The Use of Granite in the Lowell Canal System
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2004
Introduction and Acknowledgments

The materials presented in these pages are an attempt to provide an overall view covering the use of granite stone in the construction of the Lowell Canal System. It is not meant to be a history of granite itself so that part is only touched on to describe the initial formation of the stone and then it is left to the study of geology.

The quarrying and working of the stone until it was installed along the banks of the canals or its use in the building of the Pawtucket Dam or the three locks constructed to ferry the rafts and boats along the canal covers the scope of our interest. The writing is meant to be concise and to the point so it will be entertaining as well as informative and the illustrations chosen to be graphic and save a thousand words. If the reader gets to the last page and still feels the urge to know more about the subject, at least their interest has been aroused and a walk along a canal should be more enjoyable. Details of the stonework and the labor involved will certainly be more appreciated.

Footnotes only take away from the main text so they have been avoided. The sources of the information that were drawn on during the research are identified as part of the presentation. The exception is the local libraries from which much of the material that was provided from their files was used as a reference. For example, if a ledge is mentioned as being worked in Westford or stone came from Tyngsborough and the source! isn't identified, the information most likely came from the area library. Enough can't be said for the contributions to the research that was provided by the many librarians that were contacted and graciously responded. A listing of the libraries that answered my many requests for information and materials follows the text.

What can be read in an hour took many months of research to put together and several people who went out of their way in their help are to be thanked.

Martha Mayo, who put up with my many visits to the Mogan Center.
Janet Pohl who showed me how to turn a computer on and then work with it.
Jo Hill who was always there to give her utmost.
Arthur (Bud) Paquin Jr. and Bud Paquin Sr. who edited and put this work together.

With appreciation,

AI Lorenzo
THE BEGINNING

An interesting question that presents itself upon any tour of the Lowell Canal System is where did the mass of granite stone that was used in the construction come from? To begin at the beginning, the very availability of the granite was the first necessary ingredient. The answer is that the raw product was provided eons ago by the natural evolution and development of the very early earth.

But is this explanation too simple?

In a paper given by H. E. Fletcher in 1912 he quotes T. N. Dale of the United States Geological Survey on the definition of granite. "Granite is in general, an essentially crystalline igneous rock." That statement covers our basic question and many technical details have been passed over for the sake of brevity and probably the lack of interest as well.

After outlining the entire process necessary for the development of the granite in its natural state, Mr. Fletcher continues describing the details of the granite formations that were responsible for the prevalent quantity of the stone that exists in the local area. These sheets of granite were to supply building materials for construction on a vast scope including the foundations for the textile mills in Lowell as well as the stone that lined the canals and built the locks. He adds; "the overlying rock mass which furnished so large a part of the pressure required to form the granite has been in many places removed from it by erosive processes that operated through great stretches of time. Indeed, it is only by the removal of this mass that granite is anywhere naturally exposed. Although this mass may have measured thousands of feet in thickness, its former presence at some places attested only by a thin capping on the granite."

People were not completely oblivious to the geological makeup of the structure of the earth under the City of Lowell and the surrounding areas even in it's earliest days.

In a series of articles by Rev. Owen Street and published in the Saturday Evening Mail around 1880, he shows himself to be an accomplished amateur geologist who has given himself to much study of the granite formations of the area. He describes how the granite formations themselves were thrust up from the deep by volcanic action and the accompanying lava flows cool and take shape in overlapping sheets. He goes on to differentiate between the trap veins and dykes exposed in the bed of the Merrimack River, the ledges worked in the many quarries, and the huge boulders that lie scattered over the entire region.
The photographs on the following pages will best serve to illustrate Street's descriptions of several granite formations in the area.

Figures one through four will serve to exemplify the granite sheets exposed by the erosive process of the Merrimack River. These are the formations defined as trap veins and dykes, and these and many others can be viewed today from either of the two bridges spanning the Pawtucket Falls.

Figures five and six show outcropping of granite that identify the presence of ledges buried just below the surface. From these beginnings, the stone was quarried by simply following the vein until the formation became too difficult to work or the vein ran out.

Figures seven and eight are two of literally countless granite boulders to be found scattered everywhere in New England, and in fact over the entire northeast. Some of these boulders were of such a size that large finished pieces of worked granite were produced, such as those large enough to construct the columns for the Quincy Market in Boston.

And there were even earlier observations as to the origins of the granite.

An interesting article (author unknown) appeared in the newspaper "Lowell Weekly Compound", in an edition dated, 1832. In the article, the author is describing his own observations as to the rock that is present in his examination of the geology of the Lowell area. The author, whatever his qualifications may be, goes on to state "that the character of the granite in his opinion ... is rather diluvial." This would indicate deposits left by flood or glacier. He also adds in his remarks," that granite is found in Tyngsborough in boulders of great magnitude and in Westford and Pelham it is quarried."

In the paragraph above, our unknown author is describing two different natural processes that were to provide much of the supply of granite stone in the area. In the case of the boulders that were lying around in abundance on the ground, they were certainly deposited by past glacial action, probably having been ripped from some mountains that have long since been ground away by the huge ice sheets of the distant past. A Pennsylvania state geologist, Professor Wright, who had studied the great terminal moraine (mass of rock deposited by the head of a glacier) that presented itself across the whole of the east coast stated, "almost everywhere the pebbles and boulders which abound are clearly not of local origin, that they had been transported from a northerly direction."

But the boulders were comprised of granite and were the most available sources so they were the first stone to be worked and provided the basis for the first granite industry. The unknown author went on to mention that granite was quarried in Westford and Pelham as well. These ledges, and many more that existed throughout the entire sheet formation that underlined the entire area just below the surface, were to be the forerunners
of a great granite industry.

In an earlier article published in the newspaper, "Gazetteer", dated 1823 under the heading of "Mineralogy and Geology," it was stated that the Merrimack alluvion (the washing of water against a shore or bank) is worth notice; through this formation the Merrimack River passes. There aren't any photographs of the forming of the granite sheets but the photos on the following pages will serve to illustrate the granite formations that are prevalent throughout the entire area when the cover of the topsoil is removed. In this case, by the erosive processes of the Merrimack River.

From studying the topography of greater Lowell and the surrounding areas and observing the surface features of the land contours, it appears that the course of the Merrimack River has been altered more than once, and more likely several times. This fact alone would have served to aid the erosion process in order to expose the underlying granite formations.

The newspaper, `Vox Populi' published an article in 1875 that was originally printed in an edition dated 1821 and titled `Some Recollections of Lowell.' In it the past history and the past course of the Merrimack River is outlined and it's waters are supposed to have covered all of the land in the vicinity, including the area of Central and Merrimack Streets. This was confirmed when on the Rogers land in Belvidere was dug a deep cut to accommodate the Lowell and Andover Railroad. Successive layers of stone, gravel and sand were uncovered which was claimed was deposited during the ice age.

And this wasn't the only recorded change to the course of the Merrimack River over great periods of time. In excavating for one of the canals, an old channel of the river was uncovered a half mile from the present riverbed. It is also mentioned in `Practical Study of Geology' around 1880, that geologists of the day agreed then that the Merrimack River in the earliest days followed a course pretty near the same lines of the old Middlesex Canal and emptied into the sea near Boston.

Much of the documentation presented in these pages as to the origins of the granite sheets and formations, the birthing grounds of the countless boulders and of the wanderings of the Merrimack River in playing out it's erosive part in past eons may appear dated. However, this was prevalent thinking in the nineteenth century and the conclusions were arrived at based on these observations. The granite industry was more of a "hands on" operation than dwelling on theories that were developed after the fact or understanding the science behind it. And so it may help to understand how the granite industry evolved if we stand in the shoes of the early pioneers of the industry and look back at the way that they wrote their ideas, what they believed and the conclusions arrived at.

Whatever the earthly origins of the granite and the meanderings of the Merrimack
River, this much is a fact: A continuous sheet of granite exists from central New Hampshire, Maine and Vermont and continues through Massachusetts to the sea. Our area of interest however centers on a formation of granite stone that extends roughly from Ayer, Massachusetts and continues through Pelham, New Hampshire.

H. E. Fletcher in the "Granites of Middlesex" breaks the granite deposits in Middlesex County, which encompasses our area into five districts for convenience while describing it's availability in the area. The districts are the Medford, Acton, Chelmsford, Dracut and Townsend which are all designated by the name of a town that is central to their locations.

