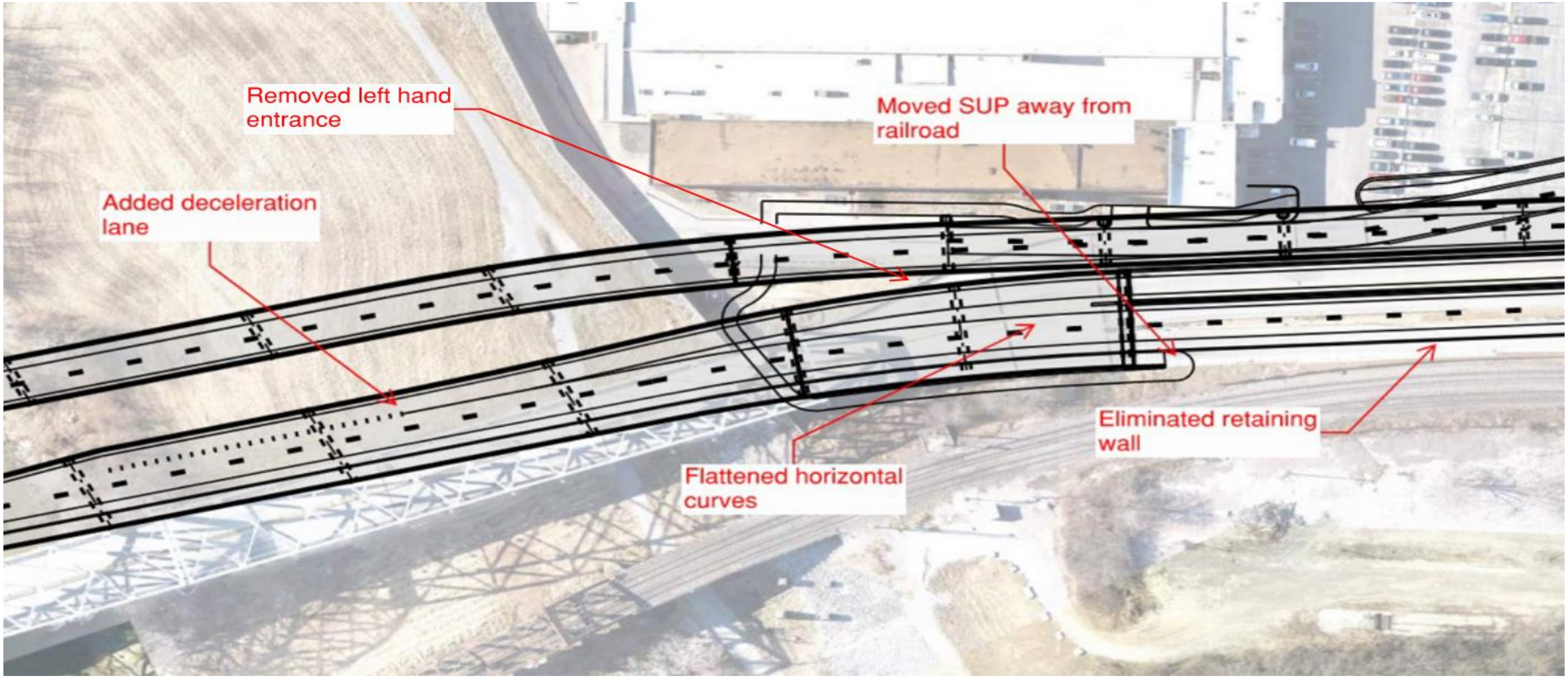
8th Street Tunnel

8th Street Tunnel

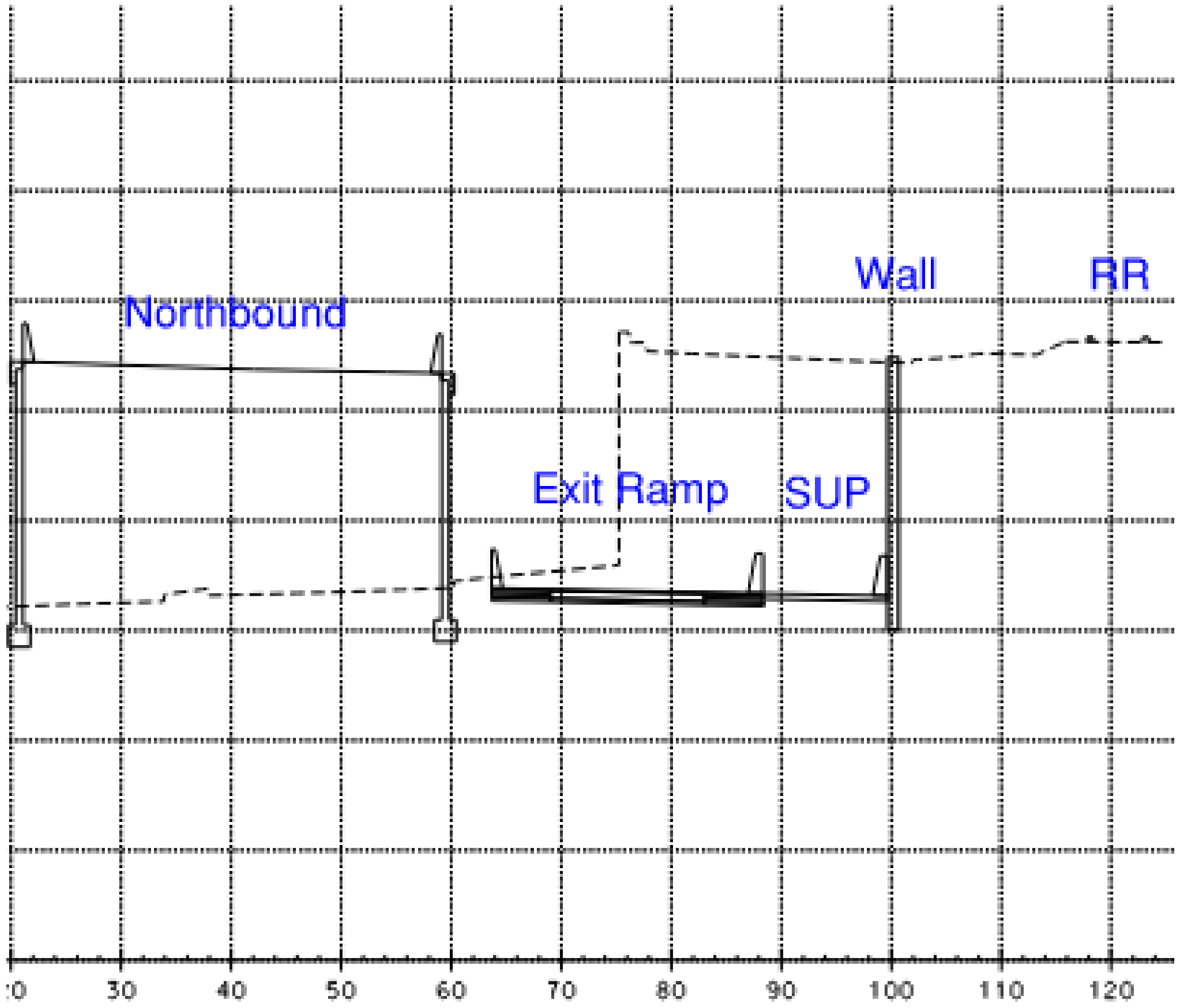
8th Street Tunnel – Homebound



Proposed Alternative – Wheeler Airport

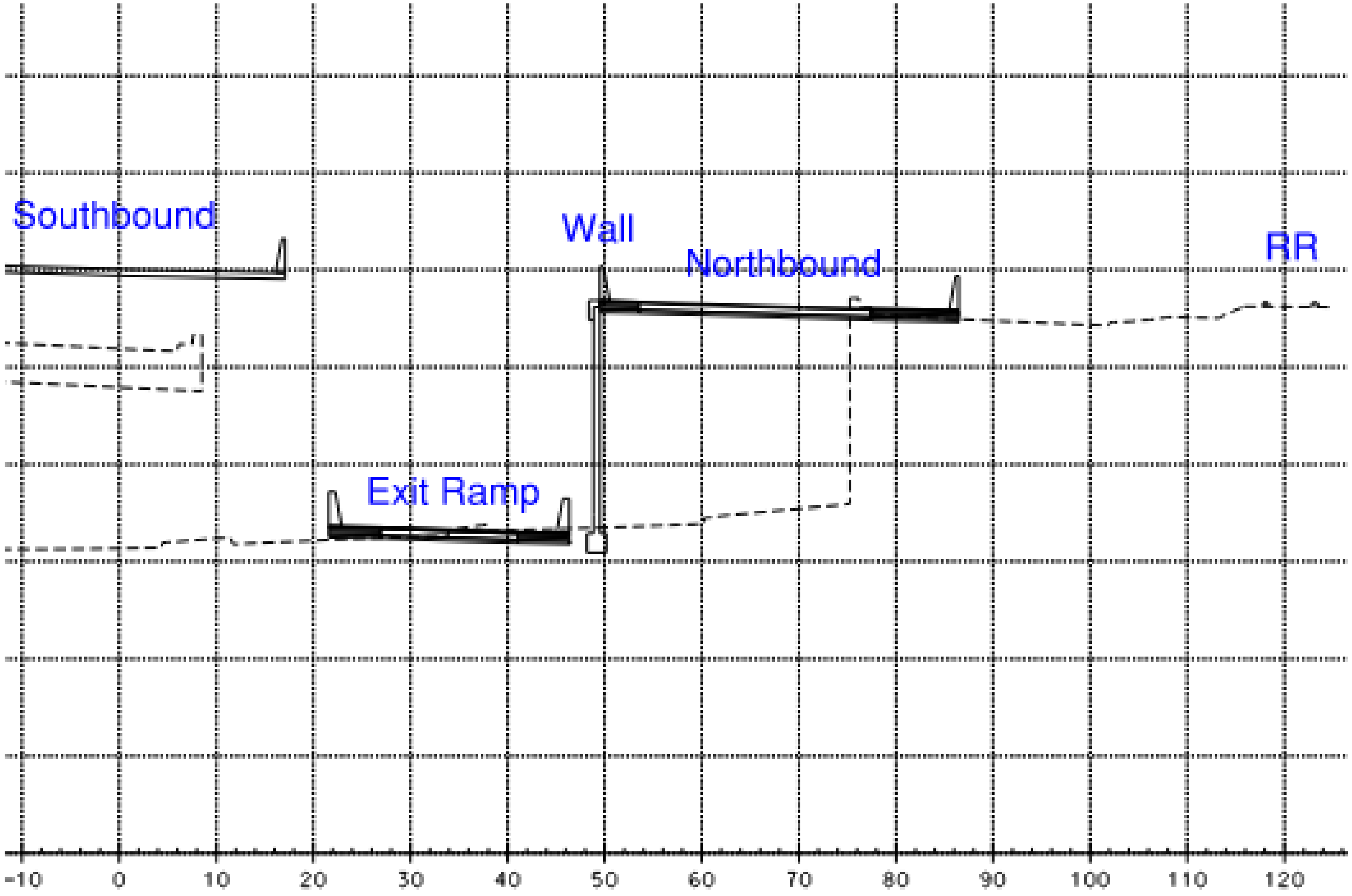


Preferred Alternative – EA



- 24-ft Wall
  20 ft from RR!!
  - Schedule/cost risk
- Righthand Exit
- Shared Use Path (SUP)

Modified Alternative – Proposed & Accepted



- 24-ft Wall **70 ft** from RR
- Lefthand Exit
- Shared Use Path re-routed away from pinch-point

AAS – Additional Appicable Standards and Design Exceptions

Pre-Award Mark Up of MoDOT Drilled Shaft Specification

Back to Table of Contents

camera and lighting equipment shall be capable of operating in dry or submerged conditions encountered during the inspection. The excavated shaft shall have the engineer of record's approval prior to proceeding with construction.

701.4.10.3.1 Equipment. ~~Methods and equipment for controlling the~~ Inspection equipment ~~camera~~ will be subject to approval from the engineer of record ~~and achievement of a satisfactory video record~~.

701.4.10.3.2 ~~**Drawings.** The contractor shall submit layout drawings to the engineer showing the relative position of all components of the video inspection system, including type and size of barge or other work area. The information submitted shall include a written description of the operating procedure in a step-by-step sequence and shall state the source of power.~~

701.4.10.3.3 Shaft Inspection. Inspection of a shaft ~~by video camera~~ shall be performed as directed by the engineer of record. The excavated shaft, including the rock socket when applicable, shall be thoroughly cleaned of all loose fragments, and sediment ~~and turbidity~~ prior to inspection. The camera, if used shall be operated such that optimum clarity of detail can be obtained and all surface areas of the shaft, including the rock socket and the rock socket's base, can be observed. All scanning of the rock surfaces shall be recorded. After completion of the inspection of a rock socket, the engineer of record will direct whether or not drilling of the shaft shall be continued to a greater depth. Camera ~~R~~recordings, SID recordings, and all inspection records shall be furnished to and shall become the property of MODOT~~the engineer~~ upon completion of the work.

701.4.11 Foundation Inspection. NX size cores will be taken by the design build contractor and engineer of record to facilitate the characterization of the subsurface, set casing requirements and determine end bearing and side friction engineering parameters. The design build contractor's engineer of record will also confirm the design assumptions during construction and inspection of the drilled shafts. At least one NX core will be taken at each planned drilled shaft location. ~~be required for drilled shafts with rock sockets, where NX refers to the nominal diameter of rock core, and the NX core barrel has a 2 1/8-inch inside diameter. At least 15 days prior to drilled shaft construction the contractor shall drill one NX size core at the center of each rock socket to a depth of 10 feet or twice the diameter of the rock socket, whichever is greater, below the bottom of the rock socket. The contractor shall use the foundation inspection hole to determine the amount of casing needed and casing ordered prior to foundation inspections holes is at the contractor's risk.~~ The contractor may be directed to extend the rock socket to a lower elevation, resulting from the engineer of record's evaluation of the foundation inspection and cores.

701.4.11.1 Log of Excavated Material. The contractor and engineer of record shall maintain a boring log of excavated material for each foundation design inspection hole. The boring logs will be included in the Project Geotechnical Report and drawings in accordance with the contract documents., ~~and a rough draft of the logs shall be delivered to the engineer within 24 hours of completion of the boring. A typed log prepared by a geologist or engineer along with recommendations for the tip of casing shall be delivered to the engineer within 5 days.~~ The log shall include the following:

(a) The amount of NX cored per run and the amount recovered. All core loss shall be noted and explained. Clay layers shall be noted and located on the log by depth.

(b) The Rock Quality Designation (RQD) for the NX core. The bedding thickness and degree of weathering shall also be noted.

