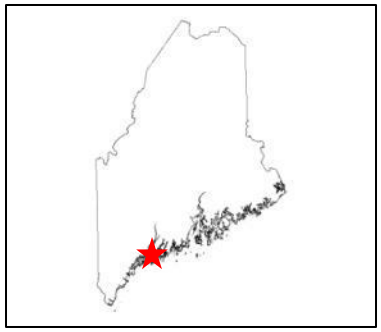
Geologic Site of the Month

December, 2015

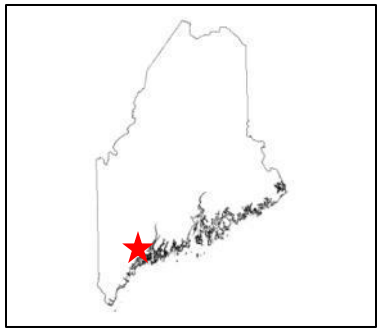
The Cribstone Bridge, Harpswell, Maine and its Granite Source Quarries

Cribstone Bridge
Harpswell, Maine



43° 44’ 58” N, 69° 59’ 19” W

Source Quarries
Pownal, Maine



43° 50’ 42” N, 70° 10’ 34” W

Text by
Daniel B. Locke

Introduction

Bridges allow us to readily transport ourselves, goods, and supplies over waterbodies with relative ease. The design and construction of bridges, in often demanding natural settings, has given rise to a very specialized niche within the engineering profession demanding unique solutions to complicated problems. The Bailey Island Cribstone Bridge in Harpswell, Maine connecting Orr's and Bailey Islands was constructed with a one-of-a-kind design using granite cribstones that has withstood the harsh tides, currents and salt air of the Maine coast for almost 90 years.

Photo courtesy of Pejepscot Historical Scociety

Figure 1. A 1946 aerial photograph of the Cribstone Bridge at high tide looking south with the south end of Orr's Island in the foreground and north end of Bailey Island in the background.

Introduction

Design plans were completed in 1926 and the bridge construction was completed in 1928. For 87 years, this bridge has weathered numerous hurricanes, strong tidal currents, ice, and the ever-present contact of salt-rich ocean water which would easily ravage structures made of iron and steel. Even concrete and mortar play a very small role in the construction of this bridge. It is the sheer mass of the 12-foot granite slabs placed in a simple box or open "crib" configuration allowing for the ocean water to readily pass through the structure which is the secret to the strength and endurance of this elegant solution to a challenging engineering problem. In this day and age of striving to be green and working with nature, this bridge stands as a testament to this concept long before it was common to do so.

Photo by Daniel B. Locke

Figure 2. A view of the crib configuration of the granite slabs

Location

The Bailey Island Bridge is situated in Harpswell about 11 miles south of the center of Brunswick.

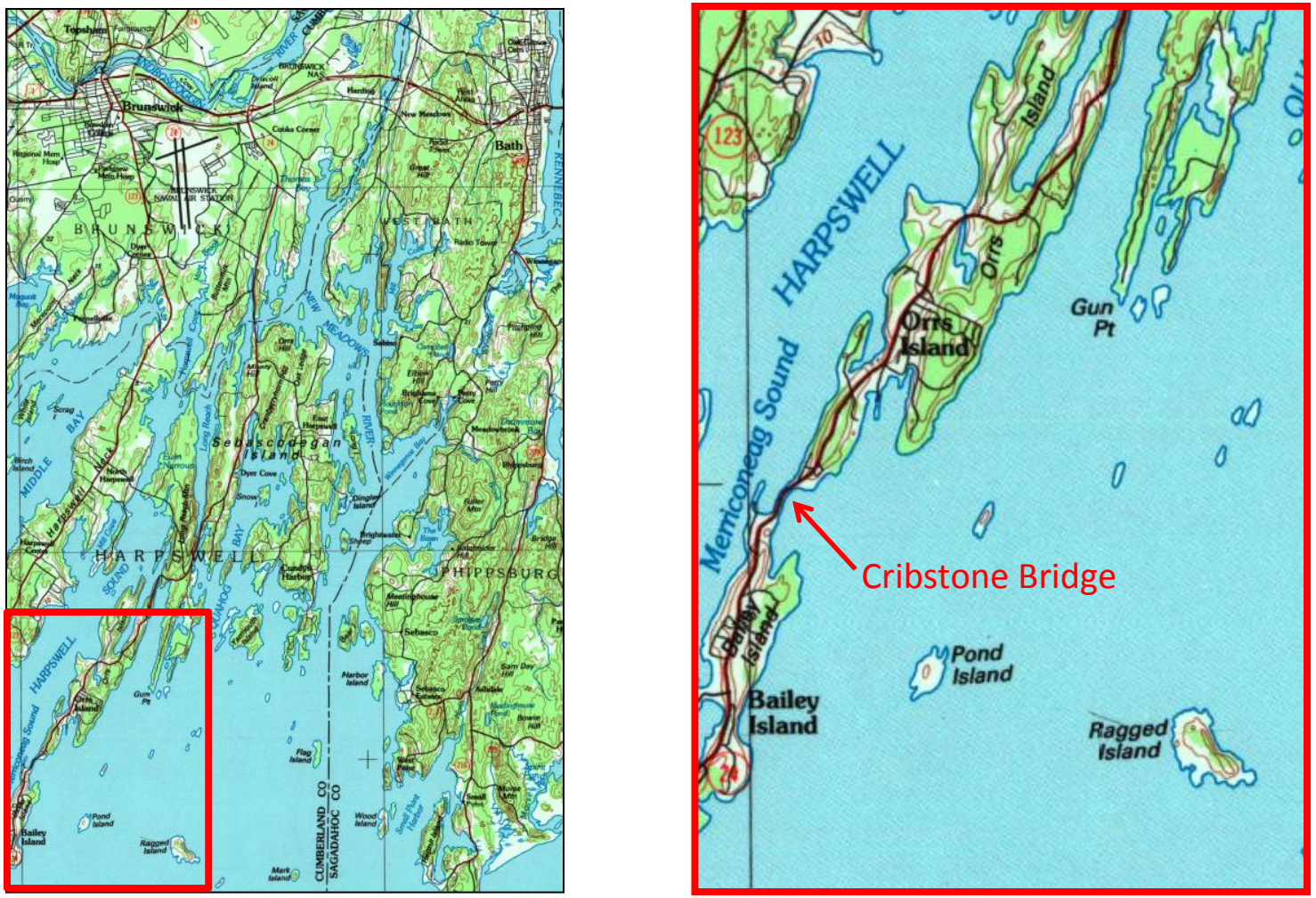


Figure 3. Topographic map sections showing locations of Orr's and Bailey islands and the Cribstone Bridge. These maps also clearly show the extent of exposure of the bridge to the weather.

