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NOTES ON THE ORIGINS OF ARCHED STONE BRIDGES IN THE CONTOOCOOK RIVER VALLEY OF NEW HAMPSHIRE

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Summary: The arched stone bridges of the Contoocook River Valley of New Hampshire are the earliest examples of dry-laid masonry vaults in a state that retains some forty comparable structures. Dry-laid masonry, employing split granite blocks or slabs, became the dominant form of stone construction for engineering structures, ranging from bridge abutments and piers to gravity dams, in New England during the 1830s. Of these many forms of dry-laid masonry, the arched or vaulted bridge was the most challenging. The earliest of these bridges were constructed under the advice or supervision of consultants from the great textile centers of the Merrimack River Valley, notably Lowell, Massachusetts, where the largest masonry buildings, dams, and power canals in the United States were being constructed at the same period.

By the 1850s and later, local artisans had mastered the necessary techniques of constructing centering, splitting and hammering stone, and balancing the loading of the vaults. Such men were responsible for the construction of the largest and oldest single concentration of arched stone bridges ever built in New Hampshire, those in the town of Hillsborough. Of the twelve arched stone bridges known to have been constructed in that town in the nineteenth century, eight survive. Of these eight, one stands beneath the waters of an artificial reservoir and is inaccessible for study. Of the remaining seven, two are double bridges that may be regarded either as one or two bridges. Treating them as single bridges, Frederick C. Rhyner, P.E., has nominated the group for consideration as Historic Civil Engineering Landmarks in his document entitled "Five Stone Arch Bridges, Hillsborough, New Hampshire."

Narrative: The first of the arched stone bridges in the Contoocook River Valley was a twin-arched span built in Henniker in 1835 at the site of a wooden bridge that already had

stone abutments and a stone central pier. This was reputed to be the first double-arched stone bridge built in New Hampshire. An earlier arched bridge, or rather an arched opening through a high stone causeway, had been built at High Bridge in New Ipswich in 1819. A smaller, single arched span was built at Troy, New Hampshire, in 1835, simultaneously with the Henniker bridge. The Henniker bridge was damaged by floods in 1936 and destroyed by the hurricane of 1938.

The new consideration of split granite for bridge construction in the 1830s was probably due to the introduction about 1830 of the plug drill and the plug-and-feathers method of splitting stone. This technique involved the drilling of cylindrical holes in granite, and the insertion of a wedge and two tapered, half-round shims in each hole. The new practice brought more force to bear upon the stone than had an older splitting method. The earlier method had entailed chiseling a line of shallow slots in the granite and inserting iron wedges in the slots, between sheet metal shims.

Introduction of the plug drill permitted larger blocks of granite to be split with greater control than did the older method. The new technique also permitted increased quarrying of granite from ledges of uniform stone, as distinct from the prevalent older practice of splitting erratic boulders of varying geological origins.[1]

Leander W. Cogswell tells of the building of the Henniker bridge in his *History of the Town of Henniker*, published in 1880, forty-five years after the feat was accomplished.[2] According to Cogswell,

> At a meeting of the town, held Nov. 5, 1832, the selectmen were instructed to "make such inquiry, and obtain such information in regard to building a stone arch over the river, as will enable them to report to the town at the next annual meeting, the expediency of building the same with stone."
>
> This was the first move made for building a stone bridge with two arches, there having been as yet no such structure, it is said, in the state. . . . After discussing the propriety of building a stone bridge, the town authorized the selectmen to employ an experienced engineer to examine and estimate the probable expense of building a stone bridge, and report to the town in the September following. James Haywood, of Lowell, Mass., was employed, who examined the matter thoroughly, and made a report to the town at the time designated, which report was accepted. [There is no record of his report.]

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[1] For a discussion of the two methods of granite splitting, and the rapid replacement of the earlier method around 1830, see James L. Garvin, *A Building History of Northern New England* (Hanover, N.H.: University Press of New England, 2001), pp. 44-47.

[2] The following narrative appears in Leander W. Cogswell, *History of the Town of Henniker, Merrimack County, New Hampshire*, reprint of the 1880 edition (Somersworth, N. H.: New Hampshire Publishing Company, 1973), pp. 248-253.

Although Cogswell says that there is no record of Haywood's report, some of the text quoted below appears to be a paraphrase of that report, being too technical in nature to have been drafted by elected officials who had no experience in the construction of stone arches.

