Twin Ports Interchange Reconstruction Project
Planning Through Construction

2023 Structural Engineering Series

February 28, 2023

DEPARTMENT OF TRANSPORTATION

Patrick Huston, P.E. | Assistant District Engineer – MnDOT District 1 Duluth
Nick Haltvick, P.E.| North Region Bridge Construction Engineer – MnDOT Bridge Office
Alex Schulz, P.E.| Project Manager – Kraemer North America

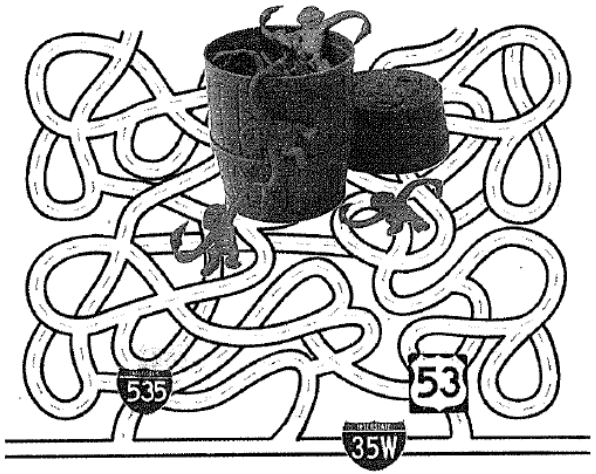
Project Background

Patrick Huston, P.E. | MnDOT District 1 Assistant District Engineer | Major Projects

Interchange and Project Details

- Locally known as the “Can of Worms”
- Built in late 1969-1972
  - Ramp from NB I-35 to NB T.H. 53 was an “add-on”
- 33 total bridges (includes Garfield & I-535, 27th Avenue West and T.H.53)
  - 25 overweight permit restricted
  - 2.6% of the bridge deck statewide
- 4th highest interchange crash rate statewide

Alternatives Analysis…..



Duluth's "can of worms" to be replaced with barrel of monkeys

Duluth, Minn. MNDOT has announced that it plans to begin construction of a new Lincoln Park highway in 2019 to replace the infamous "can of worms" with a new freeway system that experts are calling a "barrel of monkeys."

"What really gets my goat," says MNDOT spokeman Cheryl Crowe, "is not knowing who let the cat out of the bag. I mean, that's kind of the elephant in the room. I think there's a red herring floating around to give us the lion's share of the blame if it turns into a load of hogwash."

Mayor Emily Larson admit that "some constituents seems to have ants in the pants about this project. But the changes won't hurt a fly, and everyone can just hold their horses, because it's moving at a snail's pace, so we can have all our ducks in a row and not fowl up that nest of vipers like a bull in a china shop."

If the project is successful, Larson has promised to correct another Duluth eyesore, the infamous Miller Hill of Beans

Stormy Daniels to appear at DECC

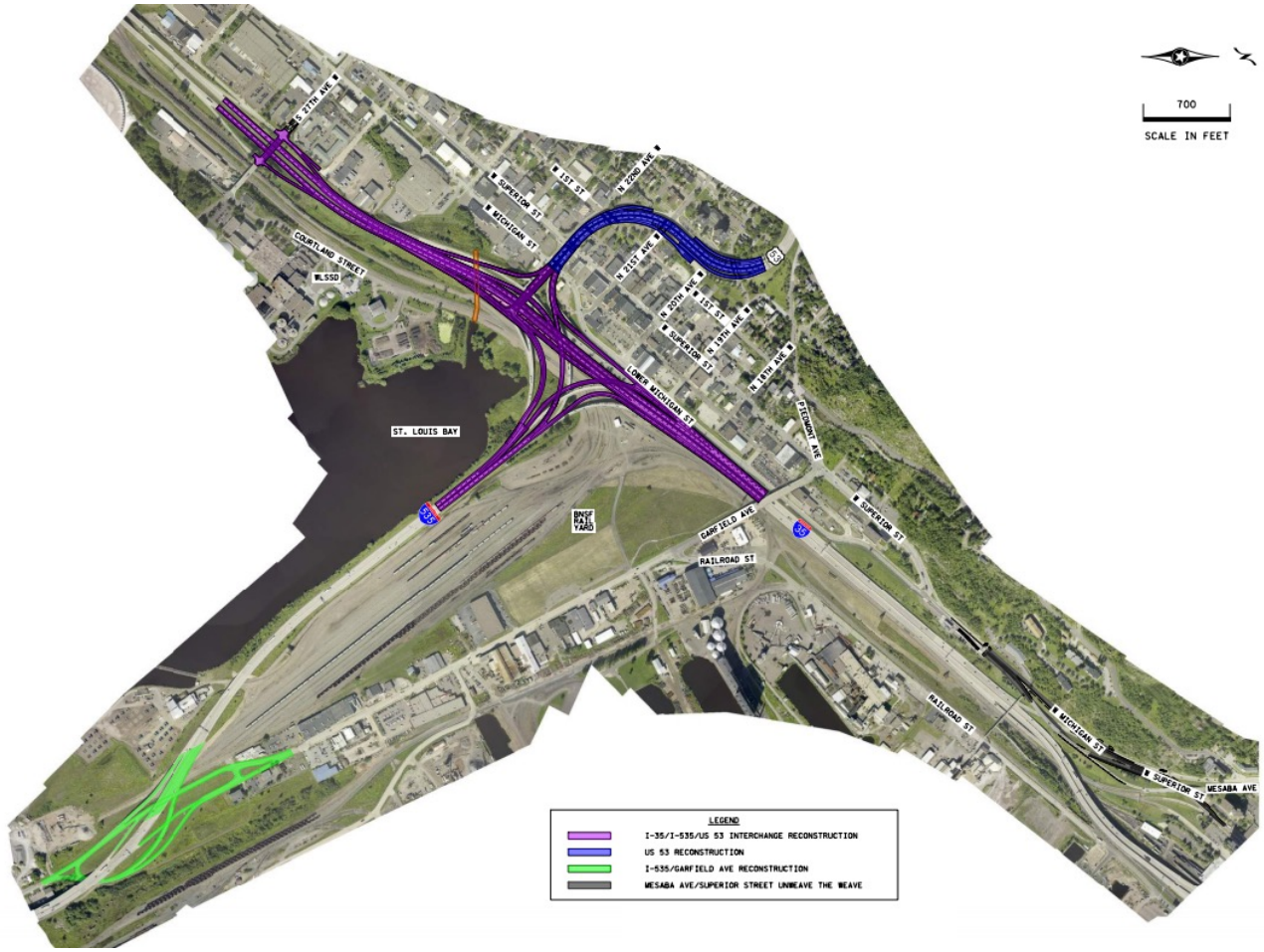
Stormy Daniels, whose alleged fling with Donald Trump resulted in scandal and payoffs and whatnot, has launched a "Make America Horny Again!" tour performing at strip clubs.

She will bring her show to the DECC April 1. "Just for Duluth, I'm changing my name to Ice Stormy

Project Goals

- **Enhance safety by eliminating blind merges and left exits**
  - Moving left exits to the right
  - Relocating merges
- **Replace aging infrastructure**
  - Reconstructing weight restricted and non-redundant bridges
  - Reduces maintenance and closures
  - Eliminates some bridge structure
- **Improve freight mobility**
  - Allow oversize/overweight freight on the Interstate
  - First and last mile to port!

Project Layout/Scope (Fall 2018)



Project Layout/Scope (Fall 2019)

TPI Timeline (Design to Start of Construction)

- Project Development
  - 2016: Roberta Dwyer, MnDOT Project Manager, starts on early work
  - 2018: Dedicated MnDOT team assigned to TPI
- September 2018 – Ames/Kraemer Joint Venture (AKJV) selected as CMGC contractor and co-location began
- **January 2019 - Final Design - Final Bridge and Roadway Design teams onboard**; key personnel co-located
- July 2019 – 30% design - Work Packages 3 and 4 deferred due to budget shortfall (November 2019)
- March 2020 COVID hits – final project development goes remote
- **October 2020 - Construction starts** (Work Packages 1 and 2)
- August 2022 - Construction starts (Work Packages 3 and 4)

Replace Aging Infrastructure

Challenge:

The infrastructure in this area comprises 3.5% of the bridge infrastructure managed in the entire state. It is in deteriorated condition and hosts some of the highest crash rates in the state, jeopardizing the ability of this economic engine to safely and efficiently conduct business.

TWIN PORTS INTERCHANGE TIMELINE:

Environmental Documentation 2017-2018

Design 2018-2020

Construction 2020-2024

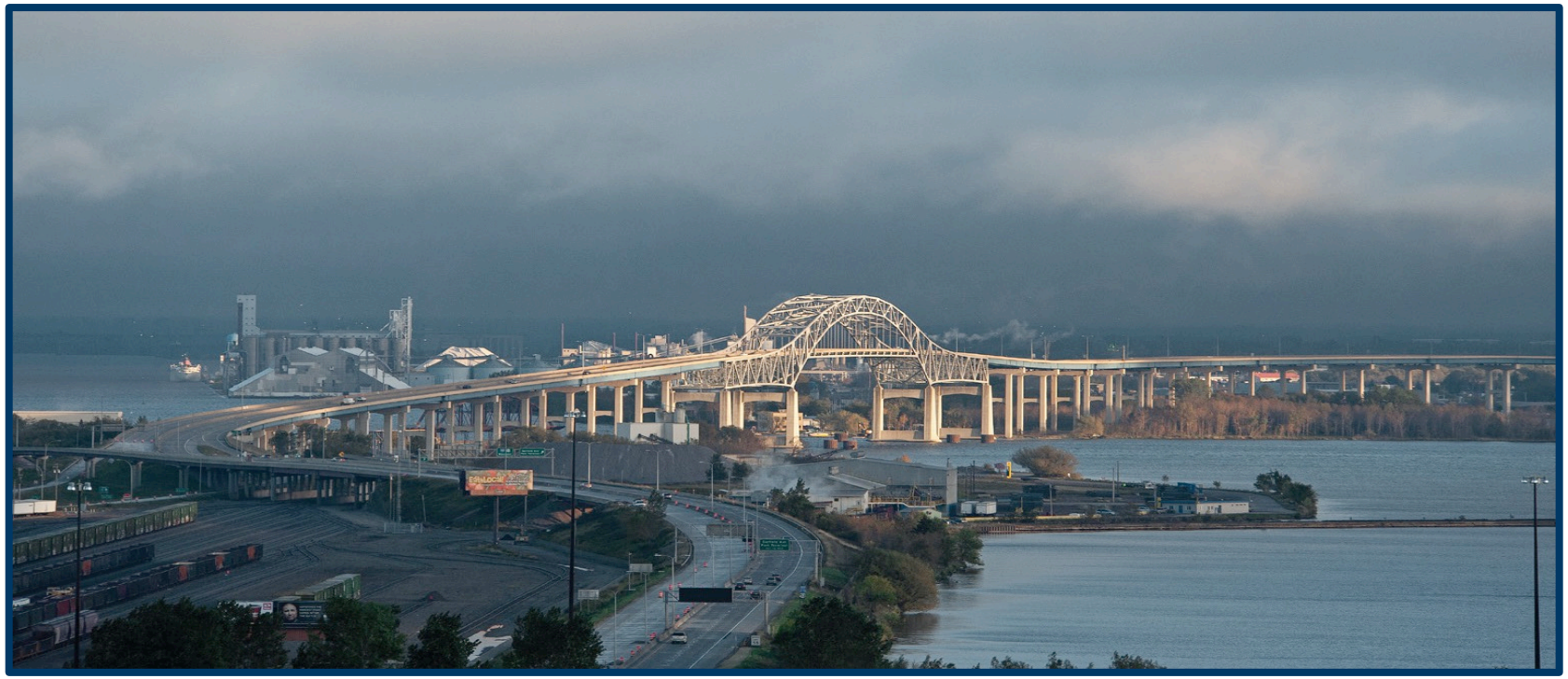
PRELIMINARY BLATNIK BRIDGE TIMELINE:

Environmental Documentation 2020 – 2024

Preliminary Design 2024 - 2026

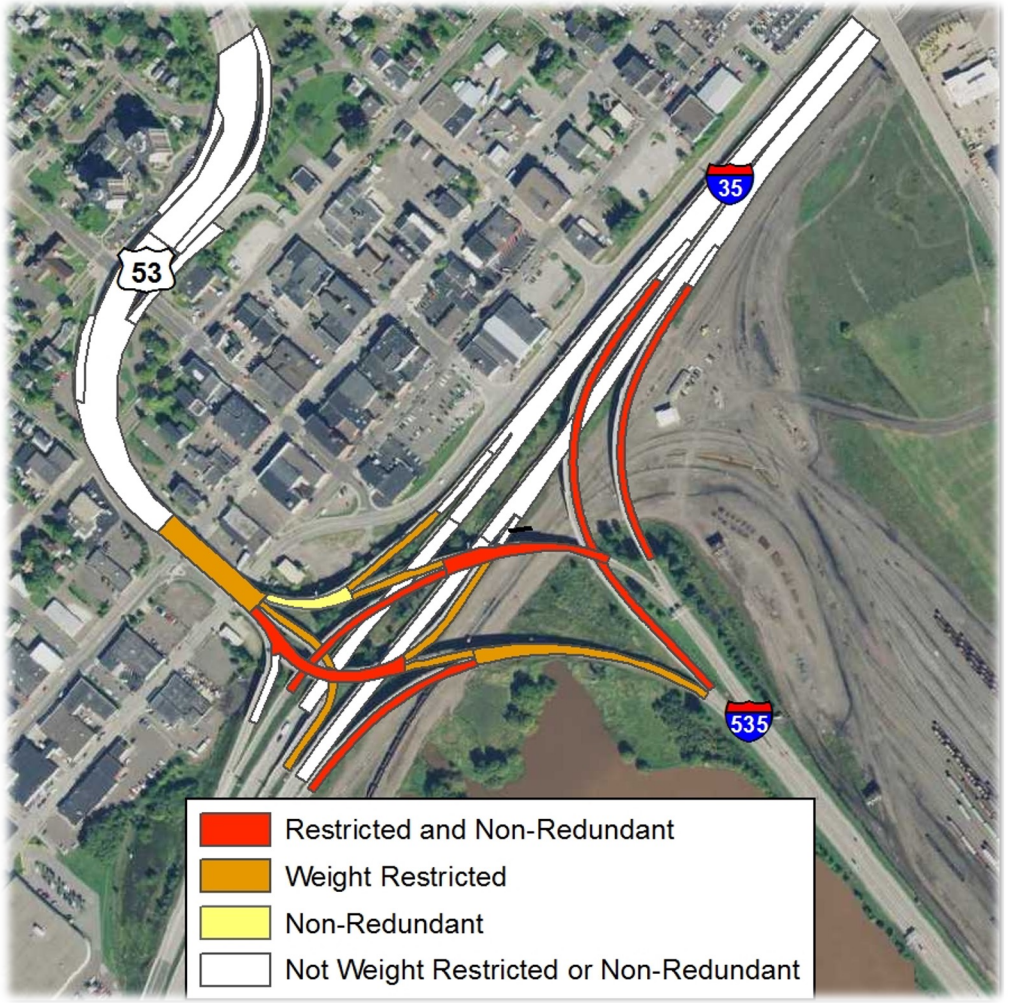
Design 2026 - 2028

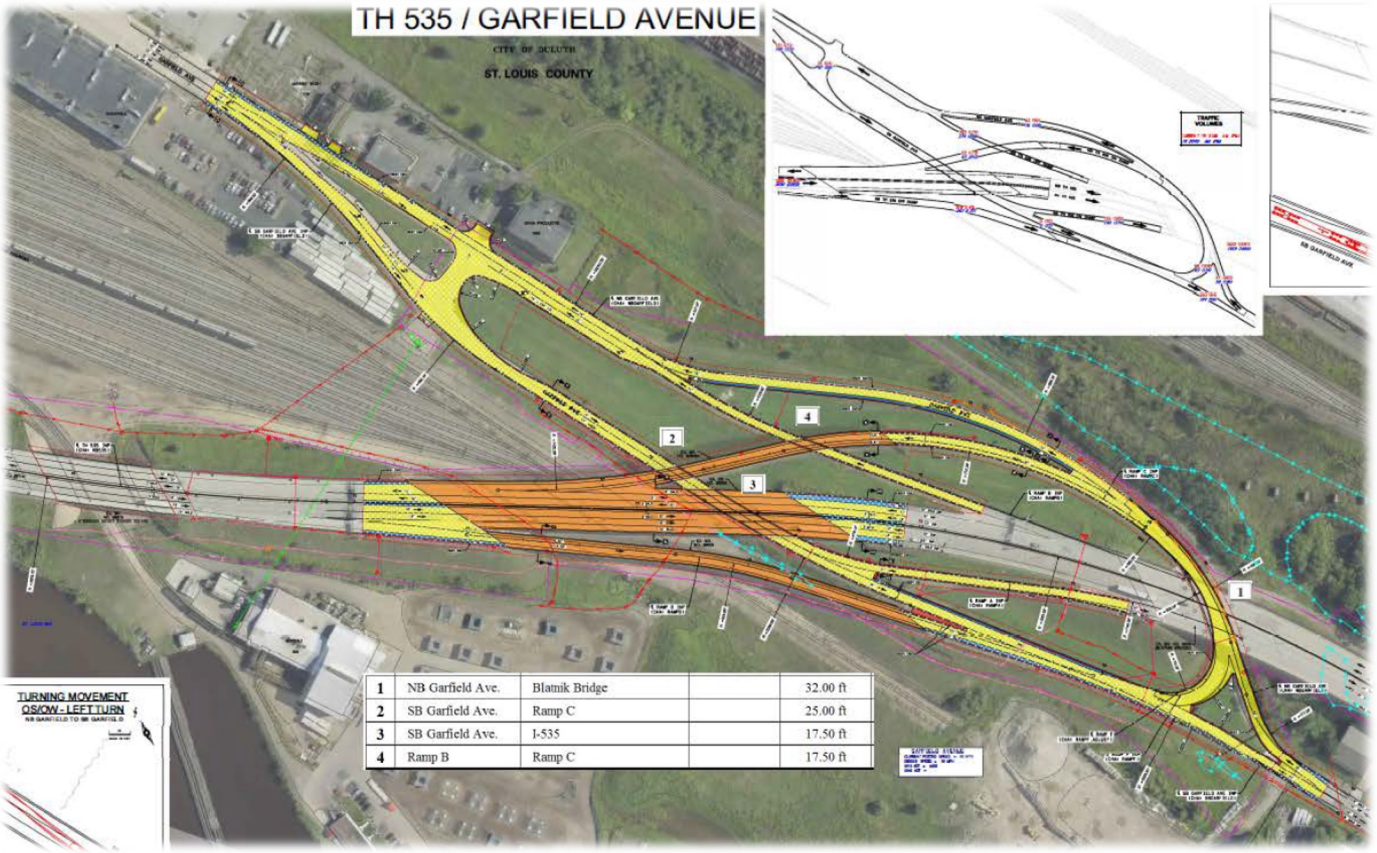
Estimated Construction Start 2028

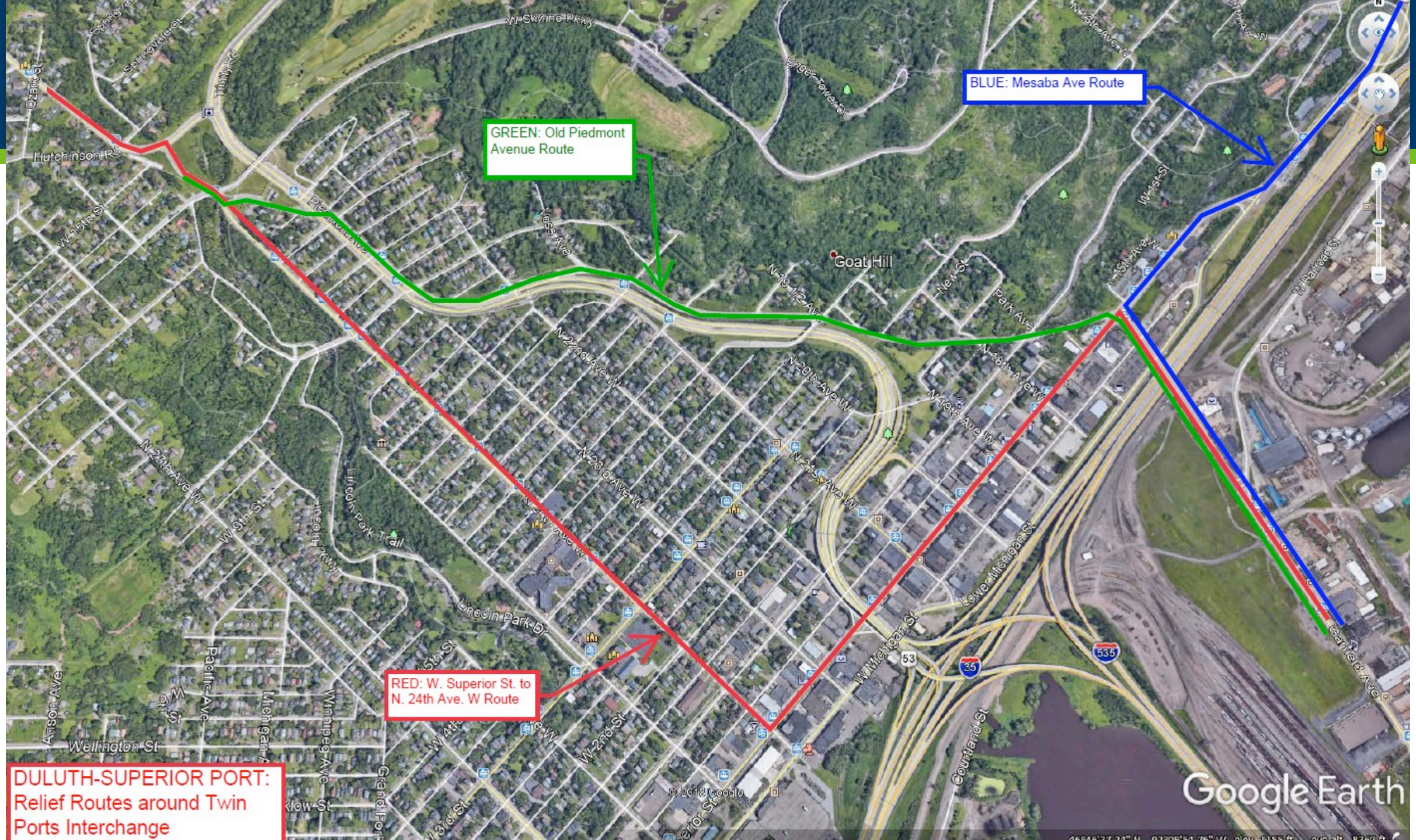


Replace Aging Infrastructure

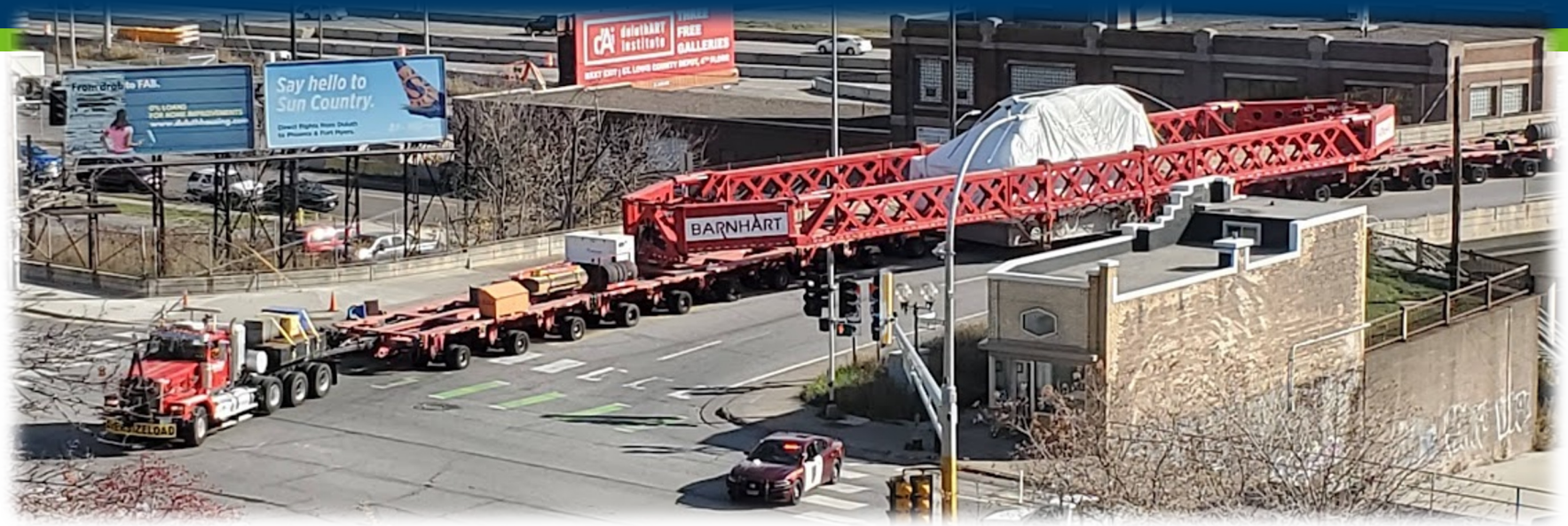
Load restrictions and Freight Mobility






BLUE: Mesaba Ave Route
GREEN: Old Piedmont Avenue Route
RED: W. Superior St. to N. 24th Ave. W Route
DULUTH-SUPERIOR PORT: Relief Routes around Twin Ports Interchange
Goat Hill
Lincoln Park Trail
Lincoln Park Dr
W Michigan St
Lower Michigan St
Courtland St
Garfield Ave
W Skyline Pkwy
Hutchinson Rd
Wellington St
Google Earth

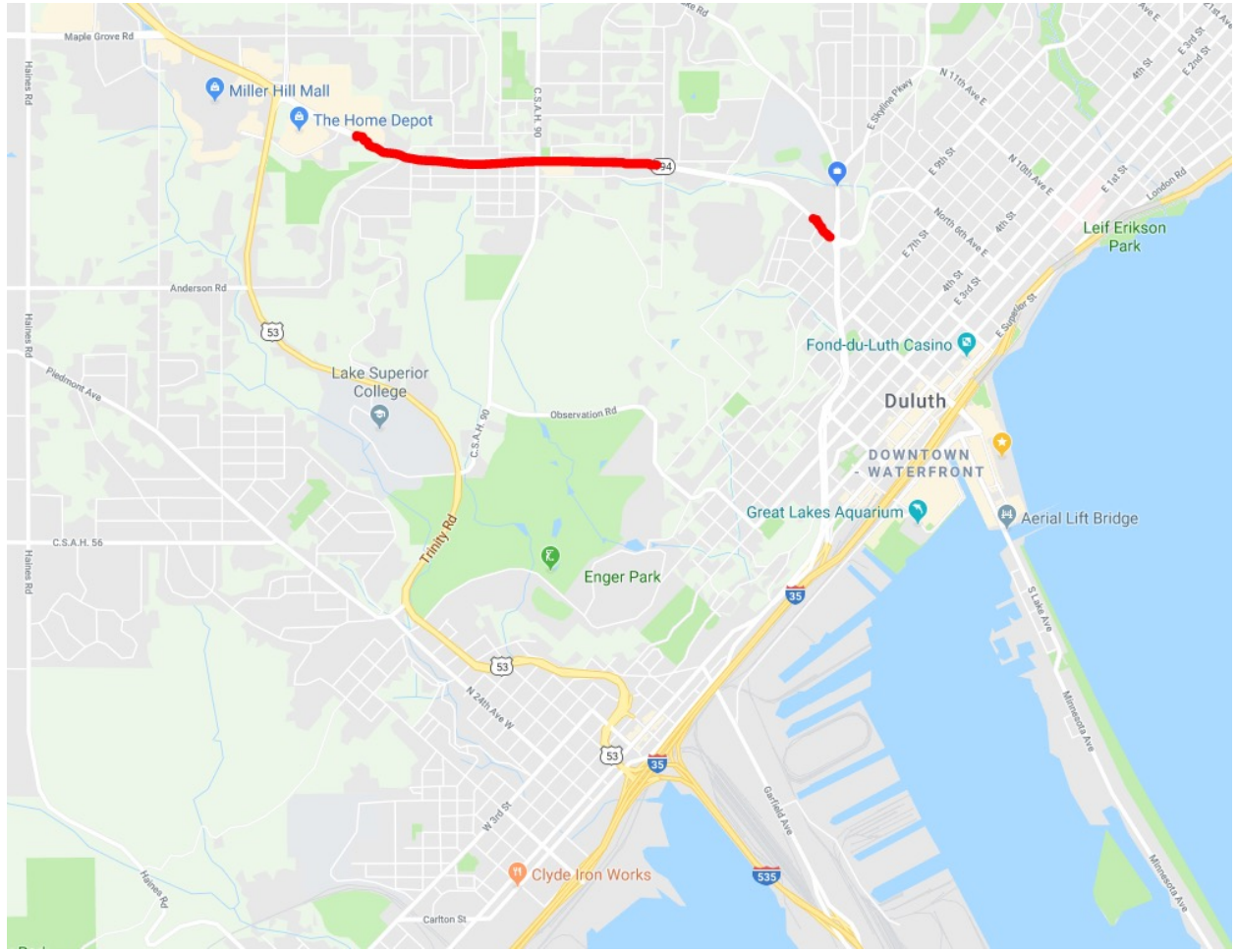
Oversize/Overweight Loads not able to travel through interchanges



2019 Local Roads Project (Separate Design-Bid-Build (DBB) Project) - **COMPLETE**

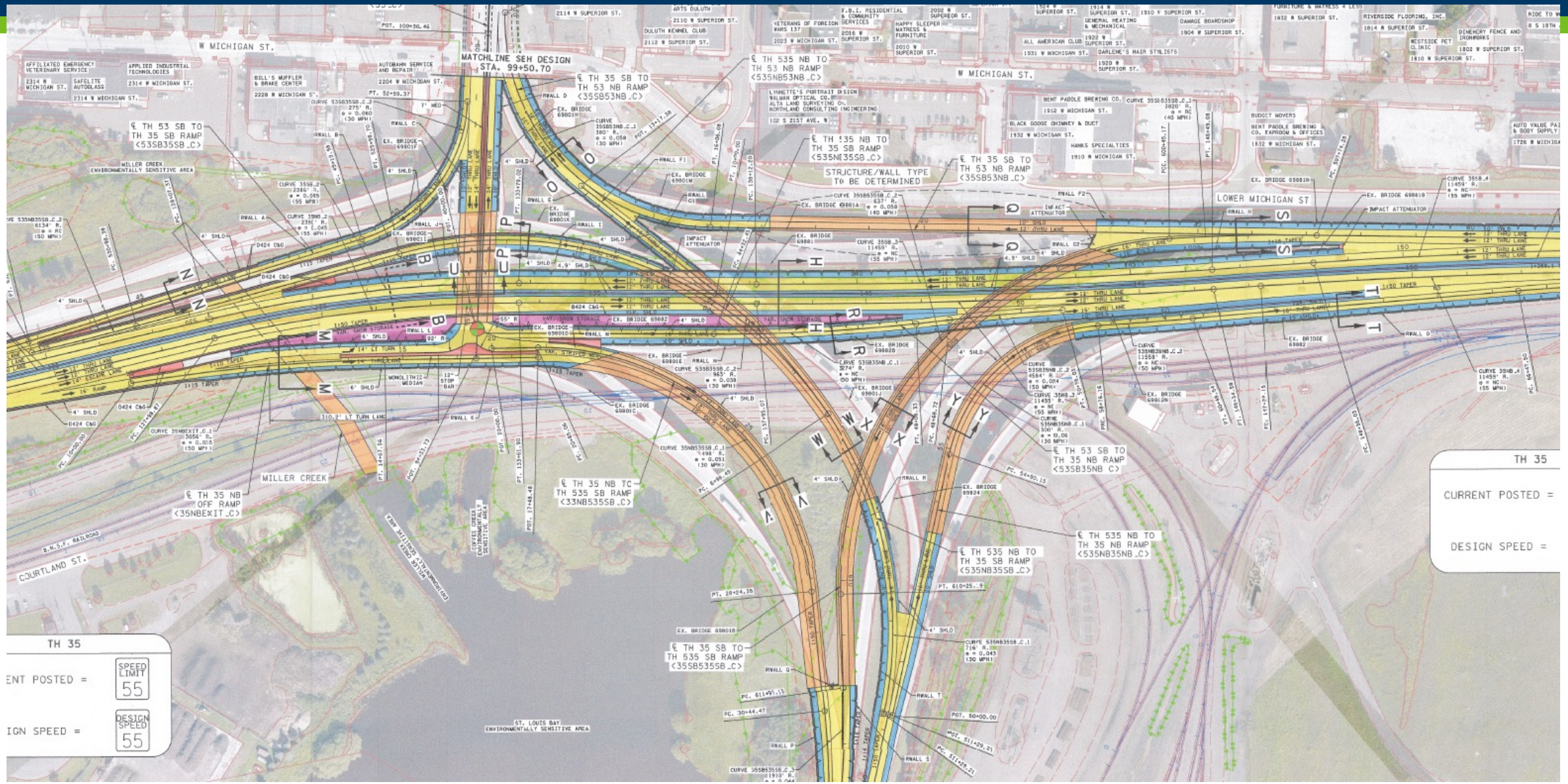
- Pavement Rehabilitation
  - 46th Avenue W
  - 27th Avenue W & restriping
  - Garfield Avenue & restriping
  - Railroad Street
- New Rail Crossings by BNSF
  - New Rail crossings at 4 locations
  - One crossing removal

2020 TH 194 (Central Entrance) DBB Surfacing: COMPLETE

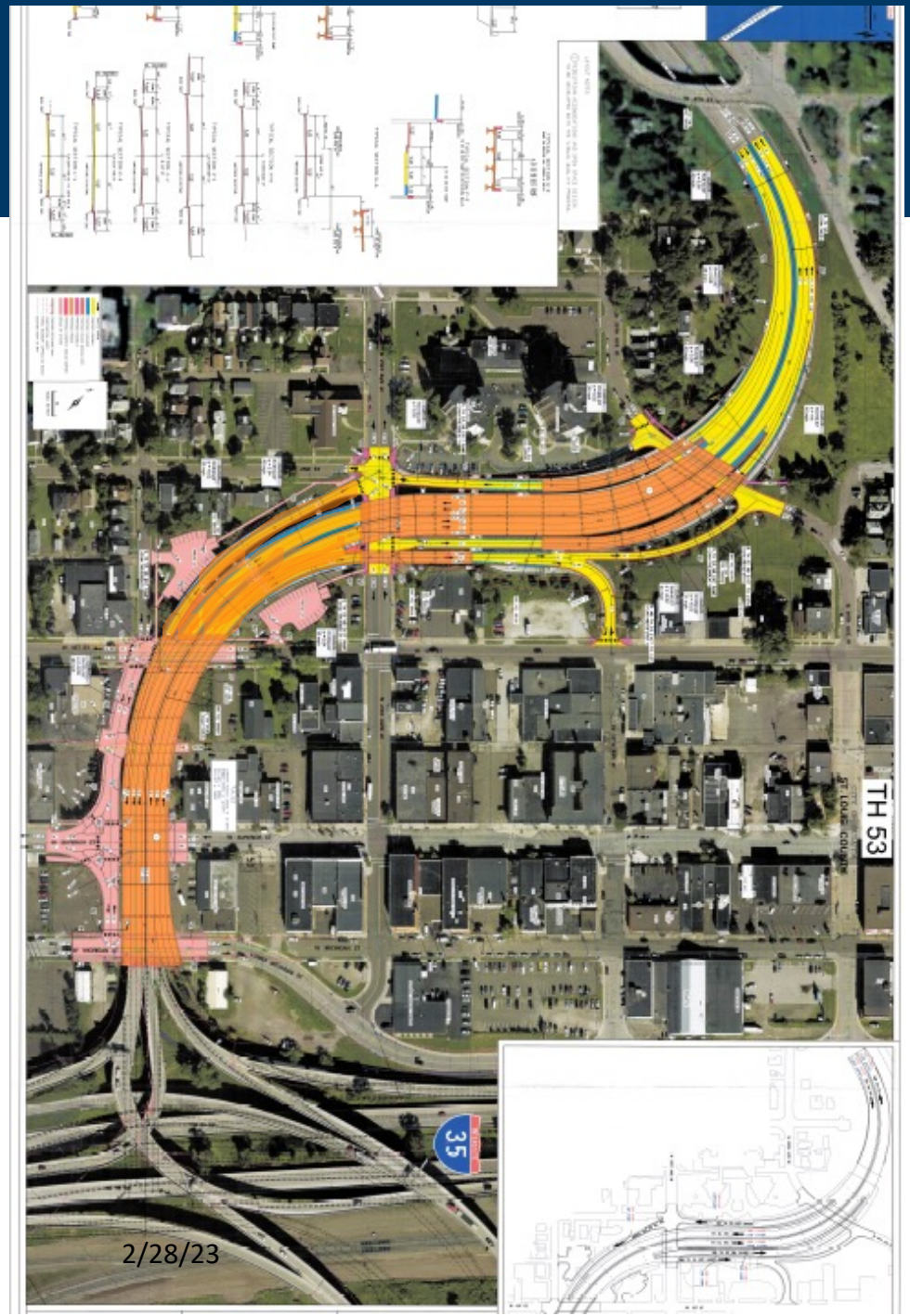


- Low-bid “Band-Aid” project
- Improve ride and hold pavement together until reconstruction

TPI WP 1 and 2 Scope

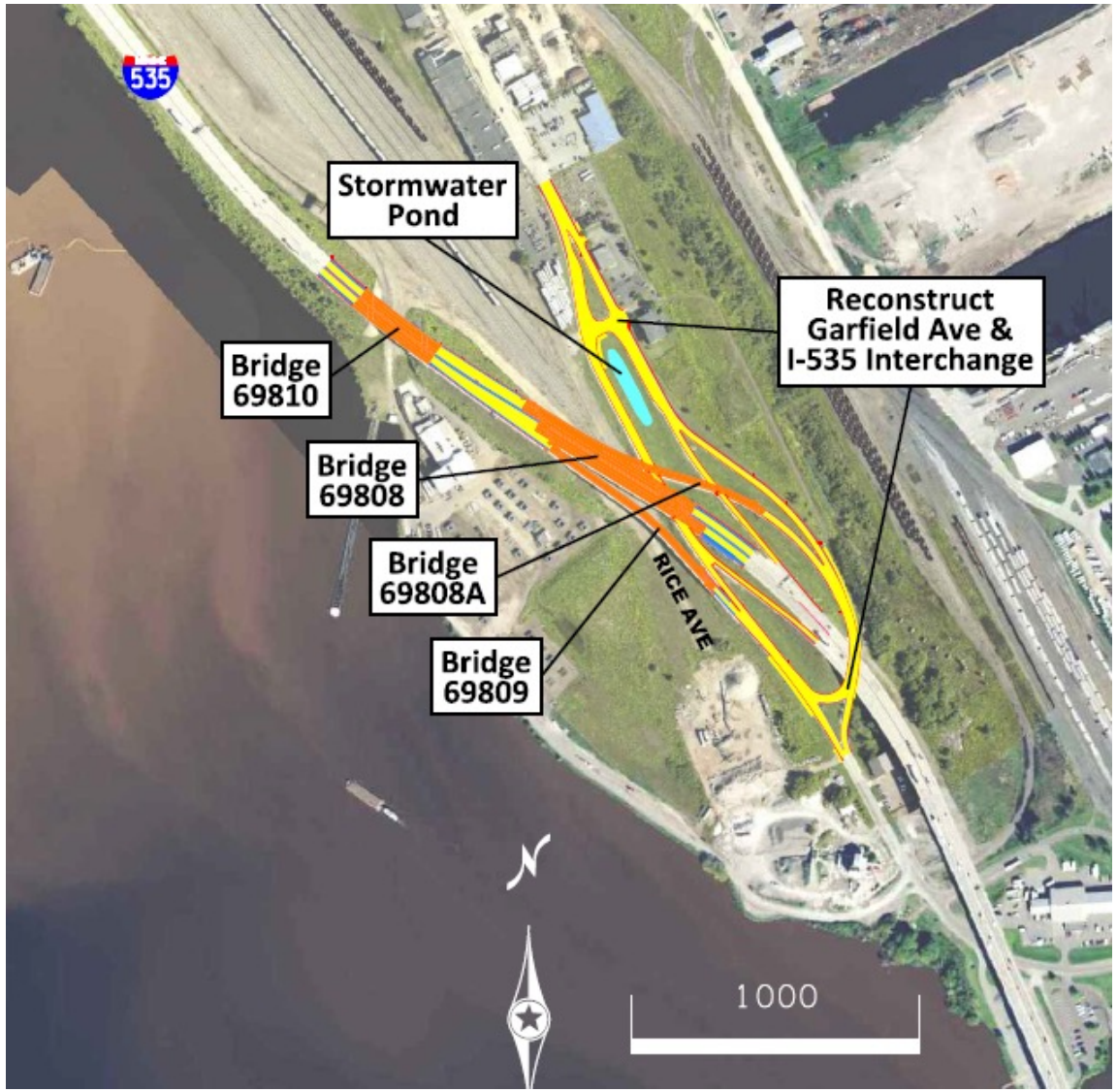


TPI WP 3 (TH 53 Bridges) Scope



- Complete reconstruction of the TH 53 bridges
- Limited utility work
- City street reconstruction
- **Deferred Fall 2019**
- **Added back in August 2022 (executed contract)**

