Clothespin Bridge Replacement

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Introduction

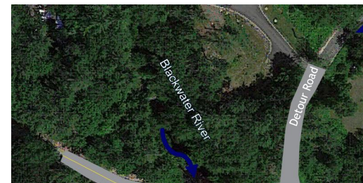
Clothespin Bridge is currently on the NHDOT Red List due to structural deficiencies. The approaching roadway does not meet the horizontal and vertical alignment requirements. The current bridge is also a one lane which creates safety issues due to the poor alignment. For these reasons, a complete bridge replacement and roadway design is in order. The project will detail the design of the substructure and superstructure to meet loading requirements as well as the roadway design which will be conducted to meet the NHDOT requirements.

Project Background

Existing Bridge

Clothespin Bridge over Blackwater River, Webster, NH:

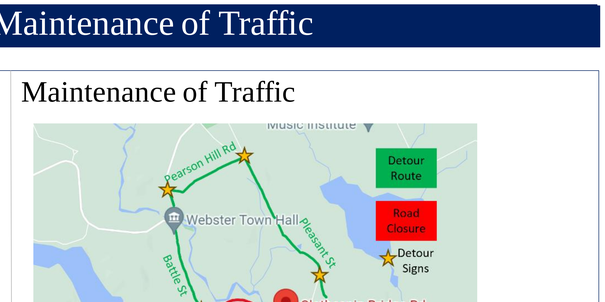
- Original construction unknown, rehabilitations were conducted in 1939 and 1954
- Steel beam superstructure with7-inch concrete deck
- 65-foot clear span
- 18-foot bridge with 20-foot approach (single lane)
- Inspection in 2022 Rated the Bridge deck "2-critical", superstructure "5-fair", and substructure "4-poor"
- The bridge has been listed on the NHDOT Municipal Red List since 2014



1. Deteriorating Deck
2. Section loss in steel girders/ cracking in east abutment
3. Section loss in west abutment

Existing Roadway

- Approach roadway width of 20 feet is satisfactory
- Vertical and horizontal alignment is substandard
- Bridge Clear width of 18 feet does not meet NHDOT 24-foot requirement



Cost Analysis

	Steel Option ($)	Concrete Option ($)
Bridge (superstructure, substructure, excavation, etc.)	1,232,500	921,000
Traffic Maintenance	75,000	75,000
Bridge Removal	150,000	150,000
Miscellaneous	331,000	287,000
Mobilization	159,000	138,000
Roadway alignment (off-line)	81,000	81,000
Item Contingency	285,000	248,000
Total	2,313,500	1,900,000

In preliminary design, a concrete beam option was compared to steel plate girders as the preferred superstructure type. The cost difference between the two was determined insignificant to outweigh the increased benefits that the steel option displayed.

Methodology

Hydraulics
- Bridge clear span determined using *NH Stream Crossing Guidelines*
- *USGS StreamStats* Investigation
- Hydrologic and Hydraulic Summary

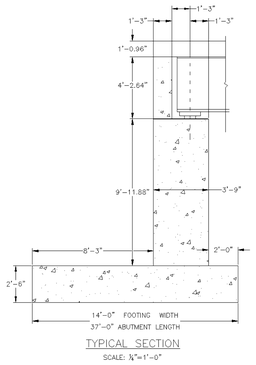
Superstructure
- Minimum depth estimated using AASHTO LRFD Bridge Design Specifications

Substructure
- Geotechnical Engineering Report
- NHDOT Bridge Design Manual

Roadway
- AASHTO A Policy on Geometric Design of Highways and Streets (Green Book)

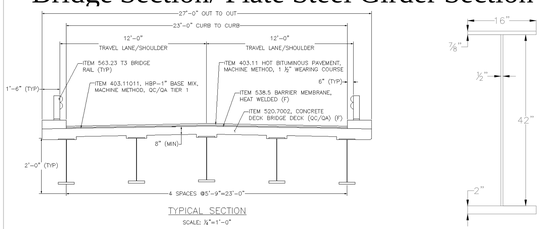
Substructure/ Superstructure Design

Cantilevered Abutment on Spread Footing



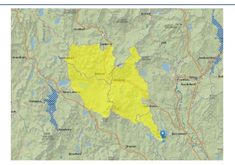
- A Geotechnical Report provided by Terracon showed bedrock outcrops at the western approach at a depth of 30-40 ft.
- Shallow foundation was selected as the preferred substructure alternative.
- Utilizing a series of calculations and the design loadings, a fully dimensioned foundation has been proposed.

Bridge Section/ Plate Steel Girder Section



- The final bridge design has been completed in accordance with CSI bridge software to verify the proposed dimensions are suitable for the design load that the bridge will experience.
- The steel plate girder has been designed to meet AASHTO LRFD Bridge Design web depth requirements based on the bridge proposed span of 107 feet.

Hydraulics



- Watershed area: 129 Square Miles
- Floodway Width: Varies from 57 feet to 84 feet (Upstream vs. Downstream)
- 1 foot freeboard accounted for 50-year flood event
- Passes 50-year and 100-year flood capacity and freeboard requirements.
- 685 square foot proposed waterway opening

Event	Design Flow (cfs)	Starting WSE (ft)	Low Chord Elevation (ft)
50 Year	2400	438.39	443.9
100 Year	2460	438.45	443.9

Permits

National Pollutant Discharge Elimination System (NPDES)
- General Construction Permit

NH Department of Environmental Services (NHDES)
- Wetlands Permit
- Shoreland Impact Permit
- Stream Crossing Permit

Roadway Design/ Maintenance of Traffic

Roadway Alignment

An off-line alignment is the preferred bridge alignment. This will resolve the horizontal alignment issue and improve sight lines. This will result in a 107-foot bridge at a skew of 40 degrees.

Maintenance of Traffic

A detour route has been mapped as complete road closure will be necessary in the demolition and reconstruction of the bridge. The detour will result in roughly a 10-minute delay and is a 4-mile loop.

Acknowledgements

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Thank you to our Faculty Advisor Matthew Low, PE.
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References

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StreamStats, streamstats.usgs.gov/ss

New Hampshire Stream Crossing Guidelines. United States Army Corps of Engineers, 2009.