General Setting

The water covered area separating Orr's Island and Bailey Island is generally wide and yet shallow with a narrow navigable channel which is as shallow as 5 feet in depth at low tide (Figure 4). Currents associated with tidal changes and storms tend to be particularly strong in this area and the narrow channel known as "Will's Gut" acts as a funnel that concentrates the flow. For this reason, the bridge had to readily allow free water passage under the most extreme conditions as well as withstand this exposed coastal setting over time.

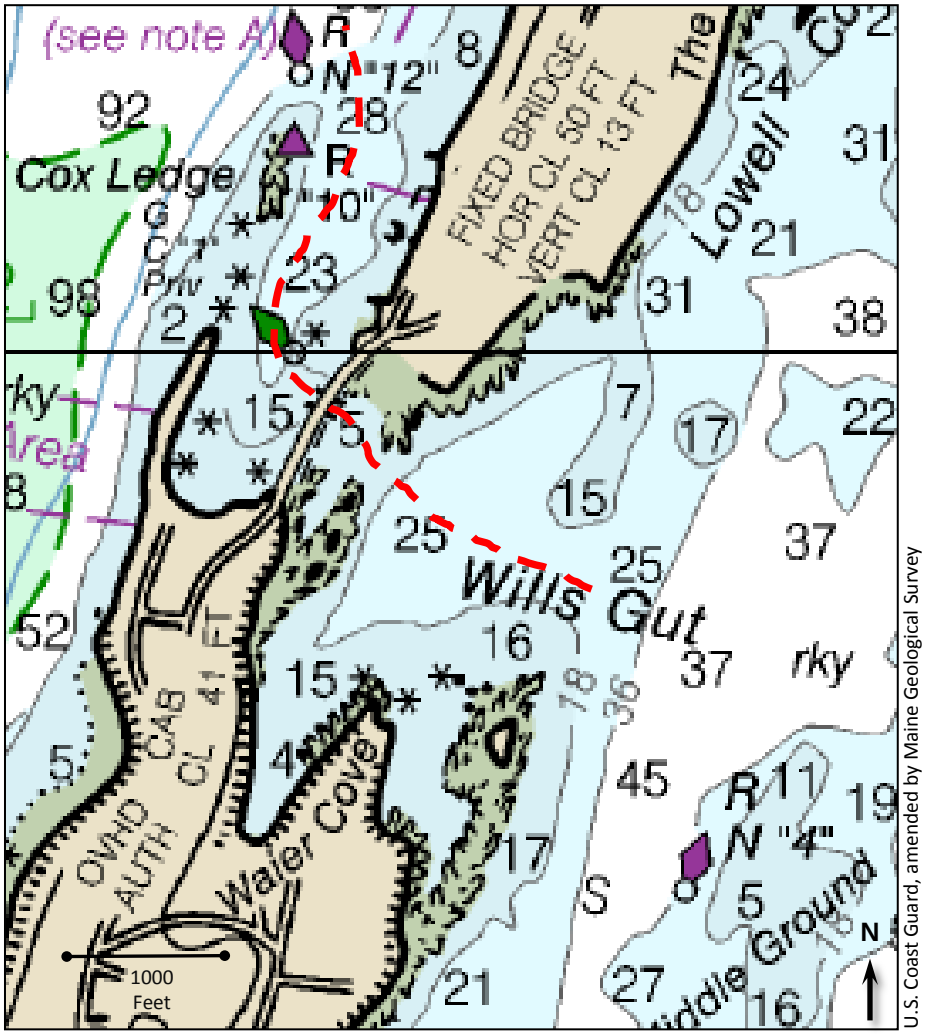


Figure 4. Section of U.S. Coast Guard Chart for Casco, Bay, Maine showing contoured depth soundings in feet, locations of bedrock or ledge outcroppings as well as navigational marker buoys. Will's Gut channel is in dashed red.

Bedrock Geology

While the Cribstone Bridge is constructed of granite slabs, the bedrock which directly underlies it is mostly composed of meta-volcanic rocks of the Spring Point Formation with a minor portion on the north end of the bridge underlain by the generally predominant metasedimentary Cape Elizabeth Formation. In fact, the east side of the bridge essentially lies along the contact between these two formations and the lateral curve seen in the bridge construction is attributed to the curvature observed in the outcroppings along this contact. The Spring Point Formation (DOpv) consists principally of a sequence of thin-bedded basic metavolcanics. The adjacent Cape Elizabeth Formation (DOce) consists generally of schistose rocks of varying composition. A complete explanation of these rock units is found in Hussey, 1971.

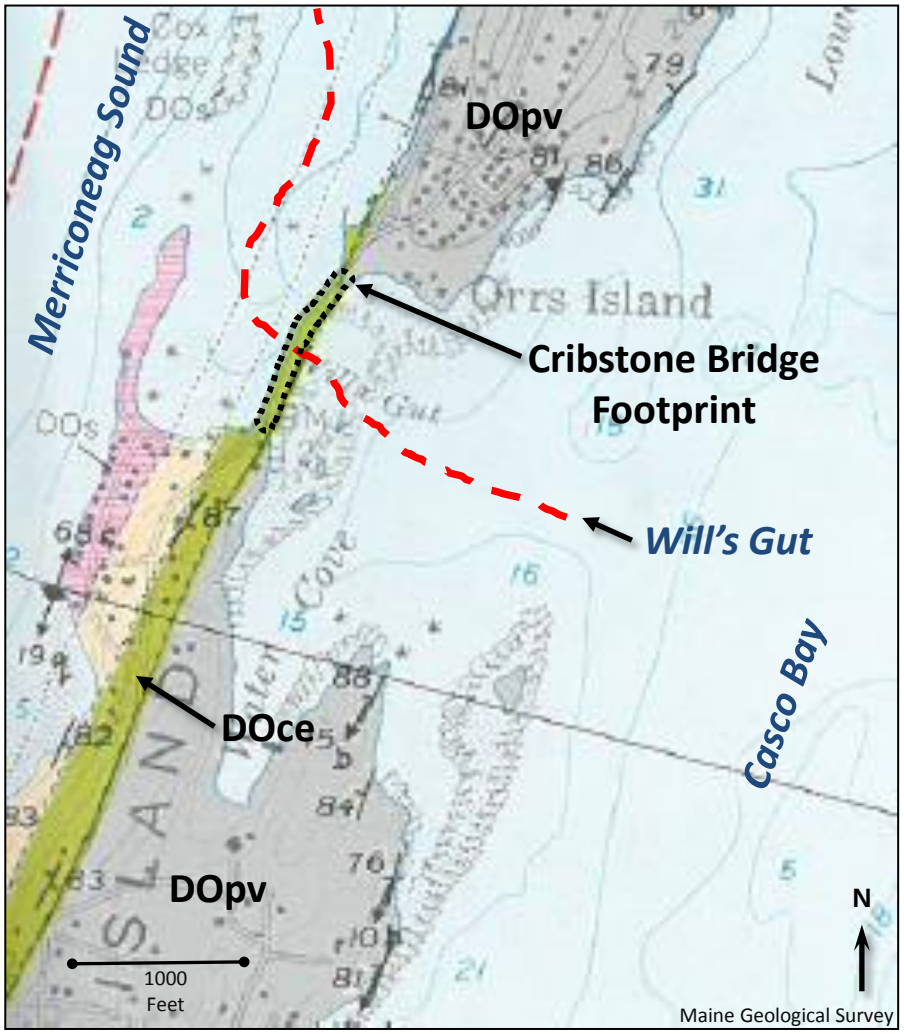


Figure 5. The bedrock underlying the Bailey Island Bridge. Will's Gut channel is in dashed red.

