Western Bridge Engineers' Seminar

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Replacing the Aging US 52 Mississippi River Bridge

September 6, 2017

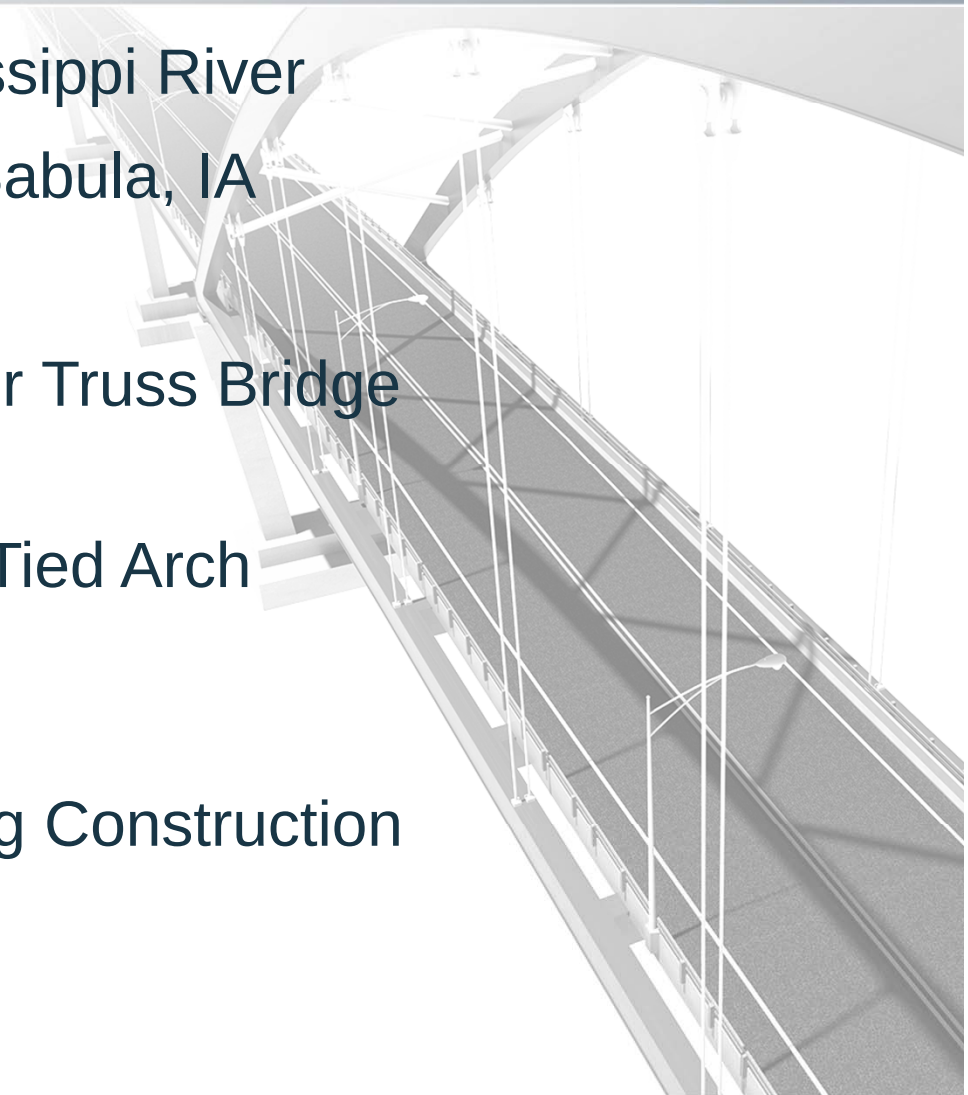
Illinois Department of Transportation

IOWADOT

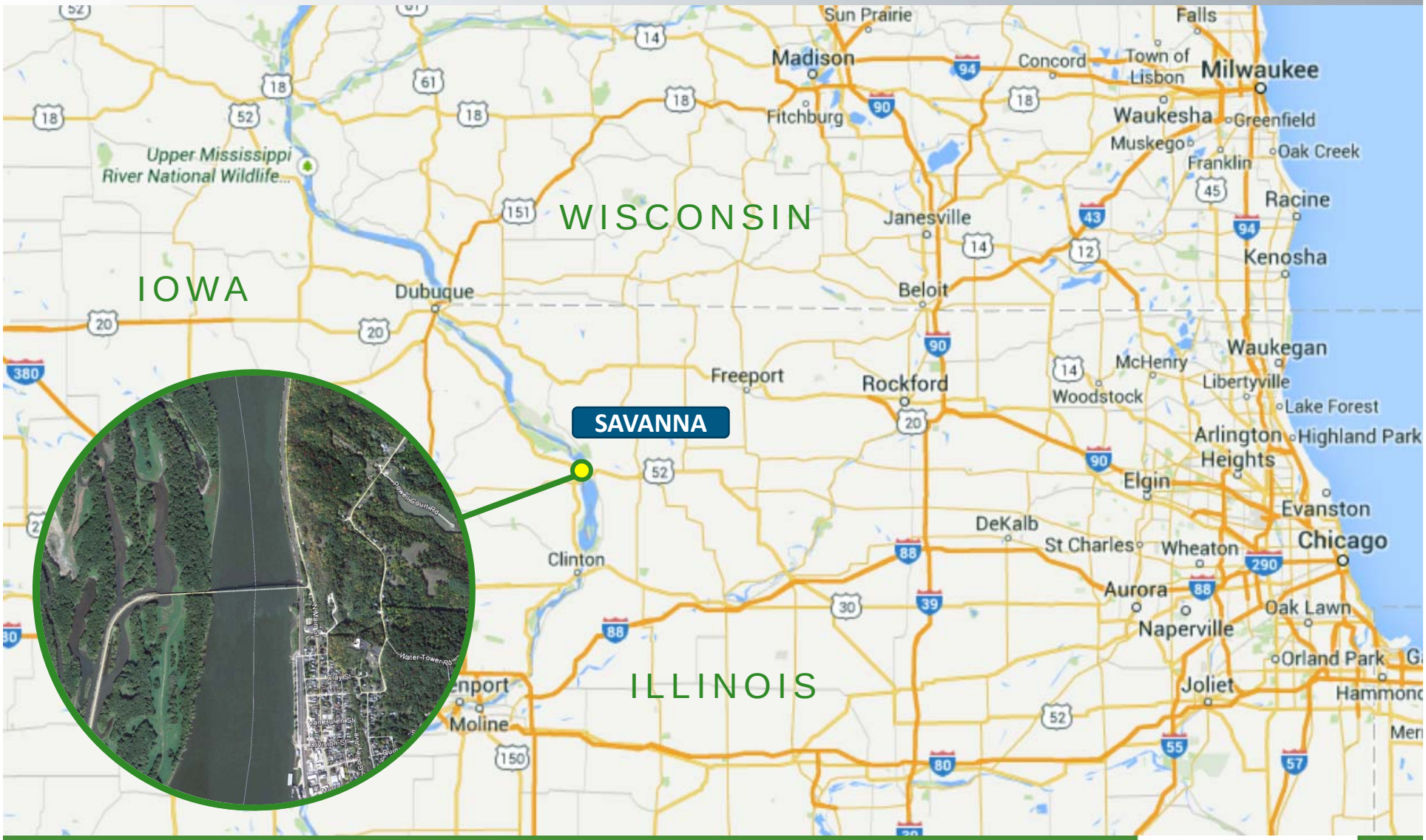
PARSONS

Project Overview

- US 52 / IL 64 over the Mississippi River
- Connecting Savanna, IL to Sabula, IA
- Illinois DOT Led Project
- Replacing Existing Cantilever Truss Bridge
  - 520 ft main span
- Proposed 546 ft Main Span Tied Arch
  - Bolted Box Tie Girder
  - Floating Deck
- Proposed “Coffercell” Footing Construction
  - Drilled Shafts
  - Waterline Footing



Project Location



Aerial Views

- Sabula
- “Iowa’s only island city”
- Pop. 576

Aerial Views

- “Savanna, Illinois a Sportsman’s Paradise”
- Pop. 2,945

Mississippi Palisades

BNSF Railroad

- Heavily used line
- 2 Tracks
- 60+ Trains per day
- Minimal closure windows
- Construction coordination required for river access

Vital Transportation Link

- Low ADT – 2400
- Education, Emergency and Jobs
- Nearest alternate crossings
  - Clinton, IA to Fulton, IL – 20 miles south
  - Dubuque, IA to East Dubuque, IL – 45 miles north

Existing Bridge

- Constructed in 1932
- Savanna-Sabula Bridge Company
- Private Toll Bridge before being turned over to Iowa
- Illinois took over jurisdiction in 1987

Existing Bridge

- 947 ft Iowa Approach
- 282 ft Simple Span Truss
- 1,160 ft Cantilever Truss
- 520 ft main span
- 78 ft Illinois Approach
- 2,468 ft in total length

