Bill Johnson, PE, SE
FIGG

NHJES 9th Annual Conference
Thursday, October 1, 2015
8:30am – 9:30am

Sarah Mildred Long Bridge –
Two States, Three Bridges in One

US Route 1A (Bypass) - The Regional Crossing Linking Kittery, Maine and Portsmouth, New Hampshire
Project Team

**Design Team**
- Bridge Design
  - FIGG
  - Hardesty & Hanover
  - Joint Venture
- Roadway Design
  - SEBAGO TECHNICS
- Geotechnical, Hydraulics
  - GZA

**Construction Team**
- Builder
  - CIANBRO
- Construction Inspection
  - MaineDOT
- Inspection Support
  - Lamb-Star
Project Team consists of three components:

- Owner
- Designer Contract
- General Contractor - Two Phase Contracts

Phase 1 – “Construction Management”
consulting contract to help with design.

Phase 2 – “General Contracting”
contract to build the project.
CM/GC Process - Selection

• Designer is selected by traditional process
  FIGG/H&H JV Selected September 2012

• CM/GC Contractor is selected by RFP Process, Scored on Qualifications and Price Component
  Cianbro Corp. Selected January 2013

• Owner also issues RFP for Independent Cost Estimator (ICE)
  HDR Engineering Selected February 2013
CM/GC Process - Preconstruction

- Design follows typical process
- CM provides Constructability Reviews
- CM Provides Construction Schedules
- CM & ICE Provide Cost Estimates at Incremental Design Completion Phases
- Owner and CM work on negotiating a Construction Contract
  - Agree on price – CM becomes GC
  - Cannot agree – Owner advertises for competitive bid
Key Project Challenges

- Improve Navigation Through Bridge
- Improve Traffic Flow (reduce bridge openings)
- Address Vessel Collision
- Minimize Impacts
  - Historic Resources
  - Essential Fish Habitat & Endangered Species
  - Local Business & Traveling Public
- Manage Project Risk
  - River Currents & Foundation Obstructions
- Meet Budget Goal
Existing bridge opened to traffic in 1940
After over 70 years the steel bridge has deteriorated and needs replacing.
Double deck truss bridge with 2 separate movable openings.

The upper deck provides vehicular traffic with 2 - 12’ wide lanes.

A vertical lift span provides navigational access for large vessels.
The lower deck provides rail access for Portsmouth Naval Shipyard. The retractable approach span stays open for small vessel passage when not in use.
Railroad Bridge Section in retracted position
(Kittery, ME approach span, looking south)
Horizontal clearance is the clear and unobstructed navigational portion of the Piscataqua River that provides safe passage - measured perpendicular to the channel.

Existing Clearance – Navigation Span

6th swiftest navigable waterway in U.S.

No protection for existing towers
• Low clearance in closed position (10’)
• 2,637 bridge openings in 2008
• Average delay of 9.5 minutes for bridge opening
• Matches I-95 bridge in open position (135’)
Proposed Horizontal Clearance for New Bridge
Proposed Typical Clearances

Generic Lift Tower Shape

Lift Span in normal position

Roadway Superstructure

Railroad Superstructure

Lift Span in typical configuration

56’
Proposed Typical Clearances

Generic Lift Tower Shape

Roadway Superstructure

Lift Span in railroad position

Railroad Superstructure

Lift Span lowered to railroad crossing configuration
Proposed Typical Clearances

Lift Span in highest position

Roadway Superstructure

Generic Lift Tower Shape

Railroad Superstructure

Lift Span in highest configuration for tall vessels to pass under

135’
Majority of the Openings are 50’ Height or Less (68% of Openings)
• Design Vessel for protection system – Harmen Oldendorff
• Typical transit speed: 4 knots
• Design collision speed: 2-3 knots
• Maximum displacement tonnage: 85,000 tonnes
• Design displacement tonnage: 65,000 tonnes
• Allow force to be transmitted to tower foundation – (within elastic range)

New SML Fender Layout

Horizontal Clearance in Channel

250’
Design Vessel – Harmon Oldendorf
DESIGN

US Route 1A (Bypass) - The Regional Crossing
Linking Kittery, Maine and Portsmouth, New Hampshire
Benefits of the New Bridge’s Alignment

1. New Alignment is Offset from Existing Bridge Crossing to Maintain Traffic During Construction

2. The alignment of the connection on the north (Kittery) side improves mobility via a new signalized intersection and sidewalks.

