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NNEC President's Report

The two days before the scheduled February 18th Conference on New England Industrial Archeology saw the severest winter weather of the year. Strong winds caused electrical power interruptions over large areas of the Northeast that lasted for several days. Nevertheless, the conference, hosted this year by the NNEC, went on as planned at Plymouth State University with 10 papers presented and 50 people in attendance.

Following a welcome by Plymouth State University President Donald P. Wharton, and me as paper chair, the morning segment of the conference focused on an historic 1898 concrete structure that has recently become the responsibility of the State of New Hampshire. The structure is the Endicott-Period gun battery, Elon Farnsworth, built just before the Spanish-American War in New Castle. The morning program progressed as follows: Nelson Lawry, Technology Historian and Author, presented *The History of Portsmouth Harbor Defense*, followed by Richard Rouleau, Facility Manager, University of New Hampshire, who presented *Battery Elon Farnsworth Concrete Condition Detail.* James Garvin, Architectural Historian, NH Division of Historical Resources detailed *The Value and Stabilization of Military Runs in the New Hampshire Seacoast*, and James McConaha, New Hampshire State Preservation Officer, spoke about the challenges of *Balancing Research and Recreation at New Hampshire Coastal Defense Sites.* The final morning presenter, Dennis Howe, Industrial Researcher, provided information about 19th-century hydraulic cement manufacturing based on *An Archeological Survey of a Rosendale Cement Works Ruin.*

The afternoon session was filled with a variety of interesting IA papers, beginning with William Gerber, Vice President. Middlesex Canal Association, who provided the *Results of Research Into the Origins and Use of the Steam Towboat*. Gil Cooke, Historian, Institute of Electrical and Electronics Engineers, presented the *Early Development of the Telephone System in New England*. Two papers concerning industrial museums were provided by Mary Boswell, Executive Director, Belknap Mill Society, who spoke of *Old Technology in the New Belknap Mill: Plans for the Museum* in Laconia, NH, and Richard Candee, Emeritus, Boston University, told the conference about *Redundant Collections of the American Textile History Museum* in Lowell, MA. The last presenter, David C. Switzer, Emeritus, Plymouth State University, provided a paper entitled *Steam Power, Explosives, and Clothing Styles: the Stuff of the Last Days of Arctic Whaling*.

The next meeting of the Northern New England Chapter is scheduled for Saturday, July 8, beginning at the Lake Champlain Maritime Museum at Basin Harbor, Vermont, at 9:00 am. The meeting and tour, being arranged by NNEC 2nd V.P. Victor Rolando, will begin with a brief presentation from Adam Kane, the Director of the Maritime Research Institute, which has ongoing archeological projects on Lake Champlain, operates an artifact conservation laboratory, and assists with management of shipwrecks in the lake. Participants will tour the Conservation Lab and Revolutionary War replica ship *Philadelphia*, which will be "beached" for underbelly maintenance. In the afternoon there will be a tour of the industrial facilities at the falls in nearby Vergennes, and Victor will provide a guided tour of blast furnace remains and mill foundations.

Dennis Howe
Concord, NH

SNEC President's Report

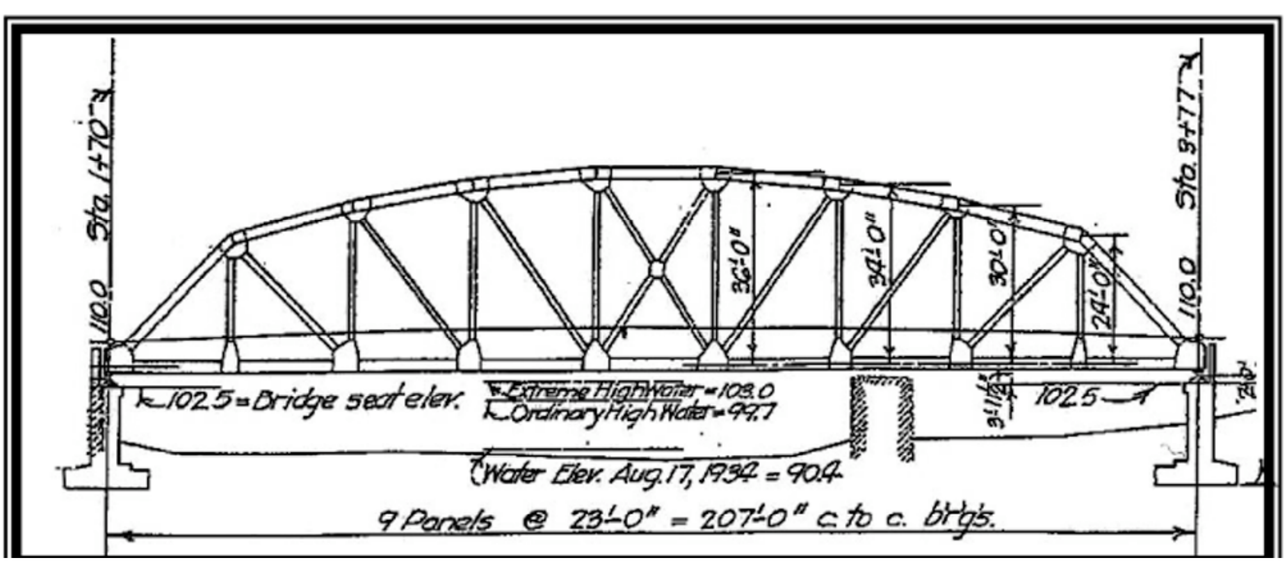
As of March 31, there isn't much to report, but there is a lot to anticipate. SNEC members should watch their mailboxes (electronic and real) for updates on the following:

- We're launching a SNEC chapter website that will post upcoming events, attract recruits, share IA information, archive newsletters, and host reports/photos/comments from tours and other activities. The initial design is complete and we expect to launch within a couple of weeks.
- We're organizing a tour of two small hydroelectric plants in and around Ayer, MA for May.
- For August, we're planning a special visit to Mystic Seaport to coincide with the live operation of steam engines usually kept under wraps.

Again, please watch your mail and e-mail for details. As always, we encourage you to encourage friends to become members. At our special "New Member" introductory fee of $10, it's a great deal!

Jonathan Kranz
Melrose, MA

Figure 1. *Planview of Depot Street Bridge, Beacon Falls, Connecticut. (Connecticut State Highway Department 1935)*



THE "DEPOT STREET" BRIDGE IN BEACON FALLS, CONNECTICUT

The Depot Street Bridge (Bridge No. 3788) crosses the Naugatuck River in Beacon Falls, Connecticut, and is located on the western end of the town of Beacon Falls. The bridge links the commercial section of town found on the east side of the river to an industrial park located on the opposite side of the river. A Bridge Inspection Report dated in 2003 recommended repair of thirty-five stringer connections and of the east abutment expansion joint as well as repainting of the whole structure. The bridge is of particular significance because it exhibits the distinctive characteristics of a Parker modified through truss structure typical of the last decade of extensive use of truss structures in Connecticut between 1930 and 1940.

Beacon Falls was initially settled in the late 1600s and incorporated from the towns of Bethany, Naugatuck, Oxford and Seymour. Since the Naugatuck River bisected the town, the residents needed a crossing point that would allow them to access lands on eastern shore of the river. In 1835, a wooden bridge was erected at a point known as the “rock cut”, approximately 200 feet downstream from the Depot Street Bridge. The towns of Oxford and Bethany provided the funds for construction. The bridge was unfortunately totally destroyed during the flood of 1855. Realizing the necessity of quickly providing a new crossing, the American Hard Rubber Company which had a factory in town, decided to construct a new wooden bridge. The bridge was then acquired by the Home Woolen Company, which with the Town of Bethany, continued to make payments on the bridge. Following the incorporation of the town of Beacon Falls in 1871, the bridge became the property of the town.