Existing Bridge

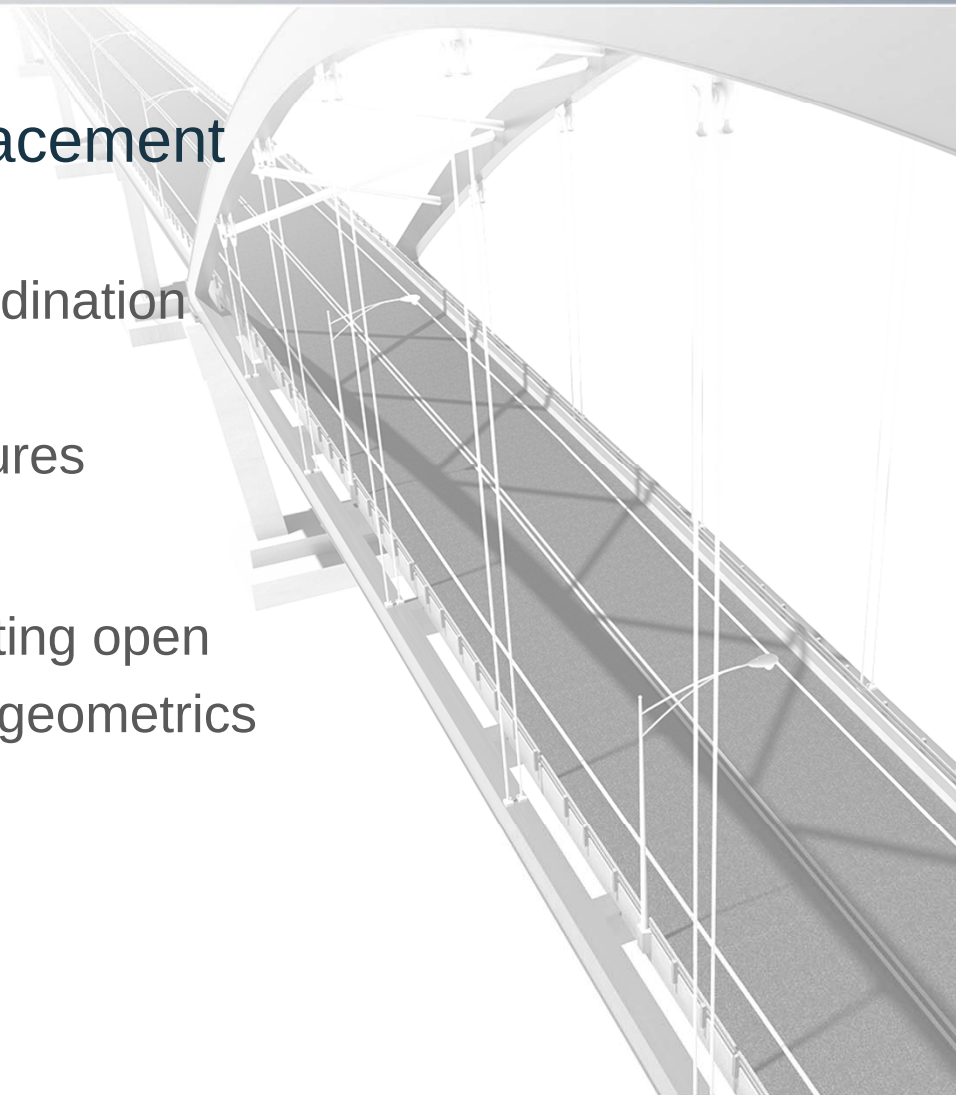
Repairs

- Major repairs in 1985
- Minor repairs in 1999
- Partial replacement of steel grid deck in 2008
  - 28 day road closure and $2.9M
  - Major out cry from public
- Identified more repairs in 2009
  - $8M repairs + $8M user cost
  - 9 month closure, 37 mile detour
- Future repairs?

Key Issues

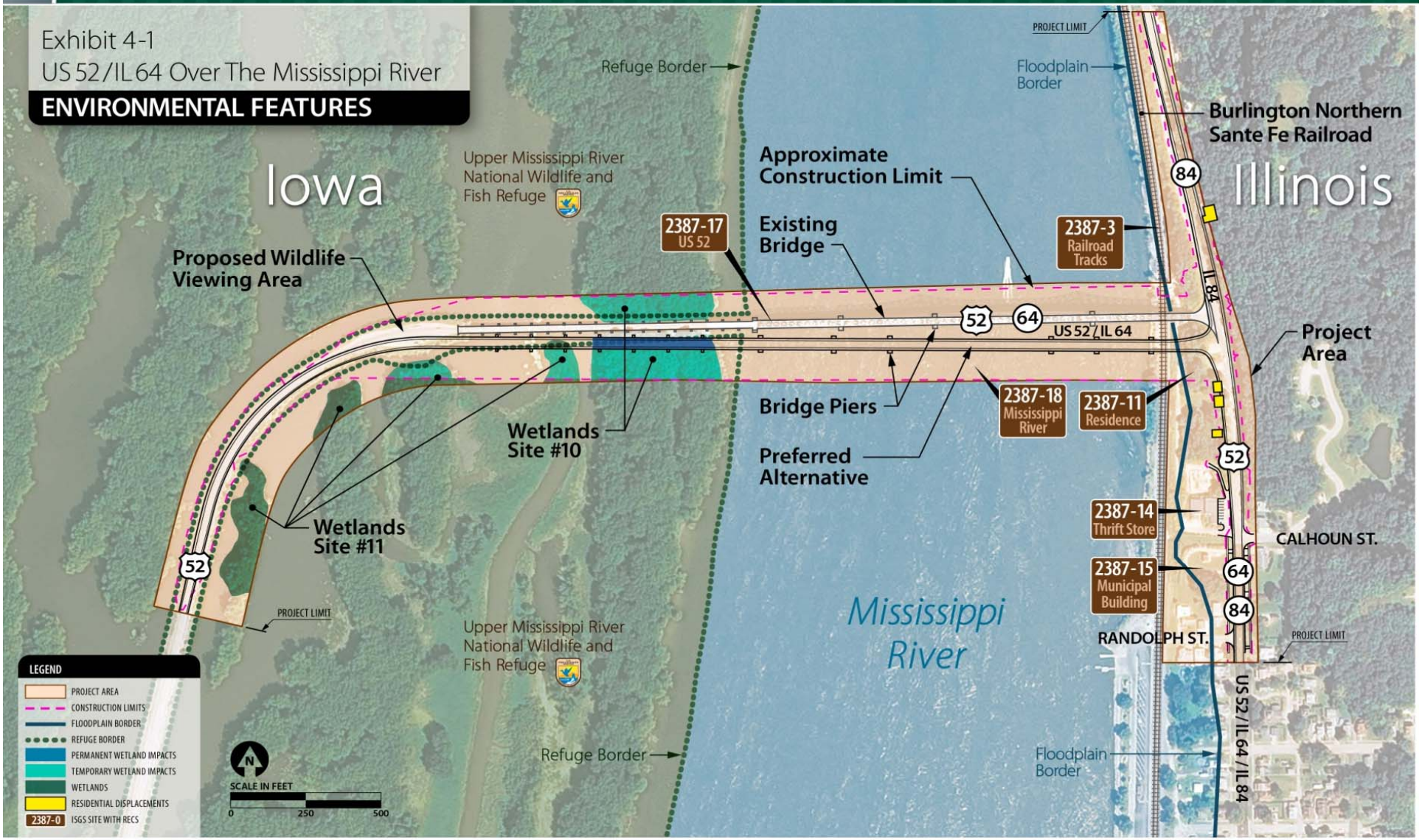
- Structurally Deficient
  - Entire Iowa approach substructure
  - Repairs needed for truss spans
  - Weight Limit
- Functionally Obsolete
  - 2 narrow 10 ft lanes
  - Trucks encroach into lane
  - Tight turning radius
  - Steel grid deck
- Remaining Service Life
  - 8 to 10 years in current state

Replacement



- District Recommended Replacement
  - Substandard Roadway
  - Extensive Environmental Coordination
  - Economic Impact of Closure
  - Future Maintenance and Closures
- New Structure
  - Parallel alignment – keep existing open
  - 40 ft clear roadway – improve geometrics

