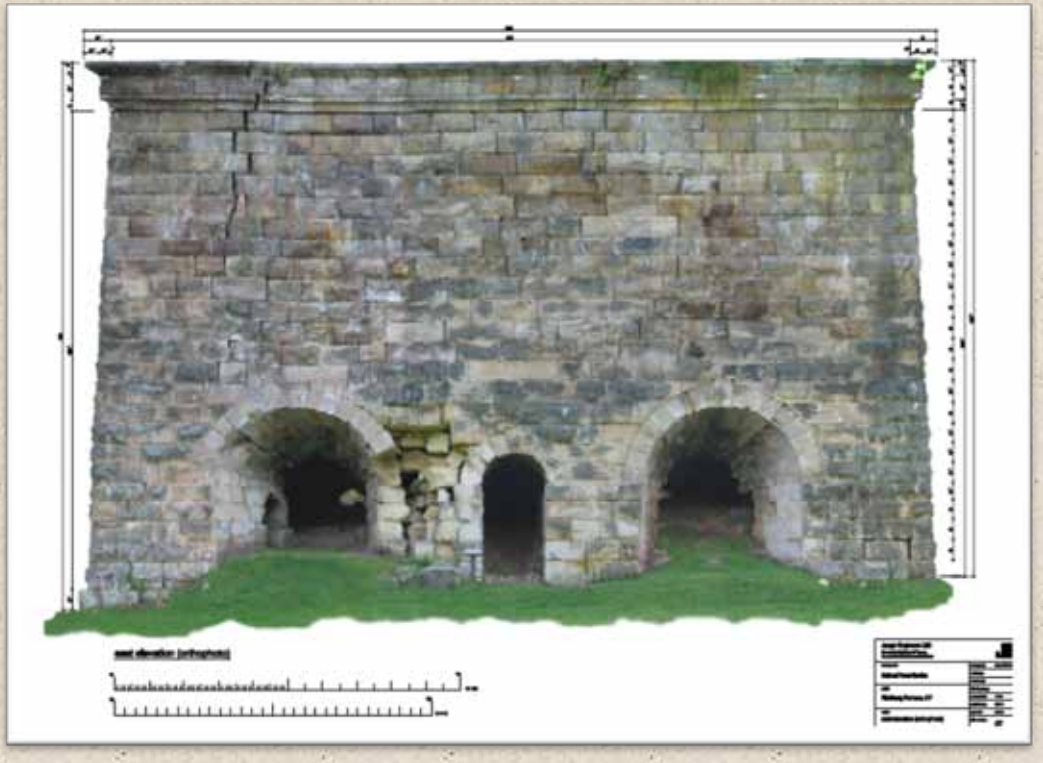
Fitchburg Furnace:

Past Achievements and Future Goals



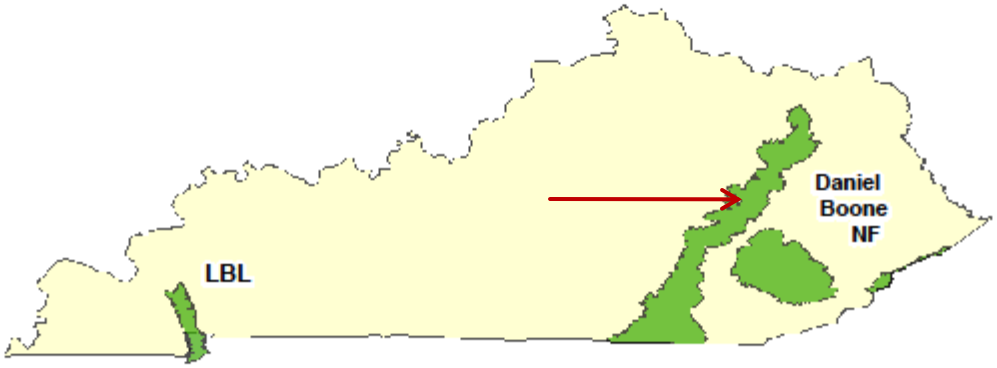
Built in 1868 and acquired by the Daniel Boone National Forest in 1973, the Fitchburg Furnace is a double-stack, steam-blast iron furnace. One of the largest charcoal-fired furnaces ever built and the only twin stack furnace in the world, it now stands a monument to its creator and the historic iron industry of Kentucky. Though it never achieved its full potential, the furnace remains a testament to the genius and determination of the designer, Frank Fitch.

