NEW HAMPSHIRE HISTORIC PROPERTY DOCUMENTATION

CENTRAL STREET BRIDGE
NH Bridge No. 113/064

NH State No. 599

LOCATION:	Central Street over Pemigewasset River, Bristol – New Hampton, Grafton County, New Hampshire USGS Bristol, New Hampshire, Quadrangle UTM Coordinates: 19.279453.4829818
BUILDER:	New Hampshire State Highway Department
ENGINEER:	Harold E. Langley, New Hampshire State Highway Department
CONTRACTOR:	Substructure: Kittredge Bridge Company, Concord, NH Superstructure: Berlin Construction Company, Berlin, CT
FABRICATOR:	Berlin Construction Company, Berlin Connecticut
DATE:	1928
PRESENT OWNER:	New Hampshire Department of Transportation
PRESENT USE:	Highway bridge
SIGNIFICANCE:	Central Street Bridge is a well-preserved example of a medium-span riveted truss highway bridge representative of the design and technology of the type as practiced by the New Hampshire Highway Department during the 1920s and 1930s. It is the longest high Parker truss bridge built in the state to repair losses caused by the Flood of 1927, the first of three great floods that badly damaged the state's transportation system in the 20th century. It was designed by Harold E. Langley, a prominent engineer who served as state Bridge Engineer and made significant contributions to bridge design and construction in New Hampshire. The Central Street Bridge was determined eligible for the National Register of Historic Places on December 16, 1987.
PROJECT INFORMATION:	Central Street Bridge 113/064 was documented in accordance with the standards of the Historic American Engineering Record in November 2006 by Historic Documentation Company Inc. (HDC), Portsmouth, RI, for SEA Consultants, Inc, Concord, NH and the New Hampshire Department of Transportation (NHDOT). The report was written and prepared by Richard M. Casella, Engineering Historian, HDC. Major portions of the text were written by James L. Garvin, Architectural Historian, NH Division of Historical Resources. Rob Tucher Photographic Documentation served as project photographer. The recordation was undertaken pursuant to a Memorandum of Agreement among the Federal Highway Administration, NHDOT, and the New Hampshire State Historic Preservation Officer pertaining to the planned replacement of the subject bridge.

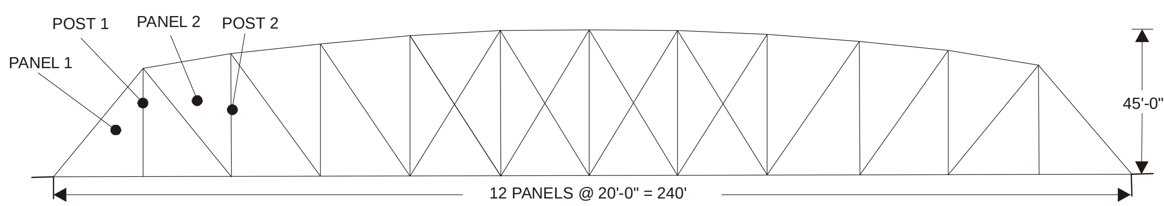
DESCRIPTION

The Central Street Bridge is a single span riveted steel thru truss highway bridge on stone and concrete abutments carrying two lanes of Central Street over the Pemigewasset River between Bristol and New Hampton, New Hampshire. Completed in November 1928, the bridge replaced a covered wood bridge that collapsed March 30, 1928 as a result of damage caused by the flood of November 1927. The bridge is 240' long, 21' wide with a maximum truss height of 32'. The bridge sits in a forested river valley with the village of Bristol located immediately up the hill to the west. The Newfound River cascades down the hillside through Bristol to empty into the Pemigewasset about 300 feet downstream of the bridge. Immediately south of the outlet of the Newfound River is a section of flat ground cut from the hillside on which the Franklin and Bristol Railroad depot stood until its abandonment following a subsequent flood in 1936. The stone retaining walls built in 1847 to support the tracks and depot still stand along the bank. As noted below, the site of the bridge lies within the impoundment of the Franklin Falls Flood Control Project. When the flood control reservoir is filled to capacity, the eastern end of the Central Street Bridge is submerged.

Superstructure

Structurally, the trusses are of the polygonal Pratt type, a design patented in 1844 by Thomas Pratt and characterized by a straight bottom chord and a curved or arched top chord connected with vertical posts in compression and diagonals in tension. The top chord is composed of straight members that connect the tops of posts of varying height to form polygonal panels. The polygonal Pratt truss is also commonly called a Parker truss, after Charles H. Parker who patented an improved version of the Pratt design in 1870 and built several railroad bridges of the type. Parker's improvements, specifically a wrought-iron I-section top chord of either rolled or built-up members, led to widespread adoption of the type and the term Parker Truss became the common name applied to Pratt trusses with polygonal top chords. Further discussion of Pratt and Parker trusses is given below.

The truss is 240' in length with a total of twelve 20' wide panels. Top chords and inclined end-posts are built-up members consisting of 12" channels joined back-to-back with 19" wide cover plates on top and with double lacing bars on the bottom. Bottom chords are built-up members consisting of 12" channels joined back-to-back with 19" wide top and bottom plates. Additional side plates, 10" x 5/16", reinforce the bottom chord webs at panels 4 through 9.



Posts consist of rolled 10" x 8" x 31 p.l.f. Carnegie Beam sections except posts 2, 3, 9, and 10 which are built-up H-sections, 10" by 10-3/8" overall in section made of four 5"x 3-1/2" angles riveted to 10"x 5/16" web plates. Single diagonals are used in panels 2, 3, 4, 9, 10, and 11 consisting of rolled 10" x 8" x 31 p.l.f. Carnegie Beam sections. Two diagonals are used in panels 5, 6, 7 & 8 consisting built up C-section diagonals using two angles and 10" tie plates. Upper lateral braces are 3"x3-1/2" angles, lower lateral braces are 3"x4" angles. The portal and sway frame struts and bracing are all constructed of angles.

The original 24" rolled I-section floor beams carried six lines of 16" I-beam stringers spaced approximately 3'-8" on center. Floor beams and stringers were replaced in 1976 with heavier wide-flange beams of the same depth. The original wood floor consisted of 2"x4" lumber laid on edge and nailed to 3"x6" wood "nailers" bolted to the stringers. In 1968 the deck was replaced with 2"x6" lumber on 4"x6" nailers. There are no sidewalks; the 6"x6" wood curbing is tight against the posts. The original railings remain, consisting of two lines of 4" angle. In 1974 standard W-beam guardrail was added to the bridge and approaches.

A builder's plate is located on one endpost at each end of the bridge and reads:

BUILT BY
THE
BERLIN CONSTRUCTION Co.
BERLIN, CONN.
1928

Substructure

The bridge was built on the same alignment as the old covered bridge and the original stone abutments were incorporated into the plan. The old bridge was built on a grade with the Bristol end approximately 8' higher than the New Hampton end. At the Bristol end, the existing cut granite abutment, laid extremely tightly in even 2' courses, was determined sound and suitable for capping with a new reinforced concrete bridge seat. The new seat raised the elevation of the bridge about 2.5' and encased the top four courses of stone with concrete on the back side of the abutment. The grade of the Bristol approach road was raised about 18". This work required 50 cubic yards (c.y.) of excavation, 31 c.y. of Class C (1500 p.s.i.) concrete, and 818 pounds of reinforcing steel.[1]

A new reinforced concrete abutment with bevel wings was erected at the New Hampton end. The elevation of the bridge seat and the approach roadway was raised nearly 4 feet, resulting in a difference in elevation of 6' between the ends of the bridge and a reduction in the grade to 2.5 percent. This work required 620 c.y. of structure excavation, 320 c.y. of Class C concrete, and 165 pounds of reinforcing steel (reinforcing the bridge seat backwall only). The north wing (upstream side) of the abutment was tied into the existing stone abutment wingwall.

Repairs

In 1968 several repairs were undertaken, the largest being replacement of the deck, previously described. In addition the expansion bridge shoes at the west end were cleaned and reset, and collision damage to an endpost and railing section at the Bristol end was repaired. Concrete repairs were made to the wings of the east abutment, and to the backwall and toe of the west abutment. The work was done by C.A. Mooney & Sons, Inc. of Bristol and totaled $29,753.33. In 1976 the I-beam floorbeams and stringers were replaced with wide-flange members and the entire superstructure painted. [2]

HISTORICAL BACKGROUND

Site History

The Central Street crossing is the site of some of the earliest bridges over the Pemigewasset River in the Bristol area. Like many early New Hampshire spans, the first bridge at this crossing was a toll bridge built by a private corporation. The New Hampshire legislature incorporated "the Proprietors of Central Bridge" on December 17, 1812, reincorporating the organization on June 22, 1820 when the first company failed to construct a bridge.[3] In both incarnations, the company was authorized to charge tolls for passage over the bridge, and was required to build any necessary roads leading to the bridge on the New Hampton side of the river in addition to such roads as the town might build in any case.

The first bridge completed by the Proprietors was opened in 1823. It was a stringer bridge without a roof, supported by two piers in the river.[4] The Proprietors found it necessary to replace this first bridge in 1836-7. The second bridge, which stood for ninety years, was a two-span covered truss bridge with a single stone pier near the center of the river. The bridge had laminated wooden arches to supplement its trusses, but it is not known whether these were original or later additions. The bridge became toll-free when the commissioners of Belknap and Grafton Counties agreed to lay out a public highway across the span in 1861, paying the Proprietors $300 in damages for the loss of tolls.[5]

The Central Street crossing long posed challenges to its bridges. The 1904 *History of Bristol* tells us that "the [wooden] bridge [built in 1836] has been an expensive one to maintain, and large sums have been expended on it from time to time. About 1854, the eastern [New Hampton] abutment was swept away by a flood of water, turned in that direction by a log jam at the [central] pier; while the bridge, itself, has several times narrowly escaped destruction by freshets. In 1870, Bristol rebuilt the western abutment and raised the western end of the bridge a few feet, at a cost of $1,355."[6]

The importance of Central Street Bridge to New Hampton increased with the building of the Franklin and Bristol Railroad 1848 to connect with the Northern Railroad in Franklin. The line ran up the west bank of the Pemigewasset River, crossing Smith's River at Profile Falls on a covered bridge and terminating at mouth of Newfound River at Bristol, just a couple hundred feet south of the bridge. In 1849 the line was bought by the Northern Railroad and became its Bristol Branch. In 1854 a 22'x47' depot and a 26'x71' freight house were erected on a section of flat land created by cutting into the hillside and filling behind heavy granite retaining walls built along the edge of the Pemigewasset River.[7]

The Boston & Maine took over operation of the line in 1887 when it leased the Northern for 99 years. The line was severely damaged by floods in January 1886, April 1895, March 1913, November 1927 and March 1936. The introduction of a bus line between Bristol and Franklin in 1925 and the closing of many of Bristol's factories during the Depression erased the line's profitability. On 19 March 1936, a great flood finished the line off, washing away the bed and the tracks in numerous places. Abandonment of the line was granted in 1937 and in 1940 the rails were removed.[8] All evidence of the Bristol Depot is now gone except the stone retaining walls along the riverbank and remnants of building foundations.

Flood of 1927

The floods of November 3 and 4, 1927, exceeded all previous flood records in northern New Hampshire, putting a tragic end to “one of the mildest and most wonderful fall seasons ever witnessed by the present generation.” Rain levels totaling between five and ten inches fell in a twenty-four-hour period. The Connecticut River rose thirty feet at Hanover, New Hampshire. The Pemigewasset and its tributaries rose swiftly, driving all the inhabitants of Beebe River Village in Campton to neighboring towns for safety, inundating the first and second stories of the buildings on Plymouth’s Main Street, and isolating Plymouth village from outside contact.[9]

Damage to roads and bridges in New Hampshire from the flood of 1927 was estimated at $2.5 million. Division engineers for the New Hampshire Highway Department reported that the heavy rains were often followed by landslides, which “blocked several of the mountain streams with debris so that their customary channels were altered, this causing the streams to overflow their banks and in many areas [to] seek new stream beds along the highways and railroad lines.”[10] Damage in Vermont, where the eastern slopes of the Green Mountains received especially heavy rainfall, was far greater than in New Hampshire.[11]

At Bristol, the waters were somewhat controlled by the Ambursen-type (buttress) hydroelectric dam that had been built upstream from the village in 1923-4.[12] Nevertheless, the old Central Bridge that stood about a mile downstream from the dam took a beating:

> At the time of the flood, the pier at this bridge was under great strain. Trees, planks and a lot of heavy debris accumulated on its upper side, pounded for many hours by the rush of waters, which rose to the floor of the structure. No doubt had ever been felt about the permanence of this pier, but during the flood the stone abutments on either end of the bridge narrowed the raceway, resulting in a tremendous force at the pier, which was undermined by the extra strain.[13]

That the pier foundation had been undermined was not readily apparent and it was not until the following spring that the seriousness of the problem became apparent. "Bristol had congratulated herself that she had sustained little loss in the November flood compared with that of many towns. But this did not prove to be so." [14]

Collapse of the Covered Bridge

On Friday March 30, 1928 "the old toll bridge, so called …collapsed about 3 p.m., the central pier of split granite rocks in the middle of the stream giving way, causing the bridge to crumble. Fortunately there was no loss of life, although traffic had continued up to the time of the collapse." [15]

Following the collapse, on April 4, 1928, the *Bristol Enterprise* reported the following:

> Of late there had been a definite change in the pier, growing worse each hour during Wednesday and Thursday of last week [March 28, 29]. By noon Friday the top of the pier leaned heavily to the east, or New Hampton side, leaving the heavy wooden supports on the Bristol side suspended in the air, and the heavy top rocks were loosening. It was a veritable tower of Pisa. Those who witnessed it state that the pier toppled into the water, the wooden structure trembled for a few seconds, and crumbled. The Bristol end was pulled from the abutments and dropped 20 or 25 feet into the bed of the stream, leaving the peak of the roof almost even with the roadbed.
>
> That this disaster is flood damage, pure and simple, no one in this locality who know the conditions, have any doubt. It could not have been by the late rains, as these occasioned only a slight rise in the river. In fact, at present, the water at this point is only 10 feet deep. Mr. Childs, the state engineer, who was here Monday, was overheard to say that before he saw the wrecked bridge he had expected it was a flood damage, and that after seeing for himself, he was even more confident of the fact.[16]

On Saturday and Monday conferences were held between the town selectmen and State Highway department engineers. On Tuesday twenty workers from the road crews of both towns began removing the wreckage and salvaging usable timbers while a surveying crew took measurements for the new bridge. An assortment of large handmade iron spikes and bolts were recovered, some with initials indicating three different makers, and given to Bristol's Minot-Sleeper Library. [17]

BRIDGE HISTORY

Planning, Design and Technology

Within days of the collapse of the old Central Bridge, State Highway department engineers were at work surveying the site for the design of the new bridge and within two weeks the plans were being drawn. Five sheets of drawings, entitled *Flood Relief Project No. 10-A, Proposed Bridge, Town of Bristol over Pemigewassett River on New Hampton Road,* were prepared for the project by the New Hampshire Highway Department (NHHD) between April 14 and April 22, 1928. The only initials on the drawings are "H.E.L." which seem to indicate that Harold E. Langley was solely responsible for designing the bridge, tracing and checking the drawings. Langley joined the department in the 1920s and by the end of the decade was a principal bridge designer responsible for several large truss bridges built in the wake of the 1927 flood. He served as the Department's Assistant Bridge Engineer from 1935 to 1941, and then Bridge Engineer until his retirement in 1961. More information on Harold Langley's outstanding career with the NHHD is provided below.

