BARRINGTON BRIDGE
(Bridge No. 123)
R.I. State Route 114,
Spanning the Barrington River
Barrington
Bristol County
Rhode Island

HAER No. RI-41

HAER
RI
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PHOTOGRAPHS

WRITTEN HISTORICAL AND DESCRIPTIVE DATA

HISTORIC AMERICAN ENGINEERING RECORD
National Park Service
Northeast Region
Philadelphia Support Office
U.S. Custom House
200 Chestnut Street
Philadelphia, P.A. 19106

HAER
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HISTORIC AMERICAN ENGINEERING RECORD

BARRINGTON BRIDGE
(Bridge No. 123)

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Location: R.I. State Route 114
Spanning the Barrington River
Barrington, Bristol County, Rhode Island

UTM: 19.309020.4622860
USGS Quadrangle: Bristol, Rhode Island, 1:25,000

Date of Construction: 1912-1916

Designer: National Bridge Company
Indianapolis, Indiana
Daniel B. Luten, Chief Engineer

Supervising Engineer: Clarence L. Hussey
Bridge Department, R.I. State Board of Public Roads (R.I. Department of Transportation)

Present Owner: State of Rhode Island
Department of Transportation
Two Capitol Hill - Rm 372
Providence, Rhode Island 02903

Present use: Vehicular and pedestrian bridge

Significance: The Barrington Bridge is an early example of a reinforced concrete arch bridge. The bridge was designed by Daniel B. Luten's National Bridge Co. of Indianapolis, Indiana. It was determined eligible for listing in the National Register of Historic Places on January 10, 1989.

Project Information: The Barrington Bridge is structurally deficient due to deterioration of the arches and abutment walls and scouring of the bridge piers. The best short-term measure is the installation of a temporary bridge. This cannot be done without removing segments of the bridge's parapet rails. An approved MOA was ratified by the Advisory Council on Historic Preservation on September 15, 1994. The MOA includes a stipulation requiring HAER documentation. This report is to satisfy that stipulation.

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HISTORICAL BACKGROUND

The Crossing

The Barrington Bridge spans the lower Barrington River at a point where the tidal waters of the 100 Acre Cove to its north feed into the Warren River, approximately 3/4 of a mile to the south. This point has been the location of ferry and bridge crossings from the southern part of Barrington to Tyler Point and Warren since the late 17th century. As such, the crossing has provided passage between Newport and Providence, historic centers of Rhode Island commerce and government, for three centuries.

In order to serve the growing settlement of Barrington, a company was formed in 1802 with the initial intention to erect a toll bridge connecting Warren, Little Island, Tyler Point, and Old Ferry Lane in Barrington at a point south of the present Barrington and Warren Bridges. The company also planned to build "a great public road from Warren to Providence in the most direct route."[1] At the time, John Kelley was already operating a toll bridge between Tyler Point and Warren in the general location of the current Warren Bridge. There was, however, no bridge crossing between the central part of Barrington and Tyler Point, and the new bridge company sought to develop one.

With the proposed toll on the new bridge system equal to the toll exacted at his single crossing, Kelley, recognizing the effect the new bridge would have on his business, sought an agreement with the newly-formed Warren and Barrington Bridge Company. In this agreement Kelley would continue to operate his toll bridge and the Barrington company would erect a new bridge from central Barrington to Tyler Point--a successful and mutually beneficial arrangement. From there, passage could be made over Kelley's Bridge to Warren. An agreement to that end was reached in May of 1802 between Kelley and what was now called the Barrington Toll Bridge Company. Tolls were collected at each crossing.

A gale in September of 1815 washed out both bridges and new construction was begun in October of the same year. By 1831 Captain James Bowen had acquired controlling interest in the Barrington Toll Bridge Company. He made an agreement with the Kelley heirs to collect one toll for both bridges and divide the proceeds equally. This arrangement continued until 1872 when the State of Rhode Island purchased the two bridges for $6,000 and eliminated all tolls. In the agreement the towns of Barrington, Warren, and Bristol were to maintain the bridges jointly.

By April 1885, the condition of the wooden bridge over the Barrington River was such that the Barrington Town Council passed a resolution to remove its superstructure, piers, and abutments and replace it with an iron bridge "to have a span of not less than 20 feet wide....The entire cost not to exceed $7,000."[2] The Berlin Iron Works of Berlin, Connecticut, was hired by the town to build an iron truss bridge in 1885. A Pratt-type truss was built, a design commonly used in the late 19th and early 20th century for spans of between 30 and 150 feet long.[3]

By 1902, streetcar tracks had been installed on the south facing side of the bridge permitting commuters to cross the Barrington River. Eight years later the dangerous condition of the Barrington and Warren Bridges prompted the Town of Barrington to advise the Rhode Island Suburban Railway Company, operator of the trolleys, that any continued passage of their cars would be at their own risk. It was a risk they were not willing to assume; streetcar service, which placed a significant live-load on the bridge, was discontinued in 1910.