The eastern portion of the bridge had deteriorated since its construction and in 1892 a 60-foot section was removed and replaced by a steel structure which extended from the shore to the first pier. However, the overall costs involved in the maintenance and the repairs to the bridge became increasingly high and eventually the bridge was deemed unsafe. During the early part of 1935, the bridge was completely demolished to make way for a steel through truss bridge. The abutments were erected during the spring of 1935 and construction of the structure extended throughout the summer months of that year. Finally, the Depot Street Bridge was completed on October 26, 1935 at the approximate cost of $75,000.00, of which $21,500.00 were obtained from a federal grant, $31,000.00 from the State Aid Road Funds accumulations, and $17,500.00 from the Town of Beacon Falls (Town of Beacon Falls 1935). A $5,000.00 contingent fund was made possible by the State of Connecticut.

The design of iron and steel bridges during the nineteenth century, a reflection of the Industrial Revolution, revolutionized the construction of bridges. As the price of steel slowly decreased, particularly after the end of the nineteenth century, it rapidly replaced iron as the material of choice for bridge construction (Darnell 1979). By the end of the first decade of the twentieth century, national standards for the reinforcement of steel had been put into place. For the first twenty five years of the twentieth century, the Pratt truss was the norm for the American bridge form (Mead and Hunt 1999:31). With increased competition, this period also saw the merger of smaller bridge manufacturers or the outright takeover of these firms by larger corporations. The largest of these takeovers occurred in 1900, when Andrew Carnegie of New York acquired more than twenty of the largest bridge companies in the country forming the American Bridge Company of New York (Mead and Hunt 1999:87). The subsequent domination of the American Bridge Company quickly led to the decline and eventual disappearance of a large number of independent bridge manufacturers.

A number of small communities throughout

Connecticut sought to replace their timber bridges with structures that would withstand the heavier loads brought about by the use of the automobile. Although nineteenth century truss types were diversified, they became more standardized at the turn of the next century. As well, pinned joints were replaced by rivets at connection points and steel came to be used instead of wrought iron (Clouette and Roth 1991:35). With the increase in vehicle traffic at the beginning of the twentieth century, engineers had to design trusses that would be able to sustain heavier loads.

Charles H. Parker of Boston, MA obtained a patent in 1870 for a bridge design that borrowed from the original Pratt truss, replacing the straight top chord with a polygonal or arched top chord. Parker, as a mechanical engineer, realized that the sheer stress forces applied to the ends were much less than the bending stresses being applied to the middle of the structure (Parsons Brinckerhoff and Engineering and Industrial Heritage 2005:3-34). Consequently, the vertical and diagonal members could be effectively shortened from the center to the ends without loosing loading capabilities. This realization allowed Parker to come up with a truss design with an inclined top chord which used less metal than a straight chord Pratt truss. The design required however, higher expenses related to fabrication and erection costs since varying length diagonals and verticals were necessary for each panel of the polygonal chords. Because trusses were priced by weight, the lighter materials in a Parker truss design offset the higher labor costs. Variations in the Parker design included the camelback truss which was characterized by five equally angled slopes in the upper chord and end posts.

Though the Parker curved chord appeared innovative, the design had been in existence even prior to the Pratt design of 1844. The ingenuity of the design resided in the minor alterations that allowed for simplifying the structural composition of the bridge. Bridge lengths could be altered by modifying or extending the slope of the end posts and the casting of these end points allowed for the connection between the top and bottom chords to be simplified (Darnell 1998:12). Because Parker truss designed bridges were much more economically efficient than the traditional Pratt truss structures, they gradually replaced the Pratt designs after the turn of the century with highway depart-

Figure 2. *View of Depot Street Bridge from the east bank of the Naugatuck River. (Photograph taken by Luc Litwinionek 10/30/05)*

ments adopting the pony trusses for spans between 30 and 60 feet and the through trusses for spans extending from 100 to 300 feet.

The Depot Street Bridge (Bridge No. 3788) consists of two Parker through trusses with a maximum span of 207 feet. The bridge itself is approximately 45 feet wide including pedestrian walks on both sides of the structure. It is composed of nine steel panels which are placed 23 feet apart. Each panel consists of seven stringers for a total of 63 stringers. The stringers, placed at five-foot intervals on center, are supported by ten four-foot deep floorbeams. Box girders with back to back channels constitute the end posts as well as the top chords of the bridge (Roth and Clouette 1990). These channels are tied with a welded connecting plate on top and lacing bars at the bottom. The box girders used as bottom chords are plated on all four sides and angled at each corner. The center panel is characterized by diagonals with two sets of paired angles which are connected by gusset plates. Pairs of top and bottom channels with lacing constitute the other truss members. The other portal struts and lateral bracing show the same configuration with angled lacing bars. The concrete slab deck with built and angled floorbeams is supported by I-section stringers. The pedestrian walks on each side of the truss structure are supported by angled triangular brackets. The opposite railings are composed of a lattice of angled metal flat bars set in a concrete footing. The bridge was designed by federal engineers from the Public Works Administration and engineers from the Connecticut Highway Department. The original contractors were the Gammino Construction Company of Providence, Rhode Island. The Leake-Nelson Company of Bridgeport, Connecticut built the steel portion of the bridge. The truss members were fabricated by the American Bridge Company of New York.

Parker truss bridges that are still in existence today are significant because they represent a standard bridge type used by the Connecticut Department of Transportation. Character defining features for these types of bridges include the characteristic polygonal top chord, the inclined end posts, diagonals present on each panel, differing length verticals, becoming shorter from the central panel outward. The well preserved nature of the Depot Street Bridge illustrates all of these characteristics and represents a fine and increasingly rare example of the Parker truss.

Luc Litwinionek and Cece Saunders,
Historical Perspectives, Inc

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The Cathance Water Tower

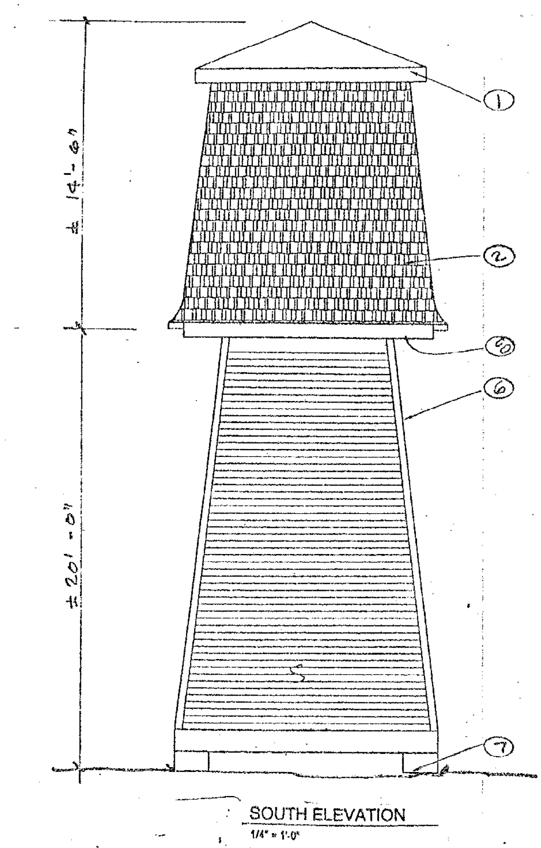
The Cathance Water Tower located in Topsham Maine was built in 1906. It was built to serve the household and farm of the Rogers family that had farmed the area since 1773.

The Tower is 29 feet high with a base measuring 12 feet 4 inches square. The tank located in the top of the tower held over five thousand gallons of water.

Currently owned by the Town of Topsham the Cathance Water Tower is virtually unaltered from the time of it's construction and is a rare example of a stylized water tower. The Tower was listed on the National Register of Historic Places in January 2001 as a locally significant rare surviving domestic water supply structure. In June of 2001 the town of Topsham was awarded a U.S. Department of the Interior matching Historic Preservation Fund grant through the Maine Historic Preservation Commission for the purpose of restoring the Cathance Water Tower.

A timber frame preservation contractor was retained to stabilize and restore the structure and this work was completed in 2002. Further interior and exterior restoration was work was completed in 2005.