Cogswell continues:

> At the annual meeting in 1834 the selectmen were authorized to receive proposals for rebuilding the Centre bridge, of wood, stone, or both, and report to the town on the first Monday of September following. At the time specified, the selectmen made their report, when they were again instructed as at the annual meeting, and to report to an adjourned meeting of the town in one month. They reported October 6, when the town voted to receive still further proposals, and then the town
>
> Voted, the Town of Henniker build a Stone Bridge across Contoocook River, near Col. Goulds store, provided, any man or men, shall within two weeks propose to the selectmen to build said Bridge at a sum not exceeding two thousand, seven hundred dollars, of such stone, width and height, as said selectmen shall direct.
>
> Oliver Noyes, Joshua Darling, and Moses Brown were appointed a committee to advise and direct with the selectmen concerning the building of the bridge.
>
> At a meeting of the town, held October 27, 1834, the selectmen and committee made the following report:
>
> Resolved and voted, that it is expedient, and in our opinion, would be for the best interest of the Town of Henniker, to erect, or construct, a good, and permanent Stone Bridge across Contoocook River near where the old bridge now stands, Provided said Bridge can be safely constructed for a reasonable sum.
>
> Resolved and voted, that the town of Henniker, now assembled in open meeting, will proceed forthwith to hear any proposals which may be offered by any person or persons, to construct a good and permanent Stone Bridge across Contoocook River as aforesaid, and upon the plan and the principles as hereafter reported by your Selectmen and Committee.
>
> Voted to accept the report with alteration and amendment of the aforesaid Selectmen and Committee which is as follows—
>
> We the undersigned, Selectmen and Committee appointed by said town to unite with the Selectmen in fixing upon a plan on which a Stone Bridge shall be built across Contoocook River, near Col. Daniel C. Goulds, Report in part, that the following principles and dimensions shall be observed in the Construction of said Bridge, and further detailed out and specified in any Contract which may be entered hereafter—The bridge shall consist of two arches; one of forty five feet diameter at the base, and the other of forty two and

one half feet, to be raised on two new abutments on each shore, near where the old ones now are, which must be nearly, or entirely removed.

They shall be built in perfect range with the Middle Pier, and of equal width; the outside Course shall all consist of large split Granite Stone laid up from the Pan or Solid Earth, with every other course of the same kind of split stone, laid ending, or crosswise, and the whole foundation upon which the Arches are to be raised, shall be of large split stone, and laid close, in a good and workmanlike manner.

All of said stone in the foundation upon which said Arches shall be raised, shall consist of large Stone, as aforesaid, not less than ten feet in length, and laid alternately endwise to the stream, and across-wise, and all to be laid in this manner up to the traveled path, and the outside of the remainder of said Abutments shall be of split Stones and tied together with headers not less than eight feet long, and put in through every other course, and the inside filled, and chinked well with small stones.

The Arches shall commence eight feet below the [elevation of the] plank of the old bridge at the Middle Pier, and shall rise three feet above the [elevation of the] plank of said old bridge. All the Arches shall commence on a perfect level. The heater [upstream ice nose] of the middle pier, must be raised six feet above where it now is, and well dowelled together with round iron of one and a quarter inch diameter.[3]

It is however understood, that the stones which are to be laid endwise, and crosswise, on the South Shore Abutments, are not to be ten feet where the large stone [ledge?] will not permit it, but as long as can be. The Stone of the Arches shall not be less than twenty inches wide at the bottom, nor less than eighteen at the top, and [shall be] hammered or hewed on each side so as to come to a bearing, or rest, one upon another from end to end: the beveling of each stone should correspond with the [radius of the] Circle which the arch is turned upon: each stone to be perfect square at the end and laid so as to break joints, at least six inches. There shall be a tier of Stone on the top of the outer edges of the Bridge of eighteen inches square, and a railing on the top of that tier [of] Stone consisting of two other tier of Stone: they shall be eighteen inches at the bottom, and eight inches at the top, and hammered, so as to correspond and lay close together, and well dowelled together with one and a quarter inch round Iron, and laid so as to break joints; the two top stone aforesaid, shall be three feet high, making the whole railing three and a half feet high.

The Railing shall extend as far as the old one. The old Bridge shall be for the use of the Contractor, or Contractors, while building the Stone Bridge and then revert to the town.

The Contractor shall be under obligation to hire a Master Workman, who shall be competent and well understands the work of erecting Stone Bridges. The Bridge shall be completed on or before the first day of October eighteen hundred and thirty-five. The Contractor shall have the privilege of occupying and using the old Bridge two months previous to the finishing [of the Stone] Bridge.

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[3] Usage in a number of documents from the eighteenth and early nineteenth centuries makes it clear that the term “heater” was used generically in New Hampshire to denote an object of triangular or wedge shape, resembling that of a “heater” or flatiron.