3. Maintains the park like, natural settings under and near the bridge.

4. Improves safety for people walking to downtown Kittery with sidewalks.

5. Overall roadway circular minimizes passage of vehicles through neighborhoods, increasing peace and quiet.

6. Minimizes need for and size of retaining walls.

7. No Bridge Street dead end

8. New alignment at 1 allows traffic to be maintained on existing bridge during nearly all of the construction phases.
Boston & Maine #3666
(Photograph from July 1939)

Boston & Maine 4-6-2 Pacific No. 3666.
Photo by Harold Boothroyd, July 3, 1939
Portsmouth Connection

Bridge spans Market Street without piers in the median
Proposed Span Arrangement

Vehicular Approach Bridge
2,432’

Railroad Bridge Underneath
1,407’

Movable Span
300’

Portsmouth

Proposed Bridge

Kittery
Portsmouth Side - Span Arrangement Comparison

New Bridge has 8 less Piers

16 Total Piers

Existing Bridge

69’ 11 @ 70’ = 770’

69’ 86’ 90’ 227’ 225’

162’ 270’ 283’ 307’ 320’ 210’

102’ 160’ 160’ 160’ 135’ 69’

Market Street

Proposed Bridge

162’ 270’ 283’ 307’ 320’ 210’

102’ 160’ 160’ 160’ 135’ 69’

Market Street
New Bridge has 3 less Piers

8 Total Piers

3 Vehicular Piers
2 Railroad Piers
5 Total Piers

Kittery Side - Span Arrangement Comparison

Existing Bridge:
- 8 Total Piers
- 4 @ 71' = 284'

Proposed Bridge:
- 5 Total Piers
- 69' 135' 160' 160' 127'
Lift Span with Vehicles

Railroad Tracks on Deck of Lift Span

42’ - 7’

14’

5’-7”
Roadway Transition from Approach Bridge to Lift Span in Normal Vehicular Position

- Railroad Tracks on Lift Span
- Drivers View
- Deck Width Transition
- 34' - 0"
- 5' - 7"
- 39' - 7"
Approach Bridge Superstructure Type

- Vehicular Bridge
- Railroad Bridge
- Concrete Box Girder
Approach Vehicular Bridge Spans

- Open Vehicle / Bicycle Rail
- Varies 8’ to 13’-6”
- Varies 16’-9” to 15’
- 37’
Approach Railroad Bridge Spans

Varies 19’

Varies 9’ to 11’

Varies 12’ to 11’-4”
Foundation and Pier Construction

Pier Exterior Shape Selected by Stakeholders

**Cast-in-Place Piers**

**Vehicular Piers:**
PV1, PV2, PV3, PV14, PV15
PS5, PS7, PS12

**Railroad Piers:**
PR4, PR6, PR8, PR11, PR13, PR14

**Piers PV1, 2, 3, 15 on CIP Spread Footings**
Movable Bridge Design

- Deflector Sheave
- Operating Ropes
- Counterweight
- Counterweight Sheave
- Counterweight Ropes
- Lifting Girder
- Access Stairs
- Machine Room
- Span Guide System
- Steel Box Girder
- Lift Span
Modified Tower Drive – Only Machinery at Tower Top

- Counterweight
- Sheave
- Upper Deflector Sheave
- Counterweight
Lift Span Tower Components
Lift Span Tower Components
Modified Tower Drive – Operating Machinery at Base of Tower

Machine Room
Modified Tower Drive –
Operating Machinery at Base of Tower
Modified Tower Drive – Operating Ropes Control Span Movement

Operating Ropes - 4 ropes per drum
(2 up haul, 2 downhaul)
Drums with opposite hand grooves
Downhaul Ropes (Green) From Drum to Bottom of Counterweight
Up haul Ropes (Yellow) From Drum to Upper Deflector Sheave to Counterweight

Color illustrates up and down rope movement
Modified Tower Drive Advantages

- Operating Machinery Located in Pier Bases
  - Easy Access for Maintenance
  - Weight of Machinery Not on Span and Towers

- Positive Control of Span Movement
  - Operating Ropes Pull on Top & Bottom of Counterweights

- Operating Machinery Can Be Fully Tested Before Lift Span is Placed
  - Counterweights Partially Loaded to Imbalance Weight and Tested as a Closed Loop
Movable Bridge - View from Water
Shape Features Selected with Stakeholder Input
### Stakeholder Meetings & Workshops

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<td>April 26, 2013</td>
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<td>November 20, 2013</td>
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Design Workshop Community Input

- Selected Theme – Local Simplicity of the Working Waterway
- Selected Open Bridge Railing
- Selected Pier Shape
- Evolved Preferences for Tower Concepts & Bridge Lighting

OPEN BRIDGE RAILING

PIER CONCEPT
Lift Tower Cross Section Shape
Exterior Shape Selected by Stakeholders