Damage from the flood of 1927 demanded the rapid construction of many steel bridges. Many of the short-span bridges washed out by the floods of 1927 were replaced by concrete bridges and culverts, and by plate girder spans measuring up to a hundred feet in length.[18] But the most dramatic of the flood replacement bridges were the high or “through” steel trusses that replaced long-span bridges lost to high water. These longer crossings were spanned by truss bridges of either the Warren type (composed of a series of triangular panels) or the Pratt type (composed of a series of four-sided panels with diagonal braces. See the Comparable Bridges section below for further discussion of the design characteristics of the flood relief truss bridges.

In the case of the new Central Bridge it was decided to use a single span and thereby eliminate the stone pier that had supported the center of the earlier covered bridge. It was apparent that building a new pier in the center of the river capable of withstanding another onslaught like the 1927 flood would be costly, and the money could be better spent on the additional expense of a long single span that would not impede the river's flow. To reach the existing abutments on each bank would require a span of 240 feet, making the new Central Bridge one of the longest of the Flood Relief bridges built as a result of the 1927 flood, and the longest of its particular type.

A Pratt truss with a polygonal top chord was chosen as the most cost effective bridge type for the site. The Pratt is a quadrilateral truss (four-sided panels) with vertical posts in compression and diagonals in tension. The type was invented and patented by Thomas Pratt in 1844 and is generally referred to by engineers as a Pratt truss with a polygonal top chord or as a polygonal Pratt truss. The polygonal top chord gives the truss a slightly arched profile and as a result the bridge form has been loosely called a variety of common names in the literature including a Bowstring truss, a curved-chord Pratt truss, and a Parker truss. To some degree, these names leave room for assumptions and confusion with other similar and not-so-similar truss types. The Bowstring truss, defined by bridge engineer and historian J.A.L. Waddell as "a truss in which the lower chord is horizontal and the upper chord joints lie in the arc of a parabola, or similar curve," describes the Pratt truss with a polygonal top chord in certain cases, but is more often used to describe the continuous arched laminated wood members found in covered wooden bridges, or a tubular wrought iron tied arch of the type patented by Thomas W. H. Moseley and Zenas King in the late 1850s and early 1860s.[19] The term "curved-chord" could be taken to imply smoothly curved members like those of an arched truss, but the polygonal Pratt truss is composed of all straight structural members. The Parker truss, as bridge historians often refer to the polygonal Pratt, is named after Charles H. Parker who essentially "re-invented" the polygonal Pratt in the 1870s after Pratt's patent expired and added some patentable and important features that popularized its use. The term Parker Truss best suits the several patent trusses built by Parker that still survive today, and its use as a common name for the polygonal Pratt truss is the most applicable and widely accepted among bridge historians. Further discussion of Pratt and Parker trusses is given below.

The Pratt truss proved especially well adapted to all-metal bridge trusses, and before the introduction of structural steel in the late 1800s was often employed with cast iron posts and wrought iron ties. The truss was easily structurally analyzed by either the graphic or the mathematical methods that had been developed by 1850. Structural analysis permitted the stresses in each member to be calculated under various conditions of loading and led to the development of the polygonal form in which the height of the panels increased toward the center of the span where the stresses are highest. The increasing use of Bessemer steel for bridge building in the United States in the 1890s increased the use of the Pratt truss, which was well adapted both to pin-connected and riveted spans.

By 1900, truss bridges with all-riveted connections – a superior design in widespread use in Europe at the time – were finding increasing acceptance with American railroad engineers. Riveted connections provided a stiffer bridge and allowed for greater distribution of stresses at the joints and a subsequent savings in metal costs. The introduction of the portable air powered riveting gun in the early part of the century allowed for the field assembly of riveted connections, eliminating the expensive and high maintenance pin connected joints. By the 1920s riveted connections had replaced pin connections as the primary method of metal truss bridge construction in the U.S.

The polygonal Pratt truss (Parker truss) proved to be an economical design and after 1890 were "widely built for both highway and railroad service."[20] [Parker's patents would have expired in 1887]. The Parker truss was widely adopted for spans exceeding 200 or 250 feet and by 1904 had been built with a span that exceeded 400 feet.[21]

Most moderate- to long-span highway bridges built in New Hampshire during the 1920s and 1930s adopted the Parker truss design. The Central Street Bridge was built as a direct result of severe floods that affected Vermont and northwestern New Hampshire in November 1927. Technologically it is an excellent example of steel truss highway bridge design and construction as practiced by the New Hampshire Highway Department in the late 1920s. Other Parker through truss bridges built after the flood included a 220-foot bridge at Chiswick Avenue (a.k.a. Beacon Street) in Littleton and a 220-foot bridge over the Connecticut River between West Stewartstown, New Hampshire, and Canaan, Vermont, both of which have been replaced.

Construction

The Highway Department prepared separate contracts for the substructure and the superstructure and opened the bids the second week of May 1928. The contract for the substructure required that the work be completed within 45 days and was won by Kittredge Bridge Company of Concord with the low bid of $9604.89. Samuel Ferguson, a Bristol contractor, lost the job by only $400. The superstructure contract was won by the Berlin Construction Company of Berlin, Connecticut with the low bid of $21,048, beating out American Bridge Company ($21,870) and Boston Bridge Works ($22,362).[22] Six sheets of erection plans were prepared by the Berlin Construction Company, between May 17 and June 11, 1928. The plans are marked "Drawn by MacMillan," however no biographical information about him was located. More information on Kittredge Bridge Company and Berlin Construction Company is contained in the Supplemental Information section below.

Five men from Kittredge Bridge Company began work on the bridge foundations on June 25, 1928 under the supervision of C. Morton Plankey of Bristol. More men were added to the crew as materials arrived, eventually reaching a total of fifteen.[23]

On Thursday, November 22, 1928 the *Bristol Enterprise* reported the construction progress and anticipated opening of the bridge the following day:

> Yesterday noon W.S.H. Remick and his force of men had completed laying 100 out of the 120 panels, and it is expected Road Agent Lowell will do the filling in at the entrance Friday, when probably the bridge will be open for traffic. The panels are two feet wide, 19 long, made of 2 x 4's. These are spiked together and laid edgewise, after being covered on three sides with a bituminous material. The panels are bolted to the nailing strips, which have been bolted to the girders every five feet. Wheel guards are to be placed along the outer edge of the floor, which will be given a coating of tarvia next spring.[24]

The final cost of the bridge, according to state records, was $34,610.87, approximately $4000 more than the original contract price.[25] It was not determined what the unanticipated additional work or costs entailed.

The high degree of quality in the design and construction of the new Central Street Bridge was demonstrated eight years later when the structure withstood the flood of 1936 with little or no damage. The 1936 flood, which surpassed the 1927 flood in severity and damage, did wipe out the Bristol Branch of the Boston & Maine Railroad, and destroyed or damaged over 200 bridges in New Hampshire alone. See below for more information on the Great Flood of 1936.

The bridge again survived inundation on June 4, 1984, when floodwaters rose to a high point of 52" above the level of the deck at the New Hampton end, a notation of which can be found on the south endpost. [This inundation may have been by relatively quiet stored water impounded by the Franklin Falls flood control dam; see below.]

SIGNIFICANCE

The Central Street Bridge is a well-preserved example of a medium-span riveted truss highway bridge, typical of thousands built in the U.S. during the first half of the twentieth century. It is the longest high Parker truss bridge built in New Hampshire to repair losses caused by the devastating flood of 1927, the first of three great floods that badly damaged New Hampshire's transportation system in the twentieth century. It is notable for its Parker truss design which was often employed for medium- to long-span highway bridges during the first half of the century, and for its span of 240 feet, relatively long by New Hampshire standards. The combination of both rolled and built-up riveted structural members used on the bridge reflects a transition period in steel truss design during 1920s and 1930s when the increasing variety of new shapes from steel rolling mills supplanted the labor-intensive built-up members.

Some bridges built to overcome the devastating losses of the flood of 1927 were constructed on standardized plans that had been pre-approved by the federal Bureau of Public Roads. Unlike these standardized post-flood bridges, the Central Street Bridge was specifically designed for its dramatic location by Harold Langley, a principal bridge designer at the New Hampshire Highway Department during the 1920s and 1930s. Although Langley provided a custom design for the bridge, he employed standard specifications developed by the federal Bureau of Public Roads, the predecessor to the Federal Highway Administration, thus qualifying the bridge for federal bridge aid funding.

The Central Street Bridge was determined eligible for the National Register of Historic Places on December 16, 1987.

ADDITIONAL BACKGROUND INFORMATION

Harold E. Langley, Designing Engineer, Central Street Bridge

Langley joined the staff of the New Hampshire Highway Department in the early 1920s. At that period and until World War II, the Highway Department designed most of New Hampshire's bridges with its own highly skilled personnel, employing consulting engineers only on large and complex projects.

Langley quickly became one of the agency's most skilful and versatile bridge designers. He designed scores, if not hundreds, of bridges in both concrete and steel. He was a pioneer in the development of concrete rigid frames, continuous steel girder bridges, and other types of statically indeterminate bridge types, and was a noted expert on long-span structures.

At about the same time that Langley designed the Central Street Bridge and other "flood" bridges in Bethlehem and Littleton, he was also becoming proficient in the design of reinforced concrete bridges. In 1927, he designed an 86-foot filled-spandrel concrete arch over the Mad River in Campton, followed by a similar arch in Colebrook in 1929. Langley and his colleagues designed a number of comparable concrete arches in the following years. In 1930, Langley designed the Vilas Bridge, a beautiful open-spandrel concrete rib arch bridge over the Connecticut River between Walpole and Bellows Falls.

Langley also pioneered in the introduction of the concrete rigid frame in New Hampshire, corresponding with Arthur G. Hayden, who introduced the rigid frame in the United States in several bridges he designed in the early 1920s in Westchester County, New York. By 1933, the New Hampshire Highway Department joined fifteen other state highway agencies in adopting the concrete rigid frame as a standard bridge design.

Langley also developed unusual skill in the design of steel bridges, both standard truss designs like the Central Street Bridge and more unusual structures such as steel arches. In 1930, Langley designed the 133-foot Beecher Falls Road Bridge over the Connecticut River at a new crossing between Stewartstown, New Hampshire, and Beecher Falls, Vermont. Langley's design was a deck span supported by a steel rib arch. This bridge received an award as the Most Beautiful Steel Bridge of 1931 from the American Institute of Steel Construction.[26] Building upon his experience, Langley superintended the design, by colleague John H. Wells, of the prize-winning steel rib arch bridges across the Connecticut River at Chesterfield-Brattleboro (1937) and Orford-Fairlee (1938).

Langley continued his pioneering efforts through the 1930s and after, leading New Hampshire to become one of the earliest states to utilize statically indeterminate continuous girder bridges. Langley's work earned him a national reputation, and in 1943 he co-authored the second edition of Hool and Kinne's *Movable and Long-Span Steel Bridges* (first edition, 1923), contributing a new section on steel arches.

Kittredge Bridge Company, Concord, New Hampshire

In 1931 the Kittredge Bridge Company was located in the Patriot Building in Concord, New Hampshire. An advertisement in *New Hampshire Highways* magazine stated that the firm specialized in "steel and concrete bridges" and was a supplier of structural and reinforcing steel. The ad listed A.H. Kittredge as president and H.P. Radigan as engineer of the company.[27] Arthur H. Kittredge was formerly superintendent of the bridge department of the Colburn

Construction Company, also of Concord, and may have previously worked for the United Construction Company of Albany, New York.[28] Information on other bridges built by Kittredge Bridge Company in New Hampshire has been compiled by State Architectural Historian James L. Garvin while discussing the Through Plate Girder bridge on Route 302 over the Saco River in Bartlett (189/129):

> The company built a two-span concrete continuous T-beam bridge over the Mascoma River in Canaan in 1925 and a ninety-one-foot through plate girder span over Sawyer's River in Crawford Notch in 1926. In 1928, following the flood of the previous autumn, Kittredge built substructures for steel Warren trusses in Bethlehem and Sugar Hill; bridges over the Oliverian Brook in Haverhill; the Apthorp Bridge in Littleton, a 120-foot span through Pratt truss; and a through Parker truss over the Pemigewasset River between Bristol and New Hampton, fabricated by the Berlin Construction Company. In 1929, Kittredge constructed a plate girder bridge in Tamworth. In 1930, the company erected the arched steel superstructure (fabricated by American Bridge Company) and the approaches to Harold Langley's deck arch span over the Connecticut River in Stewartstown, built a two-span reinforced concrete T-beam bridge in Groton, and erected a 169-foot through Pratt truss bridge over the Baker River in Plymouth. In 1931, Kittredge erected a two-span continuous through plate girder bridge in Bartlett [subject bridge] and the double-deck Warren truss bridge over the Suncook River between Pembroke and Allenstown. Kittredge constructed a fifty-foot concrete rigid frame span in Brookline in 1932 and a fifty-two-foot rigid frame in Colebrook in 1934. In 1933, Kittredge built a railroad overpass in Landaff, combining ten concrete T-beam approach spans with a two-span plate girder. Kittredge had the steel for both the Pembroke-Allenstown and Landaff bridges fabricated by McClintic-Marshall Company. In 1936, Kittredge erected a single-span through Pratt truss over the Baker River in Plymouth.[29]

Berlin Iron Bridge Company, Berlin Construction Company, East Berlin, Connecticut

The Berlin Iron Bridge Company is best known for the hundreds of lenticular truss bridges of patented design that the firm built during the last two decades of the nineteenth century. The company was officially established in 1883 with the renaming of its predecessor company, Corrugated Metal Company, but its origins extend back to 1868 to the metal-working firm of Roys and Wilcox of East Berlin. In that year, Roys organized a separate company to manufacture sheet metal building materials, including corrugated roofing and fire doors. The company started as the American Corrugated Iron Company, became the Metallic Corrugated Shingle Company in 1871, and in 1873 was renamed the Corrugated Metal Company. The product line grew to include structural building components, including iron roof trusses, but by 1877 the firm was near bankruptcy. In that year Samuel C. Wilcox took control of the company as President and injected new capital into the failing enterprise. Wilcox recognized an opportunity for Corrugated Metal to expand into the rapidly growing market for iron bridges and in 1878 purchased the rights to manufacture a lenticular truss bridge designed and patented by William O. Douglas.[30]

William O. Douglas was part owner of a wholesale hardware business in Binghamton, New York. In 1877 he sold his interest in the firm and devoted himself to the study and design of iron bridges. The following year he was granted a patent for a lenticular truss bridge and also came into contact with Wilcox, who received the license to manufacture the bridge design. Douglas joined the Corrugated Metal Company as Treasurer and Executive Manager. Charles M. Jarvis, a civil engineer also from Binghamton, probably an acquaintance of Douglas, joined the firm as an engineer in charge of bridge building operations. In 1883 the company name was changed to Berlin Iron Bridge Company, and in 1886, following the death of Wilcox, Jarvis, then Vice-President and Chief Engineer, took over as President.