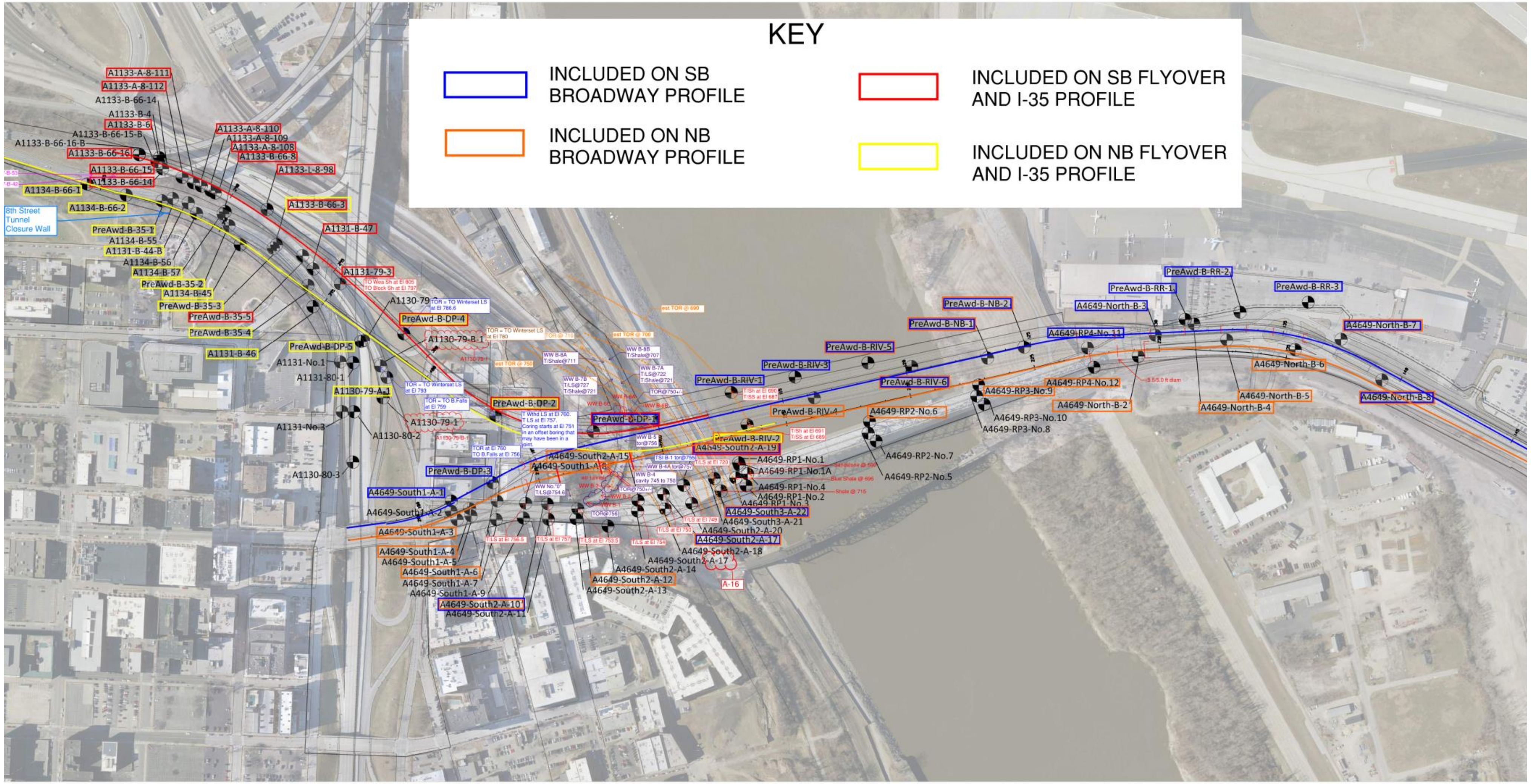
(c) One unconfined compression test shall be run per 5 feet of NX core or as directed by the engineer of record. ~~The results of these tests shall be delivered to the engineer.~~ The results of the unconfined compression tests shall be reported in units of kips per square foot (ksf). ~~Any effect on time of performance resulting from delays in delivery of the above test results to the engineer will be nonexcusable.~~

(d) Color photographs of the core.

701.4.11.2 Storage and Labeling of Rock Cores. Rock cores shall be stored in structurally sound core boxes and shall be protected from the elements. The core boxes shall be properly labeled to indicate location, depth, beginning elevation, contractor and date. ~~, and shall be delivered to the engineer~~

701.4.12 Reinforcing Steel Cage Fabrication and Placement. The reinforcing steel cage, consisting of the longitudinal bars, ties, spirals, cage stiffener bars, spacers, centering devices, and other necessary appurtenances, shall be completely assembled as a unit, and shall be placed immediately after the shaft excavation is inspected

Pre-Award Boring Location Plan



Project Definition

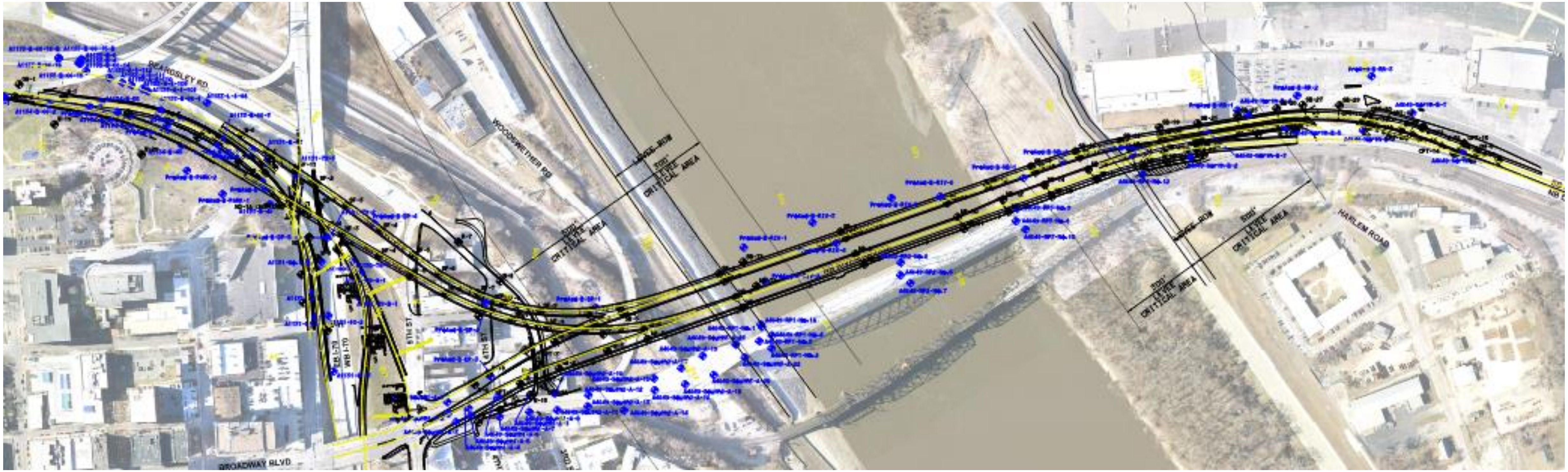
Post Award

Design-Build Project Awarded:

- to Massman – Clarkson – HNTB Team
- February 2021

Boring Location Plan

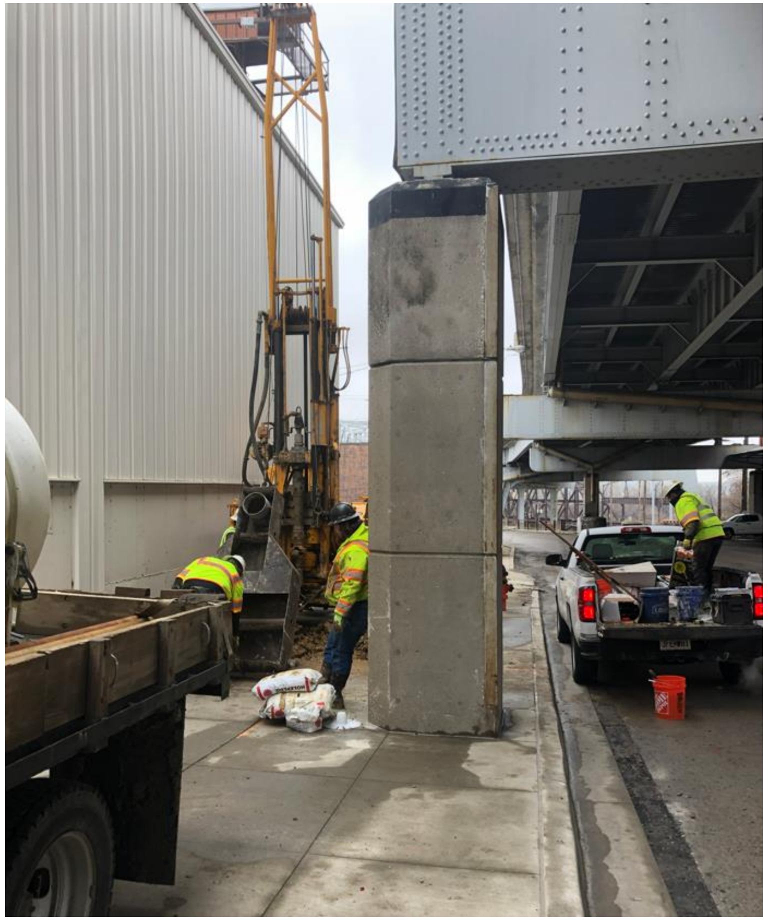
Combined Boring Location Plan



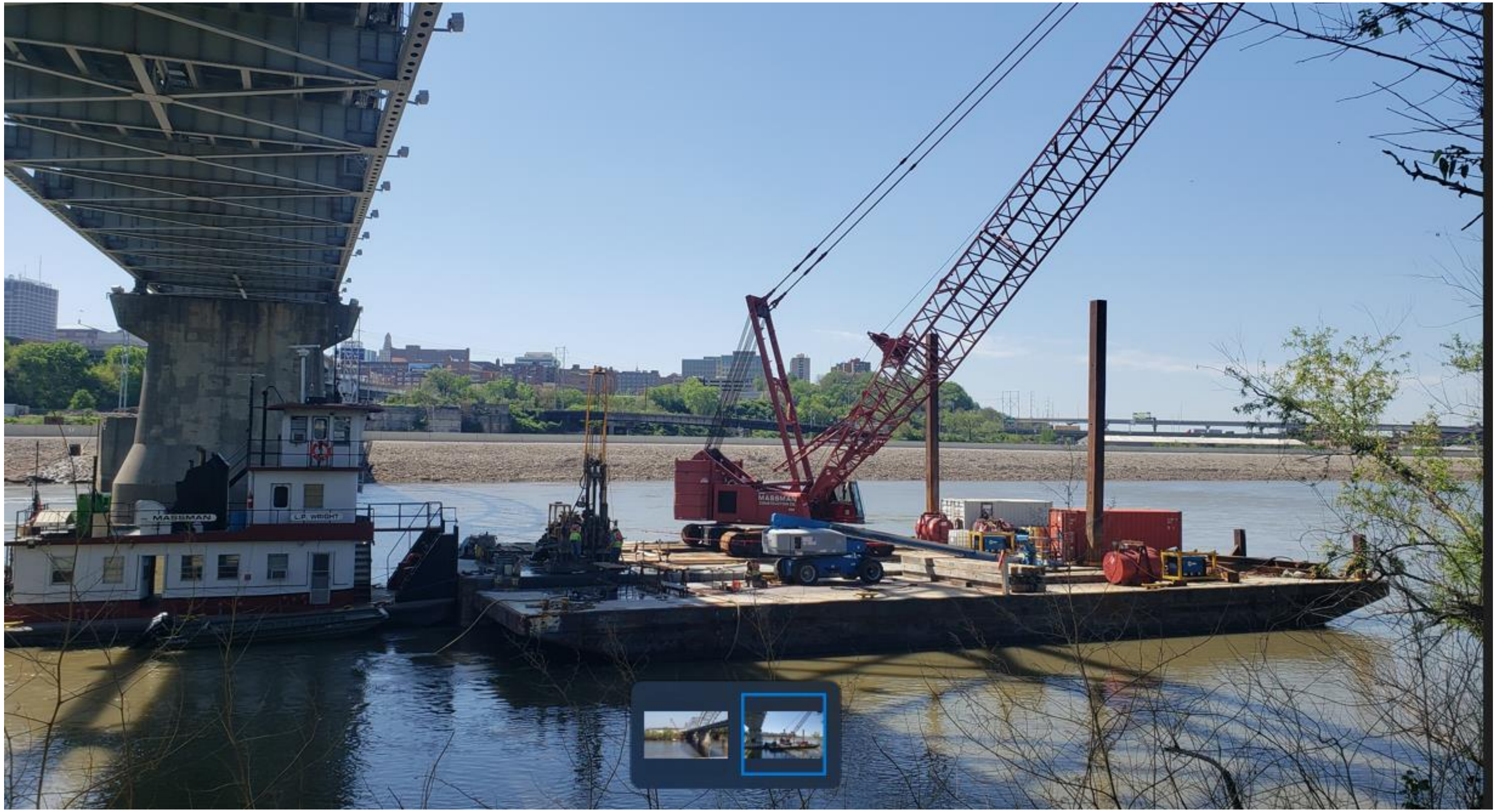
Subsurface Exploration Challenges

- Tight schedule
- Barge for water borings was iced in on the river in Iowa
- Starting at the height of the Covid Epidemic – difficult to maintain field crews, scheduled for 4 crews, ended up with 2
- Three week stretch of Feb – March cold weather
- No access to properties critical to the schedule
- Obtaining FAA permits
- Obtaining USACE permits

Borings



Water Borings



Geotechnical Elements

A. Retaining Walls
   1. MSE (9)
   2. CIP (1)
   3. Concrete Block (1)

B. Rock Slope / Wall
   1. Rock Bolting
   2. Rock Cut
   3. Loess Soil Slopes
   4. Shotcrete
   5. Catchment Ditch
   6. Soil Nail Shale

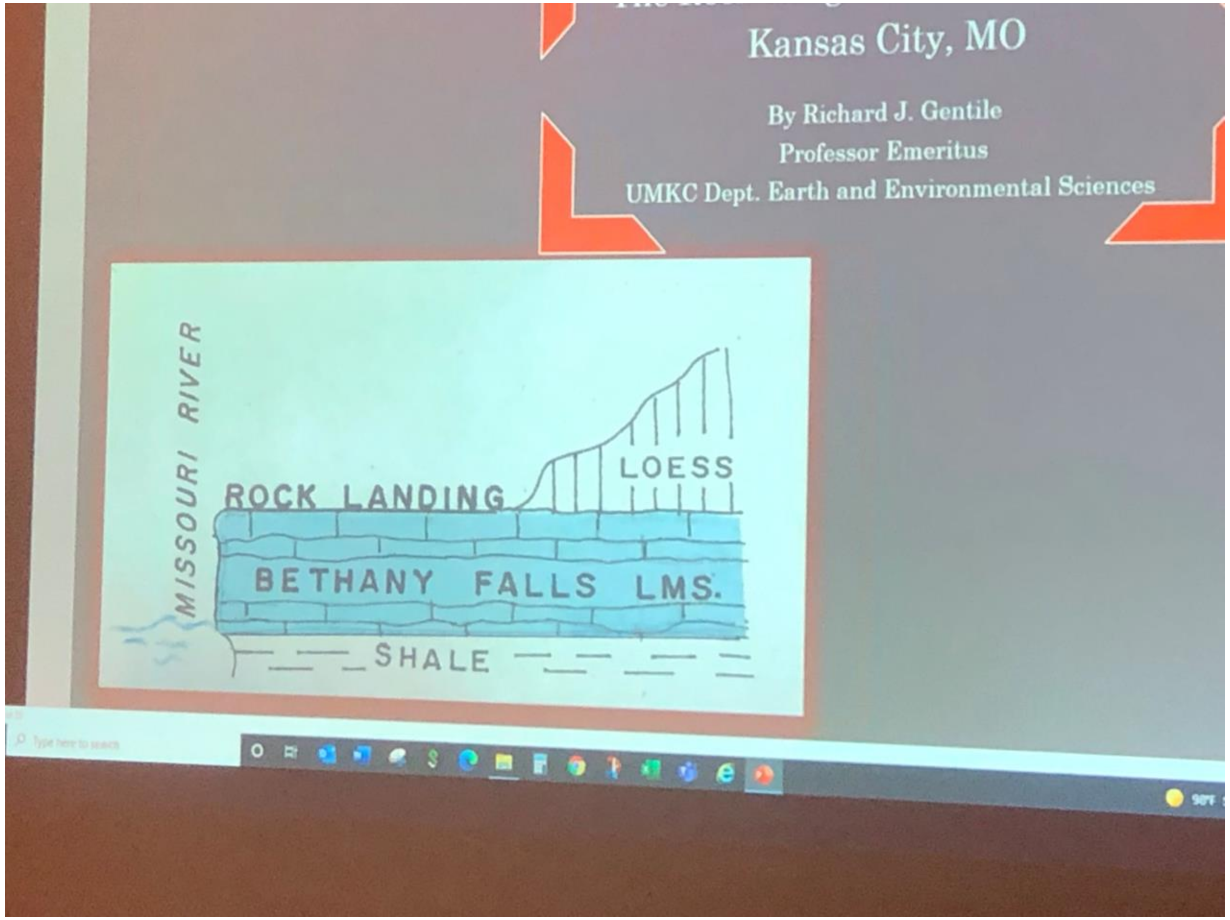
C. Embankments
   1. 30-foot max. grade raise
   2. Lightweight Fill (LDCC)
   3. Stone Columns

D. Bridge Foundations
   1. Driven Piles
   2. Pre-bored "drill and drop" Piles
   3. Spread Footing – changed to pre-bored piles
   4. Drilled Shafts - 78 total
      - Water: 11' diam., ~80 feet to rock, 30-ft-long rock sockets
      - Land: 8.5' and 5.5' diam.