By January of 1912 the "south side of the [bridge's] east abutment had been undermined to the extent of six feet, and a portion of the abutment masonry ha[d] fallen out of plumb."[4] That same month, a consulting engineer advised the Barrington Town Council of the imminent possibility of a washing out of the abutment and the bridge's collapse. Shortly thereafter, the Town's Highway Surveyor closed the bridge to all except foot traffic. Trolleys released passengers on the west end of the bridge; they would then walk to awaiting cars in Warren.

In January of 1912, the three-member Bristol County Bridge Commission submitted a report to the Rhode Island General Assembly. A year earlier the Assembly had established the Commission to inquire into the "advisability and necessity of the State assuming control of the bridges and approaches thereto, in the towns of Barrington and Warren..."[5] Town-sponsored engineering reports on both the Barrington and Warren Bridges had already indicated that neither the bridges nor the 550 foot causeway on the Barrington side were safe for vehicular traffic. After conducting its own investigation, the Commission concurred with the local studies.

The causeway on the west approach to the Barrington Bridge consisted of "two retaining walls of field stone laid partly dry and partly in mortar." It had been "...a source of trouble for years, the tide causing a flow of water back and forth through the walls, washing out the back filling and leaving it, as at present, in a very weakened condition." The 74 foot east approach, though in better condition, exhibited "settling and bulging to an alarming extent."[6]

An interesting component of the Commission's study was a traffic survey conducted to determine the importance of the bridges to

Barrington, Warren and the State. For seven consecutive days, between 6:00 AM and 12 PM in September of 1911, investigators kept a record of the number and types of vehicles, as well as the number of pedestrians crossing the bridges. The following are the results of the survey:

1,663	One-horse vehicles
364	Two-horse teams
4	Teams of more than two horses
929	Bicycles
2,554	R.I. automobiles (outside of Barrington and Warren)
256	Local automobiles
853	Automobiles (outside of R.I.)
4,316	Car passengers
5,950	Pedestrians
16,889	Total of pedestrians and vehicles

The Commission report left little doubt as to the condition and safety of the bridges and causeways. In the words of the Commission:

> The entire situation of both bridges and the causeway does not apparently warrant the amount of money necessary for repairing structures of their character. It therefore appears that new bridges and a rebuilt causeway are imperative.[7]

Test borings, carried out as part of the study, were made along the bottoms of the Barrington and Warren Rivers where future bridge footings would lay. These were found to indicate "rock formation of a solid and substantial nature within easy reach of the surface." In conclusion, the Commission sought estimates from three local contractors for two "modern reinforced concrete bridges,--one of two spans to take the place of the present Kelley's Bridge,--and one of three spans to take the place of the present Barrington Bridge."[8] As both bridges were located over tidal waters, it was required that plans be submitted to the State Harbor Commission and the National War Department. The Harbor Commission subsequently approved the proposal and the War Department released Warren from the requirement of replacing Kelley's Bridge with another drawbridge, provided that the new structure had an 8 foot clearance over mean high water.[9]

<u>The Move to Concrete Arch Construction</u>

The Commission's detailed specifications furnished to the cost-estimating contractors and the General Assembly, however, varied considerably from the actual design of the Barrington and Warren

Bridges. The Commission specified concrete beam bridges, not arch bridges. This specification was made despite Barrington Town Council President E.L. Spencer's observation that boat owners at the nearby Barrington Yacht Club spoke favorably of a "longer and wider span than the present one, with a series of arches of concrete."[10] Barrington's boat owners were in good company--the newly-constituted Bridge Department, a division within the R.I. State Board of Public Roads,[11] advocated concrete arch construction for spans between 5' and 75' long.[12] In fact, this choice was representative of a general trend on the part of the nation's state highway departments.

The reasons for the change from Commission design recommendations to the design actually constructed can probably be traced to a visit paid to the State Board of Public Roads at their weekly meeting of May 1, 1912. At this meeting, Walter N. Denman, a Springfield, Massachusetts representative of the National Bridge Company, Indianapolis, Indiana, bore a letter of introduction from R.I. Governor Aram Pothier. He made a presentation to the Board on the benefits of reinforced concrete arch bridges--as designed by Daniel B. Luten, chief engineer and founder of the company. By this time Luten held a number of patents on various aspects of concrete bridge design. He was a great promoter of reinforced concrete arch bridges and a great believer in their beauty, economy, and utility.

