



Unique Design Challenges Associated with a 643' Wide Steel Plate Girder Bridge

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PARTNERS FOR WHAT'S POSSIBLE

ABCD Susquehanna Chapter
2016 Technical Conference



22nd Street

18th Street



Vine Expressway



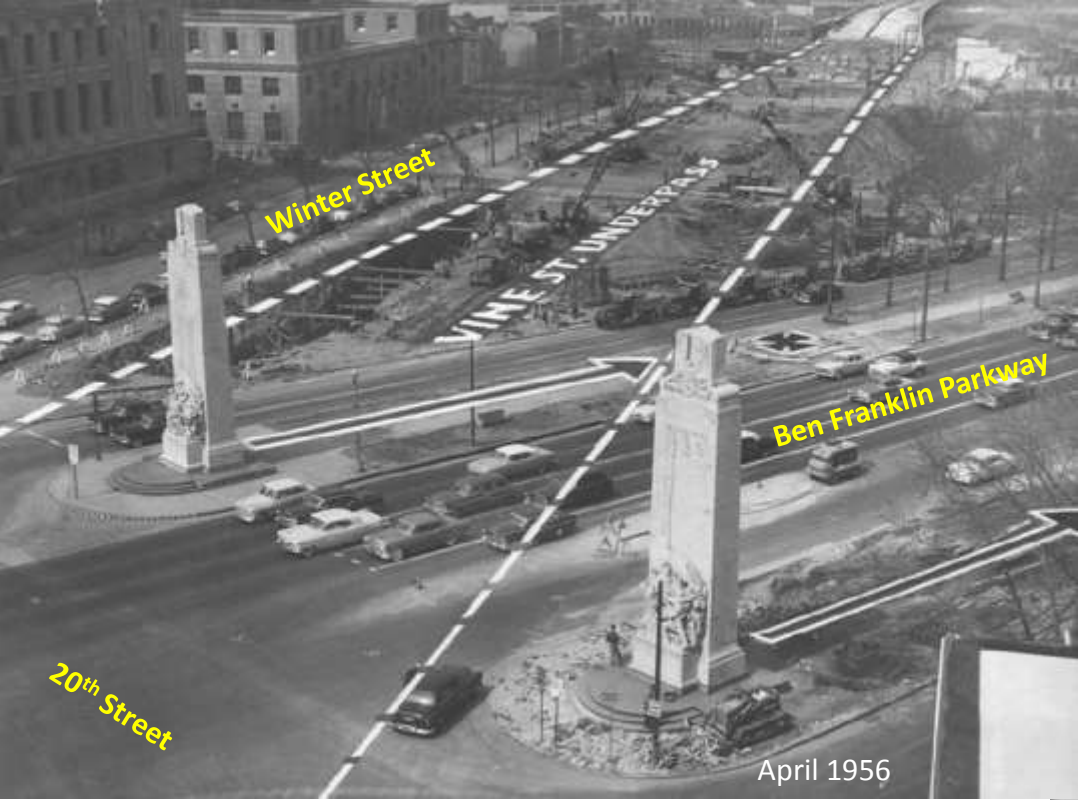
Ben Franklin Bridge



Philadelphia



Vine Expressway



Looking west

**Construction begins in 1956
from 22nd to 18th Streets...**



Looking east

Vine Expressway Overhead Bridge Reconstruction Project

Project Owners:

Pennsylvania Department of Transportation, Engineering District 6-0
City of Philadelphia, Department of Streets
City of Philadelphia, Department of Parks and Recreation

Design Consultant:

Pennoni (Prime Consultant)

Ammann & Whitney *Arrow Land Solutions*
ASC Group *AGES*
Ground Reconsidered (formerly LRSLAstudio)

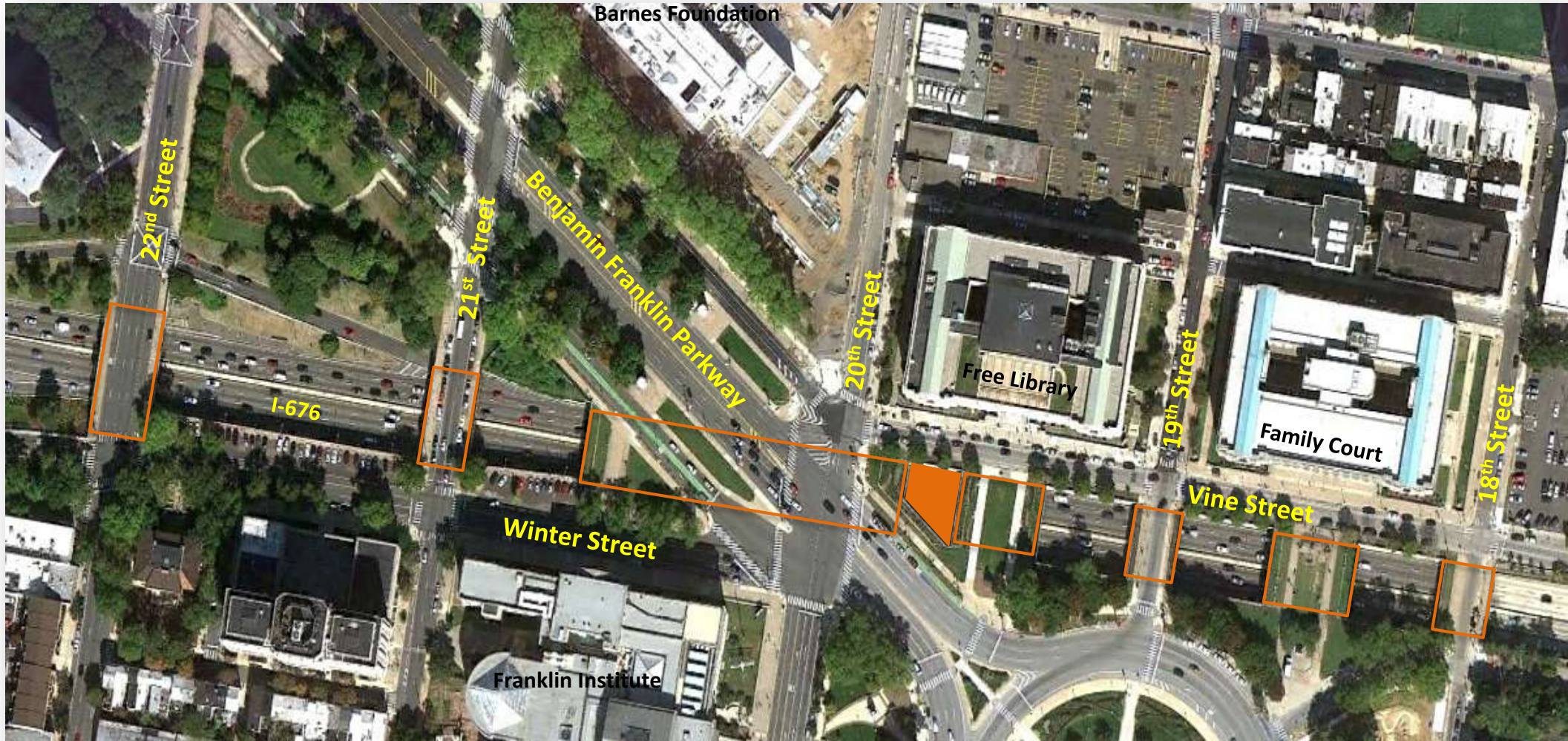
Vector Corrosion
Chilton Engineering
Bergmaier Communications

PennDOT Consultant Project Managers:

AECOM



Original Project Scope...Replace 7 Structurally Deficient Bridge Superstructures



Original Project Scope...Replace 7 Structurally Deficient Bridge Superstructures



Family Court Bridge



BFP/20th Street Bridge



21st Street Bridge

Existing Bridge Type:
**Two-span, non-composite prestressed
concrete adjacent box beam bridges**

Final Design – NTP, August 2013 *(Preliminary Engineering April 2008 to June 2013)*

Major Engineering Challenges:

- ◆ *Accelerated final design schedule, Sept 2014 P,S&E, Oct 2014 Advertisement, Dec 2014 Letting*
- ◆ *Public outreach (40+ stakeholders), project scope expands*
- ◆ *World Meeting of Families, final plans revised (July 2014) for Papal Mass on the Parkway*
- ◆ *Bridge superstructure replacements over an interstate highway*
- ◆ *Utility coordination, PECO, PGW, Verizon, AT&T, PWD, Veolia Steam, PSD*
- ◆ *Art preservation - sculpture protection & relocation*
- ◆ *Maintenance & protection of expressway and local street traffic during construction*
- ◆ *Winter Street/Parkway/20th Street intersection safety improvements and extensive architectural treatments & landscaping*

Engineering Challenge – Public Outreach

Agencies

Center City District
Fairmount Park Commission
Parkway Council Foundation
Delaware Valley Regional Planning Commission
Central Philadelphia Development Corporation
The Pennsylvania Horticultural Society
SEPTA

Neighborhood/Community Groups

Individual Residents
Logan Square Neighborhood Association
Northern Liberties Neighborhood Association
Plan Philly
Fairmount Community Development Corporation
Fairmount Civic Association

Institutional Neighbors

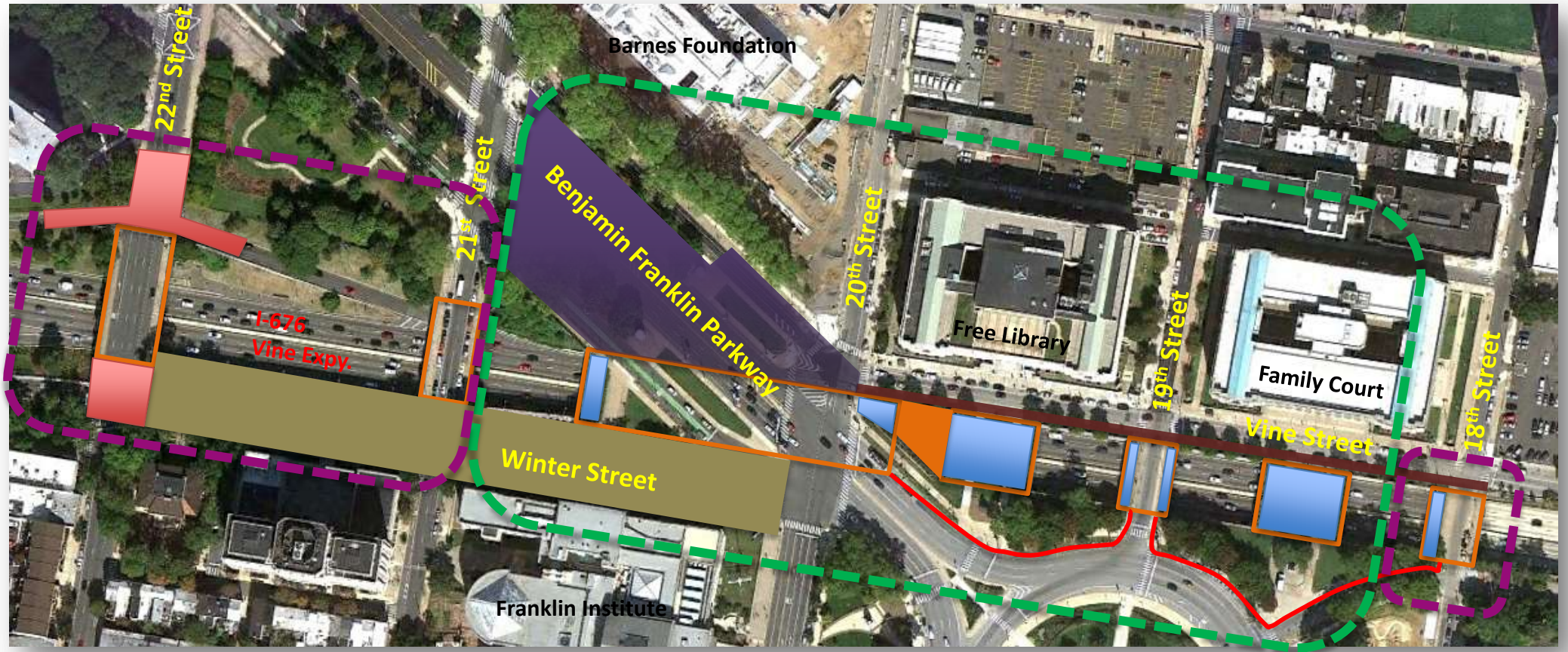
The Franklin Institute
The Boy Scouts of America
The Free Library of Philadelphia
Moore College of Art and Design
The Academy of Natural Sciences
The Please Touch Museum
The Cathedral of Ss. Peter and Paul
The Philadelphia Museum of Art
The Four Seasons Hotel
The Barnes Foundation
Parkway Council Foundation



City Agencies/Departments

Philadelphia Streets Department
Philadelphia Police / Fire / Emergency Services
Family Court (located at 18th/Vine)
Juvenile Detention Facility (located at 20th/Parkway)
Office of the Community Representative (produces Parkway events)
Philadelphia City Planning Commission
Philadelphia Art Commission
City Transportation Office
Managing Director's Office
Philadelphia Department of Parks & Recreation

Engineering Challenge – Project Scope Expands



Replace 7 Structurally Deficient Bridge Superstructures

Reconstruction 2000 Block of Parkway, Vine Street Sidewalk Construction,
Logan Circle Sidewalk Reconstruction, Extensive Landscape Improvements,