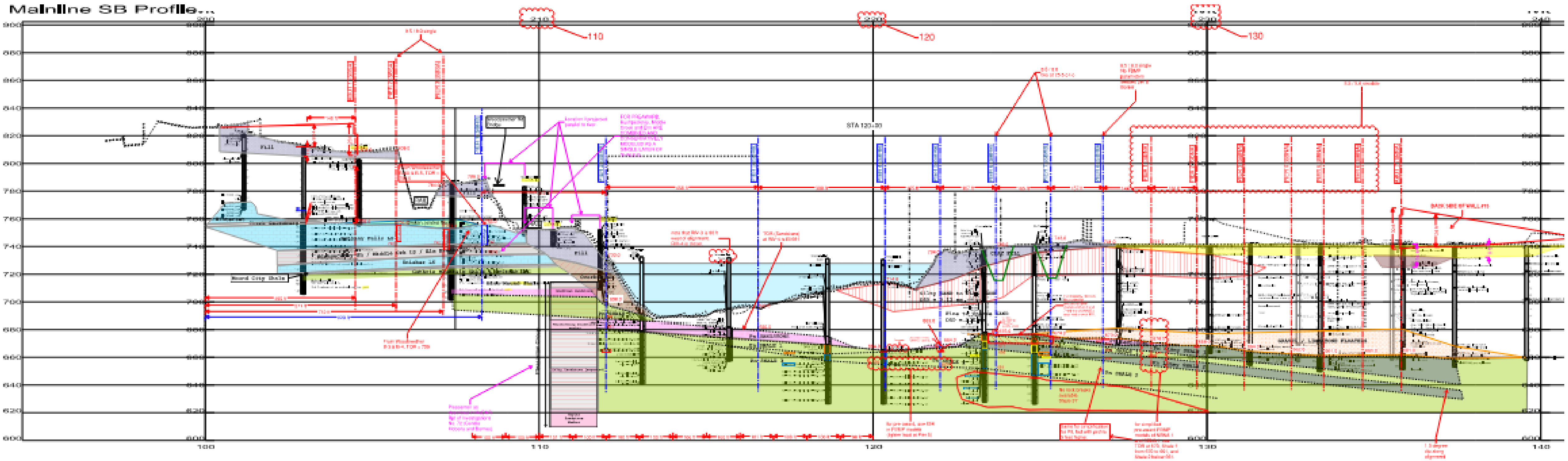
Geology

North-South cross section of the Missouri River bluff at Kansas City

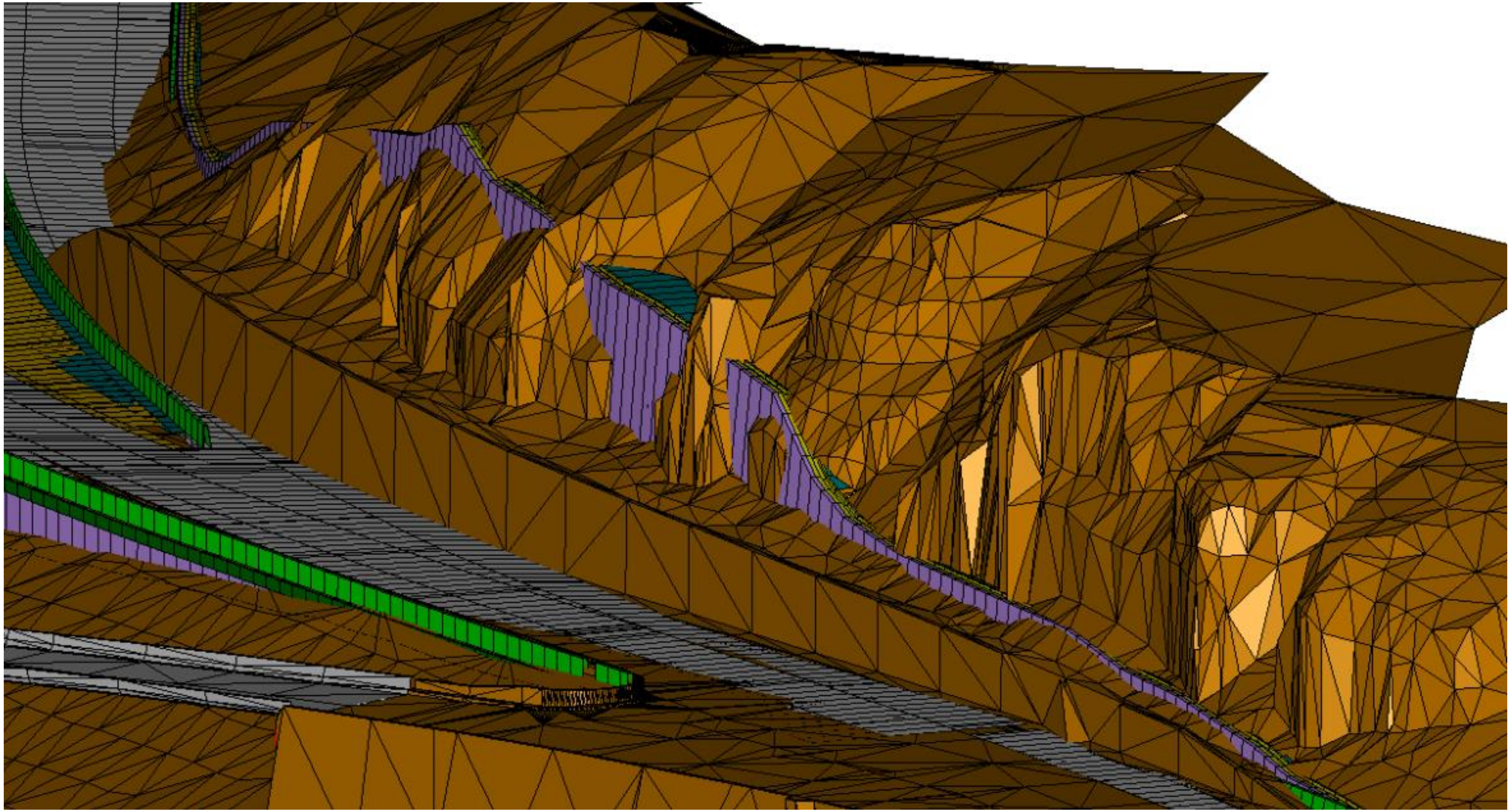
Geology


Kansas City, MO
By Richard J. Gentile
Professor Emeritus
UMKC Dept. Earth and Environmental Sciences
MISSOURI RIVER
ROCK LANDING
LOESS
BETHANY FALLS LMS.
SHALE

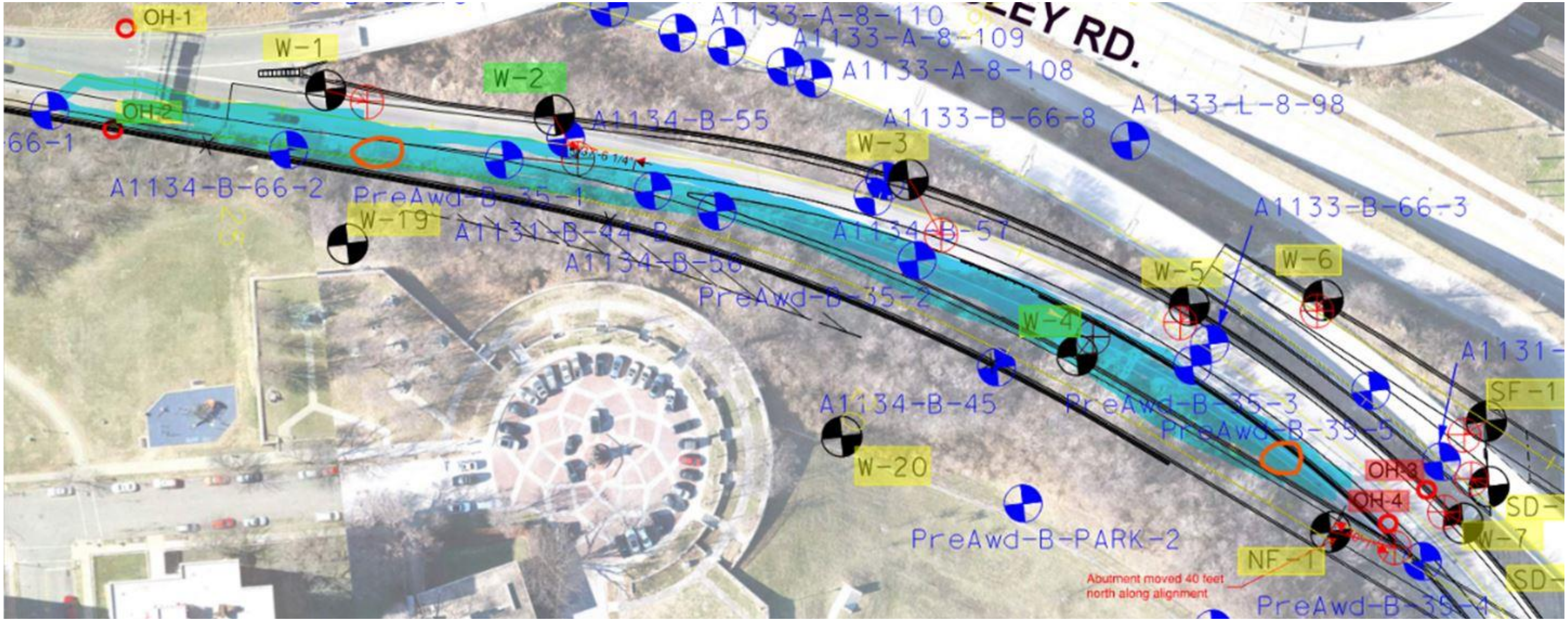
Geology Profiles

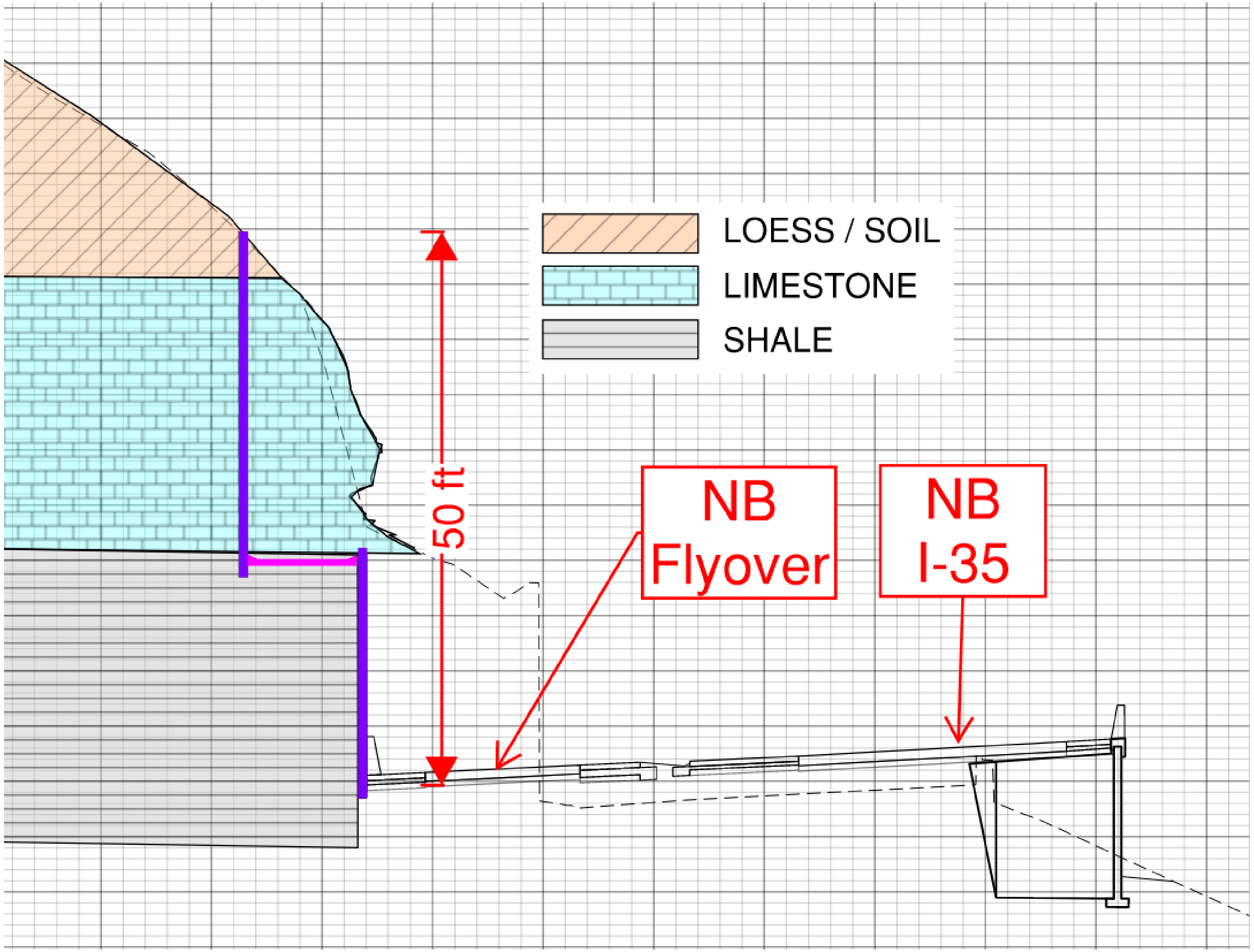


Case Park Wall



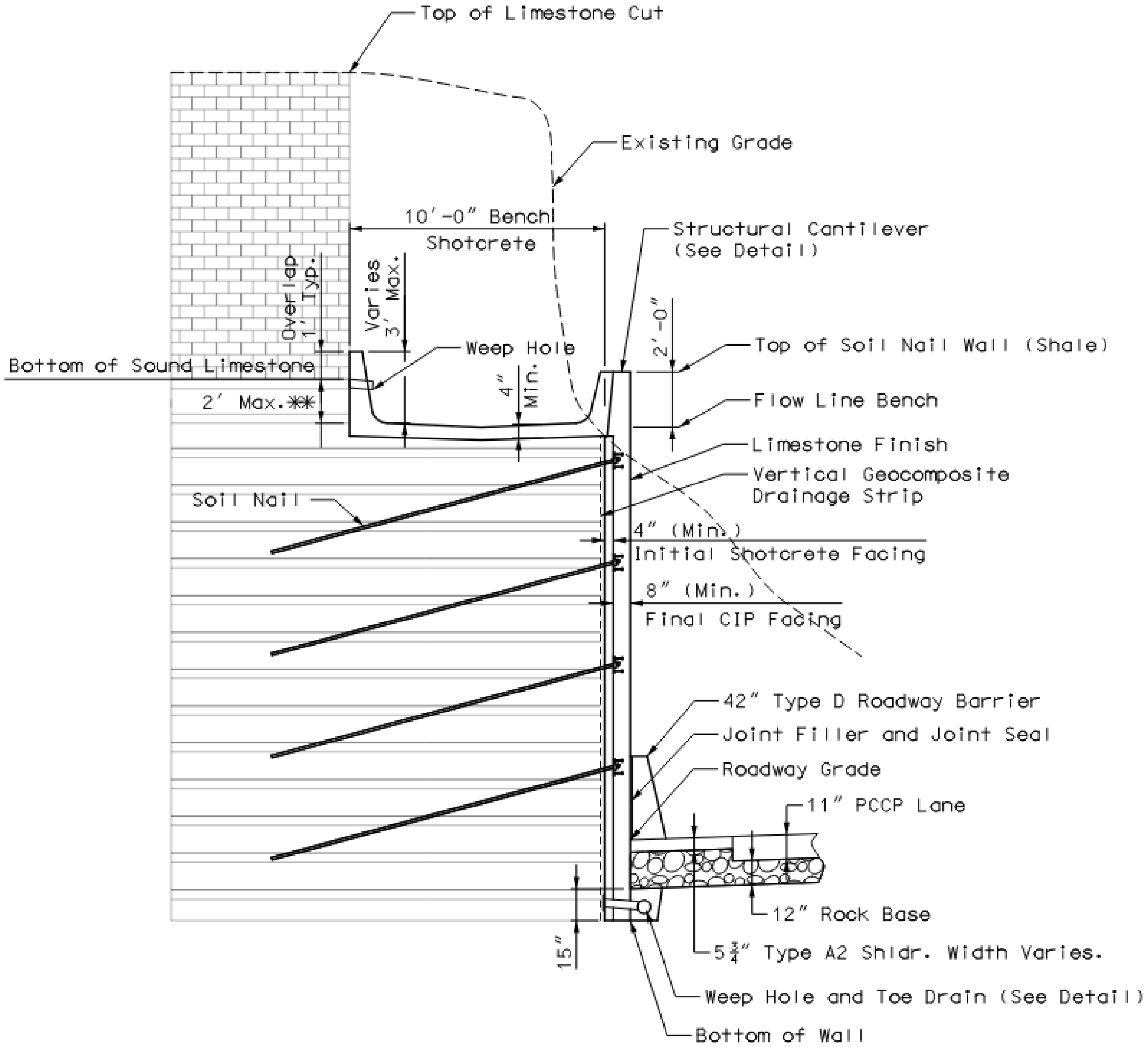
Case Park Cut and Wall





Case Park Wall

- Two-tiered wall
- Top: Limestone
- 10' bench
- Bottom: Soil Nail (into shale)