The town now wishes to recreate the original method of filling the tank by means of a hydraulic ram pump. To get water to the holding tank a hydraulic ram uses the power available from an elevated water source to pump a small portion of the water up a considerable height above the stream. Unfortunately the original source of water that powered the hydraulic ram no longer is a viable source of water so the Town may have to fall



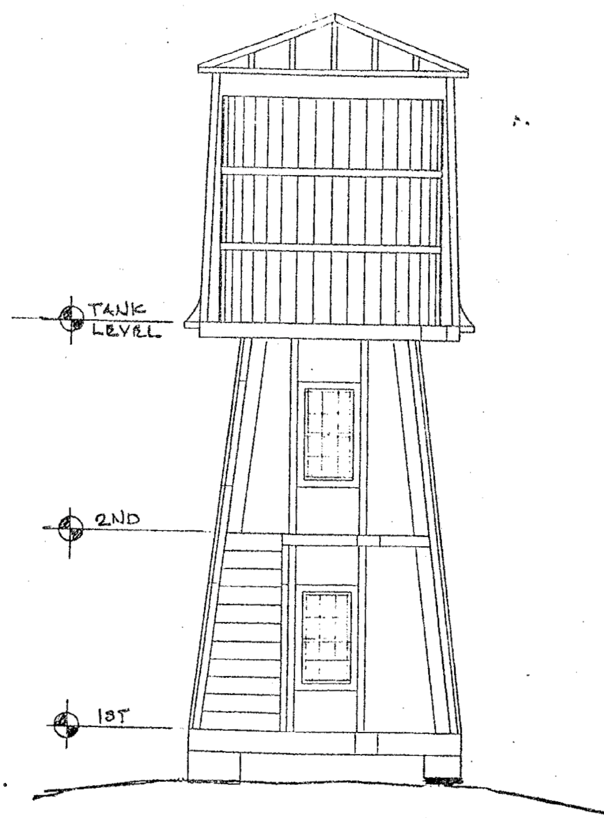
back to having a miniature working model of the hydraulic ram pump on the ground floor of the structure to demonstrate the workings of this piece of history to today's school children.

It is hoped that anyone with a knowledge restoring a water tower to a working condition particularly the workings of a hydraulic ram pump who would be willing to advise the town in their restoration project will contact Rod Melanson, Assistant Town Planner, Topsham Maine. Rod can be contacted at a/c 207-725-1724. E-mail address is rmelanson@topshammaine.com

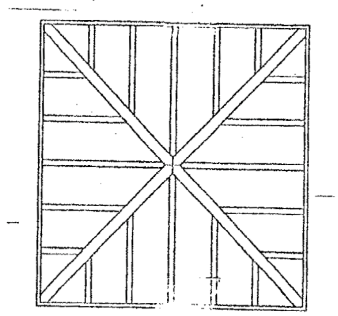
Details on the description and original workings of the Cathance Water Tower is from the Historic Resource Study and Restoration Plan for the Cathance Water Tower prepared for the Town of Topsham by Turk,Tracey,& Larry Architects Portland Maine

Ed Galvin

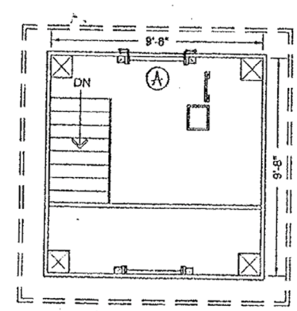
Photo, right: the tower before restoration.



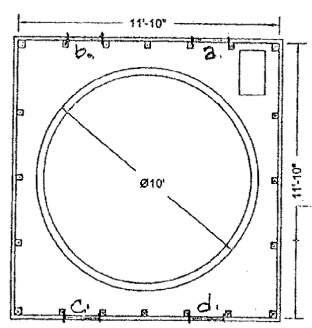
SECTION VIEW
1/4" = 1'-0"

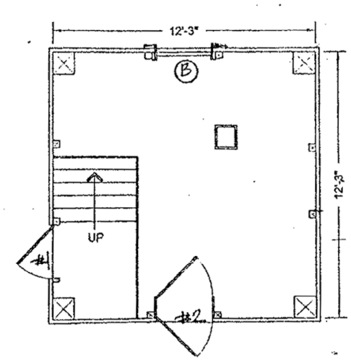


ROOF FRAMING PLAN VIEW
1/4" = 1'-0"



SECOND FLOOR PLAN VIEW
1/4" = 1'-0"





Connecticut Yankee Archaeological Study

American Cultural Specialists, LLC has completed over three years of archaeological investigations of the 520 plus acres of woodland surrounding the CT Yankee Atomic Power Company in Haddam, CT. Located on Haddam Neck on the east side of the CT River and bounded on the south by Salmon River, the property is mainly wooded uplands with little historic disturbances. CT Yankee intends to donate the property for preservation in perpetuity.

AMCS's crew excavated a total of 2,774 50-cm square shovel test units and 58.5 one-meter or larger units during Phase 1 professional archaeological reconnaissance and Phase 2 intensive archaeological surveys, totaling 722 square meters of excavation. During the Phase 1 surveys, twenty-four archaeology sites were located. We believe that 22 of them may be eligible for listing on the National Register of Historic Places. Those sites containing significant historical components are:

1. Dudley/Ackley Site (#61-99)
2. The Wharf Site (#61-123)
3. Redware Site (#61-121)
4. Brainerd Site (#61-96)
5. Rock House Site (#61-118)
6. Salmon River Dock Site (#61-119)
7. Peninsula 1 Site (#61-115)
8. Peninsula 2 Site (#61-116)
9. Smith/Dudley/Andrews Site (#61-101)
10. Schmitt House Site (#61-126)
11. Brainerd Quarry

Additional archaeological investigations are scheduled for several of these sites during the 2006 field season; specifically, those sites where only a phase 1 survey was completed need to go to Phase 2. When those excavations are completed, the CT Yankee sites should allow us to

Several sites represent represent 18th and early 19th century farmsteads. These Haddam Neck farm sites are case studies of regional farming, helping us to understand why some CT farms succeeded while other of their contemporaries failed in the transition from subsistence to commercial farming

Besides providing a window into rural American life during those time periods, such sites may also provide insight into the immense cultural changes that occurred in 19th century Connecticut. Several of the sites were associated with early industry and trade such as the Brainerd Quarry site; the Hezekiah Brainerd house and wharf, associated with the quarry and shipping industry; the Peninsula houses and wharf, which may be associated with early shipbuilding by the Smith brothers, local ship captains; the Venture Smith site, home of the world-renowned West African prince and captive who worked his way out of slavery to become a successful river trader and farmer. These sites contain information on local economy, technology, and social relations that should promote a better understanding of the process of industrialization and urbanization, consumer behaviors, and class and race relations in the lower Connecticut River Valley.

Three other sites were associated with former captive African-Americans and also have the potential to provide important information on the lives of individual colonial and early federalist period black families and their interactions with the dominant white society --the Redware site, the Rock house site, and the Salmon River Dock. Historic site occupants also represent various social classes in colonial and federalist society. Virtually all of the sites were connected by an ancient colonial road that still remains essentially unimproved. In effect, we believe that all of the Connecticut Yankee property may meet the federal and state criteria for eligibility as an "historic rural landscape district" composed of a variety of land uses that incorporates several types of landscapes – agriculture, industry (mining, lumbering), and maritime activities (fishing, shipbuilding, coastal trade), and as Connecticut state archaeological preserves.