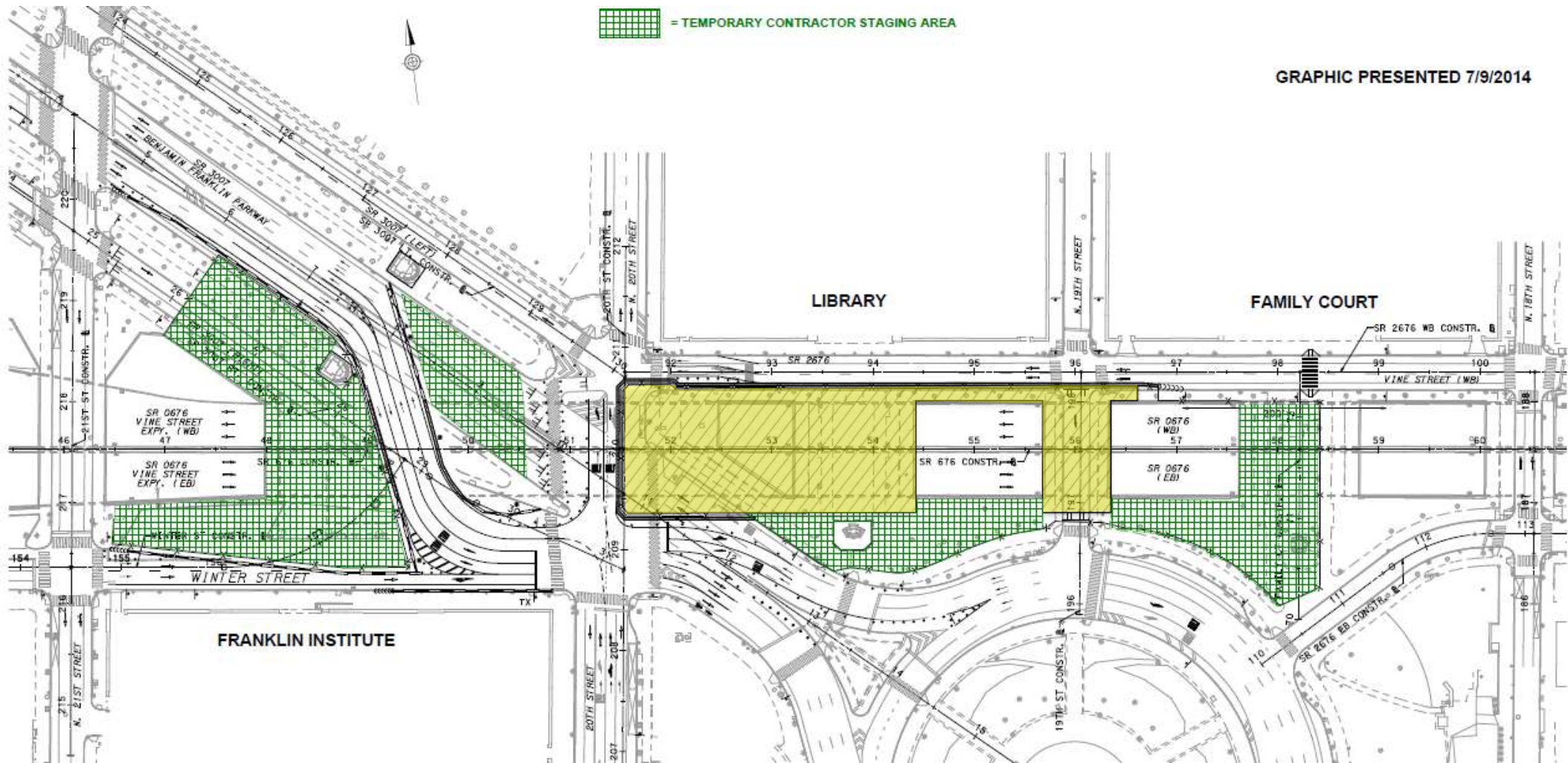
Winter Street Realignment & Improvements, 22nd Street Roadway, Ramp & Signals

Construction Stage 1 – Jan 2015 to July 2017 (Buckley & Company \$65.4 million)

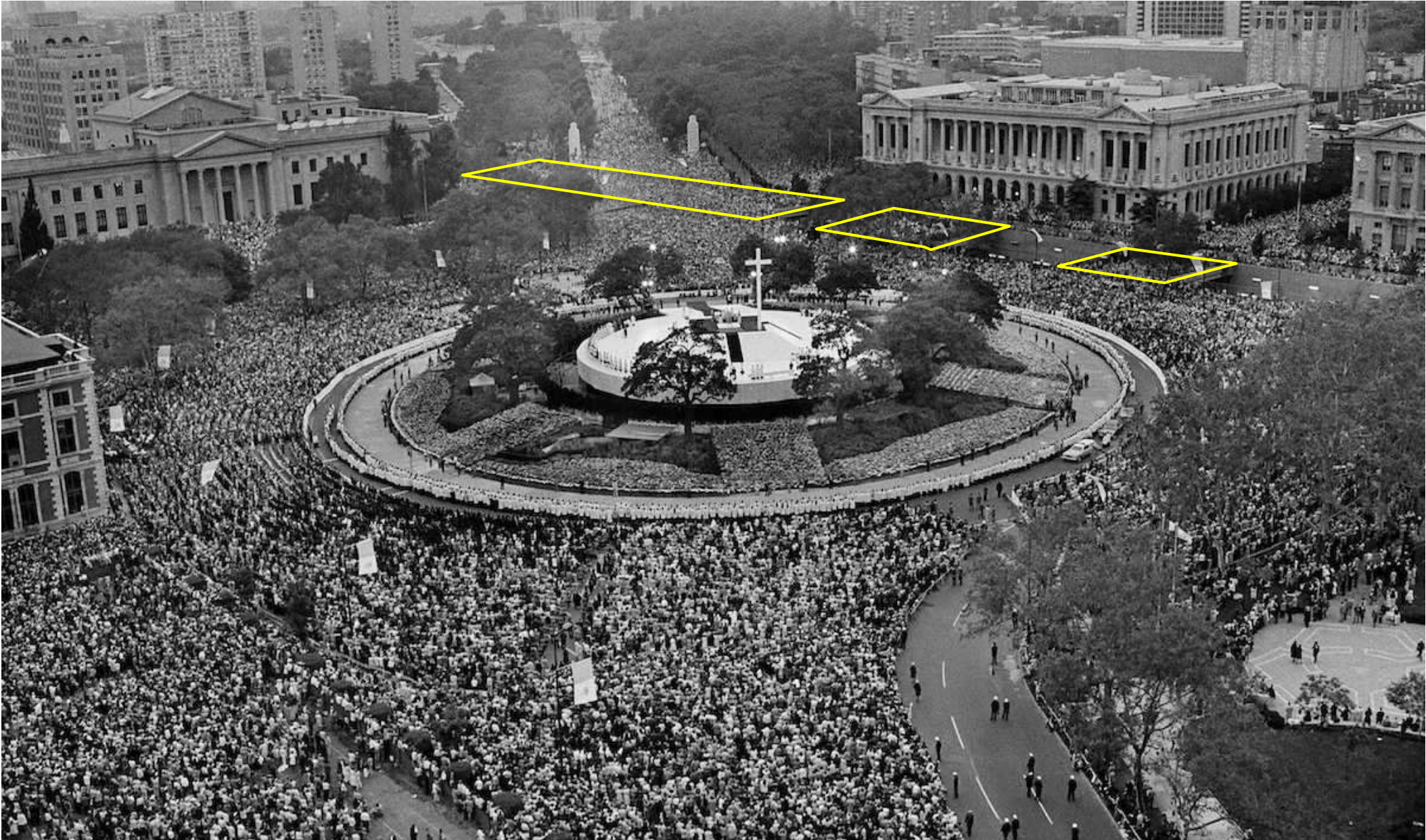
Construction Stage 2 – July 2017 to Nov 2019

Engineering Challenge - World Meeting of Families & Papal Visit

Stage 1 – Phase 2 & 3 Construction Plan Presented to City / WMOF Task Force (July 2014)



Papal Mass on the Parkway 1979 (Pope John Paul II)



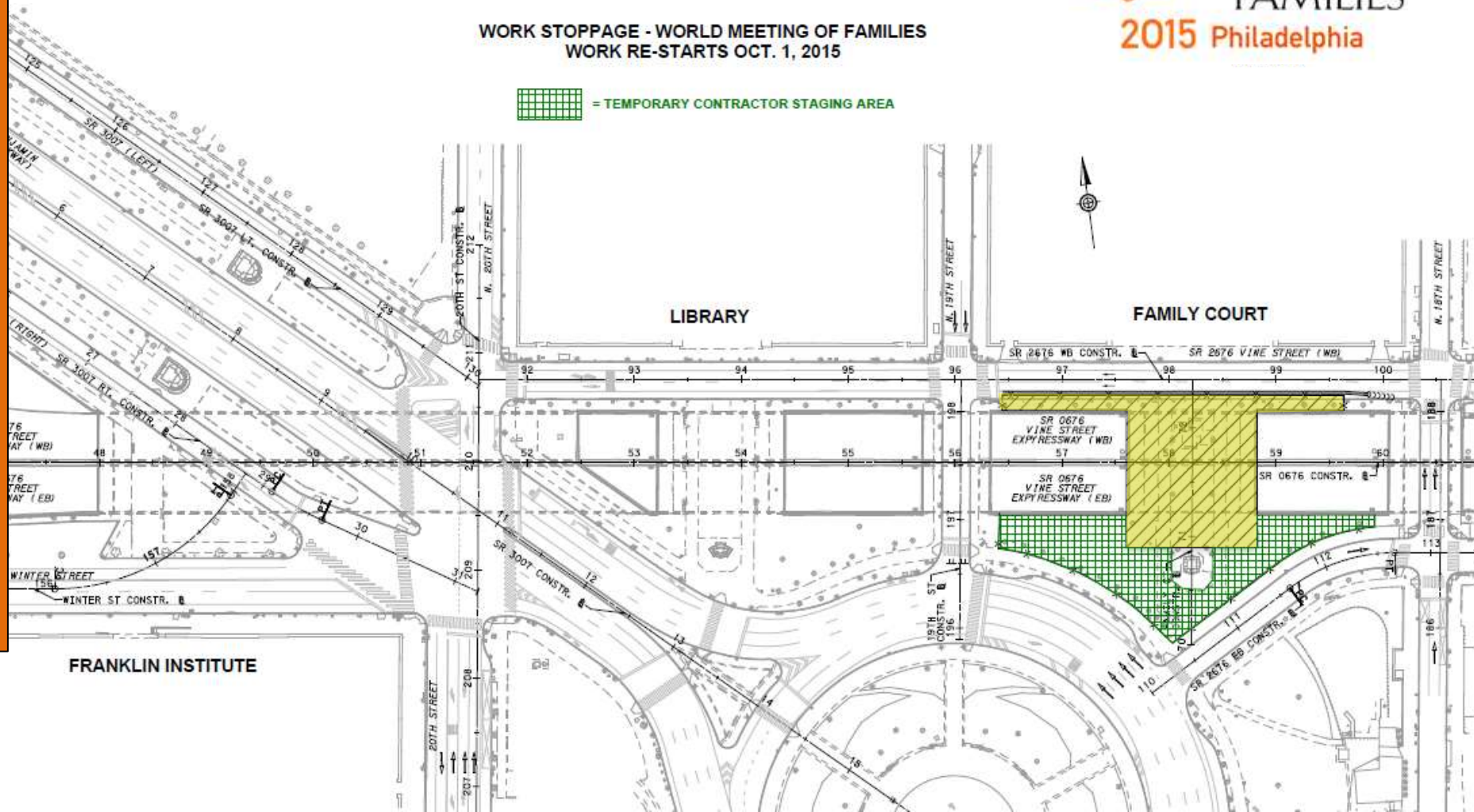
Engineering Challenge - World Meeting of Families & Papal Visit

Construction Footprint for WMOF (September 2015)



Special Provisions for WMOF

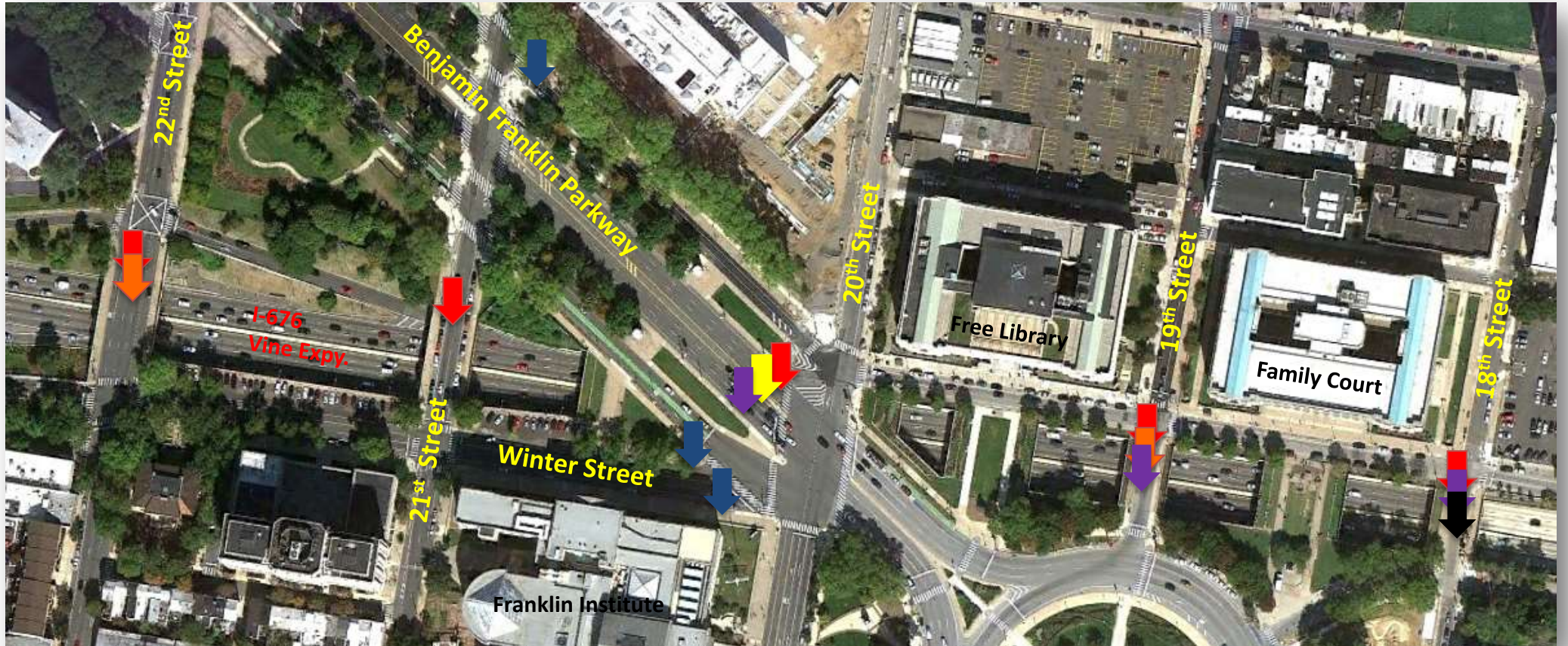
- e00300 Restricted Use of Temporary Construction Easements and Staging Areas until October 1, 2015
- e00200 Coordination with Law Enforcement Agencies During Construction
- Item 9624-0014 Security Fence Screening
- Item 9000-0180 Demobilization for the World Meeting of Families
- c90100 Project Milestones
- a00311 Road User Liquidated Damages (RULD)