At the 1912 annual conference of the National Association of Cement Users, Luten spoke of his work:

> A concrete arch, in harmony with its surroundings, but without ornamentation or embellishment of any kind, is an exceedingly beautiful structure. A concrete girder under similar conditions may be an exceedingly ugly structure. Why is it that the concrete girder bridge presents so undesirable an appearance, while the arch bridge is such a handsome improvement? Not alone because of the natural beauty of the surroundings; not merely because of the white-concrete in the arch view. The concrete arch presents the more pleasing appearance because it employs concrete in a thoroughly natural manner.[13]

Luten was not alone in his assessment of arches and girders. Frank P. McKibben of Lehigh University, writing in *Concrete-Cement Age* later that same year, viewed concrete arch bridges not only in terms of their structural qualities but as manifestations of civic pride: "The arch is a beautiful form of construction, and the ease with which concrete can be molded into graceful curves appeals alike to engineers and the general public." On a note more likely to pique the interest of elected officials, he added:

> ...the labor and most of the materials can be furnished locally. In most cases the sand, the stone and the labor can be secured without going beyond the local supplies. Only the cement and the steel need be brought in, and in not a few places these may also be obtained within a short distance of the bridge site. Here, then, the structure becomes largely the product of home talent, and correspondingly greater is the feeling of pride and interest in it.[14]

Denman approached the Board at a time when the new Bridge Department of the State Board of Public Roads had completed a survey of R.I.'s highway bridges. The survey was conducted under the supervision of Clarence L. Hussey, Chief of the Bridge Department and Rhode Island's first State Bridge Engineer. In the State's existing bridge inventory the Department "found almost every design of bridge construction imaginable except those of the latest design, some of them in an absolutely unsafe condition and some others fast approaching a similar condition." The Board decided to adopt "a standard form of construction patterned after the most modern and improved designs for reinforced concrete construction..."[15] This high regard for concrete was well-founded: the State's first reinforced concrete bridge, the 75' Flat River Bridge (Bridge No. 71)[16] in Coventry, had served Rhode Island without any maintenance since its construction five years earlier in 1907.[17]

Denman's presentation was a success. The State Board of Public Roads made an arrangement with his company to use the "Luten system of reinforced concrete bridges." In return for a 10% compensation for the use of the Luten patents,[18] the National Bridge Company would "draft and submit plans or designs for such bridges as might be called for, and to furnish the services of D.B. Luten and Walter Denman as consulting engineers whenever required." Specifically, Denman was asked to return with plans for the Barrington and Warren Bridges.

Although the original Luten plans are no longer extant, State Board of Public Roads records indicate they were submitted on June 6, 1912. The final plans, approved by Clarence Hussey, incorporate Luten designs and some modifications by Hussey. The Board promptly placed advertisements seeking construction bids on the Barrington and Warren Bridges. On July 12 the company of Miller and Mullen of Boston was awarded the contract for the Barrington Bridge at a cost of $107,874, the work to be completed in 270 days. Miller and Mullen had bid unsuccessfully on the Warren Bridge, their cost exceeding that of the low bidder, E.J. Doyle and Company of Albany, New York, by more than $12,000 and their completion date by 90 days. Doyle and Co., however, failed to perform to the expectations of the Board of Public Roads and in December 1912 the contract was relet to Miller and Mullen, whose construction to date had been described as "workmanlike and satisfactory."[19] Final specifications for Barrington called for a temporary wooden bridge to be located south of the existing bridge and a reinforced concrete bridge of five arches with causeways and approaches--a total of 730 feet overall. Work began immediately.

By the winter of 1913-14 the bridge was still only in partial use--lacking sidewalks, wire conduits, manholes, and a permanent roadway. It was not the common practice of early 20th century bridge builders to contract for finish work--and this often included the road surface. The earth fill for the area over the arches required a year's time to settle; only temporary road surfaces could be applied until that time. After a year, another contractor would finish the job.

Despite these construction delays, the 1913 Annual Report of the Board of Public Roads looked back upon the 18 months of construction of the Barrington and Warren Bridges with evident pride:

> Built mainly with by Rhode Island labor, with every precaution for public safety and convenience, of acknowledged excellence of material and workmanship, with symmetrical lines, true camber, and smooth white finish, these structures are a source of pride and satisfaction to the Board and credit to the State.[20]

In December 1913 the Board applied a cinder road surface--a satisfactory solution until the heavy traffic of the summer of 1914 ground it "into fine black powder, making a very objectionable condition." The only solution to the problem was "frequent and generous watering."[21] In the summer of 1915 the bridge roadways were given a gravel surface. A special State appropriation permitted the application of a bituminous macadam surface to the roadway in 1917. A distinctive feature of the new bridge was the urn-shaped, pre-cast concrete balustrade designed by Clarence Hussey. Hussey, whose office was in the basement of the recently-completed R.I. State House (designed by McKim, Mead and White), modeled the urns after those found on that building.

By 1929 vandalism and auto accidents had taken their toll on the concrete urn balustrades of both the Barrington and Warren Bridges. The Warren bridge was particularly affected because of its curved approaches. The same year, the State Board of Public Roads replaced the open balustrade of the Warren Bridge with the current solid concrete parapet wall with bush-hammered recessed panels. Balustrade sections salvaged during demolition on this project were used to repair broken sections on the adjacent Barrington Bridge. This experience with the easily-damaged urn balustrade prompted a shift in the Bridge Department's design policies to the solid parapet wall evident in surviving concrete bridges of the period.[22] Despite this policy change and a 1930 State Board of Public Roads recommendation for replacement, the Barrington Bridge retained its urn balustrades until full replacement in 1948. The original concrete lamp posts, however, were re-installed on the new wall.