The lenticular truss design for which Douglas was issued U.S. Patent No. 202,526 was not an original idea, but had been developed and built in France, England, and Germany as early as 1840. Patents for the lenticular truss type—called an elliptical or parabolic truss at the time—were issued in the United States in 1851 and 1855. Regardless of the apparent prior art on the subject, Douglas was issued his patent in 1878 and the Berlin Iron Bridge Company (BIBC) maintained an exclusive right to build the design by threatening to sue. The single exception was the Smithfield Street Bridge in Pittsburgh, Pennsylvania, a lenticular truss bridge built by Gustav Lindenthal in 1883, which is believed to be the only non-BIBC lenticular truss bridge ever built in the United States. When BIBC threatened Lindenthal with a patent infringement lawsuit, he pointed to the earlier patents and the suit was never filed.[31]

Under the leadership of Charles Jarvis, Berlin Iron Bridge Company grew to eventually employ 400 workers and become one of the largest New England bridge building companies. In an 1889 company catalog, BIBC claimed to have erected 664 lenticular *spans* in 12 states. Research by bridge historian Victor Darnell determined that in fact the company was counting the individual spans of multiple-span bridges. The greatest number of lenticular *spans* – meaning the following totals include each span of multi-span bridges - had been erected in New York (213), followed by Connecticut (189), Massachusetts (87), Maine (49), and New Hampshire (43).[32]

The lenticular truss form was not generally acclaimed, and on several occasions was disparaged in the engineering literature as “possessing many disadvantages” and “a bad bridge design.”[33] During the 1890s, BIBC diversified into building other more popular truss forms, such as the Pratt truss, but continued to supply a declining market for the lenticular truss. In New Hampshire, for example, 34 lenticular bridges (totaling 42 spans) were erected between 1878 and 1888. According to Darnell, between 1889 and 1898, 22 single-span lenticular bridges were erected in New Hampshire compared to 29 iron truss bridges of a different type. Darnell's numbers indicate that there may have been as many as 56 lenticular truss bridges in New Hampshire in 1898.[34] An 1898 publication, *Berlin Bridges and Buildings*, lists a total of 81 bridges in New Hampshire built by the Berlin Iron Bridge Company, including 43 parabolic (lenticular) trusses, 29 trusses of other types, 7 beam bridges, and 2 suspension bridges.[35] The reason for the discrepancy in the figures is not apparent.

In 1900, the Berlin Iron Bridge Company was acquired by J. P. Morgan and merged into his newly formed bridge building conglomerate, the American Bridge Company. A group of employees, including executives, engineers, draftsmen, and steel workers left the company to form the Berlin Construction Company. The company set up temporary shop in a leased mill in Pottstown, Pennsylvania, and by January 1901 had delivered their first major structural steel contract. The men purchased a factory site back in their hometown of Berlin and began designing and fabricating a complete factory at the Pottstown plant to be shipped to Berlin and erected. In July 1902 the new Berlin plant was complete, operations were moved from Pottstown to Berlin, and the Pennsylvania shop closed.[36]

During the early twentieth century, the Berlin Construction Company grew steadily, while redirecting its efforts away from bridge building and more toward building structural steel frames for buildings and industrial plants. The corporate name was changed in 1962 to the Berlin Steel Construction Company to reflect the broader range of services the company had developed during the post-World War II construction boom. As heavy factory construction waned during the 1970s, the company refocused on the construction of commercial office and public buildings. The company recently celebrated its one-hundredth birthday and remains in business today.[37]

The Pratt Truss

Thomas Pratt was born in Boston in 1812, entered Rensselaer Polytechnic Institute at age 14, became an engineer with the United States Army Engineers at 18, and began a professional engineering career with Boston & Maine Railroad at age 21. Pratt worked his entire life in the employ of various New England railroad companies.[38]

Pratt is famous for a bridge truss design he patented in 1844, consisting of two parallel chords connected by vertical wood posts in compression and double wrought iron diagonals in tension. Pratt's design was similar in appearance to an earlier truss patented by William Howe, but functioned structurally opposite. The Howe design put the verticals in tension and the diagonals in compression. The Pratt truss is considered to be the first scientifically designed truss, incorporating what are now considered basic structural engineering principles. Pratt used shorter compression members, allowing members of smaller cross section to be used without sacrificing overall strength. This innovation provided a lighter truss requiring less material yet offered greater span and load bearing capability than the other truss designs of the time.[39]

Pratt’s 1844 patent also diagramed and set forth claims to a truss design with a polygonal top chord. The polygonal version reflected Pratt's understanding of the application of mathematical principles in calculating the forces involved and the precise strength of material required to counter those forces. The center panels, where the stresses were the greatest required the tallest panels, with the posts getting successively shorter towards the ends of the bridge. The primary advantage of the design was a reduction in the weight of the bridge, or dead load, allowing for greater spans without increasing the sectional area of the bridge's structural members. A savings in material cost was a direct result; however, this advantage was largely offset by the cost of having to fabricate a greater variety of members.[40] The cost advantage increased with longer spans, and by the early twentieth century designers improved the economy of the polygonal truss by limiting the number of variations in the slope of the top chord to three, for a total of five polygonal segments.[41]

The use of the Pratt truss for the deck of John Roebling's Niagara River Suspension Bridge in 1855 drew worldwide attention to the design and undoubtedly contributed to its increased use. By 1889 the truss in its iron form ranked first in usage for railroad bridges. Tens of thousands of bridges, both highway and railroad have been built following the Pratt design or some variation.[42]

The Parker Truss

Charles H. Parker is another Massachusetts bridge designer and builder of renown, deservingly for the fact that several of his patent bridges incorporated clever solutions to bridge design, fabrication and construction problems. He is widely thought to have conceived of the idea of adding a polygonal top chord to a Pratt truss. This he did not do; however, his improvements to Pratt's original design ultimately led to the rapid adoption of the type and the association of his name with it.

Parker was born ca. 1842 at Ashburnham, Massachusetts. It appears he was born into a family with a manufacturing and engineering background, having begun his engineering career in the firm of J. B. Parker, designing textile and shoe making machinery.[43]

Parker was involved in the establishment of the National Bridge and Iron Works, which operated out of 15 State Street in Boston between 1868 and 1875. He apparently served as consulting engineer to the firm initially, but in 1873 was a co-owner with Cadwallader Curry. During this period he was responsible for the design and building of over 150 bridges including bridges over the Merrimack at Haverhill, Lowell and Tyngsboro. Parker was also associated with the Solid Lever Bridge Company of Boston from 1867-1871. Parker was responsible for the design of the structural ironwork for numerous important buildings and structures throughout the Northeast, including the Boston and Providence Depot, the Boston and Lowell Depot, the Museum of Fine Arts, the Boston Post Office and Providence City Hall. He was also interested in the design of mechanical and industrial systems including oil refineries, tankage pipe lines, blast furnace works, mining and hoisting machinery and power plants.[44]

In 1869 and 1870 Parker was awarded four patents for bridge designs that included a wire-cable suspended cantilever bridge, Patent No. 98,620; an unusual drawbridge consisting of a variation of his patented wire-cable suspended cantilever bridge in which the suspended center span could be swung or drawn back to allow tall masts to pass through, Patent No. 103,233; an even more unconventional design combining a suspended cantilever with a bowstring truss, Patent No. 93,638; and finally Patent 100,185 for which he is remembered, consisting of a Pratt truss design "composed of a curved top member, a straight bottom member, and vertical posts or compression members, with the usual system of longitudinal diagonal rods or braces".[45]

Parker did not claim priority for the idea of a curved top chord in any of his patents; the primary claim in Patent No. 100,185 was for an adjustable endpost that allowed simple variation of the overall length of the bridge in small increments. This made the bridge easily adaptable and suited as a replacement structure that could be dropped onto existing abutments without altering the structural characteristics of all the other truss panels. Parker's second claim was for a wrought-iron compression member, for the top chord or post, "formed of an I-section beam either rolled or built-up of plates and angles."[46] The other five claims related to the specific design of various connections for bridge members. According to Dennis Zembala who documented an authentic Parker patent truss in Vermont for the Historic American Engineering Record (HAER) in 1983, Parker's adjustable endpost gave his company a competitive edge, but it was his use of wrought-iron I-section compression members that was his greatest contribution to bridge design.[47]

Using Pratt's polygonal truss as a starting point (Pratt's patent having expired) Parker added wrought-iron I-section compression members, either rolled or built-up, that could be easily manufactured and standardized. He built several bridges of the type for railroad use during the 1870s and thereafter was associated with the design. According to bridge engineers Mansfield Merriman and Henry S. Jacoby, who assigned the name Parker Truss to the polygonal Pratt in their *Text-Book on Roofs and Bridges*, the type became "widely built for both highway and railroad service" after 1890.[48] This date would have roughly coincided with the expiration of Parker's patents.

Perhaps a vague recollection of Parker's work and unfamiliarity with Pratt's original patent claims and drawings, led noted bridge engineer J.A.L Waddell to state the following in his 1916 treatise on bridge engineering which incorrectly attributed the invention to Parker:

> During the seventies the Pratt, the Whipple, and the Warren, or Triangular trusses became the favorite types, although several large Post-truss bridges were then built. For a short span a single intersection type was found preferable, and for the long ones, the double or triple intersection. During this period C. H. Parker introduced the plan of making the top chord of through trusses polygonal, thus effecting quite an economy in weight of metal for long spans; and this modification of the Pratt truss is often termed the "Parker Truss".[49]

Early twentieth century designers improved the economy of the polygonal truss by limiting the number of variations in the slope of the top chord to three, for a total of five polygonal segments. This variation of the "Parker truss" was developed by "a large bridge company" and called a Camelback truss.[50] The method was soon applied to the simpler triangular or Warren truss, and the names Camelback and Parker became applied to the various types, often interchangeably.

Flood of March 1936

New Hampshire suffered again from widespread flooding in March of 1936 and this flood elicited a response that had an effect on the Central Street Bridge, rendering the bridge impassable on rare occassions.

Damage from this series of floods was still greater in New Hampshire than the destruction of 1927. Hundreds of bridges throughout the northeast United States were built in the aftermath. The region was emerging from one of the severest winters on record when hard rains began falling from the Ohio Valley to Maine around the 15th of March. The hillsides were laden with snow, rivers were packed with ice and the underlying earth was still frozen solid. By the 19th, a massive low-pressure center, formed in Texas and heavy with moisture from the Gulf of Mexico, pushed into the region dumping torrents of rain on the sodden snow pack and already flooded rivers.

> The melting rains coursed off the Appalachian hillsides as if they had been sloping tin roofs. Monstrously gorged rivers roared like millraces and burst their narrow channels. From Maine to Kentucky a vast, swirling chaos enveloped the valley towns and cities. As the rampant rivers tossed off their bridges, gulped in railway roadbeds, swamped highways, transportation throughout the region was practically at a standstill.[51]

The storms' toll on New England was severe: 24 dead, and an estimated 77,000 homeless and $277,000,000 million in damages. Albany and Binghamton, New York, Wilkes-Barre, Harrrisburg, Pittsburgh and Johnstown, Pennsylvania, and cities and towns along the Ohio River also suffered extensively from the floods.[52]

The damage to bridges in New England was staggering. Over 700 bridges were replaced or repaired as a direct result of the floods. The work was nearly entirely financed by the WPA and bridge plans accordingly bear the stamp "WPFR" meaning Works Progress Flood Replacement. Twelve new bridges located on Federal Aid highways, seven of which were located in New Hampshire, were built with Bureau of Public Roads funds under the Hayden-Cartwright Act.[53]

New Hampshire was especially hard hit and lost the greatest number of bridges although monetary losses were greater in Maine and Massachusetts due to destruction of several large and recently constructed bridges. To expedite bridge repair and replacement, New Hampshire moved quickly and authorized a bond issue of $2,000,000 to supplement the Federal funds. These funds allowed the New Hampshire Highway Department to immediately initiate contracts with qualified bridge contractors while neighboring states were waiting for Federal money. With the bond issue monies, New Hampshire was able to build fourteen temporary bridges and repair or replace 101 other bridges in addition to the 189 Federally funded bridges built throughout the state.[54]

The majority of the $2,500,000 in damage to bridges in New Hampshire occurred along the Connecticut, Contoocook and Merrimack Rivers, and was the result of the melting of 4' of snow in the mountains above these river valleys. Thick ice carried by the raging rivers scoured the streambeds and banks, plowing over piers and undermining abutments. Damage along the Connecticut River in New Hampshire was particularly severe, the damage exceeding $1,000,000. Five bridges were either washed away or damaged beyond repair and two other bridges required major repairs. Because the state line runs along the Vermont side of the river, the bridges are owned by the New Hampshire.[55]

In response to the disastrous floods of 1927 and 1936, occurring so close together, New Hampshire Senator Henry W. Keyes requested flood control assistance from the federal government. The result of Keyes' plea, together with the urging of many others, was passage of the federal Flood Control Act of 1936 (Public Law No. 738, 74th Congress). Under this act, New Hampshire and other states were "required to provide, without cost to the federal government, all lands, easements, and rights-of-way; to hold and save the United States free from damages due to the construction works; to maintain and operate the works after completion; and to provide tax reimbursements to affected towns."

