BRIDGE STREET BRIDGE
(Connecticut Bridge No. 03850)
Spanning the Metro North Railroad on Bridge Street
Norwalk
Fairfield County
Connecticut

HAER No. CT-51

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PHOTOGRAPHS

WRITTEN HISTORICAL AND DESCRIPTIVE DATA

HISTORIC AMERICAN ENGINEERING RECORD
Northeast Field Area
Chesapeake/Allegheny System Support Office
National Park Service
U.S. Custom House
200 Chestnut Street
Philadelphia, PA 19106

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HISTORIC AMERICAN ENGINEERING RECORD

BRIDGE STREET BRIDGE (Connecticut Bridge No. 03850) HAER No. CT - 51

Location: Spanning the Metro-North Railroad on Bridge Street, Norwalk, Fairfield County, Connecticut.

UTM: 18.634650.4551680
Quad: Norwalk South

Date of Construction: Probably 1893 or 1894.

Builder: Engineered, and probably built, by the New York, New Haven and Hartford Railroad Company.

Present Owner: City of Norwalk.

Present Occupant: City of Norwalk.

Present Use: Vehicular bridge, no sidewalk.

Significance: One of five remaining nineteenth century pony trusses over the New Haven division of the New York, New Haven and Hartford Railroad. The bridges are representative examples of nineteenth century bridge truss technology and are an integral component of the railroad corridor.

Project information: At this time the Bridge Street Bridge is scheduled for replacement, which will include widening the bridge and adding a sidewalk on the east side. HAER documentation being prepared in accordance with Memorandum of Agreement dated 8/24/90.

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May 9, 1991

1. Scope of the Study.

The proposed replacement of the existing pony truss bridge carrying Bridge Street over the Metro-North Railroad in Norwalk, Connecticut led to a determination by the State Historic Preservation Officer that several pony truss bridges over the New York to New Haven railroad corridor are representative of nineteenth century bridge technology and collectively eligible for the National Register of Historic Places. He recommended that several of these bridges be incorporated into one study documenting the use of pony bridges in the development of the railroad corridor. As such, both the corridor and the 31 bridges over it have been examined. Seven of the bridges over the corridor are through trusses. The largest of these is the 1871 cast iron through truss carrying Riverside Avenue over the railroad (Bridge No. 03845) in Greenwich, Connecticut. This bridge was moved to its present location in the late 19th century and has been recently rehabilitated (1989) and renumbered (now Bridge No. 05808). Another through truss (Bridge No. 03849) carries Lowe Street over the corridor in Norwalk, Connecticut but, although it is a Pratt pony truss, it was not constructed until 1938 by the Bethlehem Steel Company and therefore not included in this study. However, Bridge No. 03852, carrying Hales Road over the railroad corridor in Westport, Connecticut, is a nineteenth century Warren pony truss and has been added to those bridges recommended by the SHPO.

Thus, the five pony trusses considered in this study are:

Bridge No.	Location	Town	Structure Type
03850	Bridge Street	Norwalk	Warren pony truss
03674	Byram Road	Greenwich	Warren pony truss
03846	Drinkwater Place	Greenwich	Warren pony truss
03852	Hales Road	Westport	Warren pony truss
03854	Sasco Creek	Westport	Warren pony truss

2. Physical History of the Bridge Street Bridge.

Although we do not know exactly when the Bridge Street Bridge was built or who actually built it we assume the bridge was built in the early 1890's by the New York, New Haven and Hartford Railroad, based on the following information:

While no engineering plans for the Bridge Street bridge were located, a faded set of plans for the Hales Road Bridge in Westport (Bridge No. 03852) was located and is included as Fig. 2. These plans carry the title block signature of the New York Division of the New York, New Haven and Hartford Railroad. All indications are that most of the bridges over the New York to New Haven line were built as the corridor was being widened from two tracks to four in the early 1890's and were both designed and constructed by the railroad company. So, although we have no positive date of construction for the Bridge Street Bridge, all of our evidence points to a date of late 1893 or 1894. It is, of course, possible that the Bridge Street Bridge was not built at the time of this expansion, but we could find no evidence suggesting this.