Case Park Wall

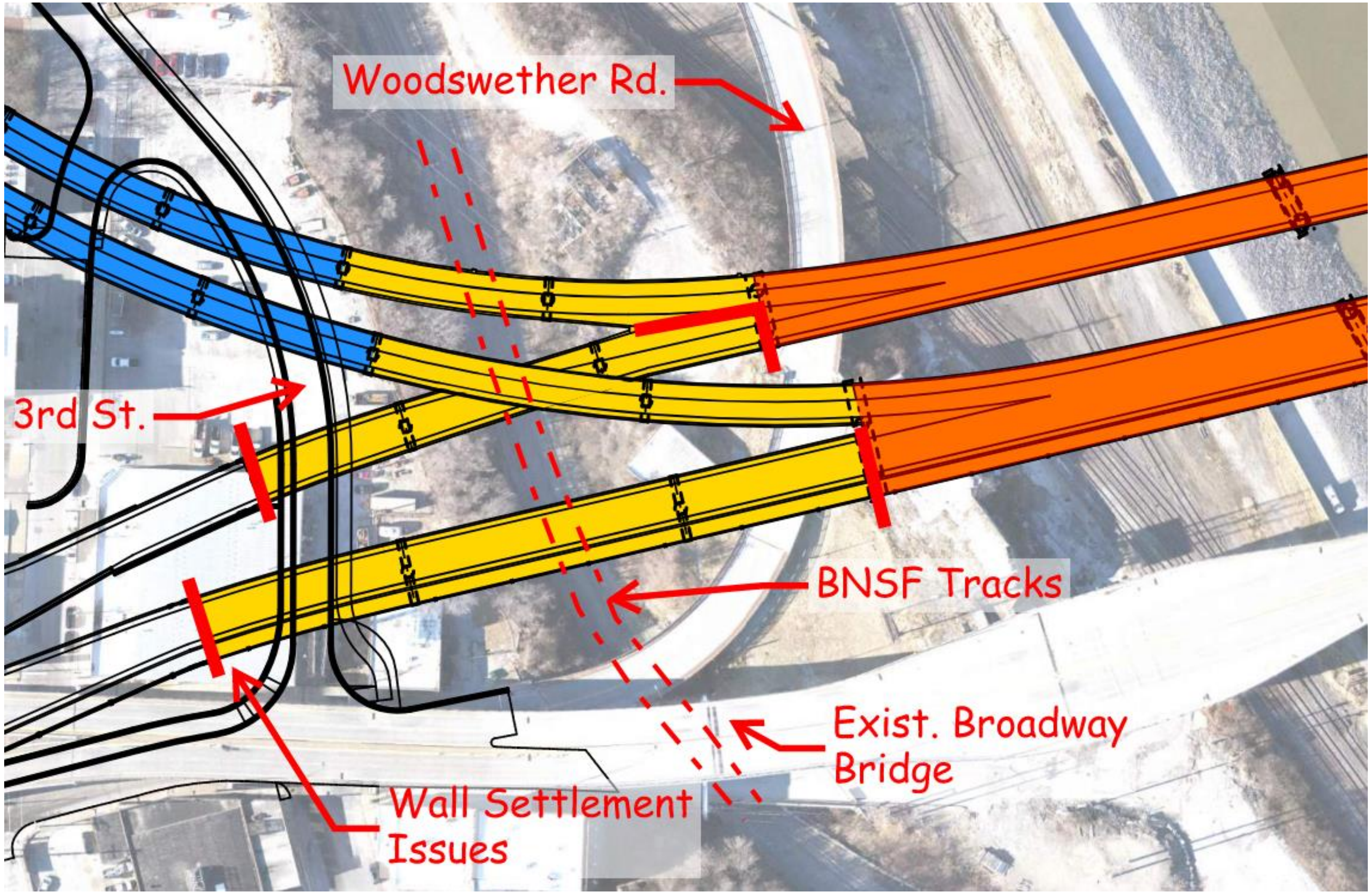
- Two-tiered wall

- Top: Limestone
- 10' bench
- Bottom: Soil Nail (into shale)

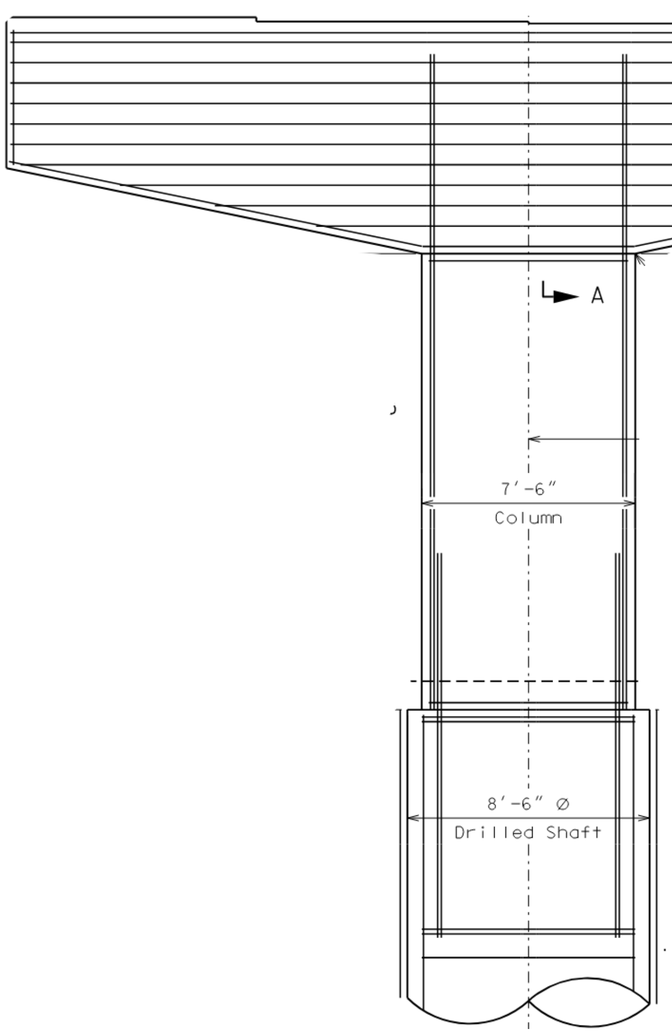

SANDVIK


BERKEL

South Approach Spans



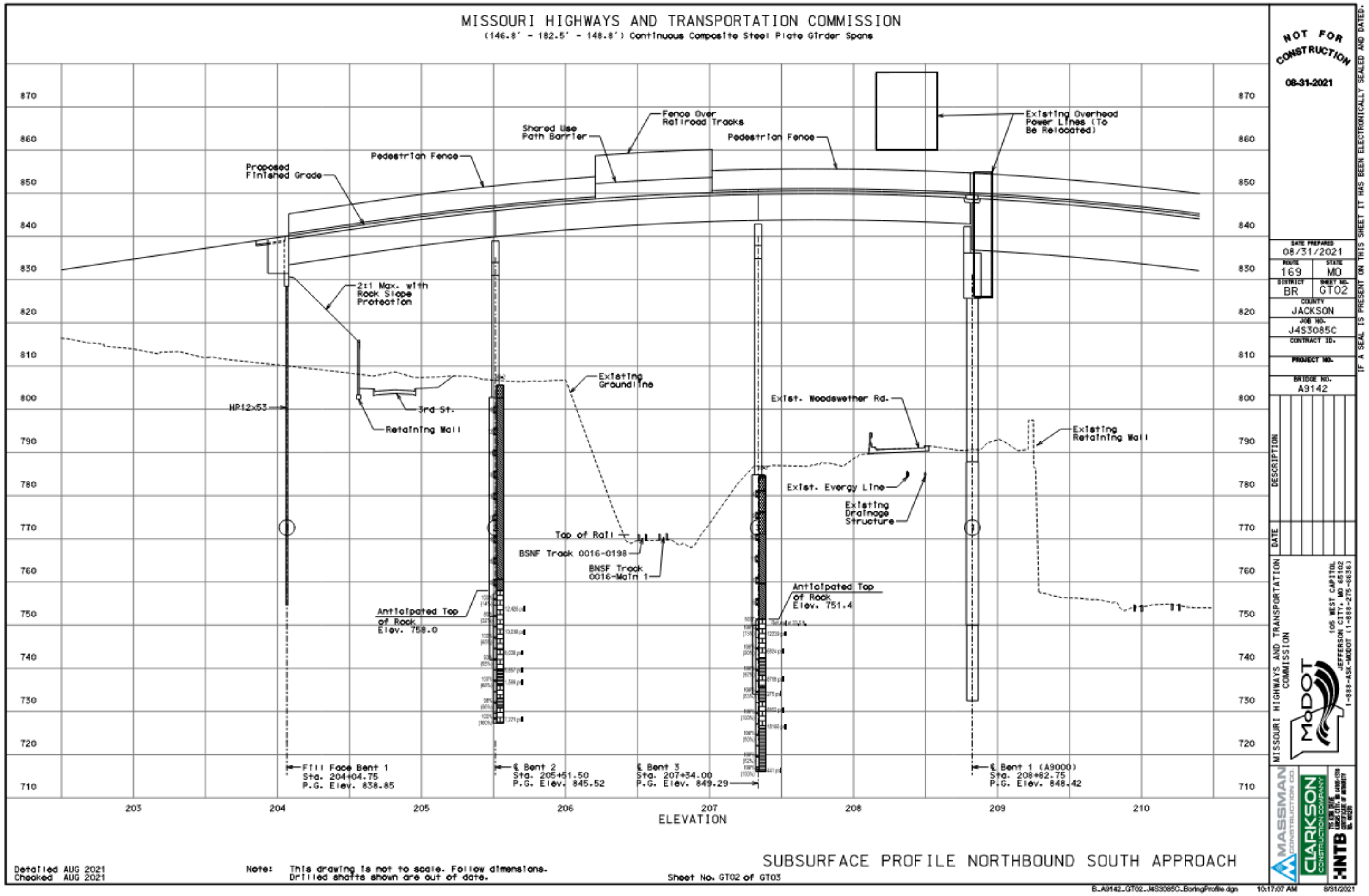
South Approaches - Substructure



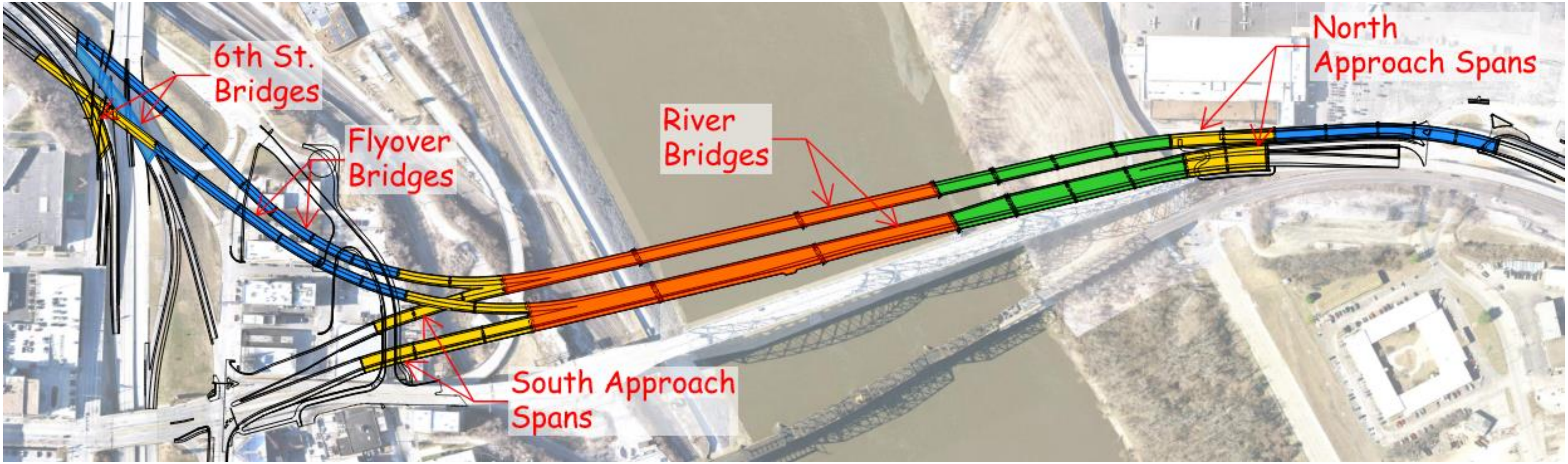
- Hammer Head Bents on
  - 8'-6" Drilled Shaft
  - 8'-0" Rock Socket

- Integral End Bents on H-Piles
  - Most Behind MSE Walls
  - One in Prebored Rock