Today, the furnace is a popular destination for tourists and school groups. Since 2004, the Forest Service has been working to stop the decline of the massive structure and to improve access for the public. This work has resulted not only in the stabilization of the furnace, but also in the discovery of additional foundations and some of the original machinery that forged cast iron from local ores. While the restoration work completed to date will help ensure the long-term survival of the impressive structure, additional plans are being shaped to develop improved interpretation at the site.

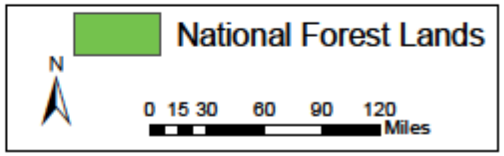
The Daniel Boone is located in
Forest Service Region 8

Daniel Boone National Forest

Land Between the Lakes

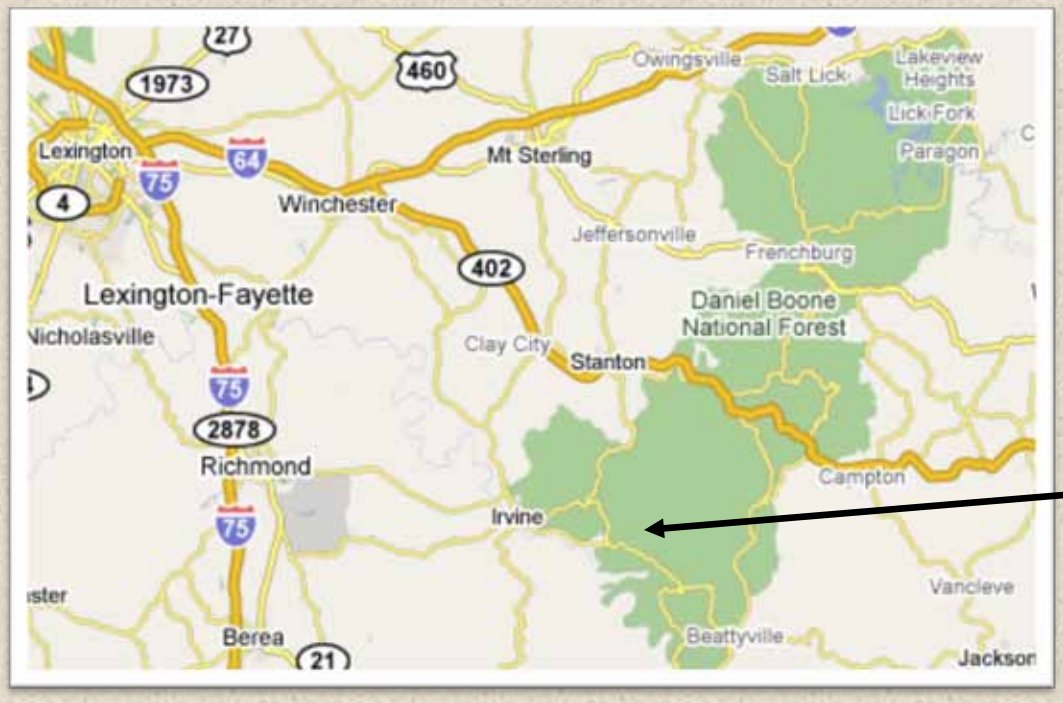


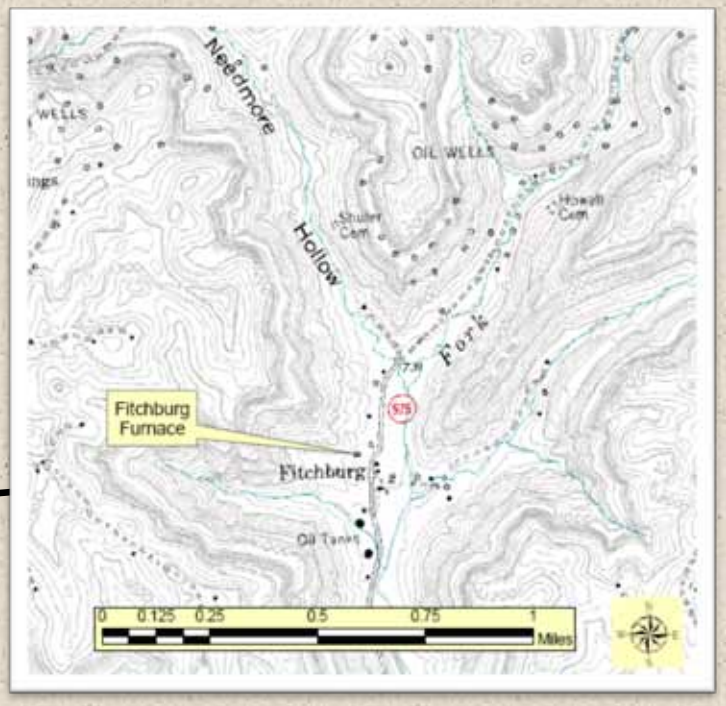
Fitchburg Furnace is located in the Cumberland District on the Cobb Hill quadrangle.



Where is Fitchburg?

Fitchburg Furnace is located in the Cumberland District on the Cobb Hill quadrangle.