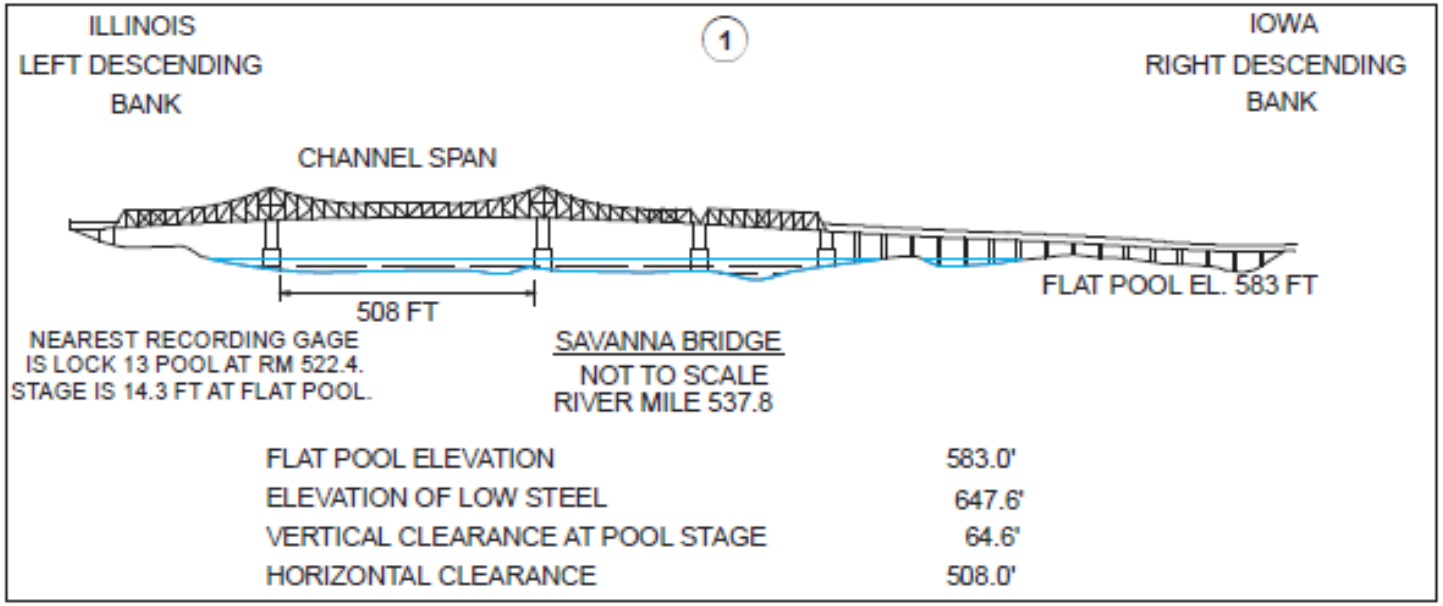
Environmental



Constraints

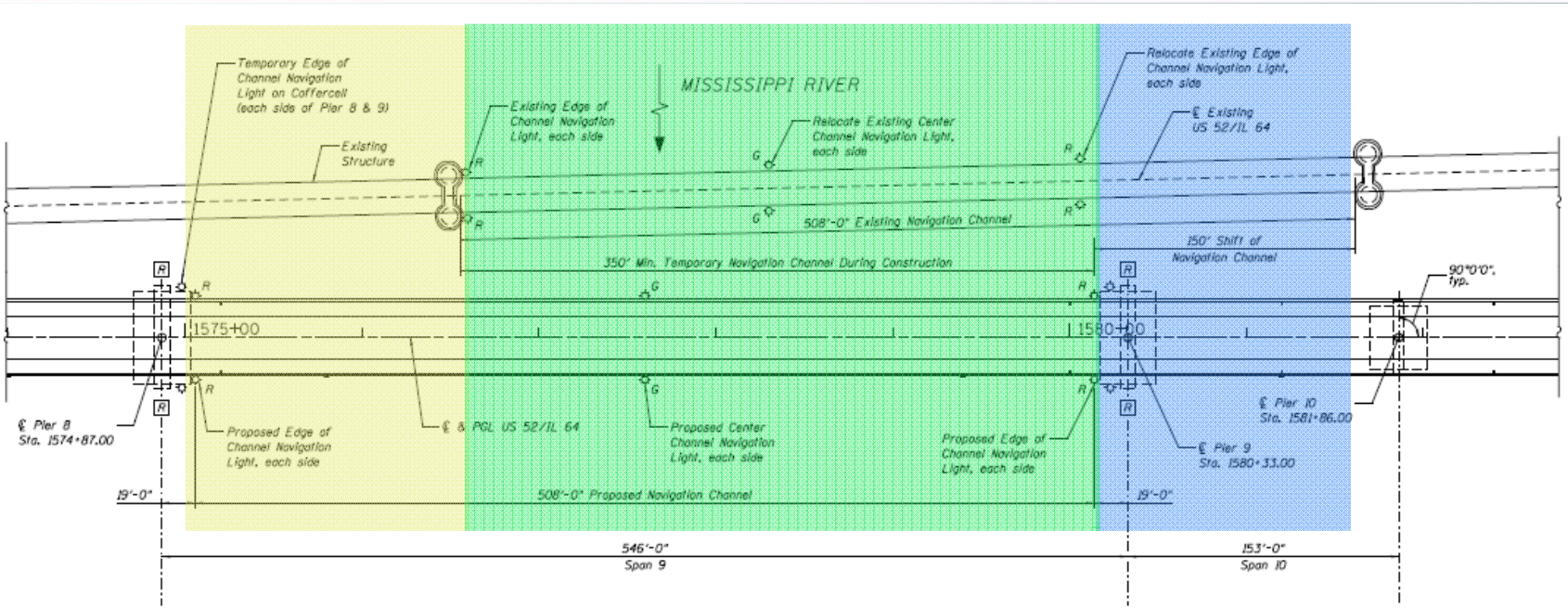
- Iowa Causeway
  - Minimize Environmental Impacts
  - Minimize Causeway Construction
- Illinois Intersection
  - Between bluff and railroad
  - Minimal change to existing IL 84
  - Tie-in at highpoint
  - Limit ROW Impact
- Minimize grades to 4% if possible

Navigation Clearance



- Maintain Existing Clearances
  - Channel near Illinois bank
  - Steep grade with existing tie-in (> 4%)
  - Minimal Superstructure Depth

Navigation Channel Shift



- Approach USCG with Channel Shift
  - Proposed 200 ft shift to west
  - Agreed to 150 ft shift to west
  - Maintain 350 ft channel during construction
  - 7.5 ft superstructure depth and 4% max grade