TPI WP 4 (I-535/Garfield Interchange) Scope

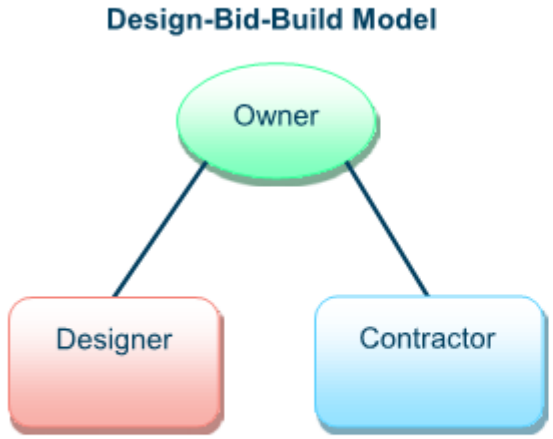


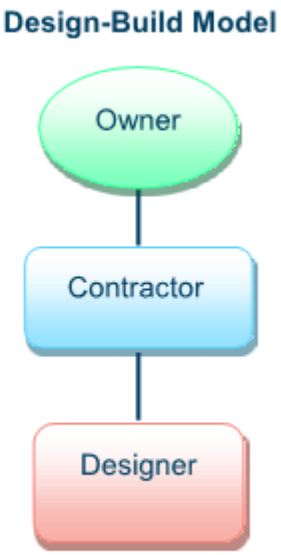
- Reconstruct bridges 69808, 69808A, 69809
- Significant reconstruction of 69810
- Utilities, storm sewer, pavement reconstruction
- Minor track relocation near 69810
- **Deferred Fall 2019**
- **Added back in August 2022 (executed contract)**

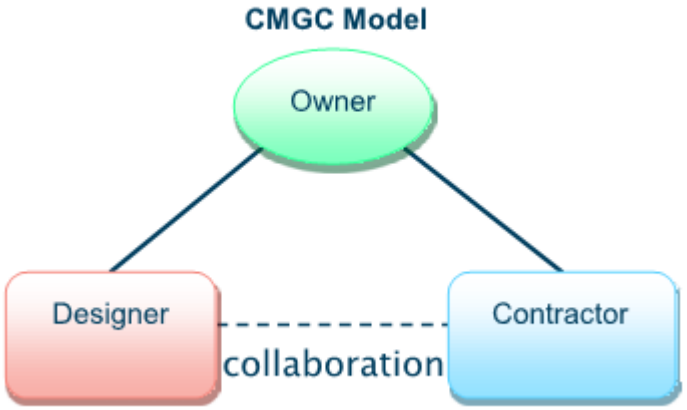
Public Outreach/ Model and Comments

Contracting Methods & Collaboration

- Design-Bid-Build (Traditional Low Bid)
  - No up-front collaboration
- Design-Build
  - Collaboration between contractor and designer
- **CMGC (Construction Manager General Contractor) – used on TH 53**
  - **State is authorized for 20 CMGC projects.**
    - **8 either ongoing or complete so far.**
  - **Collaboration between owner, contractor and designer BEFORE CONSTRUCTION (and during!)**
  - **Contractor selection complete: Ames/Kraemer Joint Venture**







CMGC Benefits & Challenges

Benefits

- **Innovation** – Contractor input into the design process
- **Cost Management** – Contractors provide real-time cost information
- **Design Savings** – Streamline design
- **Design Control** – MnDOT retains control of the design, with contractor input
- **Construction Risk** – Construction risks mitigated during project development
- **Cost Certainty** – Greater cost certainty earlier in the project
- **Time Savings** – Able to deliver early work packages similar to design-build

Challenges

- **Cost Validation** – Negotiated versus bid contract
- **Culture** – Relatively new to the transportation industry

TPI CMGC Project Team Members

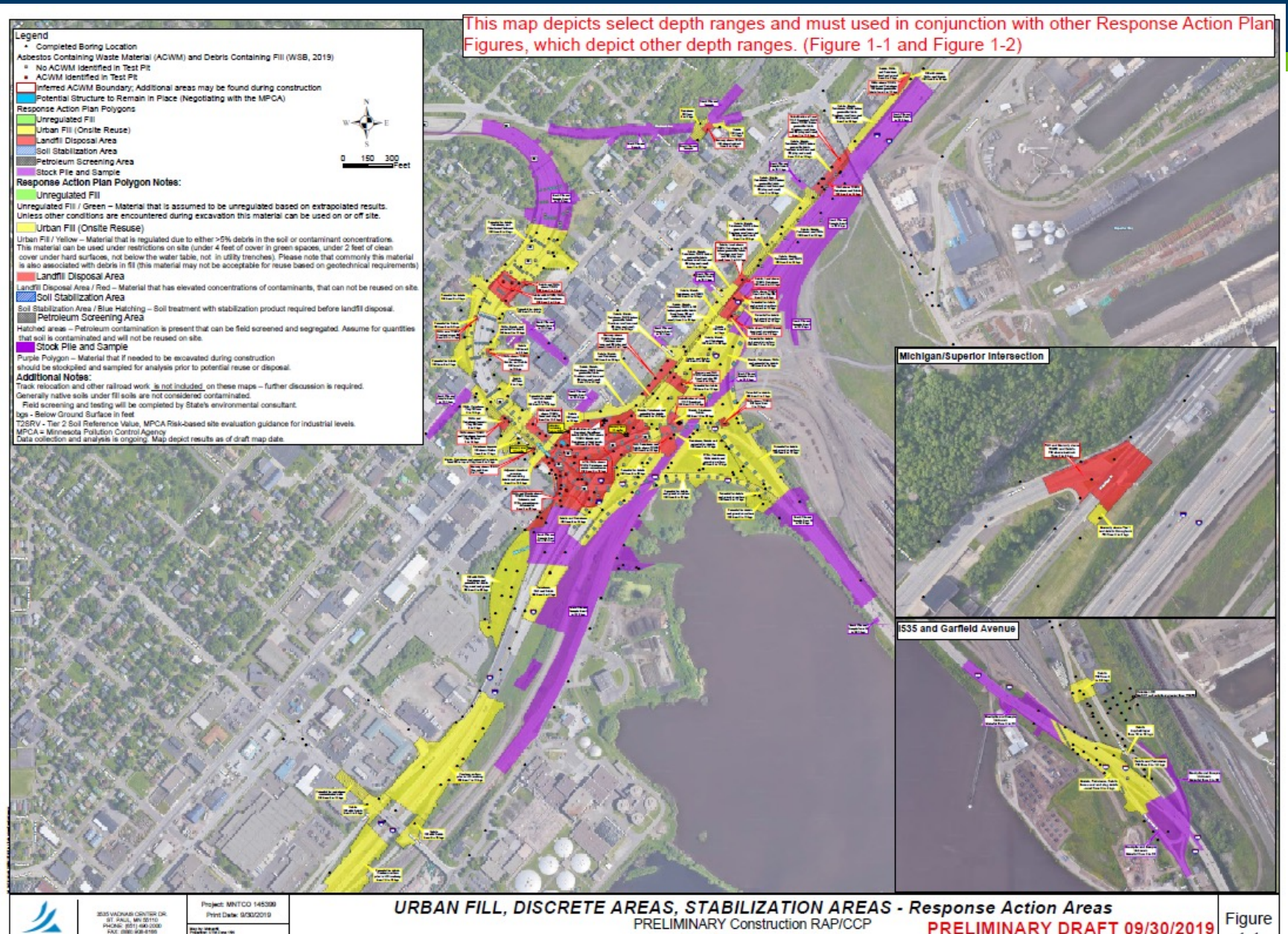
- Project Team
  - Owner: MnDOT
  - Designers: Many (or everybody)!
  - Contractor: Ames – Kraemer Joint Venture (AKJV)
- Key individuals were co-located at 1220 Railroad Street for project development until COVID 19 hit

- Co-location

CMGC Test Programs

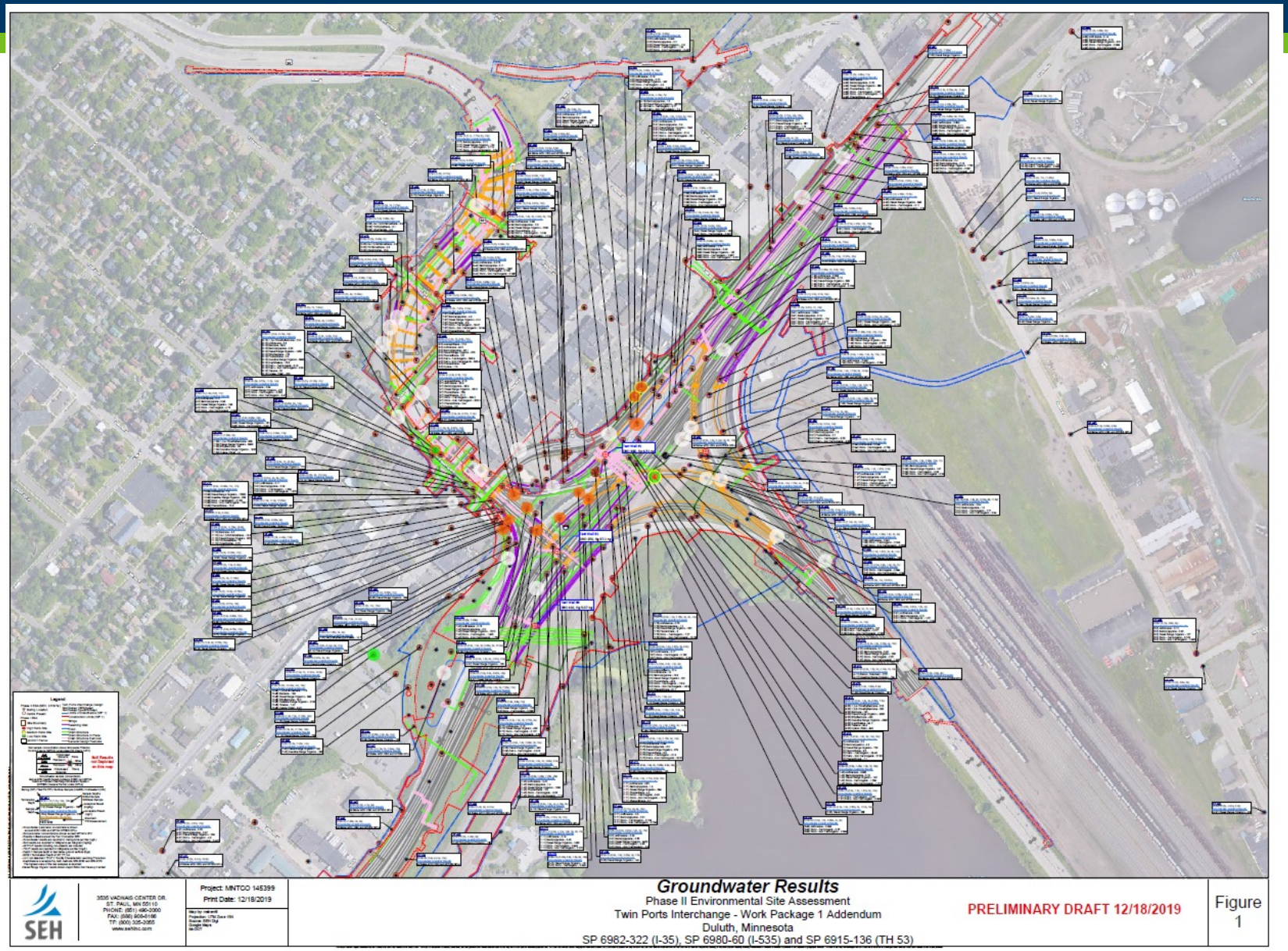
Challenges Worked Through in Advance/Preconstruction

Contaminated Soils



- Red to landfill
- Yellow can be re-used if there is an engineering purpose and there is no debris in it.
- Purple not able to drill, or not drilled yet. Stockpile and test during construction.

Contaminated Water



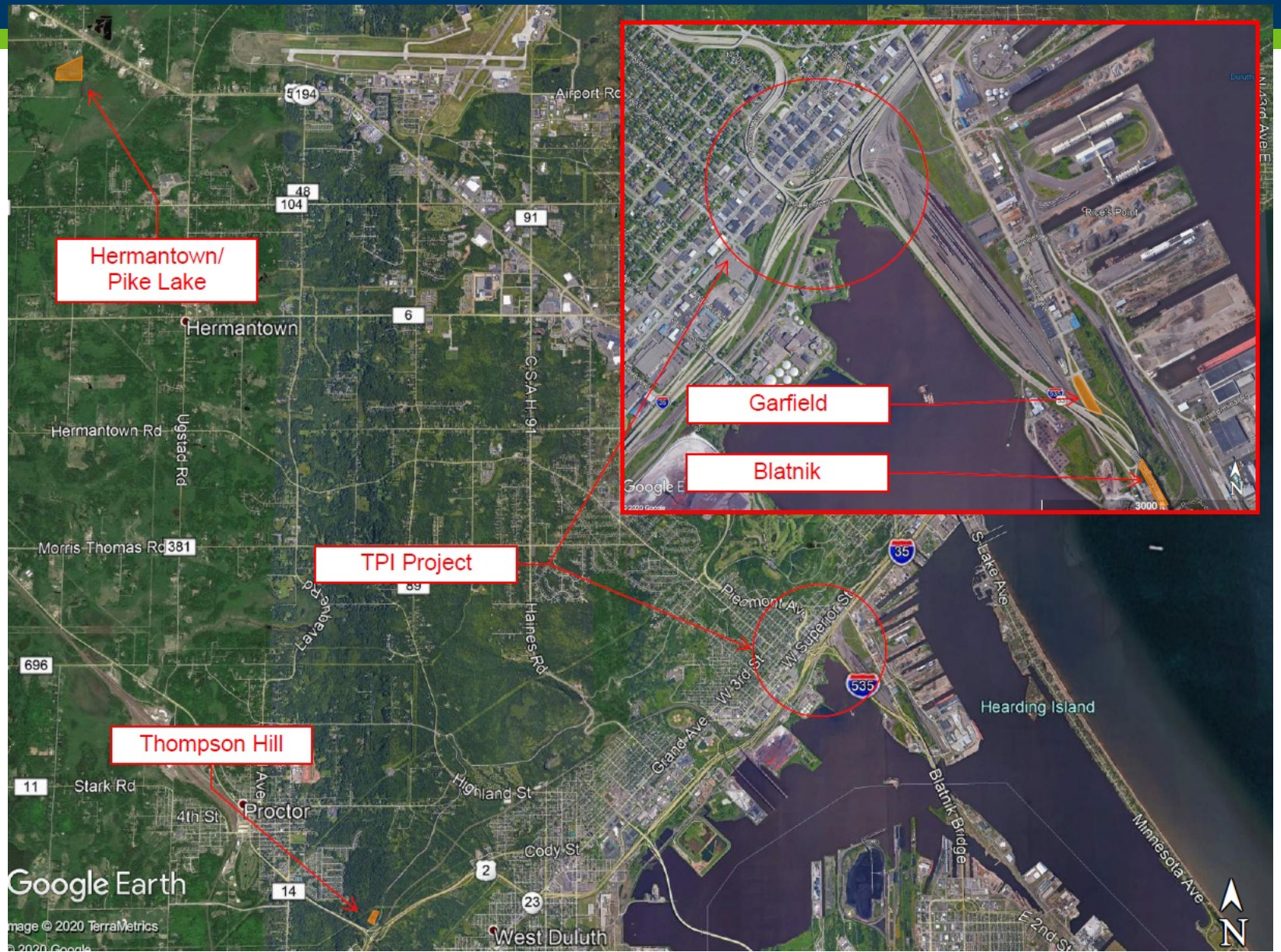
Contaminated Water

Limited area to work, store materials, etc.

- Confined Work Area
  - Limited areas for laying down construction materials
  - Limited areas for storing soil
  - Some double handling of materials will be necessary
  - Very tight quarters to construct the project

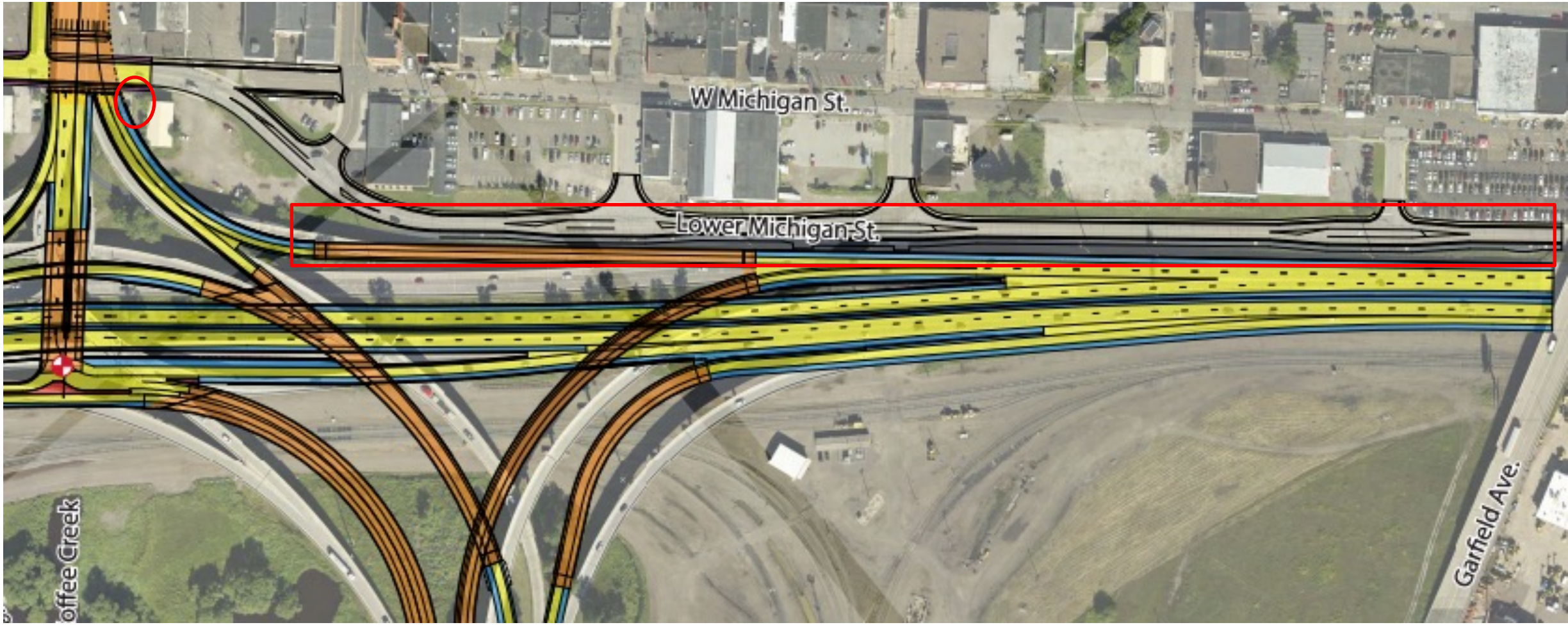
Limited area to work, store materials, etc.

Soil Storage – No Room Onsite!



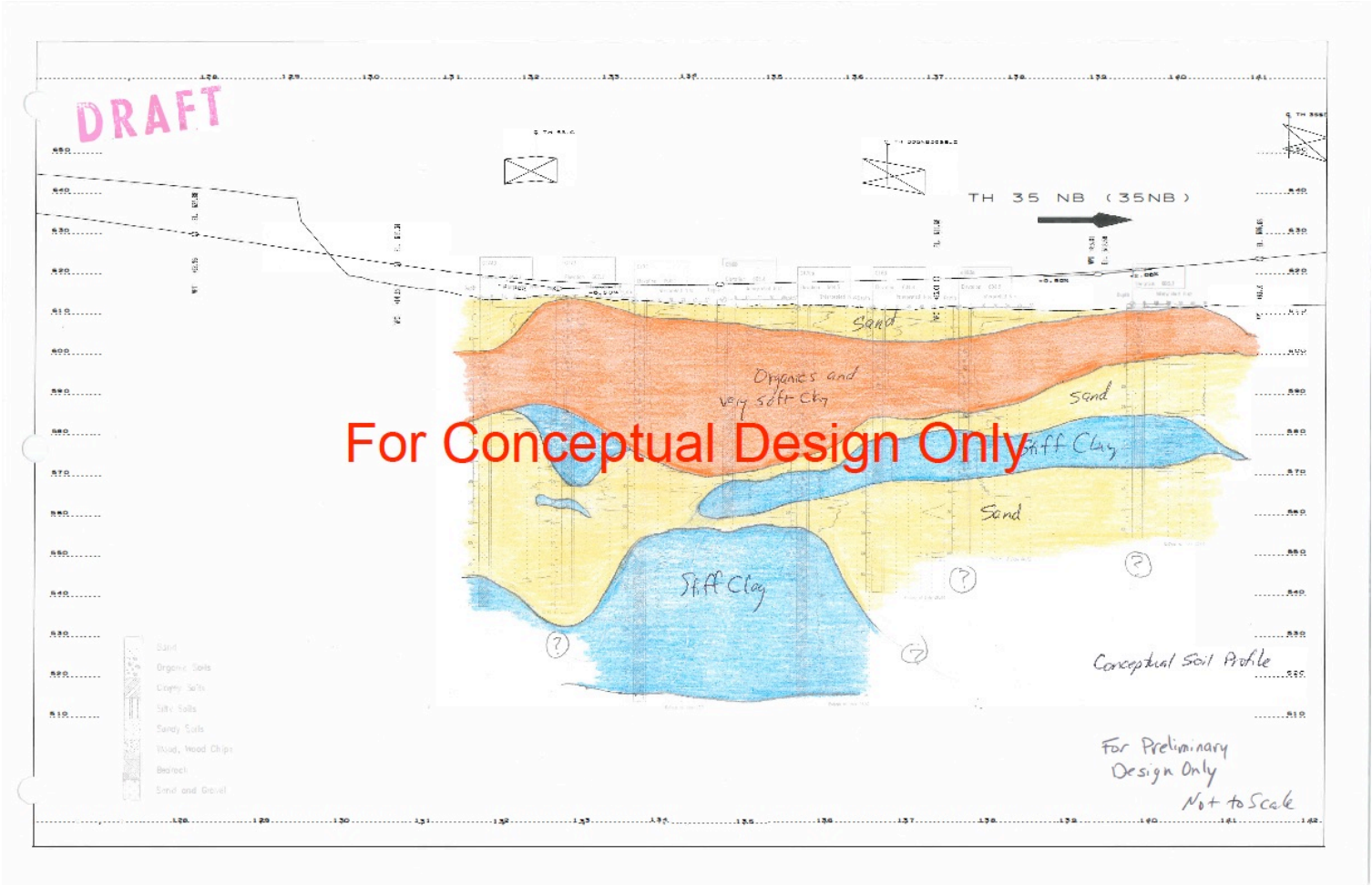
Current Soil Storage Areas

Lower Michigan Street Utilities

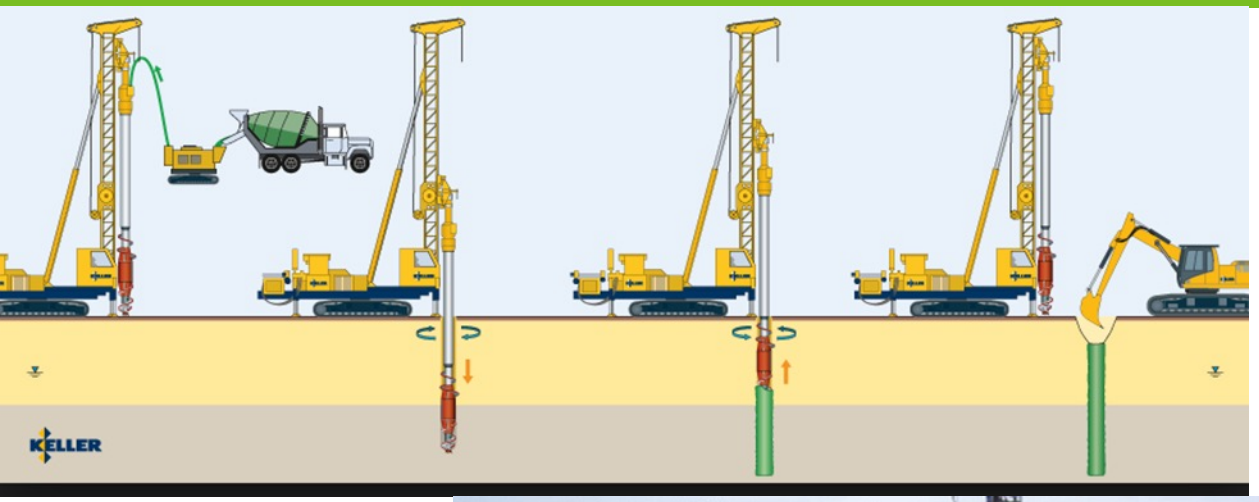


Foundations/Ground Improvements

- Geotechnical–
  - Very poor non-uniform soils, mostly old fill and debris
  - Ground improvements and cost associated with them were not known at time of planning;
  - Design as advanced and the foundation costs have become more defined.

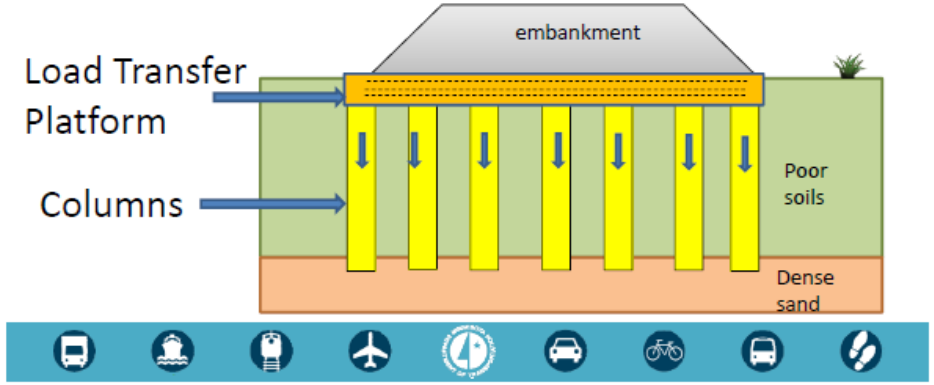


Foundations/Ground Improvements



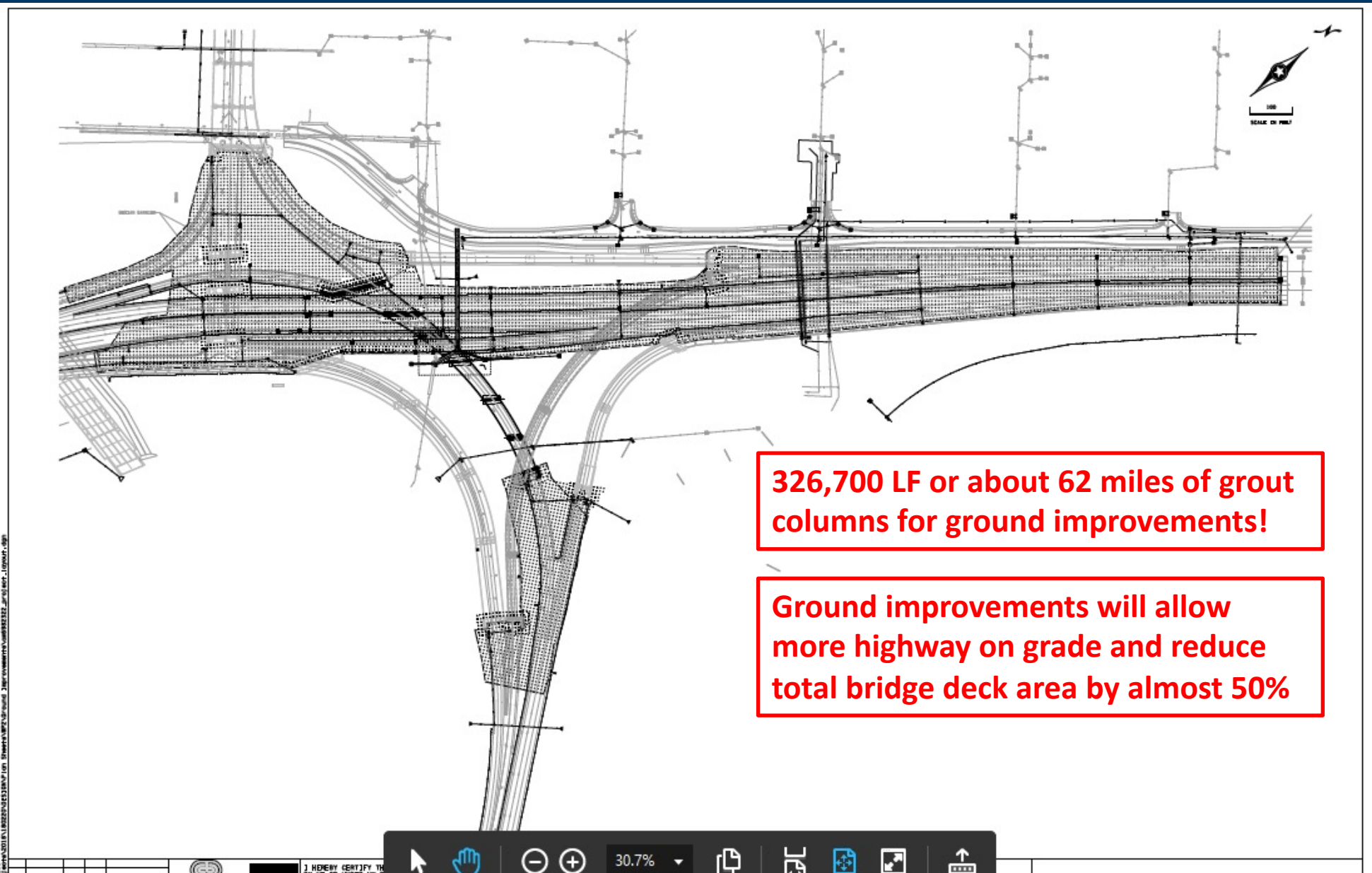
Load Transfer

- Column or Pile Supported Embankment



Foundations/Ground Improvements –Test Section

Foundations/Ground Improvements

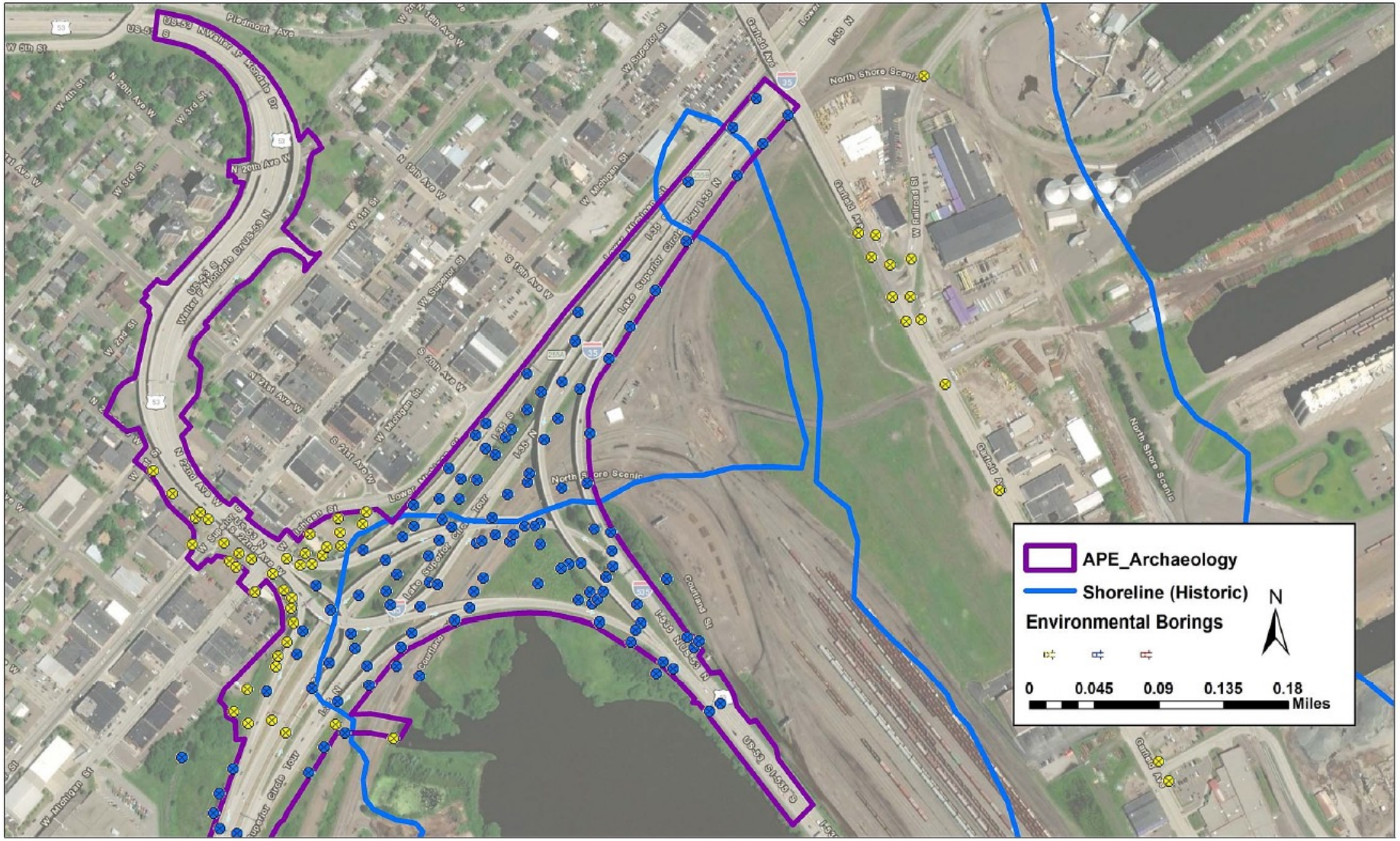


326,700 LF or about 62 miles of grout columns for ground improvements!

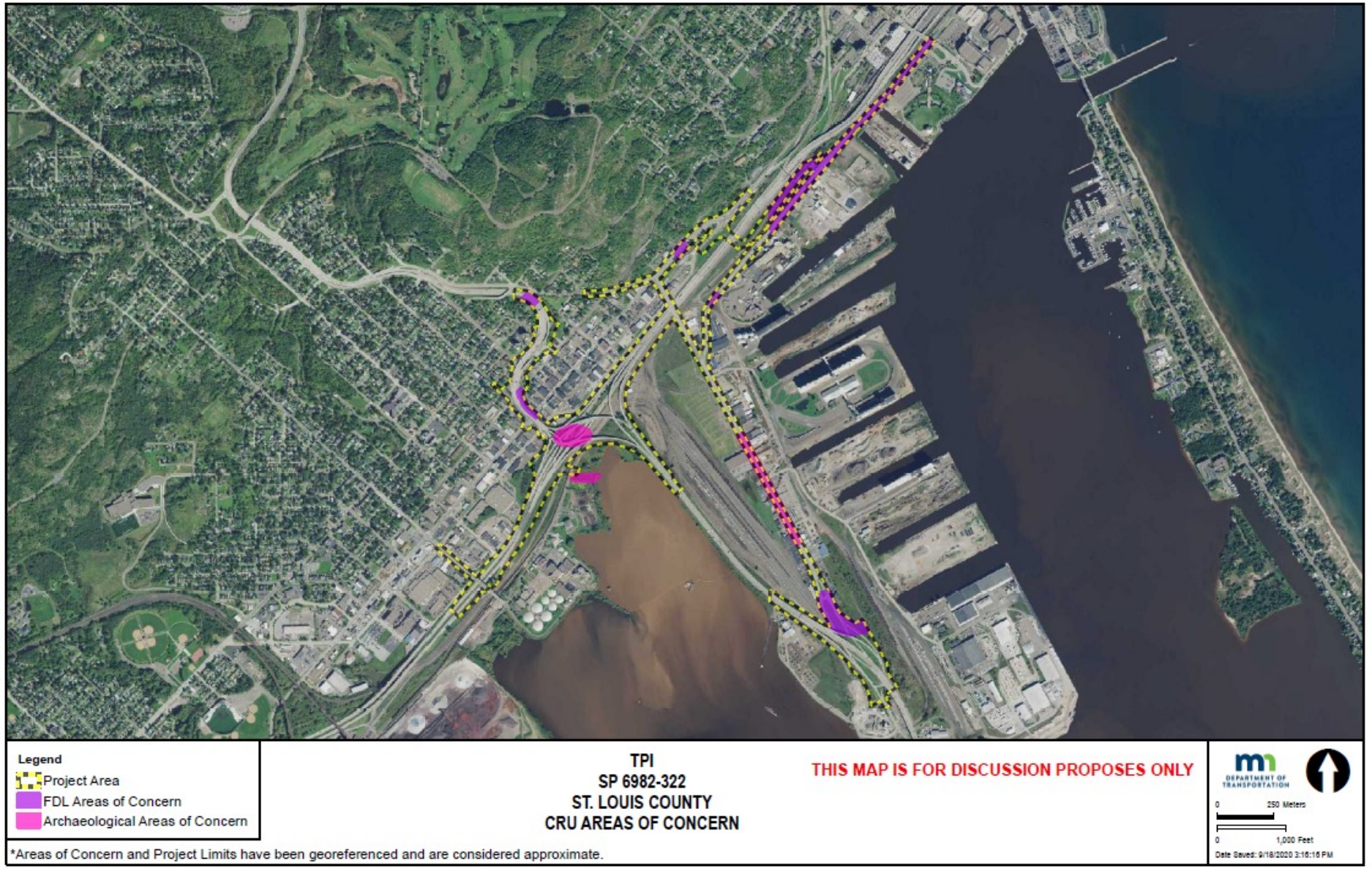
Ground improvements will allow more highway on grade and reduce total bridge deck area by almost 50%

Foundations/Ground Improvements

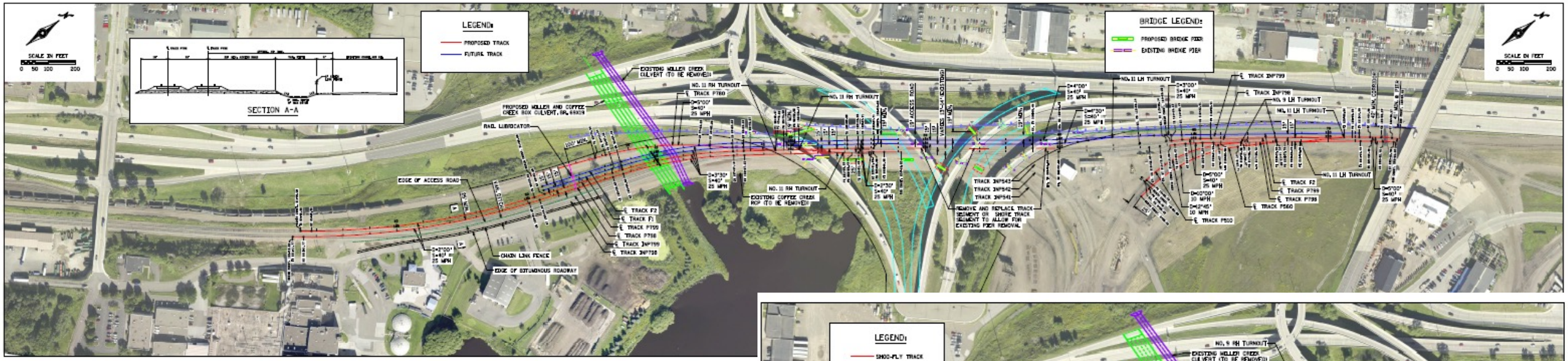
Historic Shoreline

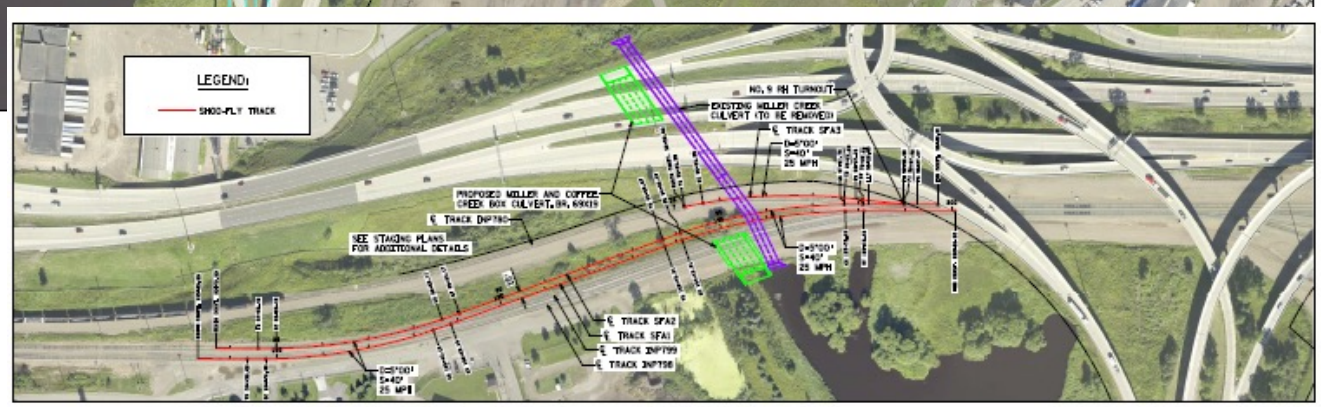


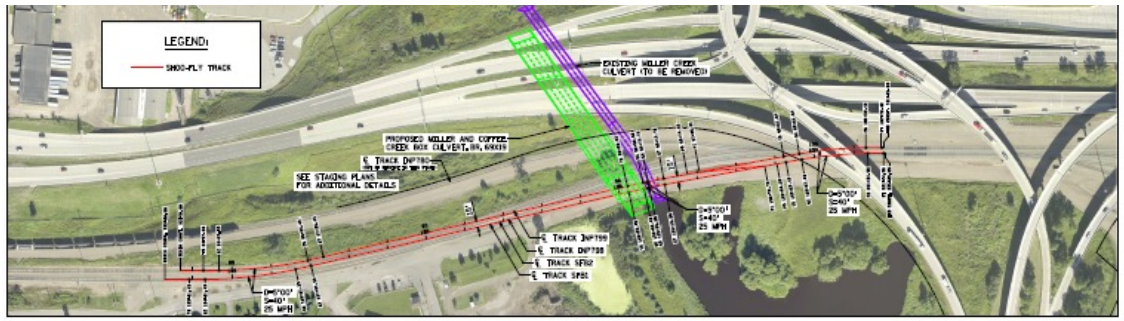
Archeological and Cultural



Railroad Coordination (BSNF)