The bridge itself consists of two Warren pony trusses 25.0 feet apart, with no sidewalk. The trusses are 61' 4" long, each made up of five panels. All panels have vertical straps holding pipe railings. Four steel floor beams run crosswise, hung from the panel points. Resting on these floor beams are 6" X 12" timber stringers, running lengthwise. The deck is a bituminous covering on wooden planks laid crosswise. The posted load limit is seven tons. Several bridge inspection reports were located but we found no records of repair or rehabilitation, probably because it was not a state bridge until recently. The bridge is listed in the 1978 legislative report on Structurally Deficient Town Bridges Over Railroads.

3. History of the Bridge Street Crossing.

Although the Norwalk section of the New York to New Haven railroad was in place by 1847 apparently there was no crossing at or near the present Bridge Street for at least another 45 years. The 1893 USGS maps for Connecticut show a double track railroad in the New York to New Haven corridor, except in the Bridgeport area, where four tracks and a freight siding are shown. It was possible to locate all the crossings in Norwalk except the Bridge Street crossing, strongly suggesting a post-1893 date for that particular crossing. There is no indication on these maps as to whether the roadway crossings are grade crossings or bridges, but the topography at the Bridge Street crossing clearly precludes any earlier grade crossing there.

Thus, the present bridge was apparently the first structure built at this crossing. As stated above, it is assumed that the Bridge Street Bridge was constructed during the widening of the railroad from two to four tracks, which would put the date at 1893 or 1894, but this is speculation. By 1894 the annual report of the Railroad Commissioners began to list the sections of the New York division which had been widened to four tracks, and the Norwalk to Bridgeport section, which would include the Bridge Street Bridge, is one of the first so recorded. There were at least three houses along a dirt road, now known as Howard Drive, on the south side of the tracks but the maps show no roads or houses north of the railroad and nothing crossing the railroad.

4. Other Pony Trusses in the Study.

A truss is defined as a system of beams "fastened together so as to mutually support each other and to prevent sagging or distortion of any kind" (Williams 1981:564). There are basically two ways of using trusses: a) as a deck truss in which the load is carried on cross members supported by the top chord so that the traffic moves on top of the trusses, or b) as a through truss where the load is carried on cross members supported by the bottom chord so that the traffic moves between the trusses. A pony truss is simply a through truss where the trusses are not high enough to have horizontal members connecting the two trusses across the top. Pony trusses are also called "low trusses" (Csagoly 1975:1) or "half through trusses" (AASHO 1931:212). The simplest truss is in the shape of a triangle which has a post down the center, in other words two right triangles placed back to back so that their hypotenuses form the diagonals (Fig. 1). If the truss is above the roadway the vertical member is being pulled down by the weight on the roadway, putting the vertical member in tension, while the diagonals are being pushed together, putting them in compression. On the other hand, if the truss is below the roadway the weight is pushing down on the vertical member, putting it in compression, while the two diagonals are being stretched, putting them in tension. A triangle with a center post is called a king post truss, and is still used for bridges up to 60 feet long (Comp 1977:3). Sometimes these trusses are lengthened by placing horizontal members between two triangles, thus forming what is called a queen post truss (Fig. 1). Basically, all truss bridges follow this same pattern of using a series of triangles, placing some members in compression and some in tension. Early bridge trusses were made up of wooden members, which are very good as compression members. They are not, however, very good when used as tension members. Although the tensile strength of the wooden beams themselves is quite adequate, there is no way to carry this strength through the joints, and these are the weak points in a wooden truss. Wooden trusses have been made for centuries but it remained for men like Theodore Burr, Timothy Palmer, and Lewis Wernwag, working in the late eighteenth and early nineteenth centuries, to develop timber trusses which avoided putting much of the stress on the tension joints. Some of Burr's wooden arch-trusses, for instance, were over 200 feet long.