Bridge Type Study

- Evaluated 3 Types – Tied Arch, Cable-stayed, Plate Girder

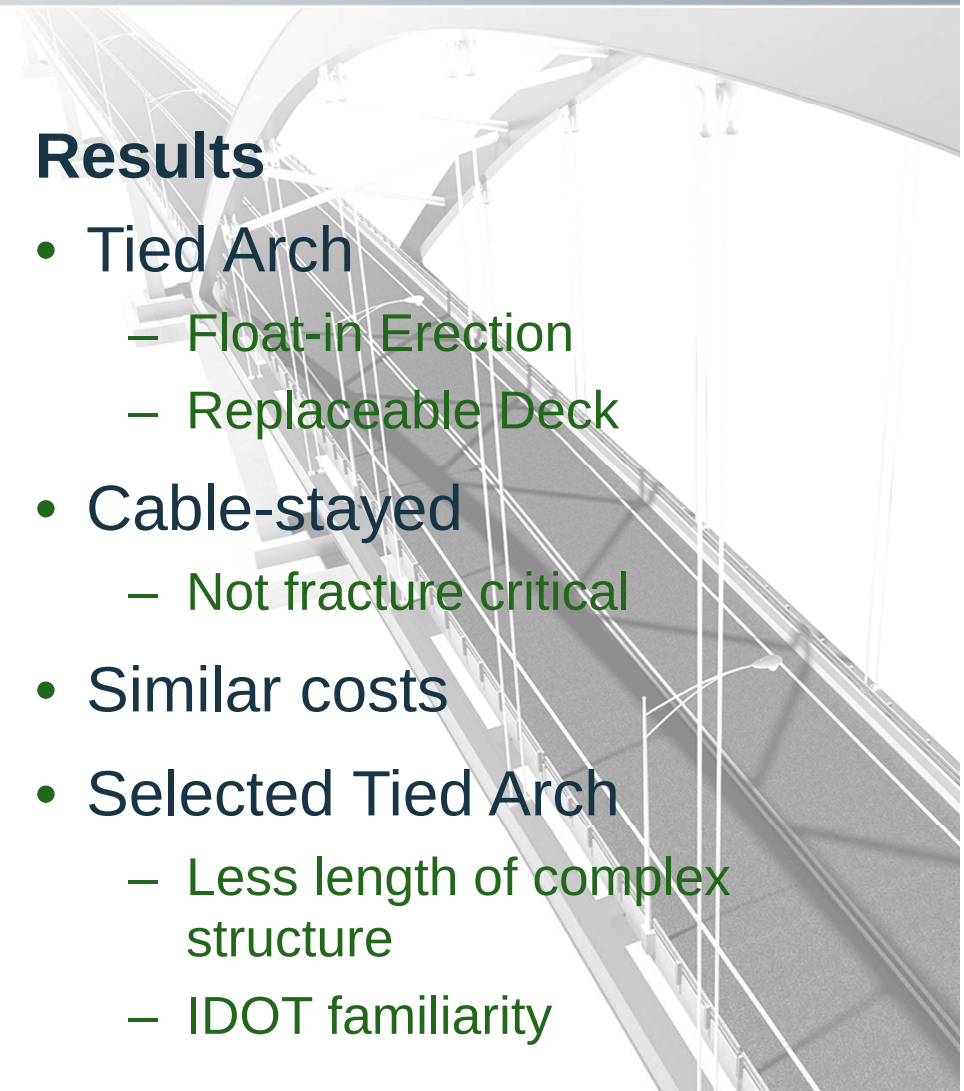
Bridge Type Study Evaluation

Criteria

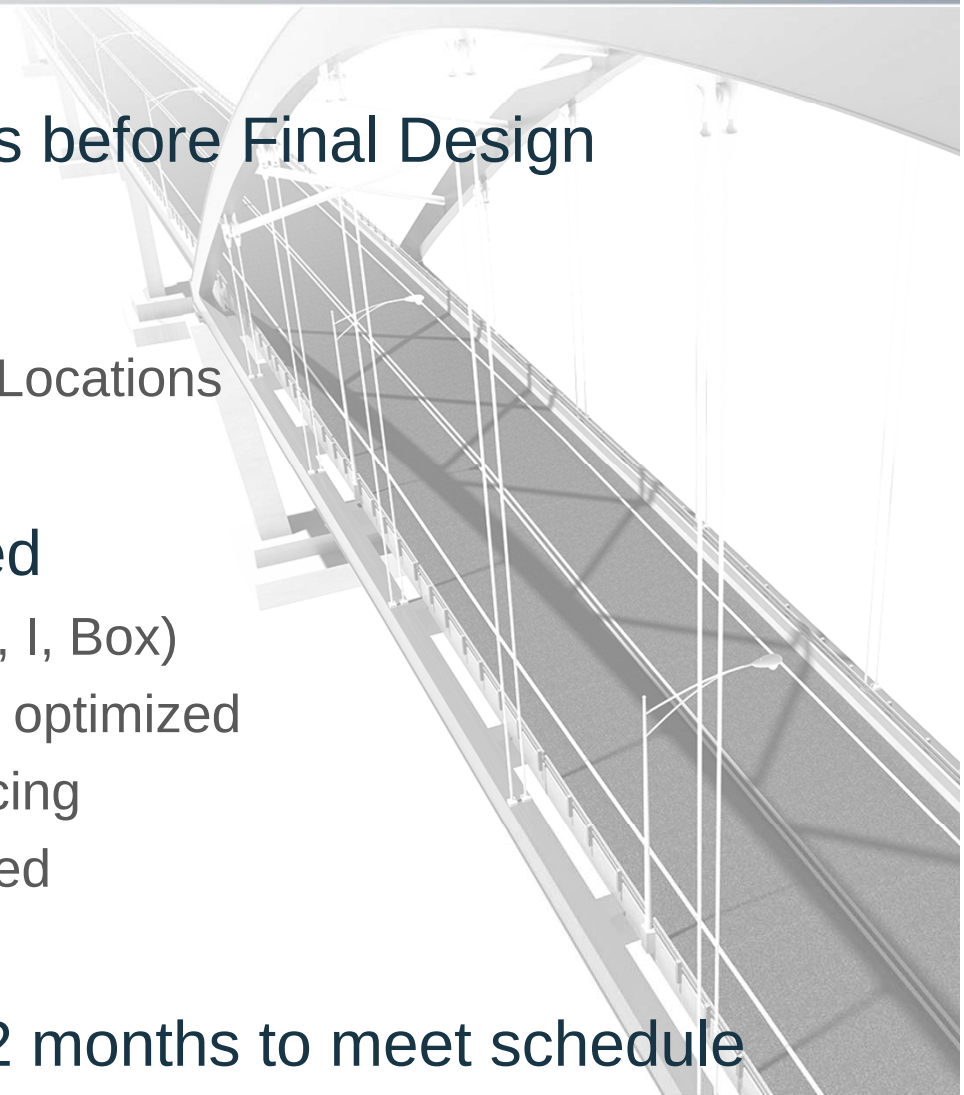
- Initial Cost
- Inspection & Maintenance
- Aesthetics
- Durability
- Constructability
- Environmental Impacts
- Structure Depth
- Geotech
- Hydraulics
- Future Widening

Results

- Tied Arch
  - Float-in Erection
  - Replaceable Deck
- Cable-stayed
  - Not fracture critical
- Similar costs
- Selected Tied Arch
  - Less length of complex structure
  - IDOT familiarity