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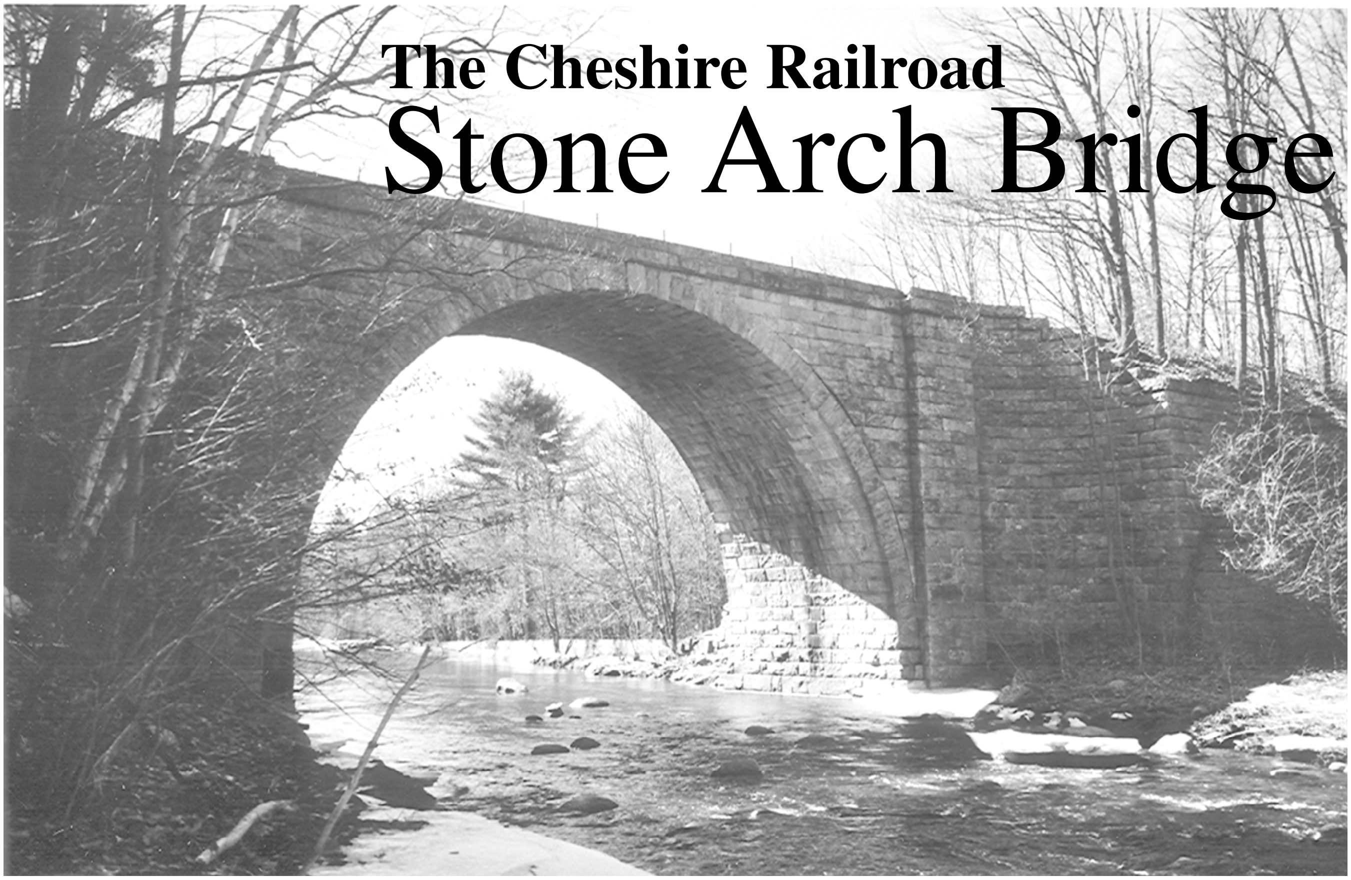
Institute for American Indian Studies
Washington, CT



The Cheshire Railroad Stone Arch Bridge

The arched railroad bridge in Keene, NH, spanning the South Branch of the Ashuelot River near the Keene-Marlborough town line, is one of the most impressive masonry arches ever built in New Hampshire. S. G. Griffin's *A History of the Town of Keene* states of the bridge and its designer,

> Mr. Lucian Tilton was chief engineer and the first superintendent [of the Cheshire Railroad], and the road was pronounced to be of superior character. The massive and graceful arch over the Branch at South Keene—a single span ninety feet broad and sixty feet high, designed by Mr. Tilton and built under his direction—is one of the finest of the kind in the country and worth traveling a long distance to see.[1]

By actual measurement, the bridge carries the rail bed approximately 48 feet above the water level of the South Branch at normal flow.[2] The bridge was considered one of the finest and most daring arched spans in the United States when it was completed in 1847. Its progress was reported in a local Keene newspaper in December 1846:

> The key stones of the great bridge (a magnificent structure) over the East Branch, in this town, were put in place last week, and the filling [over the arch] is now going on vigorously, as is the work on the whole line.[3]

The bridge is one of many impressive engineering structures on the line of the former Cheshire Railroad. Extending 42.81 miles from the Massachusetts border at Fitzwilliam to a point near the Vermont border at North Walpole, the Cheshire Railroad was chartered in 1844.[4] It completed its passage across Cheshire County to the Connecticut River and to its terminus at Bellows Falls, Vermont, in 1849.[5] The Cheshire Railroad was characterized as "one of the most thoroughly-constructed roads in the country. Its bridges, culverts and abutments, built of cut granite, are models of civil engineering." [6]

The Cheshire Railroad surpassed all other rail lines in New Hampshire in its mastery of masonry construction and in the bold use of the stone arch for its many stream crossings. Chief engineers for the line were Lucian Tilton and W. S. Whitwell. Under their supervision, contractors built twenty arched granite bridges and culverts, more than a hundred stone box culverts and cattle underpasses, and impressive cuts and fills along the 43-mile route.[7] Some of the line's culverts support over a hundred feet of overburden. Several of the stone arched bridges on the line are elliptical in outline; others are high, stilted semicircular arches. An arched highway underpass on Arch Street in the western part of Keene has in-curved portals, and the intersection of the semicircular vault and the portals represents complex geometry that required difficult stonecutting. The Arch Street underpass is accompanied by a long arched culvert that conducts nearby White Brook beneath the wide causeway of the railroad.

The Cheshire Railroad had its genesis in plans by Massachusetts investors to built a rail line from Boston to the western Massachusetts town of Fitchburg, about forty-one miles southeast of Keene, with further discussions of extending the line from Fitchburg to Brattleboro, Vermont. Seeing an opportunity to attract a line through Keene, local investors subscribed some $40,000 in December, 1843, to influence the engineers to choose a route that would pass through Keene en route from Fitchburg to Brattleboro.

When such a route was ultimately not selected, local rail proponents secured a charter for the Cheshire Railroad on December 17, 1844. The charter authorized the corporation to construct a line "from any point on the south [boundary] line of the State [of New Hampshire], in Fitzwilliam or Rindge, and passing thence through the village of Keene, to the western boundary of the State, in Walpole or Charlestown," and further authorized the corporation to build a bridge across the Connecticut River to connect with Rockingham, Vermont.[8] A second New Hampshire law, passed on December 27, 1844, authorized the Cheshire Railroad to "unite with the Winchendon [Massachusetts] railroad corporation . . . and when said corporations shall have united . . . under the name of the Cheshire railroad company . . . all the franchises, property, powers and privileges granted and acquired under the authority of the states of New Hampshire and Massachusetts respectively, shall be held and enjoyed by all the said stockholders, in proportion to the amount of property or interest held by them respectively, in either or both of said companies or corporations." [9]

By this means, the Cheshire Railroad secured authority to connect Winchendon, Massachusetts, and Rockingham, Vermont, by rail. Further action by the Massachusetts legislature authorized construction of six miles of track connecting Winchendon and Fitchburg, Massachusetts, thereby making legal a complete rail route passing through Keene from Boston to the Connecticut River at Walpole, New Hampshire, and Rockingham, Vermont.[10] By May, 1848, when the line had become active between Boston and Keene, the directors of the Cheshire Railroad reported to the stockholders that great prospects were to be expected in the near future by completion of an integrated transportation system covering northwestern New England and linking that region with Boston:

> The time has past, if it ever existed, when the final completion of the road could be regarded by any one as questionable. It is now only a question of a few weeks, in point of time,—earlier or later. But still, in this point of view, important to us,—important that we shall be realizing at the earliest day, the advantages which we shall derive from the use of our entire line,—important to us, that we shall be ready as soon as the other roads constructing above us shall be completed, to receive their business and to pass it along to its destination; with the Rutland, the Sullivan, the Central, the Passumpsic, the Vermont and Canada, and the Ogdensburg roads,—all passing on to completion, and in the business of all of which our road must participate, in a greater or less degree,—we can want no incentive to urge us on our work, and can entertain no distrust, that when the road shall be completed, the amount of