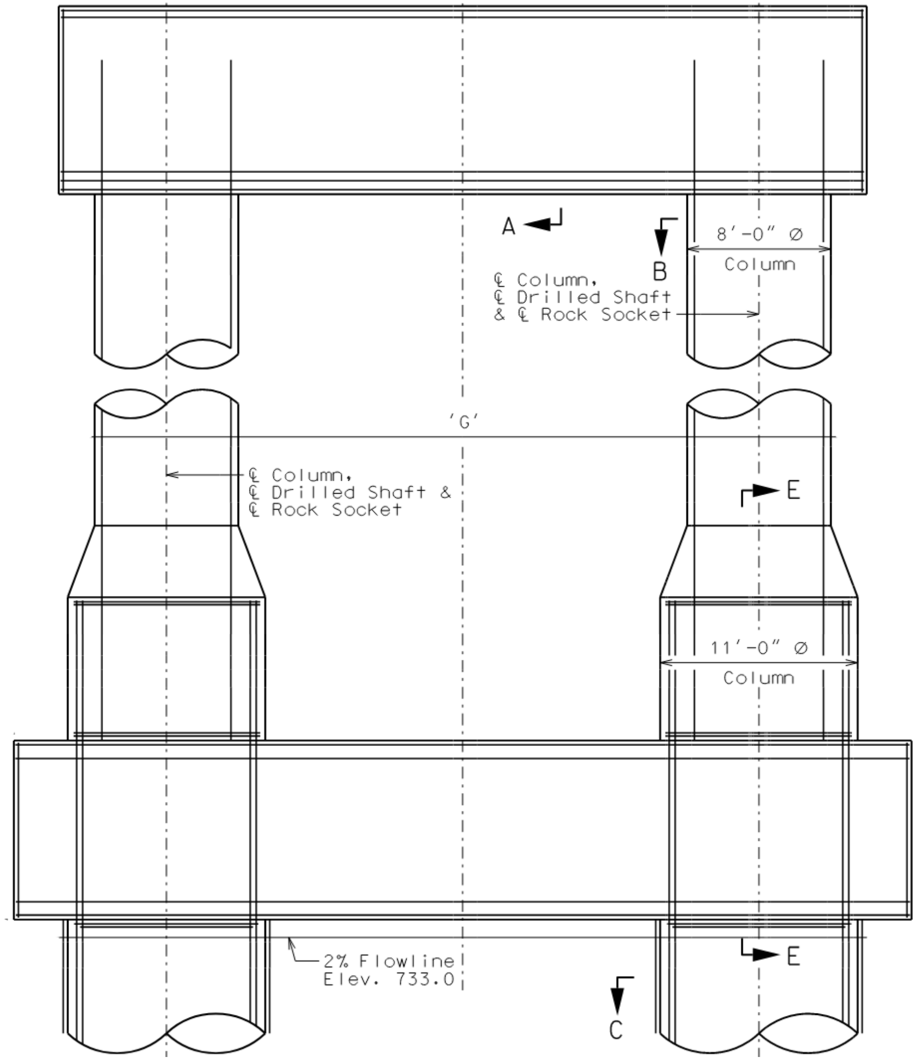
South Approach



River Bridges

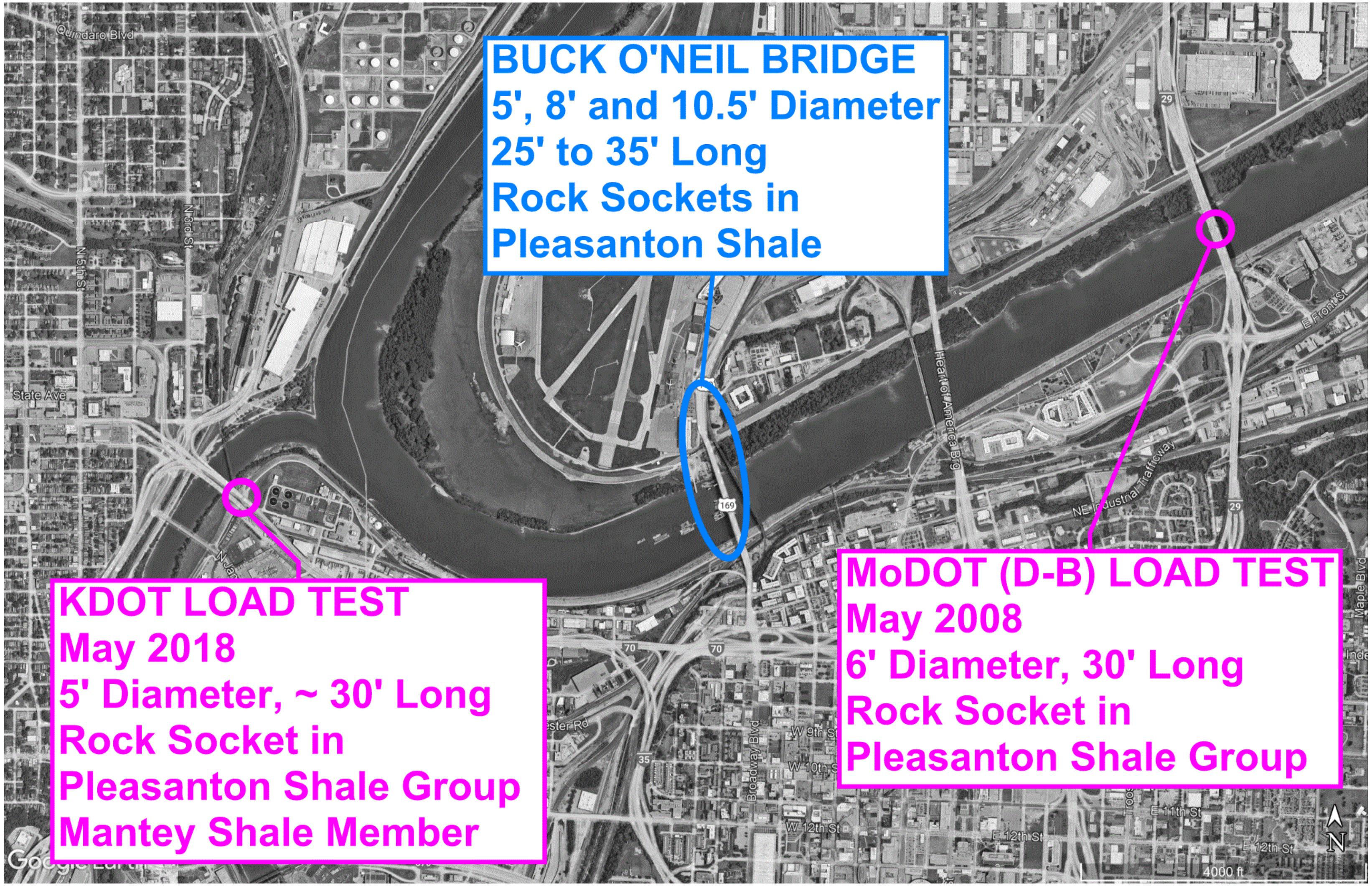


River Bridge - Substructure

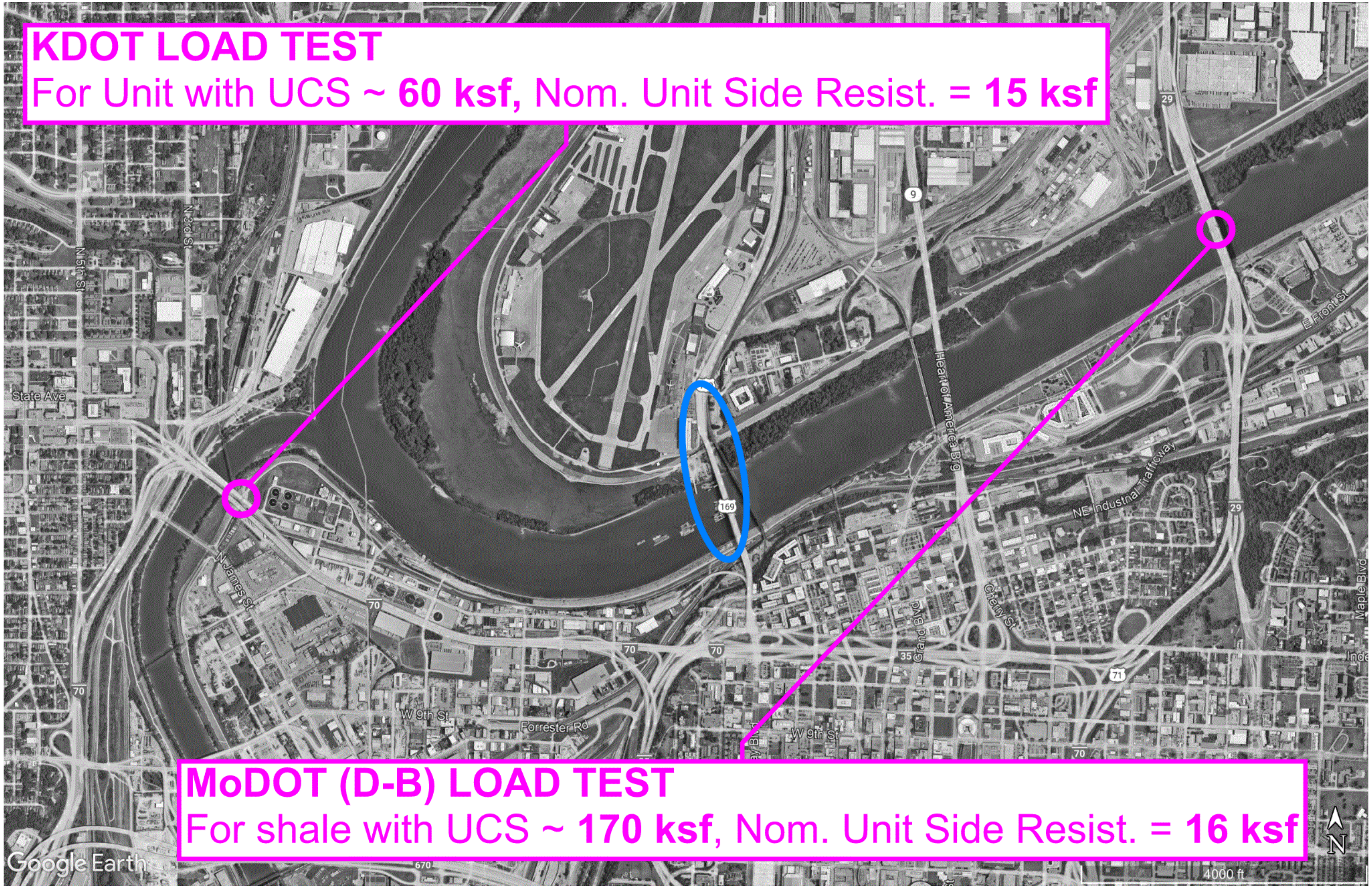


- Design for 3,450-kip Vessel Collision Load (per RFP)
- Design for Scour to Bedrock (per RFP)
- Waterline Strut
- 5 ksi Concrete
- 11'-0" Drilled Shafts
- 10'-6" Rock Sockets
- Bedrock: PLEASANTON SHALE

Nearby Load Tests in Pleasanton



SIDE RESISTANCE



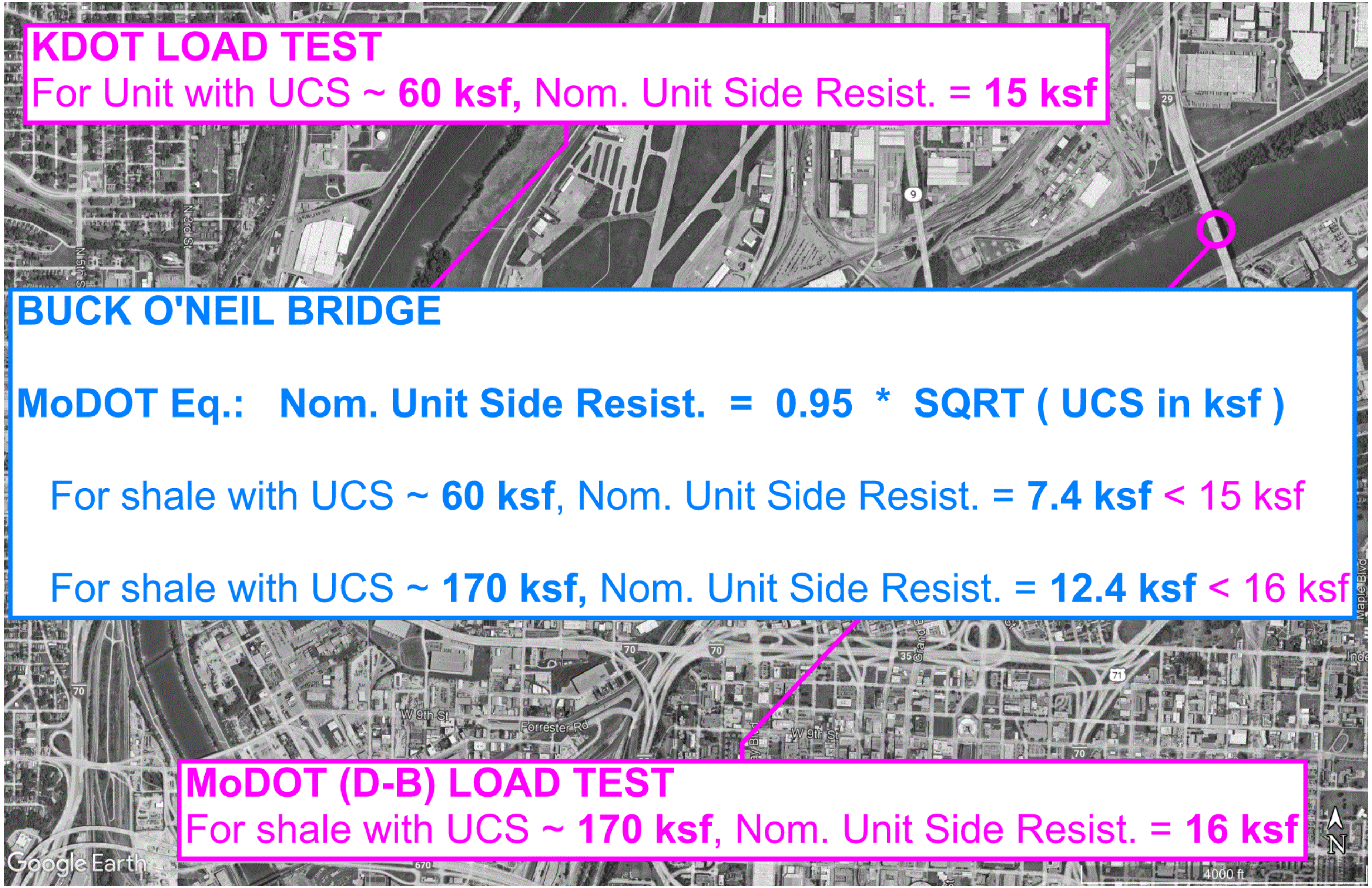
KDOT LOAD TEST

For Unit with UCS ~ **60 ksf**, Nom. Unit Side Resist. = **15 ksf**

MoDOT (D-B) LOAD TEST

For shale with UCS ~ **170 ksf**, Nom. Unit Side Resist. = **16 ksf**

SIDE RESISTANCE



KDOT LOAD TEST

For Unit with UCS ~ **60 ksf,** Nom. Unit Side Resist. = **15 ksf**

BUCK O'NEIL BRIDGE

MoDOT Eq.: Nom. Unit Side Resist. = 0.95 * SQRT (UCS in ksf)

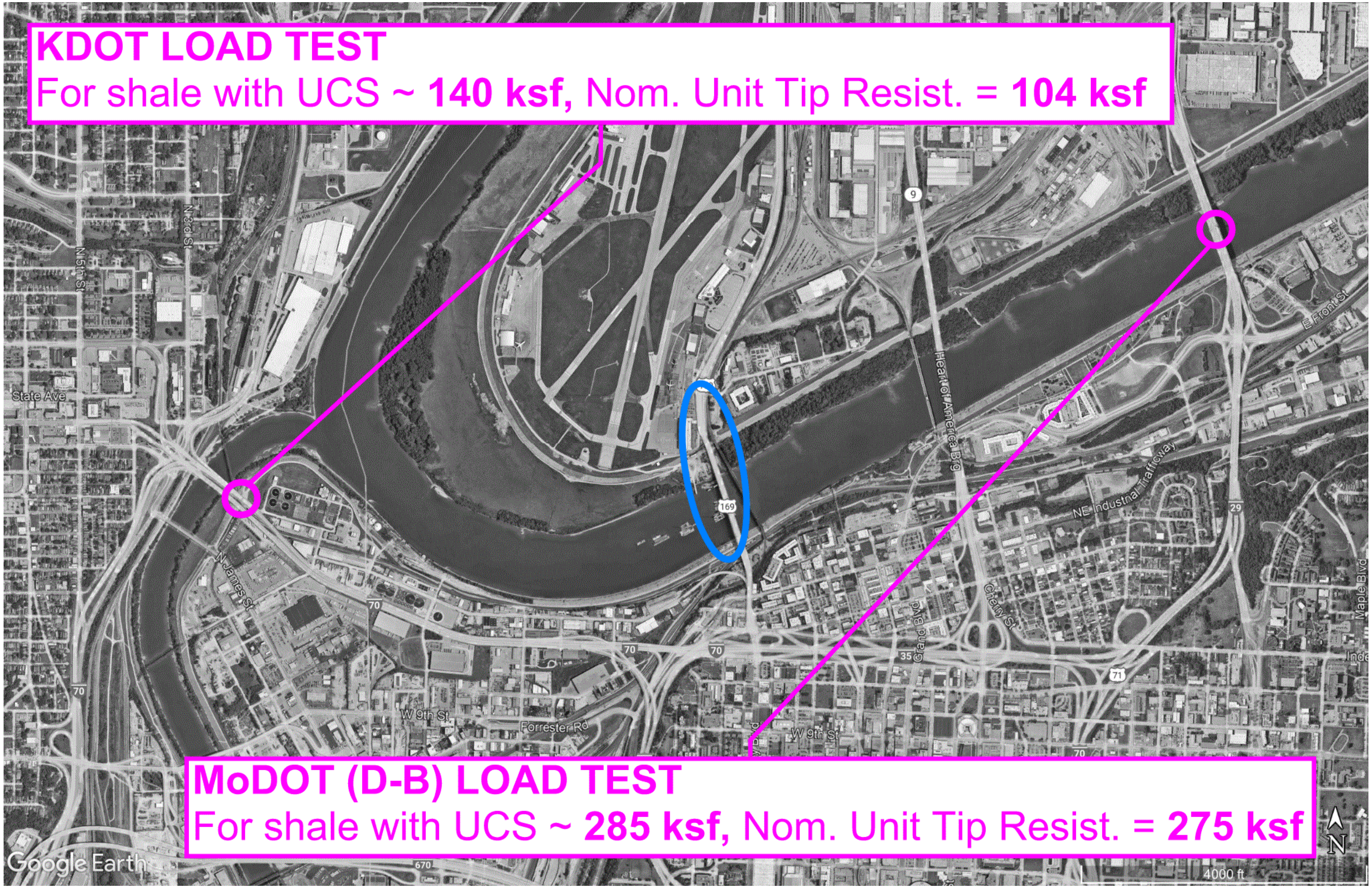
For shale with UCS ~ **60 ksf**, Nom. Unit Side Resist. = **7.4 ksf** < 15 ksf