Medford was the first to be worked but the area that it covers as described isn't thought to be important to this study.

Acton district contains large masses of stone and the quality of the granite is excellent. This district includes the southern part of Westford, Wilmington, Billerica, Carlisle and Acton but the granite as described was of too high a quality to be used in rough construction such as for canal building purposes.

Chelmsford district includes Chelmsford, Westford, Groton, Tyngsborough, and Dunstable. Much of the granite produced under the heading of Chelmsford granite was actually quarried in Westford or Tyngsborough but because both towns or parts of them were part of Chelmsford, or in close proximity to Chelmsford when the industry had it's beginning, the stone was labeled Chelmsford granite.

Townsend district extends mostly up into New Hampshire through Brookline, Mason, Milford and Amherst.

Dracut district is not well defined but the ledges there were among the first to be worked near the City of Lowell and much stone from here was used in canal construction. As a matter of fact, The Locks and Canals Company purchased a large tract in Dracut within 1 1/4 miles of the canal building sites that was known as Ledge Hill as shown on the map on the following pages, Figures nine and ten.

Figure nine identifies the location of Ledge Hill within Dracut.

Figure ten is an expanded view of Ledge Hill pinpointing the quarry area.

Much of the stone to supply the contractors working on the construction of the canals was quarried here.

Lowell itself is most likely part of the Dracut Ledge even though the city is located for the most part on the opposite side of the Merrimack River and was once part of
Chelmsford. After all the river was a wanderer and if the Merrimack once followed the course of the old Middlesex Canal, Lowell at one time could have been closer to being part of Tewksbury than Chelmsford. A trained geologist once claimed that he could determine the vicinity that a piece of granite originated on examination so we'll leave that solution to him.

The Chelmsford (including Westford, Tyngsborough and Dracut) districts appear to be the main providers of the granite sources that occupy our interest. This will be expanded on later in the chapter "Local Sources of the Granite Stone."

So much for the primeval beginnings. Now that we have stood in the foot prints of creation, we can move on to the "hammer and tongs" aspect of the quarrying of granite stone and it's uses in the construction of the Lowell Canal System.
Figure 3

Figure 4
LOCAL SOURCES OF THE GRANITE STONE

Anyone who has ever leaned over the edge of a canal or gazed at a lock has certainly asked himself where did all of this granite stone come from. In the chapter ‘The Beginning’ we at least developed an outline of the formation of the stone from antiquity. That leaves us with the task of identifying the locations that provided the stone. This aim would be the towns or districts where the boulders and ledges were worked and the sites if possible.

There are as many possibilities and probabilities as facts that turn up during the search into history. Thus there is a chance that the history may tend to get a little diluted with the telling and retelling of a fact and even a little fiction may creep in. Every effort was made to go back to the original record of the event if possible. This accounts for the seemingly dated sources that were drawn on but again, modern presentations have a tendency to offer modern views and perspectives. These events unfolded hundreds of years ago.

The earliest of the settlers were certainly aware of the granite. They undoubtedly coined many a descriptive label for the cobbles buried just below the surface as their plows bounced off them. No less the small boulders that always seemed to appear in the middle of many a cellar hole that they tried to dig.

And they must have stared in awe at the huge boulders that were exposed or partially so on the surface of the ground. These men believed in the creation. What possible design could these stone serve in the great plan for mankind. They knew that the boulders weren't mentioned in the bible and they certainly didn't show up over night. There had to be some purpose for the stone and they worked hard at finding a way to put them to use.

The earliest source of the granite stone was simply lying around in the fields. These cobbles were put into use as cow fences and to outline the limits of a piece of property. Just a glance at the multitude of stone walls throughout New England will testify to the amount of back breaking work that was involved here. But it was a start. A purpose had been found for what had been considered no more than an obstruction to plowing and tilling the fields.

There were large boulders that the farmers couldn't move out of their way so the enterprising ones began to chip away at them to reduce the size. As they learned how to
strike the boulder on the seam in order to facilitate the splitting, results were produced
that hadn’t been planned. An industry was evolving and the finished products were to take
many shapes in their everyday lives.

Large flat pieces of the stone were put to use as hearths while smaller remnants
served well for constructing chimneys. As the learning curve advanced, the next step was
probably crude attempts at shaping the stone. Even just squaring the pieces would
produce steps and later rectangular shafts that would serve as property markers, many still
in existence today. Eventually this naturally occurring wealth would find uses limited only
by man’s ingenuity. Sills, paving blocks, stone for lining wells, mill stones for the grist mills
and even sleepers to carry the first railroad tracks were in the not to distant future. One
round stone with a hole bored in the center was found in Pelham, New Hampshire. It
served as a template to shape wagon wheels and the hole was to accept the hub of the
wheel.

As the ability to work the stone progressed, more and more uses were devised.
The most significant would prove to be the construction industry. Stone for foundations
under houses to prevent them from sinking into the ground was a natural. Wooden timbers
that served as supports for bridges tended to rot or wash away. Granite proved to be
impervious to the action of the water and it possessed great strength. It followed that the
granite stone was perfect for the construction of wharves, bridge piers and before long,
even for entire bridges. Granite seemed to be the answer for any type of building purpose.

So much for the early uses of the granite that was to lead up to the development of
the industry. In the earliest writings describing the working of the stone, mining of the
stone is described in many instances as quarrying even though before about 1817 boulders
supplied most if not all of the granite.

Can a definite date be established for the beginning of the quarrying of granite in
Stone: Early Rock Quarrying in New England', the 1630s is mentioned but even that date
is a presumption. All that tells us is that the practice of the industry goes back long before
our interests. The years between 1800 and 1850 encompass the building and rebuilding of
the Pawtucket Dam, Canal and the Locks. Within that scope there is more than enough
information to provide material leading to a conclusion as to the origin of the granite stone
used in the canal construction.

An early indication as to the amount of granite available in the immediate
proximity of the greater Lowell area is offered in an article that was published in the
American Journal of Science and Arts under the title 'Lowell, Geological Facts', January,
1835. The text quotes from Benjamin Silliman, a professor of science at Yale University.
"Granite is wrought in immense quantities in all the region around Lowell, and especially
north of this town. The greater part of it is in boulders which are split for the purpose of
architecture. There are however some quarries of granite, and more of gneiss and mica slate, where these rocks are found in place”. Granite was certainly not a scarce commodity.

The areas around Chelmsford, Westford and Tyngsborough are mentioned frequently as being suppliers of the stone for the canals and the dam. The mining operations in these towns sometimes are transposed in the records for the given reason of the proximity of their location and for example the fact that Westford was once part of Chelmsford. H. E. Fletcher also groups the three areas together in his ‘Granites of Middlesex’ under the Chelmsford District. The Chelmsford and Dracut Districts along with stone from the Lowell area itself are the main sites for the origin of the granite stone used in the construction of the Lowell Canal System.

In a program given by L. Fales for the Westford Historical Society in 1973, it was brought out that quarrying the granite sources was well underway in the Chelmsford and Westford areas by 1729. Local farmers were very proficient in the working of surface boulders by this time and the granite industry was well established. And just as occurs with any mineral deposit, there are different grades within the same deposit. The granite belt in this area is too coarse for monuments or statuary but it is ideal for building purposes. Even so, there were veins scattered in the granite seams that produced an excellent quality of granite.

In Allen's History of Chelmsford' he states that the best and whitest granite is to be found in the Merrimack Plains or Newfield Pond area. The area is now known as Crystal Lake. Even though Tyngsborough is adjacent to this plain, all of the granite quarried in this area is known as Chelmsford granite. He writes "in the north part of town are granites of superior beauty and excellence. They are not found in quarries but on the surface of the earth or partially sunk into it." He also mentions that the production of granite had become a settled industry by 1817.

The granite industry had developed far beyond simply being a sideline for enterprising farmers at this stage. The amount of granite wrought in Chelmsford and transported to Boston and other markets in 1818 was estimated at upward of $25,000. The boulders had to be huge to supply the quantity of stone required to fill the demand. Around this time with improved methods the quarrying of stone from ledges in the ground was becoming well established.

Allen went on to add that in 1817, workers in the granite industry were unable to keep up with the demand for building granite. But the quarrymen were more than willing and able to satisfy the demands and many suppliers appeared to fill the market needs. What follows is a glance at some hand written notes that appear to have been recorded around 1830. The author of the notes made no effort to make their identity known. Overall a fair description of the quarrying methods of both boulders and granite mined
from ledges in the early nineteenth century is provided with some sources of the stone identified. While not directly connected with the canal construction, it does illustrate that the working of the stone by this time was well developed.