History

The Bailey Island Cribstone Bridge was designed in concept by well-known Maine State Bridge Engineer, Dr. Llewellyn N. Edwards. The actual design layout was prepared by engineer, Clarence L. Partridge. Both men worked for the Maine State Highway Commission, now known as the Maine Department of Transportation. Frank W. Carlton of Woolwich, Maine was awarded the construction contract in May 1926. Construction occurred from June 1926 to September 1928.

While Dr. Edwards is noted for his many accomplishments as a bridge design engineer, the 1,150 foot Cribstone Bridge is likely one of his crowning achievements for its unique design, incredible strength, and overall durability. Appendix A shows some of the plans of this unique design. They specify the "minimum of 30 percent void space through which the waters of Wills Gut may flow without obstruction" that gives the bridge its unique ability to not restrict water movement. It is commonly believed that the bridge was modeled after one that Dr. Edwards saw in Scotland years earlier but there is no documentation that another bridge of this design ever existed anywhere in the world. The bridge was listed on the National Register of Historic Places in 1975. In 1984 it was also listed as a American Society of Civil Engineers Historic Civil Engineering Landmark. Only 74 bridges are listed worldwide.

Throughout its history, this most stalwart of Maine bridges has been closed only once because of weather and related concern for public safety. A severe southeast storm on January 9, 1978 packed winds in excess of 75 miles per hour and 50 year tides, coinciding with a spring tide, pushing the peak to over 13 feet (Wallace, 1986). Despite all of this, the bridge stood firm and functioned as it was designed in allowing the strong storm surges to readily flow through the structure virtually unobstructed.

Quarries

There were likely other granite quarries near the bridge construction site but the source quarries for the Cribstone Bridge were in the North Yarmouth – Pownal area. Granite was moved overland in wagons and then loaded onto barges for transport to Harpswell.

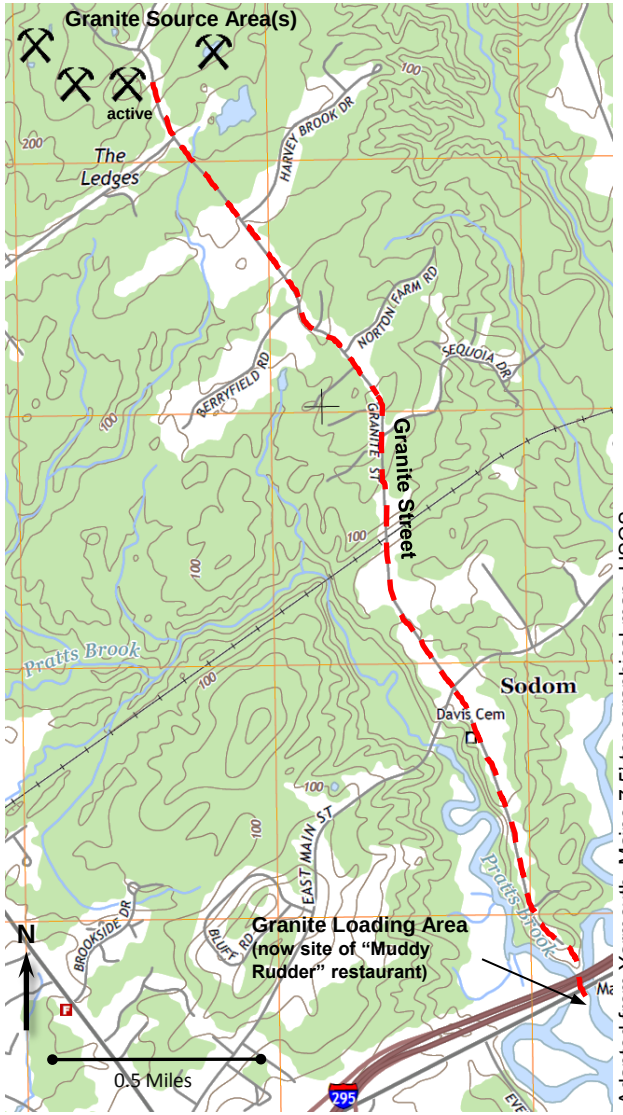


Figure 6. Map section depicting granite source area in Pownal with red dashed line showing transportation route to loading area behind present Muddy Rudder restaurant on Cousin's River in Yarmouth

Granite Loading Area

Photo courtesy of Maine DOT

Figure 7. This October 20, 1927 photograph shows granite being loaded onto a barge at high tide along the Cousins River at the end of Granite Street.

Photo by Daniel B. Locke

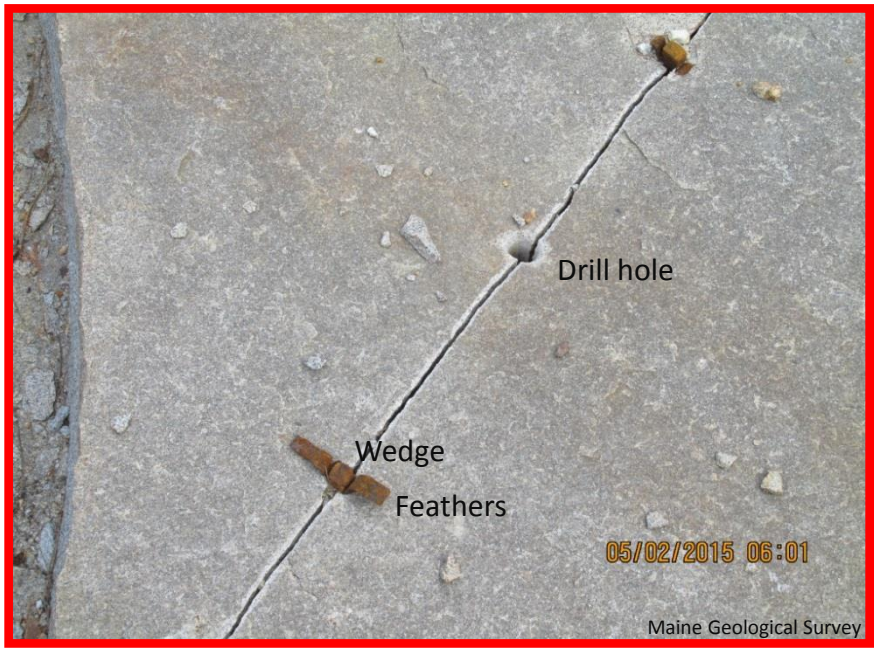
Figure 8. Photograph today looking at the loading site. The Muddy Rudder restaurant is located there now.