Family Court Bridge Under Construction August 2015



Engineering Challenge – Major Utilities



Philadelphia Electric Company

Philadelphia Gas Works

Philadelphia Water Department

Verizon / AT&T

Philadelphia Streets Department

Veolia Steam



Engineering Challenge – Art Preservation

Sculptures

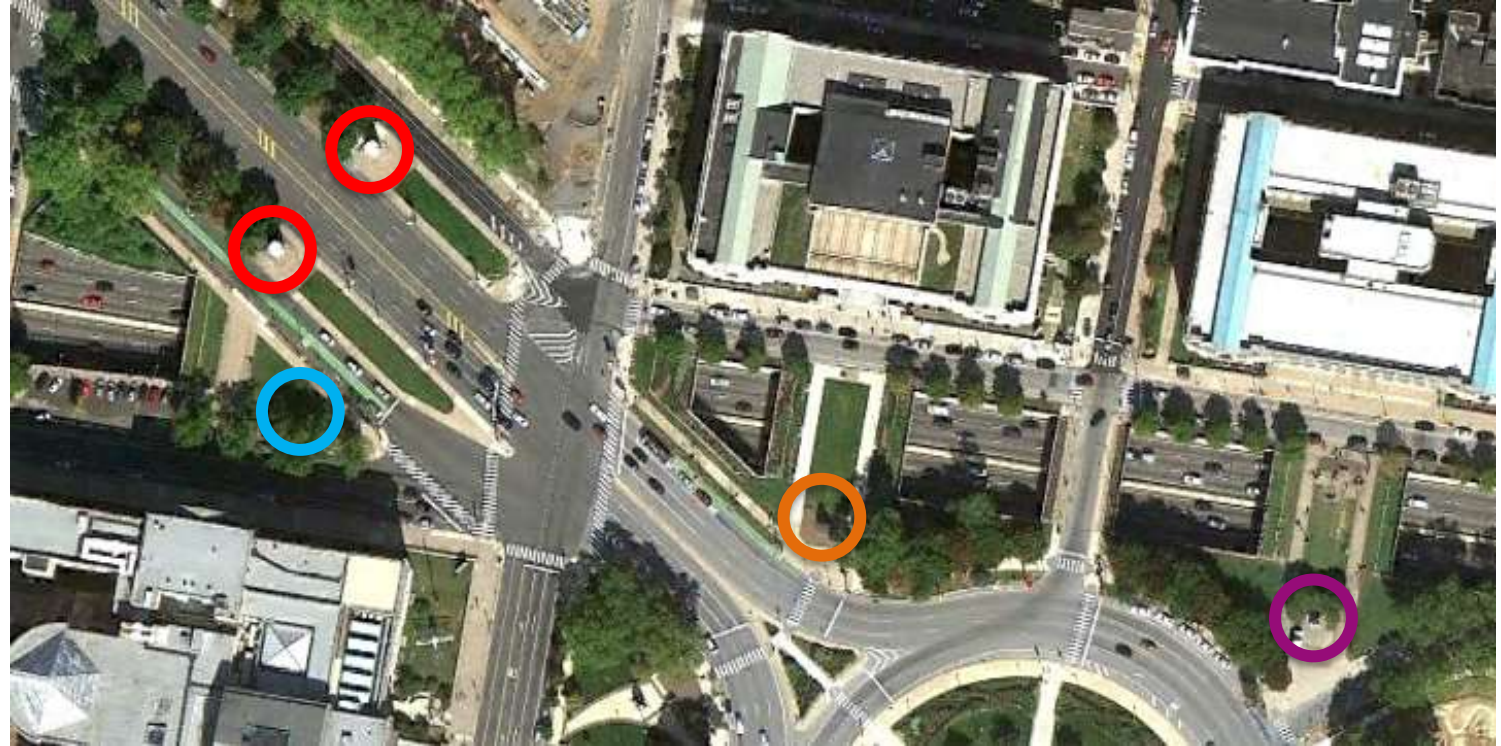
Civil War Memorials

Francisco DiMiranda Statue***

Shakespeare Memorial

General Pennypacker Monument

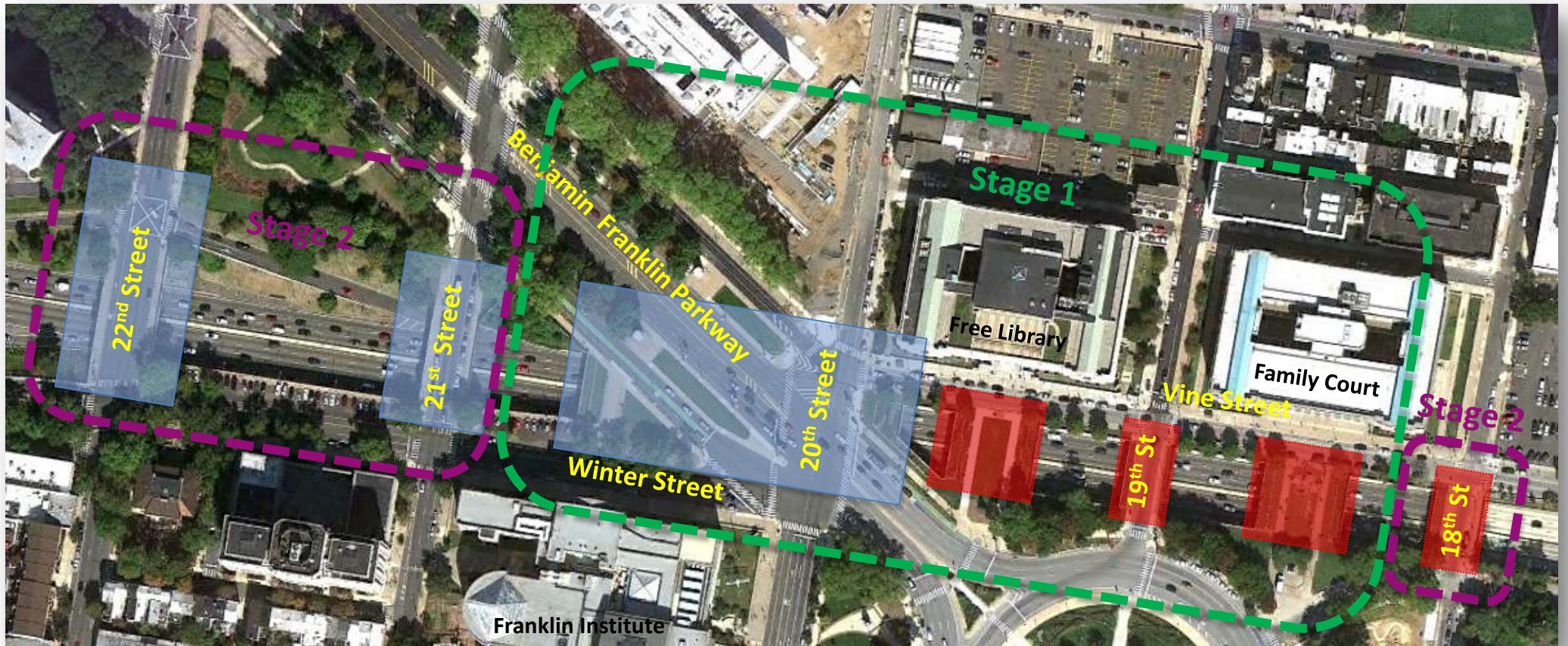
***Sculpture to be relocated



Art Preservation - Protect & Monitor During Construction



Engineering Challenge - Local Street Traffic Control



Bridge Open During Construction:

- 22nd Street (10,200)
- 21st Street (4,600)
- 20th Street (Parkway 23,600; Vine St. 10,600; 20th St. 8,800; Winter St. 2,400)

Detoured:

- 18th Street (2,600)
- 19th Street (4,600)
- Family Court
- Free Library

Approximate Average Daily Traffic (ADT) shown in parenthesis

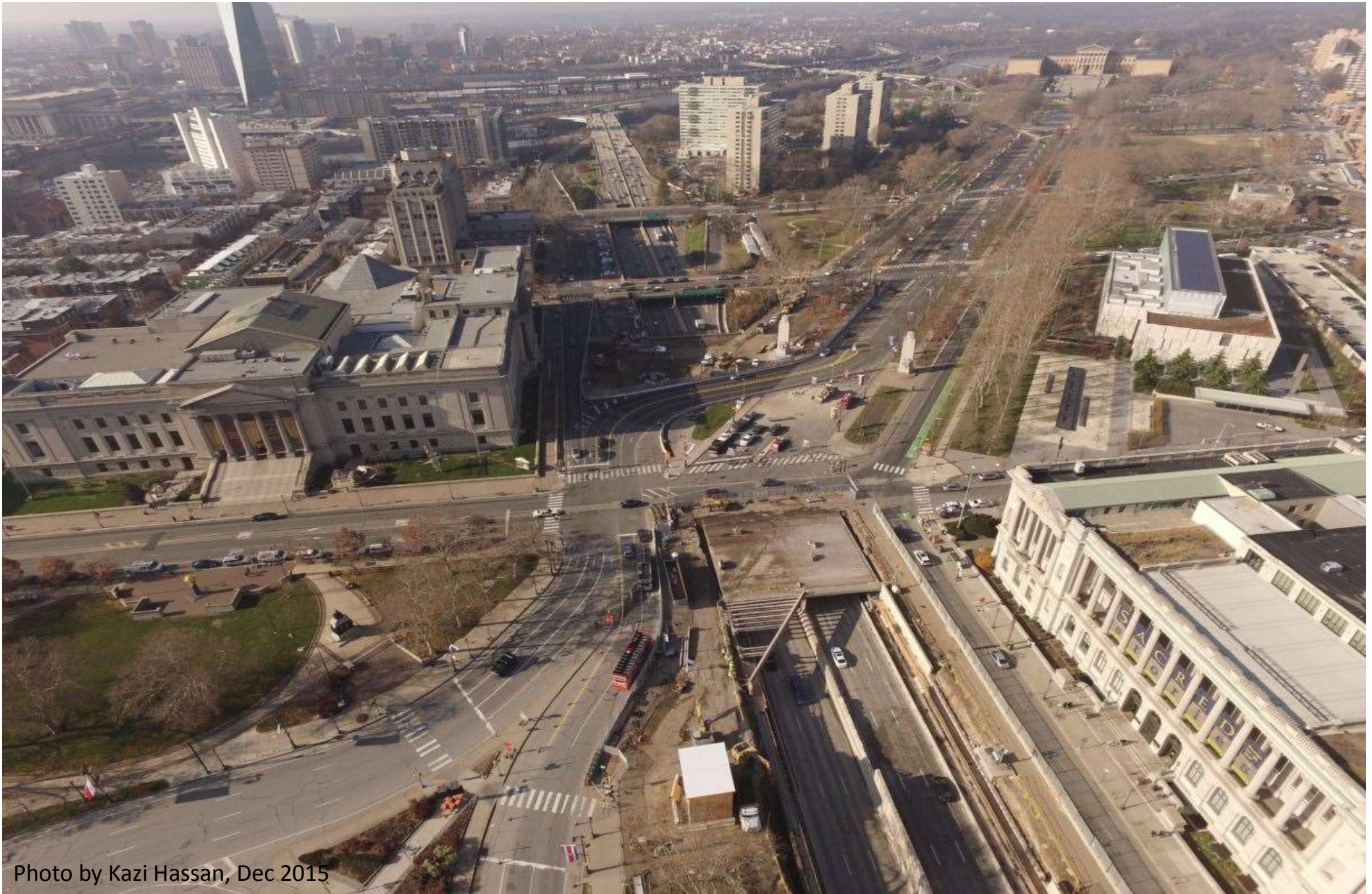


Photo by Kazi Hassan, Dec 2015



Engineering Challenge - Expressway Traffic Control



Looking west

Existing Conditions, EB & WB:

- 3' Shoulders, 3 - 12' lanes

Long Term :