For shale with UCS ~ **170 ksf,** Nom. Unit Side Resist. = **12.4 ksf** < 16 ksf

MoDOT (D-B) LOAD TEST

For shale with UCS ~ **170 ksf**, Nom. Unit Side Resist. = **16 ksf**

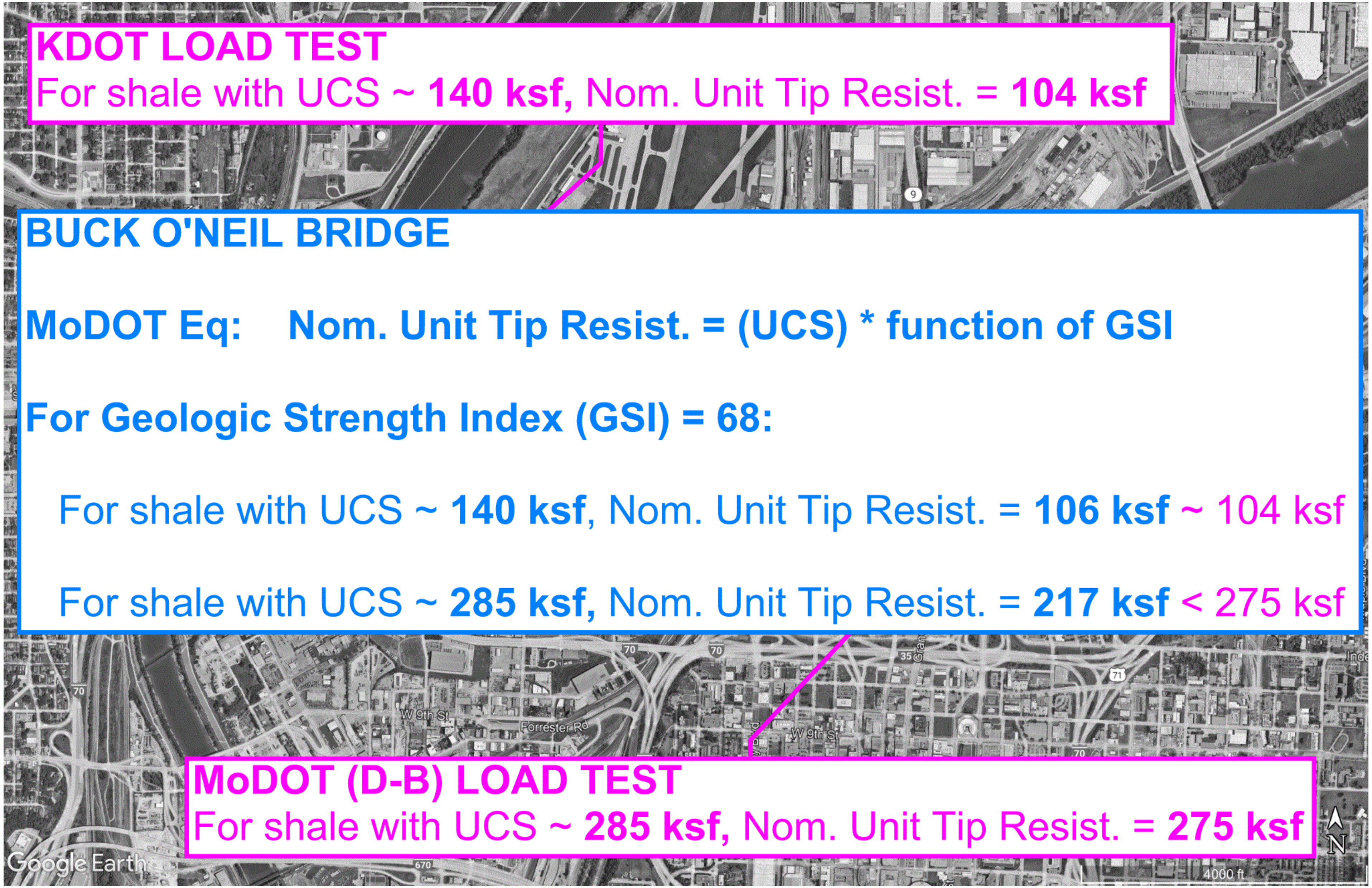
TIP RESISTANCE



KDOT LOAD TEST
For shale with UCS ~ **140 ksf,** Nom. Unit Tip Resist. = **104 ksf**

MoDOT (D-B) LOAD TEST
For shale with UCS ~ **285 ksf,** Nom. Unit Tip Resist. = **275 ksf**

TIP RESISTANCE



KDOT LOAD TEST

For shale with UCS ~ **140 ksf,** Nom. Unit Tip Resist. = **104 ksf**

BUCK O'NEIL BRIDGE

MoDOT Eq: Nom. Unit Tip Resist. = (UCS) * function of GSI

For Geologic Strength Index (GSI) = 68:

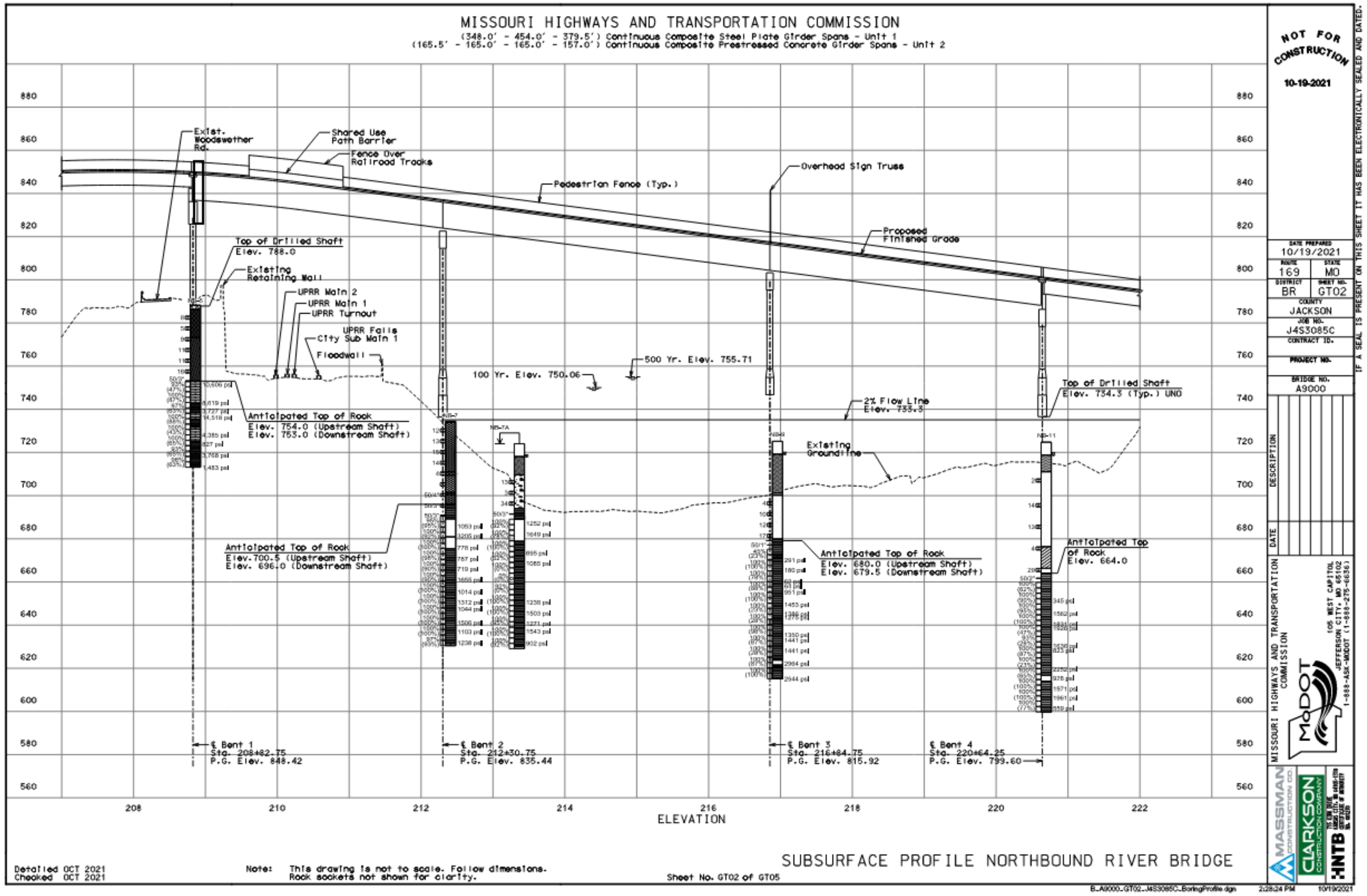
For shale with UCS ~ **140 ksf**, Nom. Unit Tip Resist. = **106 ksf** ~ 104 ksf