> The Town of Henniker shall pay the Contractor, or Contractors, One thousand dollars when they shall commence laying the stone of said Bridge, and the remainder shall be paid when the Job shall be completed according to the tenor of the Contract, with interest for delay. On receiving the first payment, the Contractor shall give approved security for the thousand dollars.
>
> Your Committee further report, that any amendments, or alterations, which the Superintendent, or Master Builder of said Bridge shall deem absolutely necessary, shall be made in the Committees report aforesaid. But it is distinctly understood that no Contractor, or Contractors, shall employ any Superintendent who is not fully acquainted with Building Stone Bridges, and who shall not come fully recommended as a man everyway competent to construct a permanent Stone Bridge.

Parrott Marsh, Charles Barker, William K. Howe,	Selectmen	Oliver Noyes Joshua Darling Moses Brown	Committee

Cogswell continued with his narrative, noting that the first bidder, Oliver Noyes, Esq., was compelled to withdraw his bid to construct the bridge for $2,845, and was released from his contract without penalty in December 1834. According to Cogswell, the town thereupon voted at its annual meeting in March 1835

> That the Selectmen be authorized, and directed to contract with some person, or persons, to build and complete a good and permanent Stone Bridge, twenty four feet wide, across the river where the Centre bridge now stands, provided such person, or persons can be found who will build, and complete the same for a sum not exceeding Thirty five hundred dollars, in the following manner, viz: that the top of the Arches shall be three feet higher than the plank of the old bridge, the abutments to be raised with stone and gravel as high as the Arches, and suitable Stone or Iron railing to be placed on each side of the bridge, to extend as far as the selectmen shall deem it necessary, and warrant the same to stand for one year after its completion. Said bridge to be completed fit for travel on, or before the first of November 1835.
>
> Such Contractor, or Contractors, shall be required to give good and sufficient bonds to the town for fulfillment of said Contract.

The bridge was contracted by William Smith, who procured the services of Isaac C. Flanders, of Lowell, Mass., as engineer.

The stone were split in the quarry in the easterly part of the town, and were drawn by ox-teams. Quite a large number of hands were employed by Mr. Smith; and the bridge was ready for travel by the time specified in the contract. During the erection of the bridge, the travel, otherwise than on foot, crossed the river at the lower mills. A footbridge was laid close to the water on the east side of the [stone] bridge: this was also used in constructing the [stone] bridge.

A great deal of curiosity was manifested by the people of this and neighboring towns as the work progressed; and numerous were the

> prophesies, that when the wooden arches were removed, the whole structure would fall with them. The bridge was completed, and the day set for driving out the key pins, which would let the wooden arches fall. Several hundred people assembled to witness this ceremony, some with anxious faces, but by far the larger part with a perfect confidence. At a given signal from Mr. Flanders, the two pins were driven out, and down came the wooden arches;—but the *bridge did not follow*. Its success was an assured fact, amidst the cheers of the assembled multitude. The "heater" of the bridge was repaired and made higher in a few years. No material damage was done to the bridge until the severe freshet in the early spring of 1852, when the water forced its way around the north end of it, doing some damage to the stonework, and at one time threatening to sweep away the blacksmith shop at the end of the bridge, owned and occupied by David Cogswell. By the timely efforts of the citizens, the current was stopped. At a meeting of the town, held May 10, 1852, the selectmen were instructed to appoint some suitable person to superintend the repairs upon the structure; and during the season it was repaired as it now stands.

From the above, it appears that New Hampshire community leaders were becoming aware of the potential to construct arched stone bridges at least as early as 1832, when the first inquiries were made in Henniker about such a bridge. It is perhaps significant that, also in 1832, a town committee in Gilsum, near Keene, made a recommendation "in favour of building a stone arch bridge" in that town, though their recommendation was not fulfilled until the 1860s.[4]

Research has thus far not disclosed the professional qualifications or the accomplishments of engineer James Haywood of Lowell, Massachusetts, who provided the first analysis of the feasibility of constructing the bridge at Henniker. Research on Haywood's career will probably have to be sought in Lowell records, city directories, newspapers, and other sources not readily available in New Hampshire. It is likely that the rather technical and detailed specifications for construction of the bridge, given above by Cogswell, are a paraphrase from the long-missing report that Hayward compiled for the town in 1833.

The identity of Isaac C. Flanders, who served as master builder or superintendent for the actual construction of the bridge in 1835, is more certain. Although Cogswell describes Flanders as "of Lowell, Mass.," it appears that Flanders was a New Hampshire native who spent much of his career in that state.