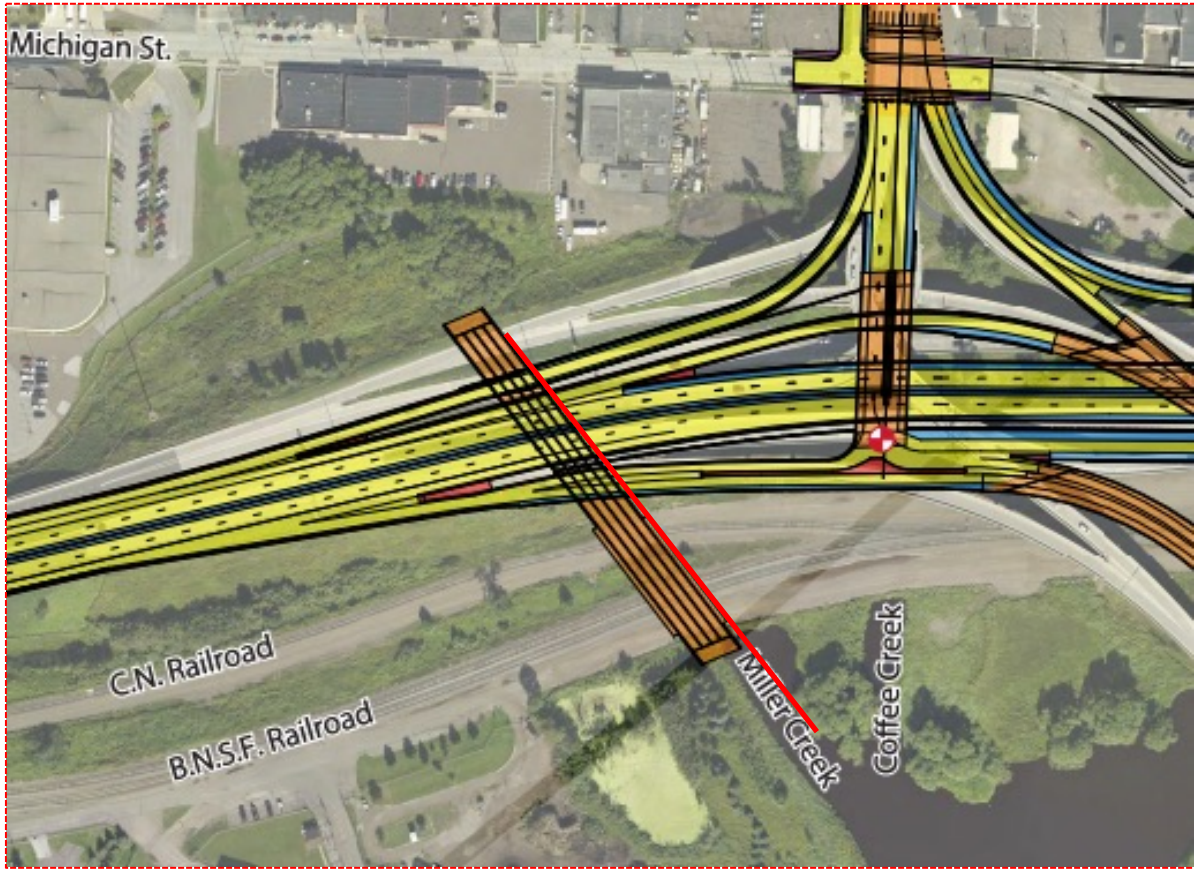


- Early and frequent coordination with BNSF on design
- Early and frequent coordination with contractor engineering submittals and approvals
- = less risk and quicker construction start

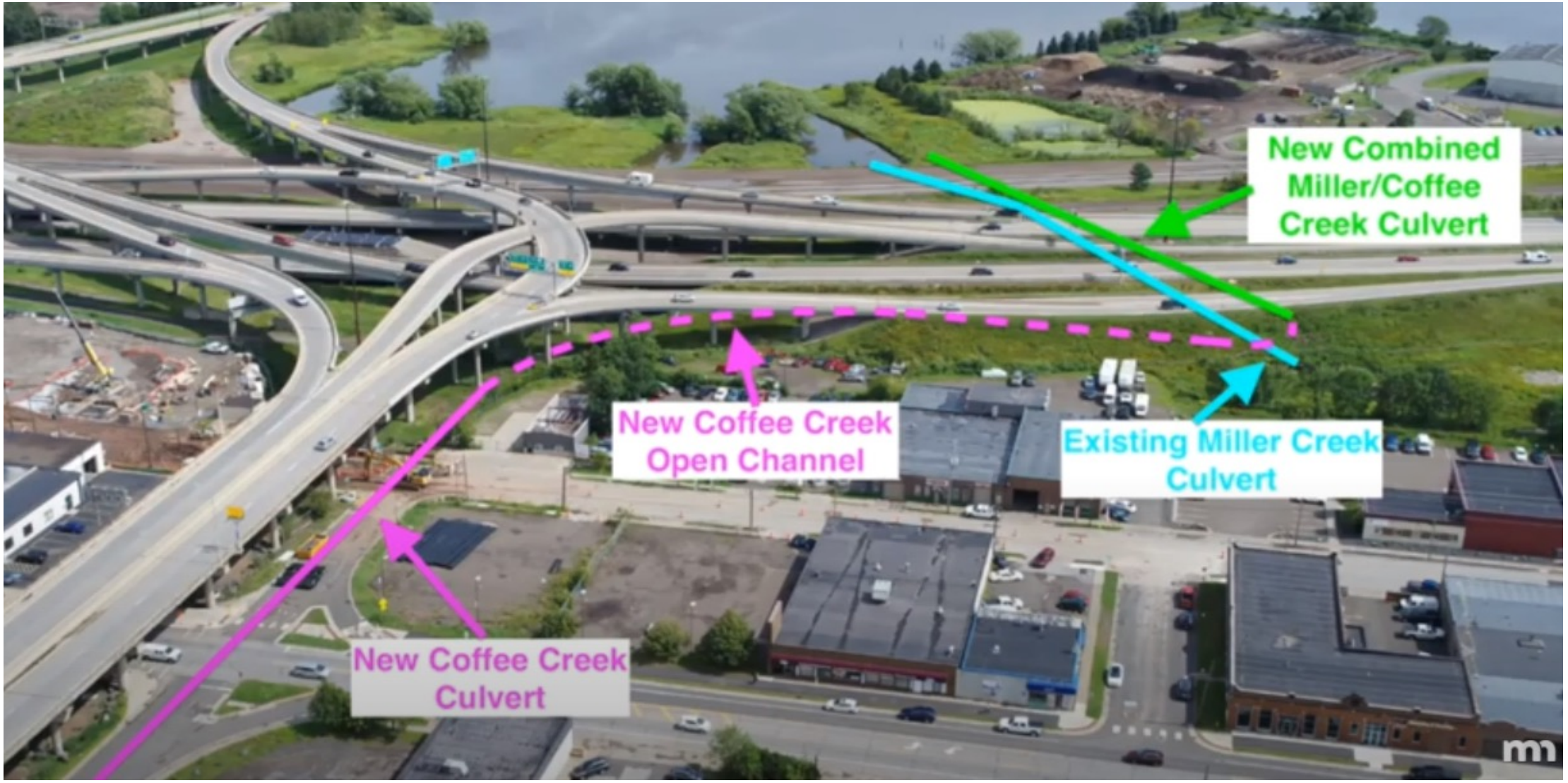
Combined Miller and Coffee Creek Culvert

Combined Miller and Coffee Creek Culvert

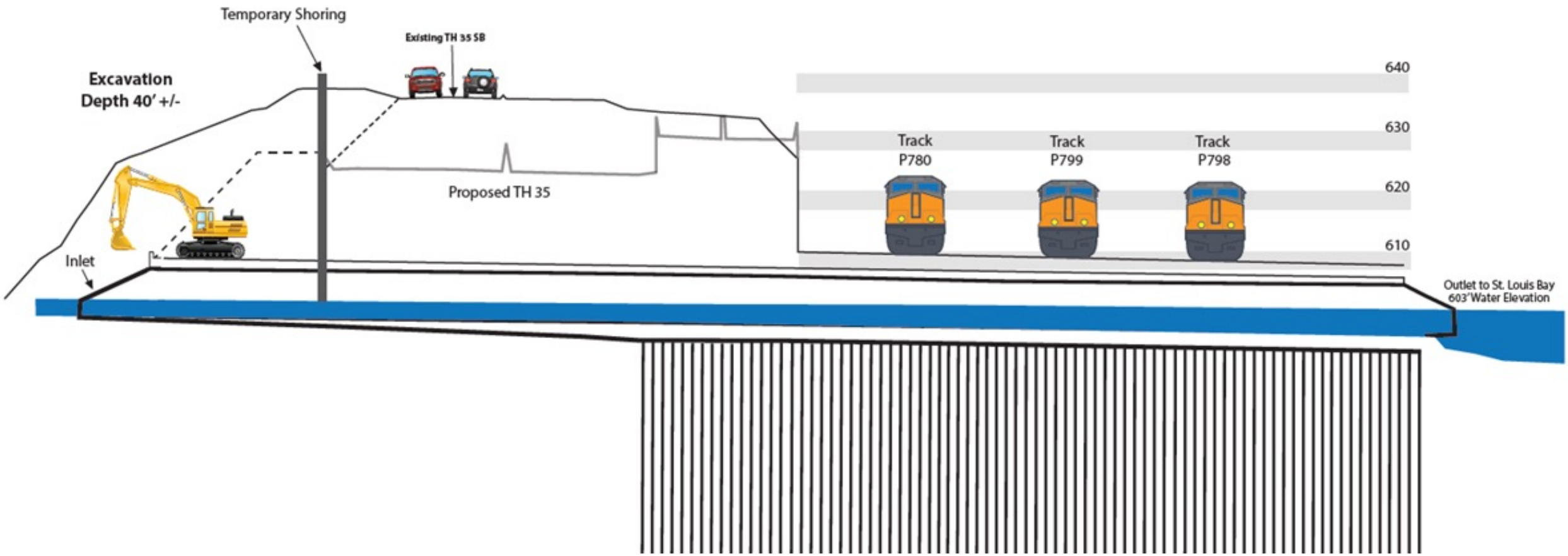
- Miller Creek Culvert Replacement
  - Deep placement
  - 10 stages of construction
  - Supporting the roadway during construction
  - Staging across the railroad
  - Poor soils
  - Require deep foundations
  - Under bay water level



Miller and Coffee Creek – they are a project on their own!



Combined Miller-Coffee Creek Box Culvert



Traffic Staging: The Driver for 2020/2021

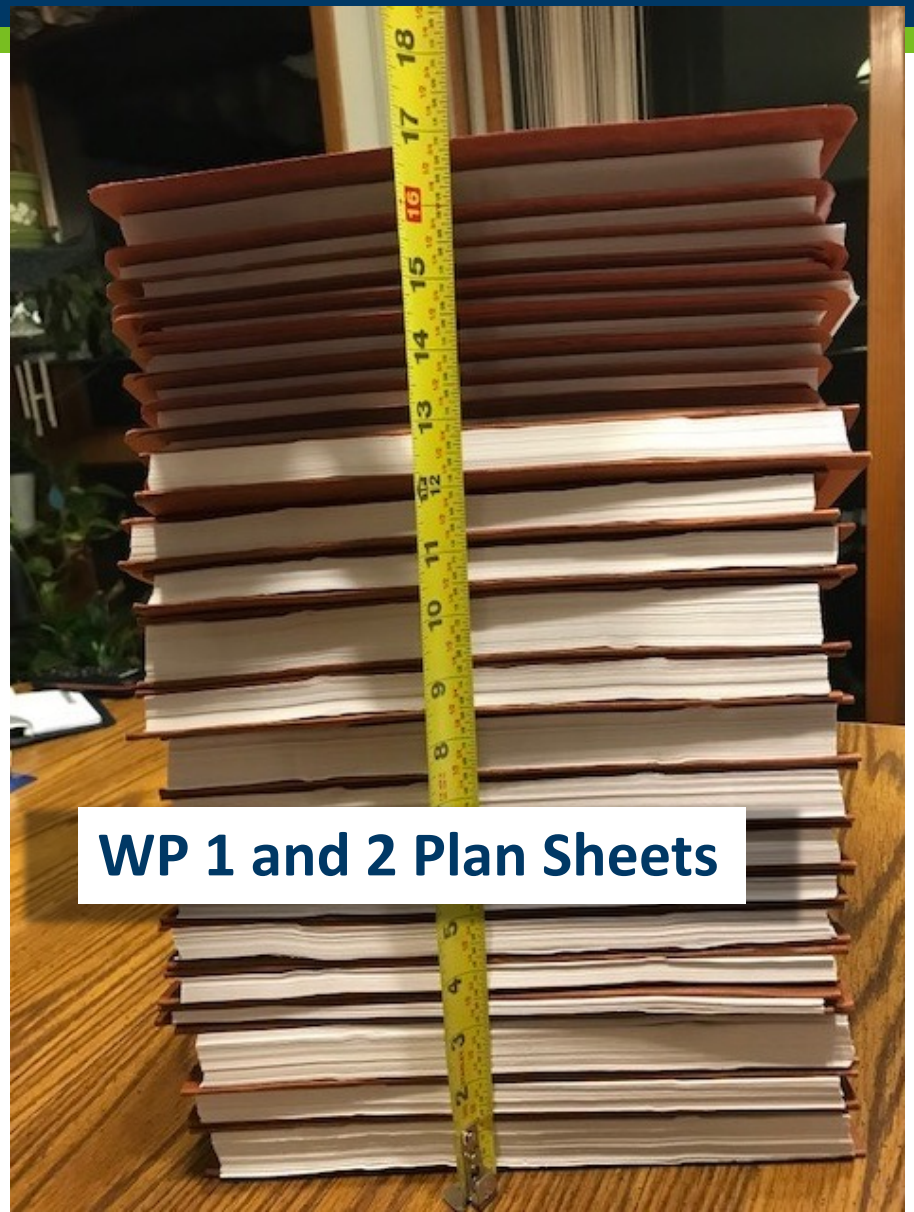
Traffic Staging: CMGC Benefits during Prelim/Final Design

- Used lower Michigan for two lanes of SB I-35
- Advantages:
  - 4 lanes of traffic through the winter
  - Allowed work to proceed through the winter
  - Reduced construction by a year

Overall Project Staging Summary

- Fall 20: Two lanes in each direction on I-35. Working offline.
- Spring 21 – Fall 21: Single lane in each direction on I-35.
- **Fall 21 – Fall 23: Maintaining two lanes in each direction on I-35 will keep traffic flowing (I-535 and US Hwy 53 detoured)**
- Lower Michigan St. bypass allows two lanes of traffic on I-35 in each direction allowing year-round construction and shortens project by one year
- Fall 2023: I-35 and I-535 open to traffic
- Fall 2024: USTH 53 open to traffic
- 2025: Final completion

Plans and Specifications – 9,505 sheets/pages



MINNESOTA DEPARTMENT OF TRANSPORTATION
395 JOHN IRELAND BOULEVARD MS 650 ST. PAUL, MINNESOTA 55155-1800
********** P R O P O S A L **********
FOR HIGHWAY CONSTRUCTION AND MAINTENANCE PROJECTS WITH
BIDS RECEIVED UNTIL 9:30 O'CLOCK A.M. ON
SEPTEMBER 11, 2020

Proposal of **AMES KRAEMER JOINT VENTURE**
(NAME OF FIRM)

2500 County Road 42 W, Burnsville, MN 55337
(ADDRESS)

(952)892-8650
(AREA CODE-TELEPHONE NUMBER)

TO FURNISH AND DELIVER ALL MATERIALS AND TO PERFORM ALL WORK IN ACCORDANCE WITH THE CONTRACT, THE PLANS AND THE APPROVED DEPARTMENT OF TRANSPORTATION "STANDARD SPECIFICATIONS FOR CONSTRUCTION, **2018 EDITION" (USING ENGLISH UNITS)**, ON FILE IN THE OFFICE OF THE COMMISSIONER OF TRANSPORTATION EXCEPT AS STATED OTHERWISE IN THE SPECIAL PROVISIONS, WHICH ARE PART OF THIS PROPOSAL, FOR:

PRIME SP:	6982-322WP1 and WP2	**CONTRACT ID:**	200605
STATE PROJECT NO.:	6982-322WP1 (TH 35=103), 6915-136WP1 (TH 53=106), 6980-60WP1 (TH 535=390) 6982-322WP2 (TH 35=103), 6915-136WP2 (TH53=106), 6980-60WP2 (TH 535=390)		
FHWA PROJECT NO.:	BLD-NHFP-NHPP I350(129)		
LOCATION:	In St. Louis County on: TH 35 from 0.28 Miles South of 27th Ave W to 0.1 Miles North of Garfield Ave TH 53 from W Michigan St to 21st Ave W TH 535 from 0.2 Miles East of TH 35 to TH 35 In St. Louis County on: TH 35 from 0.28 Miles South of 27th Ave W to 0.1 Miles North of Garfield Ave TH 53 from W Michigan St to 21st Ave W TH 535 from 0.3 Miles East of TH 35 to TH 35		
TYPE OF WORK:	Grading, Bituminous Mill & Surfacing, Box Culvert, Lighting, Signal, TMS, ADA Improvements, and Bridge Nos. 69905, 69909, 69X19 Grading, Bituminous and Concrete Surfacing, Retaining Walls, Lighting, Signals, TMS, ADA Improvements, and Bridge Nos. 69902, 69903, 69904, 69906, 69910, 69139		
LENGTH:	1.895 Miles		

STARTING DATE: October 01, 2020
COMPLETION DATE: June 01, 2025

This Contract Contains Intermediate Completion Requirements

NOTICE TO BIDDERS: **ALL BIDS MUST BE SUBMITTED ELECTRONICALLY.**

This Proposal is complete and ready for letting.

SAFO Tom Styrbicki
Digitally signed by Tom Styrbicki
Date: 2020.07.28 09:48:35 -05'00'

Tom Styrbicki, Director, Office of Project Management and Technical Support JMS

BID RIGGING IS A SERIOUS CRIME. IF YOU HAVE ANY INFORMATION CONCERNING COLLUSIVE BIDDING, EVEN A REQUEST TO SUBMIT A COMPLIMENTARY BID, PLEASE CALL THE MINNESOTA ATTORNEY GENERAL'S OFFICE AT TELEPHONE NO. 651-296-1796

To request this document in an alternative format, please contact the Affirmative Action Office at 651-366-4718 or

Project Facts

- Construction Cost: $276 million (WP 1 and 2) + $159 (WP 3 and 4) = $435 million
  - $221 million paid to date; tracking within budget and on schedule
- Substantial Completion (open to traffic):
  - I-35 and I-535 – fall of 2023
  - USTH 53 – fall of 2024
- Final Completion: Spring/Summer 2025

DEPARTMENT OF TRANSPORTATION

Foundations for Non-Geotechs

Nick Haltvick | MnDOT

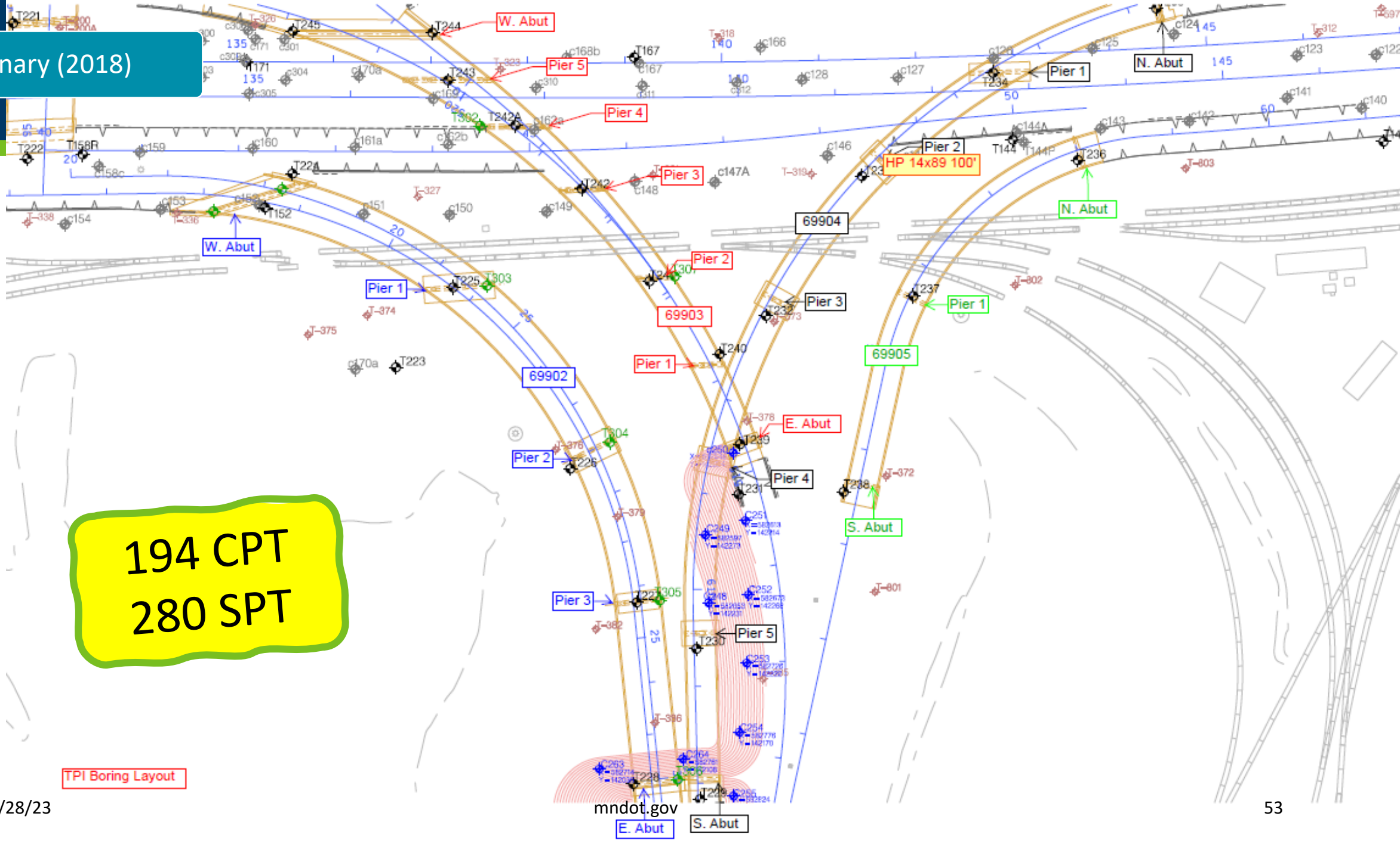
Timeline

- Preliminary (2018)
- Testing (2019)
- Recommendations & Design (2020)
- Construction (2020 – current)

Image Courtesy Duluth News-Tribune

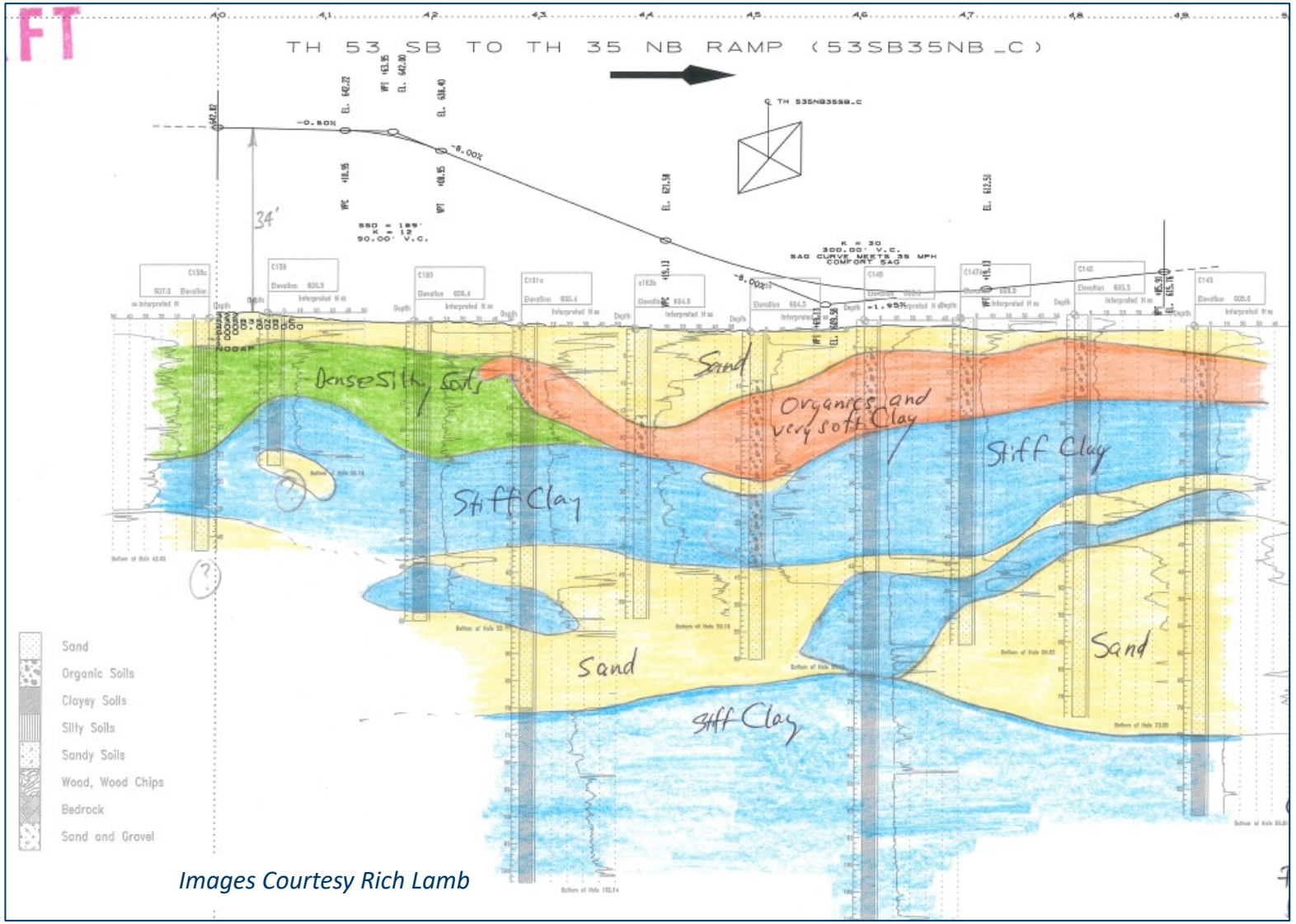
Preliminary (2018)

Preliminary (2018)

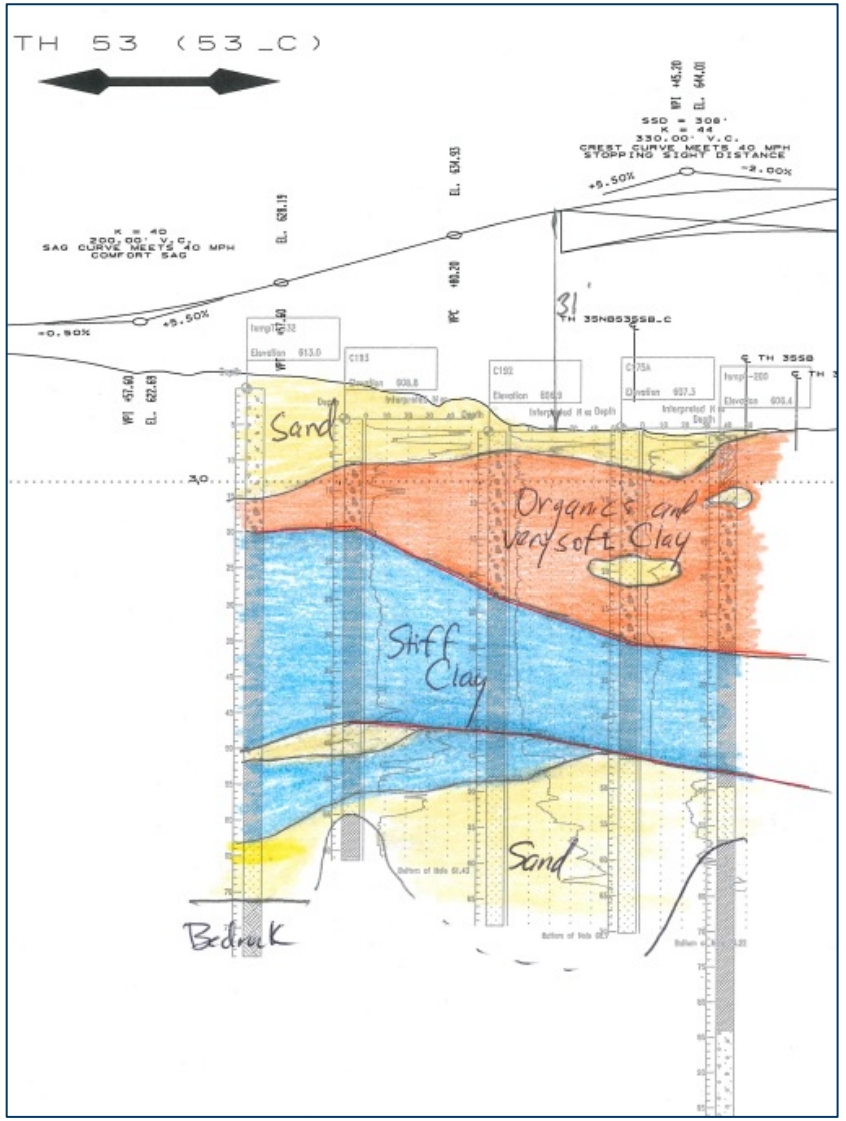


Preliminary (2018)

Variety of soils

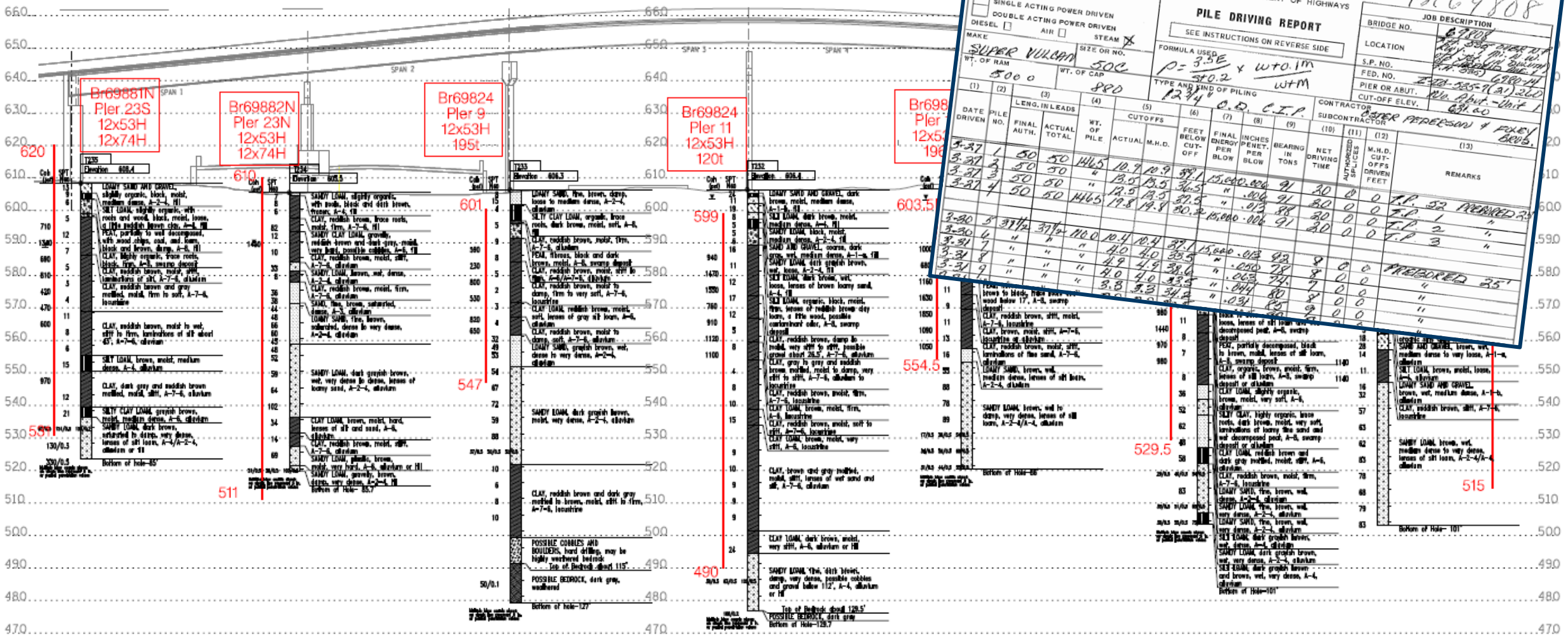


Images Courtesy Rich Lamb



Preliminary (2018)

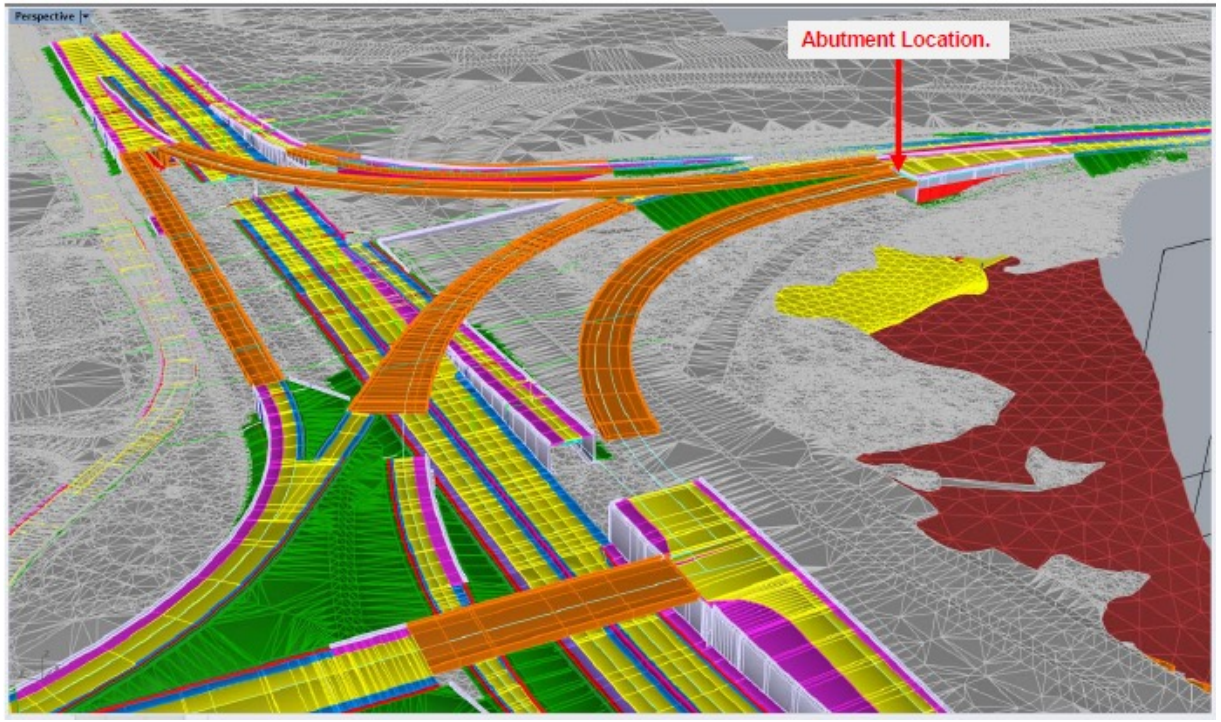
Existing pile records



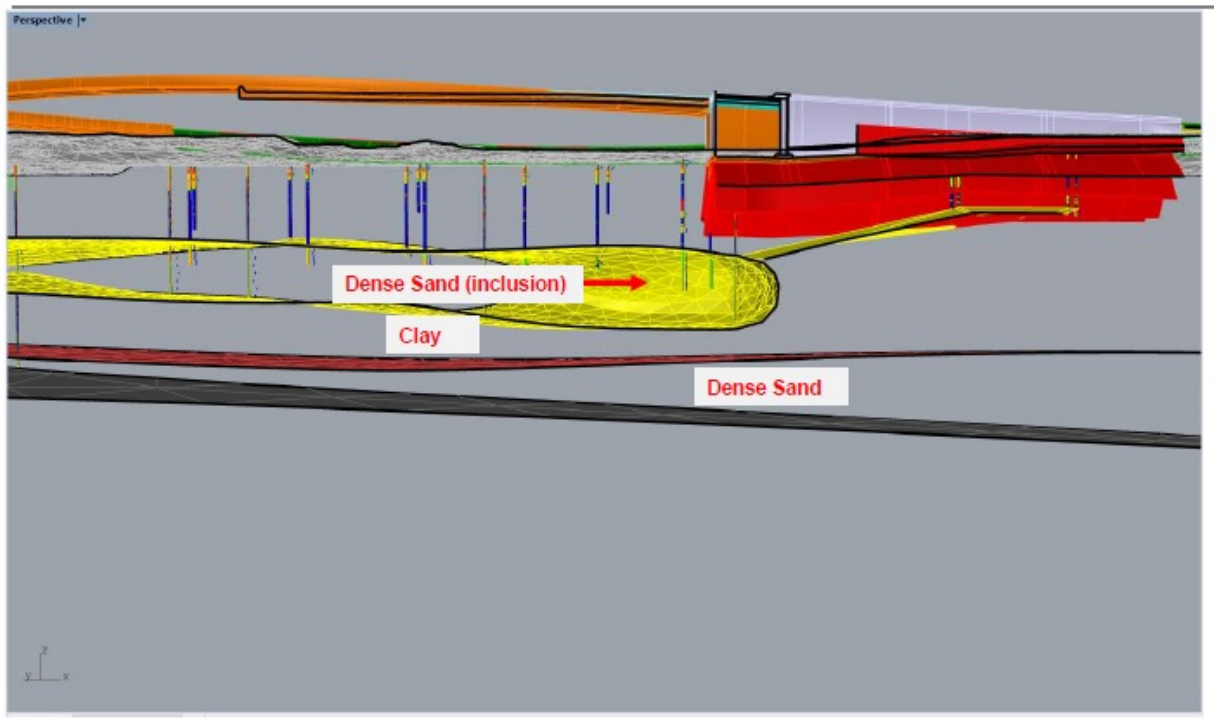
Preliminary (2018)