> business which shall be done on it will exceed any expectations which have been entertained by its most sanguine friends.[11]

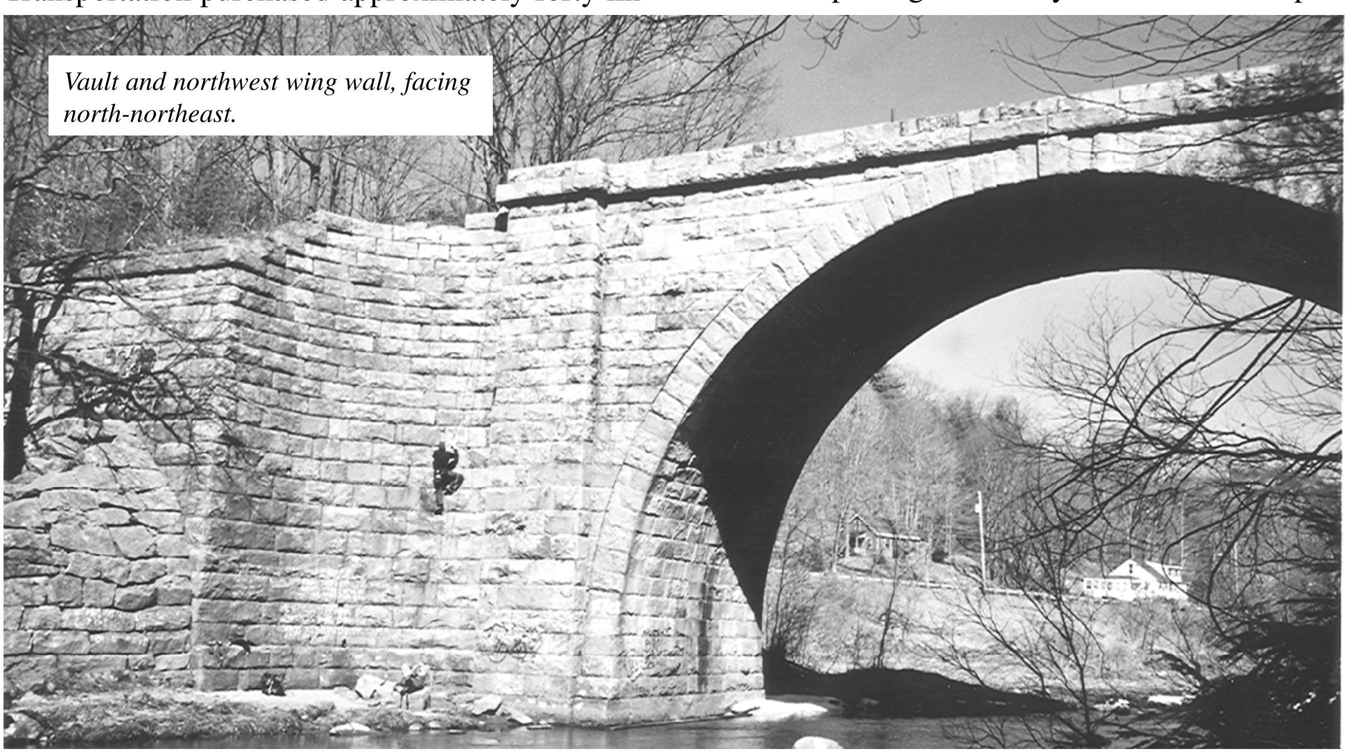
The arch over the South Branch of the Ashuelot surmounted the final major obstacle preventing a railroad connection to Keene from the south. Following completion of the bridge in 1847, the Cheshire Railroad completed its route to the heart of Keene and opened the road to regular traffic on May 16, 1848 with the arrival of a special excursion train from Boston. [12]

The bridge is by far the single most impressive structure along the right-of-way of the Cheshire Railroad. The arch is immense in scale and finished in workmanship. Its large voissoirs (the stones that form the barrel of the vault) and the stones that form its spandrel walls and wing walls are all hand-hammered to create smooth joints, yet are deliberately left with rough faces to enhance the sense of massive ruggedness in the huge structure. This bridge was an engineering triumph in its day, and remains a monument in American transportation history.

The Cheshire Railroad was officially abandoned along most of its length in 1972.[13] In the early 1990s, the New Hampshire Department of Transportation purchased approximately forty linear miles of the railroad in the towns and cities of Fitzwilliam, Troy, Marlborough, Swanzey, Keene, Surry, Westmoreland, and Walpole. In keeping with standard practice, this linear corridor was placed under the administrative care of DOT's Bureau of Rail and Transit. The Bureau of Rail and Transit, in turn, has permitted the use of much of the line as a recreational trail under the Trails Bureau of the Department of Resources and Economic Development (DRED).

Architectural Description and Comparative Evaluation

The arched bridge at South Keene is built of rough-faced granite ashlar. The granite was reportedly quarried on the Thompson Farm, located within a half mile of the bridge site in neighboring Roxbury.[14] Individual stones are hammered to precise beds that required only a minimum amount of mortar to achieve full bearing for each stone; in many cases, the stones were apparently laid dry. The exposed surfaces of each block are left with split faces, imparting a rusticated texture to the overall fabric. Many of these stones retain visible marks of the plug drills that were used to prepare them for splitting. The only features that are pre-



Vault and northwest wing wall, facing north-northeast.

Voussoirs detail.

cisely finished are the arrises of the archivolt and its flanking piers, where the corners of the stones are chiseled to a true line.

The bridge has a single open vault with a reported span of about ninety feet. The springline of the vault is elevated five courses of stone above the footings of the bridge, bringing the elevation of the rail bed at the top of the bridge to about forty-eight feet above the water at normal flow. The vault is composed of a single course of voussoirs, each having a soffit measuring about twenty inches, and a depth or height of about forty inches. The voussoirs vary in length in order to break joints, but probably average about 48 inches long. As noted above, the arris of the archivolt is chiseled to a sharp edge. The keystone is the only voussoir that projects beyond the chiseled curve of the archivolt.

Flanking each end of the vault are single heavy piers or buttresses that project about twenty inches from the plane of the arch. The corners of these piers are chiseled to a sharp arris. The spandrel walls between the vault ring and the piers are composed of coursed granite ashlar. The courses of the spandrels and the piers are aligned, and vary in depth from 24 inches at the bottom of the bridge to 18 to 20 inches at the top, beneath the wall coping, thereby enhancing a perception of the stability and height of the structure.

The granite wing walls beyond the piers curve outward on a quarter-circle radius, retaining massive volumes of earth behind their vertical faces and thereby resisting the spreading tendency of the vault. At the termination of their curved surfaces, the wing walls return to an alignment that parallels the axis of the bridge, and bury themselves in the hillsides on each side of the river. The river banks upstream and downstream from these walls have been armored with large pieces of packed granite rubble. The color of this armoring stone differs from that of the bridge ashlar, suggesting that the armoring of the embankments was carried out subsequent to the completion of the bridge.

The wing wall at the northwestern corner of the bridge is pierced by a granite arch, filled with ashlar and partly buried in the embankment. The full dimensions and purpose of this arch are unknown.

Many of the joints between the stones of the vault, the spandrel walls, the piers, and the wing walls have no visible mortar. Many of the beds of the stones appear to have been hammered to a fineness that permitted the stones to be laid dry, yet to achieve good surface contact. But some joints in the bridge are filled with a soft, brownish mortar. Preliminary tests suggest that this mortar may include some natural cement in addition to lime and sand. The mortar appears to have been employed only where irregularities in the beds of adjacent stones required a cushion to achieve even contact through the mass of masonry.

Comparative evaluation: As noted above, the Cheshire Railroad surpassed all others in New Hampshire, and probably in northern New

England, in the quality of its granite construction. The route of the railroad throughout Cheshire County affords many other examples of arched granite bridges and culverts that may be juxtaposed with the great arch over the South Branch of the Ashuelot River. Among the most impressive of these structures are the elliptical and semicircular vaults to be seen along the line. Also unusual are the enormously long granite arched culverts that conduct local streams through the causeways of the rail bed at points where the elevation of the rails was far above that of the streams below and the causeways are proportionately wide at their bases.