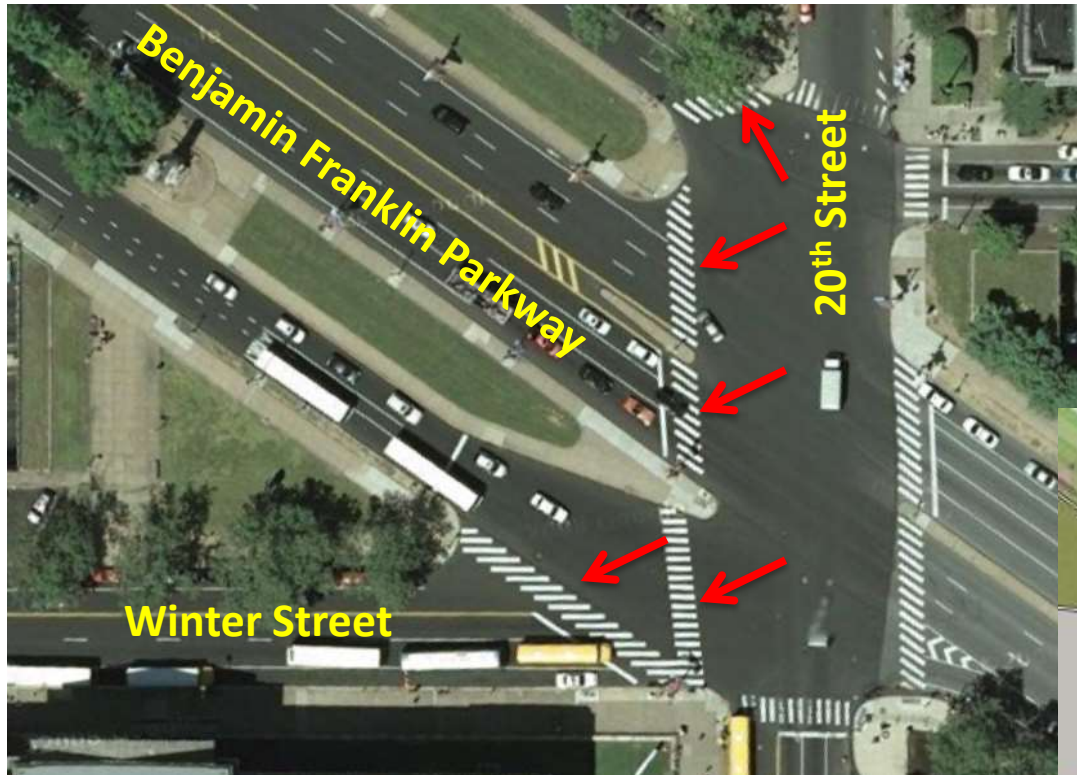
- 0' Shoulders, 3 - 11' lanes,
6' Work zone each abutment

Short Term:

- Single lane closures,
Mon-Sun, 10pm – 6am
- Double lane closures,
Mon-Sun, 11pm – 5am
- Overnight full closures,
Mon-Sun, 12 – 5am

Engineering Challenge – Vehicular/Pedestrian Intersection Safety

Parkway / 20th Street / Winter Street Intersection



- Intersection within the boundaries of Fairmount Park
- Serves the city museum district
- Intersection accommodates 45,400 (VPD) + pedestrians



Architectural/Aesthetics & Landscaping

Aesthetic Treatments – BFP Design Guidelines

- Exposed Aggregate Conc Sidewalks w/ Brick Banding
- Granite Roadway Curbs
- Granite Pavers
- Granite Veneer Planters / Stair Treads / Coping
- Granite Planter Curbs (re-use)
- Tinted Concrete / Formliners
- Decorative Fence (new & refurbished)
- Ornamental Street & Pedestrian Lighting
- Park Benches

Landscaping

- Various Trees = 141
- Various Ornamental Grasses, Bulbs, Plants and Shrubs = 10,220



Aerial View Rendering – Winter St./Parkway/20th St. to 18th Street

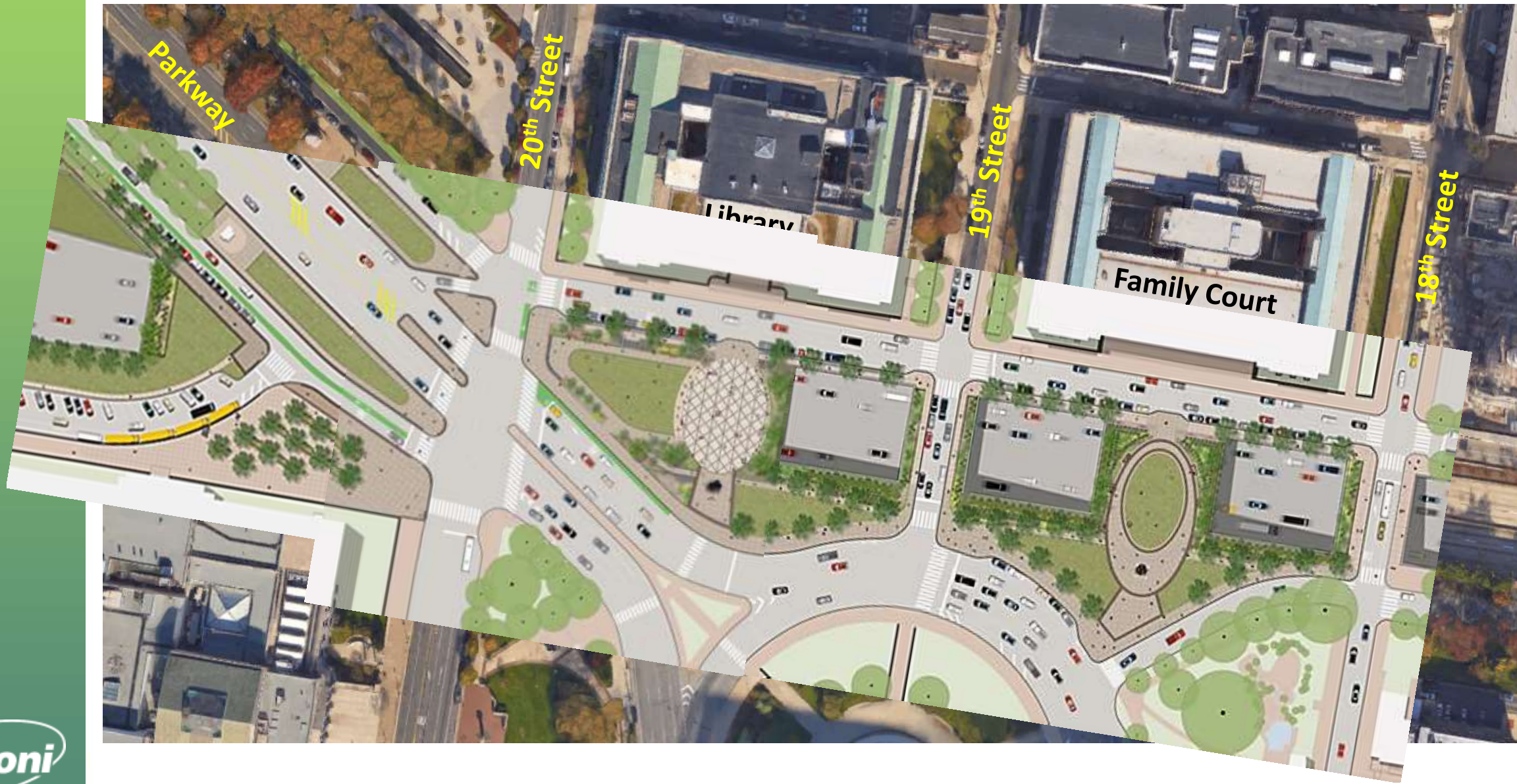




Photo by Dave Palmer, July 2016

Media Coverage

Tuesday, March 8, 2016

PLANPHILLY

a project of WHY? & NEWSWORKS.ORG

ARTICLES NEIGHBORHOODS ISSUES EVENTS

HOME / ARTICLES



Franklin Institute getting new bus loading zone, plaza in Winter Street realignment

TUESDAY, FEBRUARY 9, 2016 | BY JIM SAKSA | 18 COMMENTS | 20TH AND WINTER STREETS, PHILADELPHIA PA

The mention of winter usually conjures up images, cold and colorless, of a city depressed: gray, bare & dirty snow, drab coats trudging by with downcast eyes on the lookout for treacherous ice.

Winter Street—a short, three-lane-wide interstitial street between 20th and 23rd Streets that runs parallel and above the sunken Vine Street Expressway—emulates its eponymous, enervating season, sucking the life out of the Franklin Institute's northern side and making it harder for pedestrians to cross the Benjamin Franklin Parkway.

Pennoni

NEWS + OPINION

NAVIGATION ▼

Here's How Things Are Going With All That I-676 Bridge Construction

Everything's right on schedule, say officials, despite challenges caused by the pope, the DNC and the Verizon strike. A little more than one year in, the project is still on track to finish in November 2019.

BY MARIA MCGEARY | AUGUST 15, 2016 AT 1:38 PM



Construction continues on the 20th Street bridge, one of seven to be rebuilt by 2019. Photo courtesy of PennDOT.



THE VINE STREET PROJECT More than bridge work, a grander plan

By Paul Nashorn
STAFF WRITER

A five-year, \$83 million project to replace seven bridges over the Vine Street Expressway will also remodel the cultural spine of the city.

In time to celebrate the 150th anniversary of the Benjamin Franklin Parkway and its sister, University City, the city is pocket parks, the streets will be made more pedestrian and more functional.

The death-defying pedestrian crossing between the Free Library and the Franklin Institute will be improved. Winter Street will be realigned to reduce the traffic conflict with pedestrians.

A new patch of park will cover a piece of 1.676 in front of the library. More than 30,000 shrubs and trees will be planted, while the statue of Venezuelan revolution will be the centerpiece of the project.

See VINE STREET on A1



Engineering Challenge - Reconstructing the Existing Bridges

- ◆ All 7 bridges rated as structurally deficient
- ◆ Superstructures – poor condition with advanced deterioration, require replacement
- ◆ Substandard vertical clearance on Expressway 13'-10"
- ◆ Center Piers – poor condition with advanced deterioration, require replacement
- ◆ Abutments in fair/good condition...Replace **or reuse?**



Engineering Solutions - Reconstructing the Existing Bridges

Abutments - Extensive investigation and testing conducted, results:

- Concrete compressive strengths high, range from 4200 - 7200psi
- Delamination's & spalls sized and located
- Cracks widths & lengths identified
- **Chloride ion contamination high**

Solution - Reuse Abutments...Repair and retrofit, remove chloride ion contamination by electrochemical chloride extraction

Vector[®]

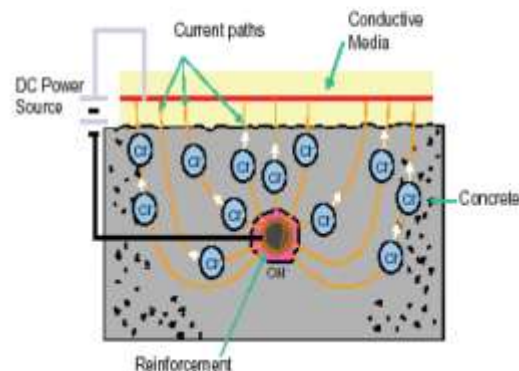
Norcure[®] Chloride Extraction

Electrochemical chloride extraction process for chloride-contaminated structures

Description

Norcure electrochemical chloride extraction (ECE) is a treatment which a) extracts chloride ions from contaminated concrete and b) reinstates the passivity of steel reinforcement. Chloride extraction is carried out by temporarily applying an electric field between the reinforcement in the concrete and an externally mounted anode mesh. During the process chloride ions are transported out of the concrete. At the same time, electrolysis at the reinforcement surface produces a high pH environment. This process returns the steel reinforcement to a passive condition.