3D Subsurface Model

3D View



Subsurface – cross section

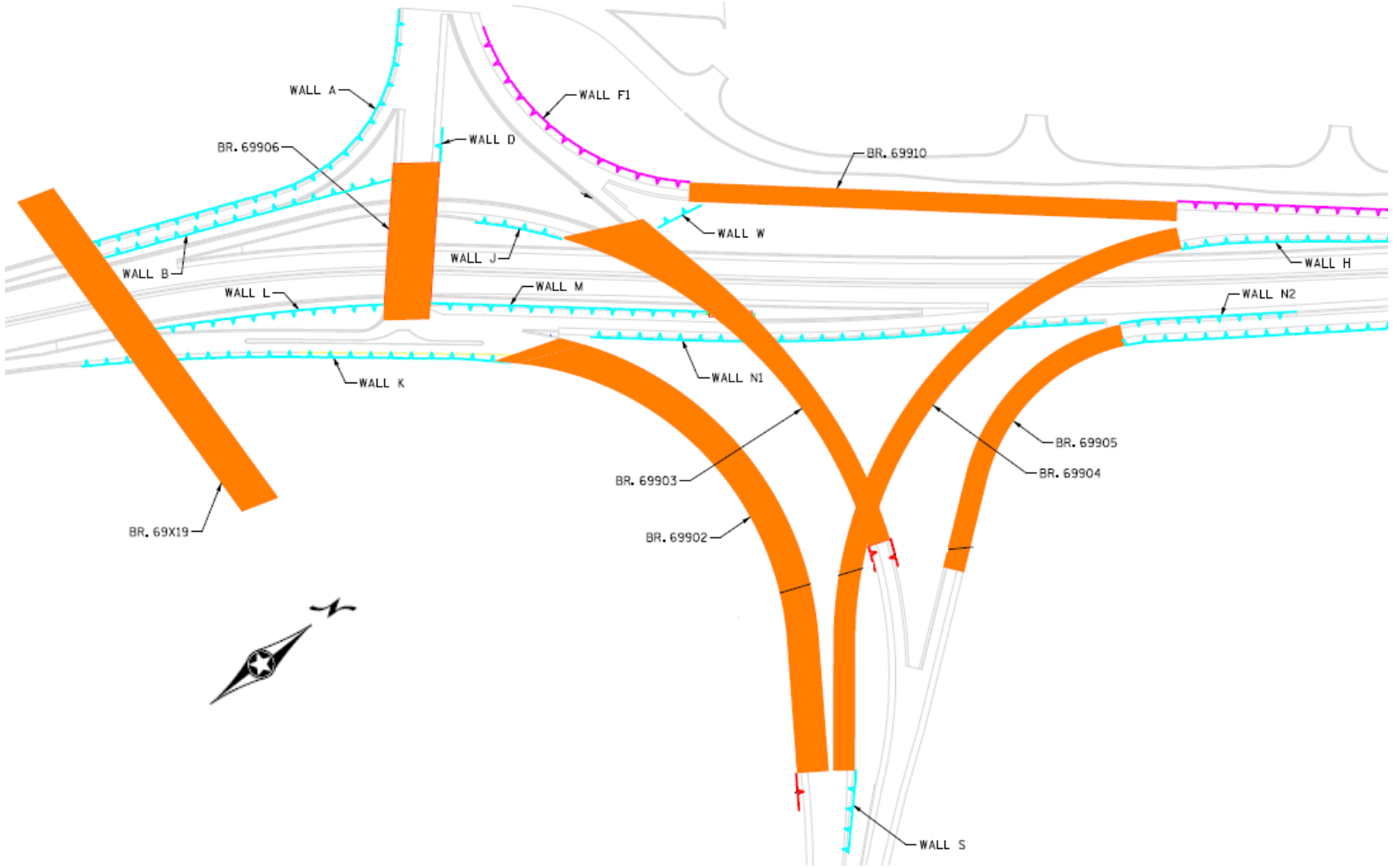


Images Courtesy Itasca Consulting Group

Preliminary (2018)

Main Interchange

← *Ore Docks*

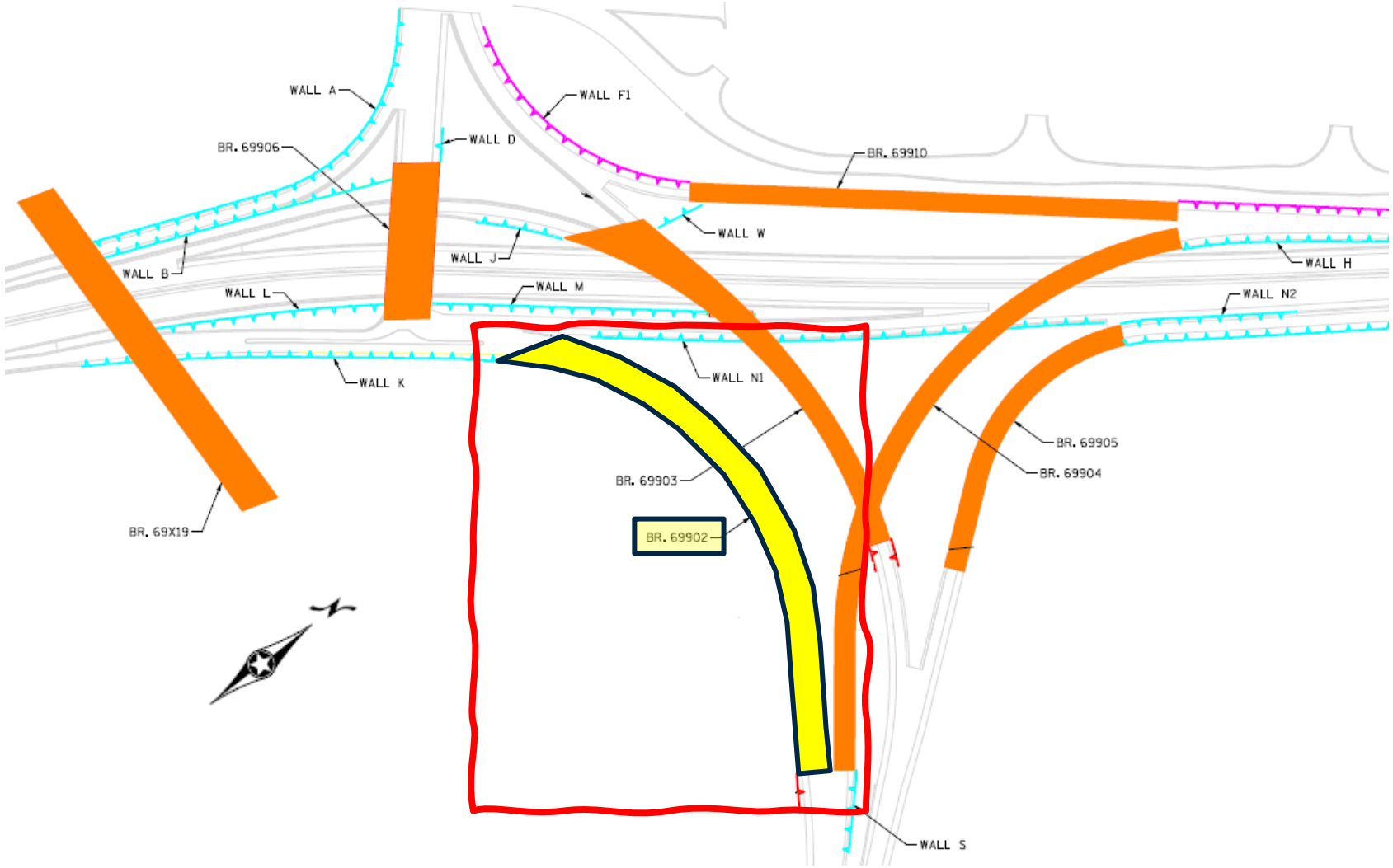


Downtown Duluth →

Preliminary (2018)

Bridge 69902

← *Ore Docks*

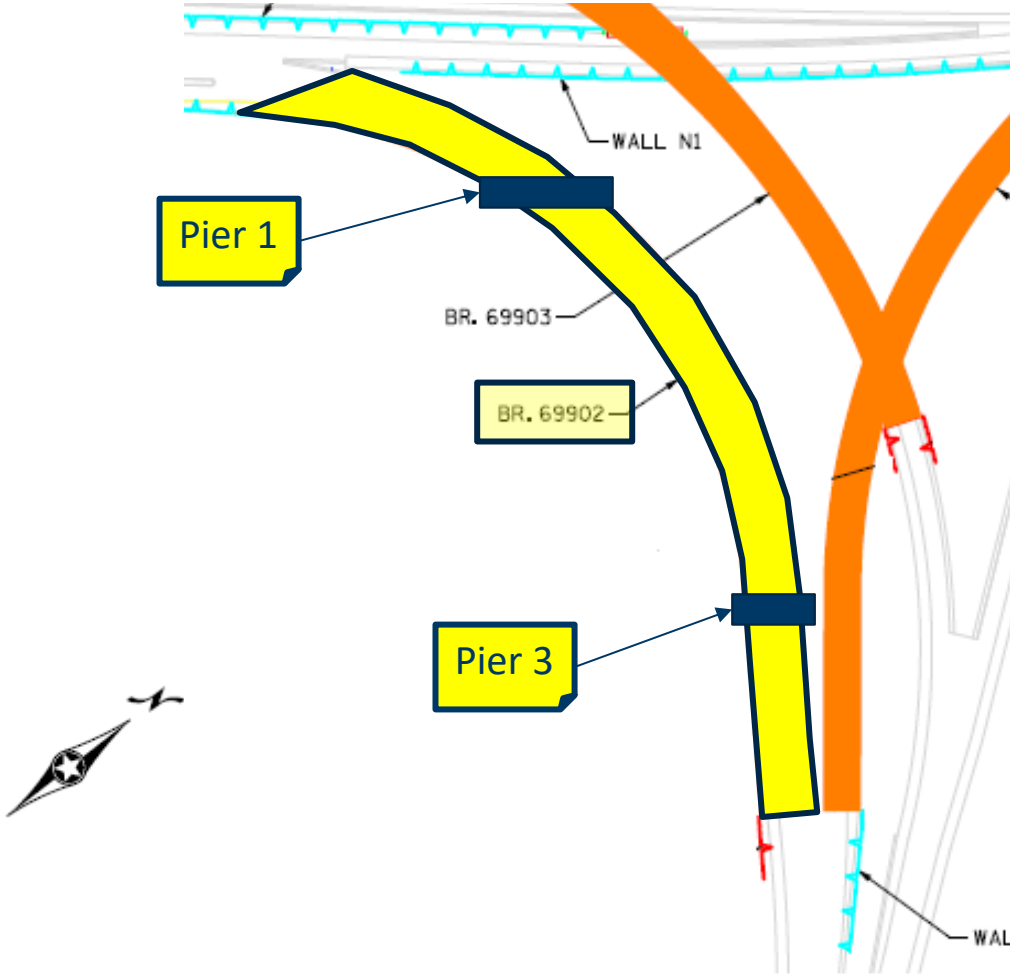


Downtown Duluth →

Preliminary (2018)

Bridge 69902 Piers 1 & 3

← *Ore Docks*

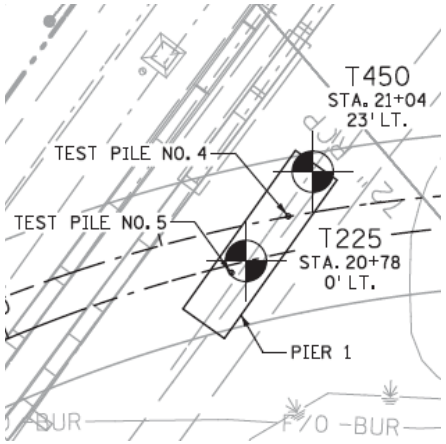


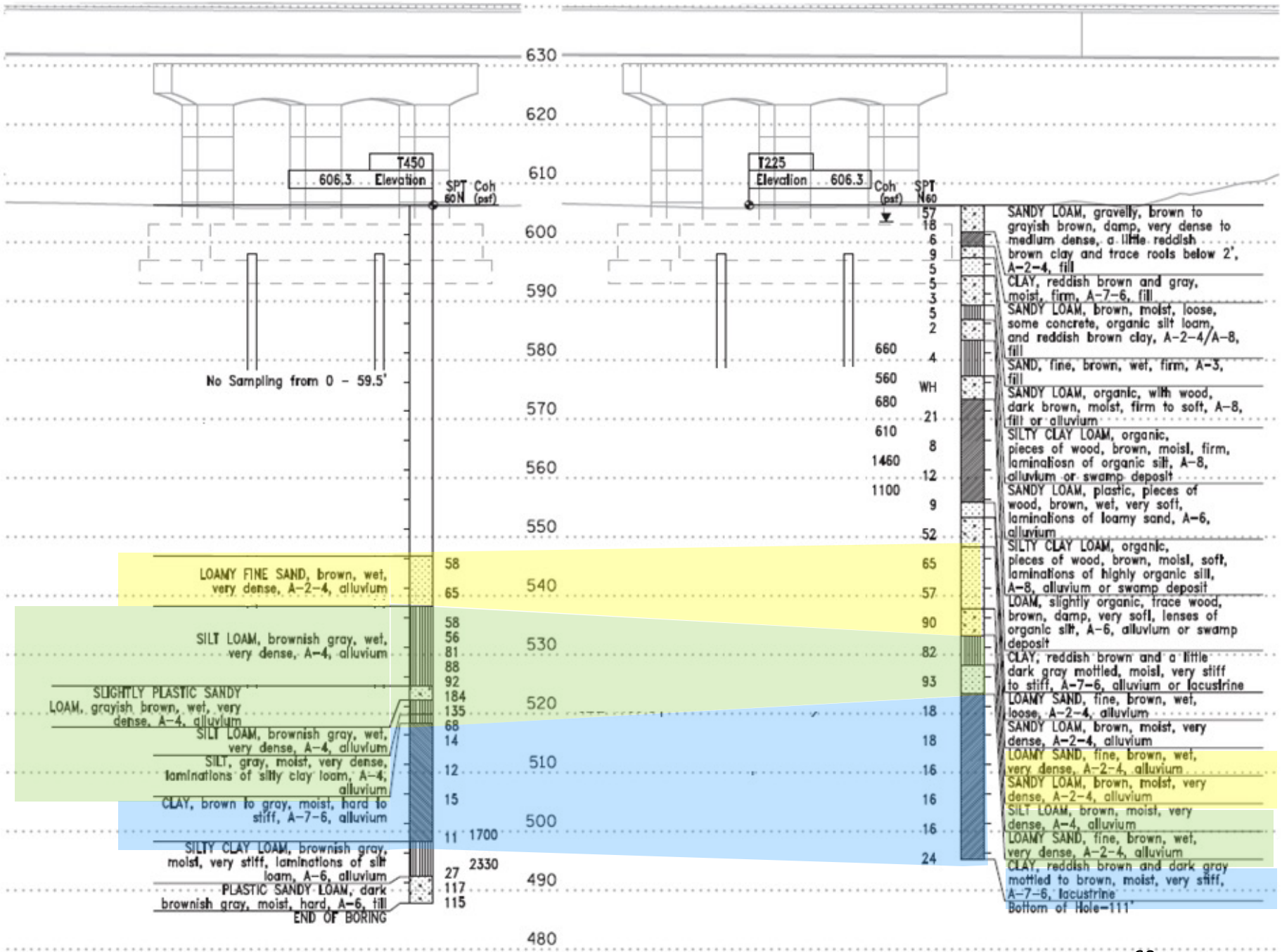
Downtown Duluth →

Preliminary (2018)

BRIDGE 69902

PIER 1

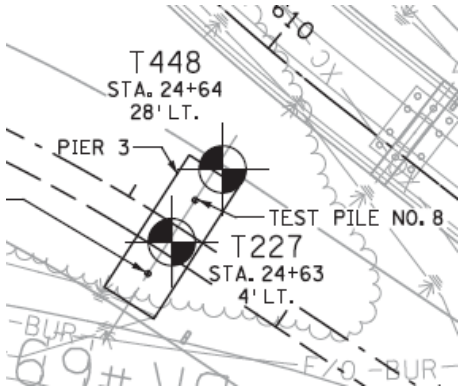


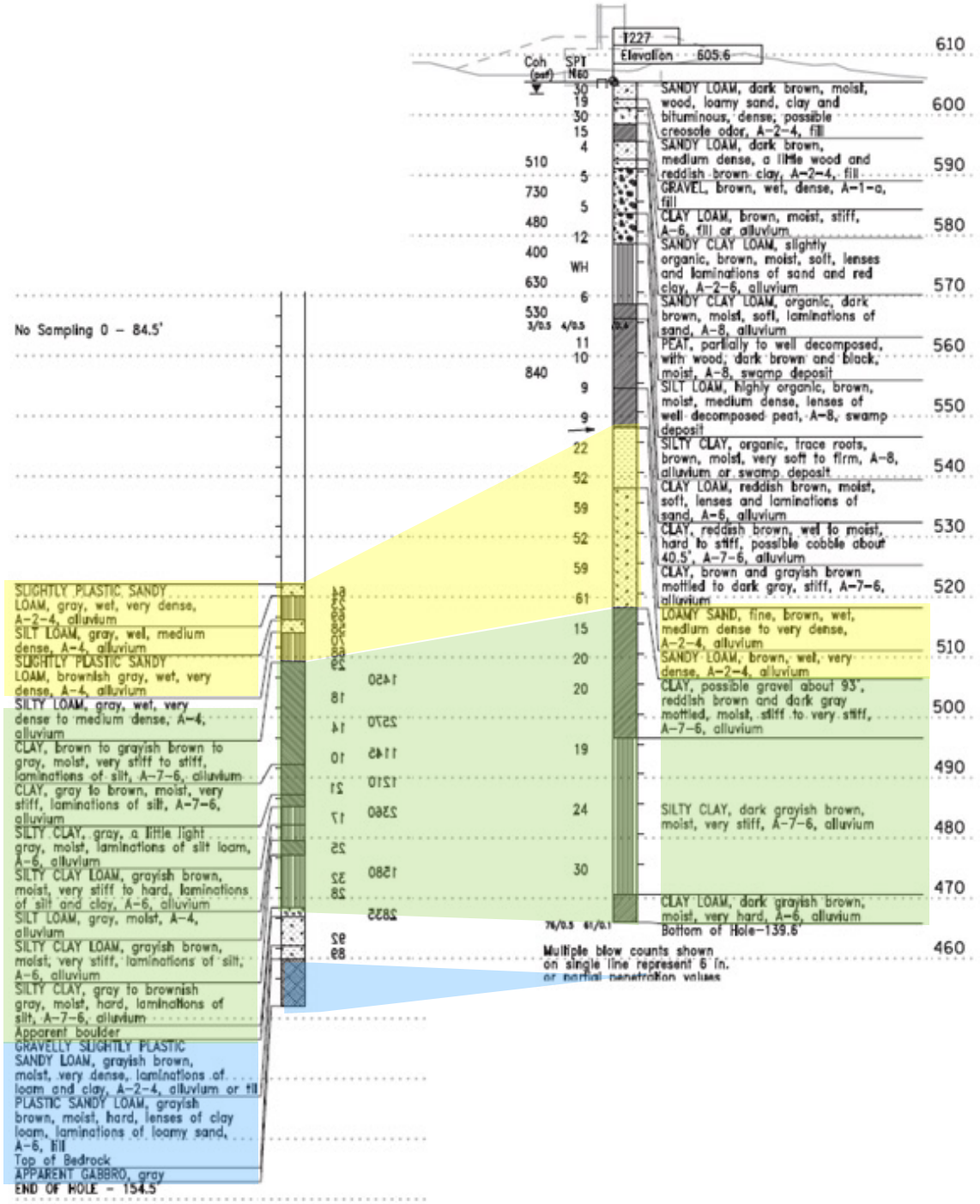


Preliminary (2018)

BRIDGE 69902

PIER 3





Preliminary (2018)

Initial Foundation Analysis

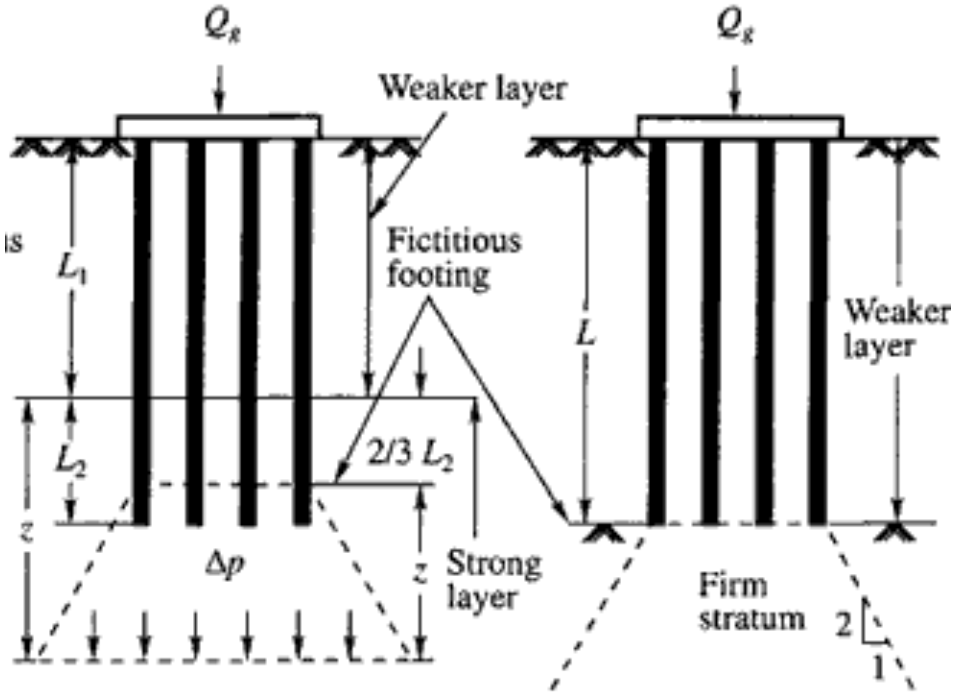
- An upper layer of weak soils in the first 40 to 60 feet, followed by a dense sand that varies in thickness from 20 to 60 feet
- Deeper soiling boring indicated that in several locations, this dense layer of sand is underlain by a compressible layer of clay, followed by bedrock.

Two scenarios applied to 16 substructures (7 Bridges):

1. Drive HP Piling to Rock
   - 40,300 LF
   - $3.9M
2. Stop piling in dense layer
   - 16,800 LF
   - $2.1M

Initial Foundation Analysis

- Initial settlement calculations indicate that long-term settlement could be as much as 2.5 inches under the dead load of structures that do not have piling which extend through the lower layer of compressible clay to bedrock



Testing (2019)

Testing (2019)

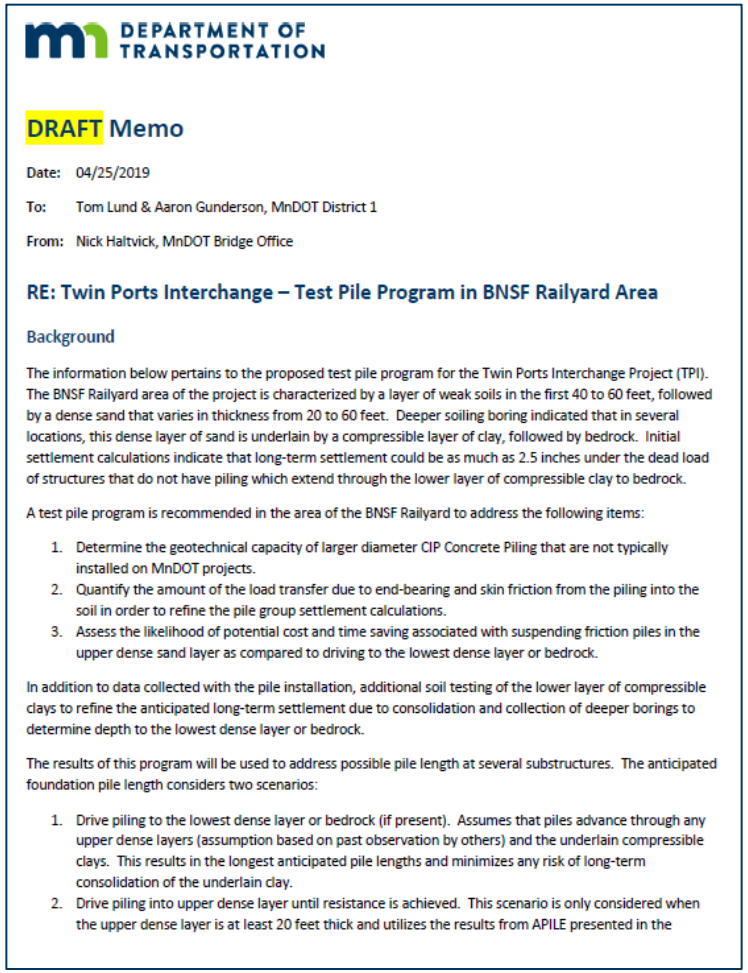
Goals

1. Determine the geotechnical capacity of larger diameter CIP Concrete Piling that are not typically installed on MnDOT projects.

2. Quantify the amount of the load transfer due to end-bearing and skin friction from the piling into the soil in order to refine the pile group settlement calculations.

3. Define the neutral plane location to refine the down drag analysis.

4. Assess the likelihood of potential cost and time saving associated with suspending friction piles in the upper dense sand layer as compared to driving to the lowest dense layer or bedrock.



DEPARTMENT OF TRANSPORTATION

DRAFT Memo

Date: 04/25/2019

To: Tom Lund & Aaron Gunderson, MnDOT District 1

From: Nick Haltvick, MnDOT Bridge Office

RE: Twin Ports Interchange – Test Pile Program in BNSF Railyard Area

Background

The information below pertains to the proposed test pile program for the Twin Ports Interchange Project (TPI). The BNSF Railyard area of the project is characterized by a layer of weak soils in the first 40 to 60 feet, followed by a dense sand that varies in thickness from 20 to 60 feet. Deeper soiling boring indicated that in several locations, this dense layer of sand is underlain by a compressible layer of clay, followed by bedrock. Initial settlement calculations indicate that long-term settlement could be as much as 2.5 inches under the dead load of structures that do not have piling which extend through the lower layer of compressible clay to bedrock.

A test pile program is recommended in the area of the BNSF Railyard to address the following items:

1. Determine the geotechnical capacity of larger diameter CIP Concrete Piling that are not typically installed on MnDOT projects.
2. Quantify the amount of the load transfer due to end-bearing and skin friction from the piling into the soil in order to refine the pile group settlement calculations.
3. Assess the likelihood of potential cost and time saving associated with suspending friction piles in the upper dense sand layer as compared to driving to the lowest dense layer or bedrock.

In addition to data collected with the pile installation, additional soil testing of the lower layer of compressible clays to refine the anticipated long-term settlement due to consolidation and collection of deeper borings to determine depth to the lowest dense layer or bedrock.

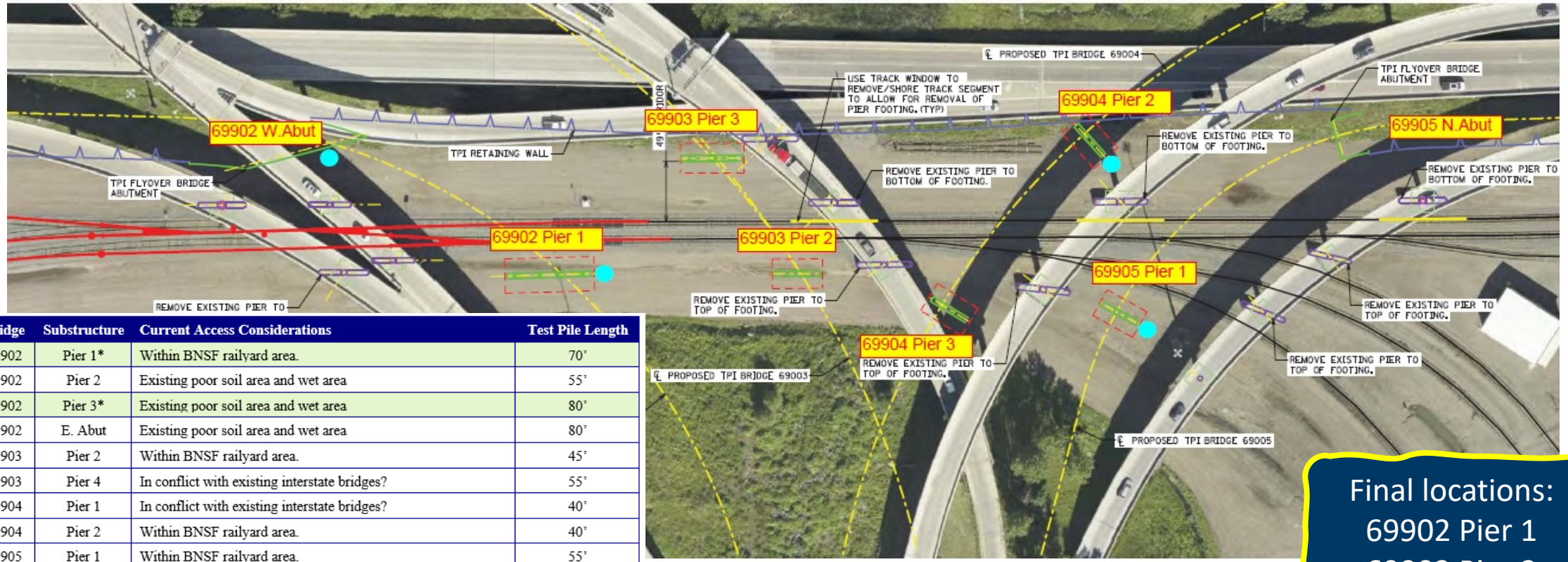
The results of this program will be used to address possible pile length at several substructures. The anticipated foundation pile length considers two scenarios:

1. Drive piling to the lowest dense layer or bedrock (if present). Assumes that piles advance through any upper dense layers (assumption based on past observation by others) and the underlain compressible clays. This results in the longest anticipated pile lengths and minimizes any risk of long-term consolidation of the underlain clay.
2. Drive piling into upper dense layer until resistance is achieved. This scenario is only considered when the upper dense layer is at least 20 feet thick and utilizes the results from APILE presented in the

Testing (2019)

Test Locations

Possible Test Pile Location
Note that locations >15' from railroad do not require a permit.



Bridge	Substructure	Current Access Considerations	Test Pile Length
69902	Pier 1*	Within BNSF railyard area.	70'
69902	Pier 2	Existing poor soil area and wet area	55'
69902	Pier 3*	Existing poor soil area and wet area	80'
69902	E. Abut	Existing poor soil area and wet area	80'
69903	Pier 2	Within BNSF railyard area.	45'
69903	Pier 4	In conflict with existing interstate bridges?	55'
69904	Pier 1	In conflict with existing interstate bridges?	40'
69904	Pier 2	Within BNSF railyard area.	40'
69905	Pier 1	Within BNSF railyard area.	55'
69910	Pier 1	In conflict with existing interstate bridges?	40'
69910	Pier 2	In conflict with existing interstate bridges?	50'
69910	Pier 4	In conflict with existing interstate bridges?	30'

Final locations:
69902 Pier 1
69902 Pier 3

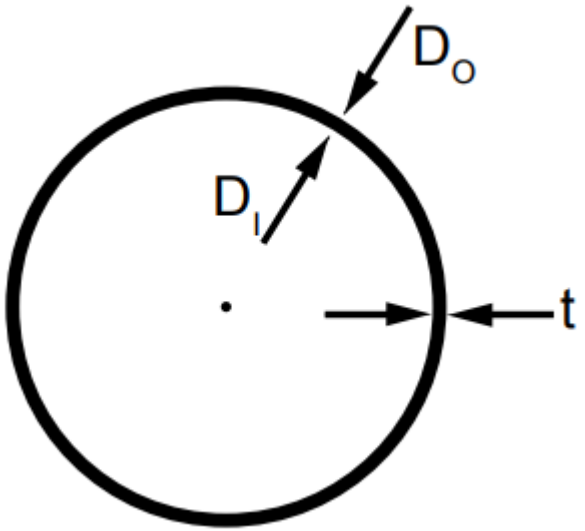
Testing (2019)

Test Pile

Location	Ground EL [ft]	Top of Dense Layer EL [ft]	Depth from surface [ft]	Bot. of Dense Layer EL [ft]	Dense Layer Thickness [ft]	Est. EOD from surface [ft]
69902 P1	606	553	53	523	30	63
69902 P3	605	541	64	518	23	75

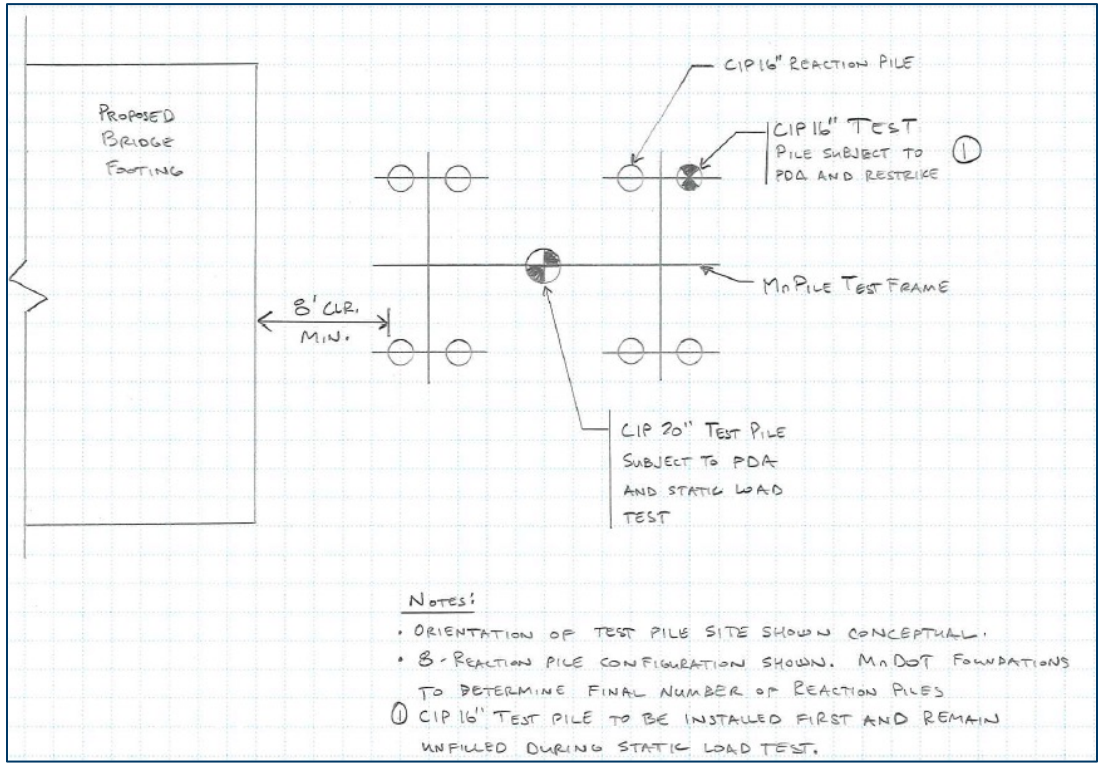
Test Piles
D_0 = 20 inch
t = ½ inch

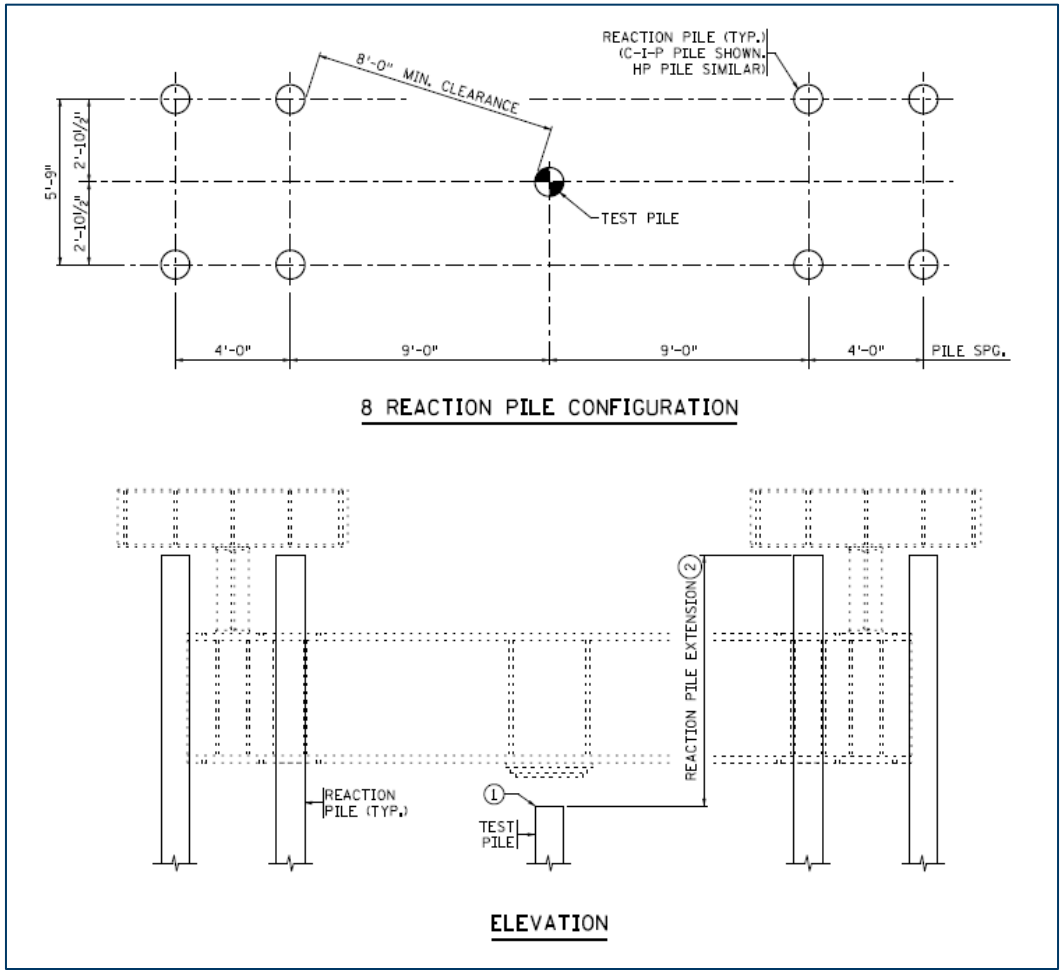
Axial Limit	Φ	ΦRn [kips]
Driveability	1.00	936
Steel Only	0.70	728
Composite	0.70	1248



Testing (2019)

1000 Ton MnPile Test Frame





Driven Lengths

Pile	Estimated Pile Length [ft]	Installed Pile Length [ft]	Estimated depth to dense layer [ft]	Observed depth to dense layer [ft]
P1 16” Rx	70	80	53	~ 65
P1 20” TP		75		
P3 16” Rx	80	95	64	~ 51
P3 20” TP		65		

DISTANCE BELOW CUT-OFF (feet)	DROP OF HAMMER OR RAM (feet)	ENERGY PER BLOW (ft. lbs.)	BLOWS PER FOOT	BLOWS PENET IN LAST 10 (inches)	PENET. PER BLOW (inches)	BEARING IN TONS
60	5.9	59826	4		3.000	**81**
61	6.1	61854	5		2.400	**97**
62	6.1	61854	5		2.400	**97**
63	6.8	68952	8		1.500	**137**
64	8.4	85176	24		0.500	**240**
65	8.5	86190	25		0.480	**245**
66	8.5	86190	32		0.375	**265**
67	9.0	91260	28		0.429	**261**
68	8.6	87204	35		0.343	**274**

Measured nominal bearing

Test Pile	Test Condition	MPF12 [kips]	PDA [kips]	Static Load Test [kips]
P1	EOD	674	917	-
	RST	670	939	-
	SLT	-	-	960
P3	EOD	602	924	-
	STL	-	-	840

NOTES

- Restrike (RST) occurred 6 days after initial end of drive (EOD).
- Static Load Test (SLT) occurred about 22 days after EOD for both locations.
- Resistances (MPF12, PDA, and Static Load Test) are shown as nominal bearing resistance.