After passage of the federal law, the states of New Hampshire and Massachusetts entered into a compact to control flooding in the Merrimack basin. A law passed by the New Hampshire legislature in June 1937, amended an earlier law that had created the Water Resources Board, declaring "a special public need for dams and reservoirs at strategic locations for regulating the flow of rivers and streams to lessen damages resulting from floods."[56]

Two other laws passed in the same legislative session created the Merrimack River Valley Flood Control Commission, empowered the Water Resources Board to acquire lands necessary for flood control dams and reservoirs in cooperation with the Flood Control Commission, and ratified the compact that had been agreed to between the State of New Hampshire and the Commonwealth of Massachusetts to carry out flood control measures in the Merrimack Valley.[57]

The first two projects specified under the compact and the state enabling legislation were flood control dams at Swett's Mills, on the Blackwater River in the town of Webster, and at Franklin, on the Pemigewasset River. The latter dam was to control

> a drainage area of approximately one thousand (1,000) square miles, and providing for flood control storage for approximately three and nineteen hundredths (3.19) inches of run-off over said drainage area, the dam at said reservoir to be constructed in such manner as to provide for flood control and in addition thereto to be so designed and constructed as to make it available for conservation or recreational purposes up to fifty percent of the volume during such portions of the year as may be approved by the secretary of war.[58]

Before construction began, the federal law was amended. The federal Flood Control Act of 1938 (Public Law No. 761, 75th Congress) specified that the flood control projects to be constructed under interstate compacts would be built entirely at the expense of the federal government and would thereafter be federally owned and operated. In 1939, New Hampshire passed a revised law that concurred with federal construction, ownership, and operation of flood control projects.[59]

The U.S. Army Corps of Engineers began construction of five flood control dams and reservoirs, including the Franklin Falls project, between August 1939 and June 1940, completing the Franklin Falls Dam in 1943.[60]

The impoundment from the Franklin Falls dam extends up the Pemigewasset River some thirteen miles, to the base of the dam at the Ayres Island hydroelectric station in Bristol. The Ayres Island dam is upstream from the Central Street Bridge. Thus, when the Franklin Falls Reservoir is filled to capacity, stored water rises some five feet above the deck of the Central Street Bridge at its eastern end, which, as noted above, stands at a lower elevation than the western end. The same phenomenon occurs at the Ramsdell Road Bridge (123/106) in Henniker, which stands upstream from the Everett Dam in West Hopkinton. The highway approaches to both bridges are gated and can be closed to traffic when water is to be stored to reservoir capacity.

Comparable Bridges

The 240-foot Central Street Bridge was the longest flood emergency Parker truss bridge constructed after the flood of 1927. Other Parker through truss bridges built after the flood included a 220-foot bridge at Chiswick Avenue or Beacon Street in Littleton and a 220-foot bridge over the Connecticut River between West Stewartstown, New Hampshire, and Canaan, Vermont. Both have been replaced.

It is significant that the Parker truss bridges in Littleton (220/056) and Stewartstown (028/146) used the same shop details and were both designed to span 220’-0” between pins. These Parker truss spans were built using standardized plans to avoid needless custom designing of bridges under emergency conditions. Such bridges were generally placed on the existing abutments of their flood-damaged predecessors, but the bridge seats were adjusted to provide for the standardized pin-to-pin distances, thereby avoiding the need to design and fabricate different truss designs for minor variations in abutment spacing.

By contrast, the Central Street Bridge was designed for its specific site and circumstances by engineer Harold E. Langley. Most of the new Parker truss spans built in response to the flood of 1927 incorporated standard specifications issued by the federal Bureau of Public Roads. Like comparable bridges built in Vermont, the high or “through” truss bridges built in New Hampshire after the floods of 1927 differed from older spans primarily in employing an increased number of rolled steel I sections in their construction. Such bridges had fewer members built up of smaller rolled angle sections linked together by riveted lacing than had older bridges, reducing the time and hence the cost of fabrication.[61]

An article by engineer John W. Childs in *New Hampshire Highways* magazine in 1929 summed up the standards to which major bridges of this period were designed. All bridges were designed to carry a fifteen-ton truck in each line of traffic. Because trunk line highways were being plowed in the winter by this time, major bridges were designed with roadway widths of at least twenty-four feet. This gave two ten-foot traffic lanes and two two-foot margins for drainage and for plowed snow.[62] Perhaps because it was primarily a local connector built on an existing alignment, the Central Street Bridge is narrower, measuring eighteen feet from curb to curb. The new Central Street Bridge was also designed without an encumbering pier in the river, permitting the greatest degree of undisturbed water flow beneath the structure.

NEW HAMPSHIRE PARKER TRUSS BRIDGES
(Pratt Truss With Polygonal Top Chord)

Town	Bridge No.	Year	Carrying/Over	Spans	Max Spn Lgt.	Disposition (November 2006)
Bristol – New Hampton	113/064	1928	Central St./ Pemigewasset R.	1	240'	Subject bridge to be replaced
Hinsdale	042/044	1926	NH Rt. 9/ channel of Connecticut R.	1	200'	In service See photos **
Lyme – Thetford, VT	053/112	1937	E. Thetford Rd./ Connecticut R.	2	232'	In service See photos **
Lancaster – Lunenburg, VT	111/129	1950	US Rt. 2/ Connecticut R.	2	198'	In service See photos **
Monroe – Barnet, VT	081/106	1930	McIndoes Rd./ Connecticut R.	1	305'	Currently being rehabilitated. See photos **
Monroe – Barnet, VT	110/125	1937	Barnet Rd. / Connecticut R.	1	264'	Rehabbed by Vermont. See photos **
Holderness – Plymouth	046/139	1934	NH Rt. 175A/ Pemigewasset R.	1	250'	Demolished 2005
Littleton	220/056	1928	Beacon St./ Ammonoosuc R.	1	220	Demolished & Replaced 2001
Stewartstown – Canaan, Vt.	028/146	1928	Main St/ Connecticut R.	1	220	Demolished & Replaced 1990
Boscawen – Canterbury	132/085	1907	Old Rt. 3-B/ Merrimack River	2	170'	Closed

*Information taken from NHSHD Annual Reports and may not be all inclusive
** See Supplemental Material section for 35 mm photographs

An existing span that can be compared to the Central Street Bridge in terms of engineering technology is the McIndoes Road Bridge over the Connecticut River between Monroe and Barnet, Vermont. Completed in 1930, only two years after the Central Street Bridge, it is 65' longer and built with larger, heavier structural members. The primary differences result from the differences in the length and height of the panels: 11 panels @ 27'-9½" on the Monroe bridge versus 12 panels @ 20'-0" on the Central Street Bridge. Fewer panels require fewer members and less erection labor, and this cost savings generally offsets the increase in steel needed to handle the greater stresses in longer members. Instead of built-up posts and the combination of rolled and built-up diagonals found on the Central Street Bridge, the McIndoes Road Bridge uses all rolled Carnegie Beam sections. By 1930 the greater variety of rolled sections was eliminating the use of material-efficient but labor intensive built-up members.

A comparison of the Hinsdale Bridge to the Lancaster-Lunenburg Bridge, the same length but separated by 45 years, reveals two primary changes in design: a 20' wide roadway versus a 33' roadway, and solid rolled vertical and diagonal members instead of built-up members. The earlier bridge has 10 panels @ 20 feet versus 9 panels @ 22' on the later bridge.

The Lyme-Thetford Bridge has two spans roughly the same length as the Central Street span, but utilizes 9 longer panels (25'-9") with heavier members instead of the 12 shorter and lighter panels on the Central Street Bridge. The technology is essentially the same; differences in panel length and height were the result of consideration of the most efficient combination of structural members based on the prevailing economics of bridge construction (materials and labor costs) and these fluctuated during the economic depression. The Barnet Road Bridge (110/125), also built 1937, has 11 spans of 24 feet, suggesting a possible trend toward longer panels by the mid-to-late 1930s.

The 1927 Hinsdale Bridge and the 1930 McIndoes Road Bridge are good examples of the transition in structural materials and technology represented by the Central Street Bridge (1928): on the Hinsdale Bridge the verticals and diagonals were built-up members; on the Central Street Bridge the verticals were built-up, but the diagonals were a combination built-up and solid rolled members, and on the McIndoes Road Bridge both diagonals and verticals are solid rolled.

NOTES

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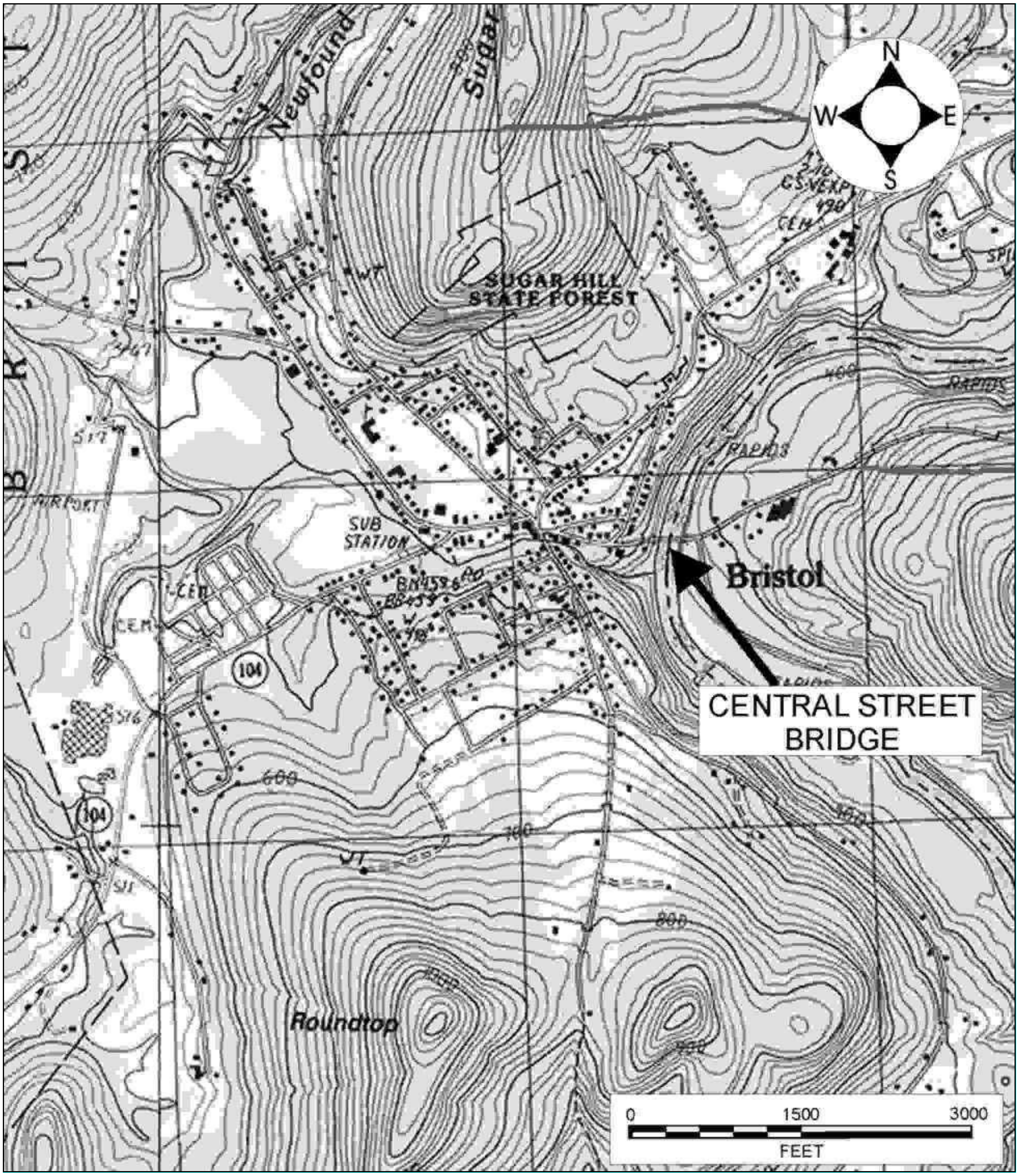

Figure 1: Location Map [USGS Bristol, NH Quadrangle, 1987, revised 2000]