More specifically, the furnace is in Estill County, about 30 miles east of Irvine. Though it was officially named the “Red River Furnace,” it was more commonly referred to as the “Fitchburg Furnace” because it was the center of a thriving community called Fitchburg, named after the founder, Frank Fitch.

At one time it was a community of over 1000 with its own doctor, store, hotel, post office, jail and churches. The furnace complex also included tramways to carry ore and finished iron and paved roads.

This photo from 1895 shows a portion of that community.

The furnace was an industrial vision developed by Frank Fitch and in which he was assisted by his brother and other financiers. In 1866, they established the Red River Iron Manufacturing Company with working capital of $1,000,000. A large portion of the money was derived from capitalists in New York and Boston, who hoped to profit from a post-Civil War railroad boom. The iron from the furnace would feed that growing market.

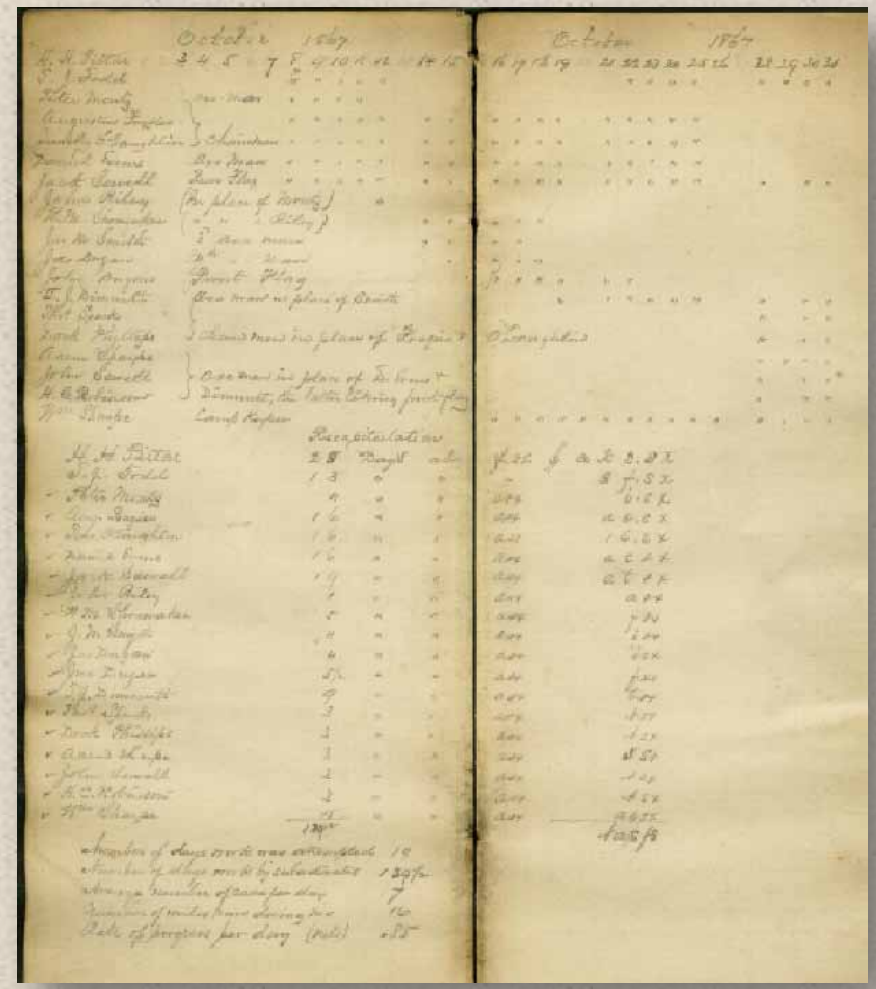
"I will design a furnace such as has never been seen before in these parts."
Frank Fitch, 1867