Over the years streambed erosion due to the extreme tidal flow of the Barrington River has been a recurrent problem--to the extent of exposing the pile foundations of the bridge piers. RIDOT drawings indicate damage, particularly to the middle west pier, as early as the mid-1920s. The most dramatic damage occurred as a result of the hurricane of September 1938. In addition to depositing several boats onto the bridge roadway, the hurricane seriously undermined the west abutment and the middle-west pier of the Barrington Bridge.

Periodic attempts have been made to repair and reinforce the concrete piers below and at the water line (1925, 1939, 1966 and 1993). These repairs included the placement of steel plates and beams (tremies) to shield them from tidal erosion as well as the placing of stones and concrete tetrahedrons to serve as rip-rapping around the piers. Recent analysis from test borings shows that this damage may have resulted from faulty construction methods in 1912-13, the concrete being too thin to maintain the stone aggregate in suspension. In this condition, the aggregate would settle to the bottom during the concrete pour, leaving the pier structurally weakened and susceptible to undermining and erosion.

As a result of a post-1938 Hurricane general assessment of the bridge's condition, the Board removed the original curbing and replaced it with a higher precast concrete curb. A "granolithic" surface replaced the original sidewalk. This reduced the effective height of the balustrade and raised the sidewalk level.

The trolley tracks in the center of the original bridge roadway were removed ca. 1948, when Rhode Island streetcar service was abandoned. The original tapered concrete lamp posts with glass globe and bronze bracket were replaced (ca. 1960) with the present style of aluminum posts and mercury vapor lamps.

SIGNIFICANCE

Concrete Bridges

The use of concrete as a construction material dates to the Hellenistic period when Greek engineers used it in the building of aqueducts. Concrete's first wide use is, however, associated with the Romans, who combined locally available volcanic sands with lime and aggregate. This combination provided a durable material, often used in combination with masonry or brickwork, that survives to the present in surprisingly good condition. The Romans used concrete as a masonry substitute, a material strong in compression but weak in tension.

Concrete fell into disuse during the Middle Ages and was not reintroduced until the mid 18th century. In the early 19th century Joseph Aspdin produced "Portland" cement by the careful measurement and mixing of limestone and clay. The resulting stone-like cement bore a resemblance to the Portland building stone commonly used in England, hence the name. While this new material, mixed with aggregate, was superior to its ancient counterpart, it was not until the introduction of steel reinforcement in the late 19th century that concrete came to be used as a material with strength in tension and compression, applicable to modern arch bridges.

In 1889, Ernest Ransome built the first reinforced concrete arch bridge in San Francisco's Golden Gate Park. Although this bridge represented a significant advance in bridge construction, its conservative design and surface treatment suggested the masonry types that preceded it. By the turn of the century, a new generation of bridge designers would begin to grasp the structural potential of reinforced concrete and begin to design to those possibilities. Daniel B. Luten, a great promoter and popularizer of reinforced concrete bridges, was notable among this early generation of concrete bridge designers and contractors.

Daniel B. Luten

Luten had studied civil engineering at the University of Michigan, where he received his B.S. in 1894. After graduation he served for one year as assistant to Professor Charles E. Greene, a leading authority on the elastic theory of arch analysis and author of *Greene's Graphic Method of Truss and Arch Analysis.* Luten spent the next four years at Purdue University, where he taught courses in architectural engineering. He resigned his position in 1900 to practice engineering. After a year working on roads and pavements, Luten moved exclusively into bridge design and construction. He remained a designer/contractor until 1906 when he limited his practice to design and supervision. During these early years Luten patented many designs and improvements in concrete bridge construction, his influence extending beyond the home base of Indiana through active promotion, including elaborate brochures, stereopticon lectures and extensive writing for professional journals and conferences.

Soon Luten's representatives were pitching bridges of "Luten design" to states and municipalities across much of the United States. According to a 1924 promotional booklet, *Reinforced Concrete Bridges*, Luten had "supervised the design of approximately 20,000 concrete bridges, of which over 13,000 have been erected of spans from five to 192.5 feet each." In the same booklet Luten provided a list of 30 advantages of concrete bridges. Among the more practical advantages:

> Concrete bridges are permanent improvements.
> A concrete bridge is the only bridge that grows stronger as it grows older, thus providing for increased weight in traffic.
> The concrete arch will discharge more flood water for a given flood level than other forms of opening of the same area.
> Concrete bridges are flood-proof, frost-proof, rust-proof, and fire-proof.