For shale with UCS ~ **285 ksf,** Nom. Unit Tip Resist. = **217 ksf** < 275 ksf

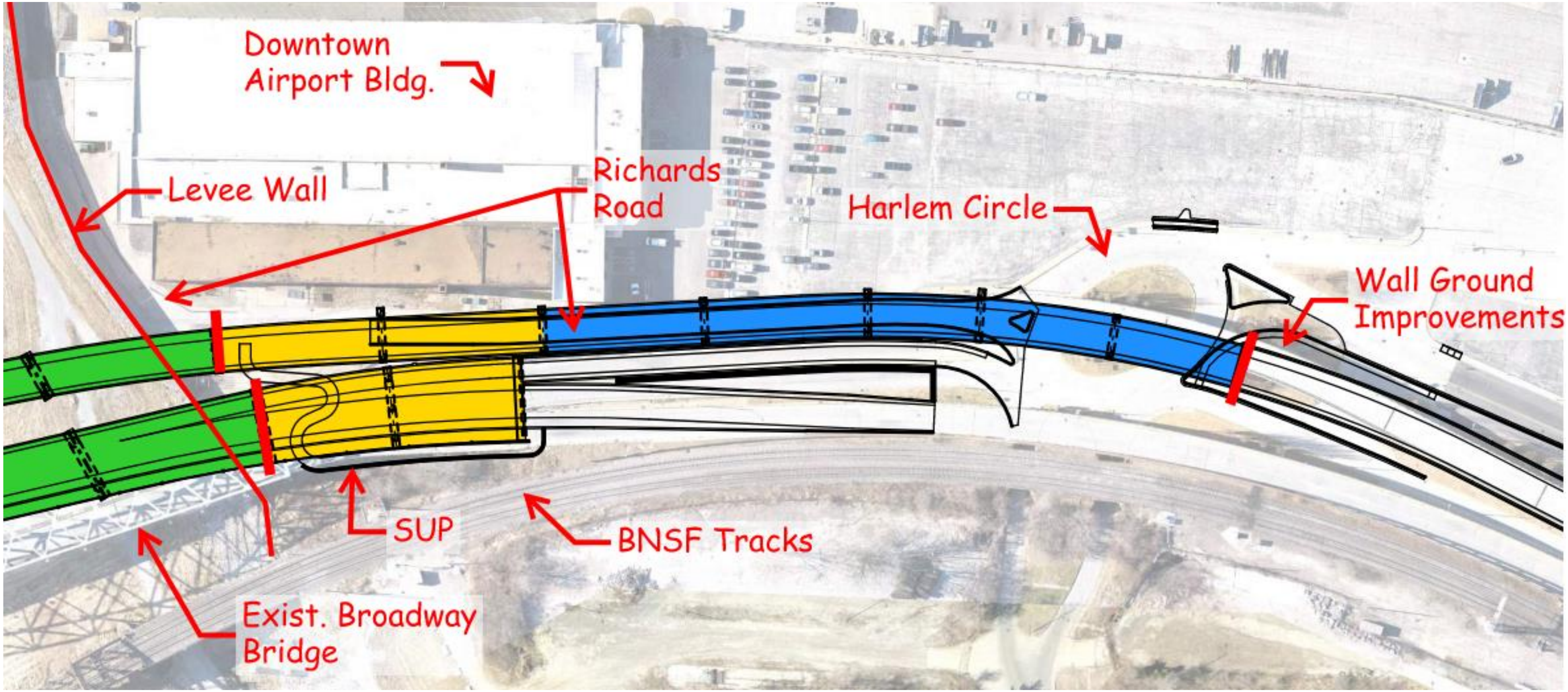
MoDOT (D-B) LOAD TEST

For shale with UCS ~ **285 ksf,** Nom. Unit Tip Resist. = **275 ksf**

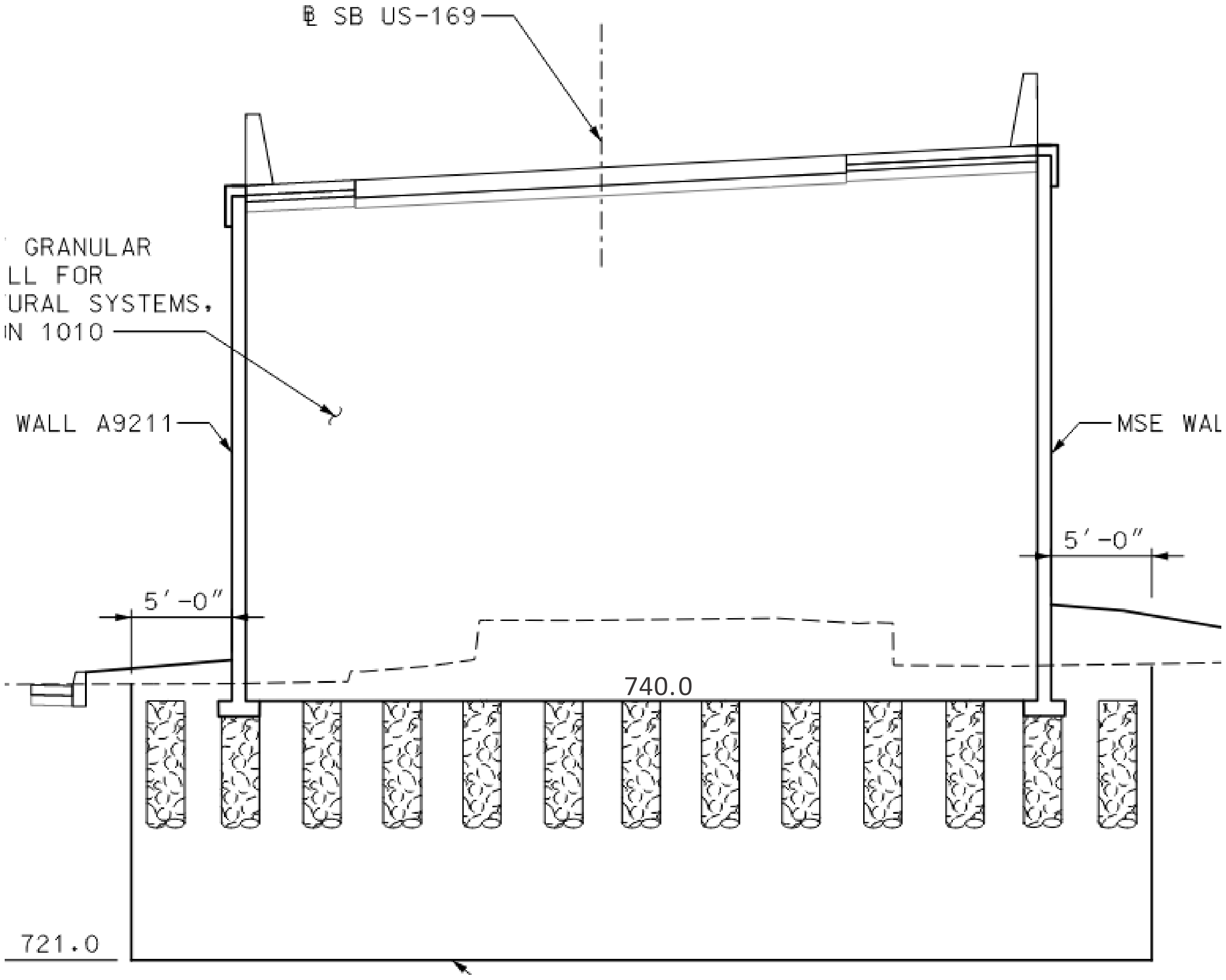
River Bridge - Northbound Main Span



North Approach Spans



SB North Approach by Airport



Wrap Around MSE Walls

- 27' Tall at Abutment

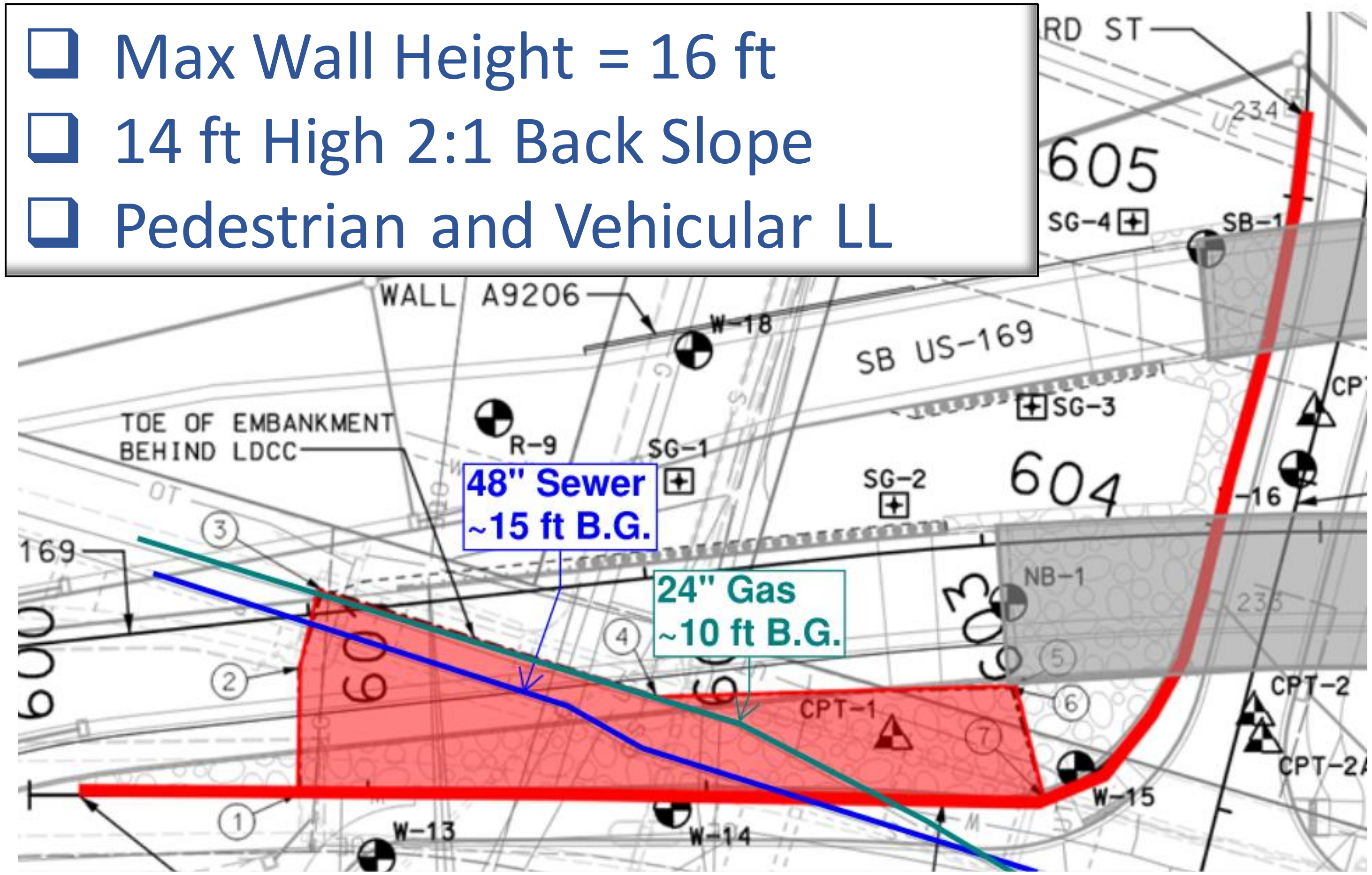
- 8' to 15' of Clay & Sand FILL with gravel, cinders & brick; over Soft Fat Clay to 18'

Stone Columns to Mitigate

- Short-term Bearing,
- Short-term Global, and
- Variable, Slow Settlement

MSE Wall at 3rd St. (South Approach)

- ❑ Max Wall Height = 16 ft
- ❑ 14 ft High 2:1 Back Slope
- ❑ Pedestrian and Vehicular LL



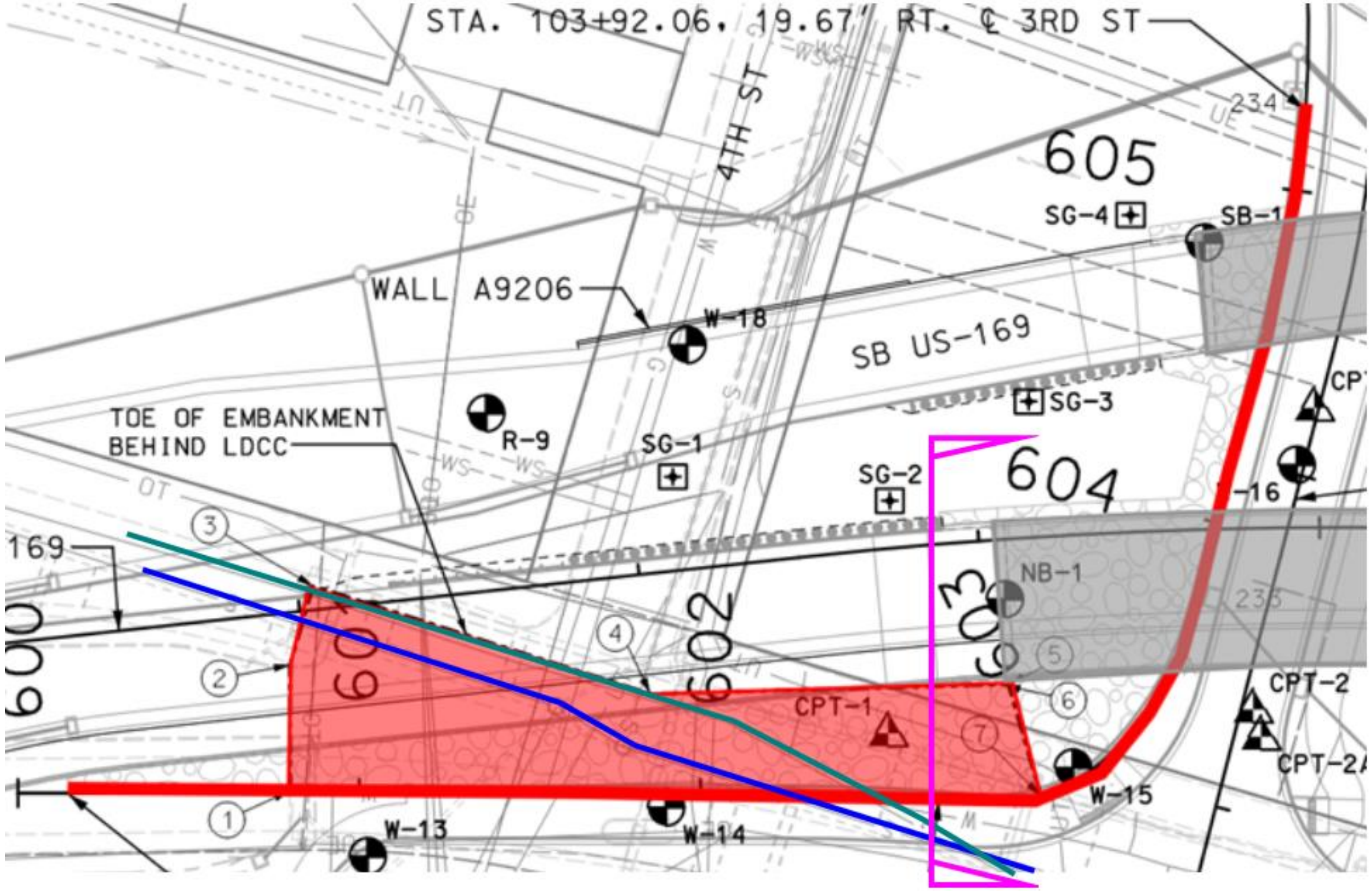
Profile:

- 6' Clayey Urban Fill
- 40' Clayey Loess
- Bedrock (KC Group)

Deep WT (5' above rock)

- 48" Sewer to stay
- 24" Gas Line to stay
- Fiber & Water Lines stay

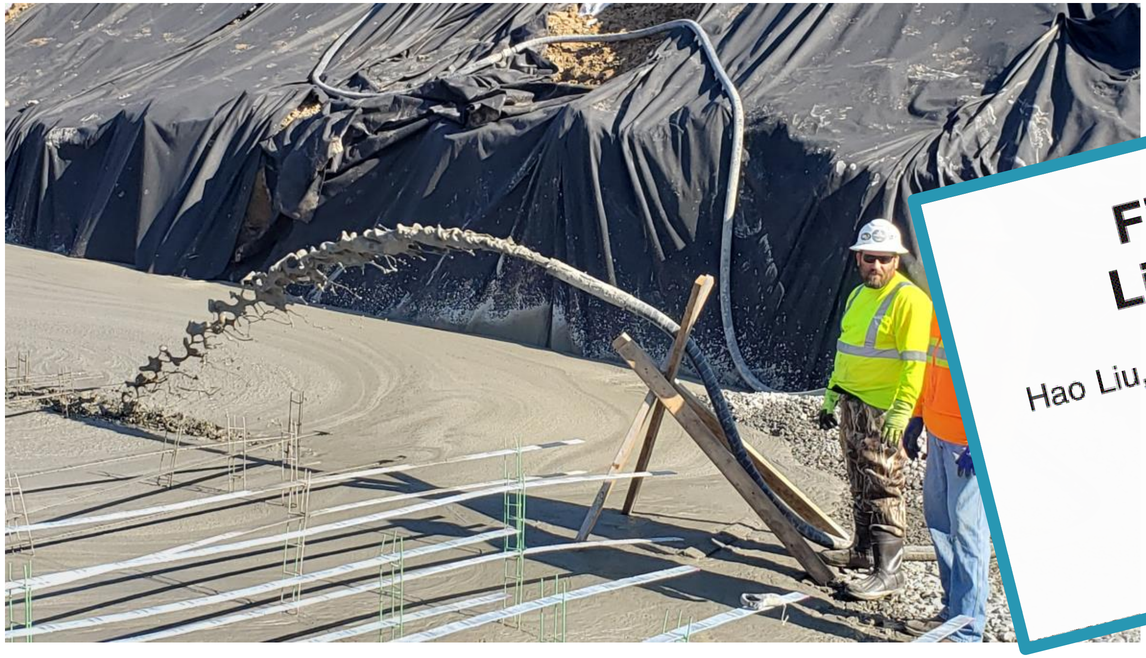
MSE Wall at 3rd St.

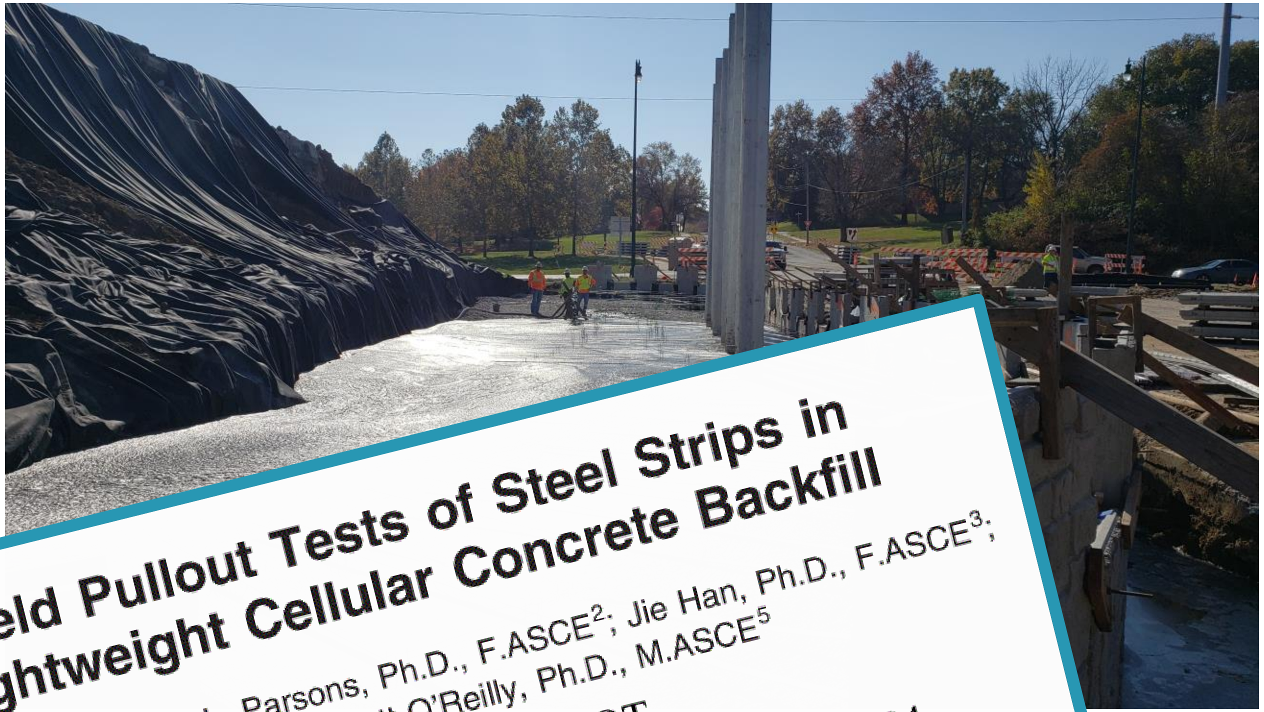


- In the RED ZONE, overexcavation limited to 4 ft below existing ground (i.e. 2 ft below B/Wall).
- Lean Clay Embankment
  - SB first then NB.
- TRY: Low Density Cellular Concrete (LDCC) where needed (RED ZONE).
  - Cast unit weight = 30 pcf
  - Phi design = 35 deg.

MSE Wall at 3rd St.