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[4] Sylvanus Hayward, *History of the Town of Gilsum, New Hampshire, from 1752 to 1879* (Manchester, N.H.: John B. Clarke for the author, 1881), p. 59.

Isaac Colby Flanders was born in Warner, New Hampshire, on February 26, 1805.[5] He was living in Lowell, Massachusetts, in 1834, when he married his first wife, Eliza Ann Heald of Carlisle, Massachusetts.[6] Although Flanders was still described as "of Lowell" in 1835, when he was employed to supervise construction of the stone bridge, he was living in Manchester, New Hampshire, a year later, when his first child was born on March 7, 1836.[7] The 1844 Manchester Town Directory lists Flanders as a stone mason, living on Hanover Street. By 1852, the directory lists Flanders as a railroad contractor, living on Chestnut Street. Flanders died in Warner, his birthplace, on August 7, 1882, at the age of seventy-seven. His obituary in the *Concord Daily Monitor* noted that he was "formerly a prominent citizen of Manchester," stating that "Mr. Flanders was a native of Warner, but went to Manchester quite early in life, and continued to reside there until within about 12 years. During his residence in Manchester he was actively engaged in various business enterprises and held numerous positions of honor and trust. He was a prominent Free Mason, and a past commander in Trinity Commandery, Knights Templar." He was buried in Manchester.[8]

The new Henniker bridge soon received favorable notice in the press. The first volume of Isaac Hill's *The Farmer's Monthly Visitor*, published in Concord, N.H., in 1839, included the following description (p. 157). This account was reprinted in the *New-Hampshire Sentinel* of Keene on November 13, 1839.

Granite Roads and Bridges

> . . . That most valuable of all kinds of rock, the Granite, which is the foundation and superstructure of the majestic mountain Monadnock, and which is as easily rived as a log of oak or maple, is now extensively used in the construction of bridges and causeways. Arches over the Contoocook and other considerable streams are constructed of pure split granite, which fixed on a foundation of the same material will stand forever. The splendid bridge erected two or three years ago by the town of Henniker which cost about $3300, and is actually worth much beyond that sum, has been already noticed in the [Farmer's Monthly] Visitor. Another granite arched bridge over a branch of the Contoocook running from the north, was erecting when we passed, the expense of which paid in cash by the town was from seven to eight hundred dollars. We are glad that our fellow citizens of Henniker are abundantly able to build and support these noble structures: such a generous public sprit as they evince richly merits and is generally

[5] Microfilm town records, Warner, New Hampshire, New Hampshire State Library, Vol. I, p. 368; Edith Flanders Dunbar, *The Flanders Family From Europe to America* (Rutland, Vt.: Tuttle Publishing Company, Inc., 1935), pp. 339-40, 414.
[6] Dunbar, *The Flanders Family*, p. 414; *Vital Records of Lowell, Massachusetts to the End of the Year 1849* (Salem, Mass.: The Essex Institute, 1930), Vol. II—Marriages, p. 308.
[7] Dunbar, *The Flanders Family*, pp. 414-15.
[8] *Concord Daily Monitor*, August 8, 1882.

> acc[o]mpanied by such prosperity as attends them. The town of Hillsborough, in imitation of its sister on the river below, is also completing the structure of a beautiful arched granite bridge over the main river at the village denominated Hillsborough Bridge.

The earlier reference to the Henniker bridge had appeared in *The Farmer's Monthly Visitor* on April 15, 1839 (p. 56):

> Another improvement evincing the generous enterprise of an interior town of New Hampshire, is the beautiful granite bridge thrown over the Contoocook in two arches at Henniker village: this bridge which in some situations would have cost ten times as much, was constructed by the town of Henniker about three years ago at an expense of 3,300 dollars. Like the stones of the temple of Solomon, the stones of this bridge were all measured and numbered at the quarries from which they were taken, and every one suited to its place. . . . The granite bridge was proof against the late violent freshet, although it had to encounter an immense weight of ice and water, proving that undermining only can destroy it . . ."[9]

As noted in *The Farmer's Monthly Visitor*, Hillsborough was preparing its first stone bridge in 1839. Charles James Smith's *Annals of the Town of Hillsborough* (1841) describes the evolution of the bridge in somewhat incongruous terms:

> The first bridge over the Contoocook River built in Hillsborough, was erected of wood in 1779, on the site of the present stone bridge, and was reconstructed in 1796. Daniel McNeil was employed by the town, as architect to rebuild the same in 1809. The town deeming it advisable to have a bridge of more substantial material; constructed in 1824 a bridge of split stone, excepting forty feet in the middle which was built of wood. Mr. Squires F. Clement, supervised this work. In 1839, this bridge was elevated five feet, with a new stone railing, and the present elegant granite