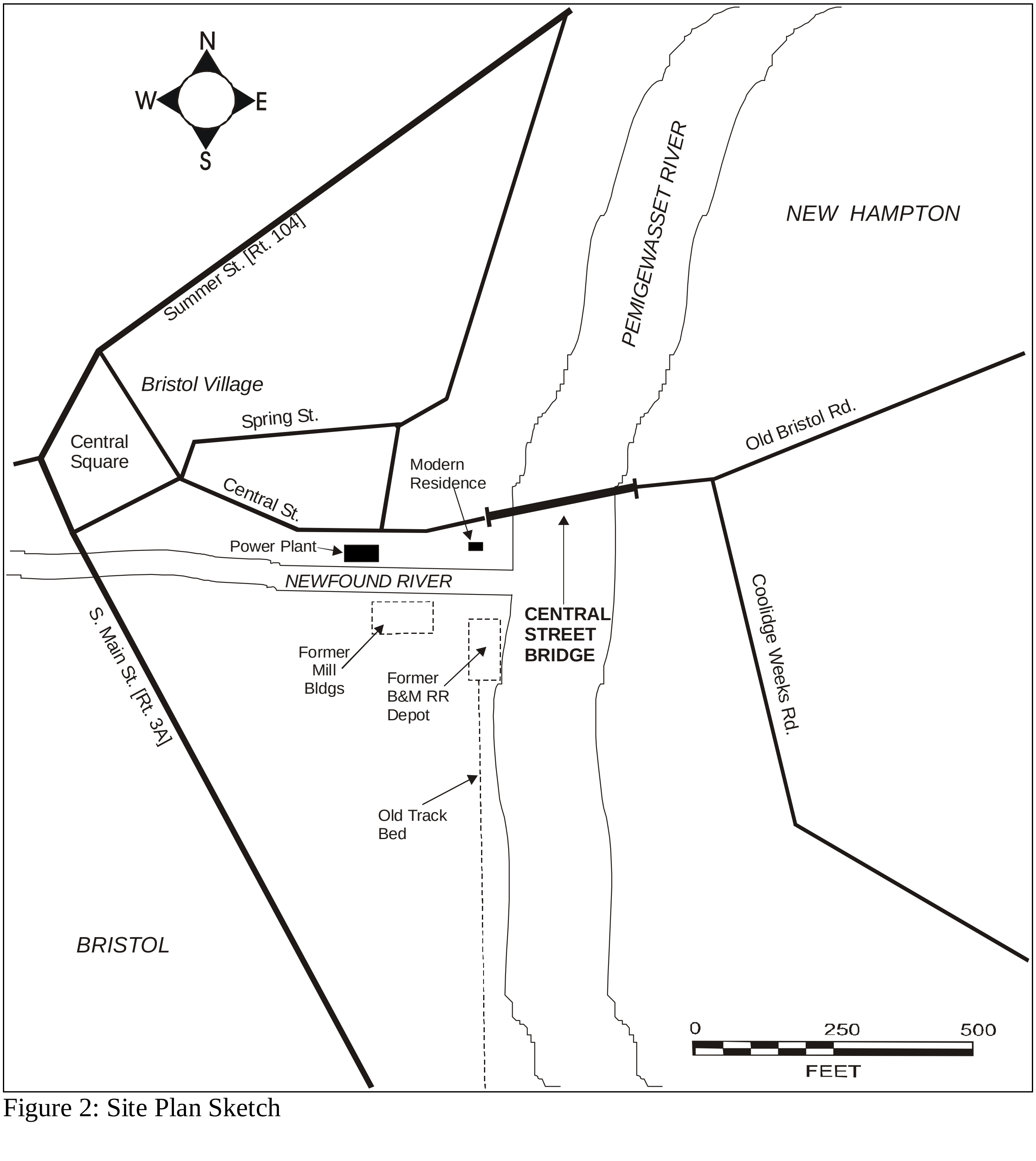

Figure 2: Site Plan Sketch

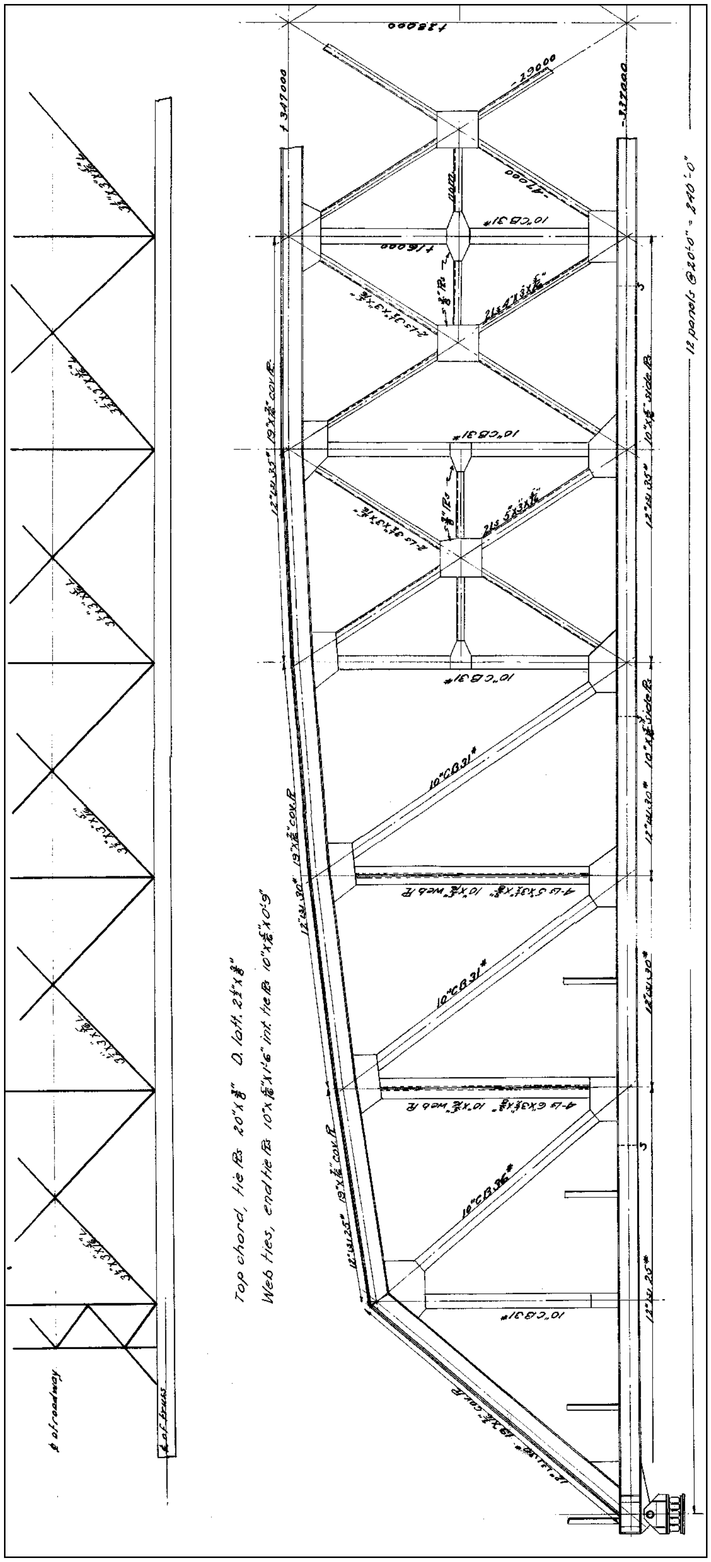

Figure 3: Bridge half-plan and elevation [source: original bridge drawings 1928].

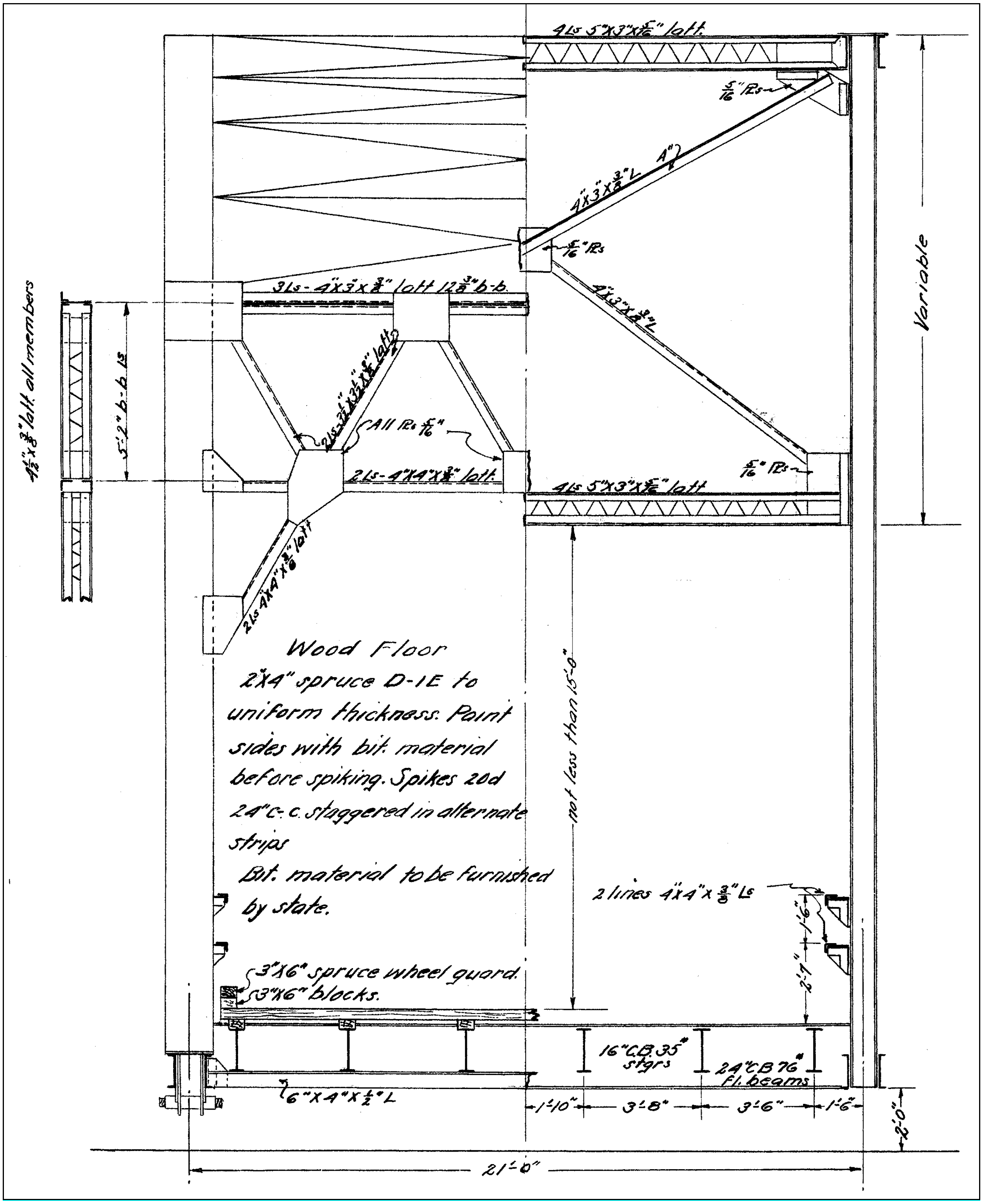

Figure 4: Bridge cross-section [source: original bridge drawings 1928].

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Central Street over Pemigewasset River
Bristol – New Hampton,
Grafton County
New Hampshire

New Hampshire State No. 599
Photographer: Rob Tucher
October 2006

NH-599-1 Overall view of bridge in context, view north.

NH-599-2 Overall view of bridge in context, view west.

NH-599-3 West approach, view northeast.

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NH-599-20 Photocopy of original New Hampshire Highway Department (NHHD) drawing, "Plan and Profile of Proposed Flood Relief Project No. 10A New Hampton Road." Title Page. Sheet 1 of 5, dated 1928. Original filed at NHDOT, Concord.

NH-599-21 Photocopy of original NHHD drawing, "Proposed Bridge, Town of Bristol over Pemigewasset River on New Hampton Road." Grade and elevations. Sheet 2 of 5, dated 1928. Original filed at NHDOT, Concord.

NH-599-22 Photocopy of original NHHD drawing, "Proposed Superstructure, Town of Bristol over Pemigewasset River on New Hampton Road." Truss plan, elevations, sections, details, and specifications. Sheet 3 of 5, dated April 18, 1928. Original filed at NHDOT, Concord.

NH-599-23 Photocopy of original NHHD drawing, "Stress Diagrams, Town of Bristol over Pemigewasset River on New Hampton Road." Sheet 4 of 5, dated 1928. Original filed at NHDOT, Concord.

NH-599-24 Photocopy of original NHHD drawing, "Proposed Superstructure, Town of Bristol over Pemigewasset River on New Hampton Road." Abutment plans, elevations sections, details, specifications. Sheet 5 of 5, dated April 22, 1928. Original filed at NHDOT, Concord.

NH-599-25 Photocopy of original Berlin Construction Company bridge erection drawing, "Lumber and Erection Plans. Bridge over Pemigewasset River on New Hampton Road, Town of Bristol." Sheet 1 of 6, dated May 21, 1928. Original filed at NHDOT, Concord.

NH-599-26 Photocopy of original Berlin Construction Company bridge erection drawing, "Masonry Plan and Details of Bearings. Bridge over Pemigewasset River on New Hampton Road, Town of Bristol." Sheet 2 of 6, dated May 20, 1928. Original filed at NHDOT, Concord.

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NH State No. 599
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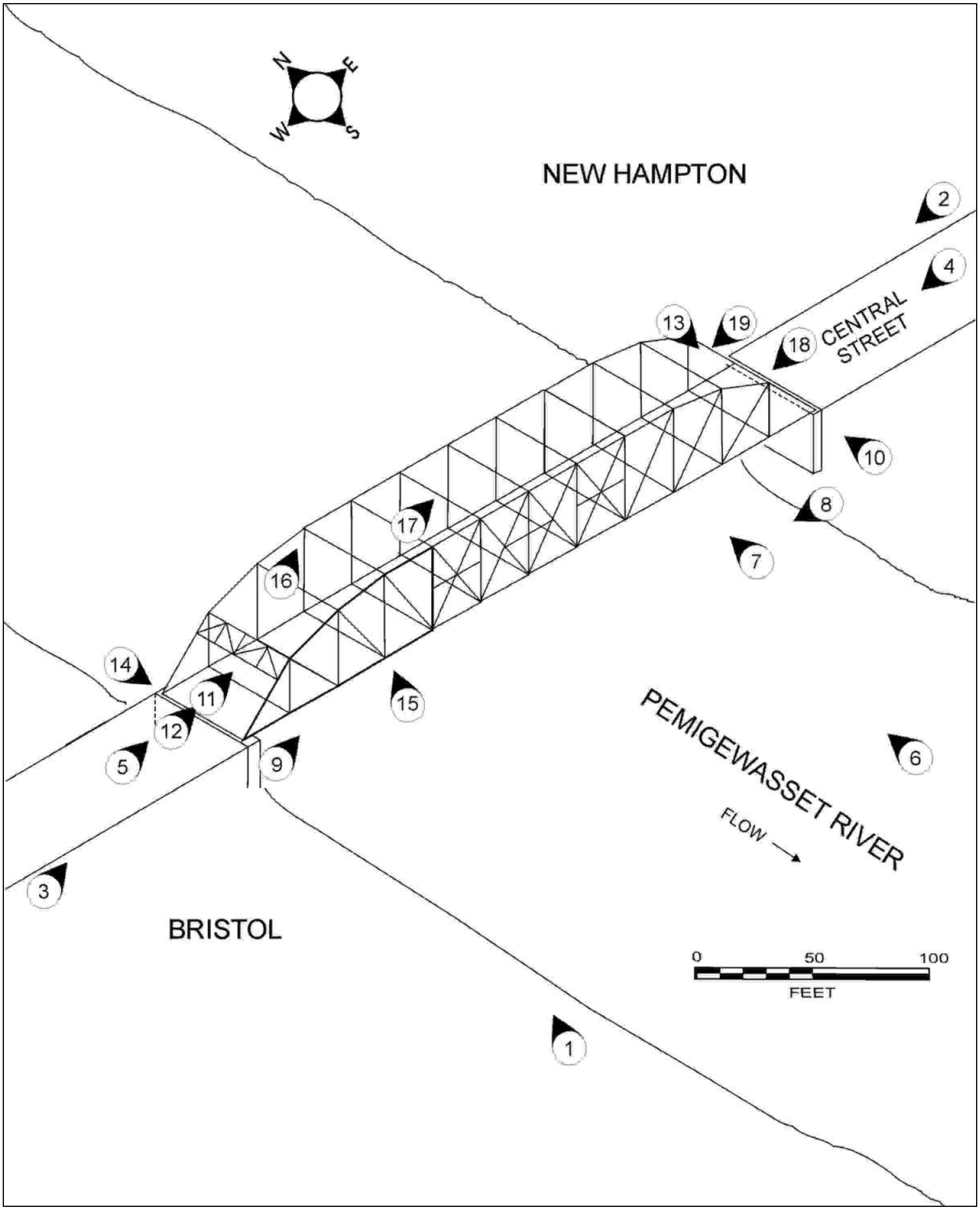