Conclusions

Geotechnical capacity	ϕRn = 600 kips (65% Utilization)
Settlement calculations	Reduced estimated settlement by 50% to 75%
Refine the down drag analysis	Established lower, project-wide value for design
Potential cost and time saving	Estimated savings $1.3M (including cost of test)

Recommendations & Design (2020)

Br69902 – Pile Type & Lengths

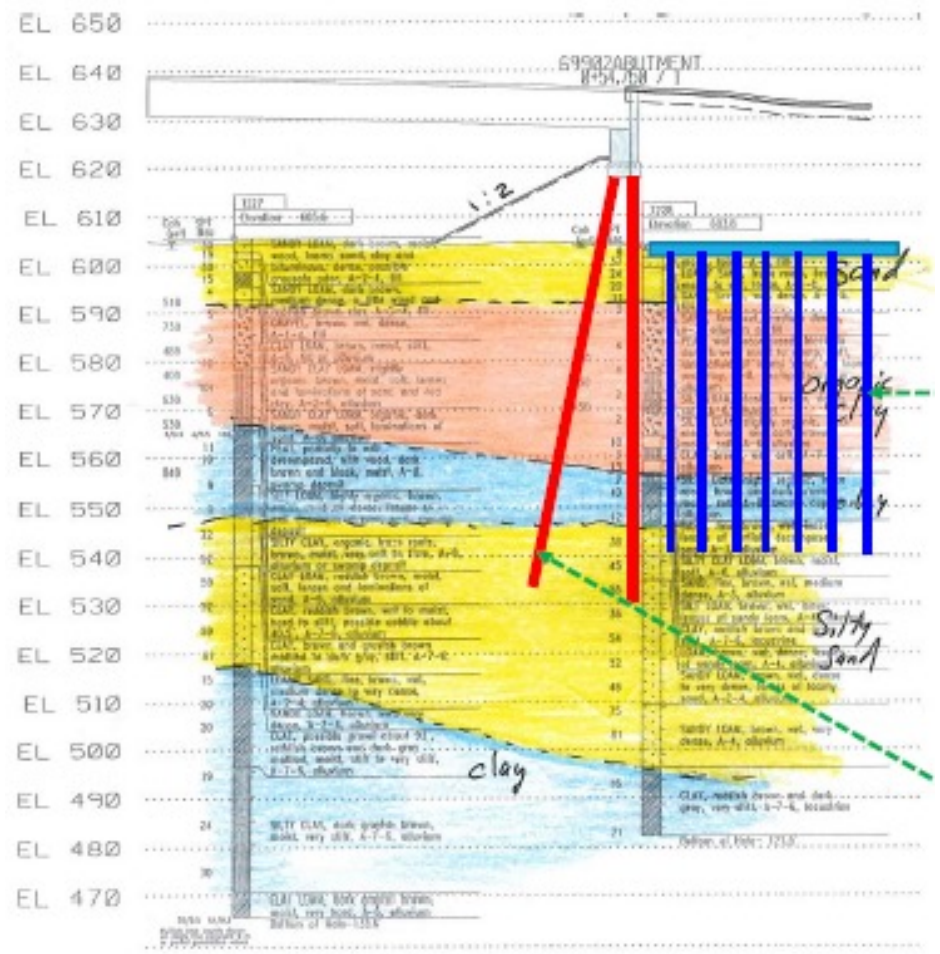
FOUNDATION
RECOMMENDATION
Bridge Construction Unit

Bridge No. 69902 Sheet 1 of 2
Location: I-35 NB to I-535 SB Ramp over RR (TPI)
District: 1 Report No. 2025

Substructure Unit	Approx. Station	Est. Bottom Elevation of Footing or Cap	Foundation Type	Factored Resistance (tons)	No. Test Piles	Test Pile Length (ft)	Tip Protect.	Redrive	PDA	Est. Fnd. Pile Length (ft)
W. Abut	18+43.0	600.0±	20"x3/8" CIP	300	3	115	①	X	②	105
Pier 1	20+79.0	597.0±	20"x3/8" CIP	300	2	75		X	X	65
Pier 2	23+00.0	605.0±	20"x3/8" CIP	300	2	75		X	X	65
Pier 3	24+63.0	605.0±	20"x3/8" CIP	300	2	85		X	X	75
E. Abut	26+54.0	616.3±	20"x3/8" CIP	300	2	95		X	X	85

Foundation Memo date:	2/7/2019, 11/22/2019
Bridge Hydraulics Memo date:	N/A
Preliminary Plans Request date:	02/15/19

Pile Size Determination



- Two pile types:
  - HP14x89 (to rock)
  - CIP20”x3/8” (to dense layer)
- Similar factored capacities
  - 250 tons (HP), 300 tons (CIP)
- CIP determined to have adequate:
  - lateral soil resistance
  - down drag resistance when battered

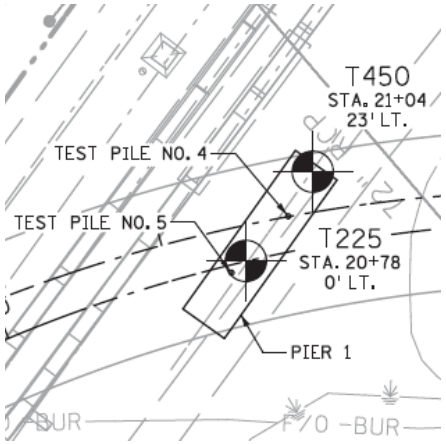
Br69902 – Pile Type & Lengths

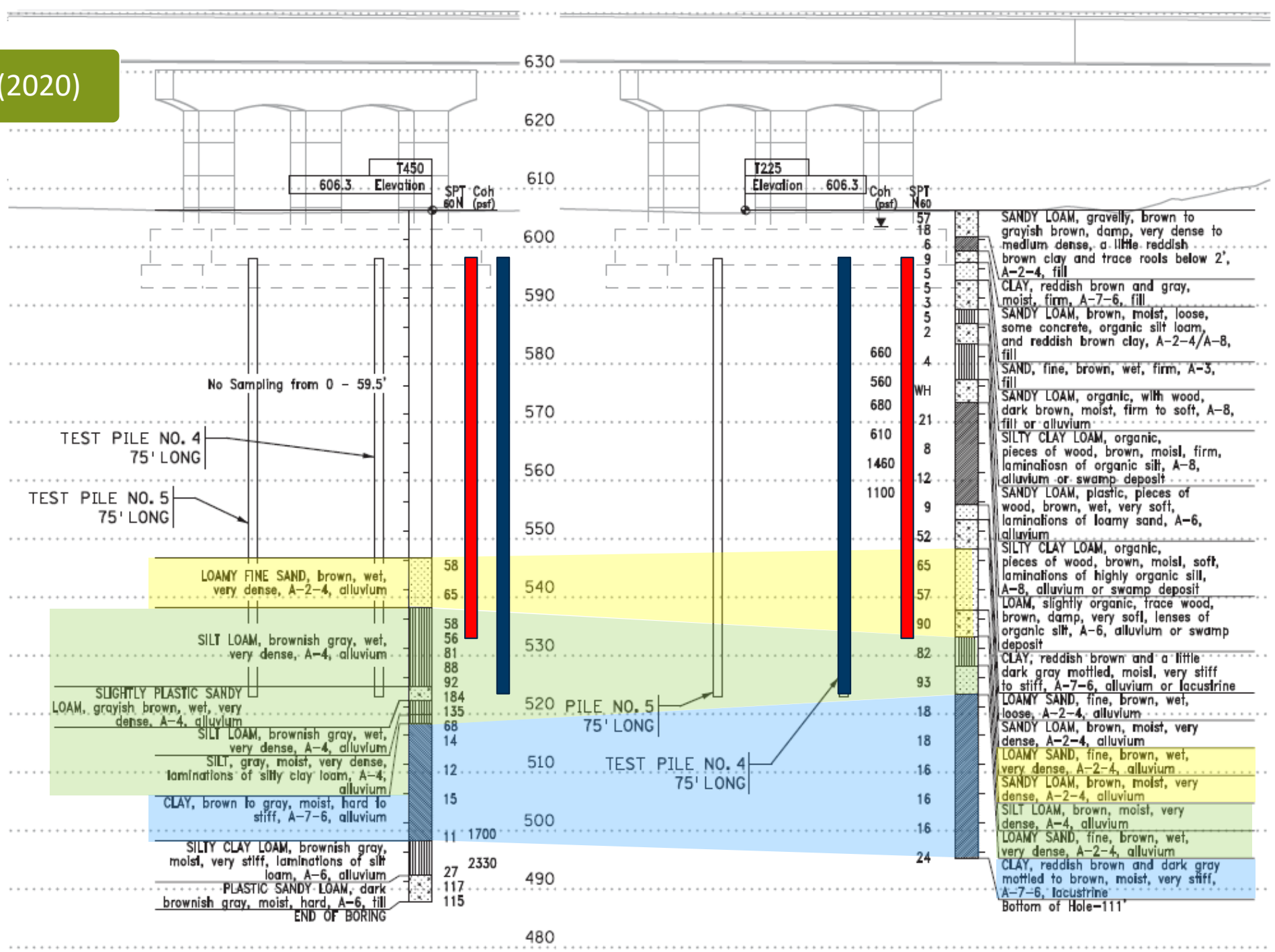
Location	Borings	Length	Remarks
W. Abut.	T152, T224, T401, T451	105’	average depth to bedrock from borings (varies by 15’)
Pier 1	T225, T450	65’	estimated to stop approx. mid-depth of 30' thick layer of dense sand
Pier 2	T226	65’	estimated to stop approx. mid-depth of 40' thick layer of dense sand
Pier 3	T227, T448	75’	estimated to stop approx. mid-depth of 30' thick layer of dense sand
W. Abut.	T228, T229, T447	85’	estimated to stop approx. mid-depth of 40' thick layer of dense sand

Recommendations & Design (2020)

BRIDGE 69902

PIER 1



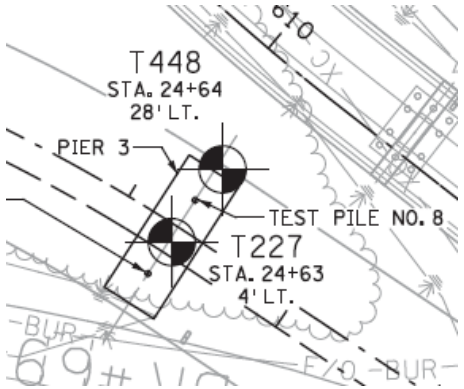


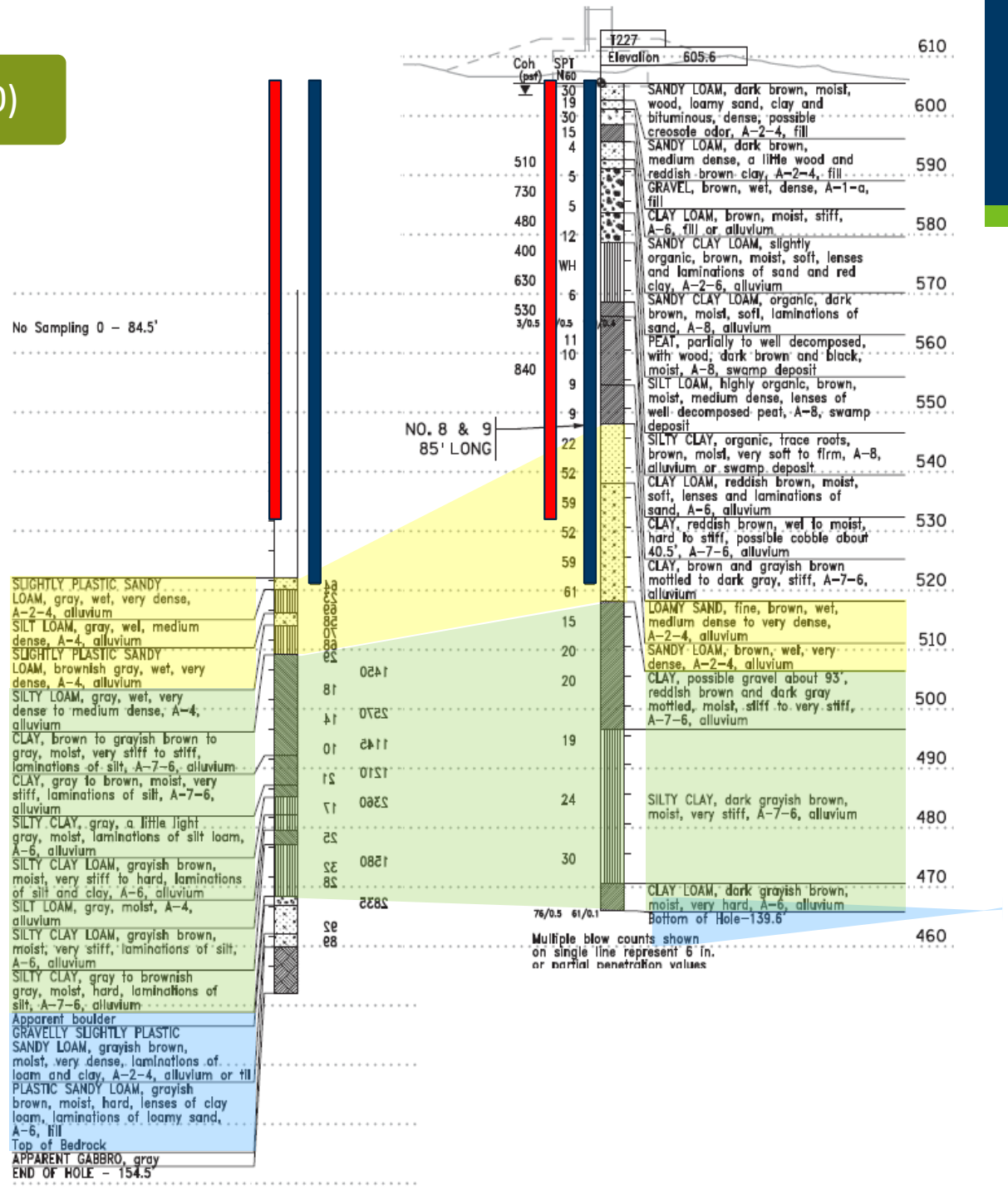
2/28/23

Recommendations & Design (2020)

BRIDGE 69902

PIER 3





Br69902 – Pile Type & Lengths

- Pile group settlement based on the piling hanging up in the upper dense layer of sand has been estimated to vary between 0.5" and 1.1" over the service life of the bridge. Given the span lengths and structure type, this settlement has been determined to be permissible.
- Downdrag has been quantified on a project-wide level as 250 kips per pile. Batter piles will be permissible.

Br69902 – Key Remarks

① Tip Protection: use a CIP-1/2" thick X 10 long section for tip protection of CIP at west abutment.

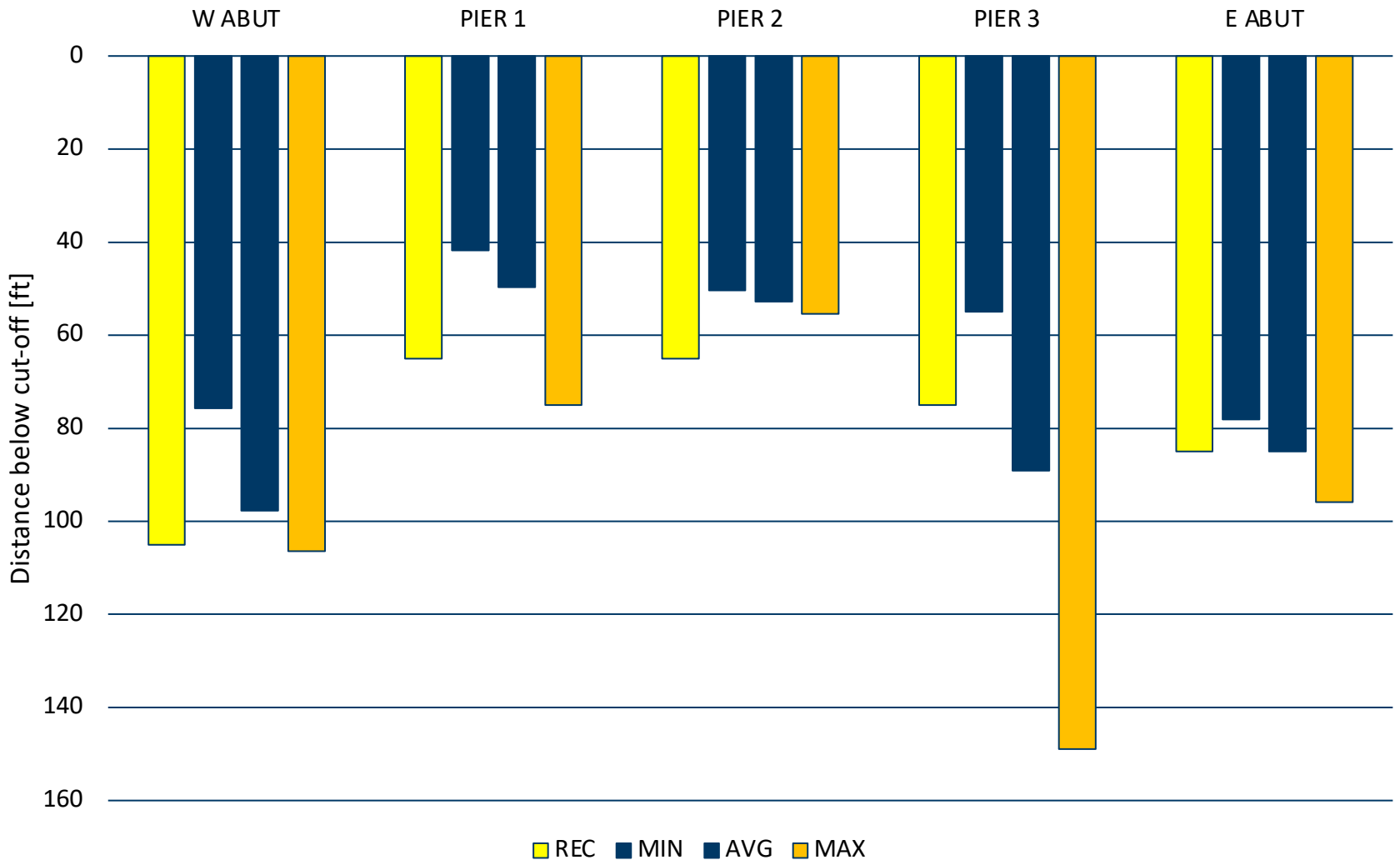
③ Water table will likely impact the West Abutment and Pier 1.

④ At Pier 2 & 3 and East Abutment, galvanize the upper #' of piling. This is to provide enhance corrosion protection in the wet/dry zone near EL. 603.

Construction (2020 – current)

Construction (2020 – current)

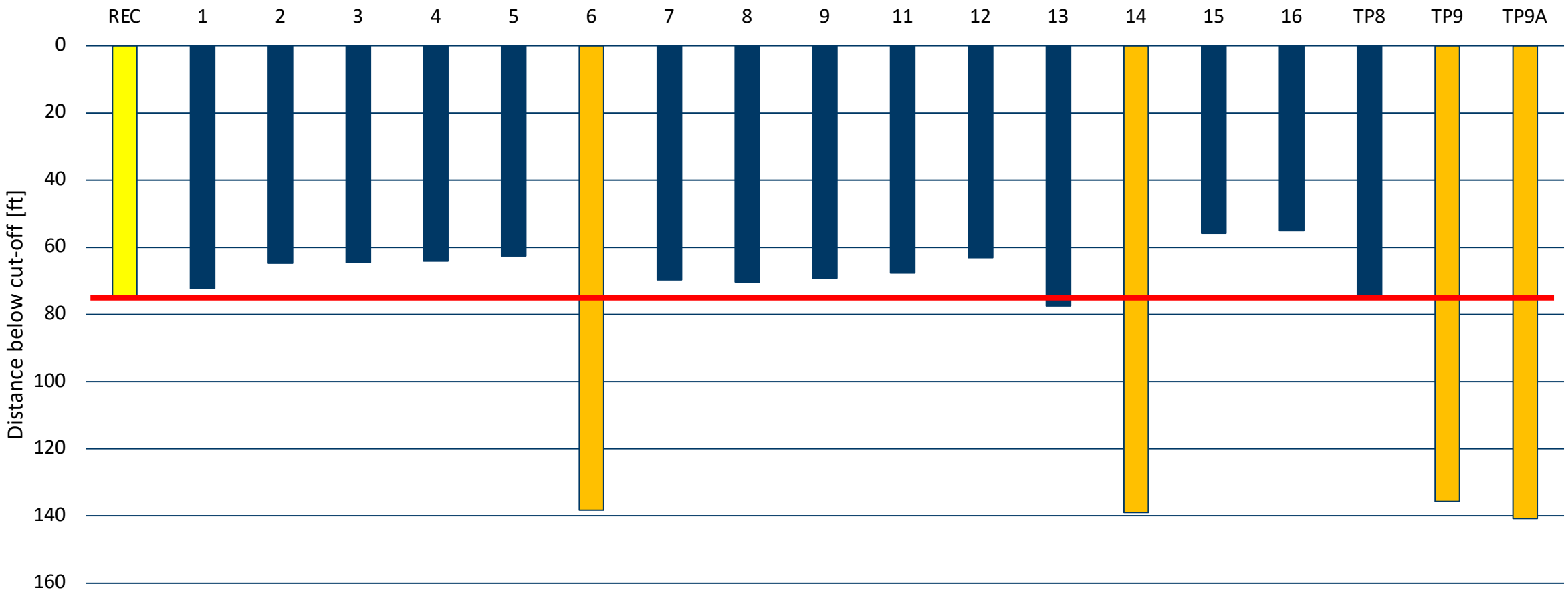
Variation in Lengths



Location	No. Driven within 5'±
W. ABUT	29 of 48
PIER 1	2 of 32
PIER 2	0 of 18
PIER 3	4 of 20
E. ABUT	12 of 18

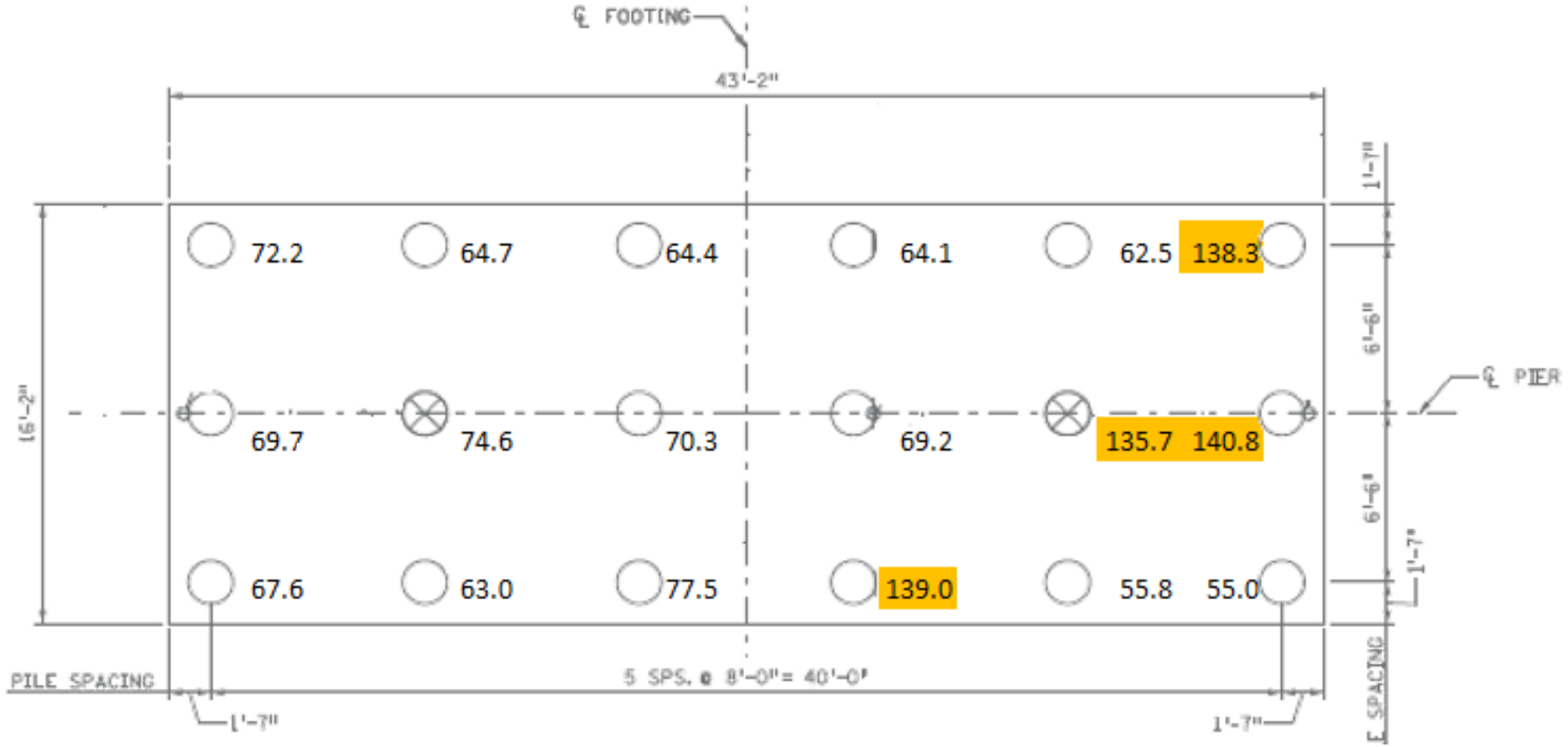
Construction (2020 – current)

Pier 3 Lengths



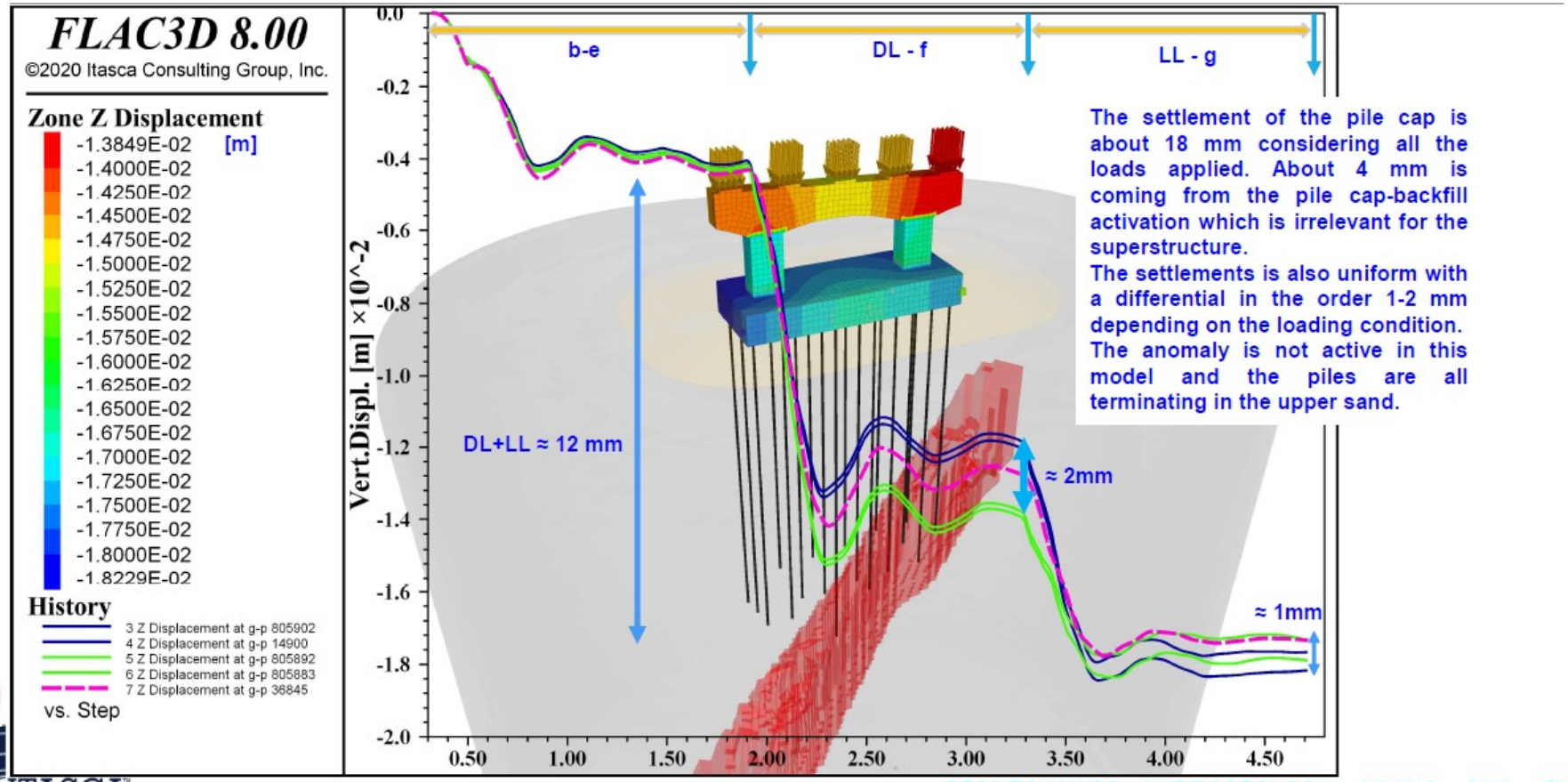
Construction (2020 – current)

Pier 3 Lengths



Pier 3 Pile Analysis

Settlements



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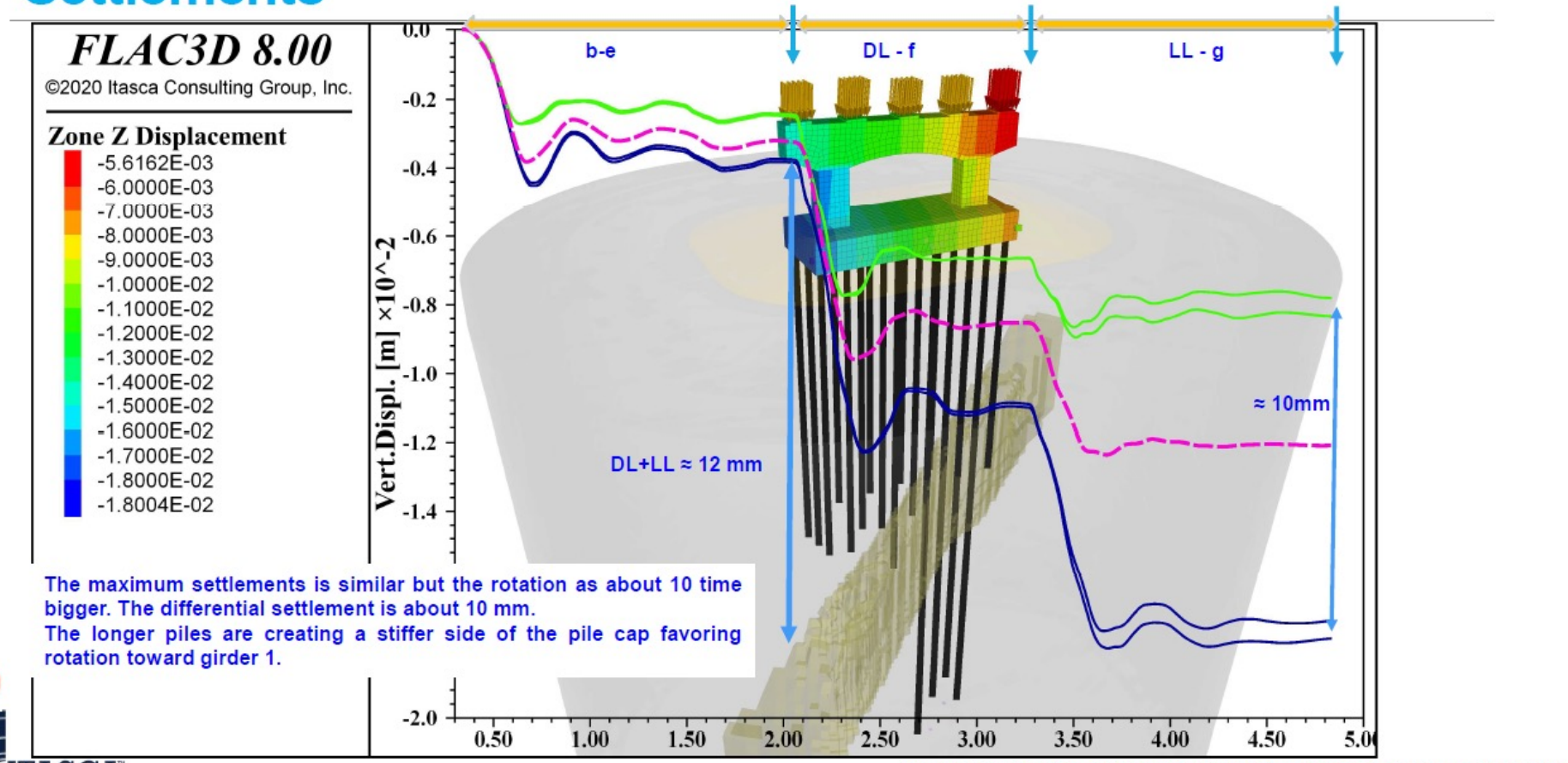
Pier 3 Pile Analysis

Settlements



The maximum settlements is similar but the rotation as about 10 time bigger. The differential settlement is about 10 mm.
The longer piles are creating a stiffer side of the pile cap favoring rotation toward girder 1.

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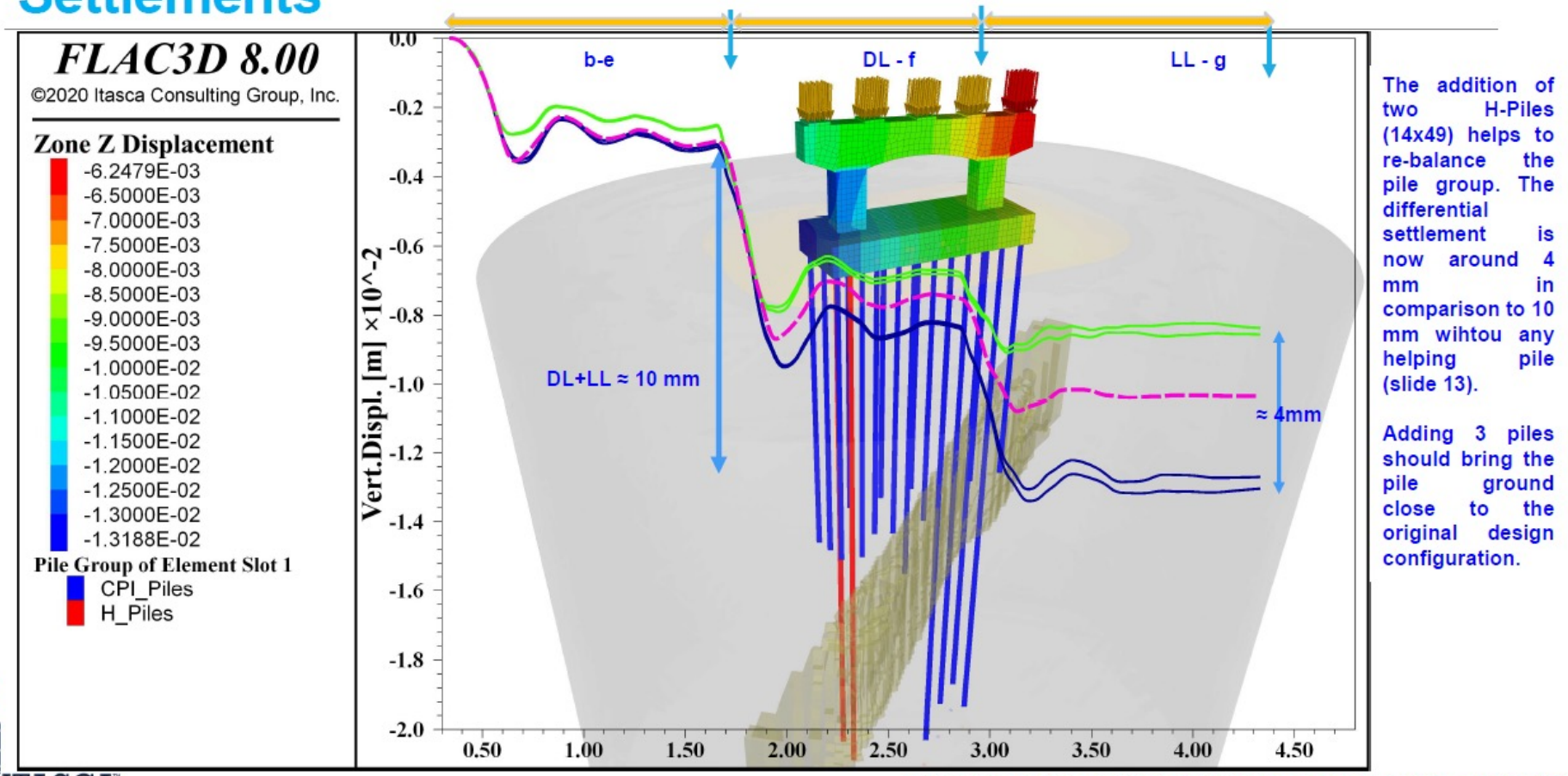
Pier 3 Pile Analysis

Settlements



The addition of two H-Piles (14x49) helps to re-balance the pile group. The differential settlement is now around 4 mm in comparison to 10 mm wihtou any helping pile (slide 13).

Adding 3 piles should bring the pile ground close to the original design configuration.

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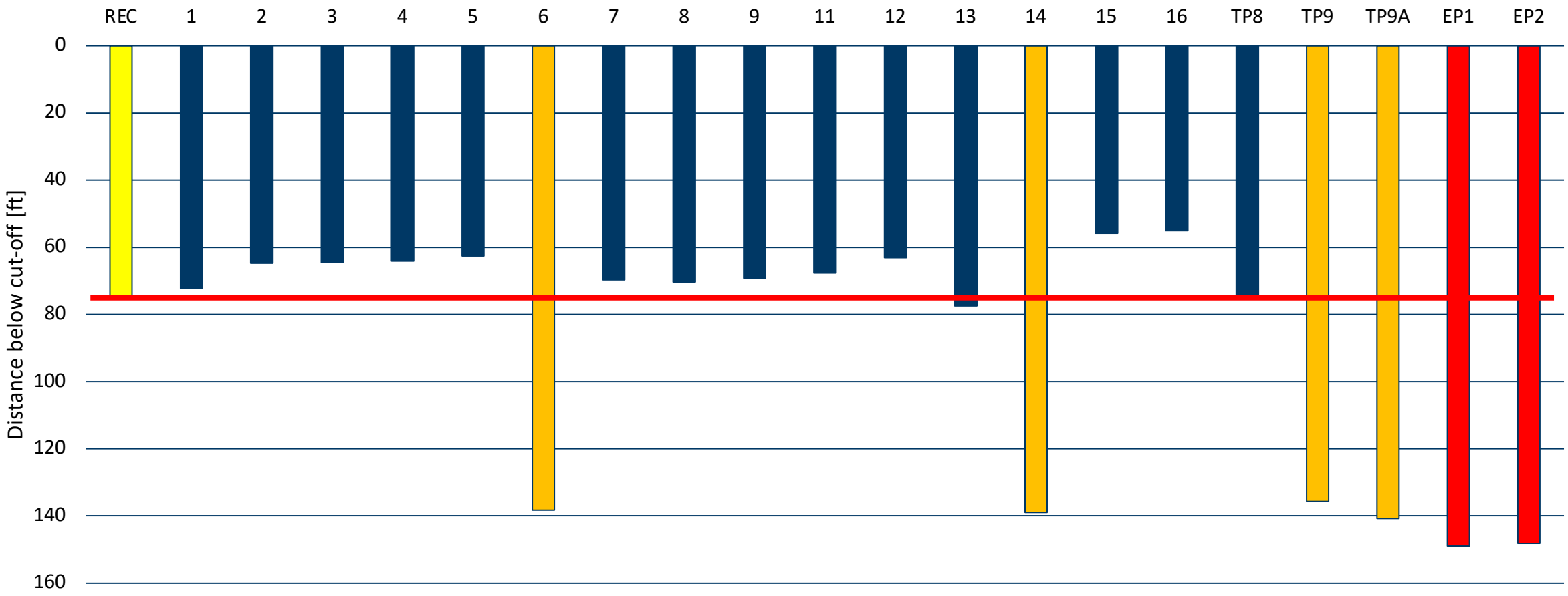
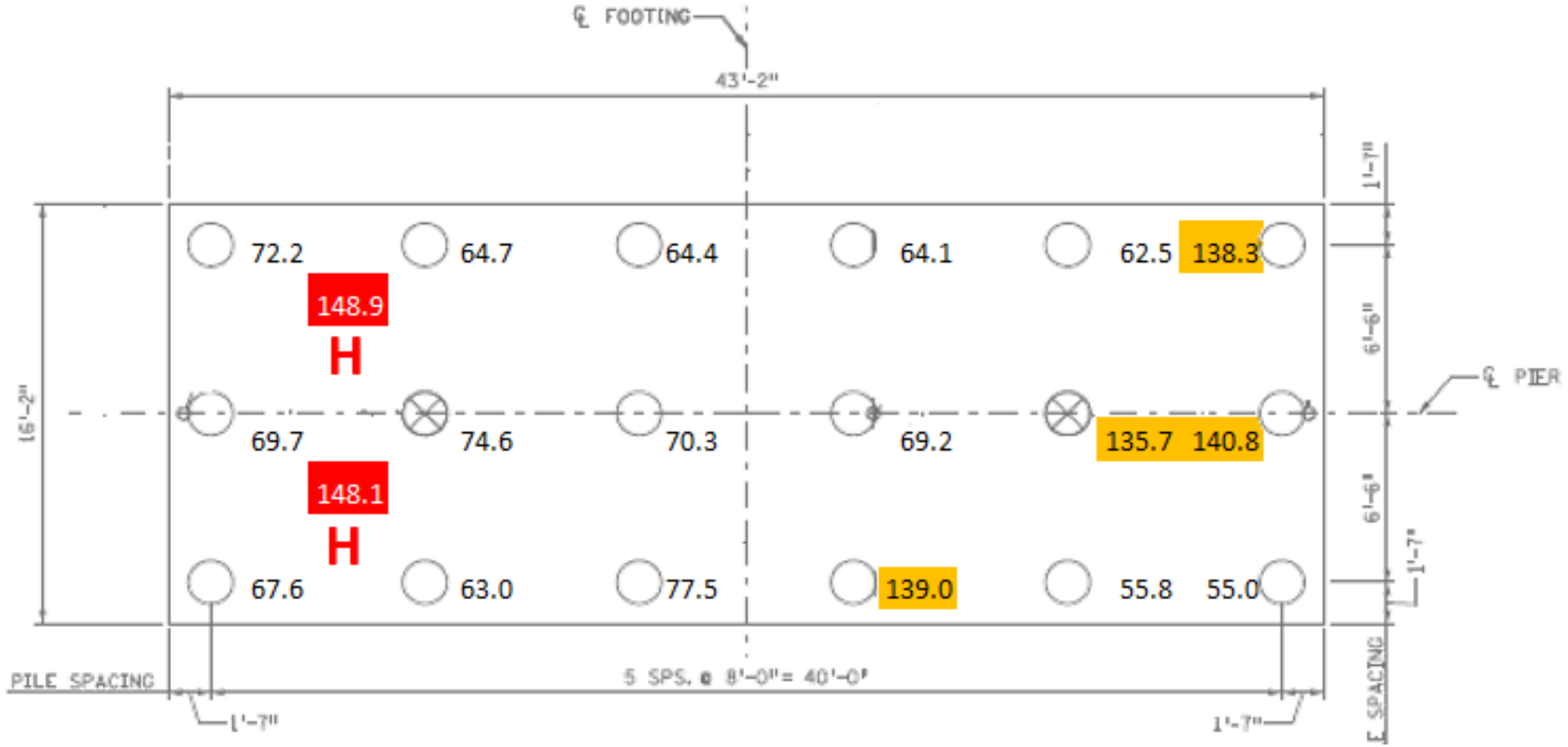
Construction (2020 – current)