About the same time these new trusses were being developed, the rapidly emerging railway systems began to require longer and stronger bridges. Types of trusses multiplied as competing engineers tried different methods of design and construction. Some bridges, such as the Riverside Avenue bridge (Bridge No. 05808) over the railroad in Greenwich, were built with cast iron members but, while these members were somewhat better than wood in compression, they were only marginally better when used in tension. It remained for the development of the so-called "puddling" process of producing wrought iron in the late eighteenth century to satisfy the needs of the blossoming bridge industry at affordable prices. Even so, it was not until 1840 that the first two iron bridges were built in America, both over the recently completed Erie Canal. One of these was a Whipple bowstring truss, using a curved top chord in compression (the bow) fastened to a horizontal bottom chord in tension (the bowstring). One major advantage of this design was that it did not put much horizontal stress on the abutments.

The use of metal trusses grew rapidly, although there were occasional setbacks. One of these occurred in 1850 when an iron truss on the New York and Erie Railroad broke under the weight of a passing train, followed by a hasty decision by management to replace all metal structures with wooden ones (Edwards 1959:71). Although this decision was limited to the New York and Erie and was reversed shortly thereafter, it does indicate the degree of uncertainty people felt about the safety of iron bridges at the time.

The patent issued to Caleb and Thomas Pratt in 1844 for the Pratt truss was to have a profound effect on the bridge industry. By putting vertical members in compression and diagonal members in tension, the Pratts designed a bridge that, with variations, soon became the most popular truss type ever devised. Well-known truss types such as the Parker, the Camelback, and the Lenticular are all modifications of the Pratt which emerged in the third and fourth quarters of the nineteenth century. Railroads quickly adopted these and even designed and built their own versions of them - the Baltimore and Ohio Railroad developed the Baltimore truss and the Pennsylvania Railroad developed the so-called Pennsylvania truss. Many southern railroads preferred either the Bollman or Fink trusses, named for their designers Wendel Bollman and Albert Fink. Both of these types used multiple diagonals running from each end post to the many panel points, but both types were evidently prone to excessive vibration and did not last.

A second basic truss type also made its appearance about the same time as the Pratt. This was the Triangular or Warren truss, patented in 1848 by two English engineers. The Warren is basically a series of triangles, where the diagonals carry both the compression and tension moments (Fig. 1). Although the name was originally restricted to those trusses using only equilateral triangles it is now generally used for any truss using the diagonals for both compression and tension stresses. The Warren truss quickly found many adherents in this country, largely for use in short span trusses, such as the ones in this study. Five of the six pony trusses in the New York to New Haven corridor are Warrens, including all of the pre-1900 ones. Longer spans also used Warren trusses of the double or triple intersection type, where the diagonals cross one or more other diagonals. In effect, these double and triple intersection trusses are essentially additional Triangle trusses superimposed on the basic truss. As such, they begin to resemble the wooden lattice trusses pioneered by Ithiel Town and others in the early part of the century, before iron was being used in bridgework. Their major problem is that of all multiple intersection trusses; the multiple intersections set up high secondary stresses in the truss.

Certainly the period from 1850 to 1885 was a period of bridge experimentation, both in design and construction techniques. Shortly after the Civil War ended cast iron blocks were being used at the joints in place of the wooden ones used in earlier truss construction. This permitted the use of plates and shapes riveted together to form individual members; an advance which made possible the riveted and pin-connected joints using gusset plates and connection angles. Later, as wrought iron began to replace both wood and cast iron as the primary material for use in truss members, manufacturing companies improved their technology even more. Bridge makers began to use riveted plate girders, made up of transverse strips of wrought iron held together by riveted batten plates. Truss bridges continued to be used for both long and short spans, primarily because they fit the contemporary practice of contracting bridges on a "price per foot" basis, and were comparatively easy to erect.