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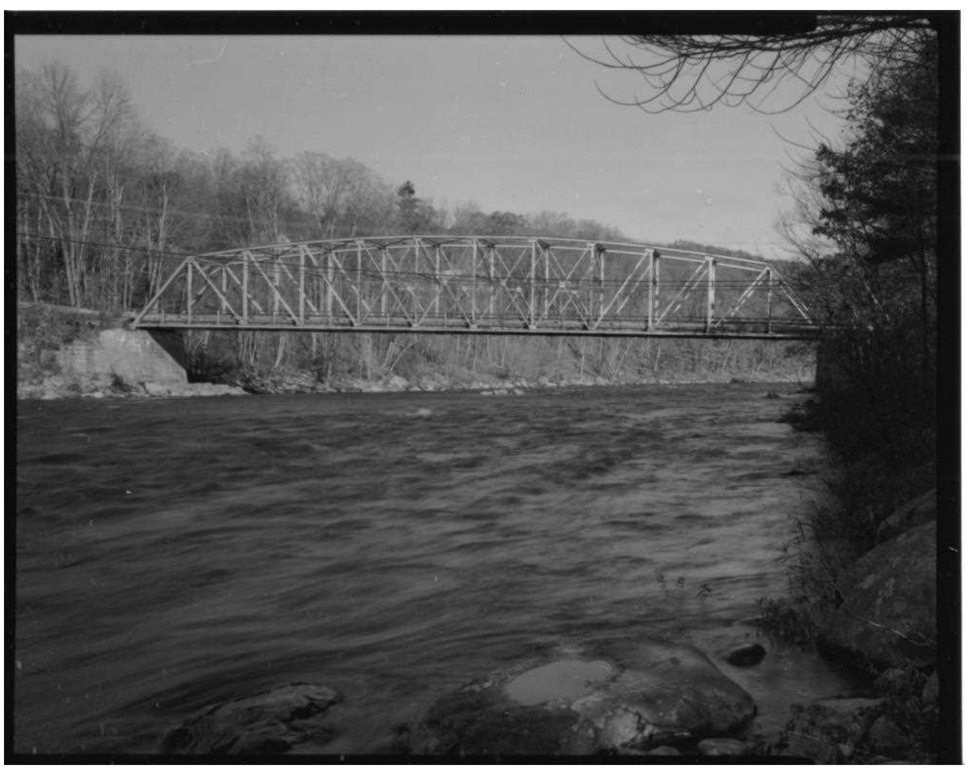

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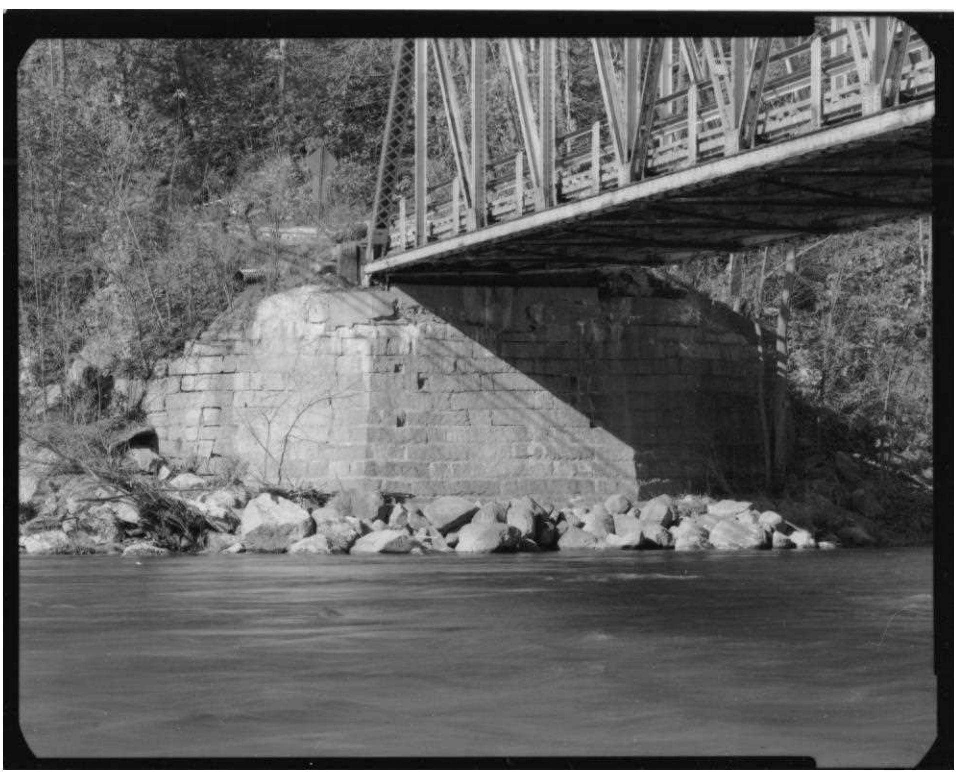

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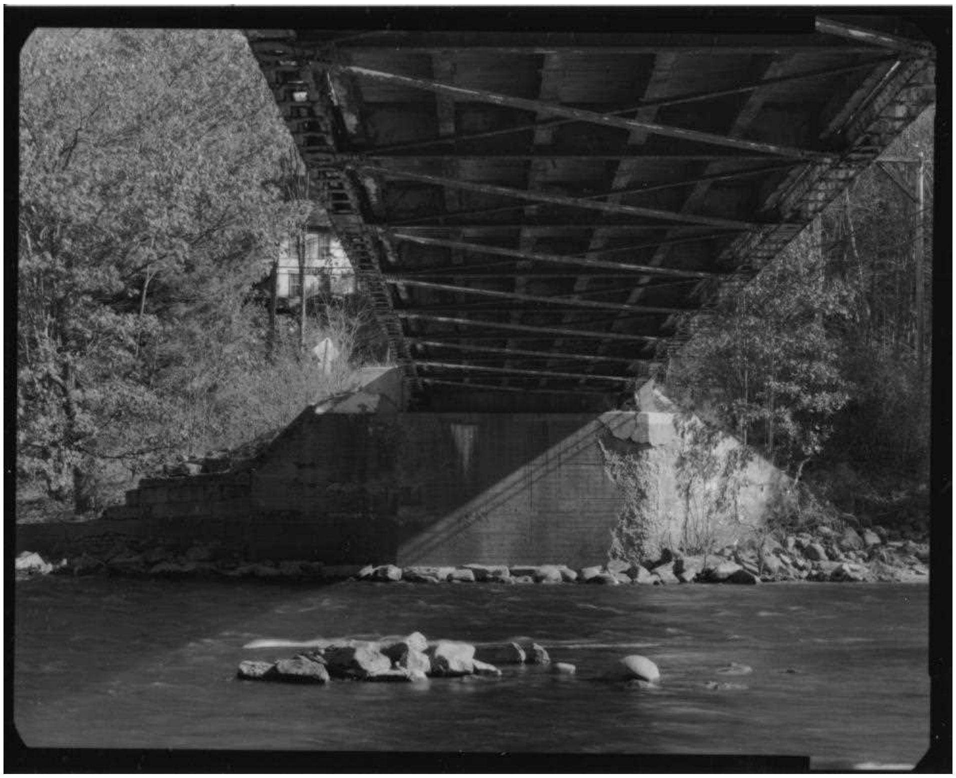
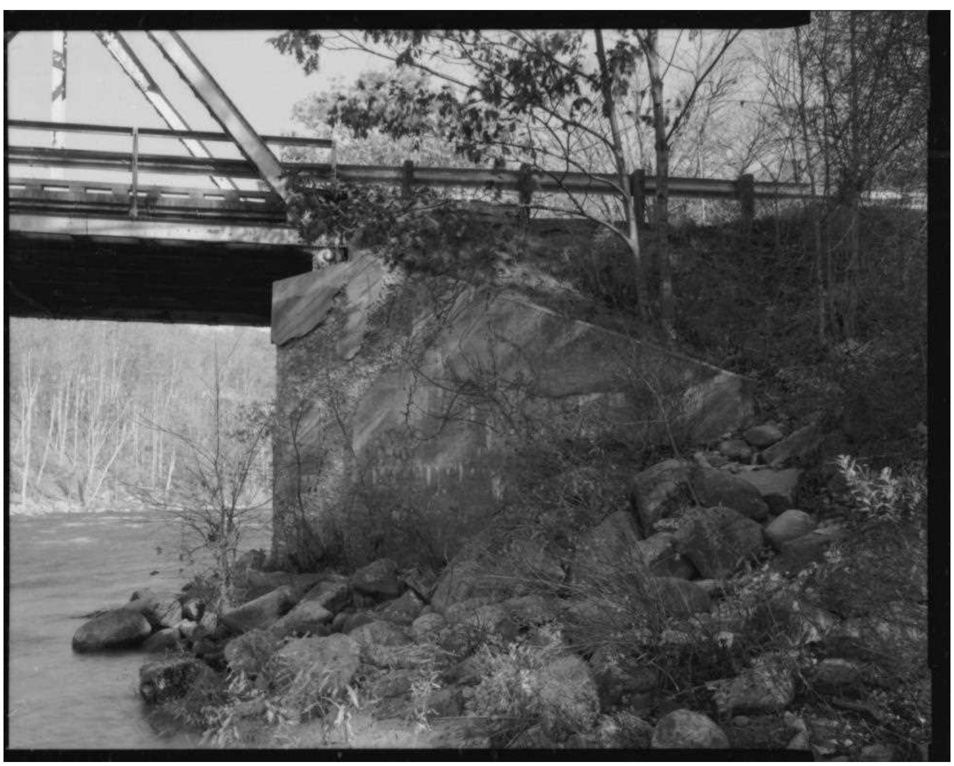


NH-599-9 East abutment, view east.



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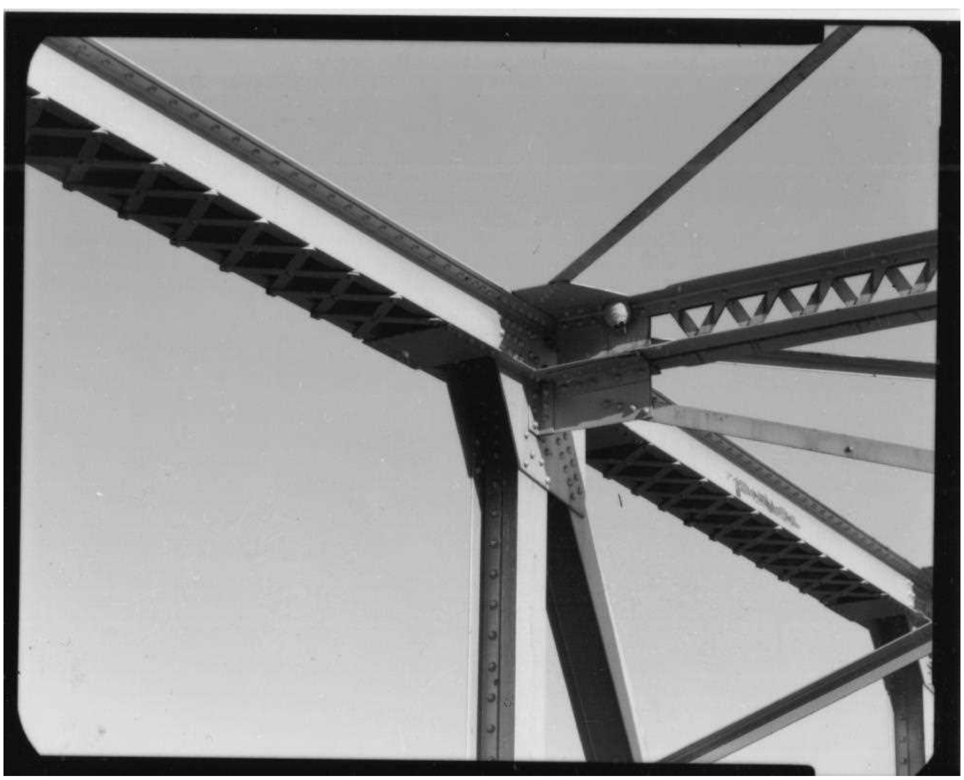

