

Introduction

Barters Island Bridge #2039 carries West Barters Island Road over the Back River in Boothbay. The Back River is a 4.8-mile-long tidal channel that defines the east and south sides of Barters Island and connects with the Sheepscot River, which forms the west side of the island. Bridge #2039 is located 7.8 miles inland of the Atlantic Ocean within the Sheepscot Bay area. In the National Estuarine Inventory, the Sheepscot Bay zone is designated as the 18-mile-long coastal limits between Small Point and Pemaquid Point.

The bridge site is subject to flow in both directions as the tide causes the current to reverse directions twice each day, with negligible inland flow from the Back River basin. The coastal area adjacent to the Atlantic Ocean are subject to periodic flooding and wave attack that accompany northeasters and hurricanes. Storm surges are also possible, as sustained inland winds and high tides combine to increase the overall water surface elevations through multiple tidal cycles.

FEMA has prepared the Flood Insurance Study (FIS) for Lincoln County (Effective date is July 16,2015), and referenced data has been used for this project. All elevations in this report section, unless noted otherwise, refer to the North American Vertical Datum of 1988 (NAVD88)

Tidal Data

Project tidal elevations were estimated for bridge using Portland as the Reference Station and Phipps Point as the Subordinate Station. See tidal elevation calculations on pp. D-13 & D-14 in Appendix D.

TIDAL DATA	
Mean Lower Low Water (MLLW)	-5.28 feet
Mean Low Water (MLW)	-4.93 feet
Mean Tide Level (MTL)	-0.35 feet
Mean High Water (MHW)	4.23 feet
Mean Higher High Water (MHHW)	4.62 feet
2015 Predicted High Tide	6.32 feet
Q10 Elevation	8.5 feet
Q50 Elevation	9.5 feet
Q100 Elevation	9.9 feet

Storm Surge Flooding

FEMA conducted study on the probability of flooding along the eastern segment of Sheepscot Bay shoreline region for flood insurance purposes. To conduct the coastal hazard analysis, cross-shore transects were placed along the shoreline of open coast areas and embayments. FEMA estimated coastal stillwater elevations to be between EL 9.7 and EL 9.8 for the 100-year event, with the source of flooding as the Atlantic Ocean. The effects of the storm surge flooding on the published 100-year stillwater elevations appear to dissipate inland where the 100-year stillwater plus wave setup is estimated to be EL 13.6 at Cape Newagen (Transect #11) and EL 9.9 (Transect #1), oceanside of the bridge. For Transect location and elevations, see pp. D-9 TO D-10 in Appendix D.

Published FEMA elevations at the transect incorporated oceanside of the bridge (Transect #1) include:

- Stillwater (1-Percent Annual) = 9.1
- Total Water Level (1-Percent Annual Chance) = 9.9 (Including stillwater elevation and effects of wave setup)
- Base Flood Elevation = 16.0 (Based on average elevations for the zone)

Sea Level Rise

MDOT specifies that rising sea level should be considered in the design of tidal areas. For this location NOAA recommends using 1.9 mm per year, which equates to 0.62 feet in 100 years. See NOAA Sea Level Trend on page D-15 in Appendix D.

Riverine Flow

Since the coastal project site is adjacent to the Atlantic Ocean and outside the hydrologic region defined by the study, riverine flows could not be estimated with the regression equations via USGS "Estimating the Magnitude of Peak Flows for Streams in Maine for Selected Recurrence Intervals" (Glenn Hodgkins 1999).

Per the November 1985 National Estuarine Inventory, the tidal prism (volume of water entering the coastal system during a tidal cycle) for the Sheepscot Bay was estimated to be approximately 22 billion cubic feet. The noted small flow ratios (proportion of the volume of freshwater entering a coastal system during a tidal cycle to the volume of the tidal prism) indicate that the tidal influence is the dominant factor, and that the effects of riverine flow is negligible. See pages D-11 and D-12 in Appendix D.

Existing Bridge

The existing Barthers Island bridge is a three-span, 288-foot, structure with two two steel girder approach spans and a center swing span comprised of a riveted steel pony truss system. The existing structure has two 10'-0" wide traffic lanes on the center swing span and two 13'-7" lanes on the approach spans and no sidewalks. The total out to out width of the approach span roadway measures 30 feet, and the out to out width of the swing span is approximately 24 feet. The swing span trusses are spaced at 22'-2" center to center. The swing span is seasonally operated using a manual gearing system. The existing navigational channel width is approximately 36 feet.

According to the existing 1931 as-built plans, the existing abutments and the piers are founded on rock. The estimated average low chord of the swing span pony truss is at EL. 10.8, and the average channel elevation through the truss spans is -16.0. The existing hydraulic opening is approximately 5300 square feet.

Design Requirements

The MDOT Bridge Design Guide (BDG) specifies that the minimum design freeboard should be 2 feet above the Q10 storm surge, including wave heights, for bridges in a tidal area. Navigational clearances and rise of sea level are also to be considered.

The Flood Profile of the Back River was not included in the FIS, but the 10-year stillwater WSEL was provided by FEMA and estimated at Transect #1 and to be 8.1 at the project site. The wave

effects for the 10-year event were estimated to be half of the value used in the Lincoln County 100-year event (0.8 feet) and called 0.4 feet for this preliminary analysis.

The estimated design WSEL's are:

- 10-Year (Stillwater) = EL. 8.1
- Wave Height = 0.4 feet
- 10-Year Storm Surge = EL. 8.5
- 10-Year Storm Surge + 2' = EL. 10.5

Proposed Bridge

The proposed bridge includes limited rehabilitation to the existing approach spans, and complete replacement of the existing center swing spans along with the swing span pier (Pier 2). The proposed clearance between the mean higher high water (MHHW) elevation and the low chord (EL. 11.3) of the proposed truss is approximately six feet eight inches, an increase in six inches above the existing truss low chord. The proposed freeboard above the 10 year storm surge elevation, including wave height (EL. 8.5) is 2.8 feet, which is greater than the two feet required per the Bridge Design Guide. The location of the proposed pier will be shifted, which results in an increase in the navigational width. The proposed hydraulic opening is approximately 5400 square feet.

Conclusions and Recommendations

The estimated low chord elevation of the proposed swing span is six inches greater than the existing low chord, and the proposed bridge meets the hydraulic requirements of the BDG. Since four of the five existing substructure elements are being retained, and the proposed new pier will be no wider than the existing pier, the overall existing hydrodynamics will not be altered by the proposed improvements. There is also sufficient freeboard (greater than 4 feet) provided above the estimated 2015 Predicted High Tide to accommodate the future estimated 100-year rise in sea level. No additional hydraulics are required for the final design of this project, and since the existing foundations and the new pier are founded on rock, a scour analysis will also not be required.

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