Among the most notable of the arched granite structures along the line are the following: 1. The stone arch highway underpass (94.57 mm) at Arch Street, Keene. The inwardly-curving portals of this bridge meet the stilted semicircular vault of the underpass in an intersection of complex geometry; 2. The stone arch highway underpass (85.45 mm) at Thatcher Hill Road in Marlborough. This high, stilted semicircular arch has straight portals but sharply outwardly-curved wing walls; 3. The semi-elliptical stone arch (83.24 mm) over the Ashuelot River at Troy; 4. The three-centered stone arch bridge (73.32 ± mm) over Scott Brook in Fitzwilliam; and 5. The double elliptical stone-arched bridge (71.08 ± mm) over an unnamed brook in Fitzwilliam.

Other New Hampshire railroad lines also retain notable stone arches. One of the earliest stone railroad arches constructed in the state was built in 1840 to span Salmon Brook in Nashua (37.87 mm). The Bridge Street tunnel in [Bellows Falls,] Westminster [Vermont] (83.80) was constructed in 1851 to allow passage of trains beneath the streets and buildings of that growing railroad center.

The 1910 Railroad Commissioners' Report indicates that there were then forty-three stone bridges on the Boston & Maine Railroad system in New Hampshire.[15] The current New Hampshire Department of Transportation Railroad Database includes a total of twenty-eight, although additional smaller bridges could be recorded as culverts due to inconsistencies in data entry.[16] The New Hampshire Department of Transportation Railroad Database (see table on page 14) shows the stone arch rail bridges in state, in the order of their length [17]

Although the above information indicates that New Hampshire retains many arched stone railroad structures, no other arched bridge, on the Cheshire Railroad or elsewhere, equaled the bridge at South Keene for sheer height, span, and massiveness of construction until the approach of the twentieth century. Many of the attributes of the South Keene bridge, however, were echoed on other, smaller spans of the Cheshire Railroad. Among these characteristics are the use of rough-faced ashlar masonry with precisely cut beds and arrises, the employment of curved granite wing walls to buttress the arches, the definition of the tops of the bridges by projecting coping courses, and a general sophistication of geometrical layout and proportioning. Together, these attributes offer a convincing visual impression of unstinting investment of thought and capital in the design and construction of the entire Cheshire Railroad line.

The only arched stone railroad bridge to equal the daring of the South Keene span was the double arched bridge across the Connecticut River at Bellows Falls, built in 1899 by the Fitchburg Railroad, which had assumed control of the Cheshire Railroad, to replace an earlier bridge across the river. Each of the spans measures 140 feet but has a rise of only twenty feet, giving this bridge two of the longest masonry arches, with the least rise, in the United States. The South Keene and Bellows Falls bridges, built half a century apart, each contributed to the reputation of the Cheshire or Fitchburg line for engineering sophistication.

National or State Register Criteria Statement of Significance

The great stone arched bridge at South Keene was one of the most impressive masonry arches to be constructed in the United States before 1850. The bridge is significant under National Register

Railroad	Town	Extant	Length (ft)	Other Dimension (ft)	Feature Crossed	Date	Other I
Cheshire Branch	Fitzwilliam	YES	20		Stream		15'-6" Ht
Cheshire Branch	Keene	YES	17.7		Ash Swamp Brook		45-6" Ht
Cheshire Branch	Keene	YES	68.25		Ashuelot River, S. Branch		19'-2" Ht
Cheshire Branch	Marlboro	YES	15.7		Thatcher Hill Road		22' Ht
Cheshire Branch	Keene	YES	19.7		Arch Street	1847	34'-5" Ht
Cheshire Branch	Troy	YES	38		Ashuelot River, S. Branch		24'-7" Ht
Concord to Woodsville	Canterbury	Yes	9	Ht 50'			
Concord to Woodsville	Concord	Yes	16.67	22-0		1906	
Concord to Woodsville	New Hampton		10	Ht 21' -6"	unnamed brook	1893	"Ashland Arc
Fort Hill	Hinsdale	YES	0	20	Liscomb's Creek	1913	21' Ht
Goffstown Branch	Goffstown		11				Ht 34-6
Main Line, Woodsville to Berlin	Whitefield		12			1892	Whitefield Ar
Manchester and Lawrence	Windham	?	19	25-6 Ht	Highway		
Manchester and Lawrence	Derry		12	28-3 Ht	Hornes Pond		
Manchester and Lawrence	Derry	?	19	34 Ht	Beaver Brook		
Manchester and Lawrence	Londonderry	YES	12	Ht 25			Mill Pond
Mountain Division	Conway	YES	25.5	17.5	Artists Brook		
Northern	Franklin	YES	10		Shaw Brook		25' Ht
Northern	Concord	YES	9.5		Horse Shoe Pond		15' Ht
Northern	Boscawen	YES	10		Glines Brook		24' Ht
Northern	Franklin	YES	13		Chance Pond/Webster		20' Ht
Northern	Danbury	YES	13.5		Gungewam Brook		15'-6" Ht
Northern	Lebanon	ALT	18		Highway/Glen Road		20' Ht/"Hogb
Northern	Boscawen	YES	10		Coles Brook		18' Ht
Plymouth to Woodsville	Rumney		30		Halls Brook	1895	34' Ht
Portsmouth to Manchester	Manchester	No	8		Cemetery Brook		8'-8" Ht

Criterion A, for its role as a crucial link in a specific transportation system and for its demonstration of the capacity of the stone arch to span long distances while bearing the weight of railroad traffic. The bridge is significant under Criterion C for its significance in engineering and as the work of a master. The engineering design for the Cheshire Railroad, including the arched bridge, was provided by W. S. Whitwell and Lucian Tilton.[18] A native of Hampton Falls, New Hampshire, Tilton (1812-1877) is credited with surveying the route of the Cheshire Railroad. He served as superintendent of the railroad upon its completion.[19] Tilton later served as consulting engineer for the Ashuelot Railroad, which connected Keene and East Northfield, Massachusetts, and was employed as superintendent of the Fitchburg Railroad in Massachusetts from 1850 to 1853. He subsequently served as superintendent of the Toledo and Wabash Railroad and as president of the Great Western Railroad; in the latter position, he and his family rented the home of the Abraham Lincoln family in Springfield, Illinois, when the Lincolns left for Washington, D. C., in January 1861. Tilton moved to Chicago in 1869, and his house there was destroyed two years later in the great Chicago fire of October 8, 1871. He was considered one of the most eminent railroad engineers in the United States.

The period of Significance is 1847-1956 (arbitrary fifty-year cutoff date).

Statement of Integrity

The arched bridge at mm 89.41 in South Keene retains integrity of location, setting, materials, workmanship, feeling, and association. The bridge retains substantial integrity of design, although the original granite parapet wall was composed of two regular courses of ashlar and a second, upper coping course above the existing lower coping course. The two upper courses of the original parapet were removed in December 1903 and supplanted by an iron railing to permit the clearance between the two parallel tracks to be increased to modern specifications. The iron railing has since been removed from the bridge.