Granite Quality

The Pownal quarries yielded granite with relatively narrow horizontal jointing patterns that produced the uniform 12-foot rectangular slabs required for the cribstone bridge structure. The granite from these quarries is described as biotite granite of light gray shade and very fine, even-grained texture containing very smoky quartz, potash feldspar (microcline), soda-lime feldspar (oligoclase) and black mica (biotite) (Rand, 1958). This even-grained and uniform texture in combination with relatively narrow horizontal (sheet) jointing makes the granite from the quarries in this area ideal as a building material. The Granite Quarrying in Maine (Johnston, 2003) provides a broad overview of the granite industry in Maine.

Figure 9. Image of active quarry (marked on Figure 6) and the narrow sheet jointing which is very conducive to the mining of rectangular slabs for the bridge construction.

Granite Processing



Photos by Daniel B. Locke

Figure 10. Placement of small and large wedge and feathers in the splitting of granite at the Taplin Quarry in Pownal, Maine. Photo with red border is close-up of area in red box. Watch a video of splitting granite with wedge and feathers.

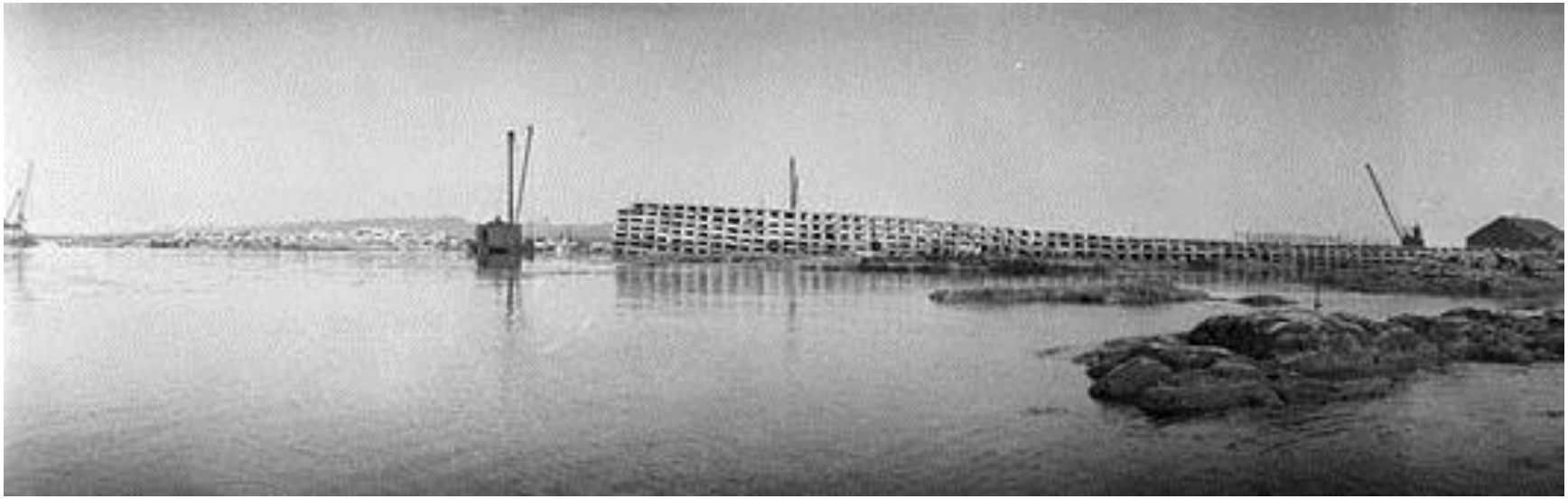
Historical Photographs

Numerous historical photographs were discovered while researching the bridge. They provide great insight into how this challenging construction project was completed. Credit goes to The Harpswell Historical Society, Joanne Rogers of the Orr's Island Library, Megan M. Hopkin of the Maine Department of Transportation, and Kirk F. Mohney of the Maine Historic Preservation Commission for access to their files and permission to use the associated images.

Orr's Island Library / Harpswell Historical Society

Figure 11. Photograph of what appears to be the completed bridge looking south toward Bailey Island.

Historical Photographs



Orr's Island Library / Harpswell Historical Society

Figure 12. Photograph taken during the time of construction showing the building of the bridge starting from the north (Orr's Island) side first.

Historical Photographs

Orr's Island Library / Harpswell Historical Society

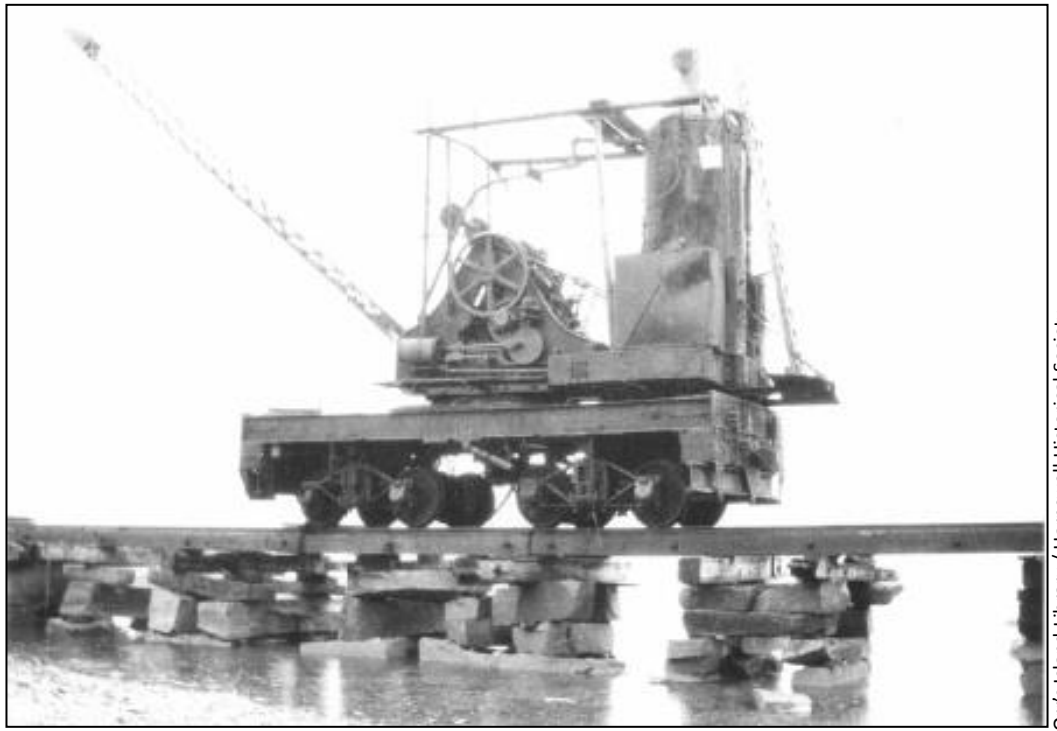
Figure 13. Photograph showing the offloading of granite from a barge.