Pier 3 Lengths



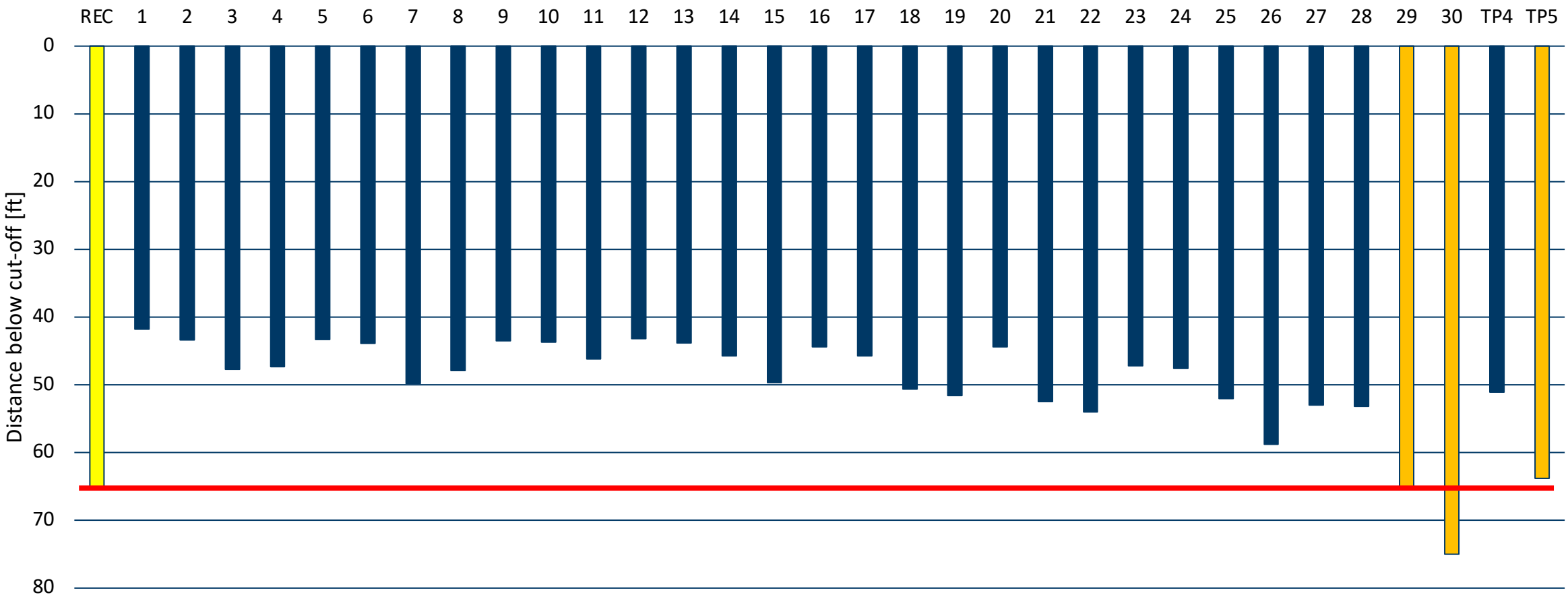
Construction (2020 – current)

Pier 3 Lengths

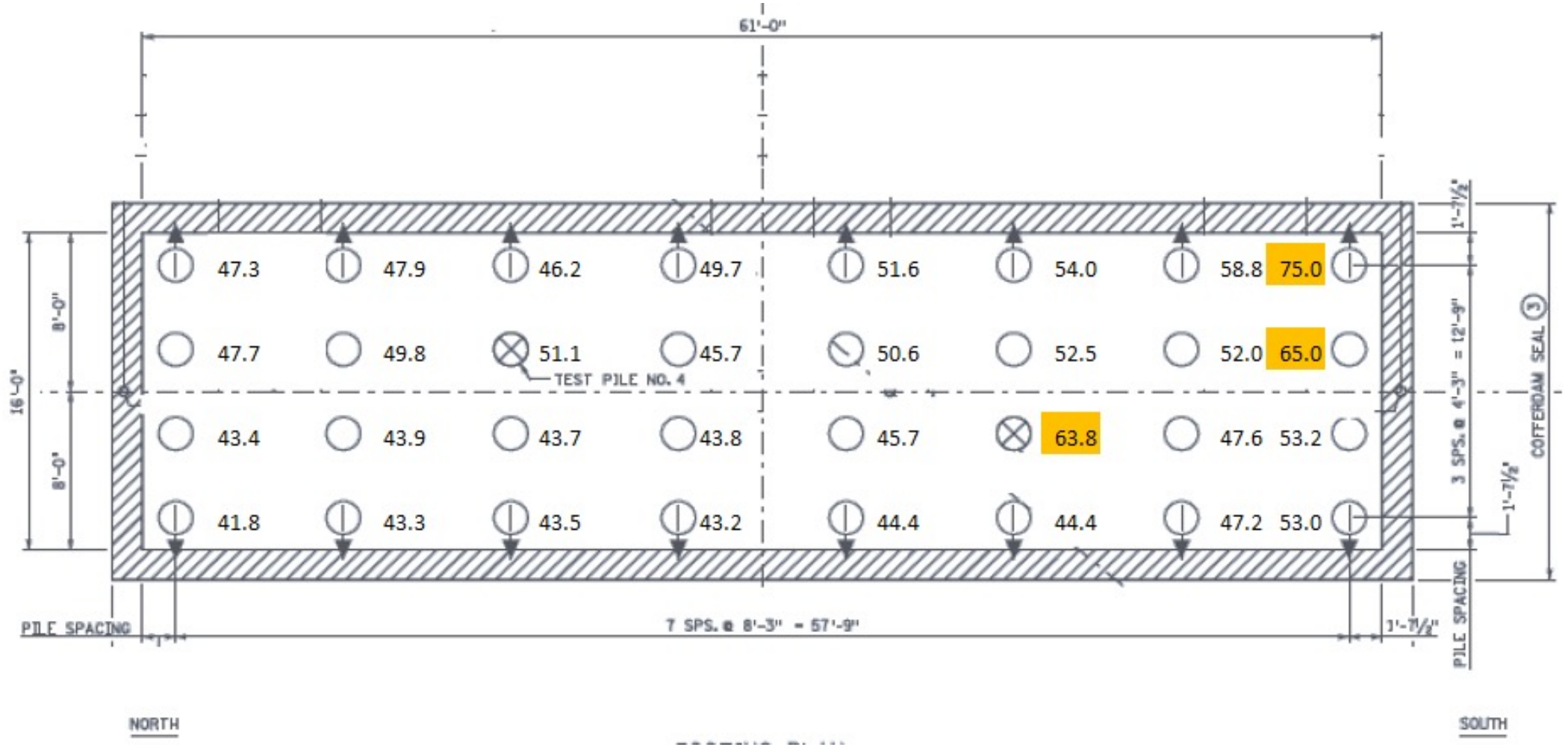


Construction (2020 – current)

Pier 1 Lengths

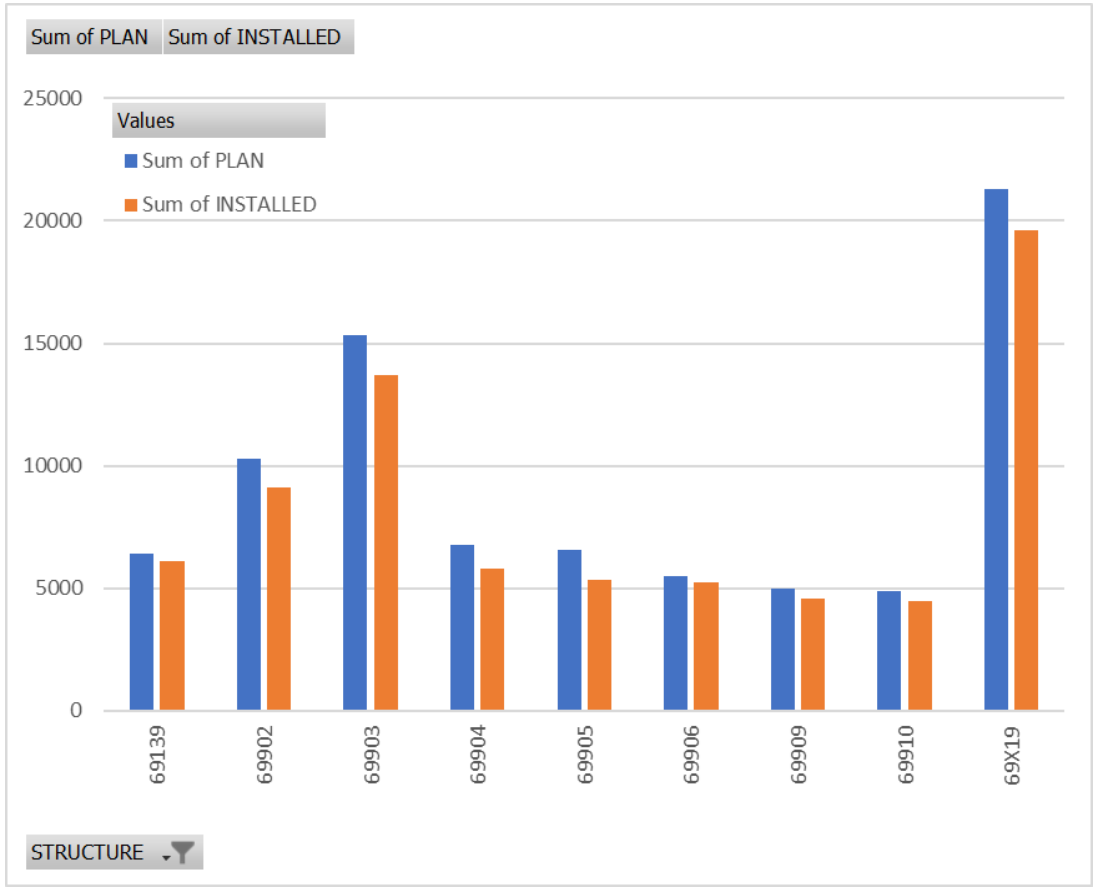


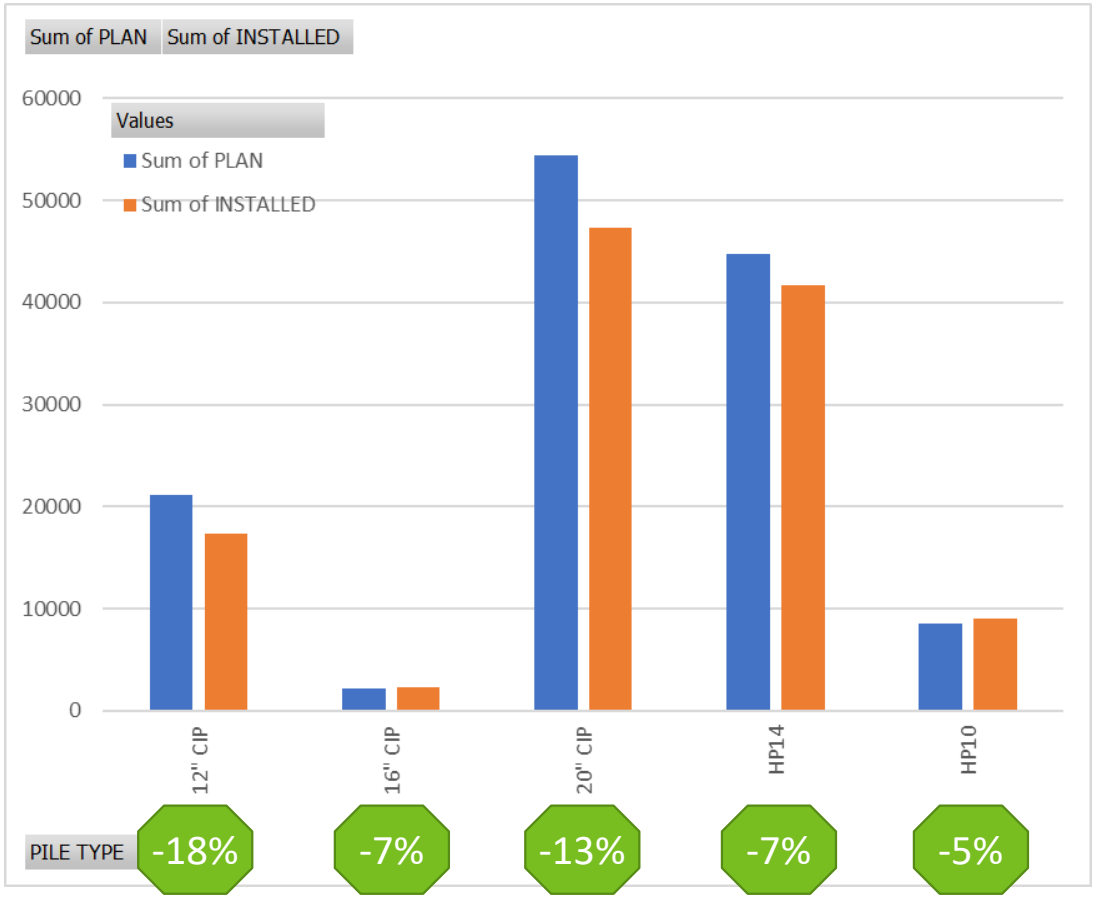
Pier 1 Lengths



Construction (2020 – current)

WP 1 & 2 Pile Lengths





Construction (2020 – current)

Weekly meetings, daily interactions

Microsoft Teams

SUBMITTAL LOG

TWIN PORTS INTERCHANGE (TPI) PROJECT
MnDOT - CMGC
State Project No. 6982-322

2/21/2023

*2 week dura
[per CMGC re

Date Received	Transmittal No.	Submittal Description	Rev. No.	Bridge No.	Submittal Type	Ball in Court	BNSF Review/Approval Req'd?	Status	*Date Due
10/10/22	T-1306	WP3_4 Hammer Report Br.69808 D19-42	--	69808 (WP4)	Spec.Rqmt.	AKJV	No	Returned	10/24/22
10/19/22	T-1335	WP3_4 Hammer Report Br.69808A D19-42	--	69808A (WP4)	Spec.Rqmt.	AKJV	No	Returned	11/02/22
10/28/22	T-1363	WP3_4 NEO WP4 Lighting	--	Roadway	Spec.Rqmt.	AKJV	No	Returned	11/11/22
11/09/22	T-1383	WP3_4 Hammer Report Br.69809 Delmag D19-42	--	69809 (WP4)	Spec.Rqmt.	AKJV	No	Returned	11/23/22
11/21/22	T-1403	WP1_2 ConcreteMountedSigns Shop Dwgs	--	Roadway	Spec.Rqmt.	AKJV	No	Returned	12/05/22
01/18/23	T-1495	WP3_4 Br.69808 Decking Formwork	--	69808 (WP4)	Spec.Rqmt.	AKJV	Yes	Returned	02/01/23
02/13/23	T-1472.1	WP3_Drainage Shop Drawings - Fiberglass	1	69139	Shop Drawings	MnDOT	No	Open	02/27/23
02/13/23	T-1558	WP4_Br69808A Drainage Shop Drawings - Fiberglass	--	69808A (WP4)	Shop Drawings	MnDOT	No	Open	02/27/23
02/13/23	T-1559	WP4_Br69808 Drainage Shop Drawings - Fiberglass	--	69808 (WP4)	Shop Drawings	MnDOT	No	Open	02/27/23
02/16/23	T-1566	WP1_2 BR 69903 Slope Paving	--	69903	Shop Drawings	MnDOT	No	Open	03/02/23
02/17/23	T-1567	WP3_Br69139C Drainage Shop Drawings - Fiberglass	--	69139C (WP3)	Shop Drawings	MnDOT	No	Open	03/03/23
02/17/23	T-1568	WP4 Wall AK Handrail Shop Drawing	--	Roadway	Shop Drawings	MnDOT	No	Open	03/03/23
02/20/23	T-1268.1	Retaining Wall B & W Pipe Railing Shop Drawings	1	Roadway	Spec.Rqmt.	MnDOT	No	Open	03/06/23

Thank you!

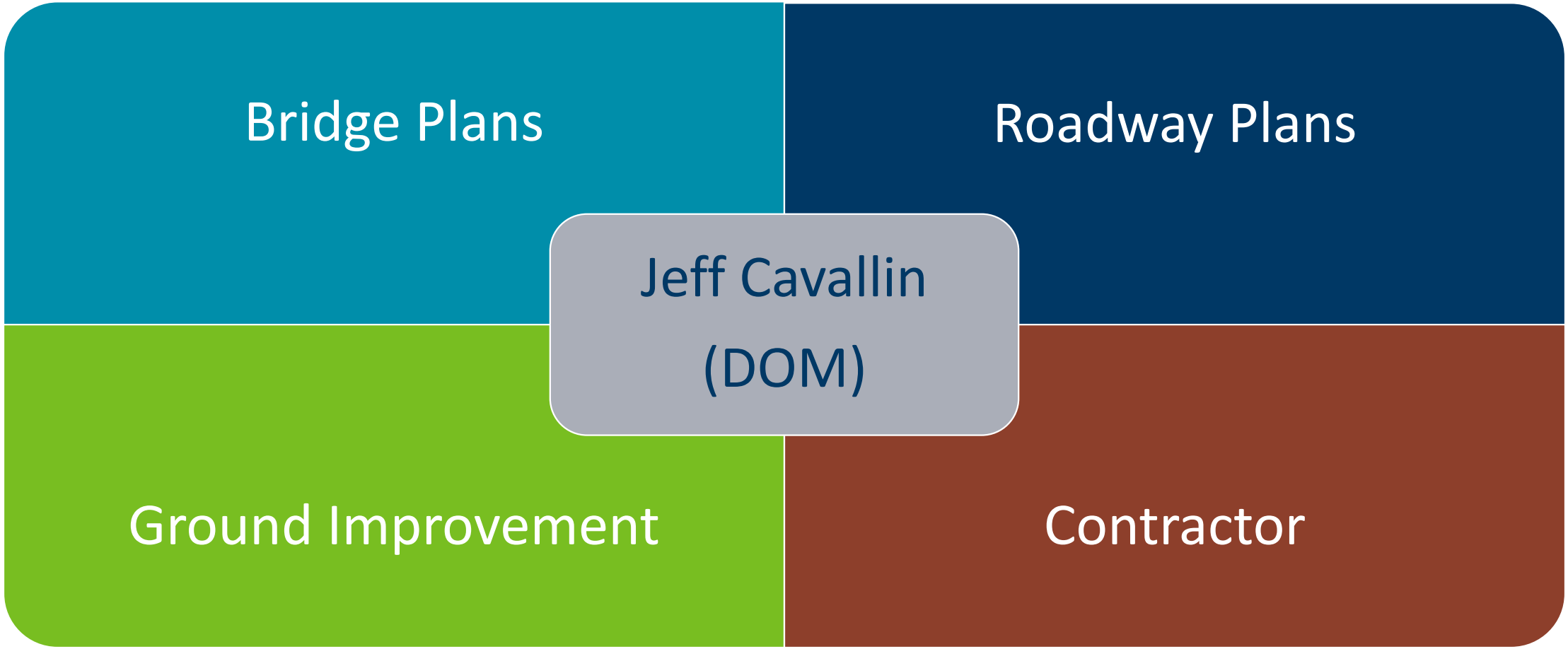
Nick Haltvick, P.E.

nick.haltvick@state.mn.us

Design Consideration

Jeff Cavallin | Parsons Transportation Group
Nick Haltvick | Minnesota Department of Transportation

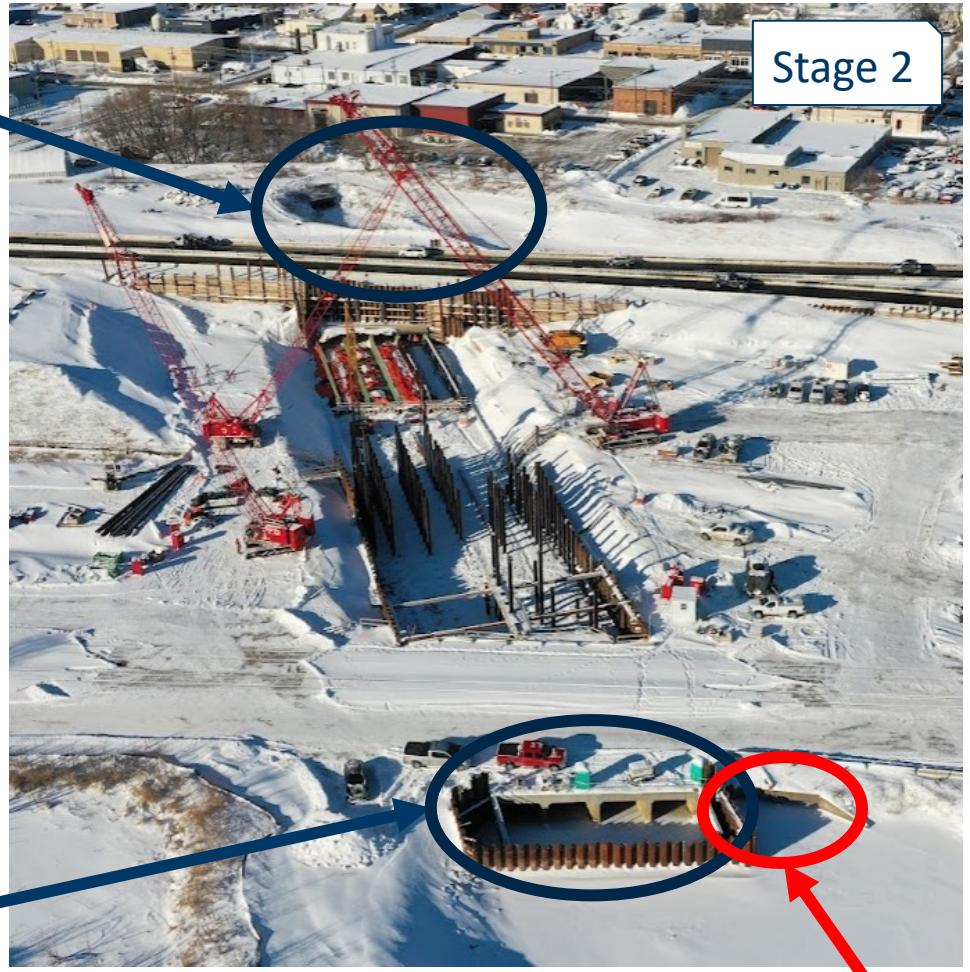
Bridge Design Oversight Manger



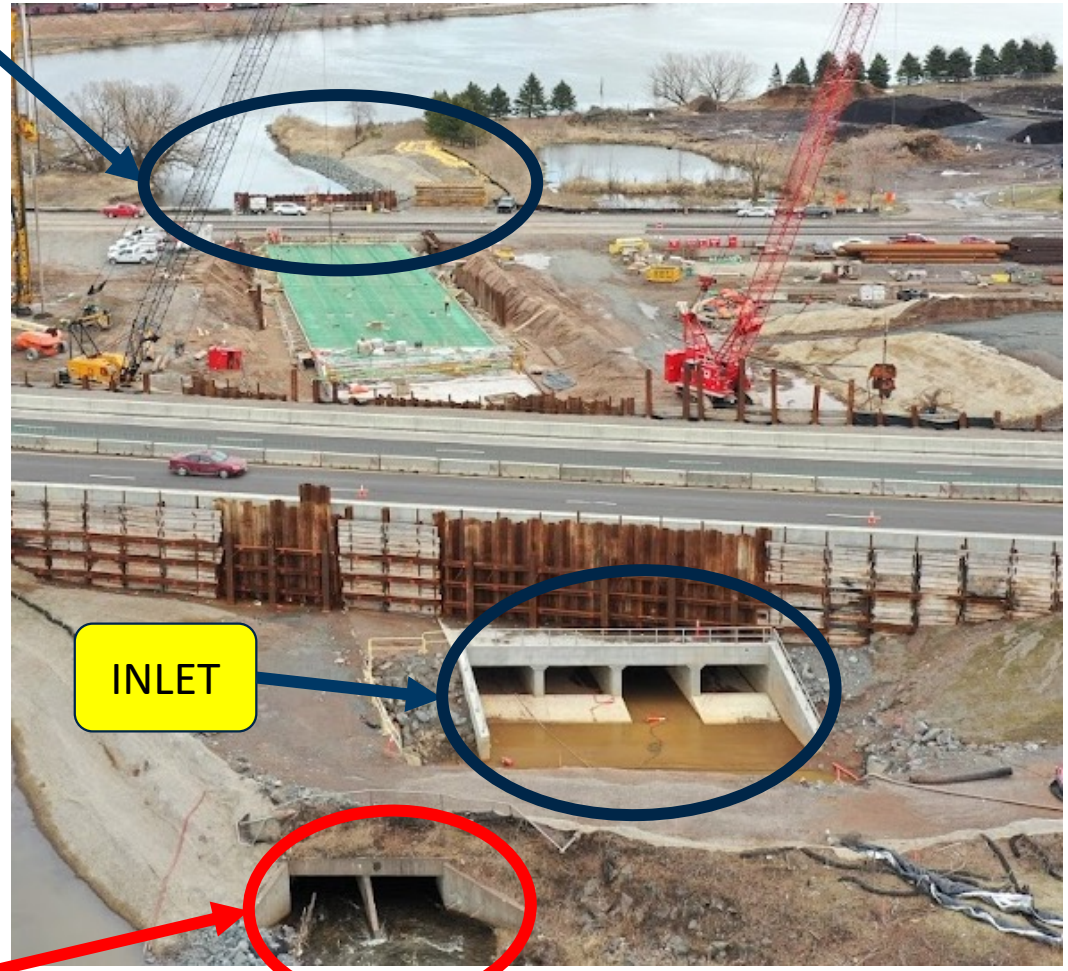
CMGC Benefits during Prelim/Final Design

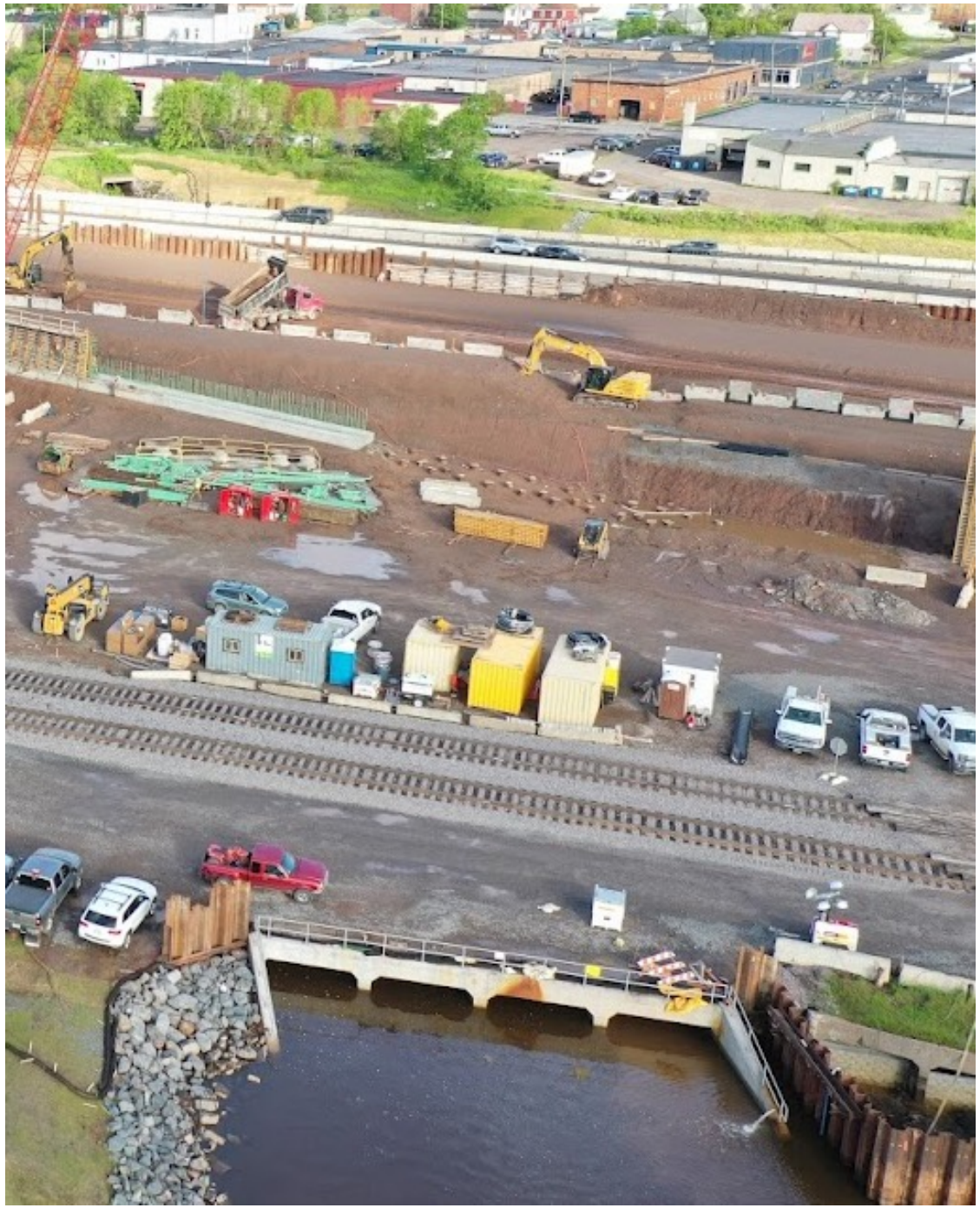
- Complex Construction Staging Development for Miller/Coffee Creek Culvert
  - Staging under both I-35 and BNSF railroad tracks
  - Temporary shoring design / dewatering

Miller-Coffee Creek Culvert



Miller-Coffee Creek Culvert





2/28/23

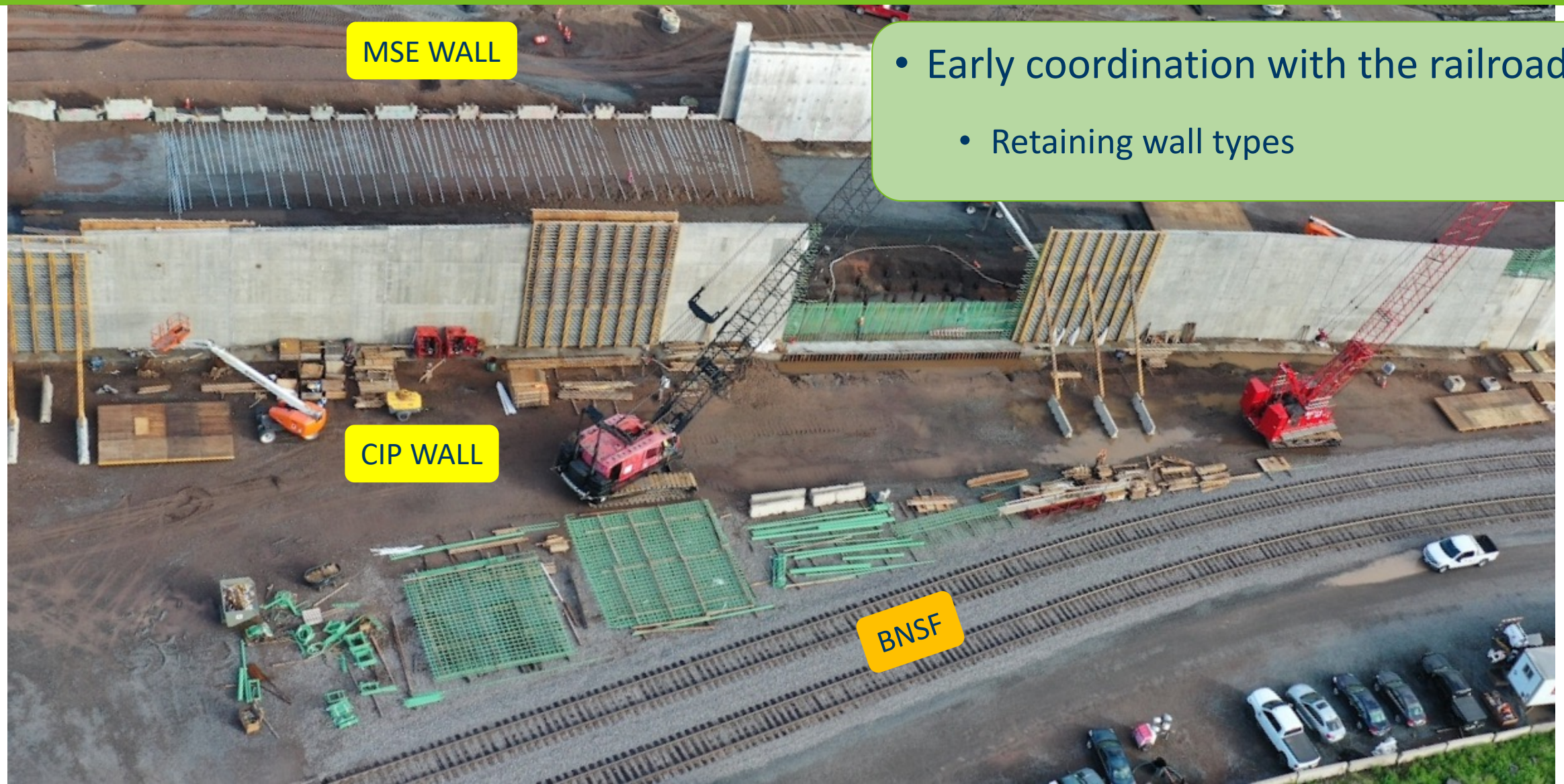
CMGC Benefits during Prelim/Final Design

- Early coordination with the railroad
  - Existing footing removal
  - Earth shoring for excavations

CMGC Benefits during Prelim/Final Design

- Early coordination with the railroad
  - Beam erection sequences

CMGC Benefits during Prelim/Final Design



- Early coordination with the railroad
  - Retaining wall types

Super Load Study

- The Twin Ports Interchange (TPI) Project
  - Super Load = OSOW = Oversize Overweight Permit Loads
  - May consist of any/all: Heavy Loads, Tall Vertical Heights, Long Overall Lengths/Turning Movements
- TPI Project Goals
  - Provide for Increased Bridge Design Capacity to handle heavy Permit Loads
  - Provide for Increased Geometric Capacity to handle large oversize Permit Loads
  - Reduce reliance on relief routes that use local streets

Super Load Study

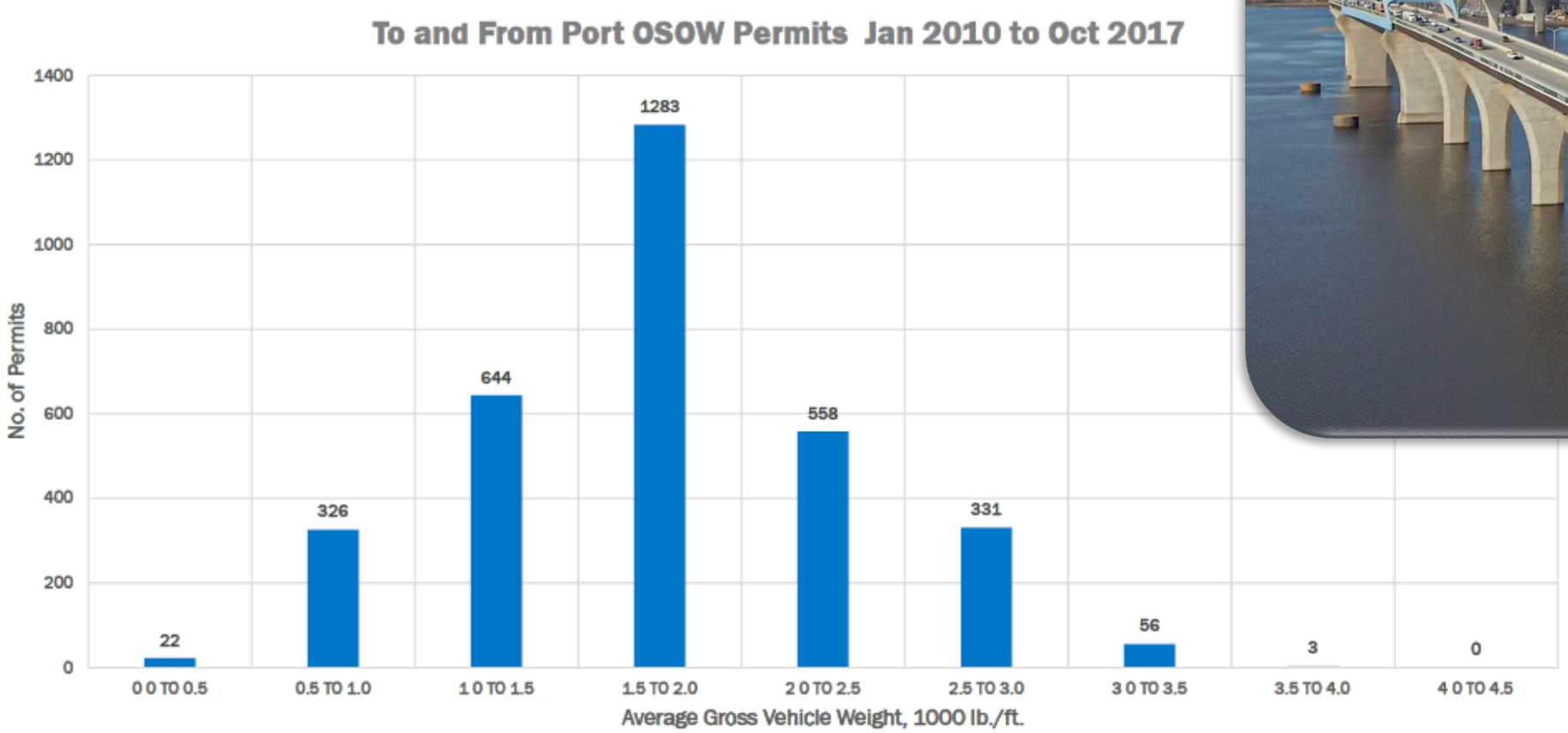
- Reviewed over 3000 single trip permit vehicle data sets from Duluth-Superior Port
- Compared with MnDOT Standard Permit Load Rating Vehicles

Summary of Single Trip Special Permit Vehicles January 1, 2010 to October 10, 2017				
Parameter	Unit	Selected Upper Limit Parameter	No. of Permits Within Limit	% of Permits Within Limit
Gross Vehicle Weight[1]	lb.	255,000	2,994	93%
No. of Axles Total[1]		13	2,849	88%
Maximum Axle Load[2]	lb.	23,000	3,132	97%
No. of Axles at Maximum Axle Load[1]		12	3,093	96%
Height	ft.	16	3,179	99%
Length[1]	ft.	117	2,559	79%
Width	ft.	10	3,142	97%
Average Gross Vehicle Weight[3]	lb./ft.	2,900	3,144	98%
Total No. of Permits			3,223	

[1] Standard P413 Truck [2] Standard C198.23 Truck [3] Standard C152b Truck

Super Load Study

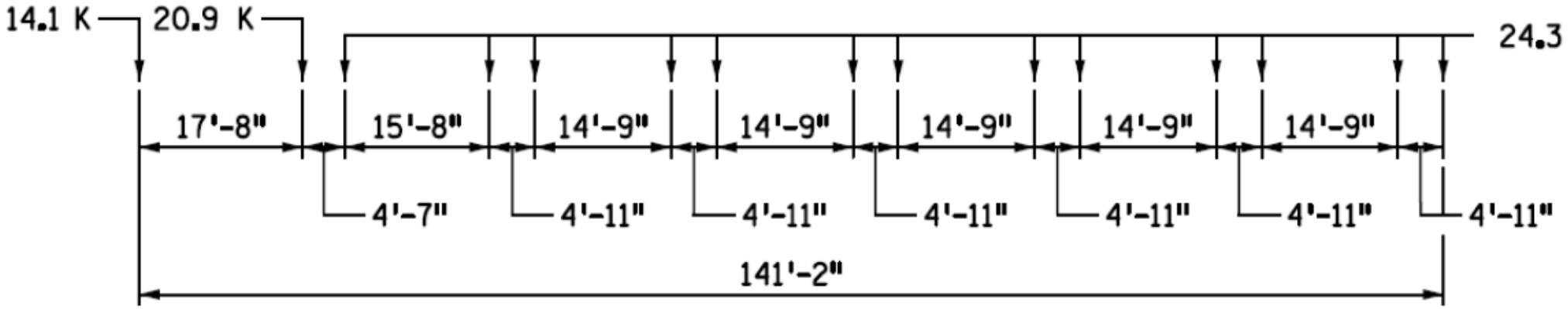
Twin Ports Interchange – Super-load Design Criteria



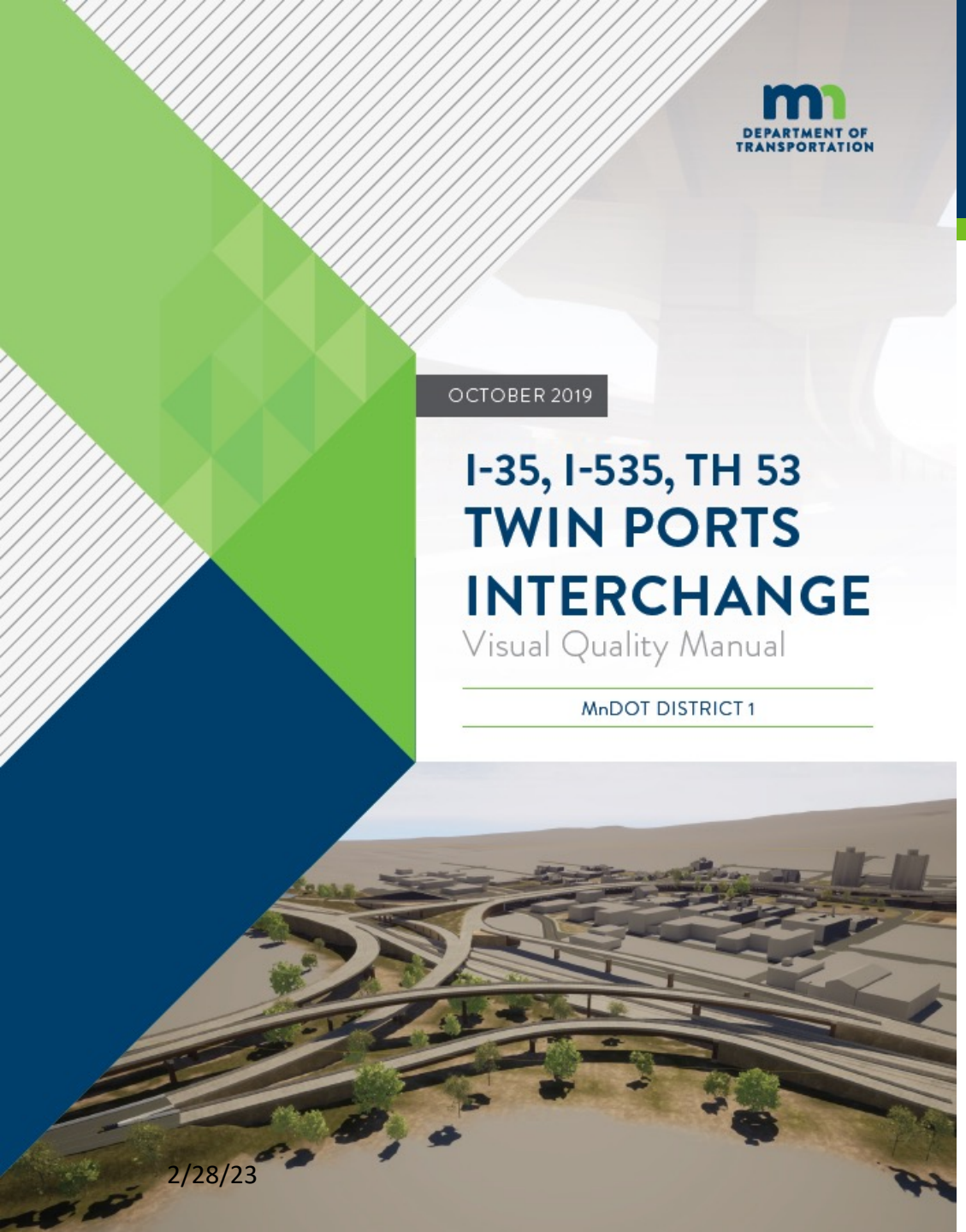
Note: Maximum Standard Permit Vehicles = 2,900 lb./ft.