[9] The same issue of *The Farmer's Monthly Visitor* describes the granite fence posts that are still seen along the old Franklin Pierce Highway east of Henniker village: "An economical mode of constructing fences, worthy [of] the attention of all farmers in the vicinity of granite quarries, is pursued by the enterprising citizens of Henniker. The Henniker granite, although not as perfect as that drawn from the bosom of our own Rattlesnake [Hill], near the banks of the Merrimack, being mixed with siennite, is rived even more easily than the pure granite. Posts from the rock are split with scarcely less facility than from logs of wood. These are readily drilled for the reception of a wooden plug, into which ordinary boards are nailed. These boards or slabs from ten to twelve inches in width fastened transversely to uprights of granite will make the best of fence. The stone posts, once procured, will always remain and fence thus constructed after continuing good for many years can be easily renewed at a trifling expense. So quick is the growth of the sapling pine that a new wood will grow up while wood of the old fence is consuming." (*Farmer's Monthly Visitor*, April 15, 1839, p. 56)

> arch substituted in lieu of the wood work of the former bridge. Messrs. Reed and Thompson of Keene were the contractors.

This description clearly implies that the stone arch was built between two already existing abutments of split stone. Photographs taken before the replacement of the original arch in 1893 show a quantity of split stone slabs at the springline of the stone arch, and also make it clear that a long stone causeway of less finished stonework approached the bridge opening from both ends. This causeway was rebuilt in two stages after the stone arch was reconstructed in 1893, and was pierced by a second opening enclosed by a concrete rigid frame after a portion of it washed out in 1938.[10]

Since "Reed and Thompson" of Keene are credited with building the first arched bridge in Hillsborough, it is worth noting that by 1839, Keene, too, was investing in substantial arched stone bridges. Keene voted in March, 1839, to use $3,300 of its federal surplus revenues, distributed to New Hampshire towns in 1837, to pay for the construction of arched stone bridges.[11] A four-arched stone bridge on South Main Street opened on November 2, 1839, costing the town about $2,100.[12] This bridge has been replaced. A two-arched bridge was built on Court Street in 1840, and remains in place, though bypassed.[13]

The identities of "Reed and Thompson" are difficult to confirm. Keene town directories of the general period list no Reeds or Thompsons as engineers, stone masons, contractors, or the like. The 1840 United States Census lists several Reeds and Thompsons without giving their trades or occupations. The 1850 census indicates occupations. It lists a Daniel *Read* as a stone cutter, living at the Eagle Hotel in Keene. This census lists no Thompsons as contractors or stone masons.

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[10] On May 5, 1893, the east retaining wall of the original arched bridge failed due to a combination of frost action and high water. Engineers condemned the original vault of 1839 and the town voted to replace the bridge with a second arched stone span at a special town meeting of June 3, 1893. The firm of Ward and Douglass of Barre, Vermont, were low bidders. Upon disassembling the old bridge, the contractors discovered that the canal under the southern causeway, supplying Contoocook Mills, was unsound. The canal and adjacent ledge were removed and reconstructed, with part of the cost shared by the mills. The entire arch and causeway south of the arch were rebuilt at a total project cost of $24,320.14. In the spring of 1902, part of the northern causeway leading to the rebuilt arch also failed. It was rebuilt by the same contractors, Ward and Douglass, at a contract price of $16,513.33, paid in two fiscal years. See *Annual Reports of the Town of Hillsborough* for the fiscal years ending February 15, 1894, February 15, 1903, and February 15, 1904.

[11] *New-Hampshire Sentinel*, October 23, 1839. The town of Pelham, New Hampshire, likewise voted in 1837 to use its federal surplus revenues to construct arched stone bridges, building three such spans between 1837 and 1840.

[12] *New-Hampshire Sentinel*, October 23, 1839; *The Repertory* (Keene, N.H.: Repertory Publishing Company), Vol. I, No. 12 (November 1925), p. 587.

[13] *The Repertory* (Keene, N.H.: Repertory Publishing Company), Vol. II, No. 3 (June 1927), p. 125. In an article on stone arched bridges, historian David Proper of Keene stated that "the name of George Benjamin Hall has been associated with construction of this bridge. Born in Keene in 1822, Hall was a resident of New Hampshire and also of western Massachusetts towns, including Orange, Athol, Wendell and Irving, where he died at the age of 80. Family tradition links him to stone masonry and bridge building. His body was returned to Keene for burial in November 1902." David Proper, "For decades, bridges stood over troubled water," *The Keene Sentinel*, March 28, 2006.