Historical Photographs

Orr's Island Library / Harpswell Historical Society

Figure 14. Photograph of the granite blocks that were stockpiled directly within the footprint of the bridge during the construction process

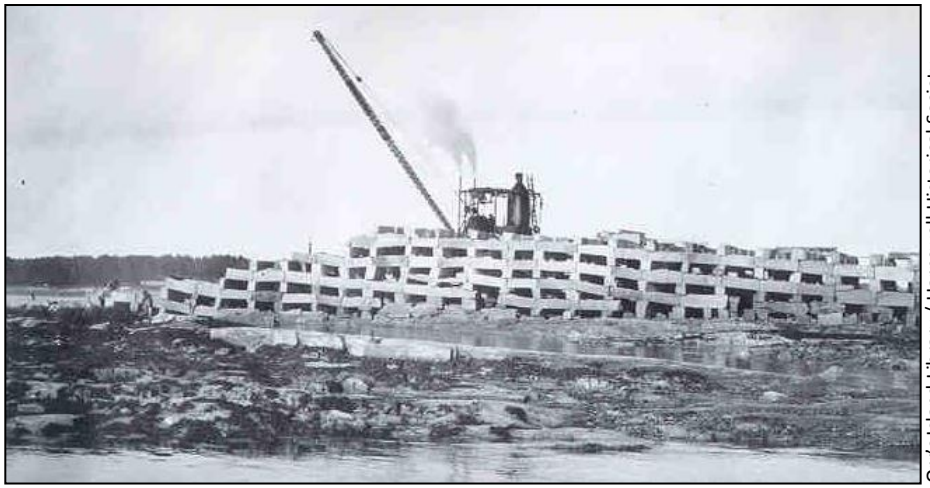
Historical Photographs



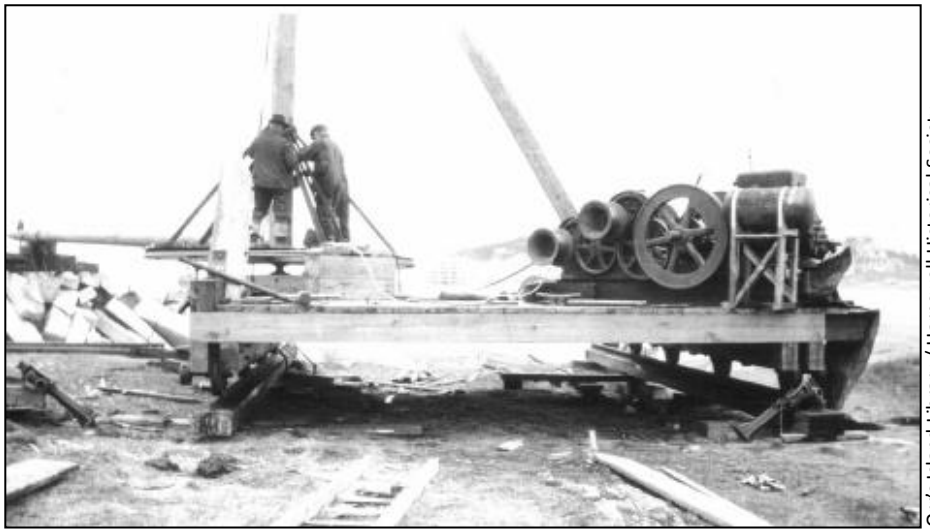
Orr's Island Library / Harpswell Historical Society

Figure 15. Photograph of a rail-mounted, steam-powered crane used in the placement of granite slabs. Note the large vertical boiler situated at the back of the crane.

Historical Photographs



Orr's Island Library / Harpswell Historical Society



Orr's Island Library / Harpswell Historical Society

Figure 16. Photographs showing the use of the crane in construction of the bridge

Historical Photographs

Maine Department of Transportation

Figure 17. Photograph of the crane lifting granite from a barge onto the bridge.

Historical Photographs

Orr's Island Library / Harpswell Historical Society

Figure 18. Photograph with ice flow formation clearly evident during bridge construction on the west side of the bridge.

Historical Photographs

Orr's Island Library / Harpswell Historical Society

Figure 19. Photograph showing placement of steel reinforcement bars in preparation of pouring concrete surface.

Historical Photographs

Orr's Island Library / Harpswell Historical Society

Figure 20. Photograph of the north end of the bridge with the road surface installed.

Possible Benchmark

There is a curious circle carved into the bedrock in Figure 21 just to the left of the date stamp. The Maine Department of Transportation has no record of this being a benchmark or survey reference point. If anyone knows what this feature is, please let us know!!

Figure 21. Present-day photograph of the bridge and small circle carved in the rock, possibly a benchmark used in construction.

Historical Photographs

In 2009-2010, the Bailey Island Cribstone Bridge underwent a major refurbishment to address broken and shifted granite slabs. All repairs retained the original appearance of the bridge and even utilized granite from one of the original source quarries in Pownal, Maine.

Figure 22. View looking east to the Bailey Island Cribstone Bridge. Note the gradual and graceful lines of this masterpiece of engineering blended into the geology of the setting.

References and Additional Information

Crawford, Tobias, 2006, Cribstone Bridge Spans History and Cultures, Bowdoin College, Summer Research at Bowdoin – 2006, website.

Harpswell Historical Society website.

Hussey, Arthur M. II, 1971, Geologic Map and Cross Sections of the Orrs Island 7 ½ ' Quadrangle and Adjacent Area, Maine: Maine Geological Survey, GM-2, Map and Report, 19 p.

Johnston, Robert A., 2003, Granite Quarrying in Maine, Maine Geological Survey (Department of Agriculture, Conservation, and Forestry) website.

Maine Public Broadcasting Network (MPBN), 2009, The Cribstone Bridge, website.