TPI Project Super Load Design Criteria

- Precast Concrete Beam Structure Types – Design per standard MnDOT Bridge Design Manual
- For Curved and Skewed Steel Girder Structure Types – Include the MnDOT Special S351 single trip rating vehicle as an additional design permit load



SINGLE TRIP - SPECIAL S351 - WEIGHT = 350.9 K



Visual Quality Process

- Project split into segments
- Engagement with multiple stakeholders
- Open houses
- Precedent imagery
- Project textures and colors

Visual Quality – Main Interchange

Visual Quality – Main Interchange

Visualization

As-built

Visual Quality – 27th Avenue

Visualization

As-built

Visual Quality – TH 53

Curved Steel Flyover Bridges

Br.69902:

- I-35 NB ramp to I-535 SB (over BNSF)

Br.69904:

- I-35 SB ramp to I-535 SB (over I-35, I-535 Ramp, BNSF)

Br.69905:

- I-535 NB ramp to I-35 NB (over BNSF)

Curved Steel Flyover Bridges

Br.69902:

- I-35 NB ramp to I-535 SB (over BNSF)

Br.69904:

- I-35 SB ramp to I-535 SB (over I-35, I-535 Ramp, BNSF)

Br.69905:

- I-535 NB ramp to I-35 NB (over BNSF)

Steel Superstructure Design Committee

- Comprised of Lead Designers from each of the three steel flyover bridges
  - Br.69902 – Parsons, Br.69904 – MnDOT, Br.69905 – Michael Baker Intl.
- Monthly meetings during design schedule to coordinate design among teams for consistency in final bridge design plans
- Coordination Items Included:

✓Use of MnDOT Std Details

✓Disc Bearing Std Details

✓Modular Expansion Joint Detailing

✓Cross Frame and Diaphragm Detailing

✓Field Splice Locations

✓Structural Steel Grade / Hybrid Design

✓Girder Painting Limits

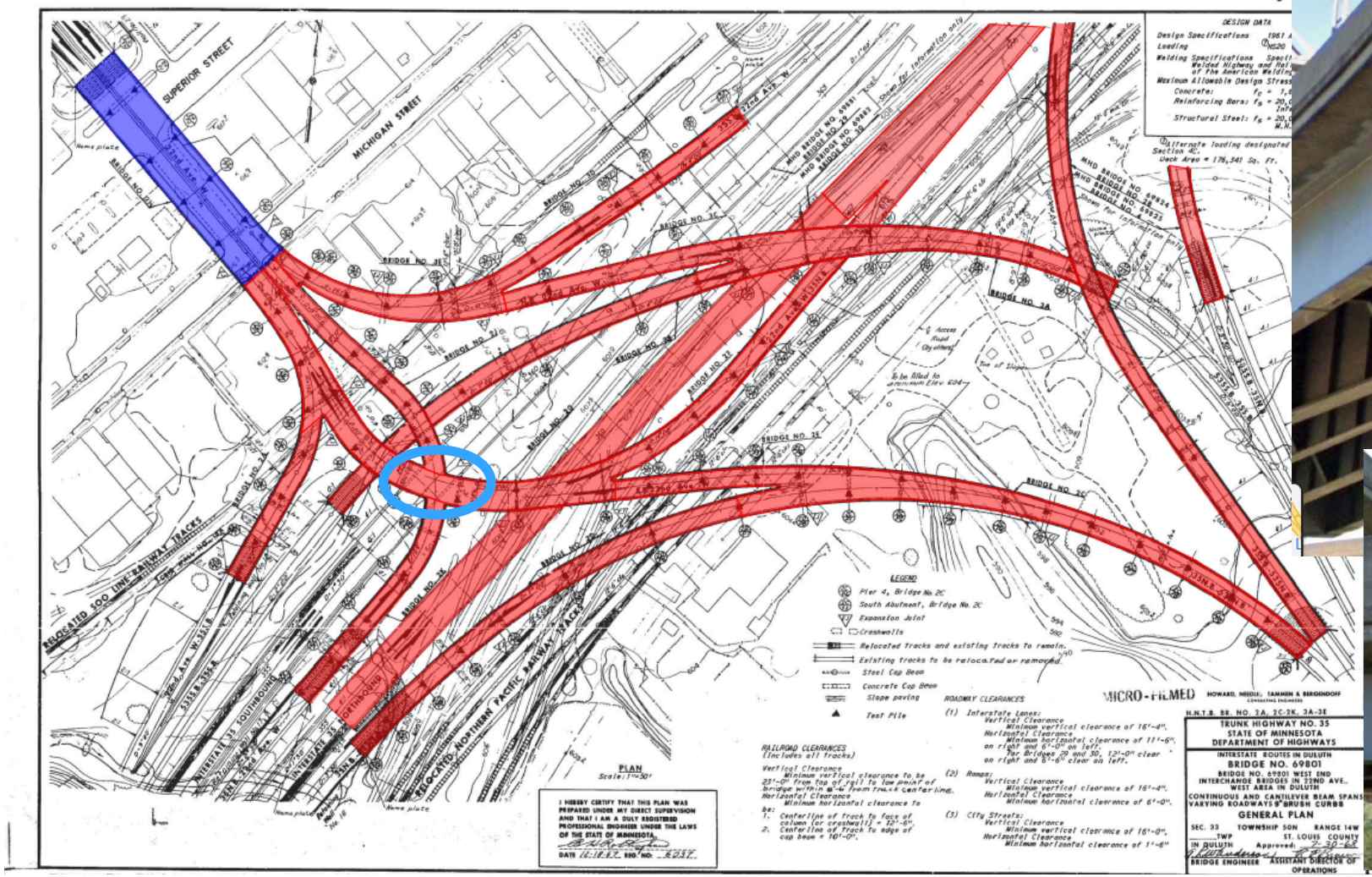
✓Bridge Deck Drain Details

Existing Bridge Removals

- Segment 1 – Main Interchange includes 27 existing bridge removals
  - MOT / Construction Staging required several ‘partial’ bridge removal operations requiring detailed structural analysis and load rating work
  - Steel girder structures, including in-span hinge joints as well as some fracture critical steel piers
- Segment 2 – TH53 bridge removals included full removal of the 2 main reinforced concrete box girder structures and the 4 connected ramp structures
  - In-span hinge joints
- Segment 3 – I-535/Garfield included full superstructure removal of the 4 reconstructed bridges as well as full or partial above ground substructure removal

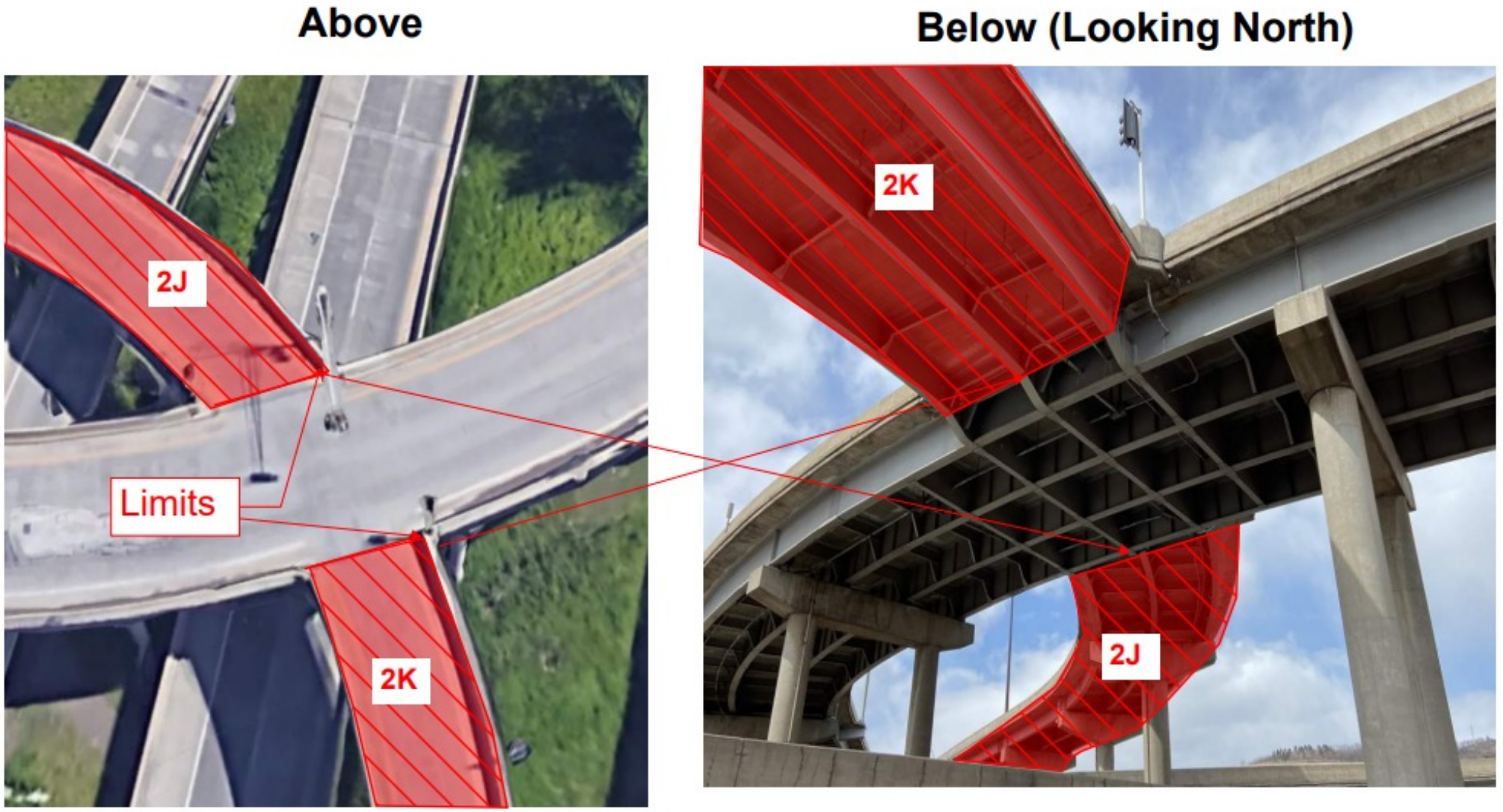
Main Interchange ‘Can of Worms’ Existing Bridge Removals

STAGE 3 REMOVALS WP 1 TPI Main



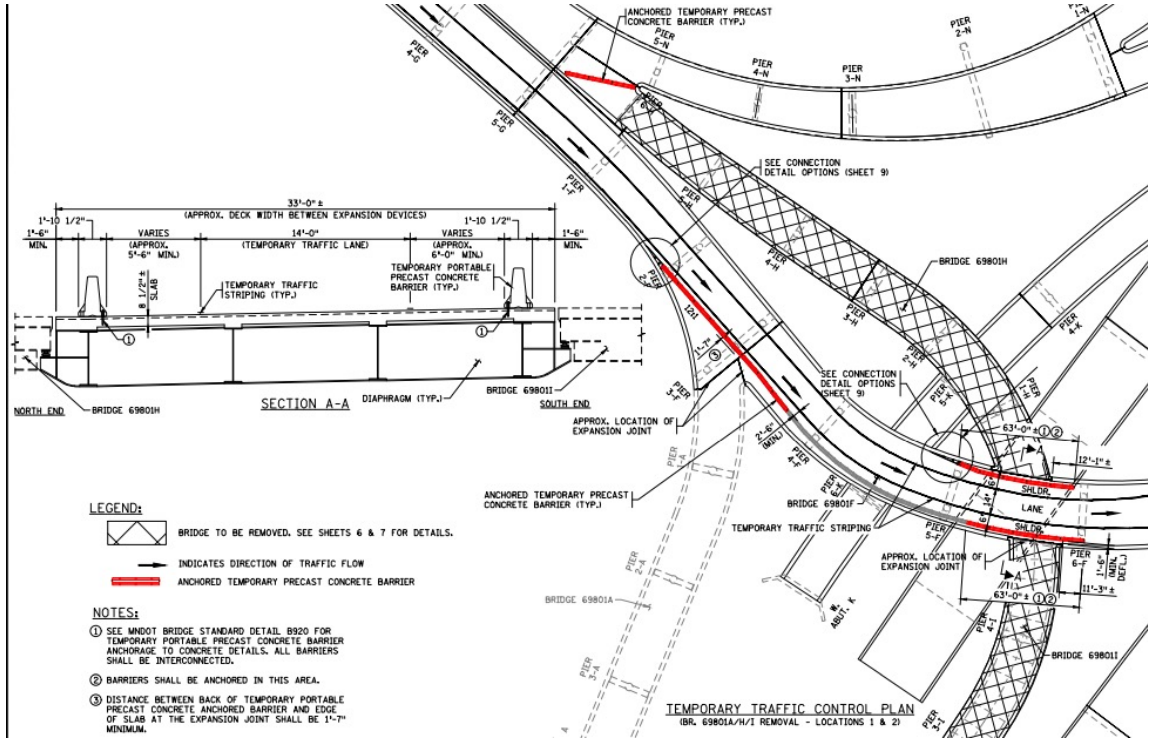
Partial Existing Bridge Removals

Stage 1 "Intersection in the Sky" Removal Limits



Existing Bridge Removals

- AKJV teamed with MnDOT Bridge Design Consultant Partner **LHB** for detailed analysis and load rating work for partial removal of existing bridges where traffic would remain supported - <u>to confirm no degradation of existing load ratings throughout removal sequence</u>
  - Example of the 'Intersection in the sky'; off ramp from I35 NB to TH53 NB



LHB

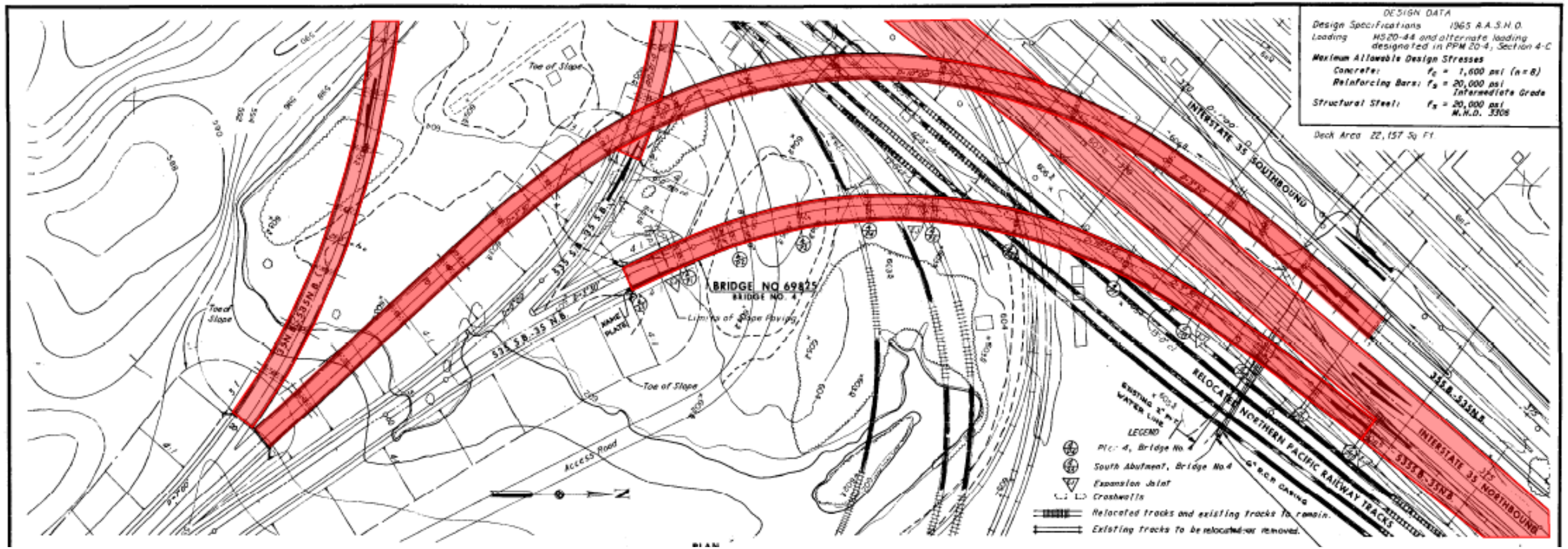
TPI Demolition - Bridge 69801F (Location 1 & 2)
Rating Factor Summary

By: CJM 3-3-21
Checked: KDM 3-11-21

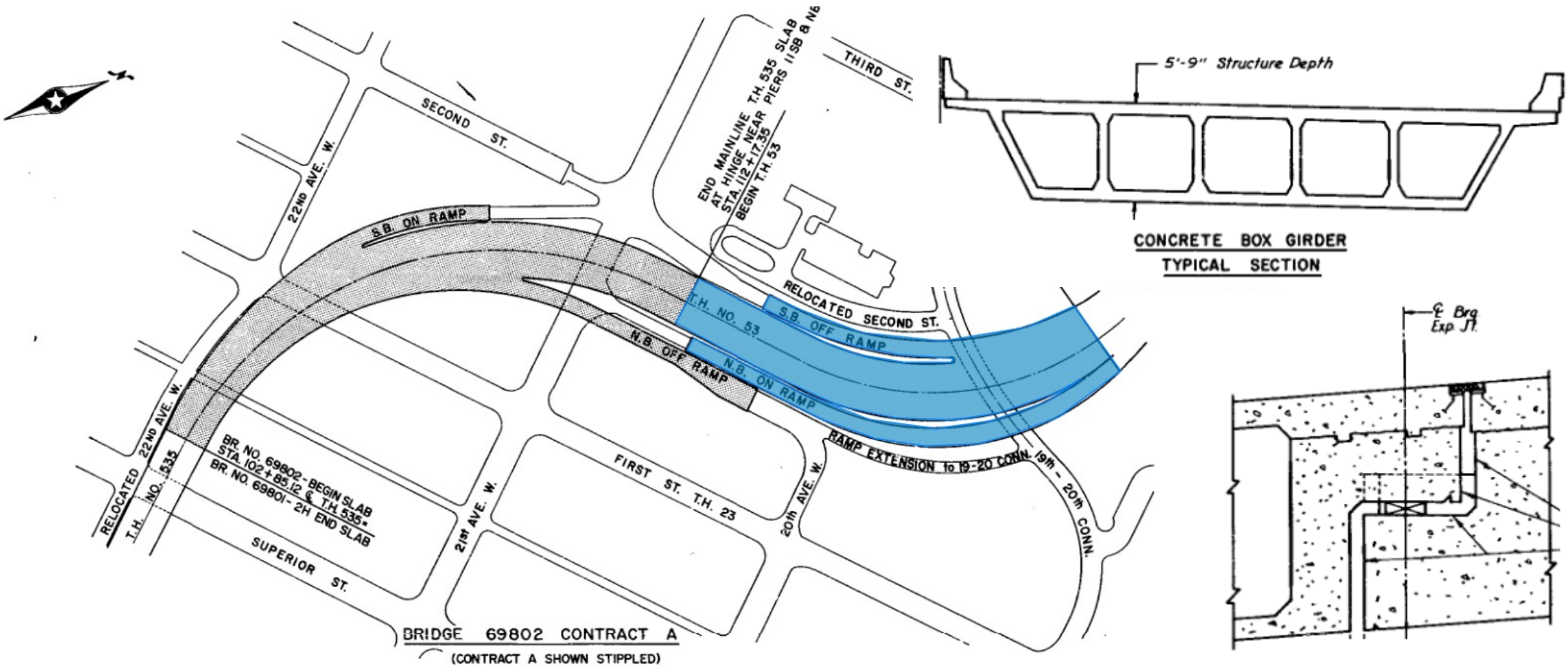
Truck	γ_{LL}	Final Condition							
		Controlling Girder - Location 1				Controlling Girder - Location 2			
		G9 - 3.0	Limit State	# Lanes	MPF	G4 - 8.5	Limit State	# Lanes	MPF
HL-93 Inv	1.75	0.72	Ultimate Moment	2	1.0	0.80	Ultimate Moment	2	1.0
HL-93 Op	1.35	0.93	Ultimate Moment	2	1.0	1.03	Ultimate Moment	2	1.0
Type M3	1.30	2.14	Ultimate Moment	2	1.0	2.16	Ultimate Moment	2	1.0
Type M3S2	1.30	1.82	Ultimate Moment	2	1.0	1.70	Ultimate Moment	2	1.0
Type M3S3	1.30	1.72	Ultimate Moment	2	1.0	1.69	Ultimate Moment	2	1.0
SU4	1.30	1.91	Ultimate Moment	2	1.0	1.91	Ultimate Moment	2	1.0
SU5	1.30	1.69	Ultimate Moment	2	1.0	1.69	Ultimate Moment	2	1.0
SU6	1.30	1.52	Ultimate Moment	2	1.0	1.55	Ultimate Moment	2	1.0
SU7	1.30	1.37	Ultimate Moment	2	1.0	1.43	Ultimate Moment	2	1.0
STD A	1.25	1.26	Ultimate Moment	2	1.0	1.28	Ultimate Moment	2	1.0
STD B	1.25	1.07	Ultimate Moment	2	1.0	1.05	Ultimate Moment	2	1.0
STD C	1.25	0.98	Ultimate Moment	2	1.0	0.95	Ultimate Moment	2	1.0
		No Posting Required				No Posting Required			
		Calculated Permit: A:1, B:1, C:X				Calculated Permit: A:1, B:1, C:X			
		Proposed Permit: A:X, B:X, C:X				Proposed Permit: A:X, B:X, C:X			

Existing Bridge Removals

STAGE 3 REMOVALS WP 1 TPI Main



TH53 Existing Bridge Removals



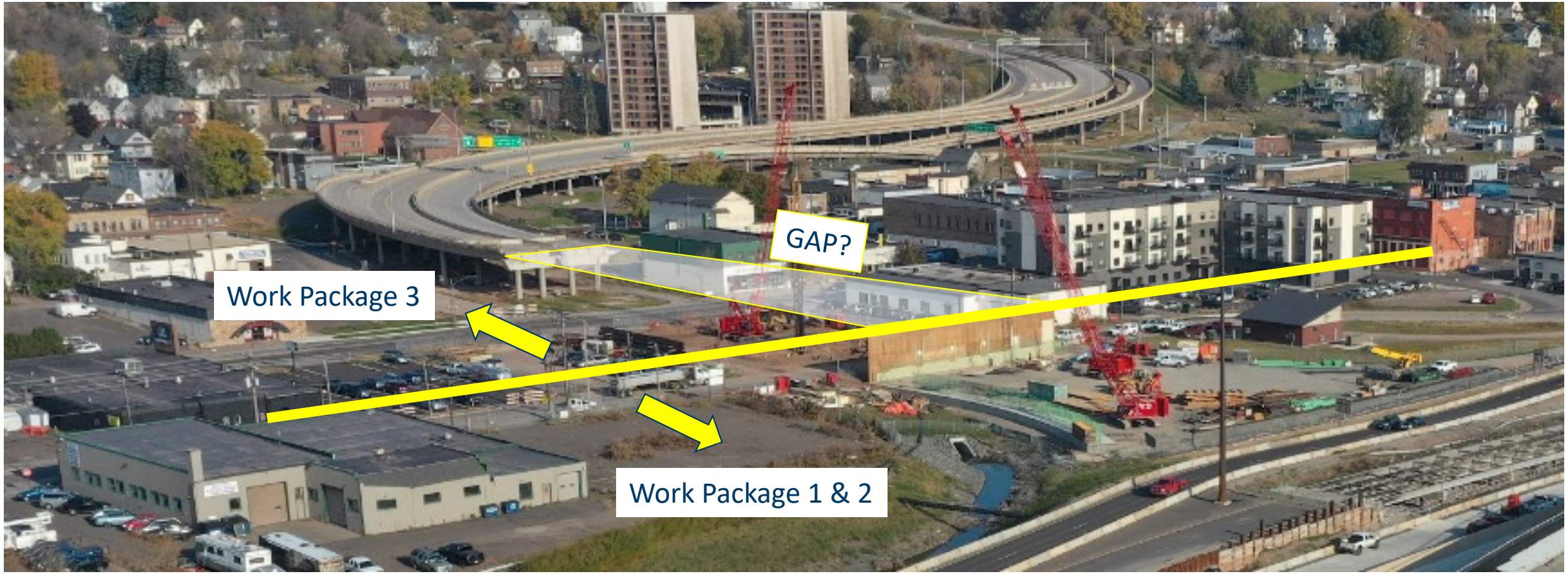
TH53 Existing Bridge Removals

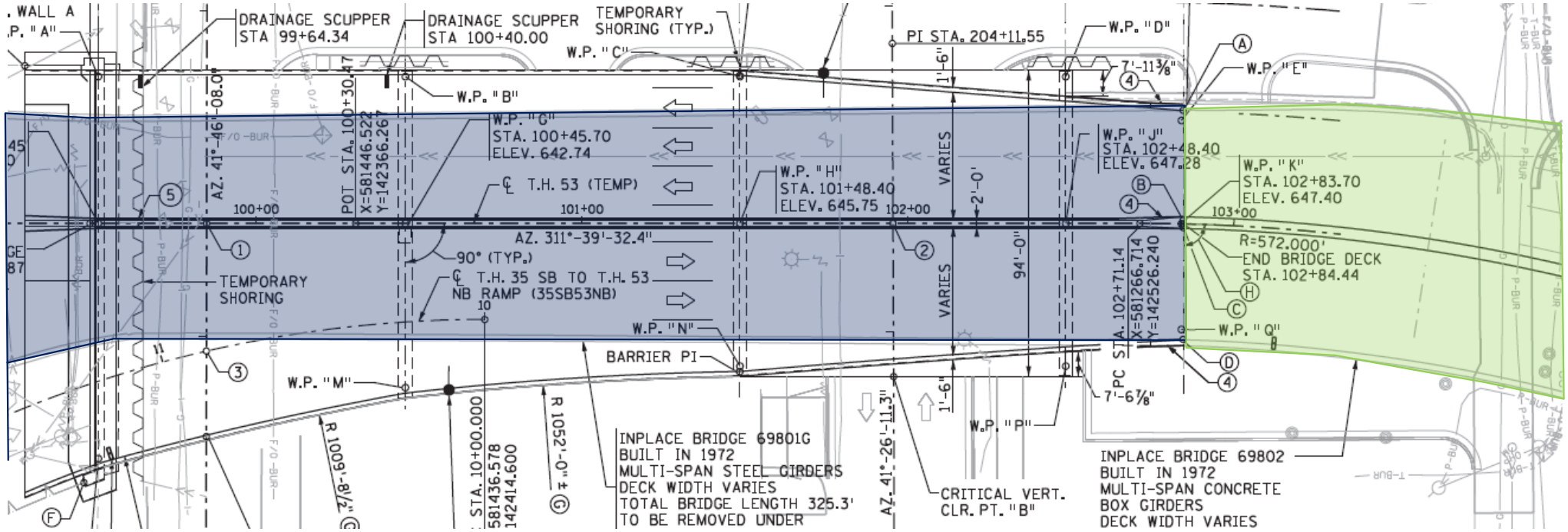
What happens when you are overbudget?

Bridge 69139 Temporary Connector

What happens when you are overbudget?