ELECTROCHEMICAL TREATMENTS



Engineering Challenge - Reconstructing Existing Bridges



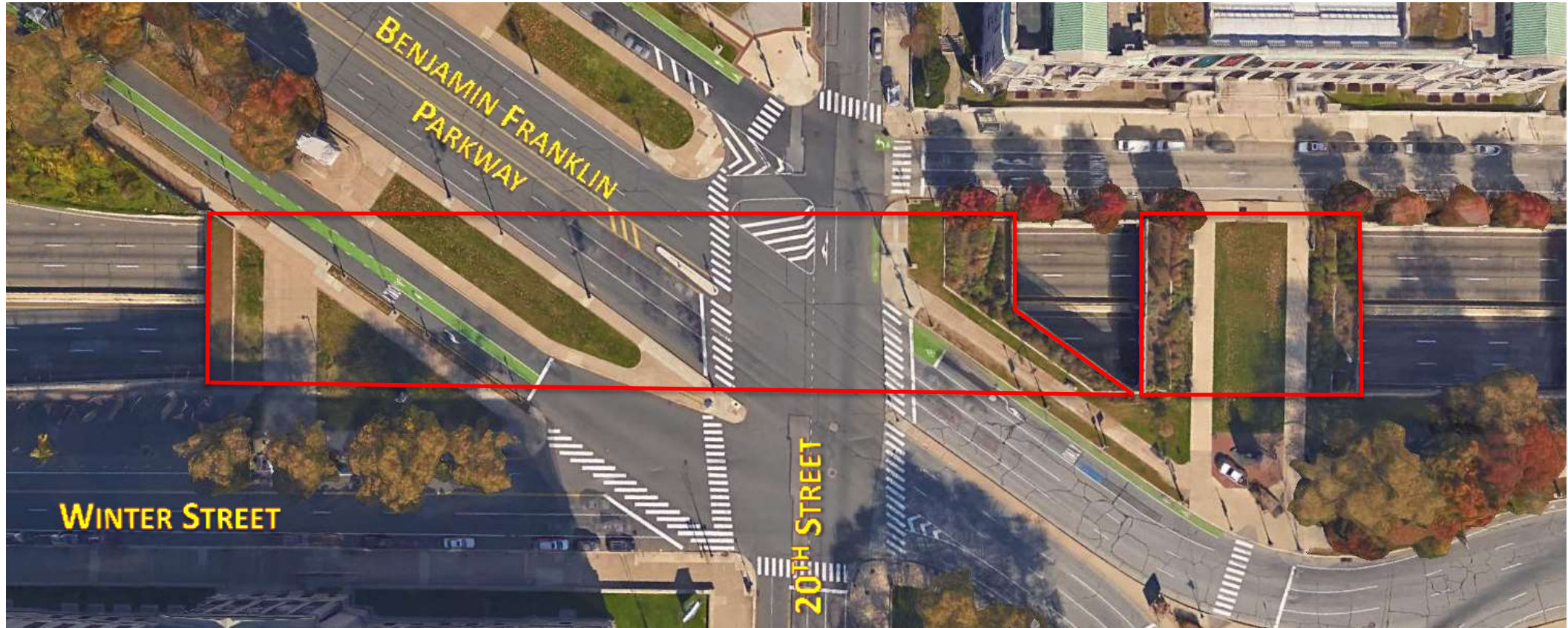
Engineering Solution - Proposed Bridges

Superstructures

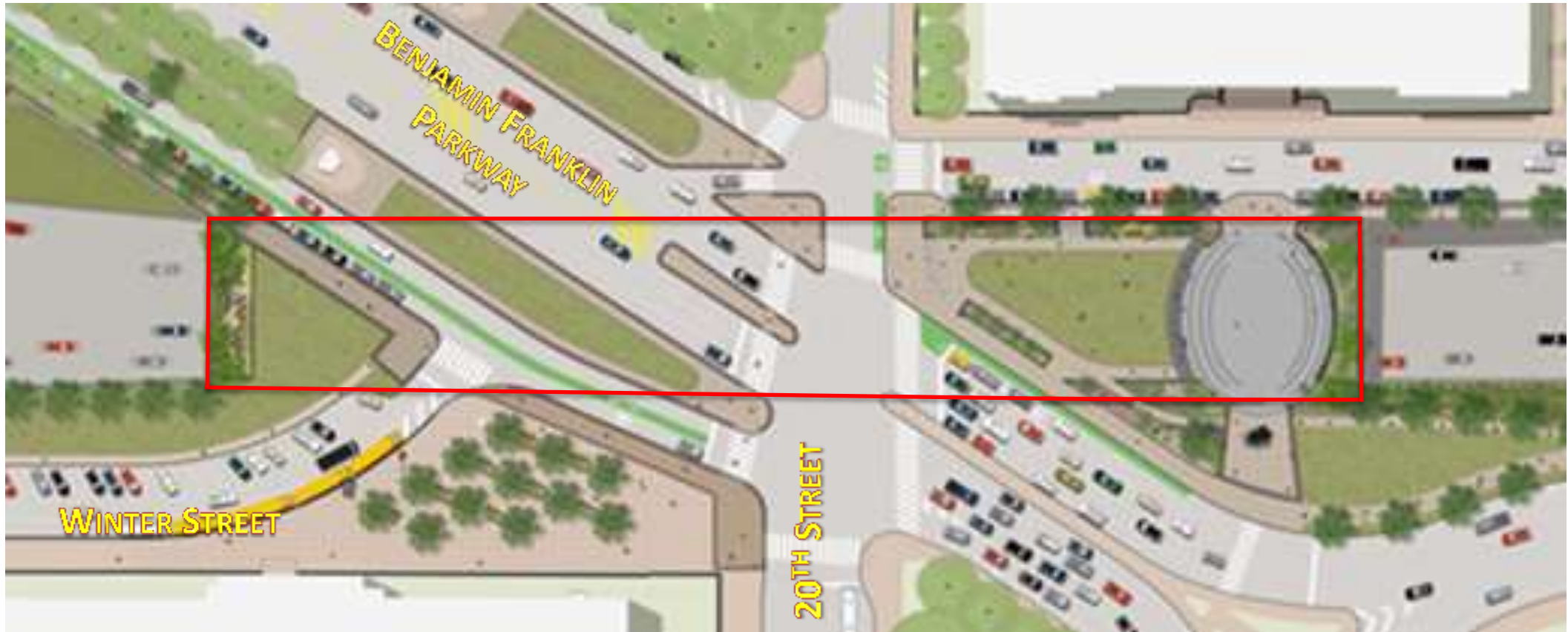
- Remove heavily deteriorated center piers
- Design shallow/stout single span steel plate girders to improve clearance
- Maintain topside roadway profiles



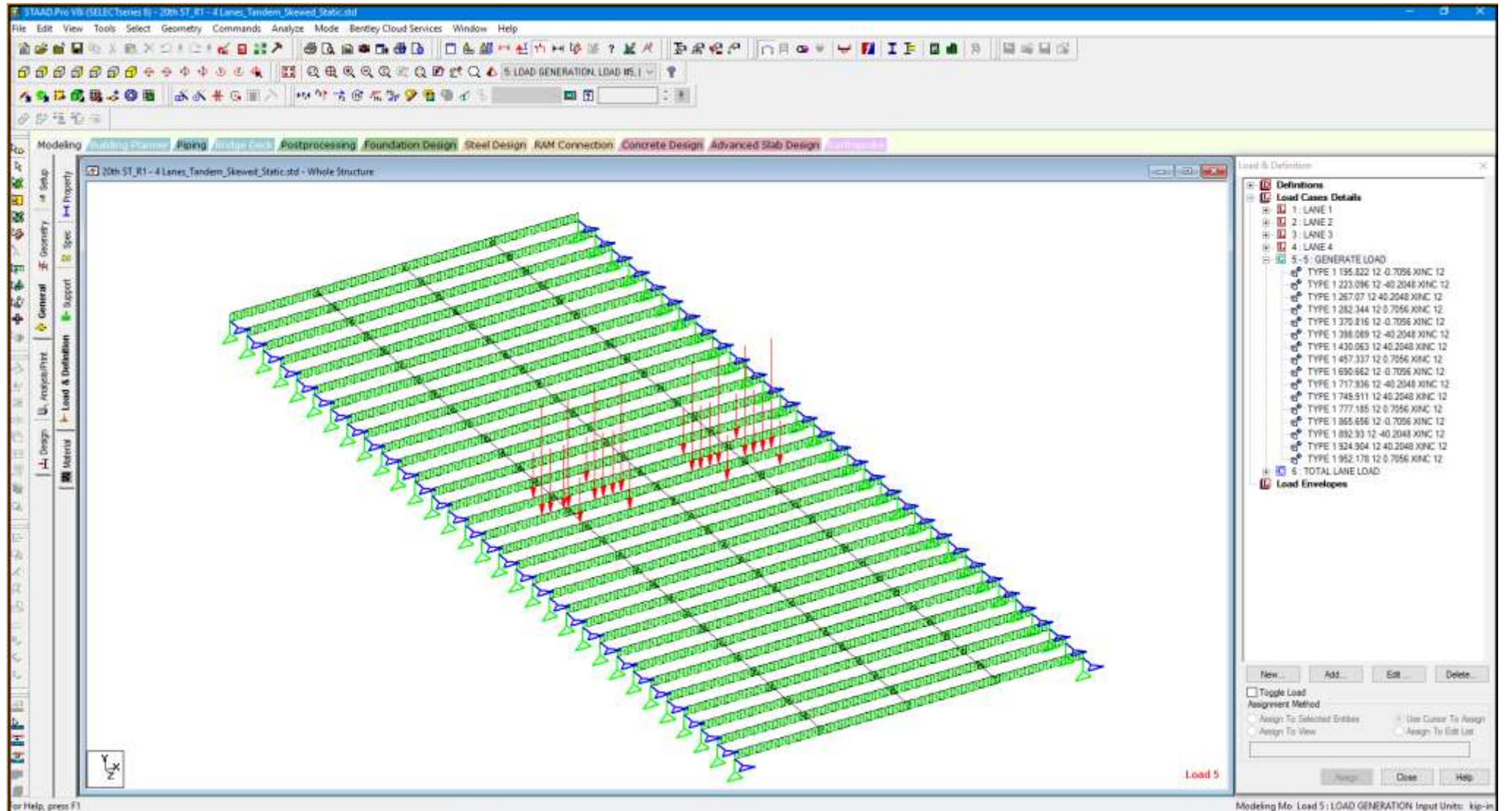
Benjamin Franklin Parkway/20th Street Bridge & Free Library Bridge – Existing Bridges



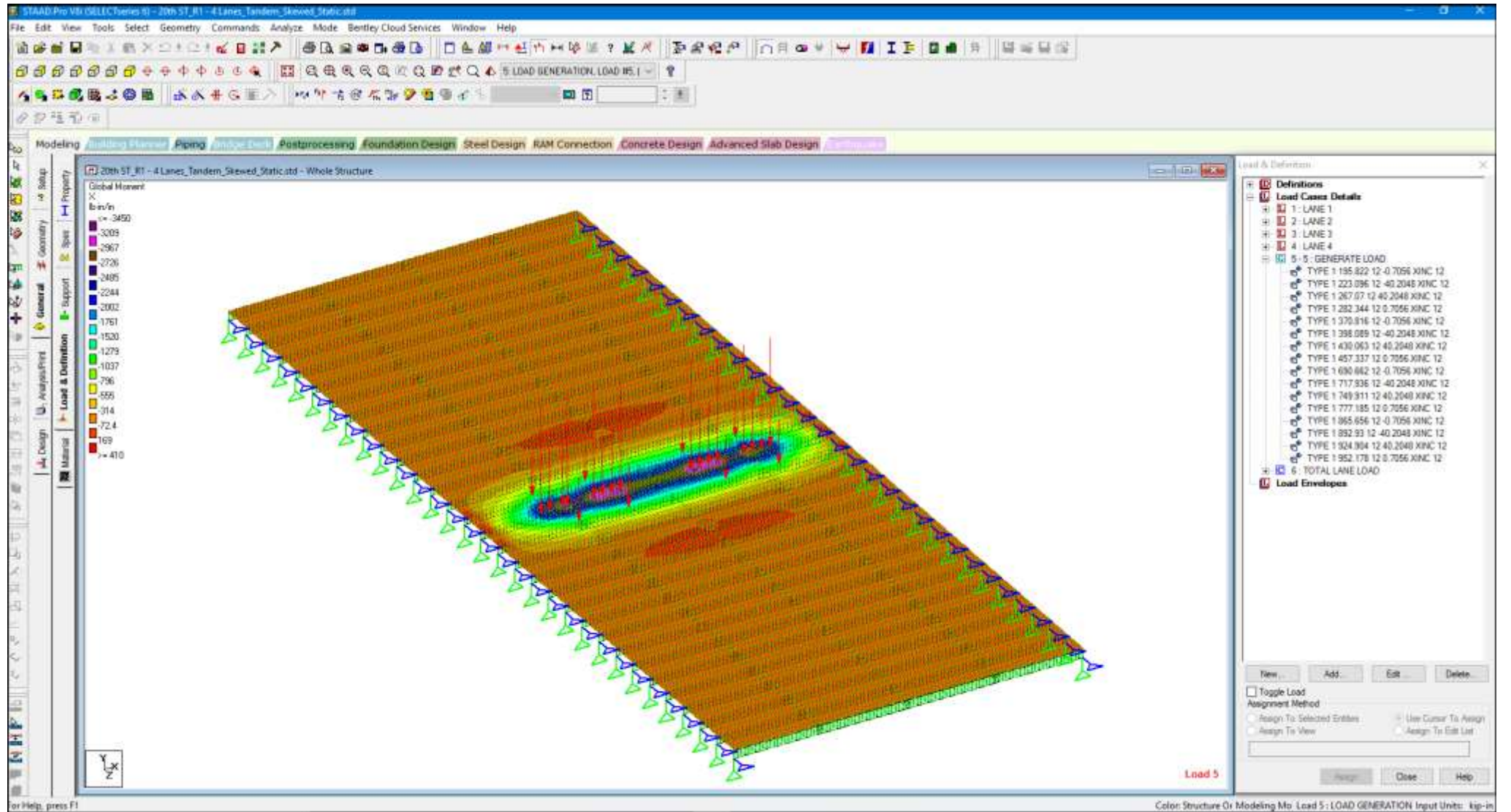
Benjamin Franklin Parkway/20th Street Bridge/ Free Library Bridge – Rendering of Proposed Bridge



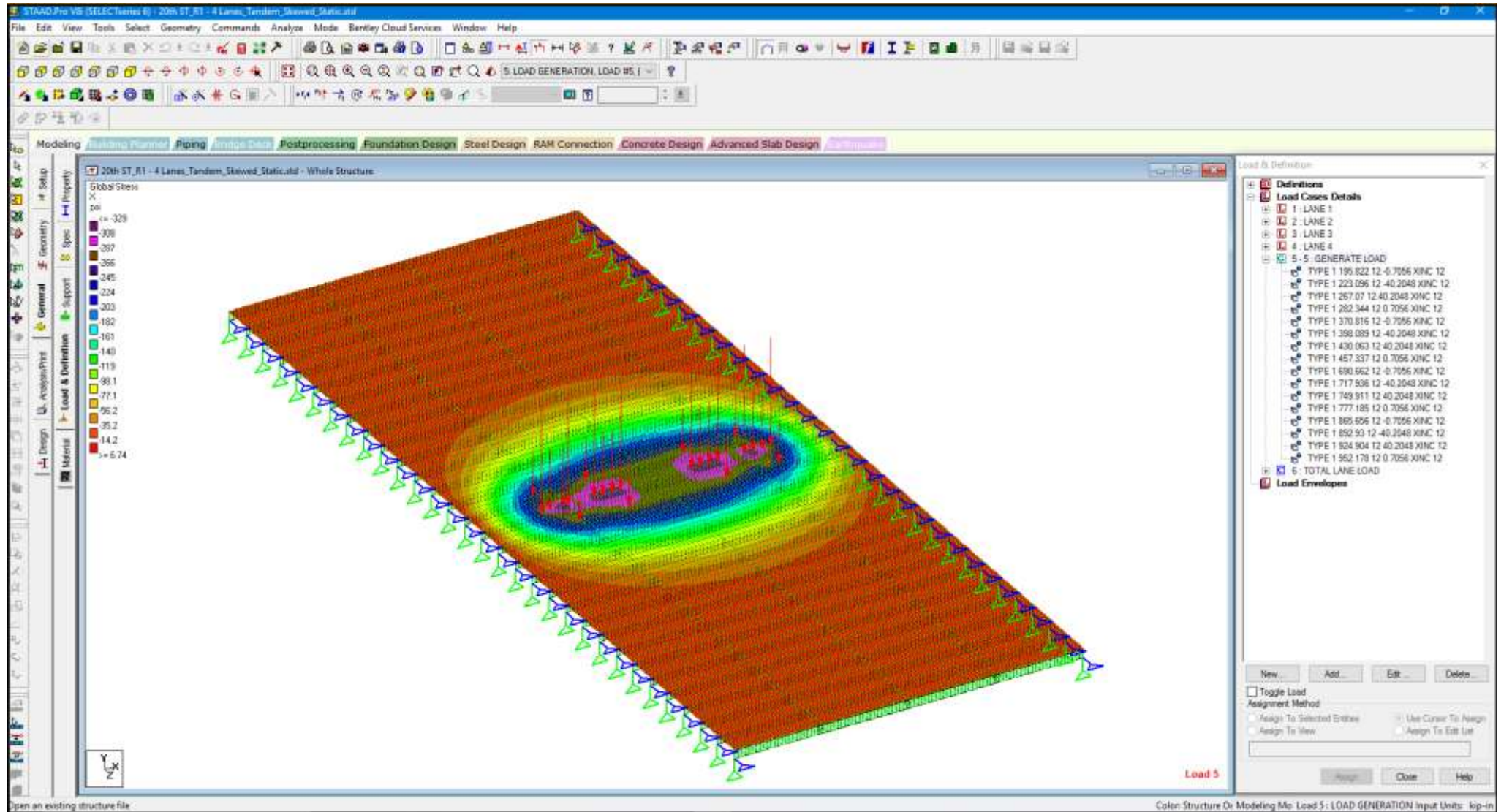
Engineering Solution – 3D Finite Element Modeling Skewed Live Load Distribution