Rand, John R., 1958, Maine granite quarries and prospects: Maine Geological Survey, Mineral Resources Index No. 2, 50 p. 1 map.

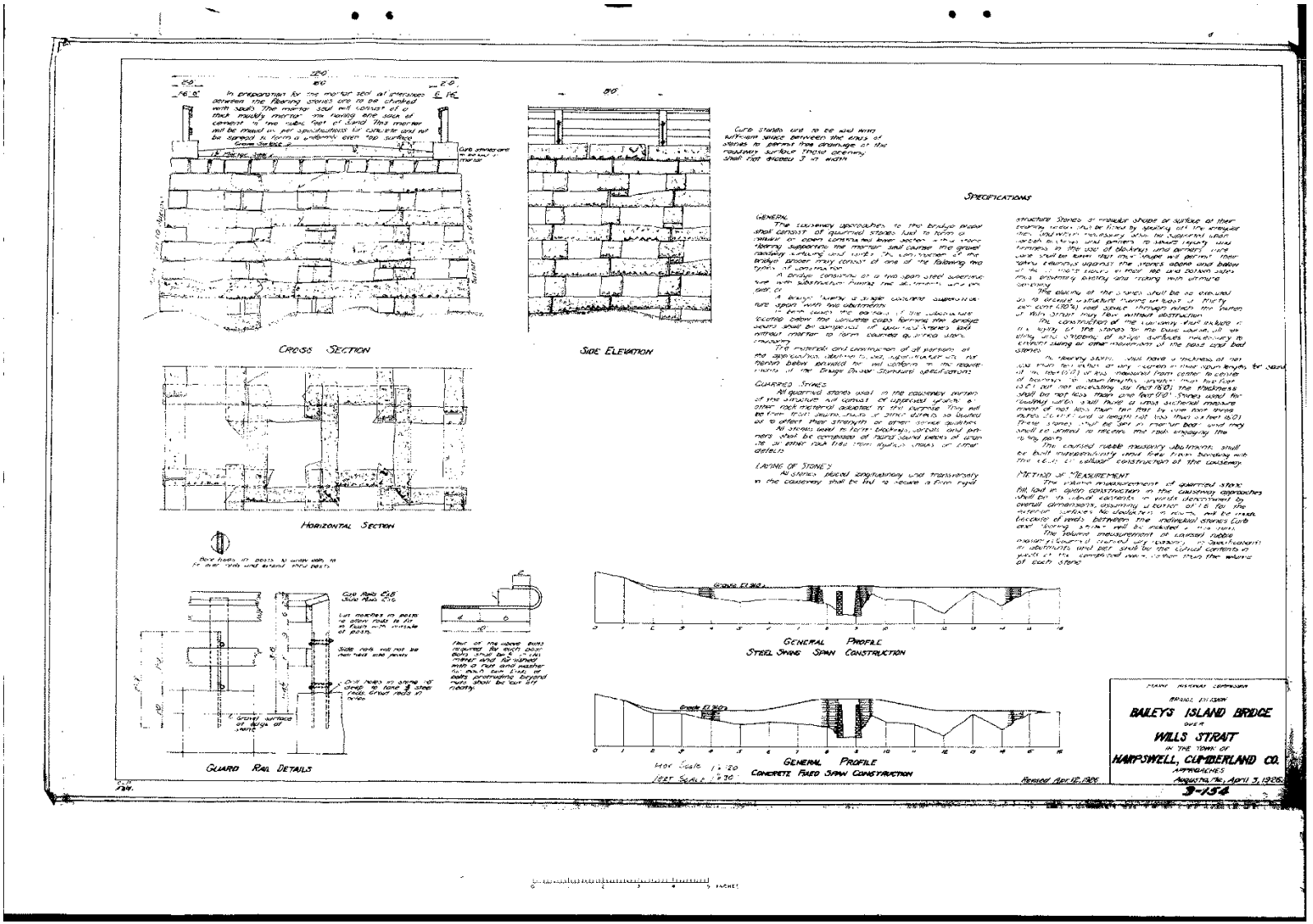
State of Maine, Department of Transportation Historic Bridges, Bailey Island Bridge website.

Wallace, Dana E.,1986, Report on Thomas Bay, New Meadows River and Observations on Thomas Point Beach, Brunswick, Maine: Sea and Shore Fisheries Consulting Co., 49 p.

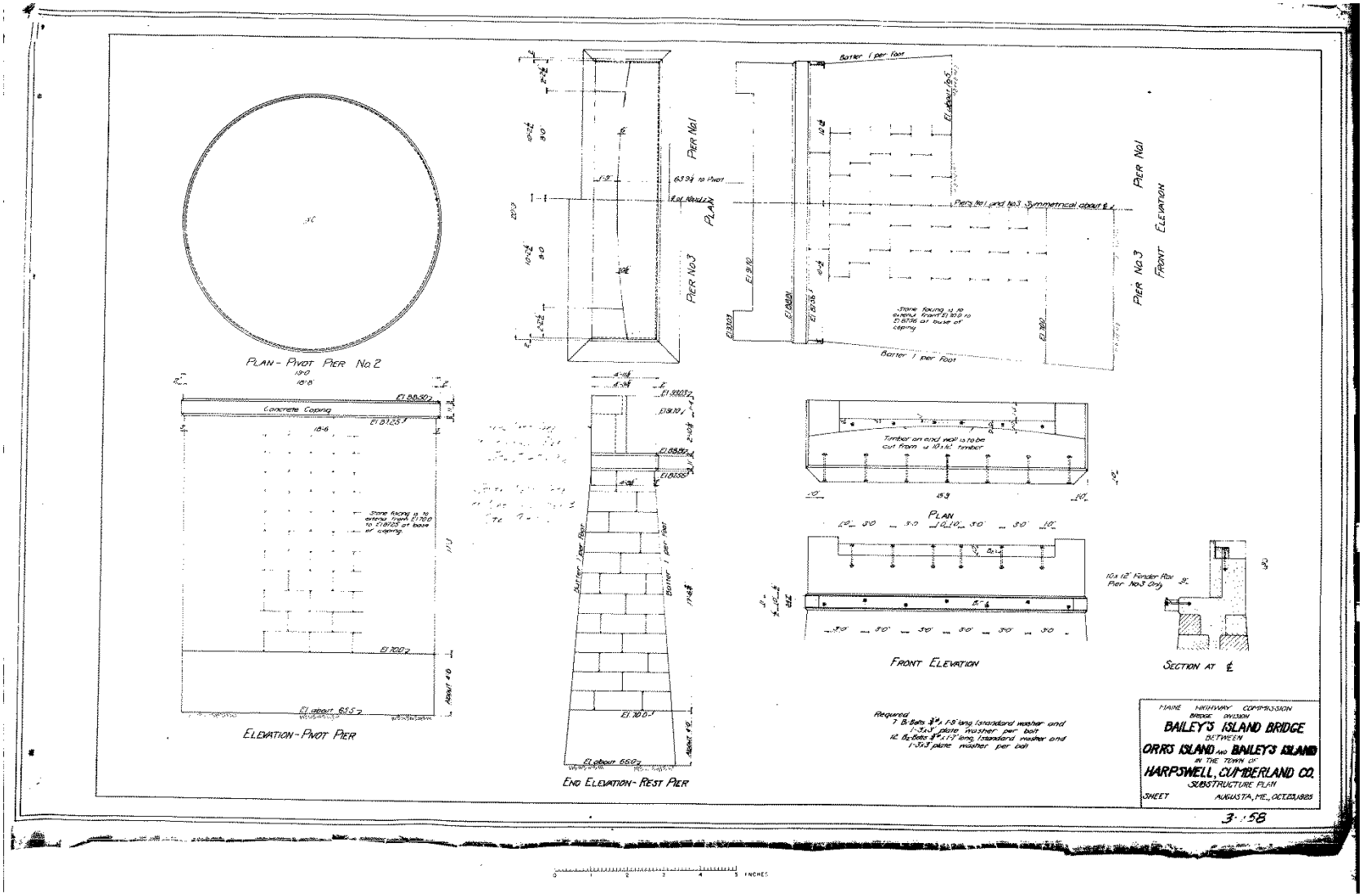
Wikipedia, The free encyclopedia, Bailey Island Bridge website.