`Pillars for the City Market.' There are eight pillars altogether. Each finished product is 21 feet long, 3 foot 6 inches in diameter at the base and 2 foot 10 inches at the top. Each weighed thirteen to fourteen ton. The rough granite shaft when removed from the rock was 37 feet long and four feet square and weighed about 20 ton.

`Chelmsford Granite.' From the `Chelmsford Banner' dated October 3, 1824. Taken for the United States Bank in Boston. Doesn't specify how many columns but the one described was 22 feet long, 4 feet in diameter at the bottom and 3 feet 1 inch at the top. The weight was about 18 ton. The article also records that the column was shaped from white stone and worked at the quarry. The interesting part of this note is a line stating how much granite is not quarried but obtained from huge boulders some weighing in at 100 ton.

`Massachusetts General Hospital.' All the note states is that there were 8 pillars. The work commenced in 1825 and completed in 1827. They were formed of Chelmsford stone, hammered and fitted by convicts at the state prison.

One entry describes how rural Westford was when it split from West Chelmsford Station. The writer claims that the area of Chelmsford and Westford was where the work of quarrying granite stone from boulders began and this is what led to the establishment of Westford. To verify the claim, a search was conducted around Stony Brook and the Lowell/Groton Road in Westford on the Tyngsborough line for an old boulder site. The author came across two large pits twenty rods [330 feet] apart from which stone for two large columns was removed. The pits were sixty odd feet in length and at the bottom were pieces of the original boulders that were left behind after the rough shaping.

There is not even a question as to the availability of granite in the area to be able to furnish the Lowell Canal System with whatever quantity of the stone that was necessary for the construction. The `Tyng Book' which outlines the history of Tyngsborough records that in 1814 the Pawtucket Dam was built using some of the granite from the David Butterfield quarry. It was located on Willowdale Avenue in that town.

In E. Hodhmans `History of Westford' he describes the hewing of the huge boulders that were predominant around the landscape. The town records also state that the first ledge on Oak Hill was opened in 1826 or 1827. Supplying stone to Lowell is also mentioned. The ledges on Snake Meadow Hill were opened around 1847. A notation adds that much of this stone was drawn by teams into Lowell. In 1848 Samuel Fletcher also hired a ledge on Snake Meadow Hill. He began quarrying and it is the first mention of hauling the stone by railroad. So much stone was furnished to Lowell that there were
twelve derricks at the railhead just for this purpose. This quarry also furnished much of the stone for the Lawrence Dam across the Merrimack River.

New Hampshire was a granite producer and it is documented that stone was supplied to Lowell and the canal system. In an edition of the ‘Evangelist’ dated November 26, 1831, a traveler described his trip through Pelham and mentions observing the quarry thereat work. An edition of the ‘Lowell Courier’ newspaper printed in 1844 featured an article about the Town of Pelham. A list of goods produced by the town was included and granite was the second largest product. In the book ‘Geology of New Hampshire’ by Hitchcock, he makes reference to Pelham and Swanzey, New Hampshire supplying granite to Lowell.

He also mentions Fitzwilliams granite being quarried in the same area with a large amount going to Boston, Worcester and Lowell.

There are many references to stone being used in the canal construction and hauled from Dracut. It was quarried at Ledge Hill and the site is identified in the maps presented in Figures 9 and 10 contained in the chapter ‘The Beginning’. This site was owned by the Locks and Canals and was worked just for their own use. The Varnums were described as being suppliers of granite for the canals but the only description of the location of their quarries was on the north side of the Merrimack River which encompasses Dracut. Many sites have probably been swallowed up by home building but one is still visible on Donahue Road. There is also the remnants of a large boulder field in what is now the State Forest that was certainly mined for granite. All of these sites are less than two miles apart and were definitely worked for the stone.

The entire City of Lowell sits atop a solid rock floor and in 1832 the Lowell Weekly Compend’ reported that there was good building stone in the Lowell area. There existed several small and not so small quarry operations located within the city itself that supplied granite stone for the canal construction. The largest of these local quarries was sited at Brants Hill on Fletcher Street in what today is the North Common area. There is no record of stone being supplied from here for any project in the city but the operation must have been sizable. Rev. Owen Street was an experienced Geologist in his own right and he conducted many field trips and lectured on the granite formations in the area. He penned an article that appeared in the 'Saturday Evening Mail' and dated July, 1884 pointing out the existence of the ledges. He described a type of stone comprised of compressed lava flows that permeated the porous granite sheets eons ago and points out the existence of the stone by it's presence in the rock at the quarry site at Brants Hill.

But there were many ledges worked in the Lowell area for materials to supply the canal building over the years. There are no signs of these sites today but they were all recorded in James Francis' field books and waste logs. He was in charge of all construction for the Locks and Canals and the engineers under him who oversaw the actual day to day
operations. Most of these work books cover the years between 1840 and 1845 but some records do exist covering prior years. To aid in identifying the quarry sites in the City of Lowell, a map is included in Figure 11 at the end of the chapter.

All of these locales are identified as supplying granite stone for the canal construction. Only the general location of the sites were recorded, as there probably was no reason for the writer to be more precise. He already knew where they were and he assumed that the reader did likewise. The street names have remained unchanged.

1. Brants Hill was never located with any exactness but it most likely was situated on Fletcher Street between Willie and Pawtucket Streets.
2. Brownell Ledge is identified as being located on Lagrange Street. Large quantities of stone were removed from this site and mentioned frequently was its use in the building of foundations and canal construction. Large amounts of gravel were also excavated from this site, some used as an ingredient for making cement but most as fill around the Hamilton Canal so it could be built on as it was no more than swamp lands.
3. Cross, Willie, Adams and Suffolk Streets were also recorded as worked for the stone and they were all located in the same confined area. The exact locations of the quarries were not identified but all of the streets are within a small radius and certainly part of the same ledge.
4. John and Paige Street also had sites that were mined for the granite stone.
5. The corner of Suffolk and Moody Streets was recorded in the field book dated August 30, 1842 as yielding stone with no other explanation.

All of these locations are right in the middle of the city as indicated on the map.

Sometimes in the records, origins of the stone is only identified by associating it with a surname such as the notation that the Boott Raceway was repaired with Mr. Farlins stone. In another instance the stone is labeled simply as Willard Colburn granite. We are left to guess as to the type of stone and where it was mined. The writers certainly knew and they assumed that just to be associating the granite with a surname that the reader would know just as well. Keep in mind that the people who recorded this information were skilled in the art of excavating, the construction of canals and locks and the uses of granite. They had no reason to expect that any but of their own bent would be interested in the material and they would already be well aware of the background behind the notes being kept in the first place.

To summarize the local sources of granite stone used in construction of the Lowell Canal System, quarrying of the stone in the middle of the city itself should be on the top of the list of sources. How long these sites were worked and the quantity of stone actually supplied to the canal building is at best speculation. All of these sites were certainly located on the same ledge that the city is built on. Also, much blasting was required in the
process of excavating for the canals. That in itself provided a source of stone right at the construction site that was certainly utilized as illustrated in the photograph (Figure 13) following the text. (circa 1800s)

The one missing ingredient in the whole story is why there wasn't more coverage of all the goings on regarding the quarrying of the stone in the local newspapers of the time. Lowell was a large and populated city during most of the time of the construction of the power canals, as is shown in the map of Figure 12 at the end of the chapter. All of this mining, laying and transporting of the stone couldn't have gone unnoticed. It had to have been disruptive to the every day lives of the people. Yet, very little is mentioned in any publications and what information is available to us was recorded years after the fact. Perhaps because building had been going on for over twenty years it was just another day in their lives and generated no added interest.

The town histories of Chelmsford, Westford and Tyngsborough describe quarrying operations in those areas and mention granite being shipped to Lowell. The records of Dracut are nonexistent even though large amounts of stone were mined at Ledge Hill and supplied to the Locks and Canals for canal building.

Pelham, Swanzey and Fitzwilliams New Hampshire were also suppliers but on a smaller scale. Use of the stone is usually not specified, except maybe as reference to being supplied to the Water Commission in Lowell or for engine mounts.

Before closing out this chapter, the illustration in Figure 14 has been added. One picture is worth a thousand words and the entire working quarry is in view. Although dated later than the time table for the construction of the Lowell Canal System, methods of mining the stone most likely have remained much the same. As for alike glimpse of the working of the boulders, that's left to imagination and the existing written records of those who were there.