The Fitch Brothers New York, 1852

Fred Fitch

Frank Fitch

Frank Fitch Notebooks, 1867-1873



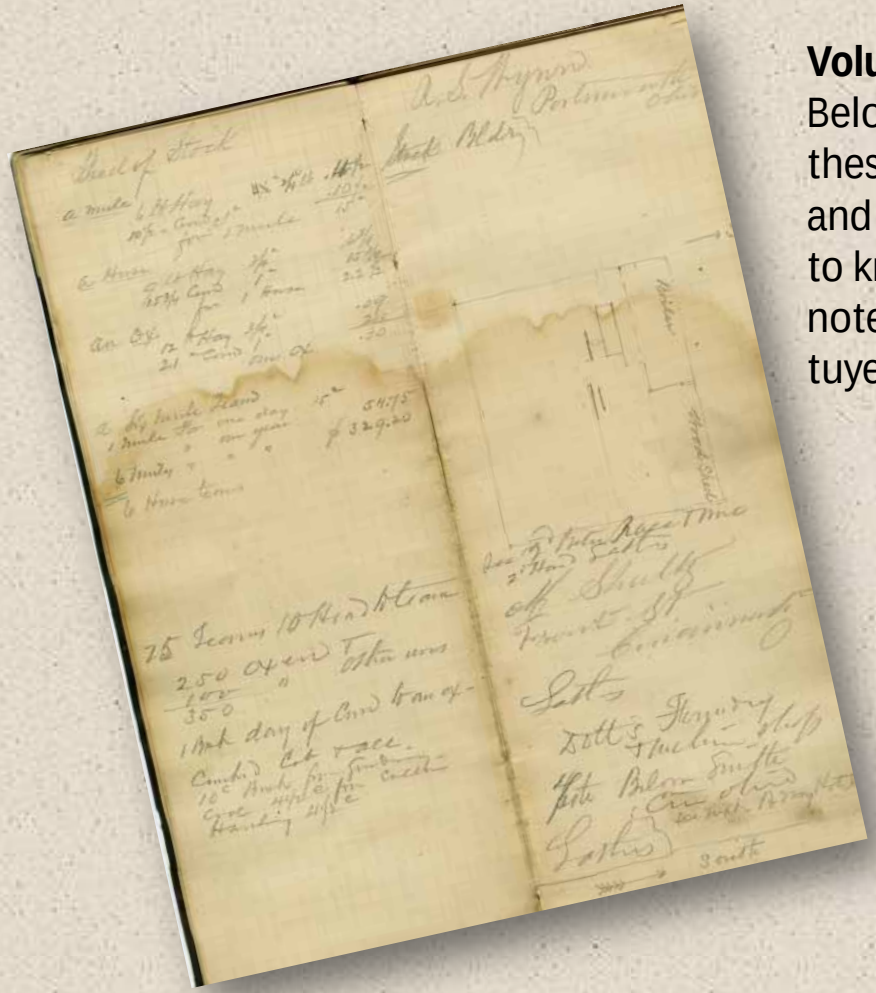
Survey Notes

-names of workers -days worked

-jobs worked -rate of progress

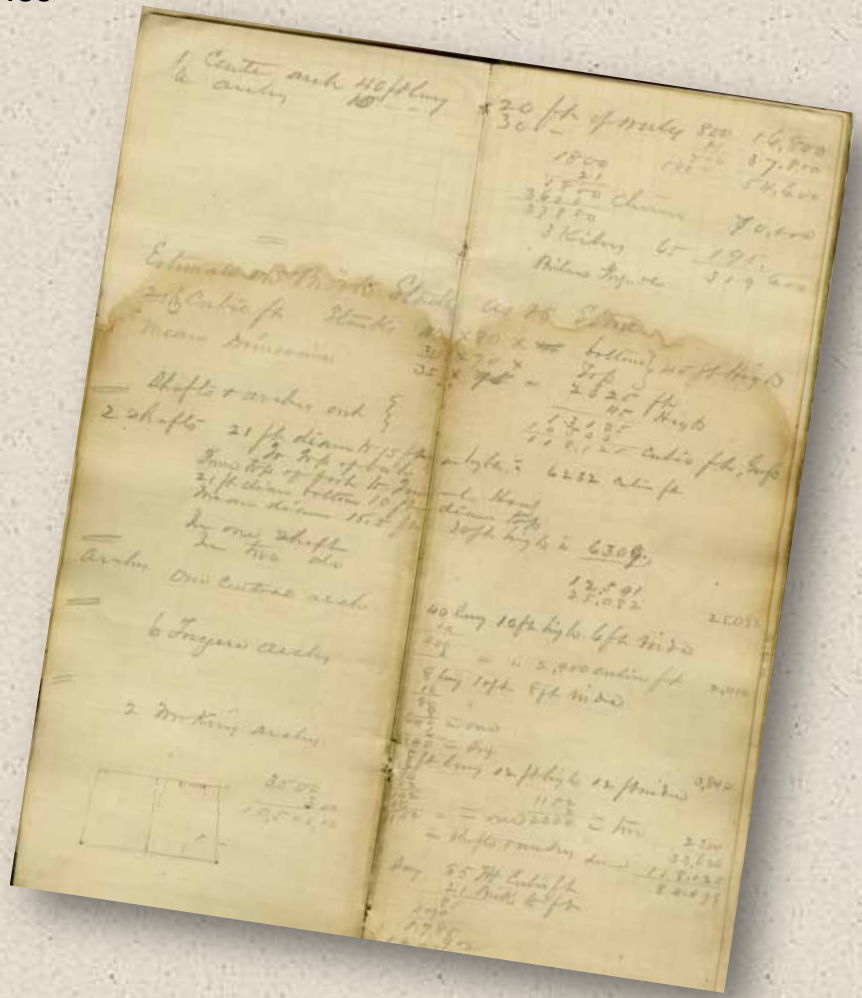
Frank Fitch was a meticulous and careful planner. Many details of his approach to the development and design of the furnace are recorded in his personal notebooks. These books, dating from 1867 to 1873, contain Frank's notes on property owners in the area, maps of the region, survey crew progress; even the cost of feeding the required number of horses, oxen and mules. Frank was thorough in his planning.

On the pages shown here, Frank is keeping track of the men surveying the area in October 1867. He lists their names, days worked, and their specific job such as axe man, chain man, rear flag, or camp keeper. Frank also noted their overall progress, and includes at the bottom the number of days that month work was attempted (19), the number of days subordinates worked (139 ½), the average number of subordinates working per day (7), the miles run during the month (16), and the rate of progress per day in miles (.85). About all he doesn't say is whether this was a good or bad rate of progress. Survey continued through February 1868.