Cast iron pretty much disappeared from railroad bridges by 1870, having been replaced by rolled wrought iron plates, bars, and shaped segments that were used to make up cylindrical or octagonal tubular units. However, cast iron continued to be used in highway bridges for another decade or so before wrought iron took over. In 1884 structural steel became available for general use and the evolutionary sequence was repeated. Wrought iron began to disappear from the bridge industry, starting first with the railroad bridges and then the highway bridges. As the transition from wood to metal members did not always come easy, neither did the change from wrought iron to steel. The very qualities that made steel good for construction work - greater tensile strength, more uniform composition, higher elastic limit - were used as arguments against the product by those supporters of wrought iron who maintained that steel had "never yet been given a fibrous structure, and until this is done the objection to its use will not have been removed" (Edwards 1959:130). Despite these reservations, most mills phased out the rolling of wrought iron plates and shapes about 1895, in favor of Bessemer steel.

Several other elements used in truss construction are important in the development history. The need for lateral bracing in early wooden truss bridges was a serious problem for designers and builders. The vibration caused by wind and traffic, along with climatic conditions, made it difficult to keep the strut and diagonal members adjusted for a balanced loading. The floor system provided the major and, in the case of pony bridges, the only transverse bracing action. In general, the same problem persisted in the early metal trusses; the lateral and sway bracing was not enough to provide adequate rigidity. Braeing to provide stiffness tended to give these metal bridges the appearance of a spider web.

The change from cast to wrought iron for many of the truss segments also led to changes in the floor beams and how they were supported. Early configurations had most floor beams attached to the bottom chord of the truss, either with joint blocks or with U-bolts. Eventually the truss posts were extended below the bottom chord and the floor beams were riveted to these posts. This method of fastening floor beams is evident in most of the pony trusses studied.

Early bridges had the deck planking laid directly on the floor beams, parallel to the bridge alignment. If a double course of floor decking was used the top course was then laid crosswise, at right angles to the alignment. As loads became heavier the distances between floor beams was increased and stringers were placed lengthwise between the floor beams. This eliminated the longitudinal planking and permitted the planking to be laid crosswise on the stringers. If a second course was used in this case it was normally laid at a 45° angle to minimize splintering.

Most American trusses built before 1880 were fastened with pins, not unlike the trunnels used in wooden beam construction. Pin-connected bridges were lighter for a given load rating; they could be finished in the shop, shipped without preassembly, and they cost less - all good reasons for using this type of construction. The major reason for using a riveted construction, which the British and Europeans did from the start, was that the riveted bridges were far more rigid. Riveted construction gradually replaced the American pin-connected bridges in the late 1870's, especially for bridges under 200 feet long.

To compensate for movement caused by temperature and other expansion forces it was common to fasten one end of the span but allow the other end to ride free, usually on a series of rollers. In this study the Drinkwater Street Bridge (Bridge No. 03846) has a roller nest of this type. Other bridges in the study apparently have been rebuilt, using only steel plates as bearing surfaces. It has been said that "no part of ordinary truss and girder superstructures is given less inspection and maintenance care than the devices designed to care for expansion and contraction movements" (Edwards 1959:118).