Photos of previous use of LDCC at nearby US-24 over Delaware Street





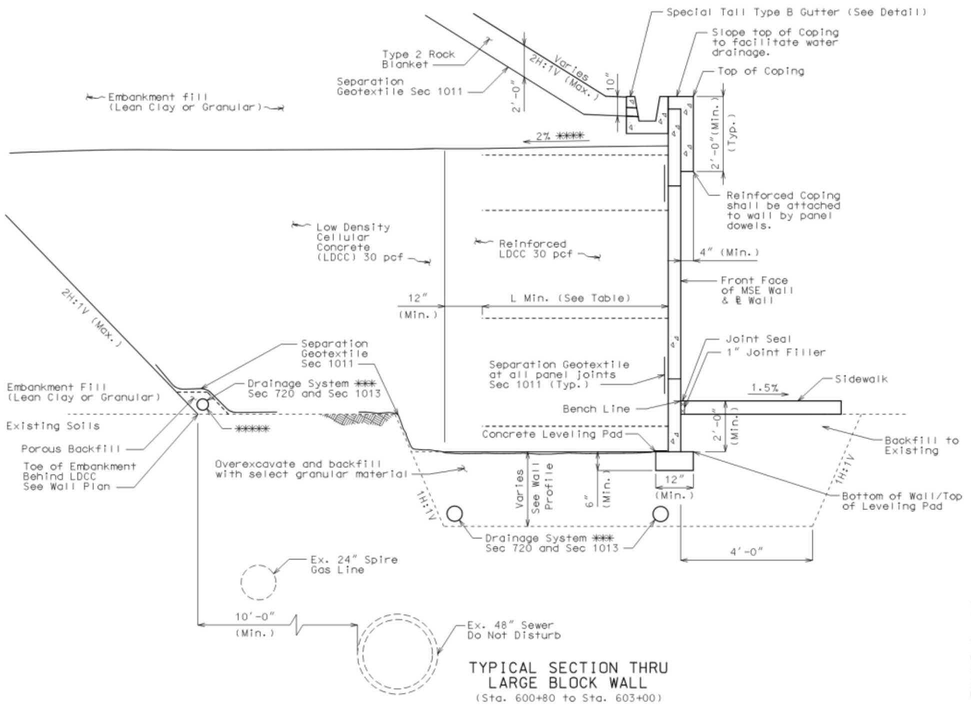
Field Pullout Tests of Steel Strips in Lightweight Cellular Concrete Backfill

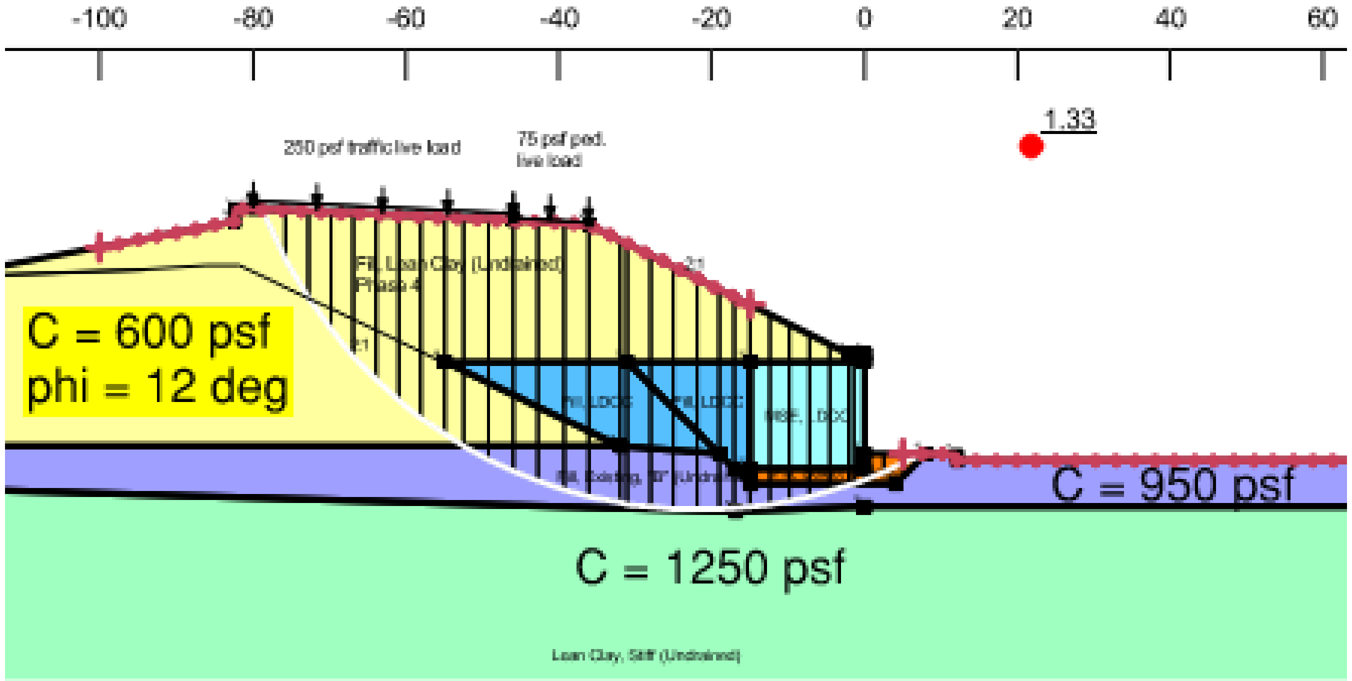
Hao Liu, Ph.D.[1]; Robert L. Parsons, Ph.D., F.ASCE[2]; Jie Han, Ph.D., F.ASCE[3]; Yuqiu Ye[4]; and Matt O’Reilly, Ph.D., M.ASCE[5]

Study Support by KDOT

J. Geotech. Geoenviron. Eng., 2022, 148(5): 06022004

MSE Wall at 3rd St. - Stability





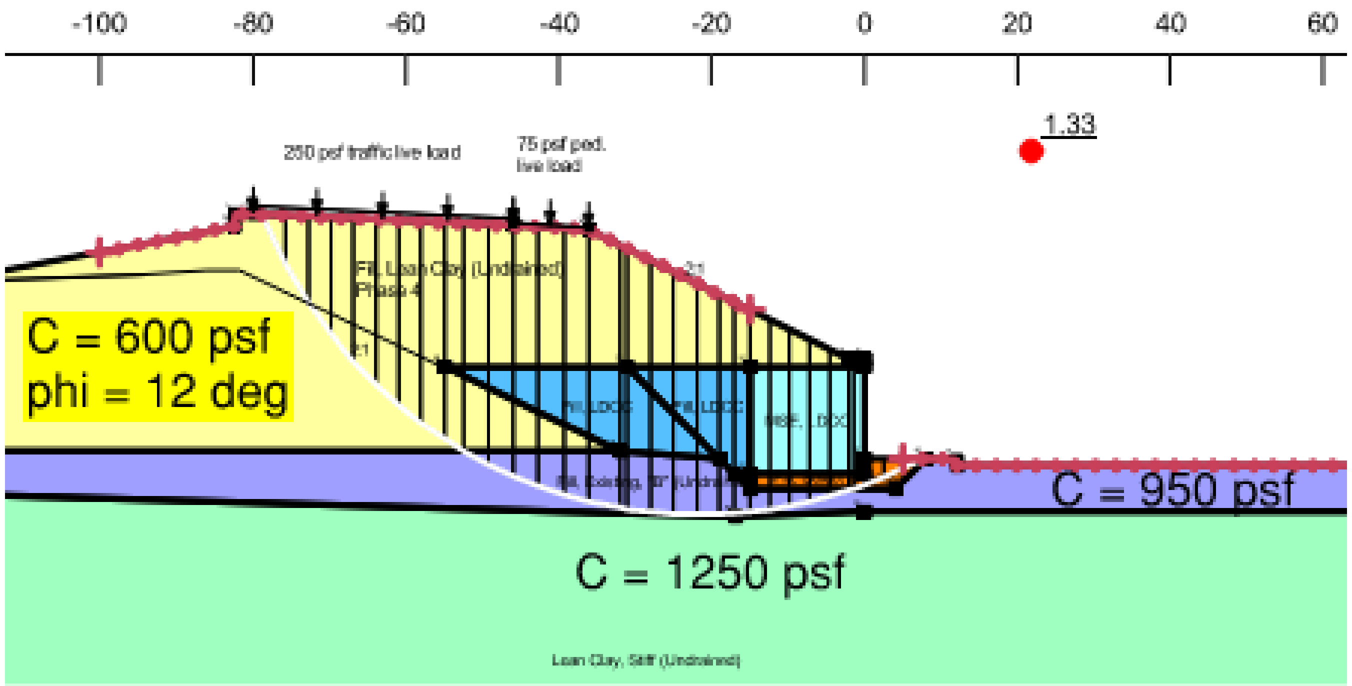
MSE Wall at 3rd St. - Stability

LDCC in Light Blue Zone:

- for Short-term Bearing
- to Limit Risk of Excess Settlement of Wall and Utilities.

LDCC in Med. Blue Zone (behind the 1:1 wedge):

- for Short-term & Long-term Global

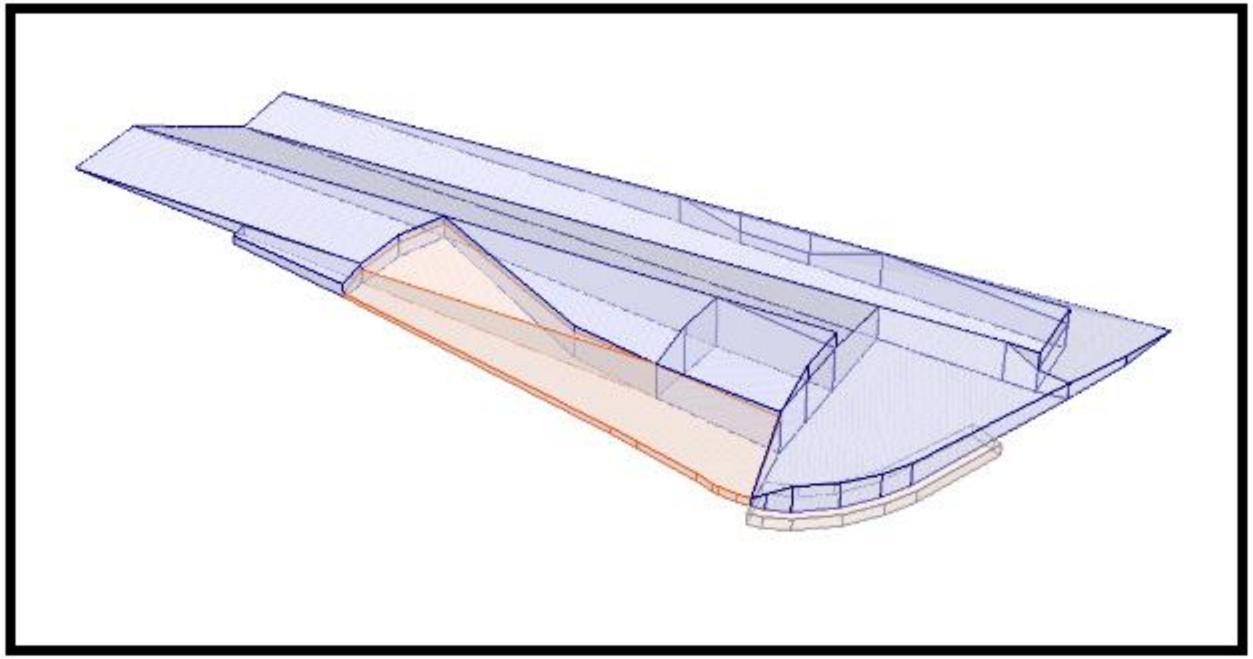


2' Gravel in Orange Zone:

- for Drainage & Sliding Stability

MSE Wall at 3rd St. – Settlement

Figure B: Isometric View of South Approach Embankment Loads as Modeled in Settle3



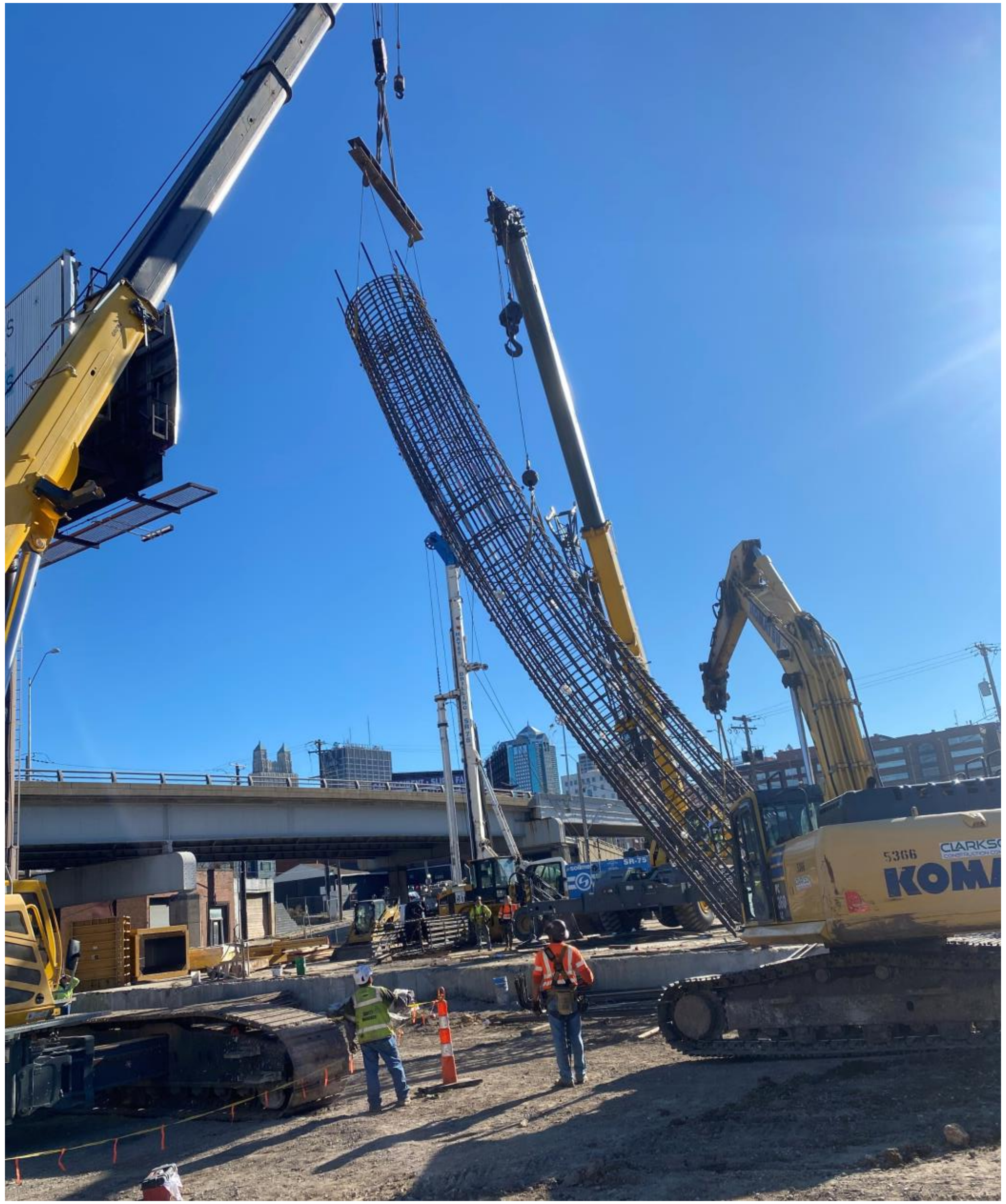
Along face of wall:
Predicted Settlement = 2 to 3 inches.

Along 48" Sewer:
Predicted Settlement < 1.5 inches.

At the shorter SB approach (20 ft fill):
Predicted Settlement = 10 inches.
Measured Settlement = 2 inches!

Construction Photos


20
15
10
5



BUCK O'NEIL BRIDGE DESIGN-BUILD PROJECT

Questions