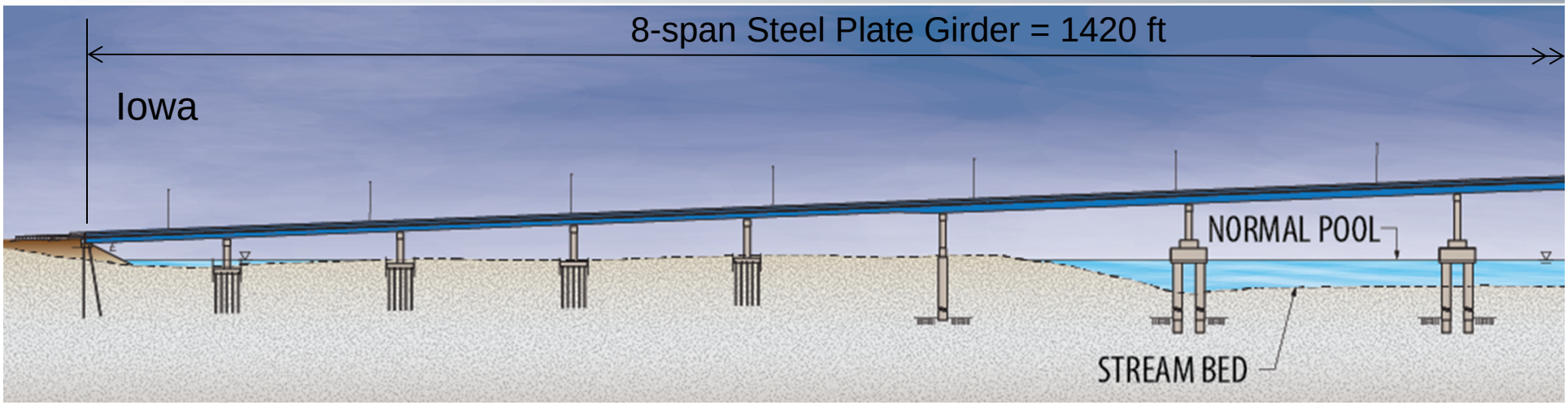


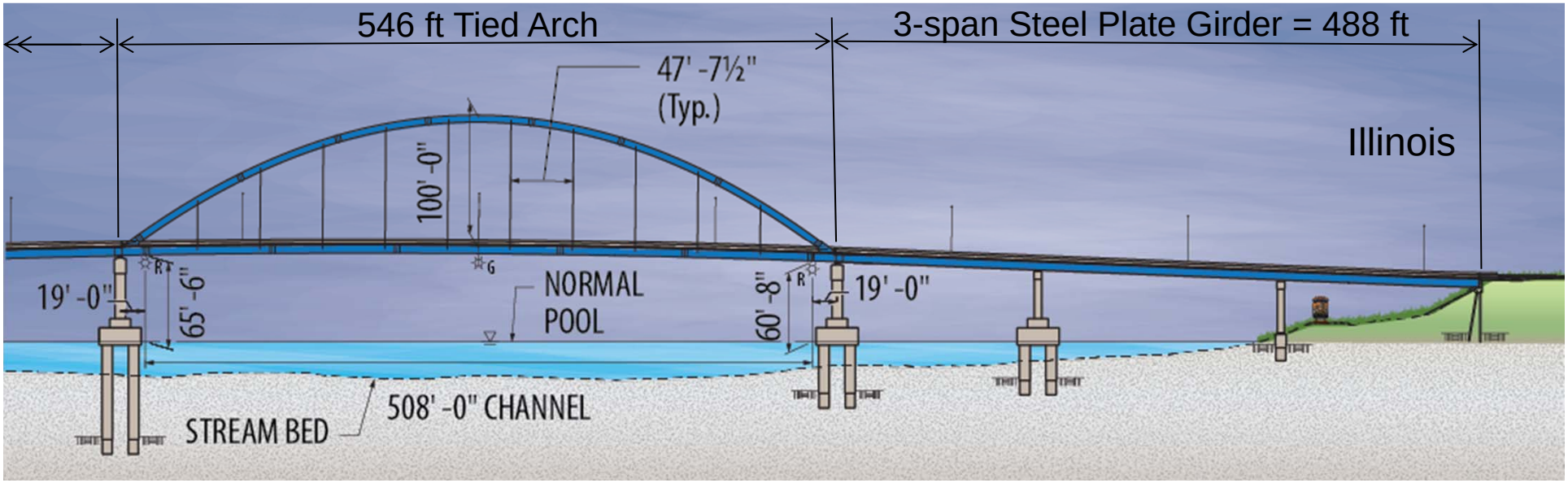
Preliminary Design Development



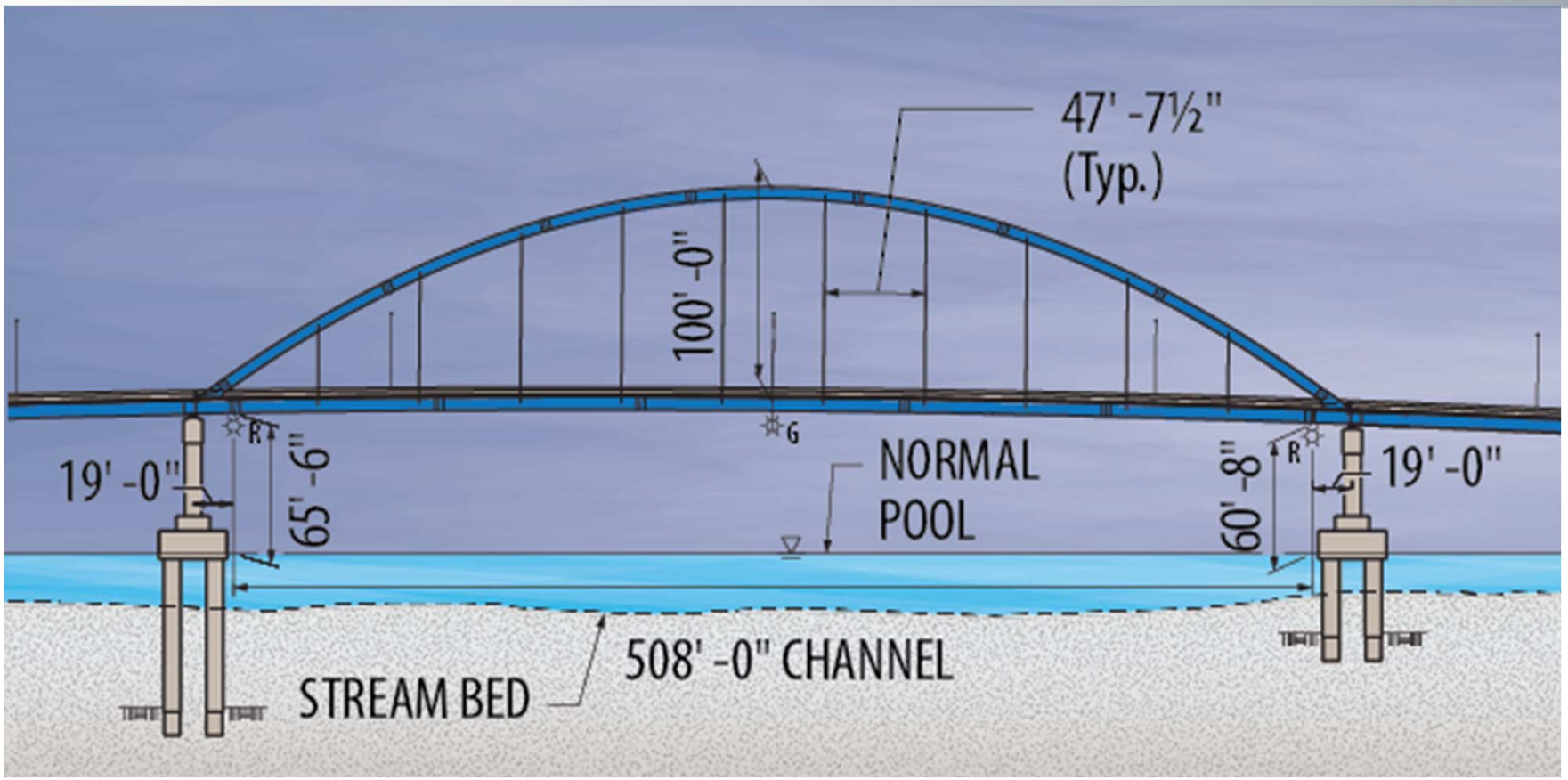
- Advance Structural Decisions before Final Design
  - Vessel Collision Study
  - Approved Design Criteria
  - Optimized Span Layout / Pier Locations
  - Foundation Type Study
- Tied Arch Concepts Advanced
  - Sections defined and sized (H, I, Box)
  - Floor beam sized and spacing optimized
  - Hanger arrangement and spacing
  - Floating deck concept advanced
  - Stringer fixities defined
- Final Design completed in 12 months to meet schedule

Proposed Structure



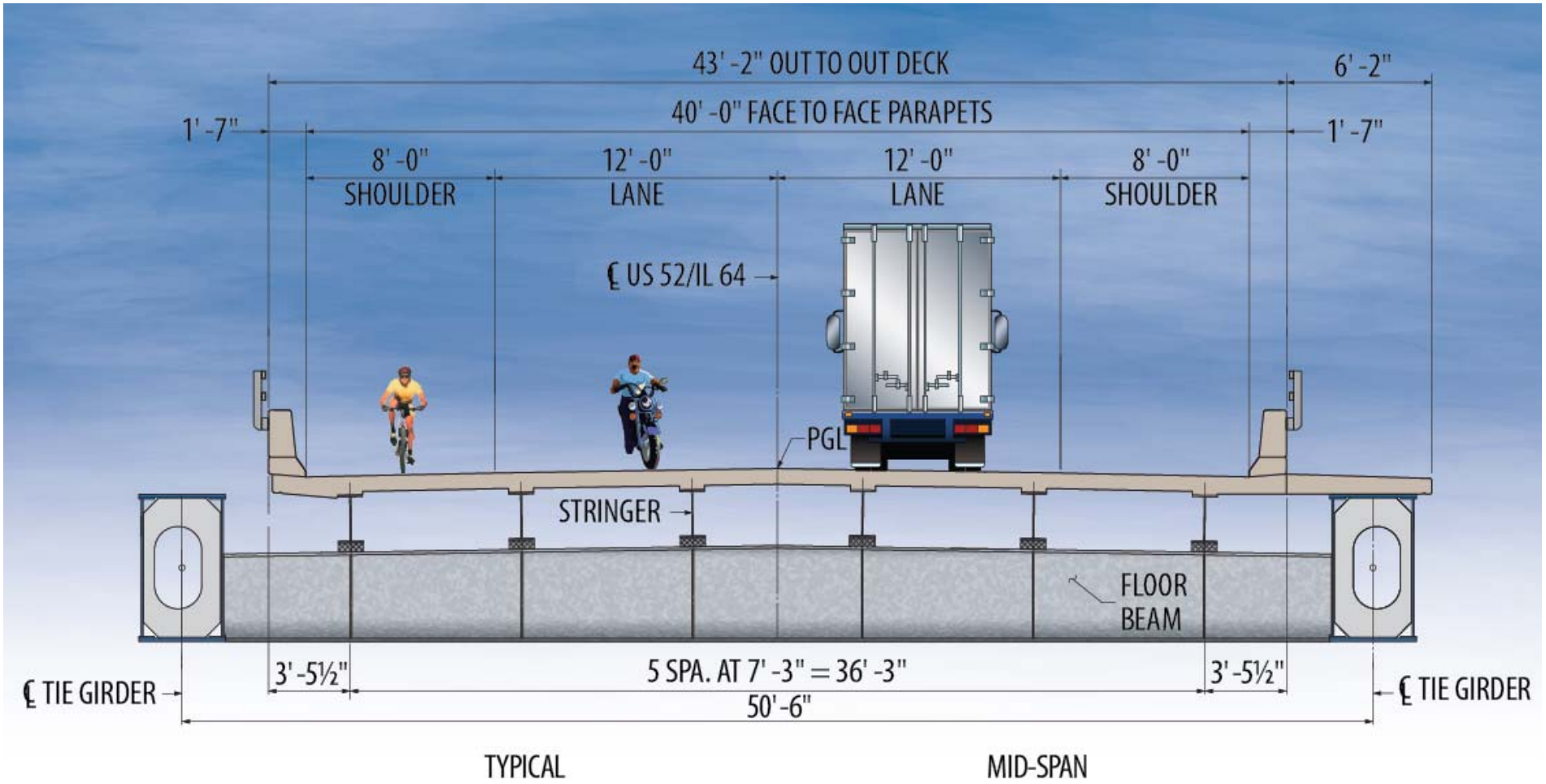


Tied Arch



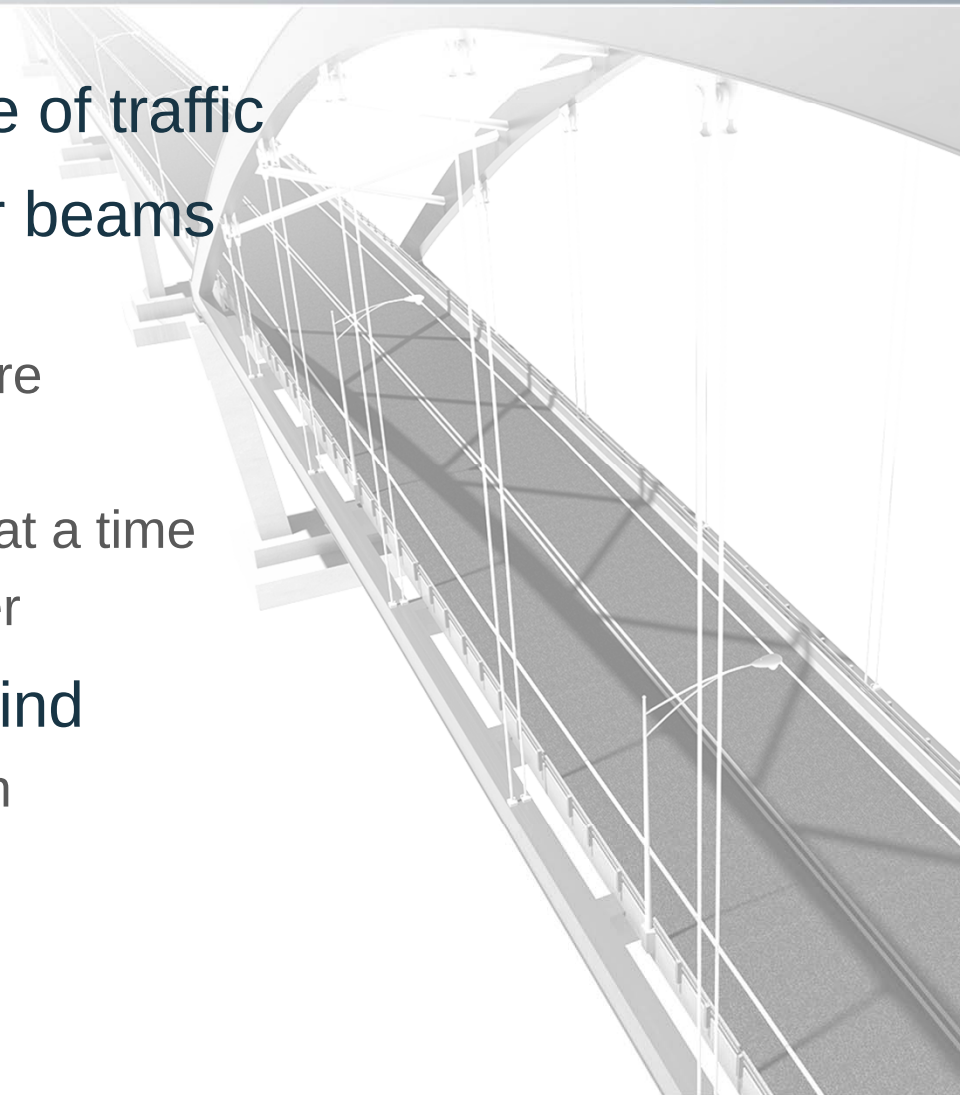
- 546 ft span, 100 ft rise, span to rise ~ 5.5:1
- Floor Beam Spacing – 31’-9”