And among the aesthetic advantages:

> Concrete arch bridges have copings and roadway cambered in graceful vertical parabolic curves.
> Concrete arch bridges have beauty of curve and line secured by proper proportions.
> Concrete arch bridges have their arch rings whitened by polishing and, their walls softened by bush-hammering.[23]

Essential to Luten's work was the protection afforded him by U.S. patents. He was an impassioned advocate of patent protection as well as the benefits such protection brought to the engineering community and to communities in general. He would often use the forum of professional conferences to discuss his patents and the broader subject of patent protection. Luten was also willing to defend his patents in court when he received reports of contractors infringing upon what he believed to be proprietary designs. He was not always successful in this litigation; in one important case in 1915 six of his patents were declared void by a judge who saw them as "the mere exercise of mechanical skill" rather than ground breaking knowledge.[24]

Although Luten's designs were many and varied there are certain features common to them. Notable among them was the tendency to lighten bridge piers for a more flowing appearance. His substantial background in arch stress analysis allowed him to counteract the horizontal thrust of one arch with its adjacent arch--thus minimizing the mass of the arch piers. He also insisted, in multiple span arch bridges, that the center arch be slightly larger to offset the visual effect of foreshortening that made the middle span appear smaller. Both of these features are visible in the Barrington and Warren Bridges. To Daniel Luten, engineering was "the art of applying science and the science of employing art."[25] He believed, as did many artists and designers of the early modern period, that structures should reveal their design elements and demonstrate honest use of materials. Daniel Luten disdained non-functional ornament and celebrated simple engineering structures "in harmony with their surroundings."[26] In this sense he contributed to the popularization of these essential modernist ideas in the American built environment.

Clarence L. Hussey

Relocating to Providence after his graduation from Massachusetts Institute of Technology in 1908, Clarence L. Hussey worked in various capacities in the engineering field before joining the R.I. State Board of Public Roads in 1912. The Board had recently established a Bridge Department to oversee the design, construction, and maintenance of the State's highway bridges. Hussey was hired as Chief Bridge Engineer. His first major project was to supervise the construction of the Barrington and Warren Bridges. In this capacity, he carefully documented all phases of their construction with photographs and hand-written notations.[27] Hussey had a profound influence on bridge design and construction throughout the state between 1912 and 1925.

An expert in the relatively new field of reinforced concrete construction and a nationally-recognized bridge engineer, Hussey formulated new, stronger concrete mixes and applied this knowledge to innovative and cost-saving bridge designs. One of the most notable of these innovations was the modified arch bridge, a design that saved as much as 50% of the concrete normally required for a span of comparable size. The modified arch had inclined, rather than vertical, spandrel walls and sidewalks and railings that were carried on brackets anchored to the arch ring. In the words of an American Society of Civil Engineers remembrance of Hussey published after his death in 1925, "His ideas, although marked by striking originality, had the saving virtue of reasonableness."[28] Hussey designed the Washington Bridge between Providence and East Providence, the original span of which still carries westbound traffic over the Seekonk River.

He also designed the only concrete through arch bridge in Rhode Island. Completed in the last year of his life, it spans Wickford Cove and is appropriately named the Clarence L. Hussey Memorial Bridge.

DESCRIPTION

The Barrington Bridge is a five-span, reinforced concrete structure with filled spandrel walls. Five elliptical arches allow the Barrington River to pass below the roadway. A concrete-walled causeway 333' long serves as the west approach; a 69' causeway serves as the east approach.

The bridge is 338' long overall, with span lengths of 55', 57', 60', 57', and 55'. This scheme of varying arch lengths follows designer Luten's insistence that the center arch be the largest to compensate for the optical distortion that would make it appear smaller. A cadence of gradually increasing and decreasing arch spans gives the illusion that all arches are of the same length.

The 30' wide roadway is bound by concrete sidewalks and parapet walls on both the north and south sides of the span; these add another 13' of width to the span for an overall width of 43'. The center of the bridge at the highest point of the deck is 12.8' above mean high water. The deck elevation at the abutments is 9.5' above mean high water. The roadway surface is paved with asphalt and has been resurfaced several times since the bridge's construction between 1912 and 1916. Although the concrete bed designed to carry streetcar tracks remains under the asphalt, the tracks that once ran down the center of the bridge roadway have been removed--probably ca. 1948, the final year of R.I. streetcar service.

The original open concrete balustrade walls were replaced with the present recessed-panel concrete parapet walls in 1948. The panel pattern matches that found in the causeway walls of the original construction. Though lacking any surface ornamentation, the surfaces of the bridge are adorned with two types of concrete finishes. The spandrel walls and the recessed panels are "bush-hammered," a rough finish that reveals much of the aggregate stone. The arch ring and raised portions of the parapet walls were originally rubbed or "polished" to a smooth concrete finish with little aggregate evident. Though still visible, these distinctions in surface treatment are subtle now due to years of exposure to weather.

Seven modern, aluminum lamp-posts are now mounted atop the bridge's northern parapet wall, replacing the original tapered concrete posts. The original poles (rising more than 17 feet from the roadway) carried bronze brackets with light fixtures. Although original plans called for a separate trolley span wire and supports, at the time of installation in 1916 the spans wires were incorporated into the light posts. These posts, as well as their solid concrete bases, were placed at intervals that mirrored the substructure's arch piers and abutments on both the north and south railings. These original concrete lamp posts and bases were left unchanged during the 1948 replacement of the balustrade railing. The current aluminum lamp posts, similar to those installed in 1960, are mounted on stepped concrete pedestals that rise above the cap of the parapet wall.