James Francis' daily log entries contain more descriptive applications for the use of the stone at the building sites but in most cases doesn't pinpoint the sources of the stone except by town. All of the questions are far from answered but at least an overall picture of sources of the granite stone for the canal construction has evolved.
Site Locations:

1. Brants Hill
2. Brownell Ledge
3. Cross, Willie, Adams
   And Suffolk Streets
4. John and Paige Streets
5. Suffolk and Moody Streets

Figure 11
From the PL&C Collection at the Mogan Center in Lowell, Massachusetts

The caption describes this pile of granite stone as the result of blasting the stone ledge, but the amount of dynamite used is blurred. The Pawtucket Canal was not lined with stone when it served only as a transportation canal. After 1822 when it was used as a power canal to operate the water wheels in the mills, it was straightened and the stone was installed over the years to reduce the friction created by the increased current. The section that was dynamited in the photograph is the approximate location of the old Minx Locks that was removed.
Figure 14

Courtesy of the Concord, New Hampshire Public Library
WHO MINED THE GRANITE STONE

Very difficult subject at best. For every name that shows up in the records identifying the people from specific areas who worked the boulders and mined the ledges, local old timers and others in the know could probably name several others. Not only unfamiliar names but just as well unknown quarry sites. But the written records that could be found will have to serve as the basis for what is presented in the following pages.

So where to start. How about the first colonist who stubbed his toe on a rock. He most likely picked it up and threw it aside so as not to have it happen again and so he did the same with the next rock. Eventually they would form a pile and the cows simply would waddle around it. At some point in the act of clearing the stones it had to dawn on the farmer that if the stones were stacked in a line instead of a pile the cows would be fenced in and not wandering in the field. The first use for the granite stones was discovered and the remnants of these crude walls are to be observed throughout New England. Many more uses were to follow.

The rocks turned into boulders and they were too big to move. The farmer probably whacked away at the boulder with some sort of hammer to reduce the size, and the boulder split into pieces. An industry was born. There were probably many boulders chipped away at and many tons of granite put to local use over the years. And surely some ledges had to have been attacked with the hammers, the wielder not realizing he was fighting a battle not with a large boulder but an unending seam of granite.

In the following pages, if the source of information is known it will be given. If the location of the boulders or ledges that were worked is noted or the names of the people that mined the granite are definite, the information will be included. Mistakes in the spelling of surnames is a given and unavoidable. Sometimes it is due to the spelling or printing and often due to the condition of the researched material over time.

The old records are sparse and for our purpose almost nonexistent. Much of the information comes from the early newspapers whose writer heard a good story or bit of history from the old days and decided to use it to fill up some of the space in the paper. For this we're greatly indebted.

A good starting point is an article from an edition of the `Chelmsford Phoenix'
dated July, 1823. It tells of Asa Parker splitting the first granite stone with the use of iron wedges around 1773-74. The whole story is told in the chapter 'Cutting the Stone'.

About 1804 in Brookline, New Hampshire, Captain Nathan Cory opened a ledge which naturally was named for him. The town is just south of Nashua so the granite could have been transported on the Merrimack River with no trouble.

David Butterfield is recorded as having cut stone on his farm located on Willowdale Avenue in Tyngsborough for use in the building of the Pawtucket Dam. This information showed up in the 'Tyng Book' printed for that town's bicentennial in 1976.

Another New Hampshire town located on the Merrimack River below Concord is Hooksett. Two quarries opened along the Merrimack and were worked by Oliver Gay about 1823.

Hodgmans `History of Westford' states that the granite industry began in 1823-24 with Charles Hollis hewing granite from large boulders found in the north part of town.

Issac Carkin opened the first ledge in Westford at Oak Hill in 1826-27. He was followed by Major Jesse Colburn, George Merrill, Sweatte & Gould, William Read, David Reed and Samuel Fletcher.

Also from the 'Tyng Book' is a latter quarryman who took granite from Oak Hill. Walter Brown shipped it out in large slabs both rough and hammered.

In Salem, New Hampshire, a quarry was opened about 1830 by a Nevins of Methuen. He furnished stone for the construction of the Lawrence Dam across the Merrimack River.

From the directors meetings of the 'Proprietors of the Locks and Canals' dated 183041, some purchases of granite stone were listed on the material invoices. Bradlee Varnum and Parker Dutton were frequent suppliers with Dutton being the larger of the two.

Again from the 'History of the town of Brookline, New Hampshire', it states that as early as 1825 Samuel Gilson continued for many years to carry on business at the Cory site in that town as both a worker and dealer in rough and finished granite stone. Another ledge known as Wright Ledge was opened up by Colonel Artemas Wright about 1840.

Concord, New Hampshire is located on the Merrimack River and was a large producer of granite. They also could have been a source of granite stone to the Lowell canal building. In the 'History of Concord', Simeon Abbott was first mentioned as working the boulders in the area but no date is given. Rattlesnake Hill is said to be the only quarry
site but it was extensive. Luther Roby and William Green acquired the Summit Ledge on the Hill in 1834. It was the first real quarry at the site. Gass and Johnson appear to be the main distributors of stone in the area.

`The Granites of Middlesex' by Herbert Fletcher record the names of Charles Hollis, Danial Tuck, Mr. Kidder and the Duttons as being connected with the granite industry around 1847.

Benjamin Palmer opened a quarry on Snake Meadow Hill in Graniteville [Westford] in 1847.

Samuel Fletcher opened a quarry on Snake Meadow Hill in 1848. He furnished granite for the dam across the Merrimack River in Lawrence. He also furnished stone for the Middlesex Canal and sills and engine beds for the Hamilton Mills in Lowell. His quarry supplied so much stone to Lowell that there were twelve derricks just for his operation alone.

Noah Prescott of Westford worked cobbles and boulders into paving blocks to be sold in Lawrence.

Major Jesse Coburn was the superintendent of stone cutters on the building of the Northern Canal. The great blocks were cut at a Dracut quarry owned by the Locks and Canals. This quarry was located at a site known as Ledge Hill. [See maps in Figures 9 & 10 in the chapter `The Beginning'.]

Pelham, New Hampshire was a producer of granite and furnished stone to the Lowell Canal System among other projects in the city. Most of the granite was quarried on Gage Hill from ledges first worked by Gage. Joseph Kittredge also worked the ledges and supplied stone for the sluices in the great river wall at the Northern Canal.

In the book `Geology and Mineralogy of the State of New Hampshire', Hitchcock states that the first quarry on Gage Hill in Pelham was opened by Abel Gage in 1782. This is one of the earliest recorded dates of working the ledges and not just the boulders. He also mentions that other quarries on the hill were operated by Benjamin and Abner Kittredge, D.H. Webster, Gage and Woodbury, J.N. Woodman, John Roney and Moses Johnson. Bodwell and Webster opened a quarry in 1850.

The following notes are taken from the waste books of James B. Francis dated 1841-45. Franklin Forbes was one of Francis' head engineers until he died in 1845 and many of the records were kept by him. These notes are only a few examples of the entries but will serve to illustrate how many people were engaged in the granite industry at the time.
Stone for piers for the Guard Gates at Northern Canal. 9775 cu.ft.
Granite furnished by Parker Dutton to Swamp Locks Dam. 2490 cu.ft.
Stone furnished by Locks and Canals to Lower Locks Dam. 2334 cu.ft.
Willard Coburn granite. 866 cu.ft.
Spillings from Brownell Ledge. 6 perches at $.50@
[perch = 24 3/4 cu.ft.]

Trull & Barr from Brownell Ledge.
Hugh Commeski took stone from the Brownell Ledge for repairs to Concord River Dam.
Page got out stone at the Brownell Ledge.
Farlins supplied stone to repair Boott Raceway.
William Austin furnished stone to the Water Commission for Merrimack Mills water wheels and flumes, Middlesex wheels and Appleton and Lowell Mill wheels.
Captain Butterfield delivered stone to the Water Commission for Eastern Canal Flume and to Locks and Canals.
Mr. Kidder delivers much stone to repair dam in Merrimack Raceway and to the Locks and Canals. Interesting enough, Kidder is the only granite supplier recorded who's delivery of stone was refused by Captain Ford at the Pawtucket Dam.
W. Parks furnished stone to rebuild Boott Mill Wasteway.
Stone supplied by Mr. Bancroft for piers and abutments. Also for Merrimack Guard Gates.
Stone furnished by Shattuck to Lowell Canal Flume for bottom anchors. Also for wheels at the Merrimack Mills.