Cross Section



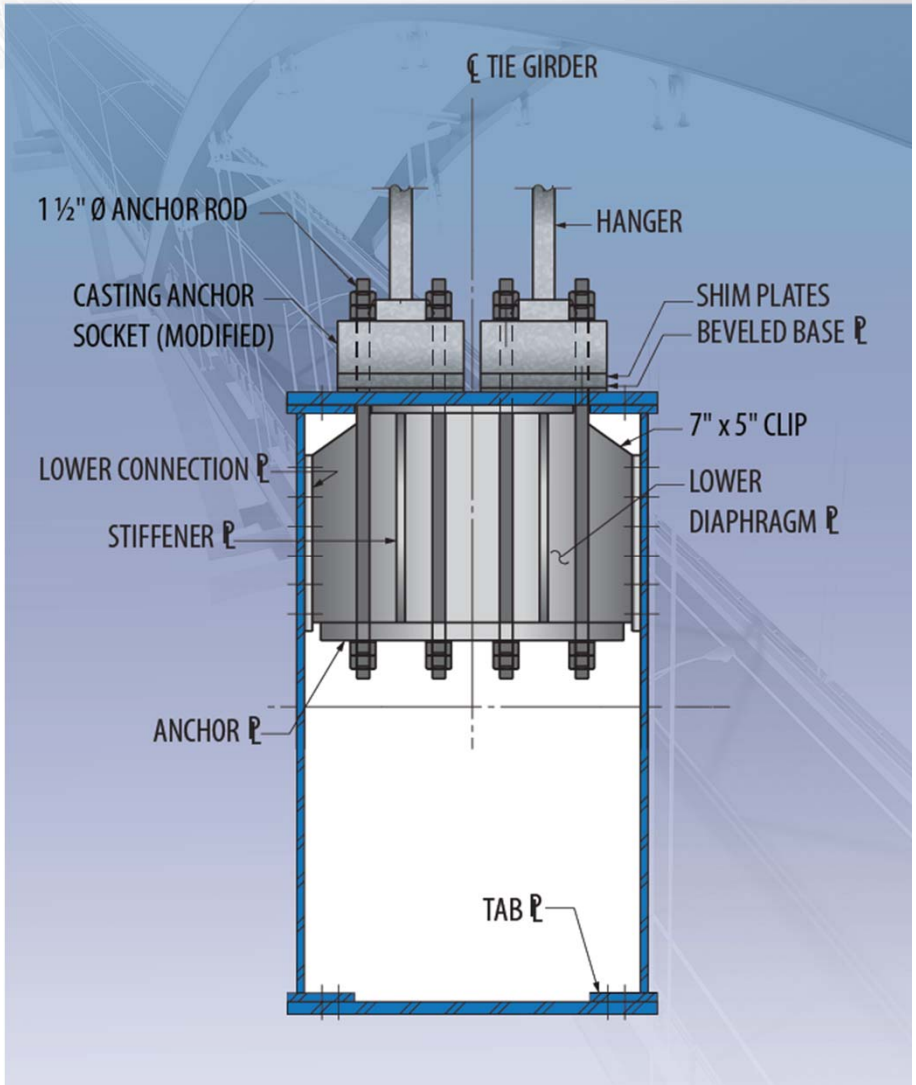
Floating Floor System

- Replaceable deck with 1 lane of traffic
- Stringers spanning over floor beams
  - Bearings at center span fixed
  - Elastomeric bearings elsewhere
  - Deck full length of span
  - Allows deck replacement half at a time
  - Deck connected to tie at center
- Lower lateral K bracing for wind
  - Braces floor beam at mid-span
- Galvanized floor system
  - Lengths under 60 ft
  - Corrosion protection



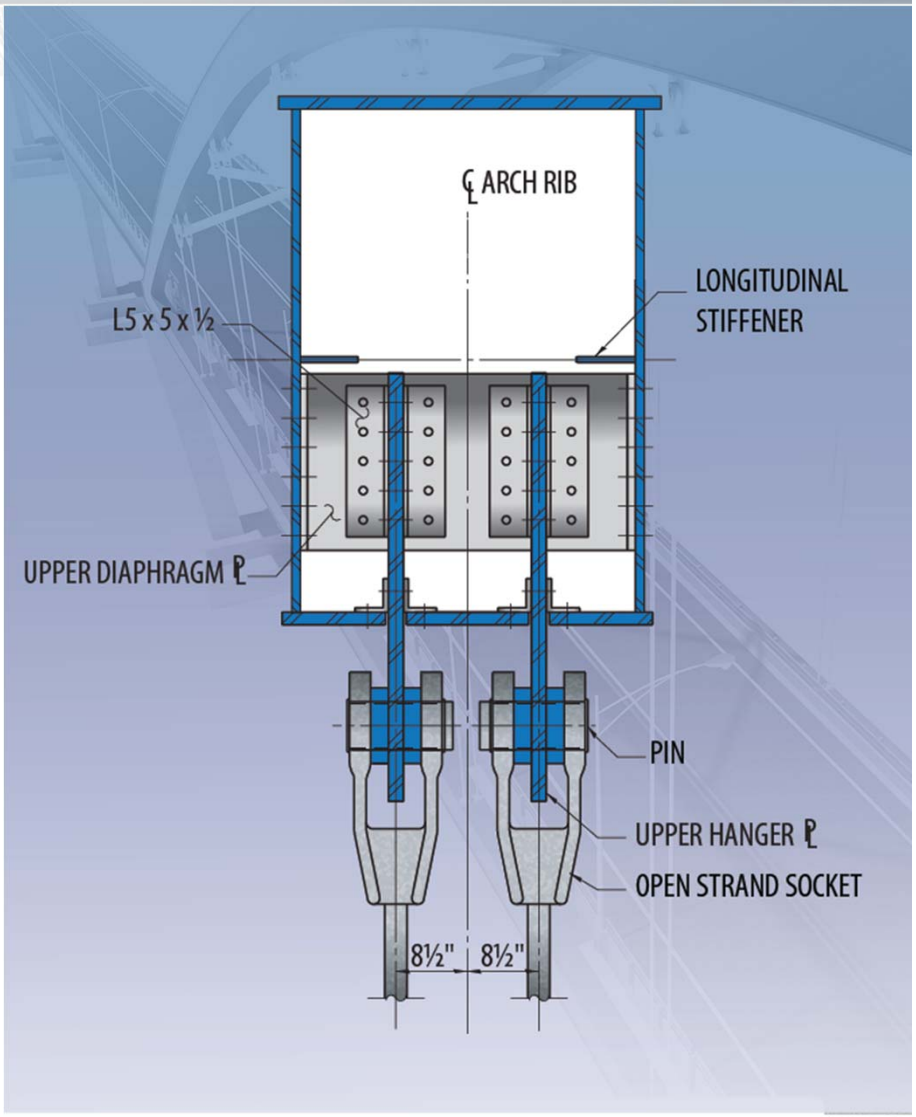
Tie Girder and Lower Hanger

- Bolted Box Tie full length
  - Tab plates
  - 6 ft deep
  - HPS50W
- Hanger connection offset from Floor beam
  - Simplifies detailing
- Connection precompressed
- 4 anchor rods provide redundancy
- Shim plates for length adjustment



Arch Rib and Upper Hanger

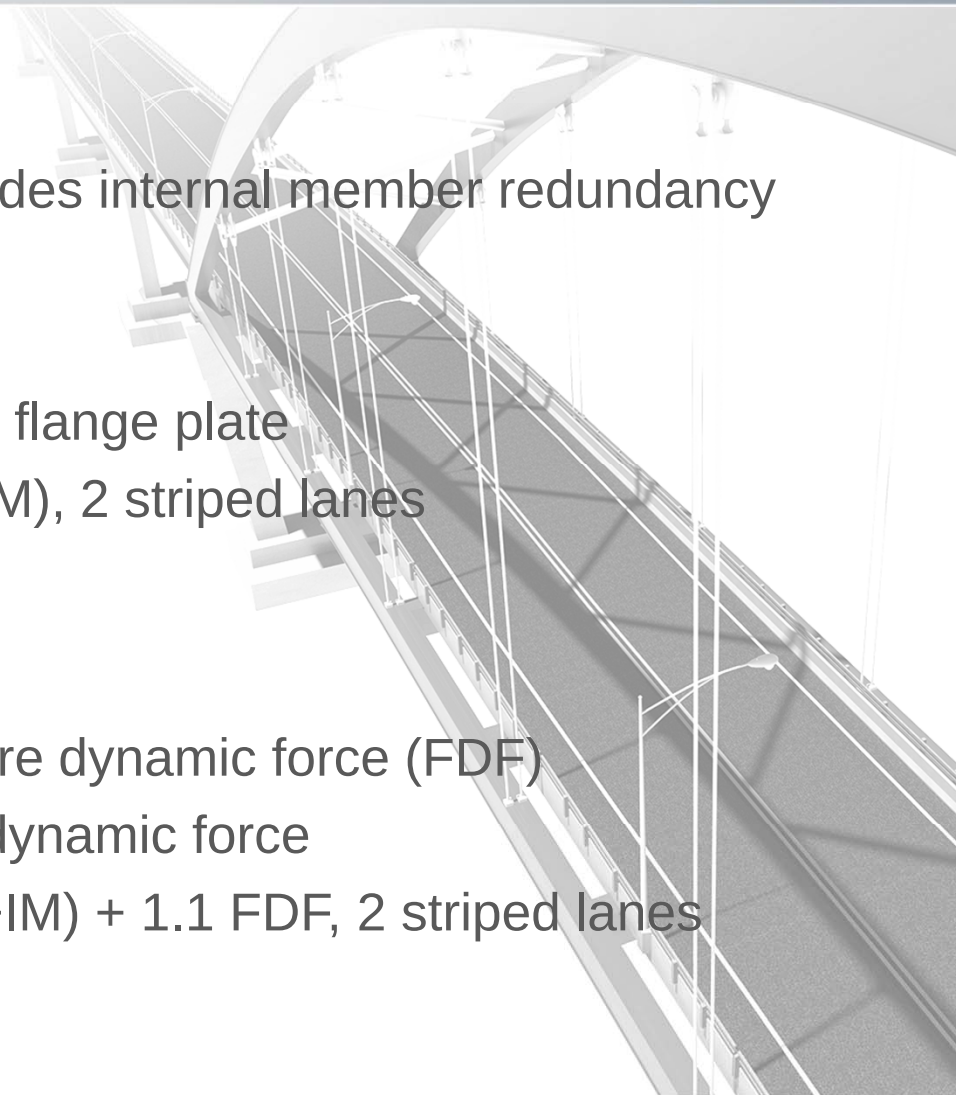
- Welded Box Rib
  - Longitudinal stiffener
  - 5 ft deep
- Hanger connection offset from bracing connection
  - Simplifies detailing
- Two hangers
  - minimize strand size
  - easier replacement
- Hanger connections bolted to rib