Precast Segments
Lift Tower – Open Top with Sheave
Open Top Selected by Stakeholders
Lift Tower - Driver’s Perspective
Glass on Face above Deck Selected by Stakeholders
Vista Looking from Market Street in Portsmouth, NH
Vista Looking from Market Street in Portsmouth, NH
Vista Looking from I-95
Vista Looking from Ceres Street

(Existing)

(Proposed)

RENDERING
Bridge Lighting

Existing Sarah M Long Bridge

Existing bridge has roadway lighting

NEW Bridge will also have roadway lighting using current LED (Light Emitting Diodes) Technology
Solid State LED (Light Emitting Diodes)
Energy Efficiency & Low Maintenance

Can vary intensity and color
Can vary intensity and color

Tower Lighting on Sheaves & Behind Glass
US Route 1A (Bypass) - The Regional Crossing Linking Kittery, Maine and Portsmouth, New Hampshire

- Access
- Foundations
- Precasting
- Lift Span
- Erection
- Demolition

In Cooperation with the

MaineDOT

State of New Hampshire

FHWA

SARAH MILDRED LONG BRIDGE REPLACEMENT PROJECT

Construction

RENDERING
Aerial View – Construction Access

Kittery, ME

Portsmouth, NH

Access Trestle – Shown as Orange
Access – Trestle from Portsmouth, New Hampshire
Access – Trestle from Portsmouth, New Hampshire
Access – Trestle and Causeway from Kittery, Maine
Access – Trestle and Causeway from Kittery, Maine
Portsmouth Access – Cofferdam for Pier PV1, 2 and 3
To Construct Seal Slab & Spread Footings
Pier PV14 / PR14
Common Footing
Drilled Shaft Installation

Kittery Causeway Access – Pier PV14 / PR14
Drilled shaft casing splicing
Drilled shaft casing splicing

Welding guides
Auger Bits

Wirth Drill Bit

Drilled shaft rock excavation
Drilled shaft rebar
Drilled shaft rebar splicing
Drilled shaft tremie pour
Footing Forms – Precast Tubs

Piers on 10’ Diameter D.S. with CIP Footing Cap

NOTES:
1. TOTAL UNIT WEIGHT NOT TO EXCEED 120 PCF WITH DCI.
2. Fc’ = 4500 PSI @ 28 DAYS
3. GRADE 60 REINFORCEMENT.
Lift Span Tower - Segment Precasting at Port of NH

Casting Beds

Segment Storage

Loading Wharf

Piscataqua River

Market Street

PRELIMINARY FOR PROJECT PRE-PLANNING
Lift Span Tower - Segment Rebar in jig
Lift Span Tower - Segment Pour
Lift Span Tower - Segment Match Casting

- Segment match cast on top
- Segment cast prior
Lift Span Tower - Segment Match Casting

Form stripped and top segment ready to be moved

Segment moved into hole here to be match cast against
Lift Span Tower - Segment Transportation

Segment cast prior
Segment match cast
on top

Kamag K25
Transport Trailer

Lift Span Tower - Segment Transportation
Approach Superstructure Segments Precast at Unistress Yard in Pittsfield, MA
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Approach Superstructure Segment Precasting Yard
Approach Bridge Spans –
P/C Balanced Cantilever Construction

- Vehicular Bridge Spans
  Vary 200’ to 320’.
- Railroad Bridge Spans
  Typically 160’.

Set Precast Pier Table, then Place Segments on Alternating Sides
P/C Balanced Cantilever Construction

Continue Attaching Precast Segments – Alternating Sides of Pier
P/C Balanced Cantilever Construction

Thread and Stress Post-Tensioning after Placing each Segment
Complete 1st Cantilever and Start 2nd Cantilever at Next Pier
Pour Mid-Span Closure Joint between 1\textsuperscript{st} and 2\textsuperscript{nd} Cantilevers. Then Repeat Sequence for Remaining Spans.
P/C Balanced Cantilever Construction

Erect Pier Table

Erect 1st Cantilever

Example from Victory Bridge for New Jersey DOT
P/C Balanced Cantilever Construction

Erect 2nd Cantilever

After Pier Table is Set, Can Erect Multiple Segments each Day

Complete Closure between Cantilevers
Schedule:

Started Construction – November 2014
Drilled Shafts Complete – March 2016
Precasting Complete – July 2016
Tower Erection Complete – November 2016
Close Existing bridge – November 2016
Segment Erection Complete – July 2017
Open to Traffic – September 2017
Demolition Complete – June 2018
THANK YOU!

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www.maine.gov/mdot/sml