Typical of bridges of the period, the span's piers demonstrate the move toward construction with reduced massing. By balancing the horizontal thrust of adjacent arches, the Luten design minimized the horizontal strain placed on the piers. This engineering scheme paired with the great strength of reinforced concrete permitted the design of piers considerably thinner than their masonry counterparts--only 4' at the arch spring lines. Similarly, the arch barrels themselves are relatively thin, especially when one considers that they are the key structural elements carrying the weight of the roadway. In order to maintain desired aesthetic characteristics, these thicknesses are neither uniform between the arches nor uniform along the length of any one arch, varying from 14" thick at the crown of the end arches to 16" thick at the crown of the center arch. The corresponding arch barrels flair to 27" and 29" respectively as they reach the abutments and piers.

Although much stronger, cheaper, and more workable than stone, concrete had one significant disadvantage in bridge construction. It was much more susceptible than stone to wear from the scouring action of moving water--certainly an issue in the swift current of the Barrington River. In order to counteract this problem, the design called for a protective layer of 11" granite ashlar on surfaces affected by tidewater. This was a standard State Board of Public Roads practice, applied to structures exposed to salt water as well as mill stream pollution.[29] On the Barrington Bridge, three to four courses of granite were placed on the lower level of the causeways. The piers, which were situated in deeper sections of the river, had as many as nine courses of stone. Fear of water damage was well-founded as extensive pier repairs were required beginning in the mid-1920s.

Additional attempts to reduce the effects of scouring on the piers are visible on the bridge today. Steel fenders have been placed around the protruding cutwaters on both the north and south sides of each of the bridge piers. These fenders reduce damage to the piers by tidal action as well as protect them from collision damage from boat traffic, flotsam, or ice. These fenders are not the 3/8" steel plate and iron rail installed c. 1939 but are the result of repair work completed in 1993.

The northeast bridge extension wall provides some physical evidence of the former balustrade railing. Although the urn-shaped balusters are removed, a 50' section of the low, 4" base upon which the balusters were mounted survives along with a 3' concrete section that once served as the end anchor for this extension wall. The bridge number is inset into this end section. Four, 21" high 1.75" square steel posts, spaced 6' apart protrude from the base of the former wall. These posts likely provided structural support for the original wall. Two other wall extensions survive--on the southeast, curving slightly south and 57'long, and on the southwest, curving to the south more than 90 degrees and extending 48' onto Mathewson Road.

SOURCES OF INFORMATION/BIBLIOGRAPHY

Engineering Drawings

Original construction and alteration/repair drawings for Bridge No. 123 are on file at the Rhode Island Department of Transportation, 2 Capital Hill, Providence, Rhode Island.

Historic Views

A comprehensive collection of black and white photographs (approximately 5.5" x 3.25" format) documenting the construction and repairs of Bridge No. 123 are also on file at the R.I. Department of Transportation. The corresponding negatives are on file at the Rhode Island State Archives, Westminster Mall, Providence, R.I.

The Barrington Preservation Society, housed in the Barrington Public Library, has a collection of continuous tone photographs and halftones depicting the crossings of the Barrington River dating from the period of the metal truss bridge of 1885. This collection includes two photos of the temporary bridge construction of 1912 not in the collection of RIDOT.

The Massasoit Historical Association, Warren, R.I., has two photos of the aftermath of the 1938 Hurricane. One depicts the boats washed onto the deck of Bridge No. 123; the other depicts the washout of the trestle to the north of the bridge.

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Annual Report of the Rhode Island Department of Public Works (1936-1948)

Clouette, Bruce and Roth, Matthew. *Historic Highway Bridges of Rhode Island.* Providence: Rhode Island Department of Transportation, 1990

Records of the Rhode Island State Board of Public Roads. Manuscript on file at RI State Archive

NOTES

1. As quoted in Thomas W. Bicknell, *A History of Barrington,* (Providence: Snow and Farnham, 1898), p. 458

2. As quoted in Nicholas Gizzarelli, *Barrington Roads* (unpublished manuscript at Barrington Preservation Society), p. 24

3. T. Allan Comp, *Bridge Truss Types: A Guide to Dating and Identifying, Technical Leaflet 95* (Nashville: American Association for State and Local History, 1977) p. 6

4. "To Close Barrington Bridge." *Providence Daily Journal,* 3 January 1912, p.1

5. Resolution from January 1911 session of the Rhode Island General Assembly, as quoted in the *Report of the Bristol County Bridge Commission* (Providence: State of Rhode Island) 1912, p. 1

6. ibid p. 5

7. ibid p. 4

8. ibid p. 7

9. *11th Annual Report of the Rhode Island State Board of Public Roads* (January 1913), p.30

10. "To Repair Barrington Bridge," *Providence Daily Journal,* 24 January 1912, p.2

11. This agency, established in 1902, was responsible for improving and maintaining State highways and bridges.

12. *12th Annual Report of the Rhode Island State Board of Public Roads* (January 1913), p. 32

13. Daniel B. Luten, "Concrete Bridges." *Proceedings of the National Association of Cement Users, 8th Annual Convention,* Vol. 8, No. 12 (1912), p. 631