All of the bridges studied are riveted Warren pony trusses. They measure from 56 to 83 feet in length, and from 20 to 25 feet in width between trusses. The number of panels, or bays, ranges from 4 to 6, with individual panels varying in width from 11' 2" (Bridge No. 03674) to 16' 8" (Bridge No. 03846). Obviously there is a reason for such a wide variation in panel width for the five bridges. One possible explanation might be found in the 1875 report of the American Society of Civil Engineers, which recommended uniform loads for highway bridges based on their assumed type of service (Edwards 1959:145). City bridges had higher load requirements than did highway or country road bridges. For bridges between 60 and 100 feet long, which includes four of the five bridges in the study, the recommended load varied from 90 lbs. per square foot for city bridges where "great concentration of weight is possible" to 60 lbs. per square foot for county roads with light loads. Using these figures, the Byram Road Bridge, with a per panel floor area of 223 sq. ft., would be rated for a 20,400 lb. load as a city bridge. At the same time, the Sasco Creek Bridge, with a per panel floor area of 406 sq. ft., would be rated for a 24,375 lb. load as a county road bridge. Thus, even though the panels of the Sasco Creek bridge have nearly twice the floor area as the Byram Road bridge, the load rating would be actually higher because of the difference in type of service. This assumes, of course, that the size and configuration of the timber stringers or floor joists are not appreciably different from the original design. Apparently some upgrading has been done when timber stringers were replaced; drawings for the Hales Road Bridge, for example, show 4" X 12" stringers and the present timbers are 6" X 12", but this kind of upgrading should be essentially similar for all bridges in the study.

It might be relevant here to mention that the Byram Road Bridge is the only one in the study to have steel I-beams as stringers. All of the other bridges have steel floor beams running crosswise and supporting timber stringers on roughly 16" centers, but the Byram Road Bridge has five steel floor beams running crosswise and supporting four steel stringers running lengthwise, which then carry timber floor joists running crosswise. Thus, the maximum distance spanned by timber is 6' 8" in the Byram Road Bridge but 16' 3" in the Sasco Creek Bridge, and 16' 8" in the Drinkwater Place Bridge.

Of course, one of the most significant variables has not been considered in most of these calculations, and that is the sizes of the steel plates which make up the girders. All of the bridges in the study are constructed with made-up members; in other words, flat plates riveted to angle irons. The chords in all the bridges have a top plate and two side plates riveted to two angles to form a deep channel. The diagonals, however, are either two flat plates held in place by the spacers which support the iron pipe railings, or are two angles held 9" apart by short flat straps riveted in a lattice pattern. In the Drinkwater Place Bridge the upper chord is made up of one 3/8" thick by 12" wide flat plate on top with two 3/8" thick by 9" flat plates on the sides. The two inside diagonals of the end panels are made up of 7/16" thick by 9" wide plates held in place by what appear to be cast iron spacers, which also hold the iron railings. All of the other panels have diagonals of 3" X 4" angles, 7/16" thick, latticed with 9" X 2" flats, 3/8" thick. Although this type of information is available for the Drinkwater Place and the Byram Road Bridges it was not available for the three bridges which have no sidewalks - Bridge Street, Hales Road, and Sasco Creek. All five of the bridges are completely shielded with corrugated metal because of the high voltage lines just under the bridges and it was only when a bridge had one truss open between the sidewalk and the roadway that measurements could be taken. All of the bridges have had their timber superstructures replaced, including updating of timber sizes and spacings. It is possible that some of the bridges in the corridor were grade crossings until the line was 4-tracked.

A brief description of the each of the bridges follows, moving eastward from New York, and not including the Bridge Street Bridge:

Bridge No. 03674 - Byram Road, Greenwich
Two Warren pony trusses 20' apart, with sidewalk cantilevered out from east truss sometime in 1944. Major reconstruction done at that time, with 9" I-beam stringers replaced with 10" I-beams and 3" X 9" floor joists 2' 3" on center replaced with 6" X 10" joists 18" on center. Posted for 10 tons. Top chord is assembled member with two 8" side plates and a 9 1/2" top plate held with riveted angles. This bridge has 6 panels, each 11' 2" wide, making them the narrowest panels in the study. It is also the only bridge with I-beam stringers, which support the 6" X 12" floor joists. As seen from the text, this is the strongest bridge in the group. Deck is bituminous overlay on planks.