Even though in the sampling of the entries listed above the Brownell Ledge is the only quarry site mentioned, there were a half dozen other sites worked just in the City of Lowell. The quarries of Chelmsford, Westford, Tyngsborough and Dracut were much larger and were worked extensively, supplying large amounts of the granite to Lowell. [Refer to the chapter `Local Sources of the Granite Stone.]

There certainly was no shortage of locations from which to mine the granite stone or the men to work the sites and the listings given here are by no means complete. In some instances, the work books detailing the canal construction provide clues. Some times it's the histories of the towns where the quarries were located. But history should be recorded where ever we find it or be lost forever. The story can never be completed no matter how hard we try. There's always another yellowed page left unread or another tale left untold and every day that passes makes it more unlikely that they ever will be remembered.
CUTTING THE STONE

The methods used for cutting the granite stone was as much involved as the mining process. The success of the industry relied on each and every aspect of the handling of the stone and no one procedure surpassed the next. The cutting of the stone began at the quarry or the site of the boulders and carried through the stone sheds where the rough and fine hammering produced the final product. When the industry was in its infancy, much of the granite stone was finished by convicts at the state prisons. But we're getting ahead of ourselves. One step at a time is the best approach and allowing the story to unfold at its own pace.

The place to begin is at the quarry with the methods of breaking the stone free from the boulder or ledge. The boulders were lying on the surface of the earth or only partially buried so they could be worked where they were found. In the case of buried ledges, a great deal of digging or the use of explosives (when it was developed) was necessary to remove the overburden found on the surface and expose the granite.

In order to make reading this a little easier and more understandable, a few definitions of the terms used to describe the working of the stone may help. Rough stone is just as it implies. It is split from the boulder or ledge, squared and used as is. Hammered stone is worked to produce the desired finish and it requires hours of tedious work. Dimension stone is worked to exact specifications as to width, height and length. Cobbles are stones that are used in the shape that they are found and are usually rounded. They can be stone picked from the ground, claimed from excavations or even hauled from the river shallows.

The earliest method of splitting the boulders is described in `Commercial Granites of New England'. It describes the splitting of dimension stone from boulders around 1750. It entailed dropping heavy iron balls upon heated boulders and hammering the split stone into shape. Crude but it worked and it could only get better from here.
Simple but effective stone working tools were in use for a long time. John Parks from Groton, Massachusetts was said to practice splitting stones with a wedge around 1767. According to this method, a series of small iron wedges are driven into a line of holes drilled into the granite which causes the granite to split along the line laid out by the holes.

Like every other good idea, they seem to occur simultaneously. The 'Chelmsford Phoenix' newspaper of July, 1823 tells the story of Asa Parker splitting the first granite stone with the use of iron wedges around 1773-74. It is possible that Parker heard about Park and his method for splitting the stone with wedges but he was so afraid of ridicule if it didn't work that he traveled to Boxford and engaged a blacksmith to make the iron wedges. Feeling secure with the distance between him and prying eyes, Parker experimented with small boulders first. He had success and went on to larger boulders. Several good swipes with a hammer did the job and this procedure was in use for many years afterward.

The first methods of mining the stone were archaic by any standards but it worked. Again in the 'Commercial Granites of New England' it states that the stone industry in New England began in colonial times with the use of cobbles and boulders. The splitting of dimension stone was a crude operation. It goes on to describe how the stone for Kings Chapel in 1749-54 was obtained by dropping heavy iron balls upon heated boulders and hammering the split stone into shape.

But the quarrymen were progressing even if rather slowly. In an article from the 'Chelmsford Banner' titled 'Chelmsford Granite', it describes splitting the stone with iron wedges, then shaping the stone with hammers and iron tools. It also adds that much of the stone was shaped by convicts at the State Prison in Charlestown by being hammered. There are many references throughout the records of convicts working the rough stone.

Evidence of methods used in splitting the granite continue throughout the records. Allen Bell was a former quarry owner in Westford. He found abandoned pits indicating that large boulders had been quarried and indications of the methods used to mine the stone. The quarrymen had drilled and split a series of holes and then broken the pieces into the sizes they wanted.

In the 'Granites of Middlesex' by Herbert Fletcher, an excellent description of mining the granite stone is given. He writes that in the old days, the stones were split to the size and shape required by drilling flat holes along a line and inserting iron shims with steel wedges between the shims. By driving the wedges with blows from a hammer, the workman striking one wedge after another along the line, the operation was repeated until the stone was split. The holes were drilled with a narrow chisel and were from one to two inches long, one to two inches deep and 3/8 to 1/2 inch wide. After the stone was split it was pried out with bars and either rolled onto a wagon or hoisted with a hand winch or
The dressing was done entirely with hand hammers, sets, chisels, peen hammers or bush hammers.

Not every operation was a success as illustrated below.

The size of some of the boulders that were worked for the stone is truly unbelievable, and the talent of the quarrymen even more so. The tale of the huge granite pillars that were supplied to Boston for the City Market and the United States Bank buildings have been told many times over, mainly in the newspapers and journals of the time. They were all over twenty feet in length and could weight up to eighteen ton each. Keep in mind that these columns were produced from single boulders and a description of the cutting of the stones is in order.

One example were the pillars for the City Market. There were eight pillars in all and they were delivered around 1825. The finished columns were twenty one feet long, three and one half feet in diameter at the base and two feet, ten inches at the top. The rough granite shaft when split from the rock with wedges was thirty seven feet long and four feet square and weighed about twenty ton. And even at that time, machinery existed to turn and shape the rough column. Here you have to imagine a modern lathe. Four men take the rough pillar and place it on the stocks. Gudgeons are placed in each end and when placed on the stone supports, it can be turned by two men. As it is turned the excess stone is removed to shape the finished pillar.

Boulders of the size that were worked to produce these columns could weigh up to one hundred ton and were certainly not all nested in the same area. Over time the ones that were available probably became more and more scarce. The ledges that were known
were most likely hacked at with the early primitive tools that were available but as the supply of large boulders became exhausted and the tools improved, the ledges provided the prime sources of the granite stone.

Quarrying from ledges began in earnest at Quincy in 1825. With the development of better implements and the "plug and feather" or "wedge and half-round method of splitting the stone, the industry developed rapidly.

As stated before, the quarrying was only the beginning of the process to provide the finished granite product but it was the initial step.

Explosives had been in use since their inception, usually just to clear the overburden of earth and inferior stone deemed of no use before the quarry could be opened. One method of quarrying with explosive was described by Clarence DeCarteret whose family quarried in Westford.

1. Drill a hole with a hand drill.
2. Put a cap and powder into the hole.
3. A long wire inserted into the hole would have battery operated plunger. At a considerable distance from the hole, the quarryman would push the plunger and there would be an explosion.
4. To get the stone out of the quarry there would be a turntable to which a derrick would be attached by a chain. A horse would go around and around the turntable and the derrick would haul the granite pieces out of the quarry.

Now the stone is out of the quarry and transported to the cutters and finishers.

There is no evidence in the descriptions given in the records that the methods of quarrying and cutting the granite stone varied drastically from one location to another. The quarry owners probably conversed amongst each other just like any businessmen and the workers would travel to where ever the work was at the time so they would intermingle. This mixing would allow for the best methods to be utilized throughout the industry with the exchange of know how between them. The following description of the working of the stone after it is removed from the quarry is taken from 'Industrial Archeology' [NHHS] and can be assumed to have been the standard for working the stone.

The stone split into blocks by the quarrymen was transported to a stone yard or shed. The blocks were manipulated using levers or jacks, derricks or windlasses, dragged on sledges called stone boats or hauled on carts pulled by oxen.

The picture on the next page gives some idea of the handling of the blocks of granite as they were stacked in the quarry awaiting transportation to the stone sheds. A
derrick, the oxen and a granite cart with a stone loaded on it are in view. Again, the caption with the illustration tells the whole story.
At the stone yards, stone cutters worked from building plans and lists of stones needed, hewing each block exactly to the dimensions required. To do this they used chisels and a special axe called a peen hammer. Bush hammers and other tools were used to finish the surface. The work of hammering the finished stone was described in 1827 as one of the most tedious operations for the cutters.