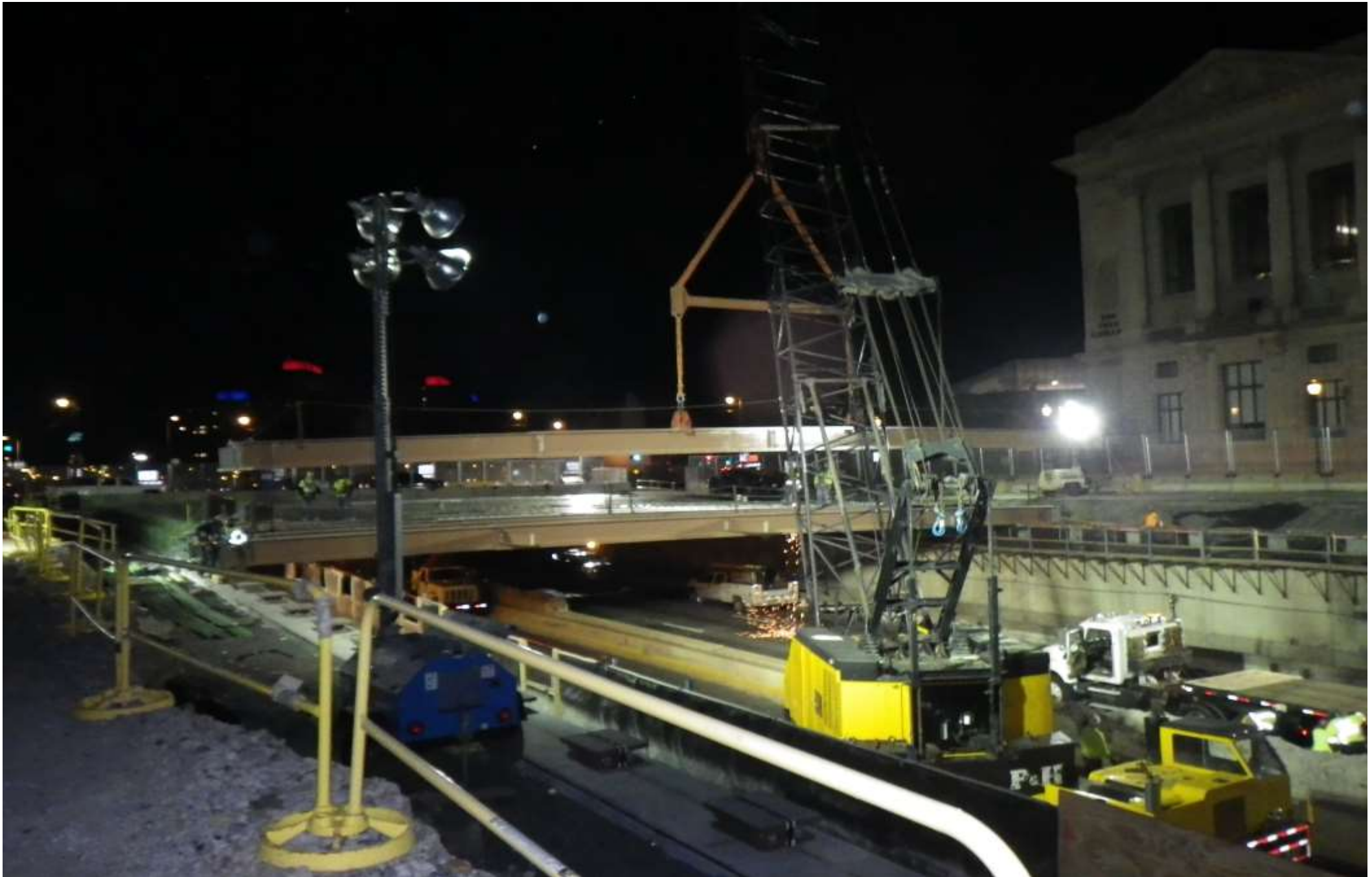


Engineering Solution – 3D Finite Element Modeling Skewed Live Load Deck Moments



Engineering Solution – 3D Finite Element Modeling Skewed Live Load Deck Stresses





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Engineering Solution – Economic Steel Girder Design

Steel Girder Design

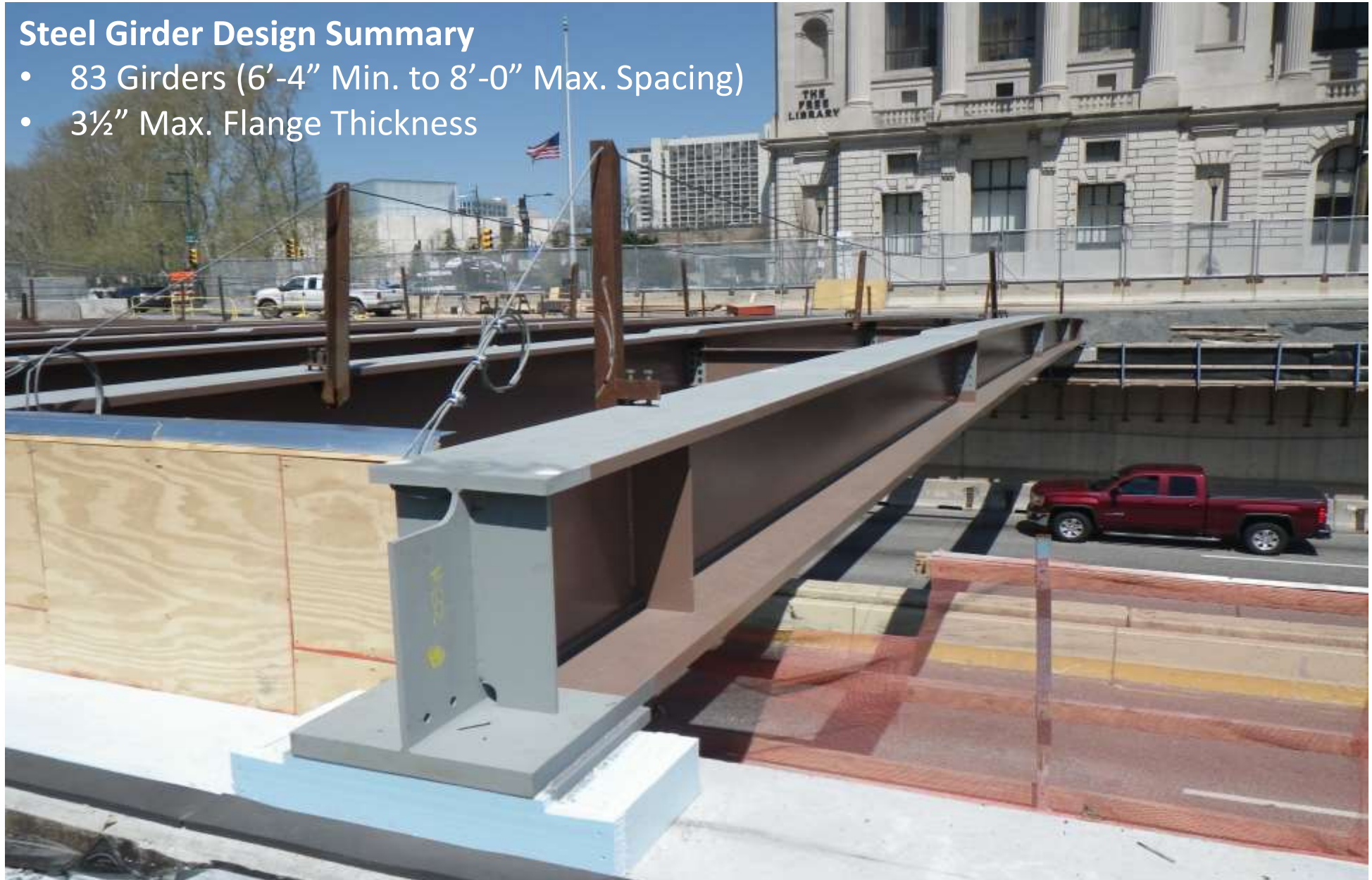
- Maintain a Constant Steel Plate Girder Design
- Given Large Dead and Live Load Variations, Vary Girder Spacing to Maximize Girder Capacities



Engineering Solution – Economic Steel Girder Design

Steel Girder Design Summary

- 83 Girders (6'-4" Min. to 8'-0" Max. Spacing)
- 3½" Max. Flange Thickness



Engineering Solution – Maximize Steel Girder Web Depth



Engineering Solution – Maximize Steel Girder Web Depth



Engineering Solution – Maximize Steel Girder Web Depth



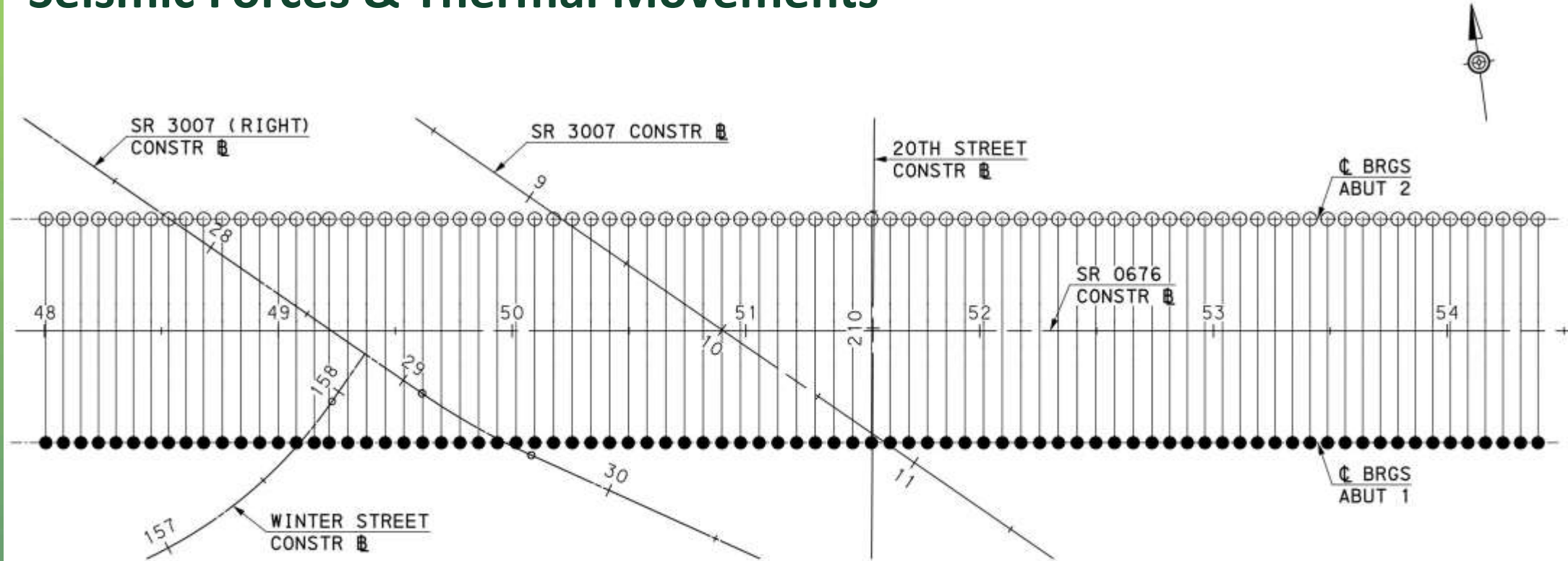
Engineering Solution – Maximize Steel Girder Web Depth



Engineering Solution – Maximize Steel Girder Web Depth



Engineering Challenge – Accommodating Inherent Seismic Forces & Thermal Movements