Bridge No. 03846 - Drinkwater Place, Greenwich
Two Warren pony trusses 24' apart, 6' 10" sidewalk cantilevered out from west side. Sidewalk added 1932. Trusses are 83' long with 5 panels. Four steel floor beams hung from panel points. Stringers are 6" X 12" treated timbers, resting directly on floor beams. Deck is bituminous overlay on planks.

Bridge No. 03852 - Hales Road, Westport
Two Warren pony trusses 25' apart, no sidewalk. Trusses are 56' 6" long with 4 panels. Three steel floor beams hung from panel points. Stringers are 6" X 12" timber beams running lengthwise, not original. Bituminous paved wooden plank deck. Not likely to have ever been a grade crossing.

Bridge No. 03854 - Sasco Creek Road, Westport
Two Warren pony trusses 25.0' apart, no sidewalk. Trusses are 65' long on skew of 33°. Four panels with three riveted floor beams hung from panel points. Stringers are 6" X 12" timbers, running lengthwise and resting on floor beams. Bituminous paved wooden plank deck. Bridge seats and abutments modified in 1955 and north half altered in 1958 to conform to adjacent bridge over I-95. Posted for eight tons. Judging from the sharp rise at the southern end of the bridge, it is quite possible that the crossing was once a grade crossing before the corridor was 4-tracked. Strap verticals at panel mid points hold pipe guardrails, which are now completely covered by corrugated metal sheeting.

5. History of the New York to New Haven Railroad Corridor.

Railroading in Connecticut began in 1832 when the state issued a charter to the New York and Stonington Railroad for construction of a railroad from Stonington to the Rhode Island border on the Pawcatuck River. There it connected with the New York, Providence & Boston Railroad to Providence and eventually to Boston itself. The purpose of this short railway was to provide a link in the New York to Boston travel route, a route which could avoid the often heavy seas encountered by steamboats forced to leave the protection of Long Island Sound and sail around stormy Point Judith.

Travellers could now take the steamer from New York to Stonington, then travel by rail on to Providence and Boston.

Ground was broken for the Stonington section in August 1832 and the first trains ran in 1837. This line was extended in 1848 when a charter was granted to construct a railroad from New Haven to New London, to be followed in 1853 by the New London and Stonington Railroad charter, which filled in the missing section. Several bankruptcies and reorganizations took place but the various pieces were finally brought together as the Shore Line Railway and began to prosper. In 1870 the Shore Line built a large drawbridge over the Connecticut River, eliminating the earlier practice of putting all the trains on ferries to cross the river. Later that same year the Shore Line was leased to the New York and New Haven Railroad, becoming the Shore Line Division of that railroad.

Another railroad chartered by the Connecticut Legislature in 1832 ran from Hartford to New Haven, although it was four years after the charter was granted before any construction contracts were awarded. After the line was completed travelers going from Hartford to New York would take the train to New Haven and then board a steamer for New York. In 1844 the New York and New Haven Railroad was incorporated with the specific purpose of building a railroad from New Haven to New York City. After a trackage controversy with the New York and Harlem Railroad was settled, the sixty-nine mile single track line was finally completed in 1849. In building this line the New York and New Haven connected the shore line cities of New Haven, Bridgeport, Norwalk, and Stamford with New York City and hoped to contract with the Hartford and New Haven line to carry their New York City bound passengers. When the Hartford and New Haven opposed such an arrangement, largely on the grounds that their line already provided a steamer connection to New York, the New York and New Haven turned elsewhere. They obtained a lease on the New Haven and Northampton Railroad, the line that had taken over the old Farmington Canal properties and was running trains between New Haven and Northampton, Massachusetts. Seeing this as a potential bypass of the Hartford to New Haven traffic and much of their upstream Connecticut River business, the Hartford and New Haven reluctantly agreed to share traffic with the New York and New Haven.