James L. Garvin
NH Division of Historical Resources

Notes

1. S. G. Griffin, *A History of the Town of Keene (Keene, N. H.*: Sentinel Printing Company, 1904; facsimile edition, Bowie, Maryland: Heritage Books, 1980), p. 446.
2. The Boston & Maine Railroad's Main Track Structures list states that the bridge has a clear span of 68'3" and a total height of 51'6" (B&M 1953).
3. *New-Hampshire Sentinel* (Keene, New Hampshire), December 9, 1846. In an article in *The Keene Sentinel*, March 28, 2006, David Proper quotes an earlier article of 1936 by Clifford Wilber to the effect that a powerful storm damaged many properties in New England on October 13, 1846: "In Keene little rain fell, but during the high winds which prevailed, the 'great framework' that had been built to support the erection of the stonework, fell, a complete ruin, with a loss to the contractor of several hundred dollars in addition to that caused by the delay." Clifford C. Wilber, "Stone Arch Railroad Bridge," "The Good Old Days" No. 472, *The Keene Sentinel,* November 23, 1936.
4. *By-Laws and Act of Incorporation of the Cheshire Railroad Company and General Railroad Laws* (Keene, N. H.: Printed by H. A. Bill, 1845).
5. *Thirty-Fifth Annual Report of the Railroad Commissioners of the State of New Hampshire, 1879* (Manchester, N. H.: John B. Clarke, 1979), pp. 107-110.
6. D. Hamilton Hurd, ed., *History of Cheshire and Sullivan Counties, New Hampshire* (Philadelphia: J. W. Lewis & Company, 1886), p. 21.
7. The Cheshire Railroad Area Form, written by Elizabeth J. Hostutler, states on page 2 that "the Cheshire Railroad is singular in the state for its high number of granite bridges and culverts, for their quality of construction, and for their survival. Seven stone arch bridges and thirteen large stone arch culverts are located along the 42.75 miles of track in New Hampshire, along with approximately 120 stone box culverts, four double box stone culverts, and four granite block cattle underpasses. Much of the credit for this stonework can be given to Lucian Tilton and W. S. Whitwell, chief engineers during construction, and the presence of local granite, sometimes within half a mile of the rail bed (Keene History 1968:288). Of particular note is the Tilton-design stone arch bridge over the South Branch of the Ashuelot River in Keene, built with granite from a quarry on the nearby Thompson Farm (Keene History 1968:288). Considered one of the finest examples in the country at its construction in 1849, the bridge is sixty feet high with a 90 foot span (Keene History 1968:395)."
8. *By-Laws and Act of Incorporation of the Cheshire Railroad Company and General Railroad Laws* (Keene, N. H.: Printed by H. A. Bill, 1845).
9. Ibid.
10. *First Annual Report of the Directors of the Cheshire Railroad Company, to the Corporation* (Keene, N. H.: J. & J. W. Prentiss, 1846).
11. *Third Annual Report of the Directors of the Cheshire Railroad Company, to the Corporation* (Keene, N. H.: J. & J. W. Prentiss, 1848).
12. Clifford C. Wilber, *Centenary of the Opening of the Cheshire Railroad to Keene, N. H., May 16, 1848* (Keene, N. H.: Keene National Bank [1948]).
13. Robert M. Lindsell, *The Rail Lines of Northern New England* (Pepperell, Mass.: Branch Line Press, 2000), pp. 60-63.
14. Keene History Committee, *"Upper Ashuelot," A History of Keene, New Hampshire* (Keene, N. H.: by the committee, 1968), pp. 89, 288, 395.
15. *Sixty-Sixth Annual Report of the Railroad Commissioners of the State of New Hampshire, 1910* (Manchester, N. H.: John B. Clarke Co., 1910), p. 114.
16. R. Stuart Wallace and Lisa Mausolf, "New Hampshire Railroads: Historic Context Statement" (Concord, N. H.: New Hampshire Department of Transportation, 2001), p. 113.
17. Missing from this list, but noted in the Railroad Historic Context Statement: "The double-arched stone bridge over the Connecticut River at North Walpole and Bellows Falls was built by the Fitchburg Railroad in 1899. Each of the spans measures 140 feet but has a rise of only twenty feet, giving this bridge two of the longest masonry

arches with the least rise in the United States." (Wallace and Mausolf, 2001:114). "There are a few examples of stone arch bridge construction, particularly on the White Mountains Division into early 20th century [sic]. The Ashland Arch (44.75) was constructed in 1893. A thirty-foot stone arch was constructed in 1896 at Rumney to replace a plank lattice bridge. In 1907 a fifteen-foot wood string bridge at Sewalls Falls, also on the White Mountains Division, was replaced by a stone arch bridge. S. C. Douglas & Company built this bridge. [These three are on the list above.] There are four stone arch bridges and one stone arch culvert on the New Hampshire segment of the Portsmouth Division between West Lowell and Rigby. [?] It appears that all of these date to the early 20th century." (Wallace and Mausolf, 2001:114)

18. *First Annual Report of the Directors of the Cheshire Railroad Company, to the Corporation* (Keene, N. H.: J. & J. W. Prentiss, 1846).

19. Tilton's place and date of birth are supplied in an article by David Proper, "Lincoln never did stay here, but Keene man rented his home," The Keene Sentinel, February 11, 2003. The United States Census of 1850 listed Tilton as a resident of Keene, "age forty." His death date of March 19, 1877, in Chicago, is given in the Cheshire Republican (Keene, N. H.) for March 31, 1877.

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THE GILBERT & BENNETT MANUFACTURING COMPANY

IN GEORGETOWN, CONNECTICUT

The former Gilbert & Bennett Manufacturing Company site encompasses approximately 55 acres along the Norwalk River in the unincorporated Village of Georgetown, Connecticut. The site is part of the Georgetown Historic District, and is listed on the National Register of Historic Places. Although the wire products factory is now defunct, having closed in the 1980s, the origins of the company date to 1818 when Benjamin Gilbert began weaving horsehair into sieves at his home in Georgetown. In 1826 he invented and put into operation the first machinery created for picking hair (Colley 2003). The mechanized "hair picker" separated matted and tangled hairs – usually horsehairs - and made them suitable for stuffing cushions and mattresses. As his business grew, he took on a partner and in 1828 the Gilbert & Bennett Company was established.

In 1830 the first Gilbert & Bennett factory building was constructed south of where the main complex now stands – along the banks of the Norwalk River. This later became known as the Lower Factory. The first floor of the shop was used for making sieves, while the second floor, where the hair picking machine and the hair rope twisters were located, was used for the curled-hair business. Machinery was powered by water from a nearby pond that was diverted through a wooden flue to an overshot wooden waterwheel (Miller and Knowles 1968).

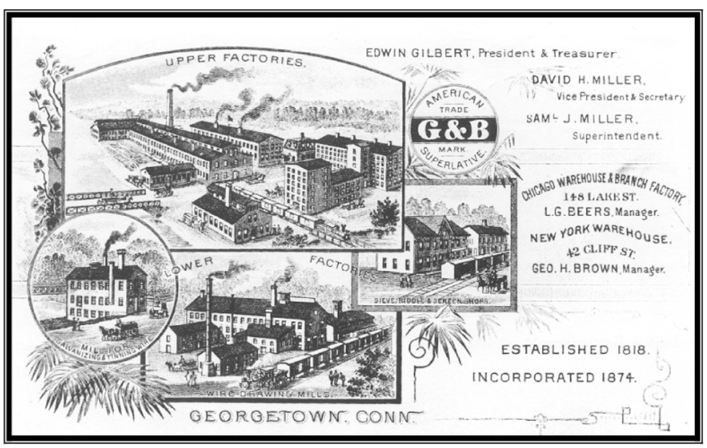

Figure 1: *Advertisement for the Gilbert & Bennett Factory in 1893.*

The frustration of working with coarse and brittle horsehair prompted Gilbert & Bennett to experiment with weaving prefinished fine wire. When hand weaving proved impractical, they borrowed a neighbor's carpet loom and adapted it to weave wire cloth. Thus the process of mechanized wire weaving was born (Colley 2003).

In 1848 as the company expanded, they purchased a small saw mill and adjacent land that now form the nucleus of what became the Upper Factory – the current site of the Gilbert & Bennett complex. All operations at the new complex were also powered by water. A stone dam was built across the Norwalk River, creating ample head waters to power large turbines.

Water powered wheels remain in the basement of the main mill building in the Upper Factory, constructed in 1874 to replace an earlier building that was destroyed when much of the complex succumbed to fire. As the company expanded, a wire mill was constructed to provide facilities for drawing iron wire – rather than continuing to purchase the prefinished product from other companies. A wood frame loom for weaving heavy grade wire cloth was developed in the 1860s and was believed to have been used through 1918.