LEGEND

- TRANSVERSELY GUIDED BEARING
- NON-GUIDED BEARING

BEARING ORIENTATION PLAN

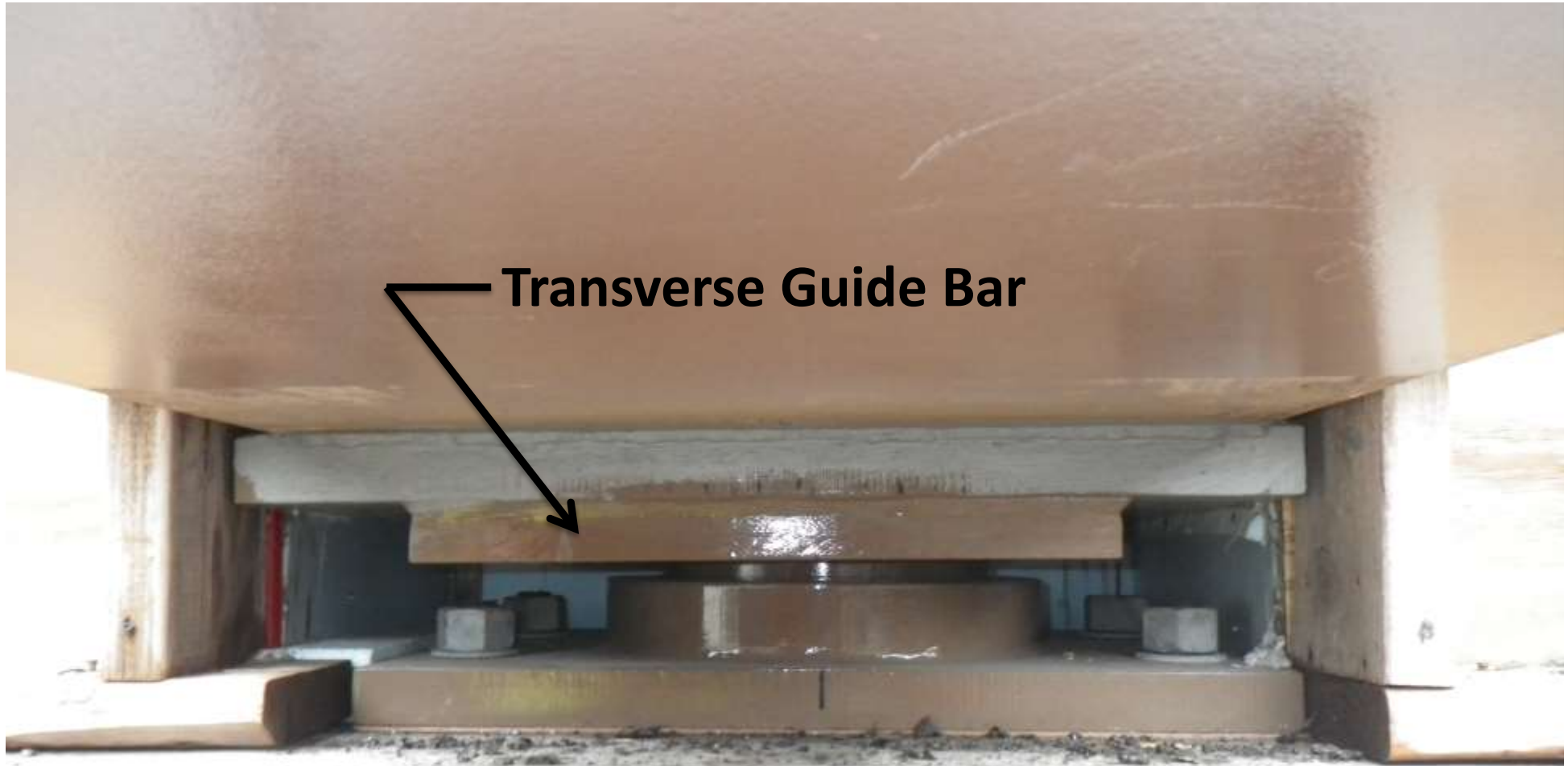
NOT TO SCALE

Engineering Solution – Non-Guided HLMR Disc Bearings



Abutment 2

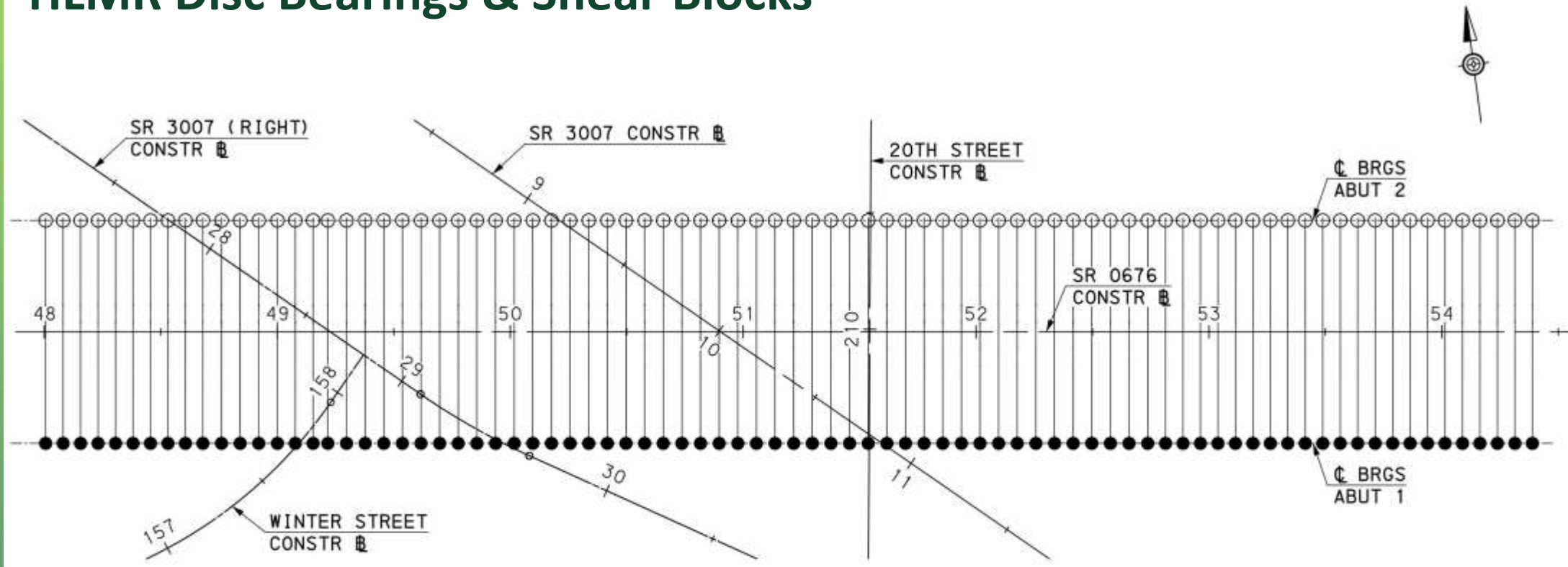
Engineering Solution – Transversely Guided HLMR Disc Bearings