As traffic on the New York and New Haven line grew, a number of connections were made to other north-south lines in the state. The Stamford and New Canaan, the Danbury and Norwalk, the Naugatuck, and the Housatonic railroads all fed their New York traffic into the New York and New Haven, running along the coast. Increased traffic necessitated the construction of a second track from New Haven to New York in the 1850's. And, as the New York and New Haven prospered, so it expanded. In 1870 the New York and New Haven leased the entire Shore Line Railway and finally, in 1872, The New York and New Haven merged with the Hartford and New Haven to form the New York, New Haven and Hartford. The new company was called the "The New

Haven" by most people, "The Hartford" by J. Pierpont Morgan, and simply the "Consolidated" by others.

Shortly after this, the New Haven began to acquire the pieces of what would quickly become a virtual monopoly of railroads in Connecticut. The first president of the New Haven, George Watrous (1879-1887), negotiated the acquisition of the Air Line, the Canal Line, and the Valley routes. During the presidency of Charles Clark (1887-1899) the railroad went through a rapid, and sometimes unprincipled, period of expansion. Clark quickly moved to eliminate any possible competition to the New Haven by buying up or leasing most of the remaining railroads in Connecticut - the Stonington, the New York and New England, the Shepaug, the Litchfield and Northern, the Meriden and Cromwell, the Meriden and Waterbury, the Naugatuck, and the Housatonic - as well as a number of railroads in Massachusetts and Rhode Island.

As part of this expansion program the New Haven rebuilt much of the trackage and rolling stock of the companies it took over (RC 1893). Many of these companies had been in poor financial condition and had let their equipment deteriorate. The New Haven double tracked the New Haven to Springfield route and, starting in the early 1890's, began to widen the New York to New Haven route to four tracks (RC 1892). Work on the four track expansion began in 1892 in the section between Milford and New Haven. Obviously the widening of the corridor from two tracks to four necessitated the reconstruction of all the bridges over the corridor. By 1894 the four-tracking between South Norwalk and New Haven, which would include the Bridge Street Bridge, was complete. Widening the section between South Norwalk and Greenwich required some difficult land condemnation and was not completed until 1895 (RC 1894, 1896). There do not appear to have been any significant modifications in either the location or layout of this section of the corridor since that time. The entire four track route was electrified between 1905 and 1909 (Turner 1986:219), under the presidency of Charles Mellen (1903-1913).

Bridge construction expenditures in the corridor for the period from 1891 to 1895 were:

1891 - $118,646
1892 - $390,499
1893 - $299,638
1894 - $584,385
1895 - $277,773

During the same period the number of overhead highway bridges in the corridor went from 145 in 1891 to 237 in 1893 but dropped back to 143 in 1895 and stayed at that number for several years. One possible explanation for the 1893 bubble is that many of the bridges recorded were temporary bridges associated with the widening of the corridor (RC 1891-1896).

It was during this expansion period of the 1890's that J. Pierpont Morgan became a director and began to influence the New Haven Railroad. First elected to the board in 1891, Morgan was not really active in New Haven affairs until after President Clark's resignation in 1899, but it soon became apparent that the next president (1899-1903), John Hall, was too bland and retiring for Morgan and his group of New York confederates. Morgan had Hall replaced with Charles Mellen who, at the time, was acting as president of another Morgan plaything, the Northern Pacific Railroad. From then until 1913 Morgan and Mellen manipulated the affairs of the New Haven in an effort to control all transportation in New England. After they consolidated their control over most of the railroad companies, they began to take over the rest of the New England transportation system by buying most of the street railways and the steamboat companies which carried passengers up and down Long Island Sound. Many of their actions relating to these acquisitions were either fraudulent or outright illegal, often both. It is widely believed that Morgan used millions of New Haven dollars for his personal use, and helping friends out during the panic of 1907 (Turner 1985:229). Investigations by Louis Brandeis, then a private Boston attorney, brought much of this duplicity to light and Morgan's empire began to fall apart. Disillusionment among investors and worsening economic conditions caused a drop in revenue for the New Haven, leading to reductions in manpower and upkeep of the lines. These, in turn, led to an increased number of accidents and fatalities. Finally Mellen, as president, was indicted for violating the Sherman Anti-Trust Act and even for manslaughter because of the many deaths his cuts in maintenance caused. Many lawsuits were brought by the government against Morgan's co-conspirators but few were ever prosecuted. Although the New Haven had periods of apparent well-being after Morgan it never fully recovered and finally entered bankruptcy in 1935.