Hillsborough town records are not available on microfilm after 1828. Various printed town reports are available, and bridge references in these reports are summarized and annotated below.

REFERENCES TO BRIDGES IN HILLSBOROUGH TOWN REPORTS

1842	*Filling up South end of Arch Bridge*.	
	Cash paid to George Smart for Job,	$18.75
	" " Cyrus Colby "	18.00
	" " Ezra Clement "	124.00
	" " Thomas Wilson for stone railing on Bridge,	120.00
	" Also $50 to same last year, making $170.00	
	" Hiram Monroe 5 days' work and 2 carts 1 day,	5.50
1858	Ezra Clement, building bridge	115.00
	[Note that a Manahan photograph of the Tuttle Bridge bears a caption stating that this bridge was "Built by Dow, {and}Clement." The 1858 county map indicates a Tuttle living near what is today called Breezy Point on the Jackman Reservoir or Franklin Pierce Lake, where an arched stone bridge remains under water. The bridge that is captioned the "Tuttle Bridge" is not among those currently accessible in Hillsborough. It is unique in having projecting granite beams on at least one side. These receive and support diagonal iron braces that extend up to the bridge rails.]	
1859	Ezra Johnson, for labor on Shed[d] Bridge	10.38
	David Starrett, building bridge near C. L. Hartwell's	21.50
	Reuben E. Loveren, for building Stone Bridge	300.11
	Solomon McNeil, for land and stone to build bridge near Levi Shed[d]'s	10.00
	[This bridge was replaced by concrete slab bridge 089/064 in 1919.]	
1860	Many accounts for repairs to timber bridges	
1861	Many accounts for repairs to timber bridges	
1862	Many accounts for repairs to timber bridges	
	C. A. Gould, building stone bridge near H. Brockway's	90.00
	[This is a stone culvert in the northern part of town.]	
	R. E. Loveren, labor on Hillsboro' Bridge	2.00
	irons for do.	6.92
1863	Report missing at New Hampshire Historical Society	
1864	J. H. and C. A. Gould, building stone bridges near	

	Elijah Reed's and David Fuller's	100.00
	[The bridge at David Fuller's is probably the Second Turnpike Bridge at Fuller's Tannery at the Lower Village. The accounts given below under "1866" identify J. H. Gould as James H. Gould, and C. A. Gould as Calvin A. Gould.]	
	Many accounts for repair of timber bridges.	
1865	No references.	
1866	Many accounts for repair of timber bridges	
	Stanley Abbott, labor on Shedd Bridge	$11.00
	Albert H. Griffin, do.	14.50
	Levi Shedd, labor on Shedd Bridge	12.50
	D. Starrett, labor on Sawyer and Kimball Bridges	30.91
	S. S. Eaton & Farewell, frame for Sawyer Bridge	60.78
	A. Tuttle, stringers for Kimball Bridge, and labor and stone for Sawyer Bridge	52.16
	James H. Gould, labor on Sawyer Bridge	66.93
	Edward Grace, do.	12.25
	Calvin A. Gould, do.	68.25
	T. B. Newman, framing arch, do.	3.00
	Dennis Potter, labor on do.	2.87
	R. E. Loveren, do. do.	123.19
	Horace Eaton, do. do.	23.00
	Jas. C. Richardson, do. do.	4.37
	Fred W. Gould, sharp'g tools, do.	20.60
	R. E. Loveren, labor on Shedd Bridge	25.98
	Albert H. Griffin, do. Sawyer do.	52.00
	Wm. B. Pritchard, framing arch	12.00
	[Sawyer Bridge (the bridge near S. N. Sawyer's house) is the double-arched bridge on Route 202 toward Antrim, now bypassed.]	
1867	Edward Kellom, labor on stone bridge	10.00
	W. W. Grinnell, do. do.	6.00
	E. T. Heath, do. do.	23.00
	Stanley Abbott, do. do.	41.62
	Rodney Clark, do. do.	51.37
	Charles F. Gould. Do. do.	10.00
	Perkins Cooledge, do. do.	10.00
	Richard Clement, do. do.	1.00
	Herbert Kimball, do. do.	8.75
	Kneeland A. Burtt, do. do.	6.00
	James W. Clark, do. do.	59.25
	Alvah C. Gould, do. do.	76.00
	J. H. Gould, do. do.	44.81
	Wm. Merrill, do. do.	12.00
	Nathan Kendall, do. do.	9.25
	R. McAllister, do. do.	14.50
	W. C. Eaton, do. do.	6.75
	Luke Merrill, do. do.	6.83
	Carlos Nelson, do. do.	74.00