Upper Bracing

- X-bracing chosen
  - Smaller members than Vierendeel
  - Tension & Compression only
  - More modern look than K-bracing
- HSS 16x16
  - Efficient member section
  - Consistent box section
- Galvanized
  - Corrosion protection on inside of box
  - Distinct contrast with blue rib
  - Low maintenance / impact to traffic

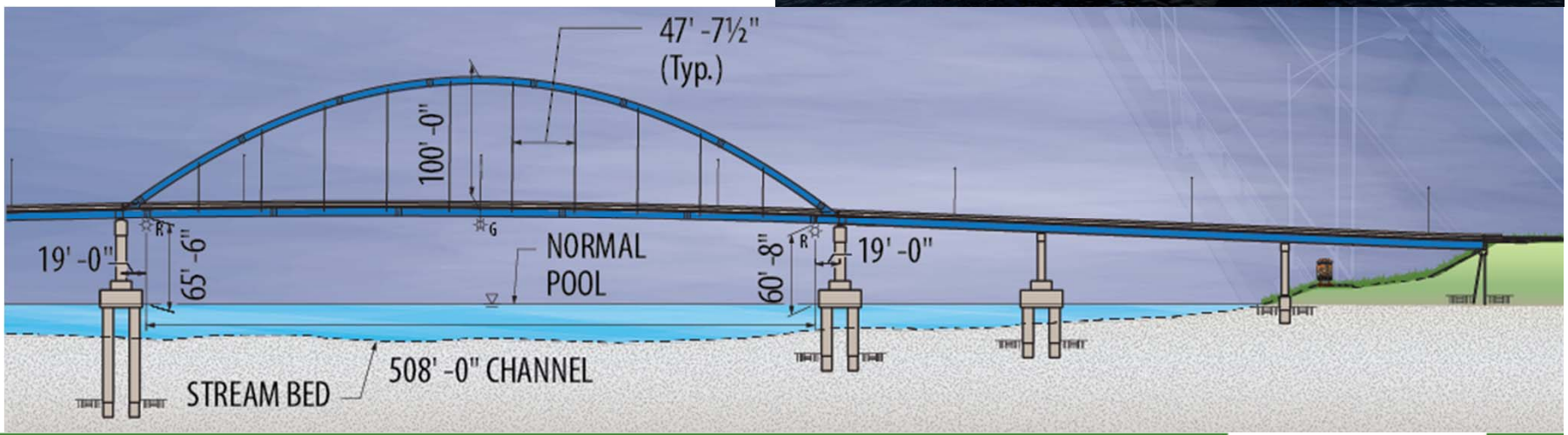
Redundancy



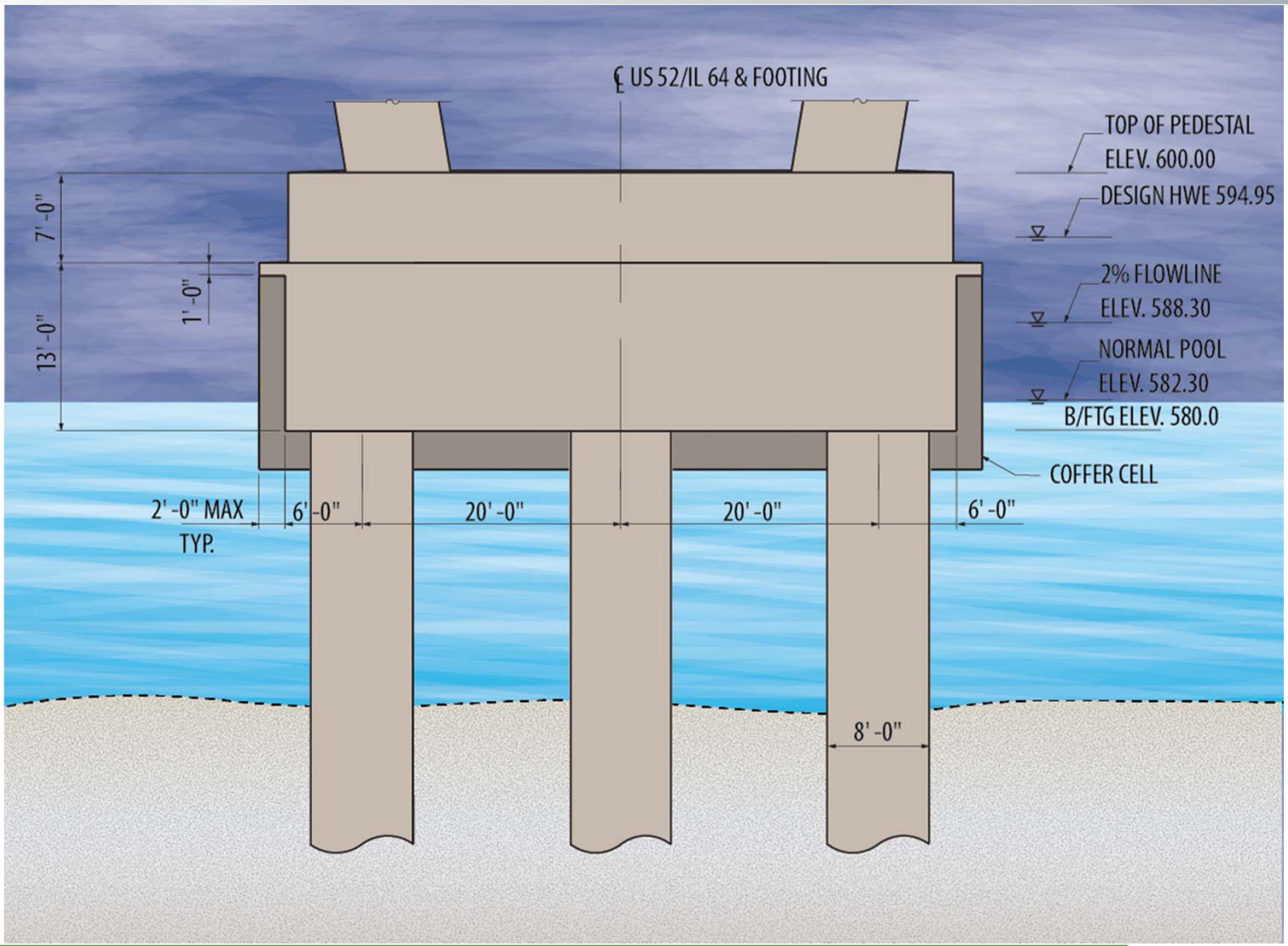
- Tie Girder
  - HPS50W and bolted box provides internal member redundancy
  - Limits propagation of fracture
  - Still Fracture Critical
  - Designed for loss of tie web or flange plate
  - 1.25 DC + 1.5 DW + 1.3 (LL+IM), 2 striped lanes
- Hangers
  - Two hangers per location
  - Loss of one hanger with fracture dynamic force (FDF)
  - Loss of both hangers without dynamic force
  - 1.1 DC + 1.35 DW + 0.75 (LL+IM) + 1.1 FDF, 2 striped lanes

River Pier Foundations

- Minimal cost aesthetic enhancement for arch piers
- Rock close to surface in IL
- 130 ft of sand + on IA side
- Deep river pool
- Waterline footings