One thing that should be mentioned here while discussing the cutting and finishing of the granite blocks was the exacting specifications relative to stone preparation used in the canal construction. There were very detailed instructions for the stone work, rough or finished. Each stone had to be marked with black or red ink to determine the location when assembled at the construction site.

The bush hammer was probably the most indispensable tool in the process of finishing the stone. Below is a reproduction of a sketch of the tool. When hammering of the finished stone is mentioned, this is the tool. The hammer consists of a series of steel plates bolted together and the cutting blades could readily be replaced. [Courtesy of the New Hampshire Historical Society]

![Figure 14. Wood engraving of a bush hammer, from an advertisement for Nutting & Hayden, 1890. The bush hammer, a series of steel plates bolted together and used for dressing stone, was a specialty of Concord tool manufacturers Luther M. Nutting and Henry W. Hayden, in business together from 1888 to 1908. This ingenious tool, with cutting blades that could be readily replaced, was outmoded in the first decades of the 20th century by the pneumatic surfacing machine. A surfacer operator could do the work of 12 men with bush hammers. Courtesy of the New Hampshire Historical Society.]

Stone working tools needed continual sharpening and/or replacement due to the nature of the material worked. A typical stonecutter could wear out one or two drills in splitting a single stone. Manufacturing and sharpening bush hammers was a trade in itself which required considerable experience in order to have knowledge of the temper required for the tools to cut different grades of granite.

Given the times, the industry offered employment to many men and generated a large cash income to all of the locations that were lucky enough to have the granite and knew how to exploit it. It was all accomplished with brute strength and ingenuity. And if you take the time to look around older cities, the fruits of their labor are still with us and their work is part of history.
TRANSPORTATION OF THE STONE

Cutting the stone loose from the quarry ledge was only the first of many operations necessary in the procedure of harvesting granite. Moving the stone to its final destination for use was still a major part of the production process for the industry. There weren't many options open to the quarryman in the early 1800s. Hauling the stone was the primary method, in sleds or carts pulled by horses or oxen. The only other option was to float the stone in barges if there were any means available locally. But as usual, back when the industry was in its infancy, if brute strength wouldn't do the job, ingenuity would and the early quarrymen weren't short on either.

The derrick and the hand winch were the tools employed to get the granite blocks out of the quarry and pry bars and rollers provided the means for loading the stone onto the sleds for the trip to the sheds for finishing. If the stones weren't too large of size, carts or wagons could be used. These same methods would also serve to unload, maneuver and set the stone at the construction site. The engraving reproduced on page 22 [Courtesy of Concord Public Library] and a little imagination is about as close as we can get to observing the actual handling of the granite blocks. The derrick, pry bar and stone cart in the background are all in use in this view along with oxen and horses providing the power needed.

It made no difference whether the stone was quarried from boulders or ledges. The same prime movers would have to be utilized in one form or another at the quarry and the building site. That left the problem of transporting the stone between the supply and demand to solve.

In the late 1700s when granite stone first came into use for building material, it was most likely confined to local applications and not very distant from the source. Transportation wouldn't have presented too large a problem and the stone could have been moved by cart or simply dragged. But when the industry began to develop distant markets, moving the stone was to become a large part of the overall picture. The old records contain a variety of descriptions and drawings of the methods used to overcome the distances that will be reviewed.
Overland hauling of the stone must have been backbreaking. The roads were no more than ruts or at best a cleared path. More than one piece of granite probably had to be moved again at a later date because it was abandoned and left where the cart or wagon broke down or it just fell off. In some instances if it were a very large piece of granite and required a bigger wagon than normally used, the road might have to be widened to accommodate the passage. When Rand brought his equipment down from Vermont to rebuild the Lower Locks with granite in 1823, his crew was engaged in just such road widening throughout the trip. He brought with him a very large pair of wheels with which to move the boulders and granite blocks. They were fourteen feet in diameter and eight to ten feet high. When suspended from the Axel, stone of up to ten ton could be moved by one or two yoke of oxen then set into place with pry bars and rollers.

The pillars for the Quincy Market were mined in Chelmsford. They were each twenty one feet long and weighed thirteen to fourteen ton. They were barged down the Merrimack River and Middlesex Canal to Boston. From there they were drawn to the building site by twenty two yoke of oxen on wheels three feet nine inches in height and ten inches wide.

It was also noted in the `Chelmsford Banner’, October 3, 1824 that the columns for the United States Bank in Boston were of about the same size and weight. Presumably the same methods were used to transport those columns including huge wheels and oxen.

As the market for the granite expanded, employing the natural waterways must have proven to be a godsend. The Merrimack River would have been considered a highway. Still water transportation was not without its own problems because of the many rapids and falls until the coming of the era of the canals. It was in their interests to clear the obstacles in the river because they would impede business. The alternative was to build locks to float the boats around them. Once the river was open from Concord, New Hampshire to Lowell, Massachusetts access would be provided to both the Pawtucket and Middlesex Canals. The Pawtucket opened in 1797 and the Middlesex in 1803.

The Pawtucket Canal was only intended to ferry timber from the forests of New Hampshire to Newburyport, Massachusetts around the Pawtucket Falls. Before the completion of the canal, the rafts of timber would be taken apart and hauled around the falls to be reassembled again on the river to complete the trip. After the mills began to operate and draw water from the canal to turn the great wheels that powered the looms, the current increased to the point that even that trip constituted a hazard. But during the construction of the Lowell Canal System and the need for granite for the foundations of the new mills that were being built, the Pawtucket Canal was well utilized in order to move the granite to the sites.

Interestingly enough is a glance at a list of tolls for the Pawtucket Canal. Timber for sure shows up first. Lumber of all types is noted as are hogsheads of molasses, rum
and many other commodities but no mention of granite. Was granite simply overlooked? Not at all. The canal was meant to ferry timber to Newburyport and all other articles that made use of it were for sheer convenience. Newburyport already had access to all of the stone that they could ever use from the many quarries at Cape Ann. When the granite for canal construction was barged on the Pawtucket Canal, for example the building of the Western and Eastern Canals, only the upper lock was used. Because the contractors involved were employed by the Locks and Canal Company, no fees were charged for the passage of the materials that were used so there was no record of the passage.

Boston was to be the market for the granite stone as the construction of new buildings intensified with the growth of the city. Also its seaport would allow for shipping the stone along the coast and to overseas markets. The success of the early granite industry was to rely wholly on the completion of the Middlesex Canal from the Merrimack River to the Neponset River in Milton outside of Boston.

Our interest lies only in the use of granite in the construction of the Lowell Canal System and the methods used to transport the stone from the quarry to the building site. Sometimes in describing the transporting of the stone the subject will unavoidably go off on a tangent. But as long as the end result arrives at the same conclusions it will have served the purpose. Neither the buildings in Boston or the Middlesex Canal have any connection with the study presented here but it is not possible to see everything wearing blinders. Both are involved in the transportation of stone by the use of wheels and waterways so knowledge is added to the overall picture.

On page 37 is an illustration of a boatload of granite blocks starting downstream on the Merrimack River. A close look at the water under the overhang of the shed on the bank will reveal another boat in the process of loading more stone. Behind the shed can be seen the future doom of the Middlesex Canal; a rudimentary horse drawn railroad is in view.

The lack of available records dealing with the construction of the older canals presents a problem in understanding the methods used to build the earliest of the waterways but they were only open ditches and no granite stone was involved until they were rebuilt as power canals.

The first mention that we have of granite being used in the initial construction of a canal is in the building of the Western and Lowell Canals, both begun about 1828. It is noted in the `Cultural Resources Inventory, Industrial Canals', that the large amounts of stone that were supplied to line the Western Canal were transported on barges along the Pawtucket Canal. In the final draft of `The Transportation System, Lowell Heritage State Park', it states that after the rebuilding of the Pawtucket Canal in the 1820s, the Pawtucket Canal carried construction materials for the building of the cotton mills and the canals.
But the bell was tolling for water transportation of all cargo and this included the granite stone. The canals had served the purpose for which they were intended and sometimes the success of the canal actually contributed to its own demise. The Middlesex Canal hauled the granite sleepers that supported the tracks for the Boston & Lowell Railroad that followed the same route and ultimately surpassed the canal as the prime mover of people and goods between these two cities and all points in between. To make the cheese more binding, even the first engine to be used by the railroad was hauled on the canal from Boston to Lowell after it arrived from England.