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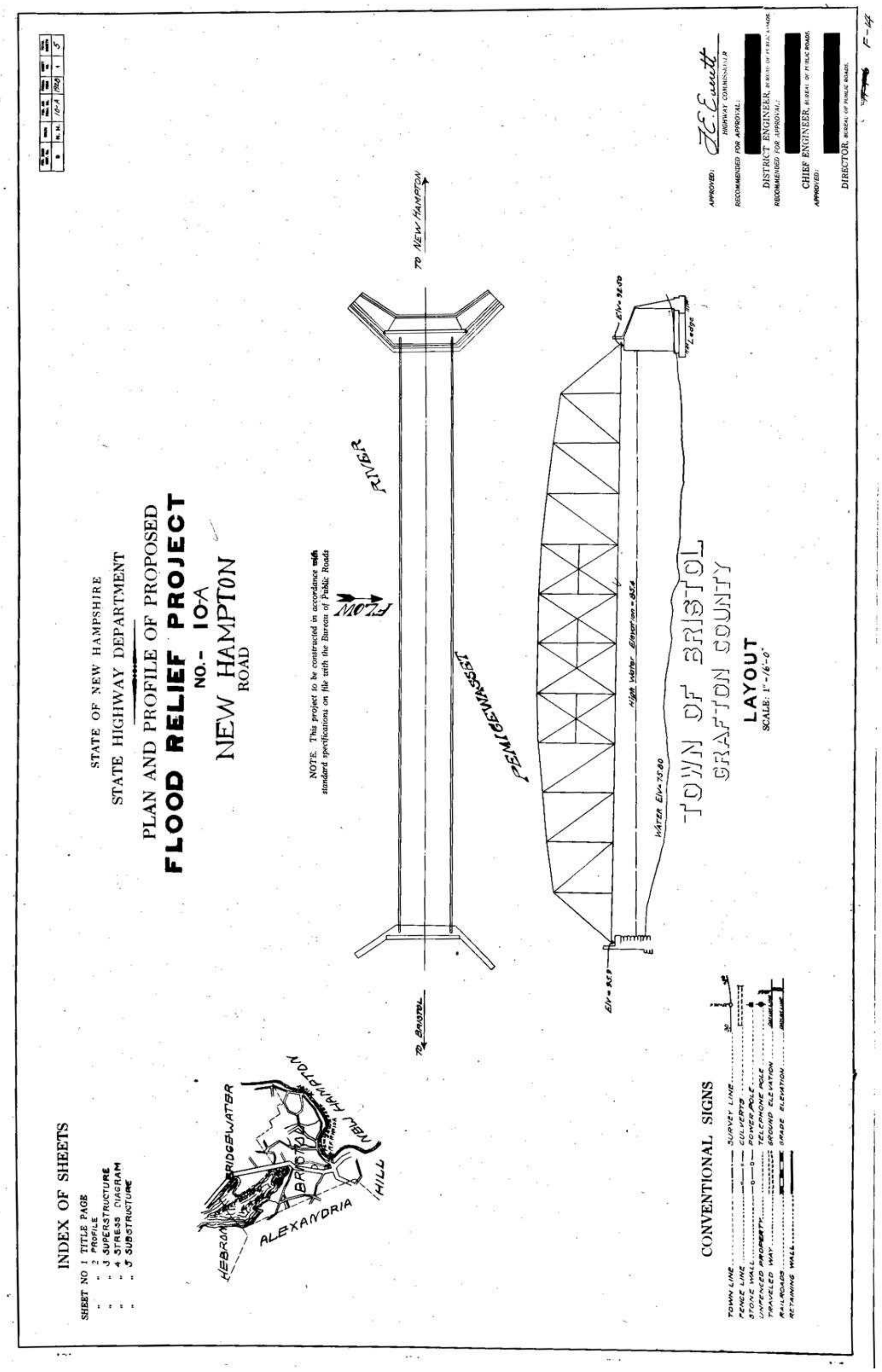

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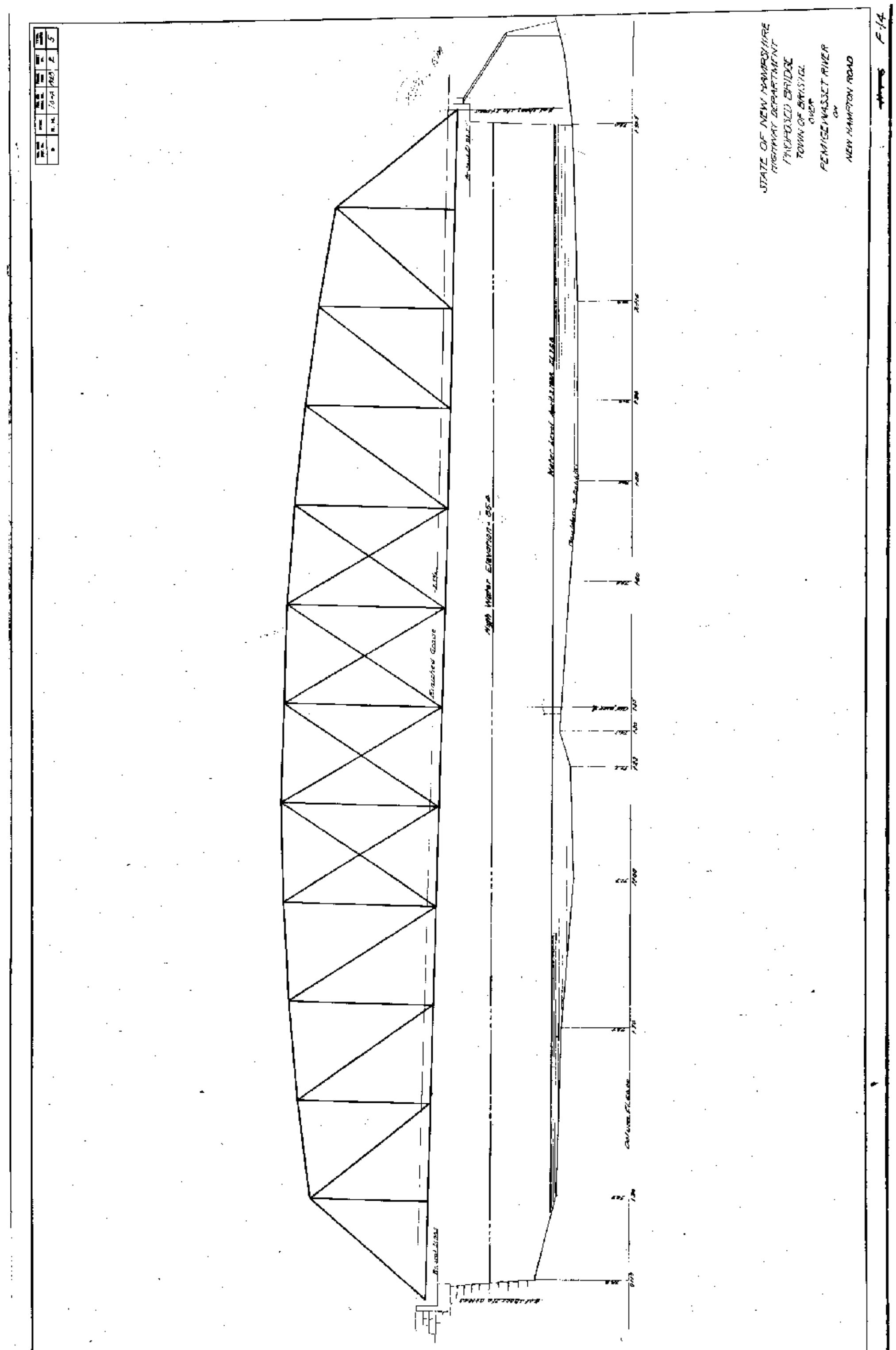

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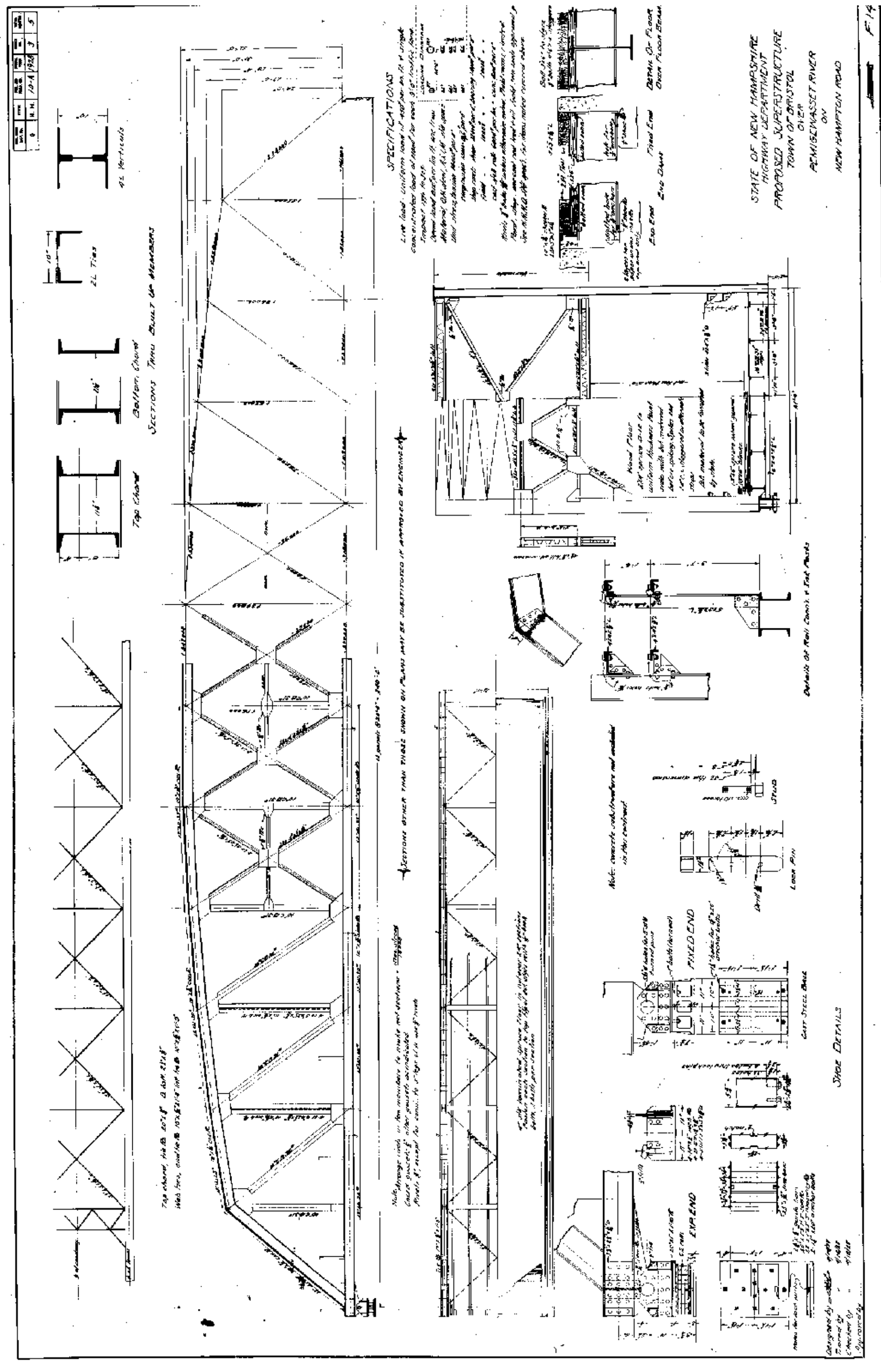

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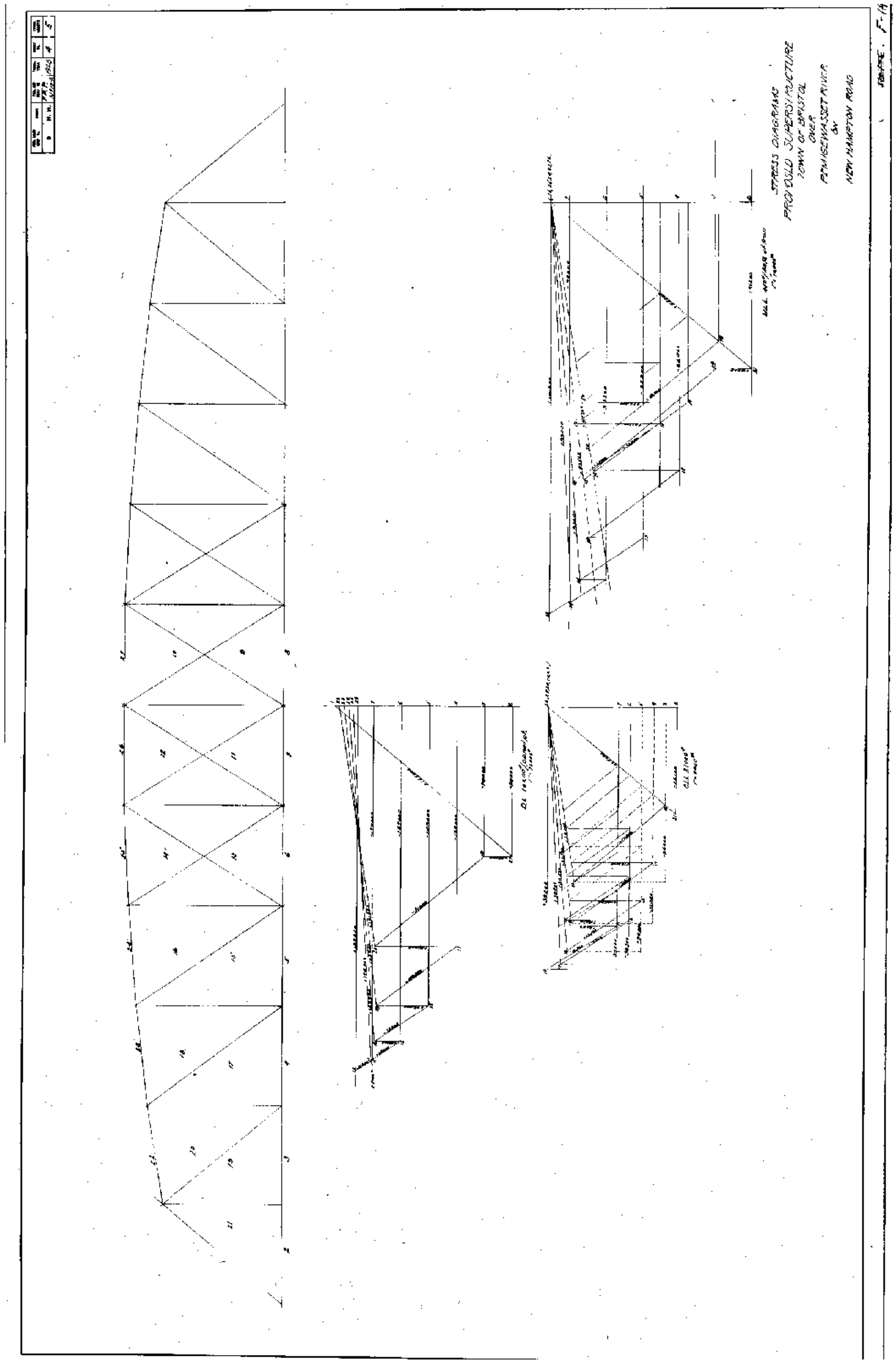