14. Frank McKibben, "The Present Status of Bridge Building." *Concrete-Cement Age,* Vol 1, No. 6 (December 1912), p. 48-49

15. *11th Annual Report of the Rhode Island State Board of Public Roads* (January 1913), p. 29-30

16. This bridge was replaced circa 1955 by the current bridge.

17. "A New Era in Bridges." *The Providence Sunday Journal.* 22 February 1914. Sec. 5, p.5

18. Per minutes of the State Board of Public Roads meeting of August 14, 1912, compensation for use of the Luten patents was increased by another 10% (manuscript Records of the State Board of Public Roads, R.I. State Archives) to include patents, engineering and inspection (*11th Annual Report of the State Board of Public Roads*, p. 34)

19. *11th Annual Report of the Rhode Island State Board of Public Roads* (January 1913), p. 31

20. *12th Annual Report of the State Board of Public Roads* (January 1914), p. 39

21. *14th Annual Report of the State Board of Public Roads* (January 1916) p. 49-50

22. It is possible that the bush-hammered, recessed panel concrete parapet wall is a Clarence Hussey design. This type of wall was used until 1950 when the R.I. Department of Transportation began its use of steel bar railings.

23. Daniel B. Luten, *Reinforced Concrete Bridges* (Indianapolis: published by the author), 1924

24. "Six Concrete Patents Void on Broad Grounds," *Engineering News* Vol. 74, No. 23 (December 1915) p. 1094-5

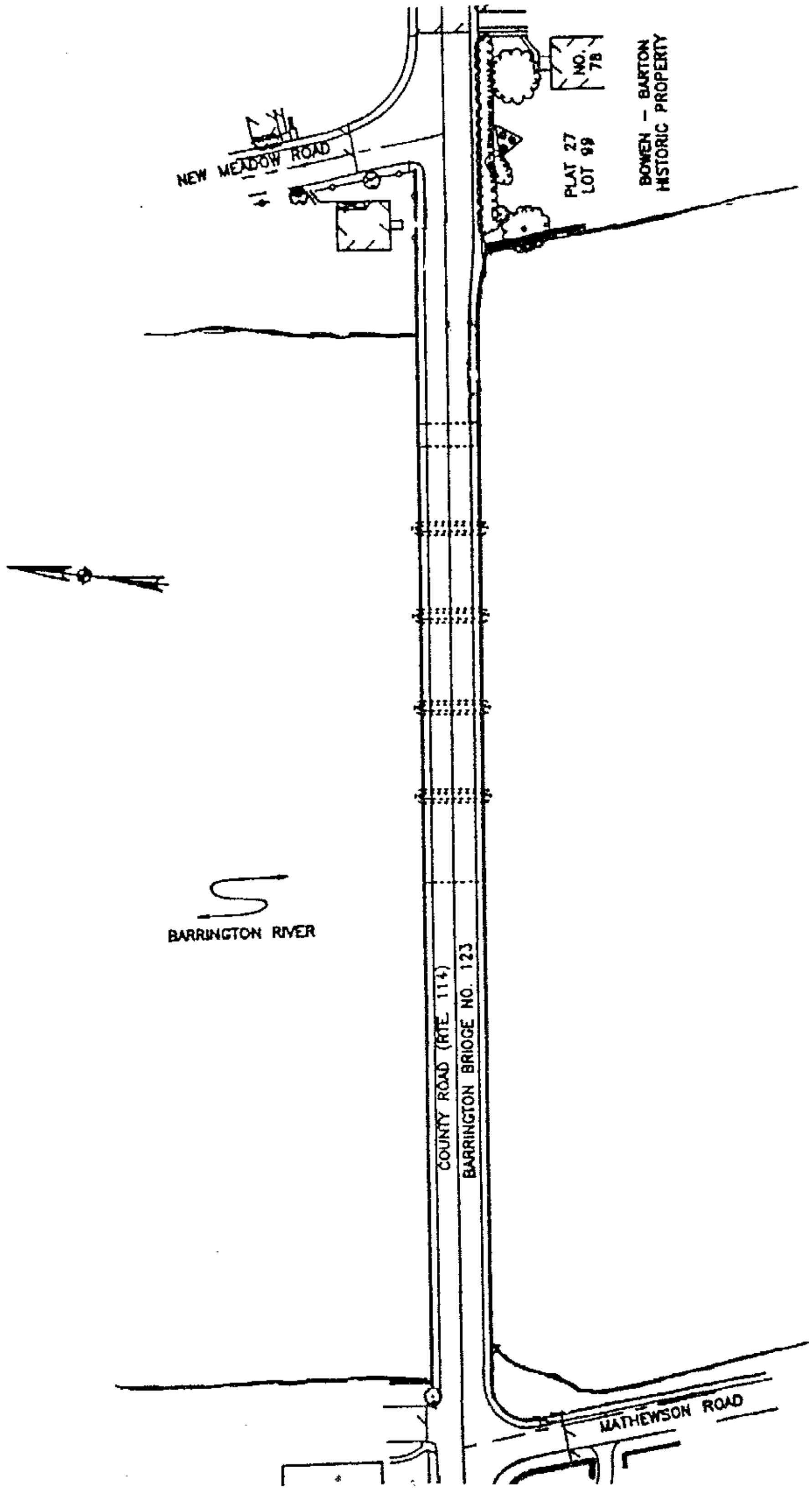
25. Daniel Luten, "Patented Concrete Bridges," *Proceedings of the American Society of Contracting Engineers* (October 1912), p. 359

26. Daniel B. Luten, "Concrete Bridges." *Proceedings of the National Association of Concrete Users*, Vol.8, (1912), p. 631

27. These photographs form the main part of a historic bridge collection at the R.I. Department of Transportation (in positive form) and at the R.I. State Archives (in negative form).