Before we take leave of the fantastically simple but effective mode of water transportation, a few words should be spoken in behalf of the faceless men who handled the boats and barges that shipped the granite on the river and the canals. No records were available that identified the men who worked the Pawtucket Canal exclusively but there's no reason to surmise that the boatmen who toiled on the Merrimack River and the Middlesex Canal wouldn't have also hauled the stone from the quarries to the canal building sites. Labor was labor and more important, profit was profit. The Boston round trip averaged four days. The Pawtucket Canal trip was local.

The following entries were taken from the toll records of the Middlesex Canal
from 1821 through 1828 and represents only a small sampling. They do not list the points of origin or destination on the canal and there were many landings along the way. A check of the loads that the vessels carried indicate that the average shipment of the granite weighed twenty ton. Most of the stone is noted as being of rough finish although some is hammered. Also mentioned is passage through the locks at Cromwell and Wicasee falls, both located on the Merrimack River above the entrance to either the Middlesex or the Pawtucket Canals. The cargo isn't specified.

Benjamin Blood is very active at this time in hauling the granite stones. He owned and operated several boats.

Justin Pike appears, usually in partnership with Benjamin Blood or at least operating one of Blood's boats.

C. Blood shows up as owning a boat or boats and Asa Carkin is listed in toll records as being an operator.

J. Chamberlain is recorded as hauling the granite stone and is in good company with the following names that appeared in the toll and passport records. John Vincent, George Flynn, William Pike, T. Parmer, Davis, C. Marshall, William Littlehale, Pierce, John Miner, L. Danforth, W. Robins, Robert Chase, L. Knight, S. Tyler, W. Procter, Tim Blodget and untold others.

There were many more to be sure. Gone but not forgotten if one takes the time to look around at the end results of their labor. One visitor to Lowell, upon a tour of the canal system, only had one question of her guide. "Where did all the granite come from?" Nobody noted if even the guide knew.

With the development of the railroads, transportation of the granite stone would probably reach its peak. Much of the handling of the stone once it left the quarries would be simplified by the proximity of the rails to the finishing sheds and a fully loaded train could carry the equivalent tonnage of many boat and barge trips. Even for the hauling of the stone at the quarry site itself, rails were laid to facilitate the moving of the Granite stone.

Credit is given to the Granite Railway Company built to haul the granite from the Quincy quarries to the site of the Bunker Hill Monument as being the first railroad. There were many crude horse drawn tracked vehicles during this era but that railroad was awarded the distinction. In 'The Early Days of Railroading' by Herbert Taft, 1909, a description of the operation of the Granite Railroad is given but no source for the information is offered.

The cars used for transporting the granite had four wheels nearly eight feet high
and the Axel were arched [to give added support to the weight]. The load was carried on a platform about ten feet long by four feet wide. This platform was placed on the tracks and the blocks of granite rolled onto it. The wheels were then run over the loaded platform, chains were hooked into eye bolts at the corners of the platform and by a system of wheels and levers the platform was raised and suspended between the wheels. The cars ran down from the quarry propelled by gravity and were hauled back by horses. This contraption won the first railroad award.

According to the "History of Concord, New Hampshire", a similar named railroad was formed by a Luther Roby. He had acquired the Summit Ledge on Rattlesnake Hill and it appears that this railway served several quarries in the vicinity. It doesn't record how extensive this operation was but to be of any use outside the quarry it most likely went as far as the Merrimack River.

The Boston and Lowell Railroad is generally considered to be the second railroad to be put into operation, at least in New England. It was chartered in 1830 but wasn't completed until about 1835 and it spelled the death knoll for the Middlesex Canal. The listing of the freight tariffs includes many bulk items such as pig iron, coal, flour and grain but doesn't mention granite. The canal was fast becoming a nonentity and the stone had to be transported somehow. The markets still existed in Boston and elsewhere. Other railroads existed and many of them were on record as hauling the granite stone but the charters stated that no railroad could lay tracks next to another existing track for thirty years so for the time being the Boston and Lowell Railroad was the only way to go.

The Nashua and Lowell Railroad was chartered in 1836 and the Stony Brook Railroad was in use prior to 1848. There were smaller local lines that passed through or close to the quarrying operations that surely were engaged in carrying the granite but the only railroad that was recorded as hauling large amounts of the stone was the Stony Brook. Samuel Fletcher was reported to have drawn a large quantity of stone to this railway and heavy blocks were shipped to Lawrence for construction of dam on the Merrimack River. The Stony Brook was also a Lowell based Railroad with James Francis being the president for over twenty years.

Why was Lowell the center of the railroad industry in the area. Why not Nashua or Manchester, New Hampshire or Boston or Andover or Fitchburg, Massachusetts. All of those cities had railway terminals and all were associated with railroad lines. The answer was that Lowell had the Proprietors of the Locks and Canals on the Merrimack River Company. That company built the canals and aided in construction of the mills, all of which used granite in one way or another. But the biggest asset for Lowell was the existence of the company's machine shop. There was forged and worked all of the machinery for the canal system; the looms, water wheels and turbines for the mills. As a sideline the machine shop built steam locomotives for use on the railroads and it was to be a very successful enterprise.
Below is an early photograph of a railroad steam engine built in the machine shop of the Locks and Canals Company in 1836 for the Boston and Lowell Railroad.

The days of the oxen, wagons and enormous wheels, the boats and barges, and even the railroads are gone. The granite now is moved from quarry to customer over the road by truck. It's their turn. The industry adapts and progresses and keeps developing but the charm is missing. Now it's just another job.
LAYING THE GRANITE STONE

The laying of the stone was in itself a project but it simply represented the final step in utilizing the granite. The records of who actually laid the stone are scarce. Perhaps it wasn't considered that big a deal even though to us it appears to have required great skill. To try to develop at least a rudimentary picture of the stone laying process, several reproductions of photographs of men working the stone are included with the text.

Whoever the masons were, they weren't simply given a pile of stone and told to stack them up one on top of the other. The finishing sheds at the quarry were furnished with very detailed descriptions of the cut stones that were necessary and the instructions had to be followed. Each stone was marked with black or red ink to determine their location when assembled at the construction site.

Cobbles and pieces of granite that were available as a result of the excavating and blasting were also put to use and can be seen in the lower courses of many of the canal walls when they are drained of the water. A good illustration of granite tailings as a result of blasting can be seen in the chapter, 'Local Sources of the Granite Stone'. Possibly the laborers employed in the digging began the wall construction with what materials were salvaged and usable for a foundation for the granite blocks. If so, it was not work that was done haphazardly.

James Francis was the engineer in charge of all the details of the construction for the Proprietors of the Locks and Canals on the Merrimack River Company and there were competent engineers working under him in charge of overseeing the work. Every stone was laid in position exactly where it would do the job according to design and planning and the plans were followed.

Once again is mentioned that the most amazing thing about the entire process of building the canals is the lack of coverage in the local newspapers of the time. The
construction was to cover thirty years from start to finish and repairs and rebuilding of the canal walls and locks were to add many more years of work with the granite stone. Some writings did appear but the backbone of the available records rests in the entries contained in the daily work and field books kept by the employees of the Locks and Canals Company.

In an article published in the `Lowell Telegram', 1947 by Frederick Coburn, he states that Major Jesse Coburn was the superintendent of stone cutters on the Northern Canal project. It states that he was supplied with a memorandum of the granite stones with quantity and sizes that must be got out (sic) from the Dracut quarry. This would have spanned the years 1846-48 but he was most likely in charge of the quarry at the Dracut Ledge for many years. The ledge was owned by the Locks and Canals and Coburn is mentioned frequently in Francis’ work books as being a supplier of the stone. In some instances the name of Coburn is spelled Colburn but because the author of this article claims relationship, Coburn is considered the correct spelling.

Working with Coburn was Albert Whiting whose job it was to oversee the placing of the granite blocks securely bound together one over the other. While these two men worked directly for the Locks and Canals Company, `The Cultural Resources Inventory' tells us that many others were independent contractors employed frequently to perform many tasks including laying the stone. Naturally the names of their employees wouldn't appear in the company field work books. For example it goes on to say that James Russell and Cummings Barr were contractors and they hired their own labor force to line the Western Canal with stone. Construction began in 1828. The names of Russell and Barr appear often in the work records.

Another name that appears regularly as supplying and laying the stone is Varnum. Bradly Varnum excavated the Lowell Canal in 1828 and laid the walls with stone provided by the Locks and Canals. The capping stone was supplied and laid by Timothy and Thomas Varnum who together owned extensive quarry lands on the north side of the Merrimack River.