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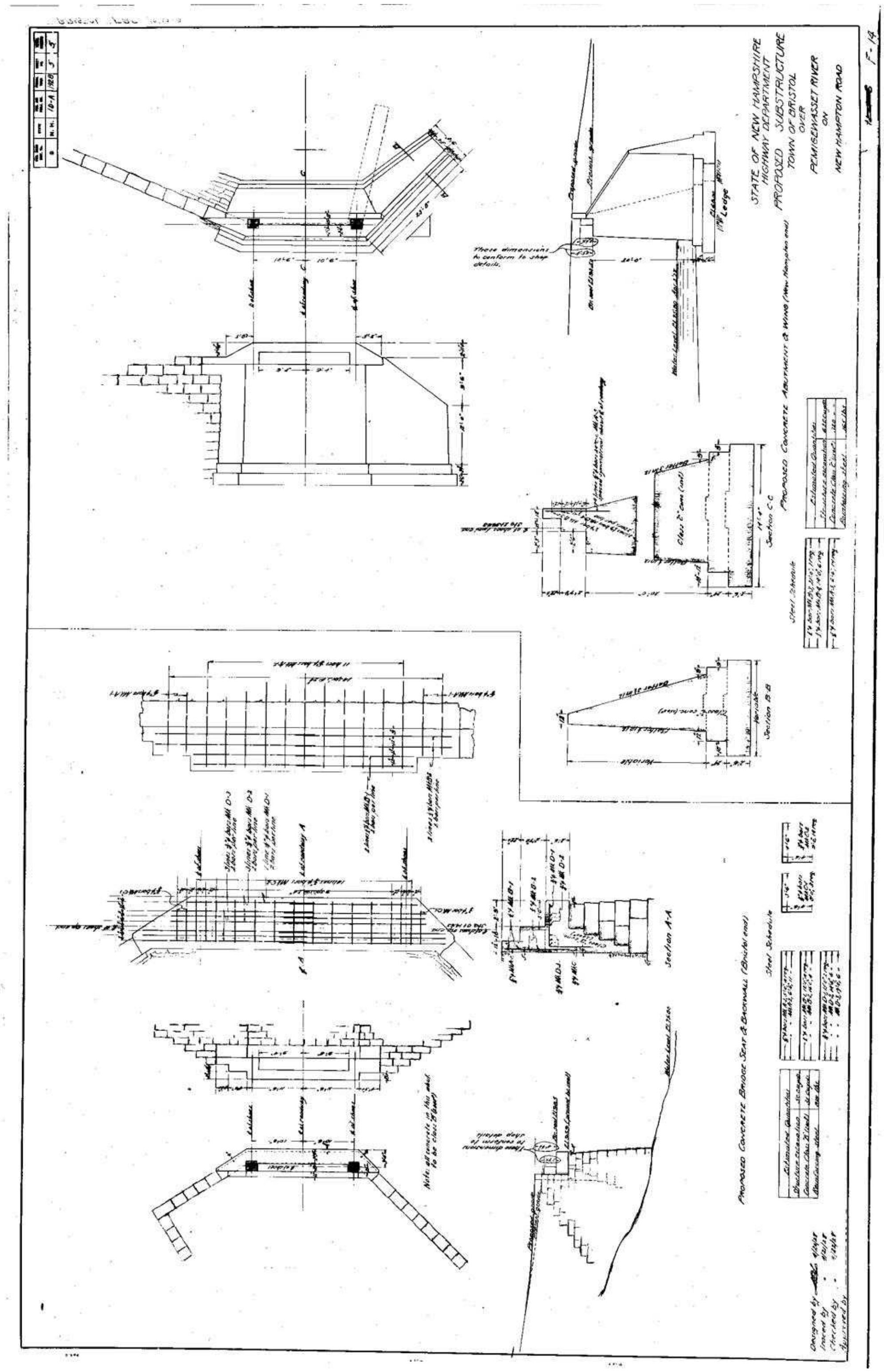

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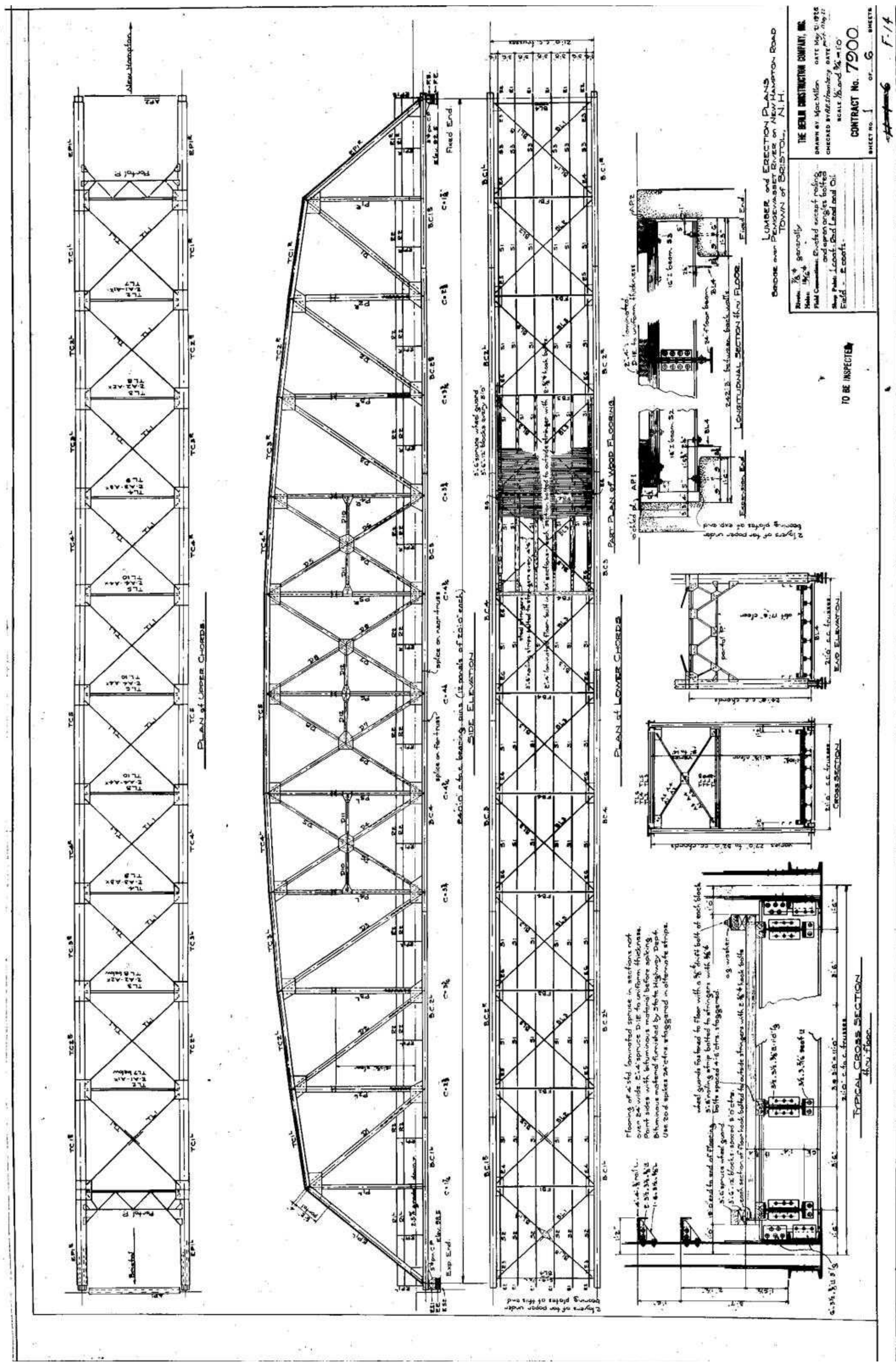

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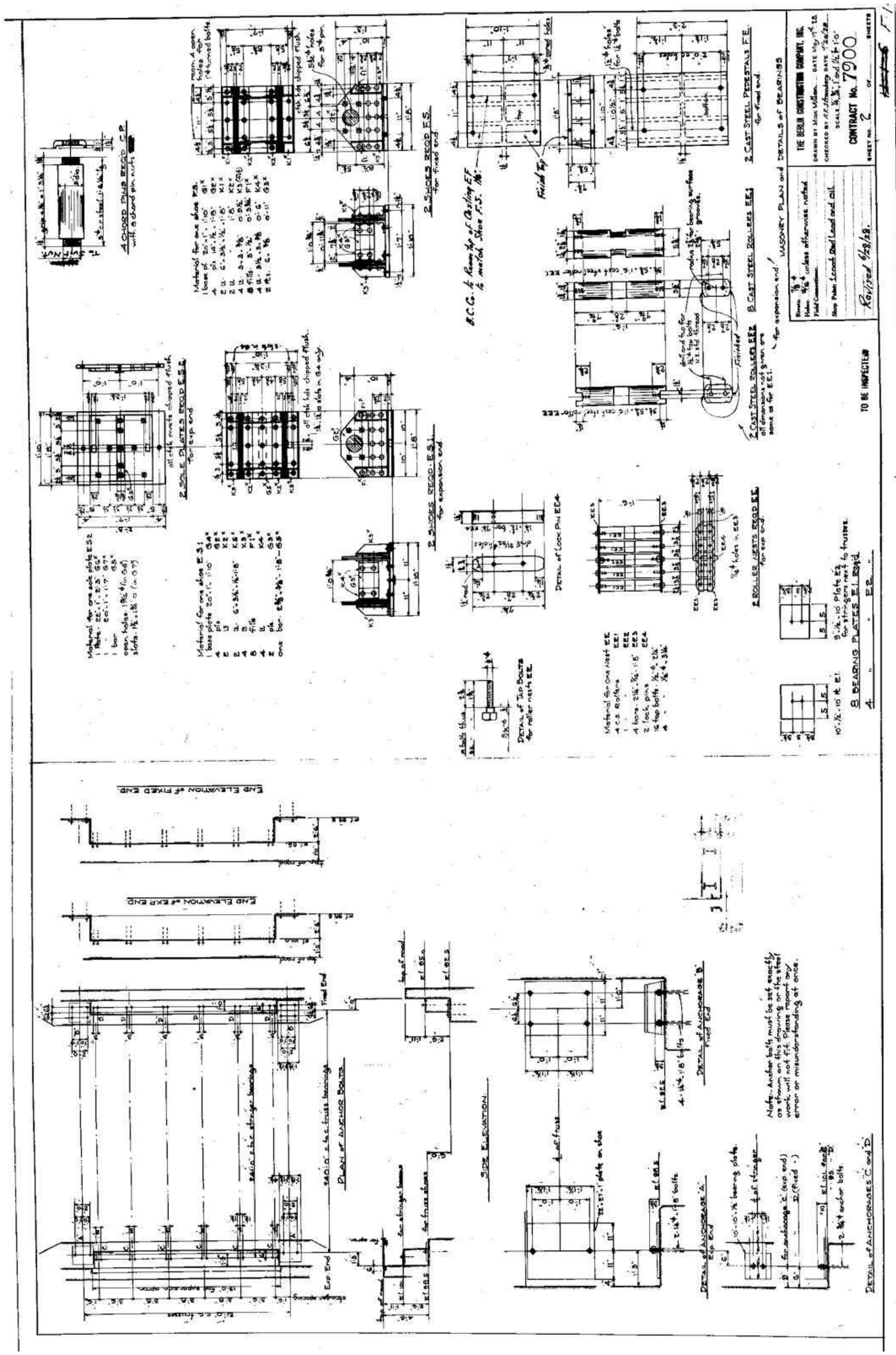

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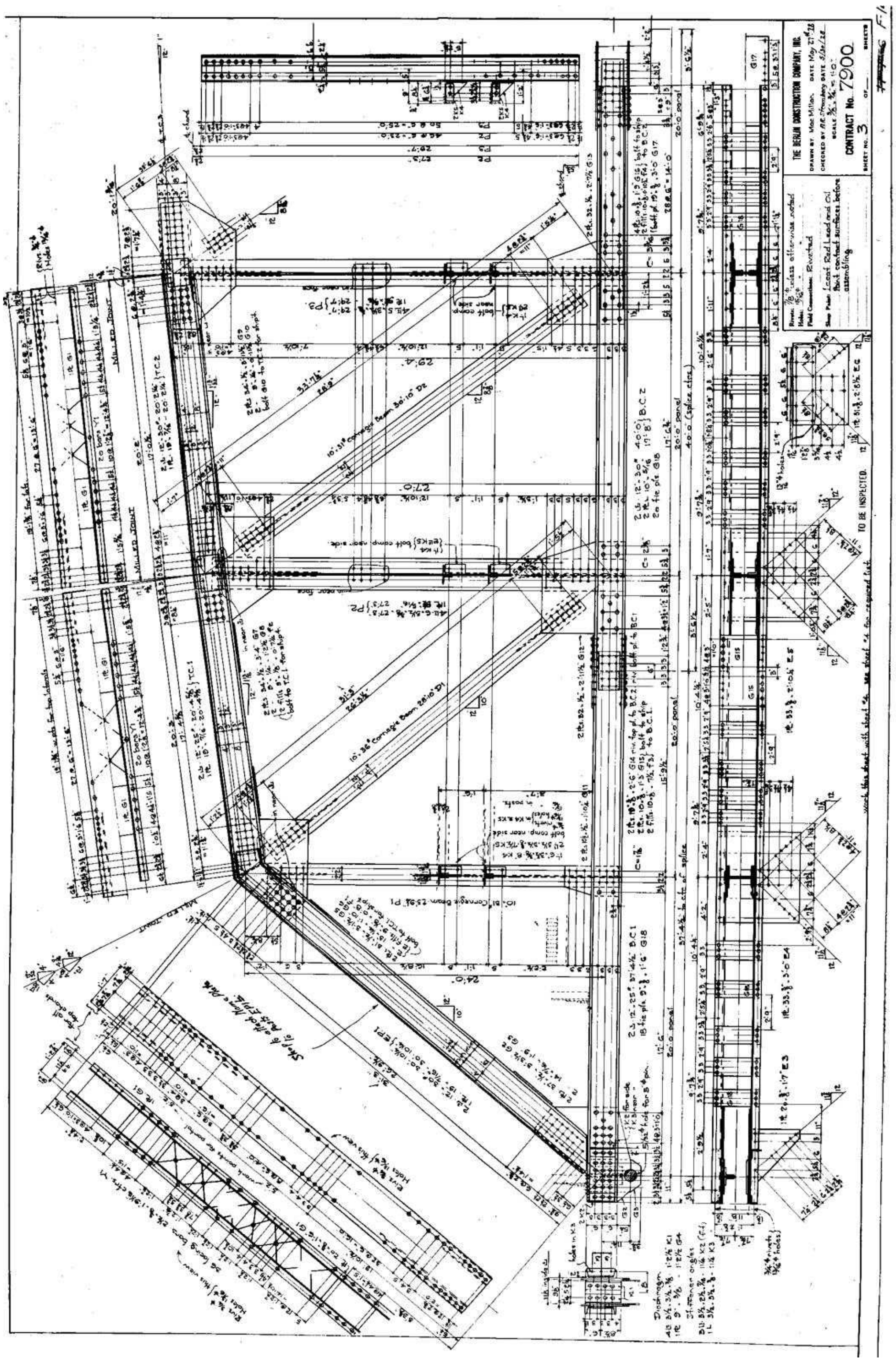

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