The company expanded as rapidly as the market dictated by adding new buildings and equipment. In 1865 they installed the first power machinery ever used in the United States for making galvanized wire poultry netting on power twisters. The company introduced the first "Insect Wire Screening" in 1861; the first "Galvanized After Weaving Wire Cloth" in the early 1860s; and,

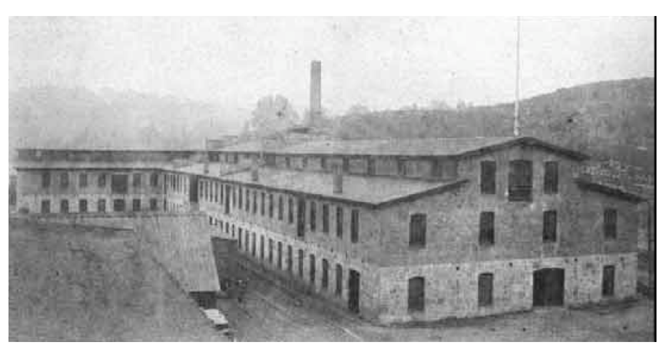

Figure 2: *Main mill building, constructed in 1874 to replace the original factory that burned down.*

the first "Galvanized After Weaving Poultry Netting" in 1865. For years, the Gilbert & Bennett Company fabricated all of the poultry netting made in the United States (Miller and Knowles 1968).

In 1875 a new corporate office was built in the Upper Factory complex, with Gilbert & Bennett using its construction as an opportunity to flaunt the virtues of using their products rather than standard building materials. The framework of the structure inside and out was fabricated from stapled wire cloth (called wire lathing), used in place of the usual wood lathing and sheathing of the period. The exterior was covered with incised cement designed to imitate stone, and the interior was plastered. The company boasted that "this style of construction is not only a novelty but a perfect success" in their "Wire Wonders" book of 1893 (Colley 2003).

After successfully opening a retail store in New York City, a second was established in Chicago. In 1879 the corporation received a Medal of Excellence Award from the American Institute of New York for their wire goods (an Institute established in 1829 for the encouragement of agriculture, commerce, manufacturing, and the arts). A new plant was constructed in Chicago to meet growing demands for their wire products. It was also in Chicago that Gilbert & Bennett exhibited their wares at the 1893 World's Fair – providing about three miles of woven fencing to enclose railroad platforms, and eight acres of netting to hang beneath glass roofs in various buildings to prevent loose glass from falling on visitors (Miller and Knowles 1968). In 1889 the Lower Factory was destroyed by fire. All work in Georgetown was shifted to the Upper Factory.

Figure 3: *Sawtooth Wire Mill building, ca.1910. Now "encased" in a warehouse, redevelopment plans call for the structure to be uncovered, refurbished, and outfitted with solar panels for adaptive reuse.*

Despite their prosperous years at the turn of the 20th century, the company suffered greatly from the effects of the depression in the years following 1929. In recognition of the need to modernize buildings and equipment in order to compete profitably, and to develop new products in order to beat out competitors, the Georgetown plant was expanded and upgraded. As part of this revitalization, in 1930 Gilbert & Bennett installed one of the first industrial liquid water disposal systems in the state of Connecticut.

Nine years later the company purchased a fabric welder for producing the first Galv-After Light Grade Welded Mesh. This machine reportedly ran at double the speed of any welder of the time. Products from this welder were quite successful, particularly "Perma Gard," the cage material used by fur ranchers and poultry producers, crab pots, machinery guards, wire partitions and fencing (Colley 2003).

Striving to retain their status as innovators in their field, the company was the first to develop special plastic-coated wire cloth to reinforce brake linings in cars. During World War II, they became the first supplier of camouflage netting, and also manufactured hex netting mats for beach landings like those used for the infamous storming of the beach in Normandy. They also fabricated tow targets for air gunnery training, and galvanized wire for both signal corps assault wire and armoring electric cable (Colley 2003).

Although, a devastating flood damaged much of the manufacturing complex in 1955, only two months later, the factory reopened for business.

Despite numerous upgrades to the physical plant in the latter half of the 20th century, fierce competition from modernized overseas facilities forced the company to close its doors permanently in the 1980s.

The Gilbert & Bennett complex is historically significant because of its age and the roll it played in the development of the Georgetown community (Cunningham 1986). The company continuously evolved and adapted the manufacturing complex, integrating old and new processes, as well as structures. It was known world-wide for its chicken wire, hardware cloth, cages, screens, antennas, acoustical tile lining, and splints. Their products were adapted for use in greenhouses, outdoor furniture, radar/radio reflectors, and radar telescopes.

The proposed redevelopment of the Gilbert & Bennett Factory site is for the adaptive reuse of the mill and numerous other buildings. The plan combines environmental remediation, green building practices, historic restoration, and new construction, which will include mixed residential, commercial, and light industrial uses while striving to keep key factory buildings intact.

Thanks to the efforts of former Gilbert & Bennett employees, hundreds of company documents, die casts, personal effects, maps, plans, wire products, and other artifacts remain in the former company headquarters. These items will be curated in order to ensure their survival and availability for future research. Although much of the machinery was sold when the factory closed in the 1980s, several large machines – some with wire products still on them – are still inside the former factory buildings. One or more of these machines might be renovated and retained on-site for public display.

Faline Schneiderman-Fox
Historical Perspectives, Inc.

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Re-enacting a

19th Century Ice Harvest

From 1900 to 1925 the largest natural ice cutting operation in New England was located on Congamond Lakes on the Massachusetts-Connecticut border, about seven and a half miles west of the Connecticut River. The Congamond Lakes were the high point on the canal system that went from New Haven to Northampton. When the railroad took over much of the canal's right-of-way in 1848, the lake area was linked by a good transportation system to major cities on the East Coast.

Much of the natural ice supply for New York City at this time came from the upper Hudson River. During the 1860's the ice on the Hudson was poor and increasingly contaminated by industrial waste. The search for a marketable source of ice led to the Congamond Lakes which had a source of pure water fed by springs; the ice was of the finest quality. A Company that had been cutting ice for local sale started shipping ice on the railroad.

The railroad sold its canal property in 1879 to the Berkshire Ice Company, which built five of the largest ice houses in the United States. Together the buildings held 225,000 tons of ice, 45,000 to 60,000 tons each. The largest icehouse covered two acres of land. The company shipped 60 to 90 carloads of ice daily to large cities like Bridgeport, New Haven and New York.

To celebrate the local ice industry, the Suffield Land Conservancy and Dennis Picard, Curator at Storrowtown Village, held a re-enactment of a 19th century ice harvest in February. The harvest was repeated on a larger scale in early March to provide a scene in an upcoming British Broadcasting Corporation documentary. The two-hour film, being made by well known English producer-director David Dugan, will be based on *Absolute Zero* and the *Conquest of Cold*, a 1999 book by prolific Connecticut author Tom Shachtman.

Dugan learned about Picard's February demonstration in Suffield through an Internet search. With the help of Bob Stewart, SIA vice-president, Dugan and Picard organized the repeat event. It entailed eight appropriately clothed re-enactors and a team of oxen from Massachusetts. The videographer and audio technician were hired locally as well; only Dugan and his research assistant flew over from England.

During one long cold and windy day's work, the crew cut about a ton of 100-pond blocks from the 12 inch-thick ice, loaded them on an ox-drawn sledge, and hauled them across the White's Pond dam, all in repeated "takes" as directed by Dugan. Pickard supervised the cutting. Author Shachtman, who is writing the script for the documentary, watched and advised. Jim and Pike, the oxen, patiently did what they were told.

Shachtman described some of his extensive research for *Absolute Zero*, including forays to sources in Europe. His book is an engrossing narrative of the early efforts to provide and use cold and a readable explanation of the science and technology that led to mechanical refrigeration and cryogenics. The concept of absolute zero, eventually defined as minus 273.15 degrees Celsius, was unthinkable in earlier centuries. One reviewer of the book wrote that Shachtman had done with *Absolute Zero* "what Dava Sobel did with *Longitude*." The BBC documentary is planned for airing late this year or early in 2007 on local PBS stations.

Lester Smith & Bob Stewart

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