S. E. McKean,	do.	11.50
J. L. Ellsworth,	do.	15.75
P. Cooledge,	do.	2.50
T. J. Moudough,	do.	1.00
Daniel Wyman,	do.	10.00
C. A. Gould,	do.	1.50
Horace Barker,	do.	$30.00
R. E. Loveren, use of derrick and labor on stone bridge		24.10
Joshua Marcy, lumber and	do.	16.50
Ira S. Appleton, stone to repair bridge		3.00
Cutting & Blanchard, blacksmithing for	do.	1.65

[The above charges total $588.63. It is not clear whether this job entailed repair of the main bridge at Hillsborough Bridge, or construction of another. The note below, pertaining to interruption of the running of a factory, suggests that this job involved repairs or reconstruction of the arched bridge at Hillsborough Bridge village. There are additional charges for "labor on bridge" in this year, but these could pertain to another bridge.]

C. P. McAdams, making side walk for stone bridge	6.49
Daniel Bailey, plank for Preston bridge and labor on stone bridge	19.13
John B. Smith, damages on account of stopping factory to repair stone bridge	50.00

Lumber for railing stone bridge, in the amount of sixty dollars and eighty-five cents, was bought of William Merrill and paid for with money received from the highway tax in District No. 3.

1868	Reuben E. Loveren, clearing sluice under Hillsborough bridge	11.25
1869	No references.	
1870	Report missing at the New Hampshire Historical Society.	
1871	Sawyer and Merrill bridges "built" (after a flood?)	
1872	A. Tuttle, labor on Stone bridge	21.75
1873	Wm. Merrill, cash paid for use of derrick	11.34
	[Merrill did "labor on bridge" worth $58. He was a selectman with a separate financial account in the report.]	
	One day at Weare after derrick [selectmen's accounts]	2.00
	Many accounts for repairs of timber bridges.	
1874.	Many accounts for repairs of timber bridges.	
1875	Many accounts for repairs of timber bridges.	

1876	Town inventories: R. E. Loveren owned 16 acres worth $1,450.00.	
1877	R. E. Loveren, labor, stone, and iron in repairing arch bridge	$50.63
1878	Many accounts for repairs of timber bridges	
1879	Many accounts for repairs of timber bridges	
1880	Report missing at New Hampshire Historical Society.	
1881	No references.	
1882	No references.	
1883	No references.	
1884	No references.	
1885	Two-day trial of road machine	20.00
1886	Report missing at New Hampshire Historical Society.	
1887	Report missing at New Hampshire Historical Society.	
1888	Storage of road machine, 1884-6 Storage of road machine, 1886-7 Repairs and moving of road machine Many accounts of road and bridge repairs	6.00 2.00
1889	Many accounts of road and bridge repairs	
1890	Building police station, including cells supplied by Berlin Iron Bridge Company @	300.00
1893	Rebuilding the vault and the southern causeway of The arched stone bridge at Hillsborough Bridge, and the power canal to Contoocook Mills, after failure of the east retaining wall of the bridge on May 5, 1893. Foss & Merrill, engineers; Ward & Douglass, contractors; iron sidewalk and railing supplied by Berlin Iron Bridge Company.	24,320.14
1902	Collapse of part of the northern causeway of the bridge at Hillsborough Bridge and its rebuilding by Ward & Douglass, contractors, with F. S. Berry as engineer	16,651.47
1903	Payment of balance on the causeway reconstruction	523.34

From the above, it is clear that the construction and repair of arched stone bridges had become important factors in the highway expenses of Hillsborough by the late 1850s. George Waldo Browne, in his *The History of Hillsborough, New Hampshire, 1735-1921*, notes that

> Hiram Monroe, during that period active in the affairs of the town, was an earnest advocate of this style of bridges, and did more than any other man towards their construction, claiming they were cheaper in the end than the wooden structure, and the wisdom of his judgment is shown by the fact that they have withstood the wear and tear of years with comparatively little expense in repairs, while their contemporaries of wooden construction have been replaced by new ones several times.[14]

A few names stand out prominently among the builders of these mid-century spans. First among these names is that of Reuben E. Loveren, who worked on the Shedd Bridge in 1859 and the Sawyer Bridge in 1866, and who is documented as owning a derrick and carrying out a number of other stone masonry jobs. James H. and Calvin A. Gould also appear prominently, and the accounts seem to document to them the two arched bridges, connected by a long stone causeway, on the Second New Hampshire Turnpike at Fuller's Tannery, built in 1864.