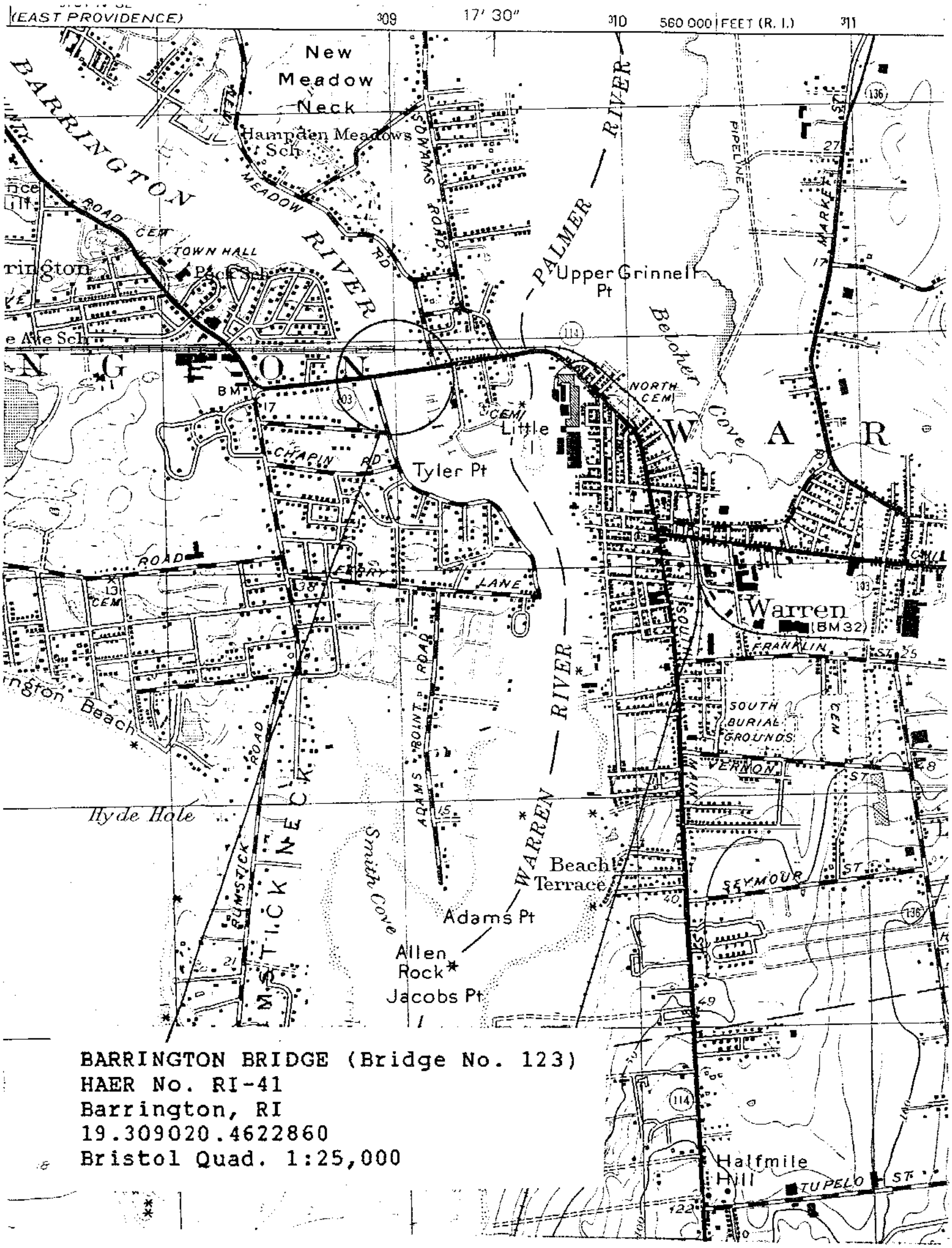
28. George Henderson, "Memoir of Clarence Loring Hussey," *Transactions of the American Society of Civil Engineers* (1926) p. 1632-33

29. *24th Annual Report of the Rhode Island State Board of Public Roads* (January 1926), p. 98



SKETCH PLAN

SCALE:1"=120'



BARRINGTON BRIDGE (Bridge No. 123)
HAER No. RI-41
Barrington, RI
19.309020.4622860
Bristol Quad. 1:25,000