Franklin Forbes was one of the engineers under Francis and also kept many of the daily work logs that recorded the canal construction. The entries particularly for the handling of the granite stone are niggardly. Not because it wasn't important to the company but probably because anybody who would be likely to examine the records was assumed to know the every day details. The names that were identified as laying the granite stone appear over and over throughout the entries. Perhaps even back then, a very few contractors had a corner on the market.

Sometimes the dates aren't given and often the locations as well. It's a small cross section and we'll never know all of the individual names. Their work outlived them and their identities.
The Boott Mill Raceway was rebuilt by W. Parks who also furnished the stone between 1846-47.

One note identifies Short as a builder using stone but the details are guess work.

John Trull laid the stone for the race wall at the Lower Locks and also did the excavating in 1841.

Rough stone and cobbles were laid by Shattuck and Hill. No mention of the location. Recorded in the daily field notes between 1841-45.

One entry states that rough stone was furnished by the Locks and Canals and laid by Trull and Barr.

Mentions a wall laid at the Western Canal by Page.

Mentions a wall laid by Shattuck, period.

John Trull was also recorded at laying the stone for the paving at the Lower Locks Dam. This probably entailed setting the granite blocks in place that constituted the flooring for the dam raceway.

Adams laid stone furnished by the Locks and Canals Company.

The field notes of 1841-45 also mention ledge stone put in by Faulk.

This list is certainly incomplete in naming all of the people that were involved in the laying of the stone for the construction of the canals over the years but it does give a sampling of the most frequently mentioned in the past records.

One of the more complete descriptions of the methods used in laying the huge stone in the reconstruction of the Lower locks on the Pawtucket Canal in 1823 was given by William and John Kittredge and was reported in the newspaper `Vox Populi' in 1872. It was even commented on in Francis' Day Book #15 and his 'Lowell Hydraulic Experiments' along with a mention in the 'Merrimack Manufacturing Journal', volume 14, page 157.

Rand was from Vermont and he contracted to rebuild the Lower Locks. Rand brought with him to East Chelmsford about twenty workers and all of his own tools and equipment. What was unique was the pair of wheels that he brought with him to aid in moving the stone into place. They were fourteen feet in diameter and eight to ten feet in height. The old locks had been built of timber which was removed and the earth excavated to a depth of forty feet before he began work.
The tale goes on to describe how the large boulders were moved into place as part of the walls of the locks. The contract specified that the locks were to be constructed of stone of the largest capacity, shaped and joined so as to be impervious to water. So the stones were not only moved from the beds where they were found but also cut and fit right at the site.

Rand's men would dig around the large boulder to get a chance to make fast a chain or insert a clevis in the top into which they could hitch. Then they would place the huge wheels astride the stone. With the lifting apparatus attached to those wheels [to the Axel between them], one man could raise stones weighing several tons each. One or two yoke of oxen would easily convey them to the place in the walls where they were wanted where the stone would be lowered onto a platform and then by means of rollers and pry bars moved to the place for which they had been selected. All of the stones too large to be put on a cart to be transported were put on sort of a platform and suspended between the two great wheels and carried to the canal building site.

Presumably the rough and hammered granite blocks that were cut from the quarry for the construction of the locks weren't as large as these boulders and were moved by cart or wagon. Also the possibility exists that the granite blocks could have been brought down the Merrimack River and the Pawtucket Canal to the building site.

In describing the laying of the granite, James B. Francis writing in 1855 tells us that the side walls of the locks were constructed of large and small stones laid without mortar. Interestingly enough, Francis goes on to add that in order to render the locks capable of holding the water, planking was fastened to post resting immediately against the side walls. ['Lowell Hydraulic Experiments' page 104.] Planking has been mentioned in other records of lock building but never in detail giving its purpose. The planking wouldn't be necessary over the canal walls because the fill behind the stones would serve to hold the water. When the Pawtucket Canal was strictly a transportation canal it was only a ditch carved out through the landscape. The stone was only added when it became a power canal to prevent the banks from collapsing and to reduce friction in the flow of the water because of the irregular shape of the walls.

The one exception to the method of laying the stone without mortar was the Great River Wall that separated the Northern Canal from the Merrimack River. The wall is almost a thousand feet in length and sits on solid ledge in the bed of the Merrimack River. The height of up to thirty six feet allows the canal to carry water at the same level as the river above the dam at the falls and thus increase the power and efficiency of the canal system. Many reports of the construction of the Great Wall state that Newark Hydraulic Cement was used in the amount of fourteen hundred barrels per month for a total of several millions pounds. But James Francis was the head engineer and in charge of the work. He ran the show and developed his own mixture for the cement. [from the Proprietors of the Locks and Canals collection, January 23, 1847]
24 cu.ft. broken granite.
12 cu.ft. coarse gravel unscreened.
3 cu.ft. sand gravel unscreened
1 cask of cement

The above proportions are for the large casks used at this time.

The names of the individual men whose skill and labor built the canals are lost in the past but not their accomplishments. The structures that they built are all around us and Lowell trumpets their achievements. The buildings are massive and beautiful but the five and one half miles of waterways lined with the granite stone that comprise the canal system was the backbone of the whole industrial empire that allowed the very existence of the city.

Until the invention of photography there obviously was no way to document any of the granite work except by means of sketches and etchings so all of the scenes presented in the following pages were photographed in the late 1800s. They at least illustrate what was entailed in the actual laying of the block at that time. Even though our interest was in the canal construction between the years 1820-50, the Pawtucket and Merrimack Canals were not completely lined with granite until the late 1800s and the same methods were probably still in use.
This photograph shows the north wall of the Pawtucket Canal being built in 1891. It is an end view of the granite stones being laid on a prepared foundation adjacent to the existing earth bank that was the original canal wall. The granite block in the foreground has been shaped at the quarry. No cobbles or boulders were used in the construction of this wall as were in the earlier canals.

On page 47 is a picture of another portion of a wall being built at the Pawtucket Canal. Notice the way the wall is structured in order to reduce the friction of the flowing water. The derrick used to set the stone is in full view atop the wall.
Good view of the men at work laying the granite stone and their equipment
Epilogue

The story told here is in no way complete. There are many smaller stories that put together really make up the entire history of usage of the granite stone in the construction of the Lowell Canal System. The dim past is in many cases just that and there's no way to resurrect much of it.

The quarry workers who mined and split and hammered the stone are all gone, faceless images only appearing in early drawings, etchings or photographs frozen in their stances. Sometimes in the course of the research a passing sentence will note how a man was killed by a falling stone or horribly mangled by a blasting charge that went off when unexpected. That begins and ends the report. The builders and teamsters didn't even get that much of a mention.

The only way to really appreciate the scope of the work involved in the lining of the canals with the granite stone is to take a walk along one of the canals when it is drained of water after you have read the book. As you gaze at the blocks of stone stacked one over the other, your imagination will superimpose the derrick that was shown in the illustrations atop the canal bank, the half finished canal walls with the granite blocks scattered around the base to be put in place the next day, or Rand's huge wheels building the Lower Locks as described in the text.

If you have gotten this far then you can appreciate the vision that these men had and the will to carry it through. The engineering and the daily toil also become part of the picture. If you stare long and hard enough at the granite blocks, it all becomes alive again, at least for you. An industrial empire was built here because of the flowing water in these canals and many a fortune made. It is doubtful if any of the men who worked digging the ditches or laboring with the stones ever realized any of the rewards. They simply moved on.

An era has come and gone. The mills are still with us or some of them anyway, but they serve a different purpose now. The waters in the canals still flow and it too has a different function. Electricity is still generated by the same ancient generators that powered the mills in their waning days of operation, but now it is sold to an outside electric utility. A new use for the constant supply of water is for processing purposes now, such as air conditioning or the demand of small industries located in the rejuvenated mill buildings. Life goes on and so few people even give the canals that they cross or pass every day a second thought. The canals, dirty and ignored as they are represent the backbone of the industrial revolution that took place in Lowell, the effects of which are still with us today.
Massachusetts

Dracut Historical Society.
Tyngsborough Conservation Commission.
Tyngsborough Library.
J.V. Fletcher Library, Westford.
Town of Chelmsford Library
Town of Chelmsford, Mackey Newfield Library.

New Hampshire

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Milford Public Library.

And for the helpful information that Thomas Belt of Wilton offered.

Thanks to all.