Transverse Guide Bar

Abutment 1

Engineering Solution – Unique Combination of HLMR Disc Bearings & Shear Blocks



LEGEND

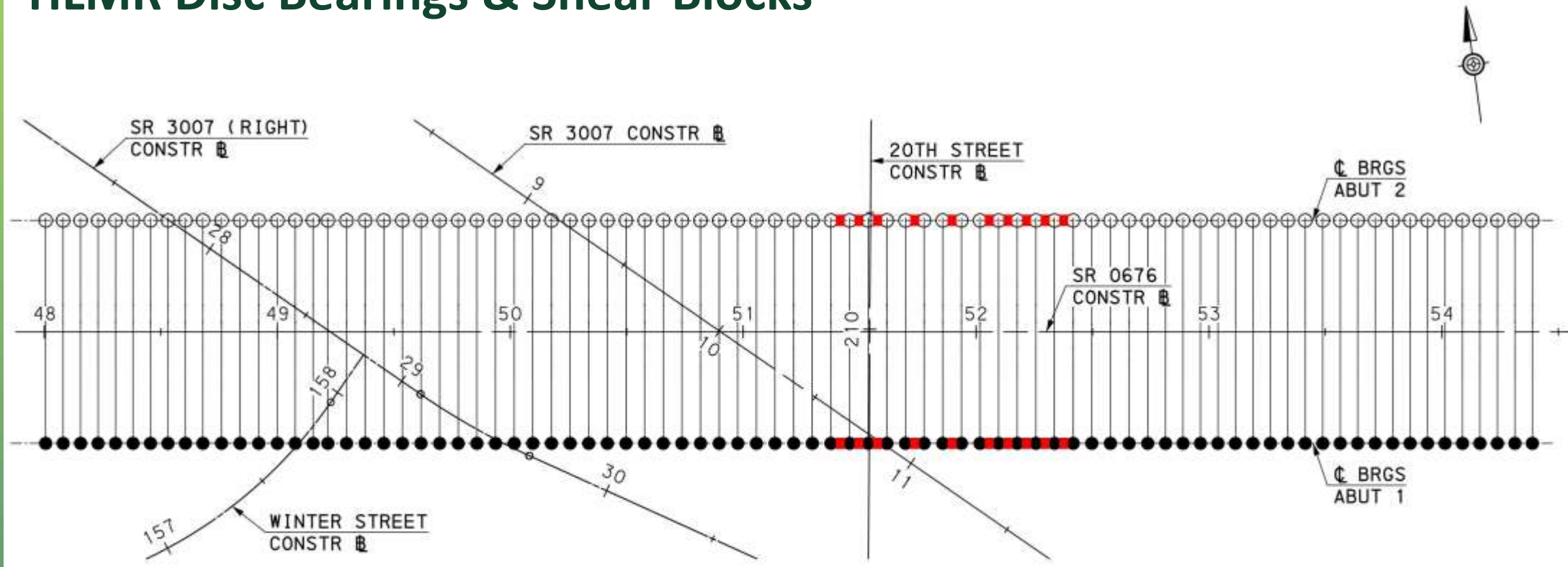
- TRANSVERSELY GUIDED BEARING
- NON-GUIDED BEARING

BEARING ORIENTATION PLAN

NOT TO SCALE



Engineering Solution – Unique Combination of HLMR Disc Bearings & Shear Blocks



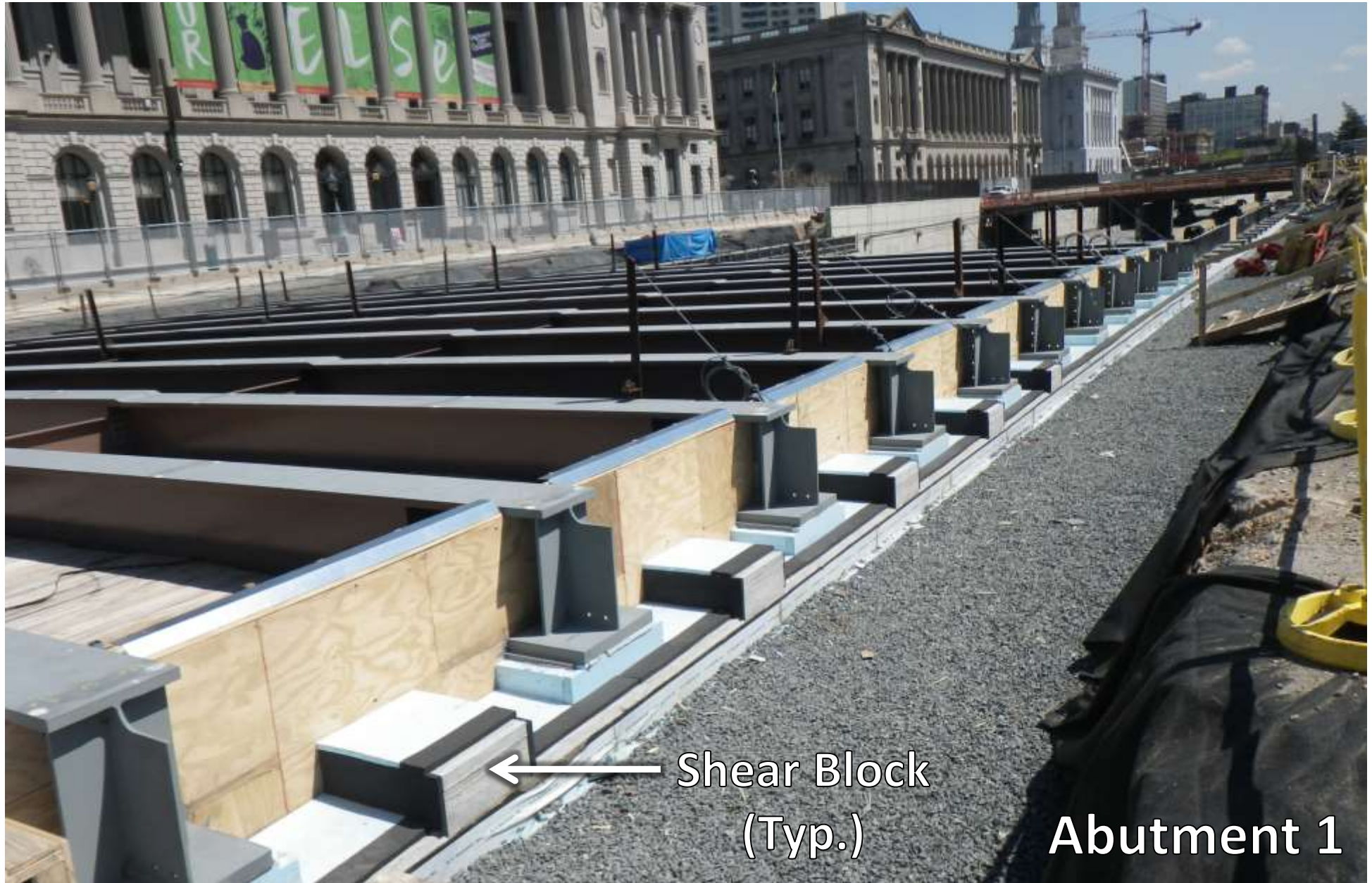
LEGEND

- TRANSVERSELY GUIDED BEARING
- NON-GUIDED BEARING
- SHEAR BLOCK

BEARING ORIENTATION PLAN

NOT TO SCALE

Engineering Solution – Shear Blocks



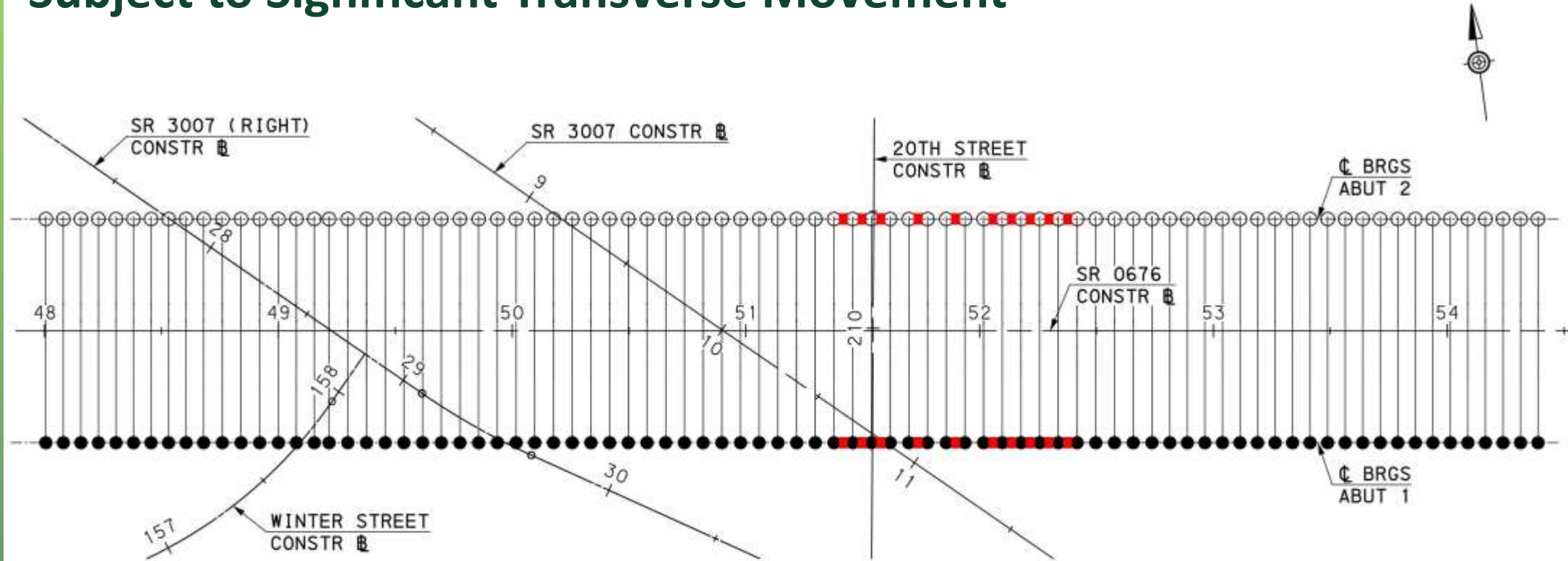
← Shear Block
(Typ.)

Abutment 1

Engineering Solution – Shear Blocks



Engineering Challenge – Supporting Multiple Utilities Subject to Significant Transverse Movement



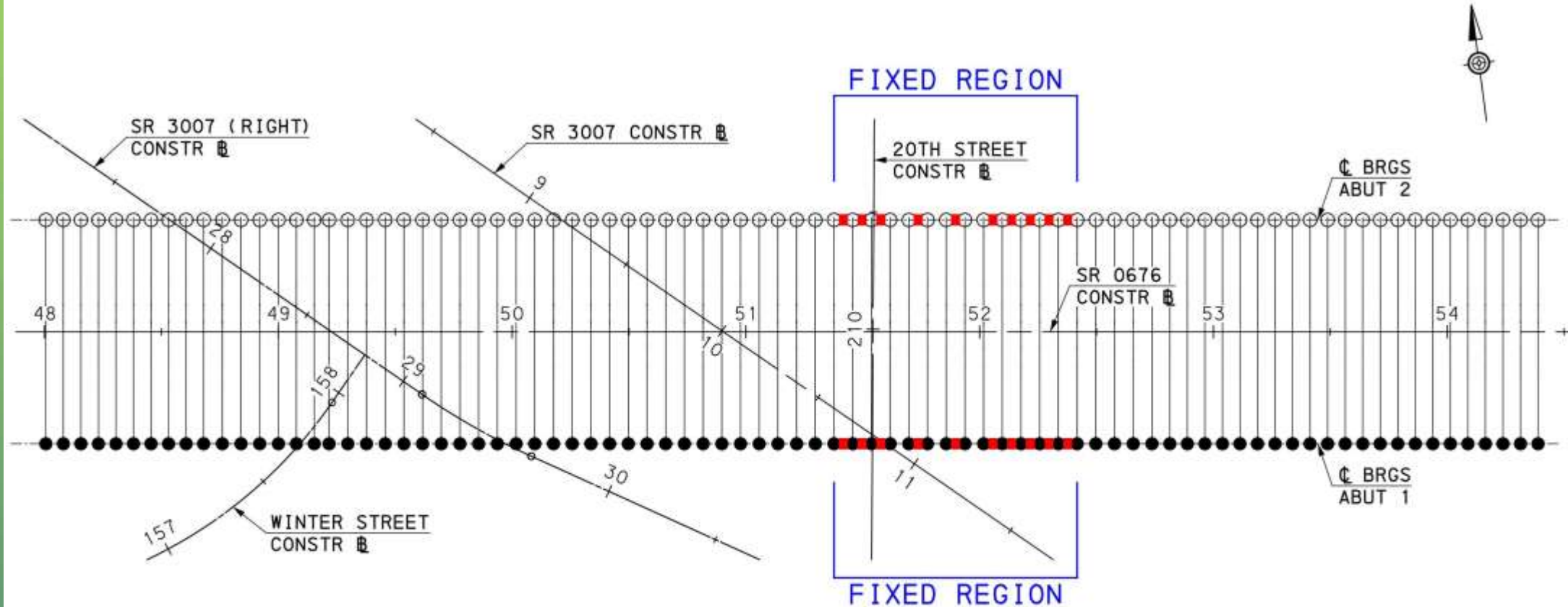
LEGEND

- TRANSVERSELY GUIDED BEARING
- NON-GUIDED BEARING
- SHEAR BLOCK

BEARING ORIENTATION PLAN

NOT TO SCALE

Engineering Solution – Using the ‘Fixed’ Region to Support Utilities



LEGEND

- TRANSVERSELY GUIDED BEARING
- NON-GUIDED BEARING
- SHEAR BLOCK

BEARING ORIENTATION PLAN

NOT TO SCALE

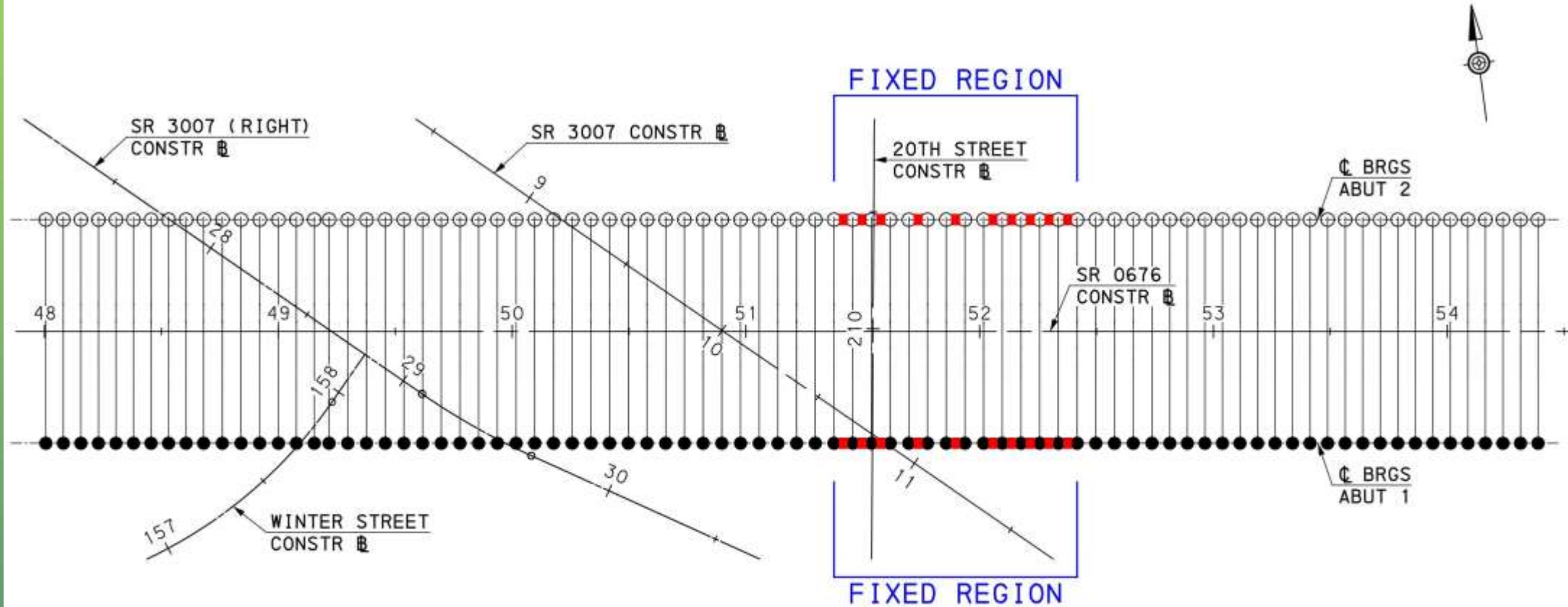
Engineering Solution – Utility Bays in the ‘Fixed’ Region



Engineering Solution – Utility Bays in the ‘Fixed’ Region



Engineering Challenge – Temporary Lateral Support



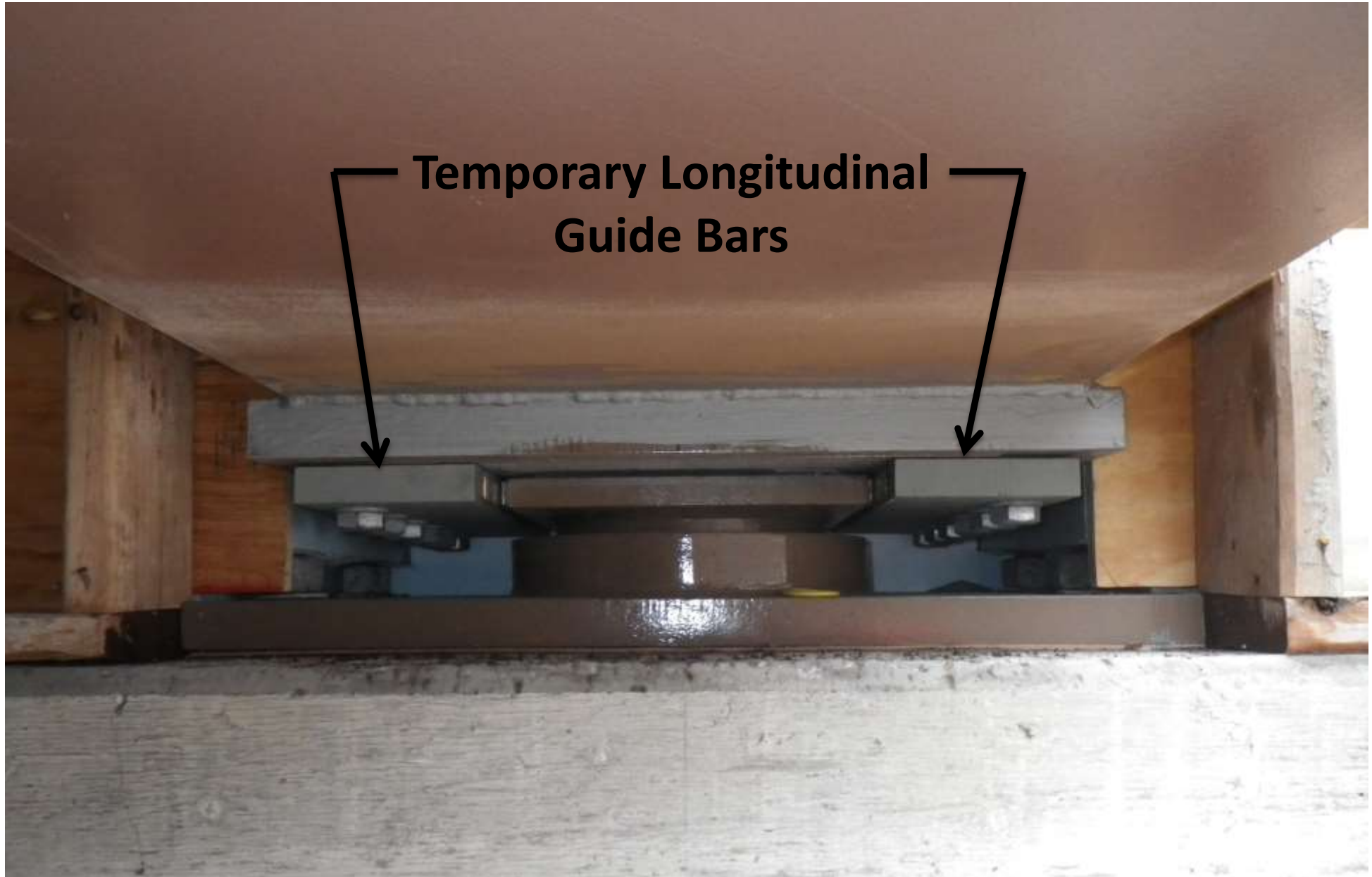
LEGEND

- TRANSVERSELY GUIDED BEARING
- NON-GUIDED BEARING
- SHEAR BLOCK

BEARING ORIENTATION PLAN

NOT TO SCALE

Engineering Solution – HLMR Disc Bearing with Temporary Guides





KEY BRIDGE STATISTICS

- ❖ Total LBS of Structural Steel = 5,690,203 LBS
- ❖ Total Square Footage of Bridge Deck Replaced = 105,950 SF
- ❖ Total Linear Footage of Public Utilities Relocated = 13,300 LF
- ❖ Total Cubic Yards of Concrete = 5,375 CY
- ❖ Total Number of Girder Bearings = 278

Questions