6. Sources Consulted

Abbreviations used in text: **RC** = Railroad Commissioners' Annual Reports

AASHO
1931 *Standard Specifications for Highway Bridges and Incidental Structures.* American Association of State Highway Officials. Washington.

Boller, Alfred P.
1876 *Practical Treatise on the Construction of Iron Highway Bridges for the use of Town Committees.* John Wiley, New York.

Comp, T. Allen and Donald Jackson
1977 *Bridge Truss Types: a guide to dating and identifying.* Nashville, TN. American Association for State and Local History Technical Leaflet 95.

ConnDOT
1978 *Structurally Deficient Town Bridges over Railroads.* State of Connecticut Department of Transportation, Wethersfield.

1988 *State Highway Bridge Log.* State of Connecticut Department of Transportation, Wethersfield.

Crofut, Florence S. M.
1937 *Guide to the History and the Historic Sites of Connecticut.* Yale University Press, New Haven.

Csagoly, P.
1975 *Lateral Buckling of Pony Truss Bridges.* Ontario Ministry of Transportation and Communications. Ontario, Canada.

Darnell, Victor C.
1984 *Directory of American Bridge-Building Companies.* Society for Industrial Archeology Occasional Publication #4. Washington.

1989 The Other Literature of Bridge Building. *Industrial Archeology* Vol 15, No. 2. pp 40-56. Washington.

Edwards, Llewellyn N.
1959 *A Record of History and Evolution of Early American Bridges.* Orono, Maine. University Press.

Ellis, Theodore G.
1866 *Description of the Iron Bridge over the Connecticat River on the Hartford and New Haven RR, with a brief History of Iron Bridges.* Brown & Gross, Hartford.

Geis, Joseph
1963 *Bridges and Men.* Doubleday, New York.

Hall, Edwin
1865 *The Ancient Historical Records of Norwalk, Connecticut.* Andrew Selleck, Norwalk.

Kemp, Emory L.
1989 The Fabric of Historic Bridges. *Industrial Archeology* Vol 15, No. 2. pp 3-22. Washington.

Ketchum, Milo S.
1918 *Structural Engineers' Handbook - Data for the Design and Construction of Steel Bridges and Buildings.* McGraw-Hill. New York.

New York, New Haven & Hartford Railroad
1891 Plan of Bridge #84 at Hale's Crossing, Westport, Conn. New York, New Haven, and Hartford archive files.

Railroad Commissioners
1870-1912 *Annual Reports of the Railroad Commissioners of the State of Connecticut.* Case, Lockwood & Brainard, Hartford.

Ray, Deborah W. and Gloria Stewart
1979 *Norwalk, being an historical account of that Connecticut town.*. Phoenix Publishing, Canaan, New Hampshire.

Roth, Matthew
1981 *Connecticut: An Inventory of Historic Engineering and Industrial Sites.* Society for Industrial Archeology, Washington.

Turner, Gregg M. and Melancthon Jacobus
1986 *Connecticut Railroads..An Illustrated History.* Connecticut Historical Society, Hartford.

Waddell, J. A. L.
1925 *Bridge Engineering.* John Wiley, New York.

Williams, Kristine T., ed.
1981 *Construction Dictionary.* Phoenix, AZ. National Association of Women in Construction.

Maps: 1893 Topographical Atlas of the State of Connecticut. USGS.
1989 Fairfield County Atlas. Hagstrom, New York.

Interviews: 1990 Victor Darnell
1990 Emory Kemp
1990 Eric DeLony