Browne's *History of Hillsborough* states that Reuben Loveren was born in the neighboring town of Deering on February 4, 1817 and died in Hillsborough on April 3, 1883. "He was a lumber dealer and res[ided] at [Hillsborough] Bridge Village most of his business life."[15] He would have been forty-two when he built the Shedd Bridge in 1859.

An inventory of all the arched stone bridges known to have existed in New Hampshire enumerates at least forty arched stone bridges built of dry-laid masonry before 1900. The dates of some of these spans are known; the dates of others are undocumented, but can be placed before 1900 by physical evidence. This list does not include arched railroad bridges or overpasses, which began to be constructed in considerable numbers along various New Hampshire routes during the 1840s.

This inventory lists twelve dry-laid arched stone bridges in Hillsborough, of which eight survive, one of them submerged under the waters of the Jackman Reservoir (more recently called Franklin Pierce Lake) and inaccessible for study. Of these eight, two are double-arched bridges in which the arches are separated by causeways by such a distance that the New Hampshire Department of Transportation has assigned separate bridge numbers to the two arches. The seven accessible Hillsborough bridges (with two of the double-arched bridges considered as single structures) have been submitted for consideration as Historic Civil Engineering Landmarks by Frederick C. Rhyner, P.E., in his nomination entitled "Five Stone Arch Bridges, Hillsborough, New Hampshire."

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[14] George Waldo Browne, *The History of Hillsborough, New Hampshire, 1735-1921*. Two Volumes (Manchester, N.H.: John B. Clarke Company, 1921), Vol. I, p. 302. Hiram Monroe was born March 24, 1799, and died on May 28, 1871; see Richard S. Munroe, *History and Genealogy of the Lexington, Massachusetts Munroes* (Florence, Mass.: by the author, 1966), pp. 71, 126-7.

[15] George Waldo Browne, *The History of Hillsborough, New Hampshire, 1735-1921*. Two Volumes (Manchester, N.H.: John B. Clarke Company, 1921), Vol. II, p. 377.

No other town in New Hampshire is known to have built as many as twelve dry-laid arch bridges. The nearest rivals were the towns of Peterborough, which once had five, and Jaffrey, which retains six. The Jaffrey bridges are interesting in that they all date from after 1900, one having been built as late as 1939. Of the six Jaffrey bridges, three span the Contoocook River, and three cross tributaries of that river. All stand upstream of the Hillsborough group, in the same watershed. Although the New Hampshire Division of Historical Resources has not inspected these bridges in the field, survey information on file suggests that they have mortared vaults and spandrel walls.

Although these late arched stone bridges are apparently of mortared construction, most of the other forty arched stone highway bridges built in New Hampshire before 1900 employed dry masonry. As noted in Frederick Rhyner's nomination of "Five Stone Arch Bridges, Hillsborough, New Hampshire," lime mortar was almost the only form of masonry cement available until the very end of the nineteenth century. Lime mortar is easily dissolved, has low compressive strength, and is slow to harden in locations where it is not exposed to carbon dioxide. It is not a hydraulic cement, and cannot be used under water or in constantly wet situations.

For all these reasons, dry-laid masonry was superior to mortared masonry in the age before the introduction of Portland cement or other artificial or natural hydraulic cements. If skillfully executed, a dry-laid arch has uniform compressive strength throughout its entire fabric, being composed solely of split granite. It has the further advantage of being self-draining. When stream water levels rise and saturate the bridge (and streams have sometimes risen so high as to overtop a number of these bridges), the water readily drains out of the structure as stream levels recede, preventing frost jacking or damage in cold weather.

Other bridge components in New Hampshire were also routinely built of dry-laid masonry until the end of the nineteenth century. Virtually all nineteenth-century abutments and piers for wooden bridges were constructed of split granite slabs laid dry, and many of these structures continue to support wooden bridges or their steel truss successors.

Dry-laid stone masonry employing split granite is, then, a technology that remained dominant for the better part of a century and proved its strength and longevity in a myriad of structures, both in the form of arches and vaults and in the form of abutments and piers that support vertical loading. The arched stone bridges of Hillsborough are collectively an important document of the capacity and longevity of dry-laid stone masonry. The Hillsborough bridges are the largest and oldest concentration of arched stone structures in a state that once had at least forty highway bridges of comparable construction. As such, the arched stone bridges of Hillsborough are a paradigm of the larger, scattered collection remaining throughout New Hampshire. The New Hampshire bridges, in turn, are characteristic of comparable structures, built by both urban and rural craftsmen, that are found in the older states of the United States wherever suitable stone can be quarried. All are important documents in the history and evolution of stone masonry.