Also, we wish to thank Mr. Kenneth Taplin of Pownal, Maine for his willingness to discuss with us his quarry and permission to take a number of photographs which illustrate the unique qualities of the granite making it well suited for use in this particular construction.

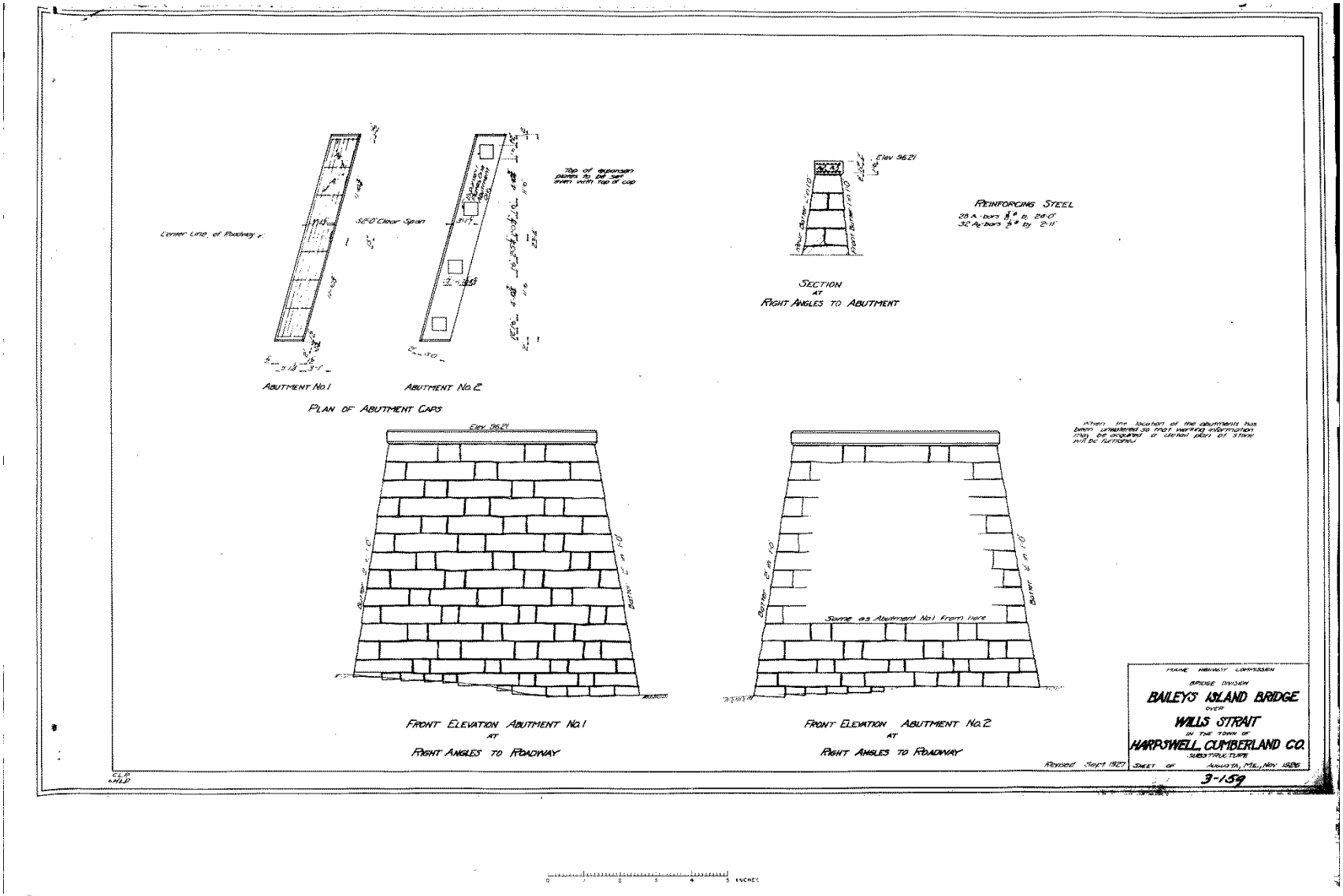
Appendix A: Design Plans - 1



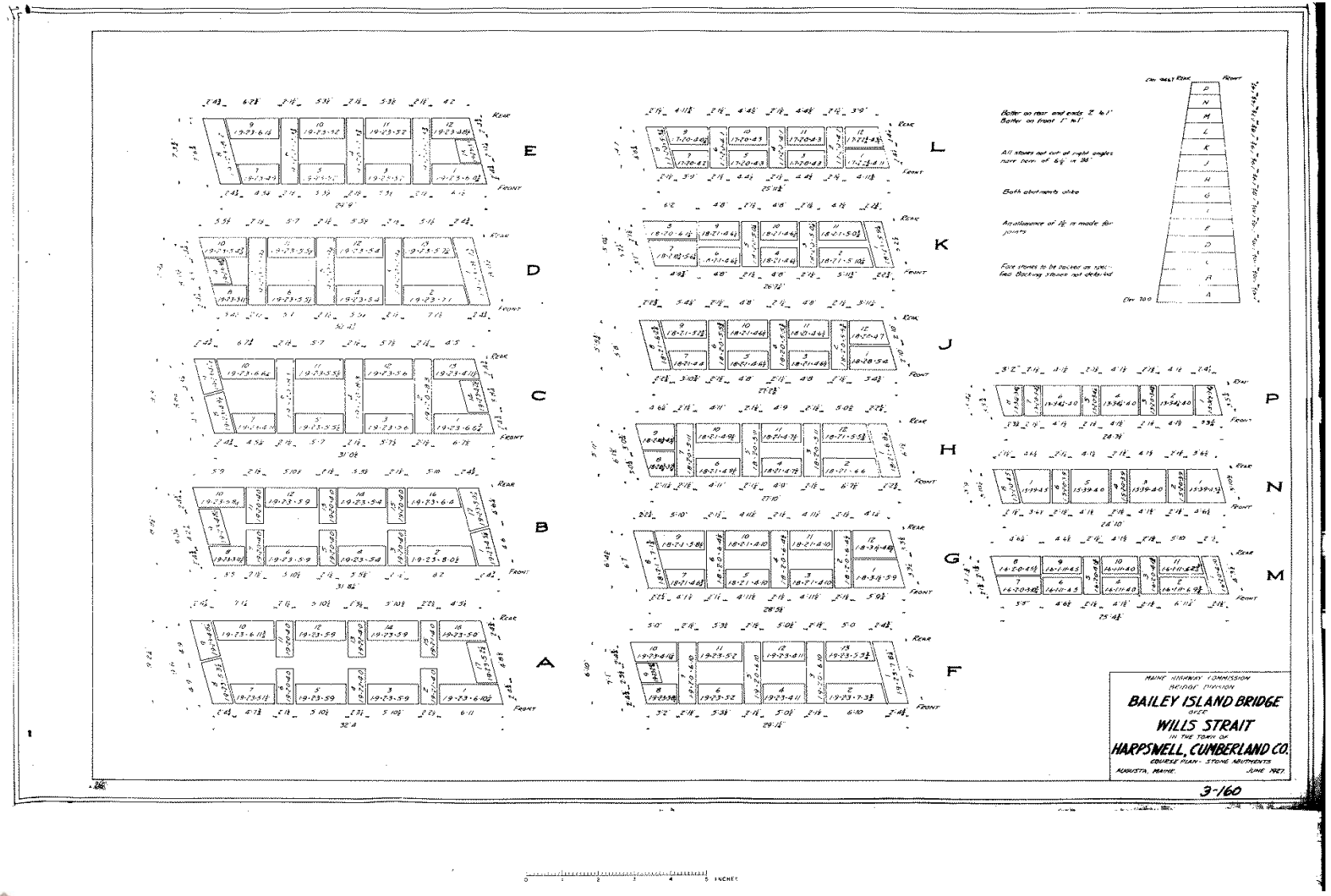
Appendix A: Design Plans - 2



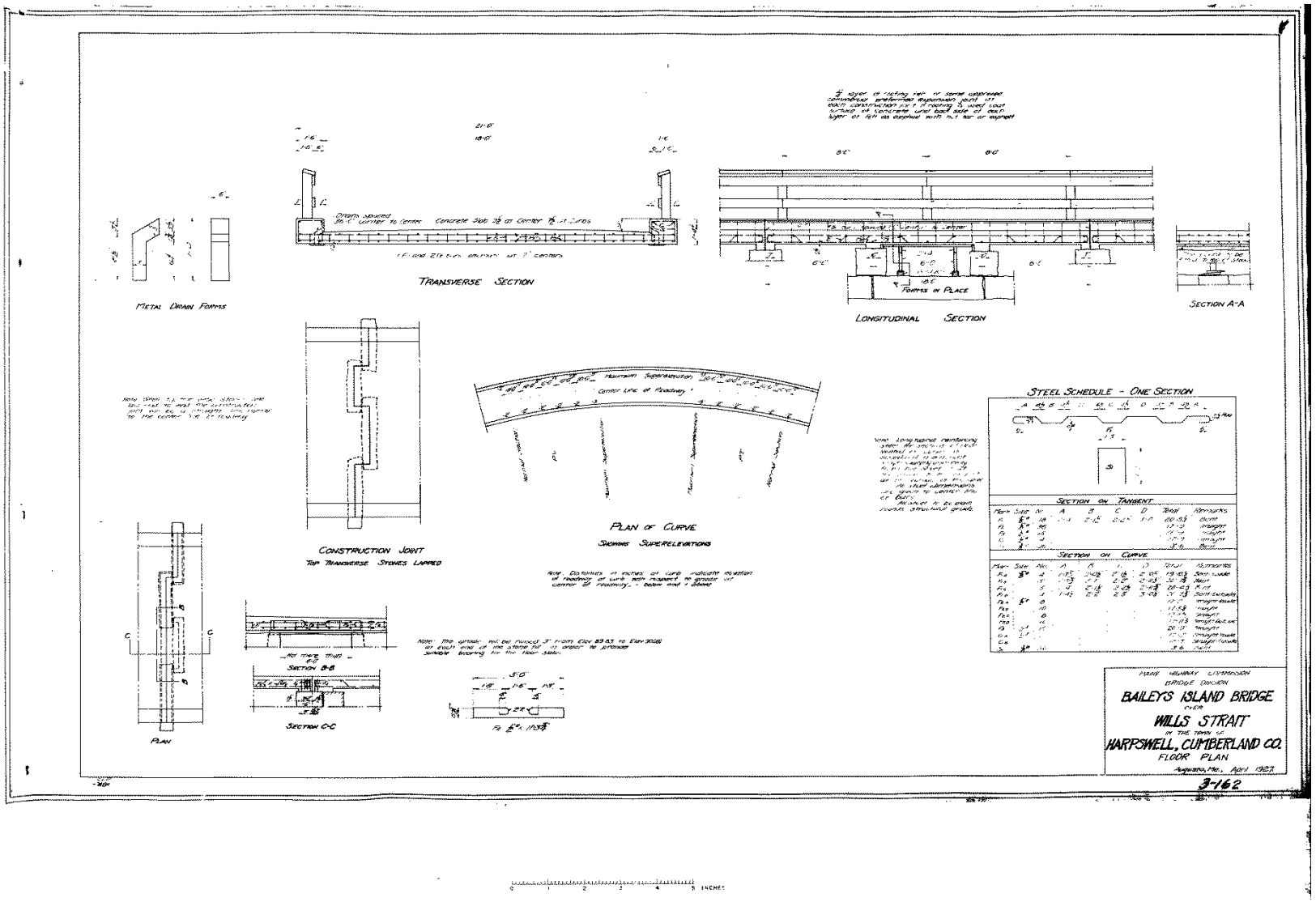
Appendix A: Design Plans - 3



Appendix A: Design Plans - 4



Appendix A: Design Plans - 5



Appendix A: Design Plans - 6