Drilled Shaft with Coffercell

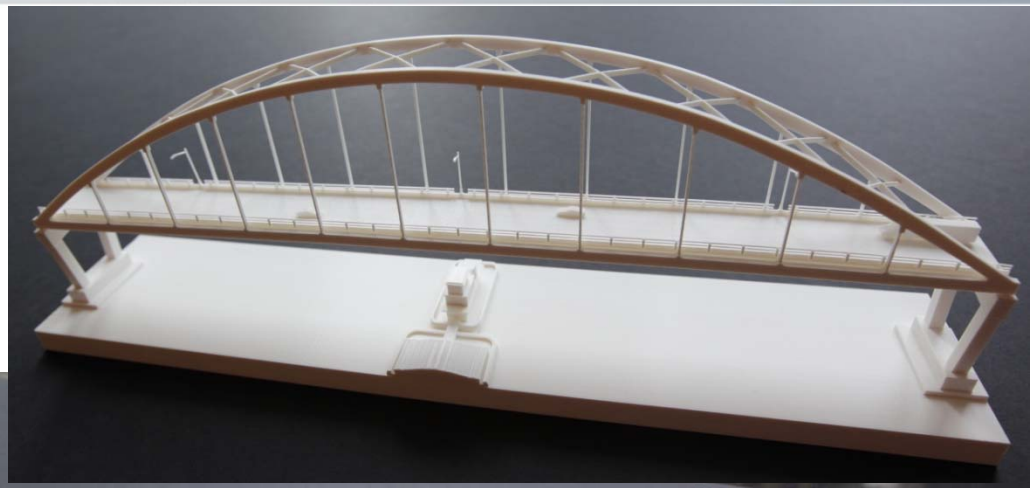


Constructability Review

- Provided IDOT a constructability review
  - During preliminary design phase
- Parsons Construction Group
  - Experience in Large River Bridge Construction
  - Identified staging and access areas
  - Identified potential construction issues
- Provided IDOT a contractor style estimate
  - Preliminary and Final Design
  - Parsons construction estimating group

3D Printing Model for Public Communication

- In house capability for conveying signature or complex details



Construction

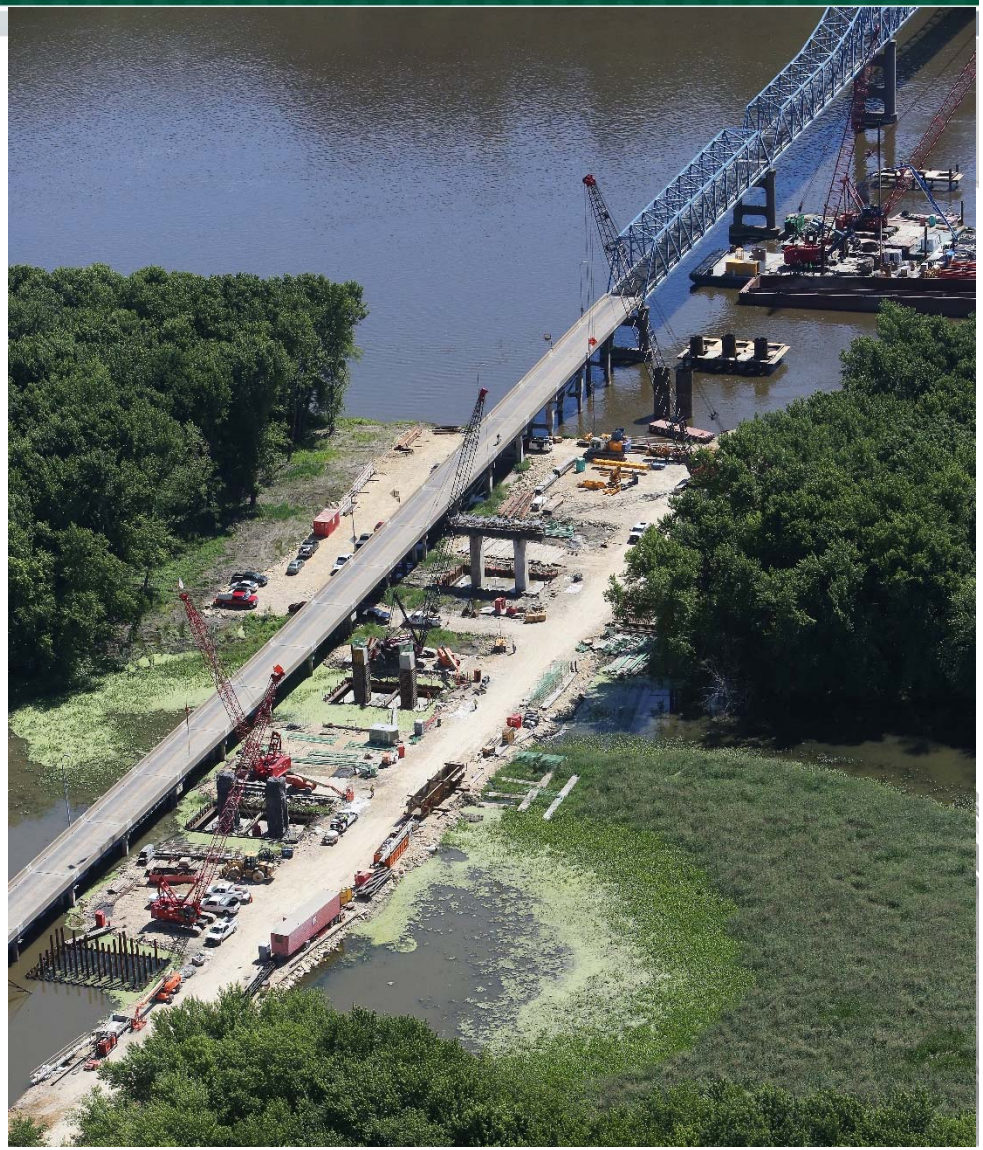
- Five Bids Received Sept. 18, 2015
- Winning Bid of $80.6M from Kraemer N.A.
  - Steel Fabricator – Veritas
- Within 3.9% of Engineer's Estimate
- Cantilever Erection of Tied Arch
- New bridge open in November 2017

Aerial June 2016

Aerial June 2016

Aerial June 2016

Aerial June 2016



August 2016

August 2016

August 2016

April 2017

April 2017

April 2017

April 2017

June 2017

June 2017

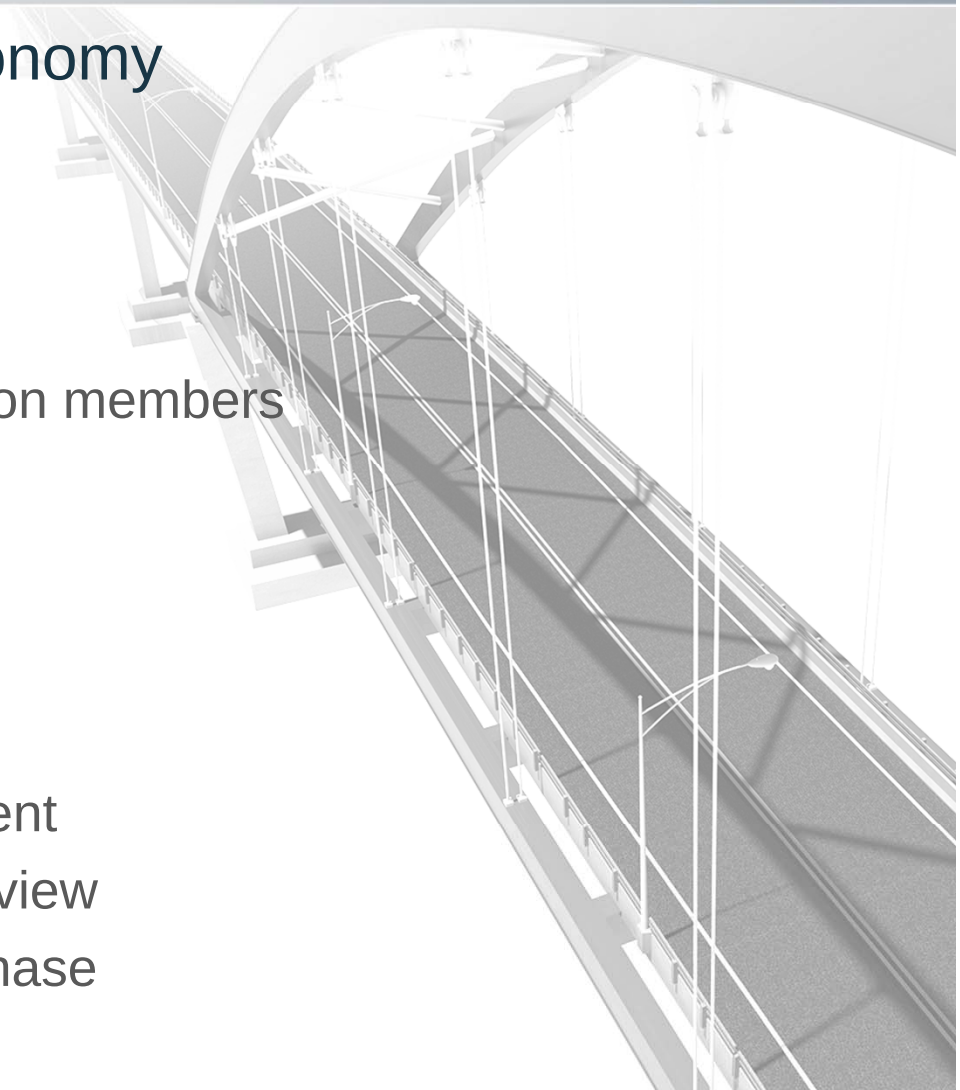
June 2017

June 2017

August 2017

Summary

- Aging Bridge key to local economy
- Replace with Tied Arch
  - Improved geometrics
  - Replaceable deck
  - Provided redundancy for tension members
  - Waterline footing construction
- Keys to Success
  - Strong Community Support
  - Early Client Involvement
  - Preliminary Design Development
  - Contractor Constructability Review
  - Led to efficient Final Design phase



Questions?

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