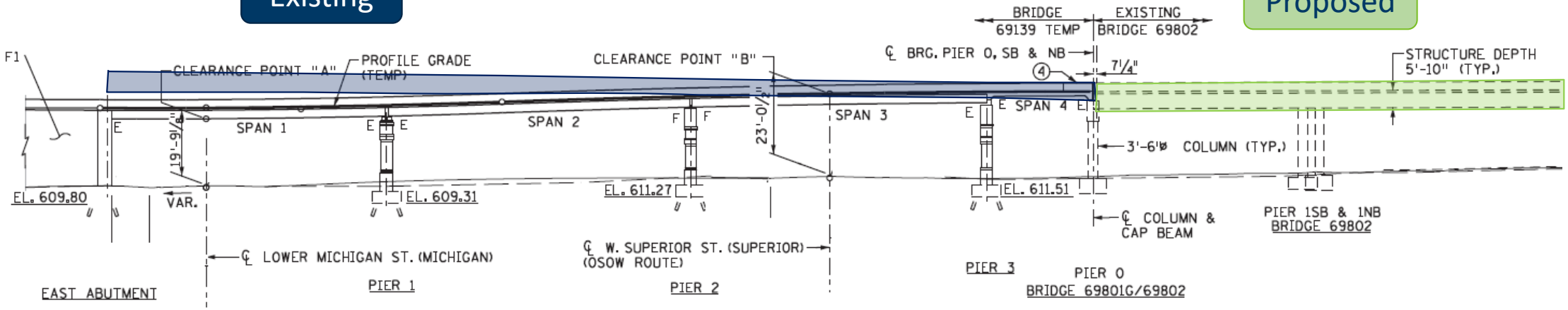
Bridge 69139 Temporary Connector

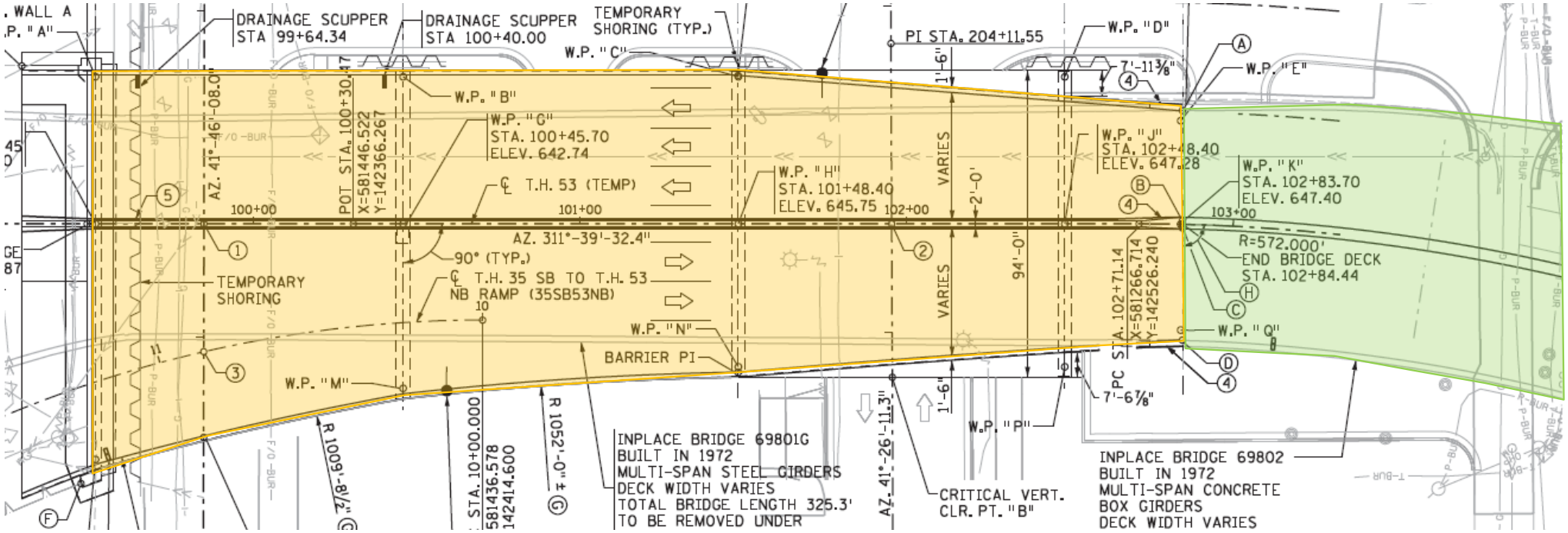




Existing

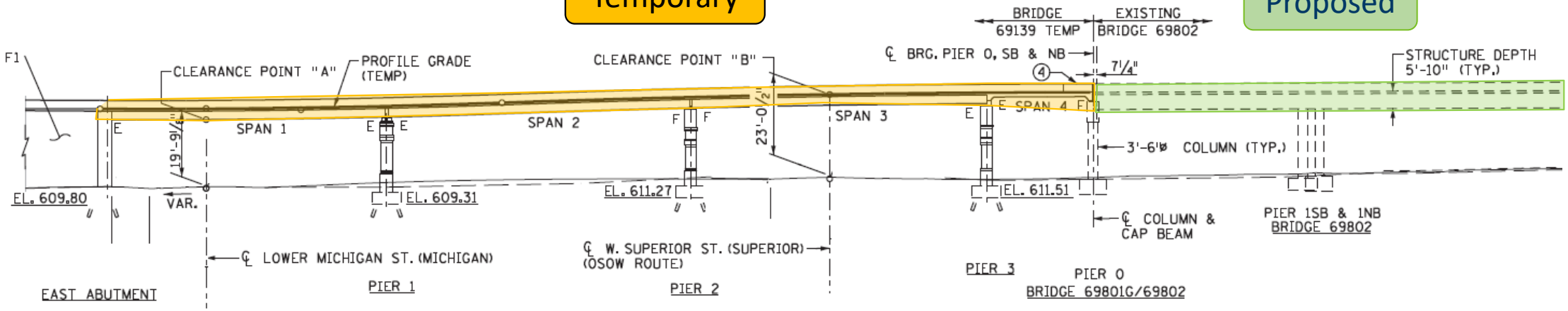
Proposed

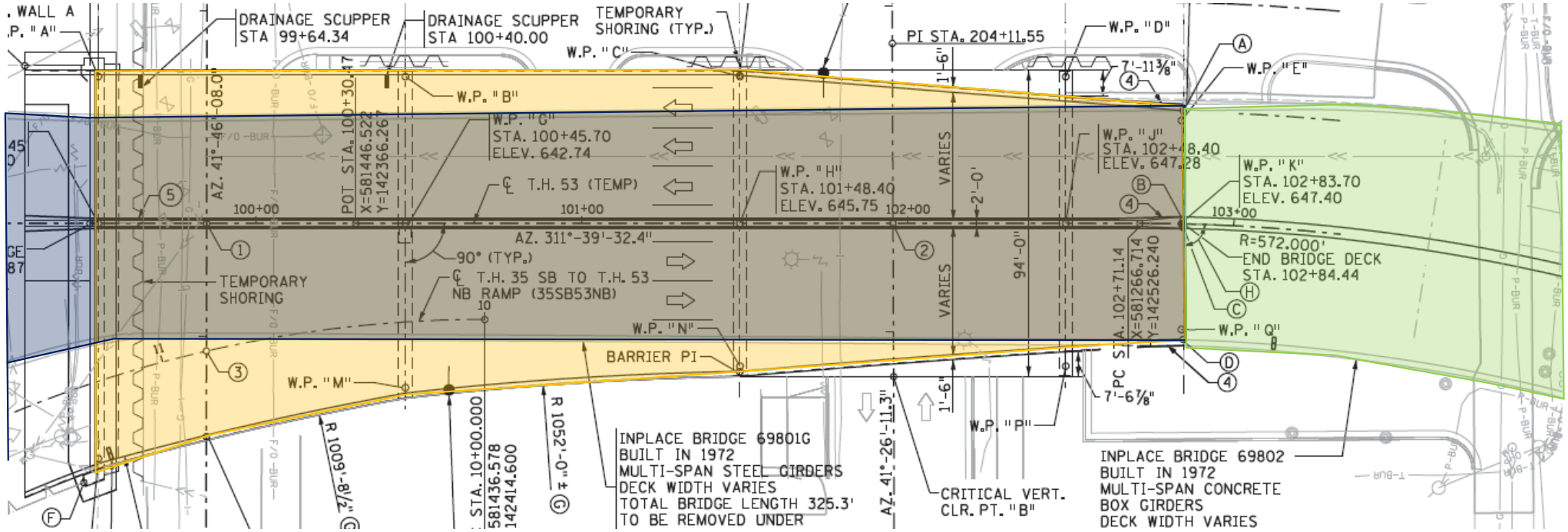




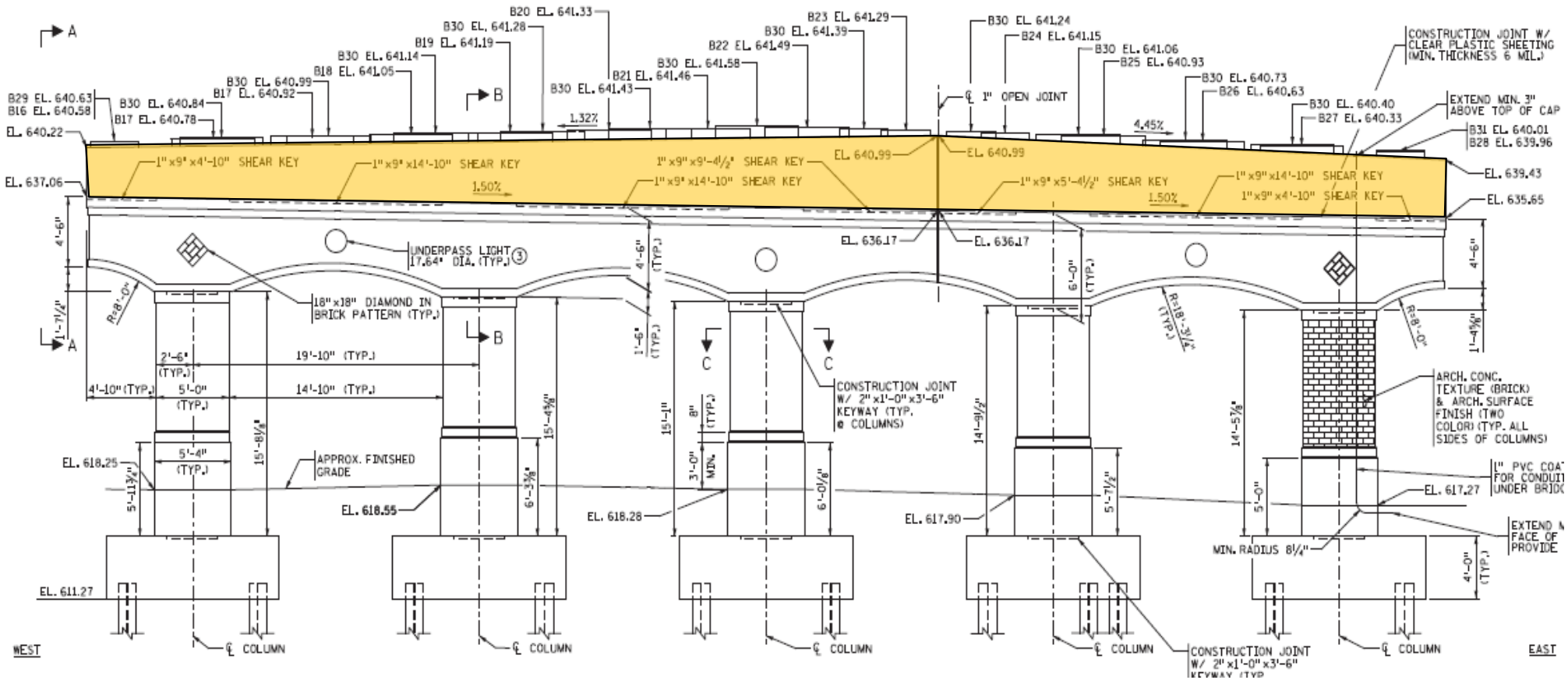
Temporary

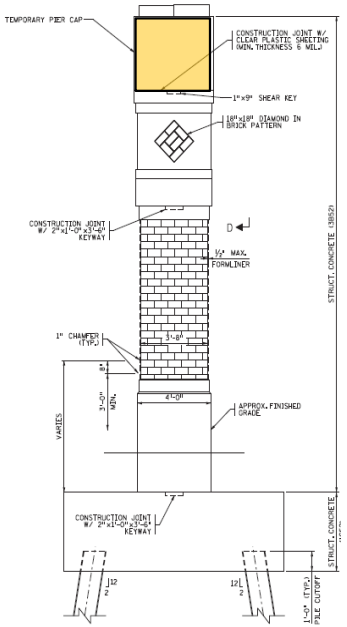
Proposed



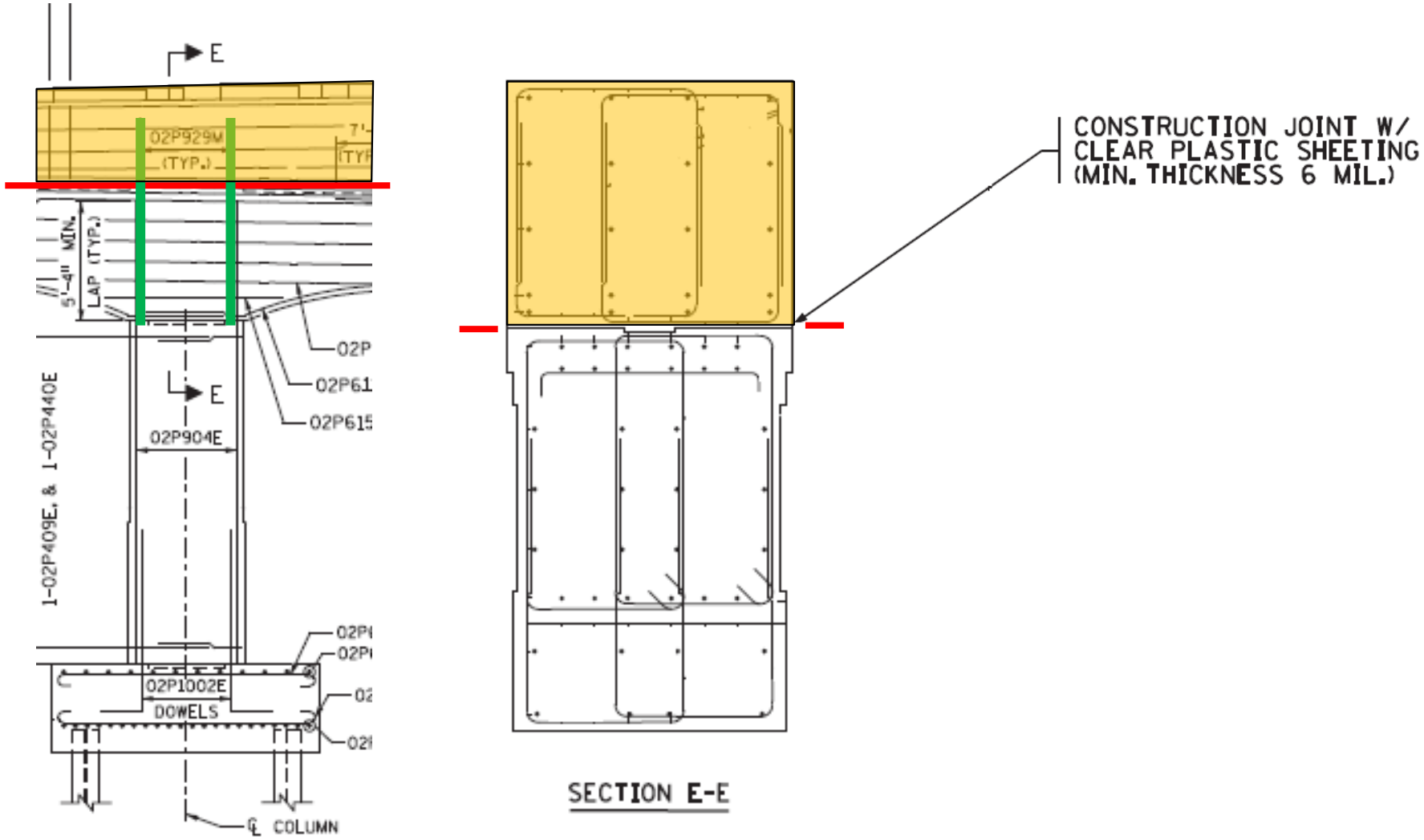

DRAINAGE SCUPPER STA 99+64.34
DRAINAGE SCUPPER STA 100+40.00
TEMPORARY SHORING (TYP.)
W.P. "C"
PI STA. 204+11.55
W.P. "D"
W.P. "E"
W.P. "B"
W.P. "G" STA. 100+45.70 ELEV. 642.74
T.H. 53 (TEMP)
W.P. "H" STA. 101+48.40 ELEV. 645.75
W.P. "J" STA. 102+48.40 ELEV. 647.28
W.P. "K" STA. 102+83.70 ELEV. 647.40
R=572.000' END BRIDGE DECK STA. 102+84.44
AZ. 311°-39'-32.4"
90° (TYP.)
T.H. 35 SB TO T.H. 53 NB RAMP (35SB53NB)
TEMPORARY SHORING
W.P. "N"
W.P. "M"
W.P. "Q"
W.P. "P"
BARRIER PI
INPLACE BRIDGE 69801G BUILT IN 1972 MULTI-SPAN STEEL GIRDERS DECK WIDTH VARIES TOTAL BRIDGE LENGTH 325.3' TO BE REMOVED UNDER
CRITICAL VERT. CLR. PT. "B"
INPLACE BRIDGE 69802 BUILT IN 1972 MULTI-SPAN CONCRETE BOX GIRDERS DECK WIDTH VARIES
Existing
Temporary
Proposed
BRIDGE 69139 TEMP
EXISTING BRIDGE 69802
CLEARANCE POINT "A"
PROFILE GRADE (TEMP)
CLEARANCE POINT "B"
℄ BRG. PIER 0, SB & NB
STRUCTURE DEPTH 5'-10" (TYP.)
SPAN 1
SPAN 2
SPAN 3
SPAN 4
3'-6'ø COLUMN (TYP.)
EL. 609.80
VAR.
EL. 609.31
EL. 611.27
EL. 611.51
℄ LOWER MICHIGAN ST. (MICHIGAN)
℄ W. SUPERIOR ST. (SUPERIOR) (OSOW ROUTE)
℄ COLUMN & CAP BEAM
PIER 1SB & 1NB BRIDGE 69802
EAST ABUTMENT
PIER 1
PIER 2
PIER 3
PIER 0 BRIDGE 69801G/69802

Bridge 69139 Temporary Connector





Bridge 69139 Temporary Connector



Thank you!

Jeff Cavallin | Parsons Transportation Group
Nick Haltvick | Minnesota Department of Transportation

TPI Construction Challenges

Alex Schulz, P.E. | TPI Construction Manager - Kraemer North America

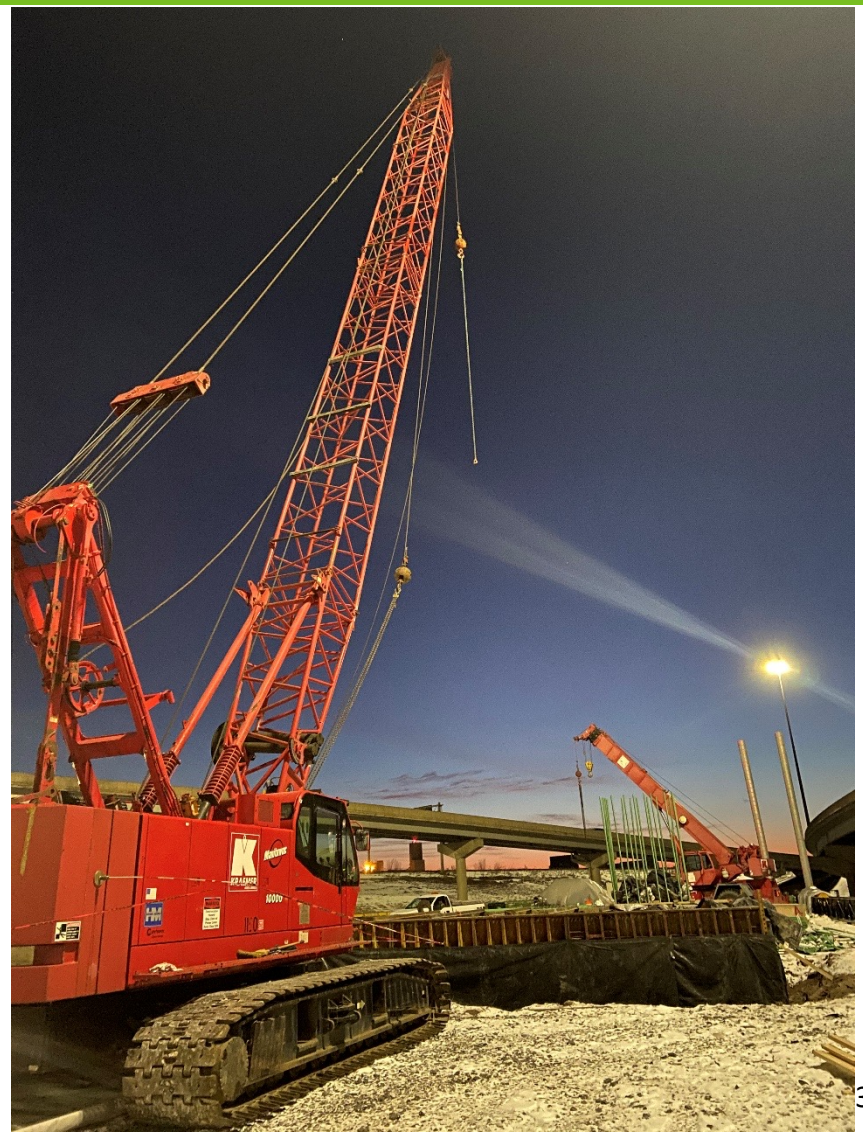
CMGC Procurement

Cost and Schedule Certainty

Constructability Reviews

Long Lead/Critical Submittals

- Temporary Earth Retention Systems
- Bridge Demolition Plans
- Girder Erection Plans
- MnDOT/BNSF Review



Preconstruction Submittals

Temporary Earth Retention Systems

- Traffic/RR Staging
- Foundation Type and Location

Bridge Demolition Plans

- Traffic Staging
- Structural Stability

Girder Erection Plans

- Field Splices
  - Trucking Concerns
- Shoring Tower Locations

Temporary Earth Retention Systems

27th Avenue Bridge

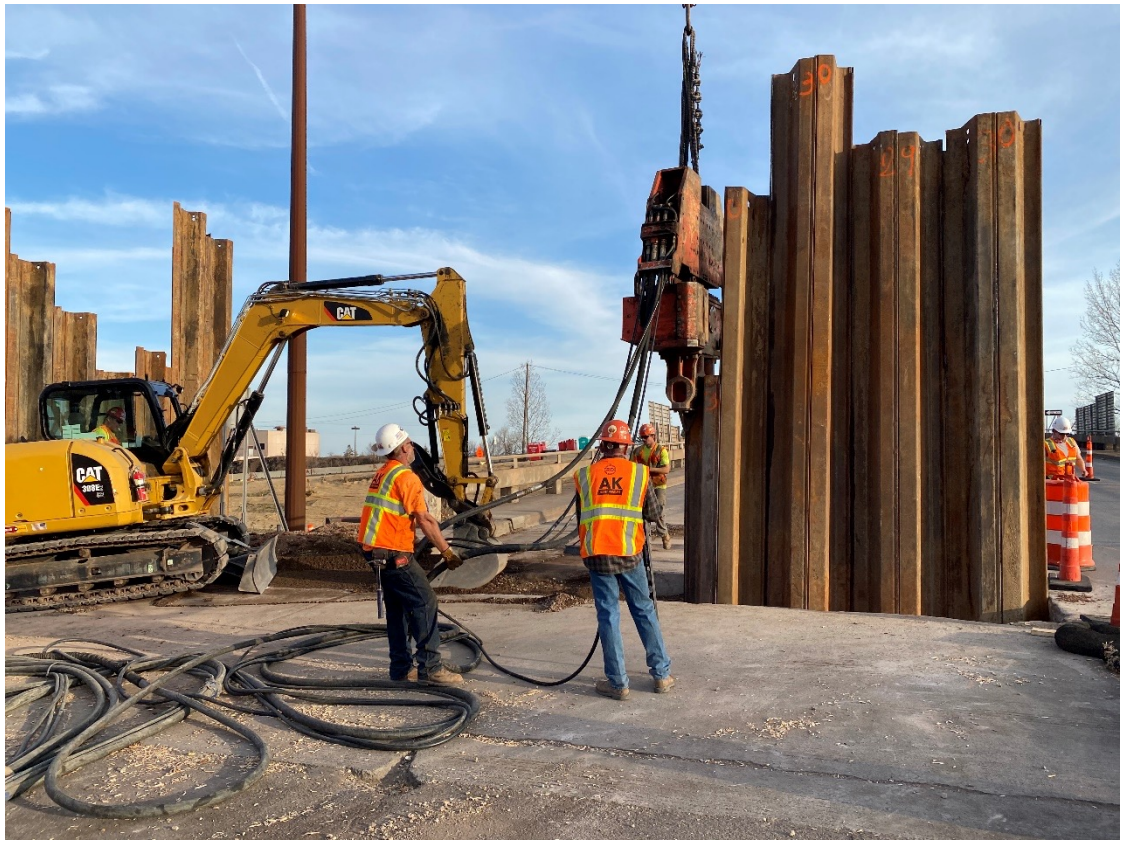
- Maintaining Traffic
  - Installation
  - Bridge Construction

Main Interchange Area

- RR Track Support

Temporary Earth Retention Systems

27th Avenue Bridge - ERS Installation



Temporary Earth Retention Systems

27th Avenue Bridge – Bridge Construction

Temporary Earth Retention Systems

27th Avenue Bridge – Bridge Construction

Temporary Earth Retention Systems – Main Interchange

Bridge Demolitions

27th Avenue Bridge

- Weekend Closure

Main Interchange Area

- Staged Demolition
- Detailed Removal Sequence
- RR and Freeway Constraints
  - Superstructure Removal

Bridge Demolitions

27th Avenue Bridge

Bridge Demolitions

Main Interchange Area

- Staged Demolition
- Detailed Removal Sequence
- RR and Freeway Constraints
    - Superstructure Removal

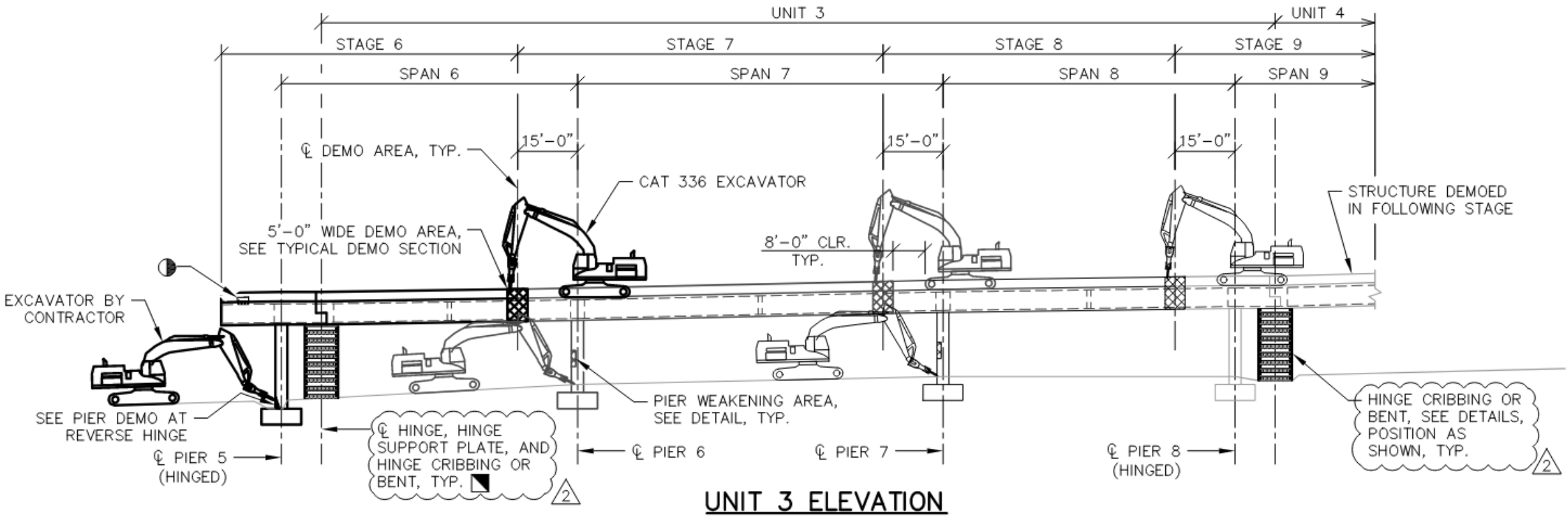
Bridge Demolitions

Bridge Demolitions

TH53 Bridge

- Proximity to public
  - Vibration Monitoring
  - Dust Control
  - Utility Protection
  - Controlled Access
- Unique Structure Type
  - “Non-Linear” Hinges
  - Falsework

TH53 Demolition



UNIT 3 ELEVATION

TH53 Demolition

Miller/Coffee Creek Box Culvert

Miller/Coffee Creek Box Culvert

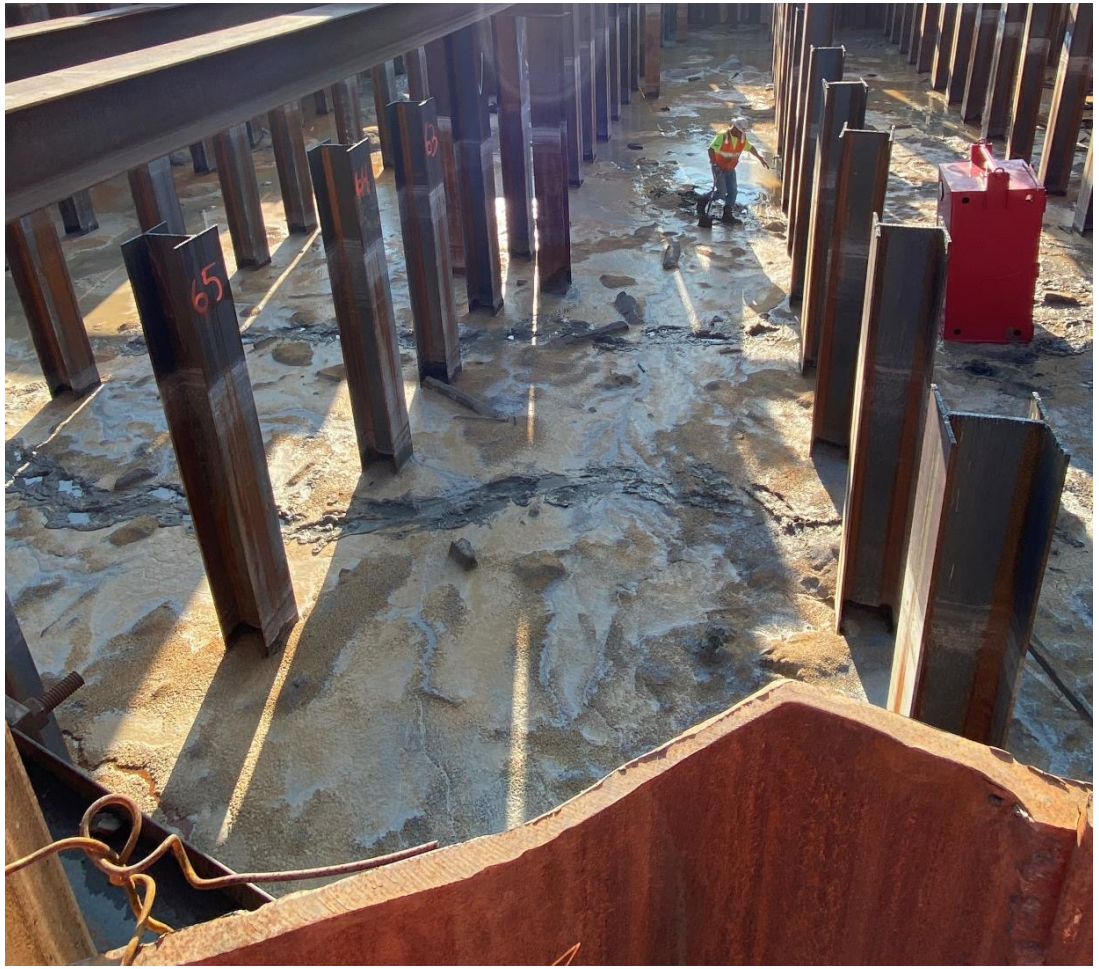
Miller/Coffee Creek Box Culvert

Miller/Coffee Creek Box Culvert Outlet – Support Piling

Miller/Coffee Creek Box Culvert Outlet – Structure Excavation

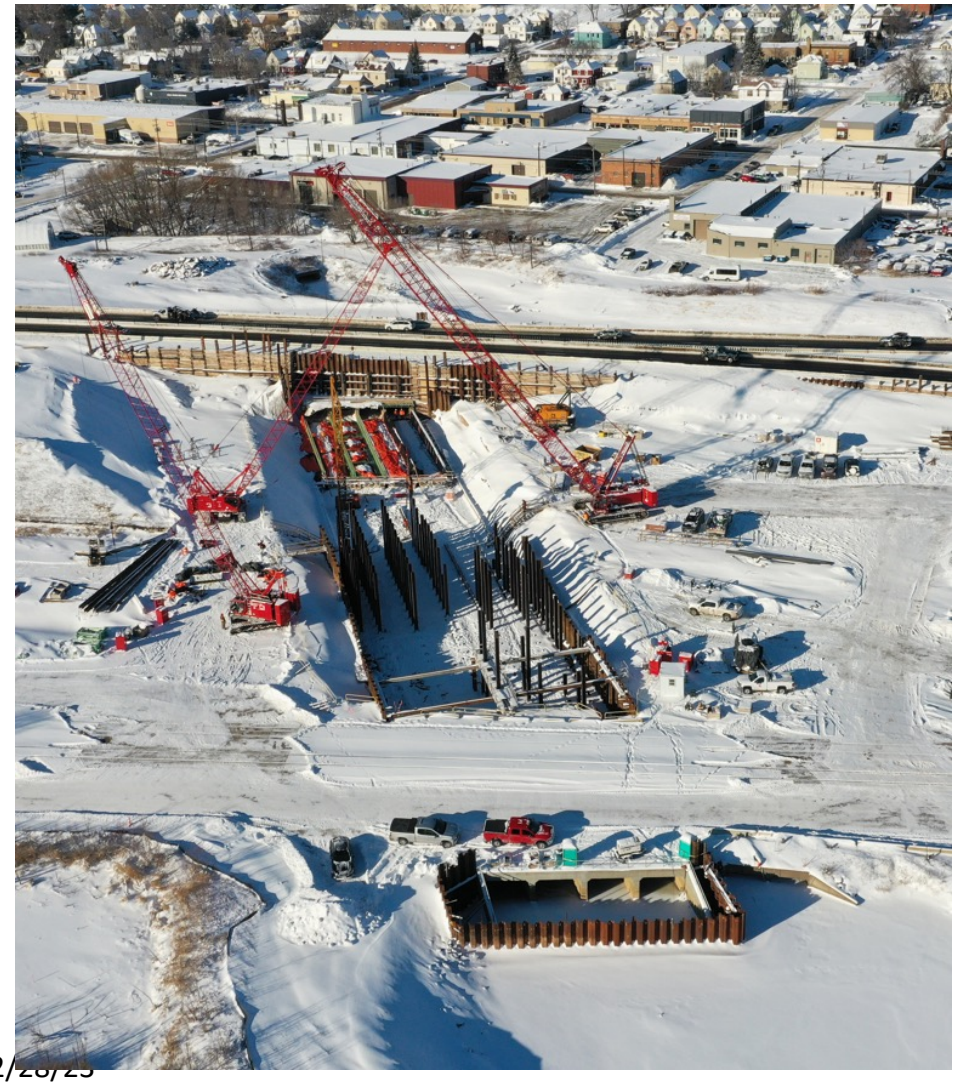
Timber Pile Discovery

Seal Pour

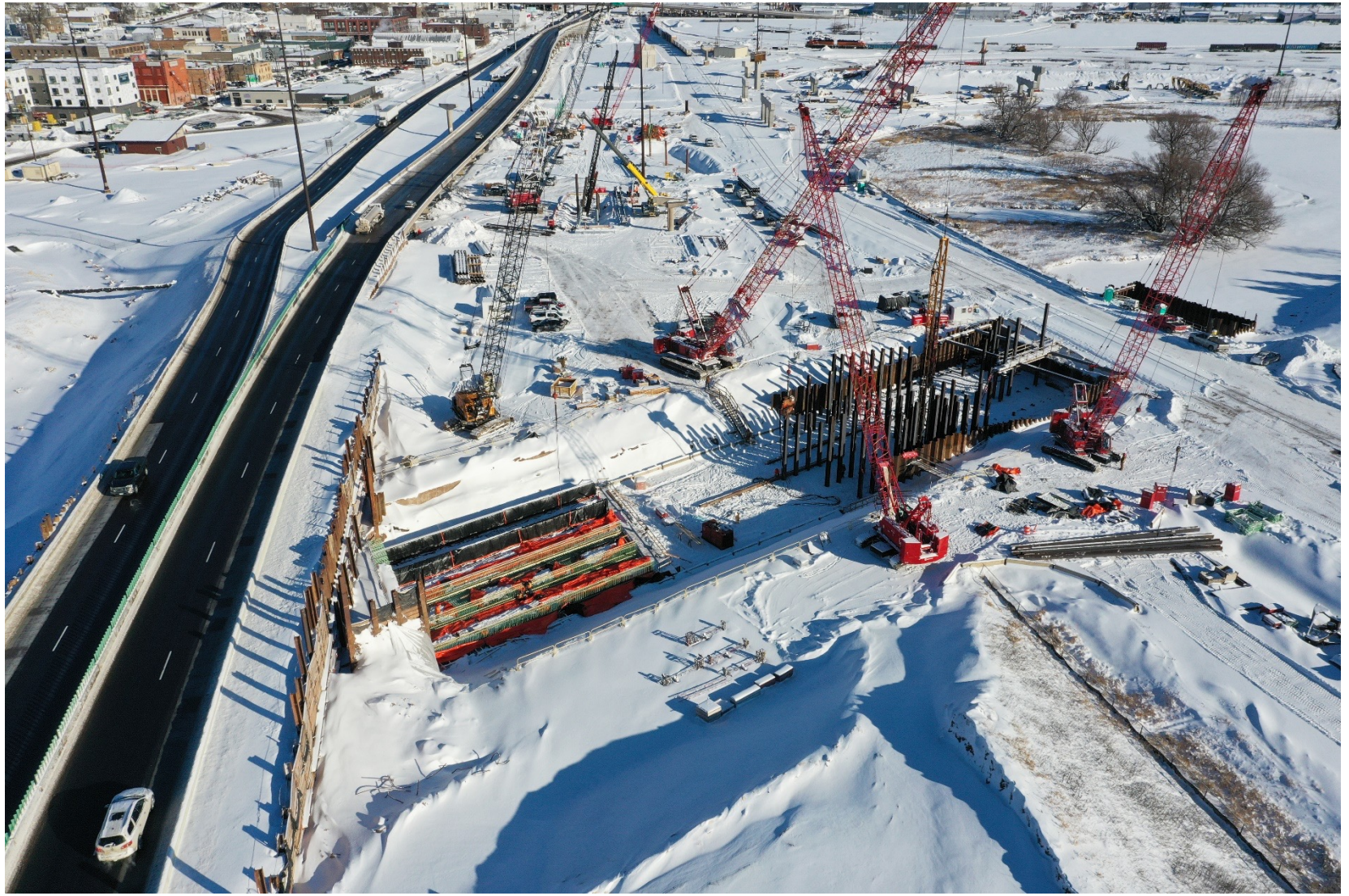


Temporary ERS/Permanent Construction Interface

Miller/Coffee Creek Box Culvert - Middle



Miller/Coffee Creek Box Culvert - Middle



Miller/Coffee Creek Box Culvert – Weir Pours

Miller/Coffee Creek Box Culvert – Final Stripping and Opening

Foundation Piling

- 20”/16” Pipe and 14” H-Piling
  - Overall Quantity
    - 142,000 LF (Proposed WP1/2)
    - Material Handling/Storage
  - Variable soil conditions and bedrock depth
    - Additional Piling (Added HP, test piling)
    - Galvanizing
    - Quantity Management
  - Piling in Water

Cast-In-Place Retaining Walls

- Variable Heights
  - Multiple formwork types needed
- Proximity to RR
  - Schedule impacts
  - Access issues
- Reduced schedule
  - Clashing operations/activities
  - Formwork needs
  - Dissipating cure

Cast-In-Place Retaining Walls

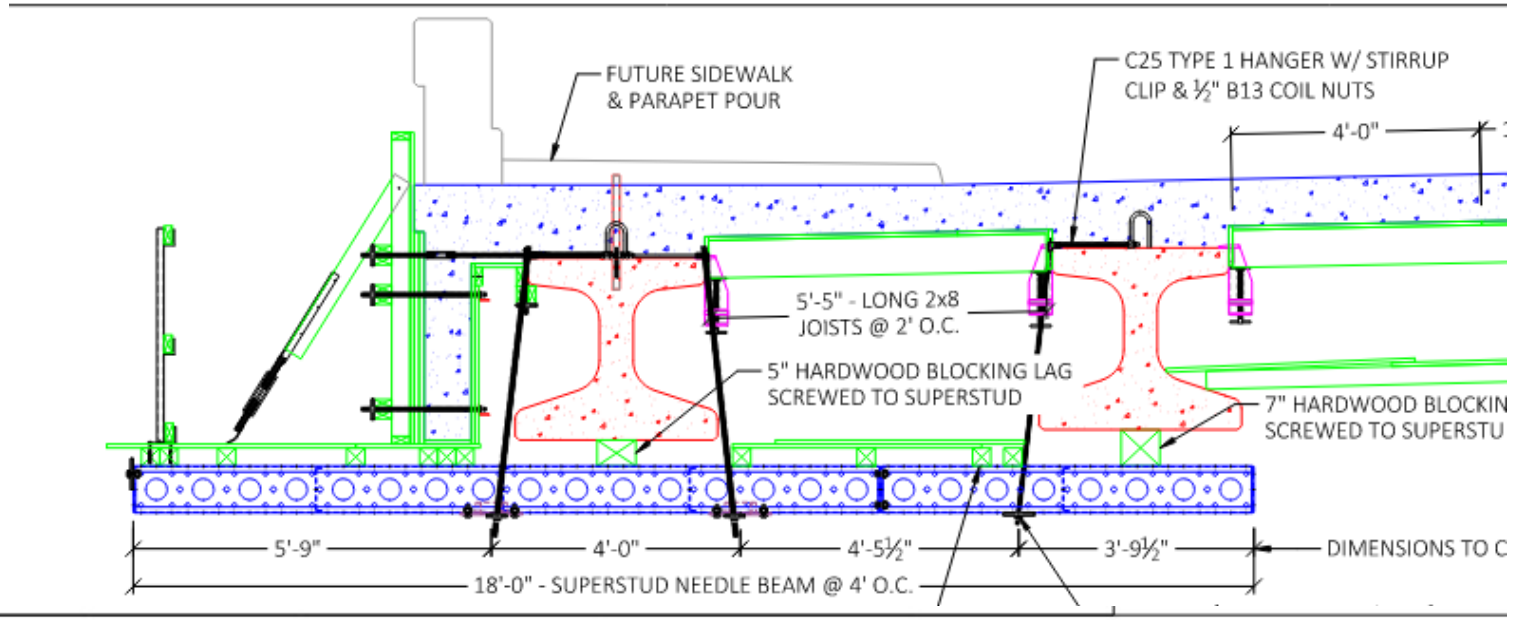
Visual Quality

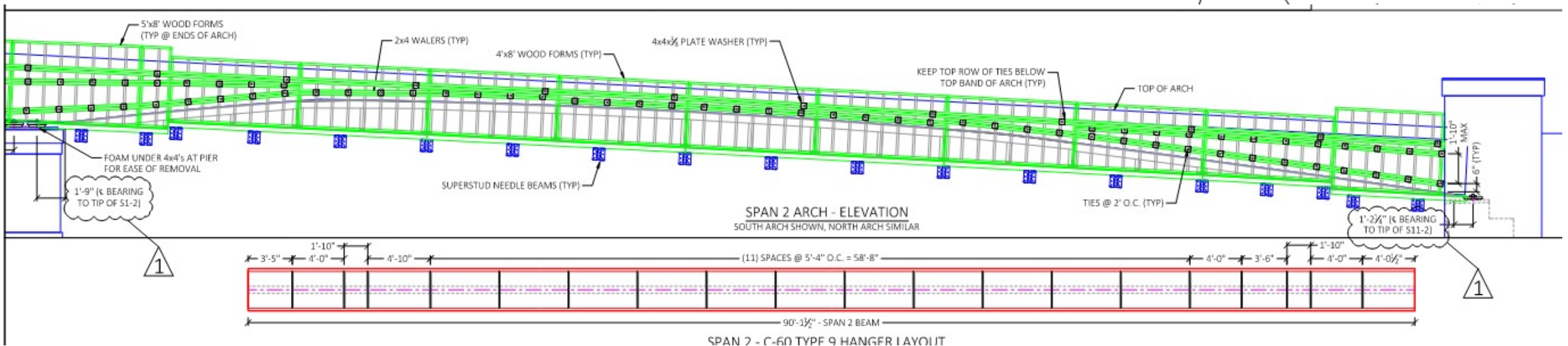
- Arched Facade
  - Bridge 69909
  - Bridge 69906
- Formliner
  - WP2 CIP Retaining Walls
  - WP2 Abutments
  - WP3 Substructure

Visual Quality

Arched Facade

- Bridge 69909





Visual Quality

Visual Quality

Visual Quality – TH53 Substructure

Steel Girder Erection

Submittals

- Precision Bolting System
- Quality Management Plan

Training

- Project Specific training for all project personnel operating the Precision Bolting System

Steel Girder Erection

Delivery Challenges

- Multiple staging/offload locations
- Load Restricted Bridges
- Police Escorts
- Traffic Control

Steel Girder Erection

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Steel Girder Erection

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- Multiple staging/offload locations
- Load restricted bridges
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Steel Girder Erection

Quality Issues/Challenges

- Material Testing Failures
  - Washer galvanizing thickness
  - DTI hardness
- Steel fabrication
  - Undersized/missing splice holes
  - Undersized/missing bearing/flange holes
- Blocking Challenges
- Access Challenges

Steel Girder Erection – Access Challenges

Steel Girder Erection – 69902 Span 1 Misalignment

Winter and Mass Concrete

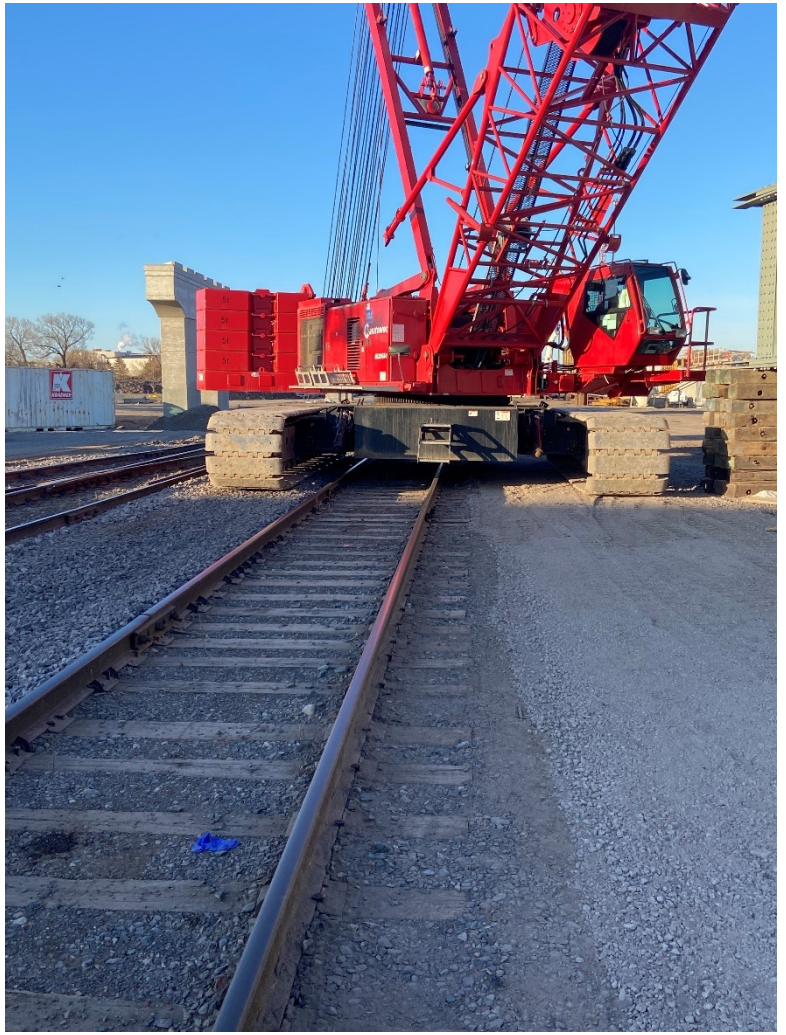
- Temperature Control
  - Command Center software
  - Blankets/Poly
  - Heaters
    - SPCC Plan/Environmental
- Schedule
  - Necessary to pour in winter
  - Extended Cure Time
  - Additional Formwork

Winter Concrete

Railroad Coordination

- Full time BNSF flagger
- Pre-Activity Meetings
- Full/Intermediate Closure Planning
  - Bridge Demolition
  - Girder Setting
  - Deck Forming
  - Deck Pours
  - Stripping
  - Painting

Railroad Coordination



Mainline I35 Closure Planning

Fully or partially close I35 traffic

- Multiples bridges/spans
- Bridge Demolition
- Girder Setting
- Deck Forming
- Deck Pours
- Stripping
- Painting

Thank you again!

Alex Schulz

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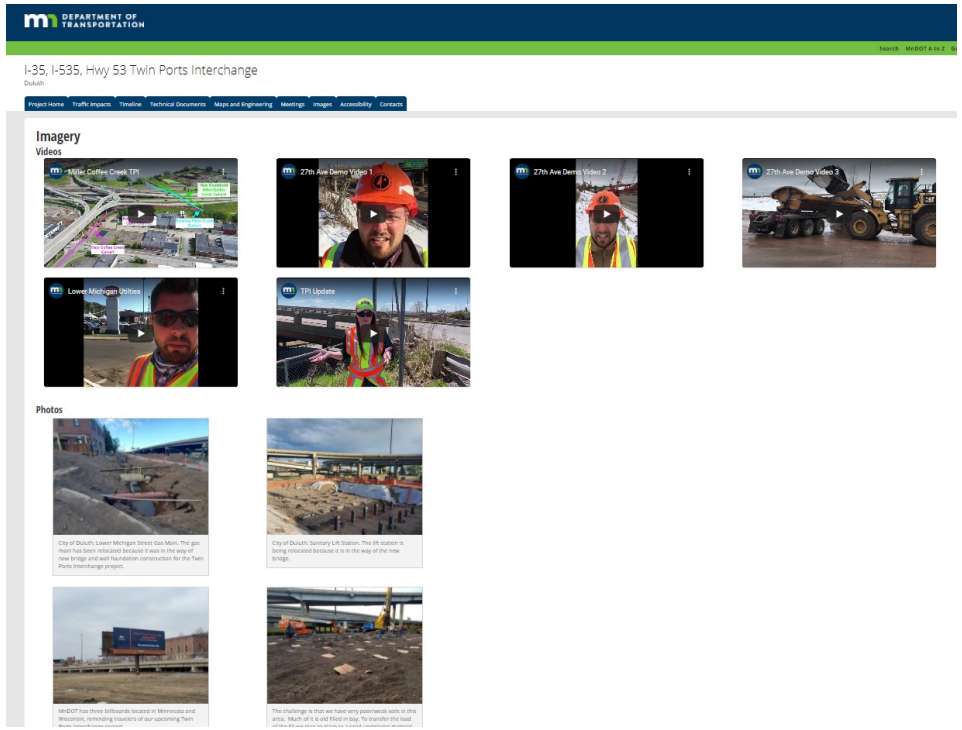
Check out posted photos and videos

- Sign up for updates on the project website: https://www.dot.state.mn.us/d1/projects/twin-ports-interchange/



- There are three project cameras on the project home page

Questions?