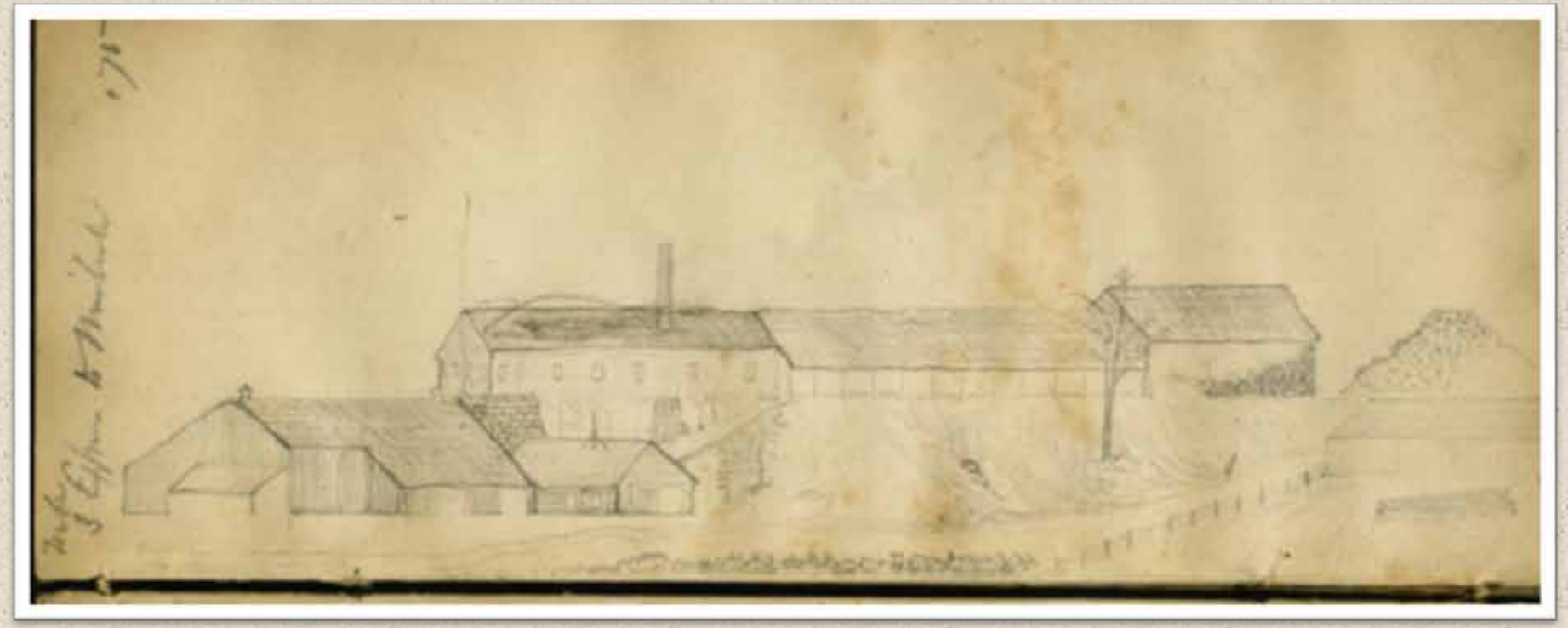
Volume Calculations

Below is an example of his "Volume Calculations." On these pages, Frank is calculating the volume of the shafts and arches of the planned furnace, presumably in order to know how much stone and brick to order. These notes mention two shafts, one central arch and six tuyere arches



"Feed of Stock"

Above are Franks notes on "Feed of Stock" where he calculates "One mule" requires 6 lb of hay and 10 ½ lb corn which cost 15 cents. Similar calculations are presented for horses and oxen, and at the bottom he shows his figures for how much it would cost to feed them for a year ($54.75 per year, per mule).

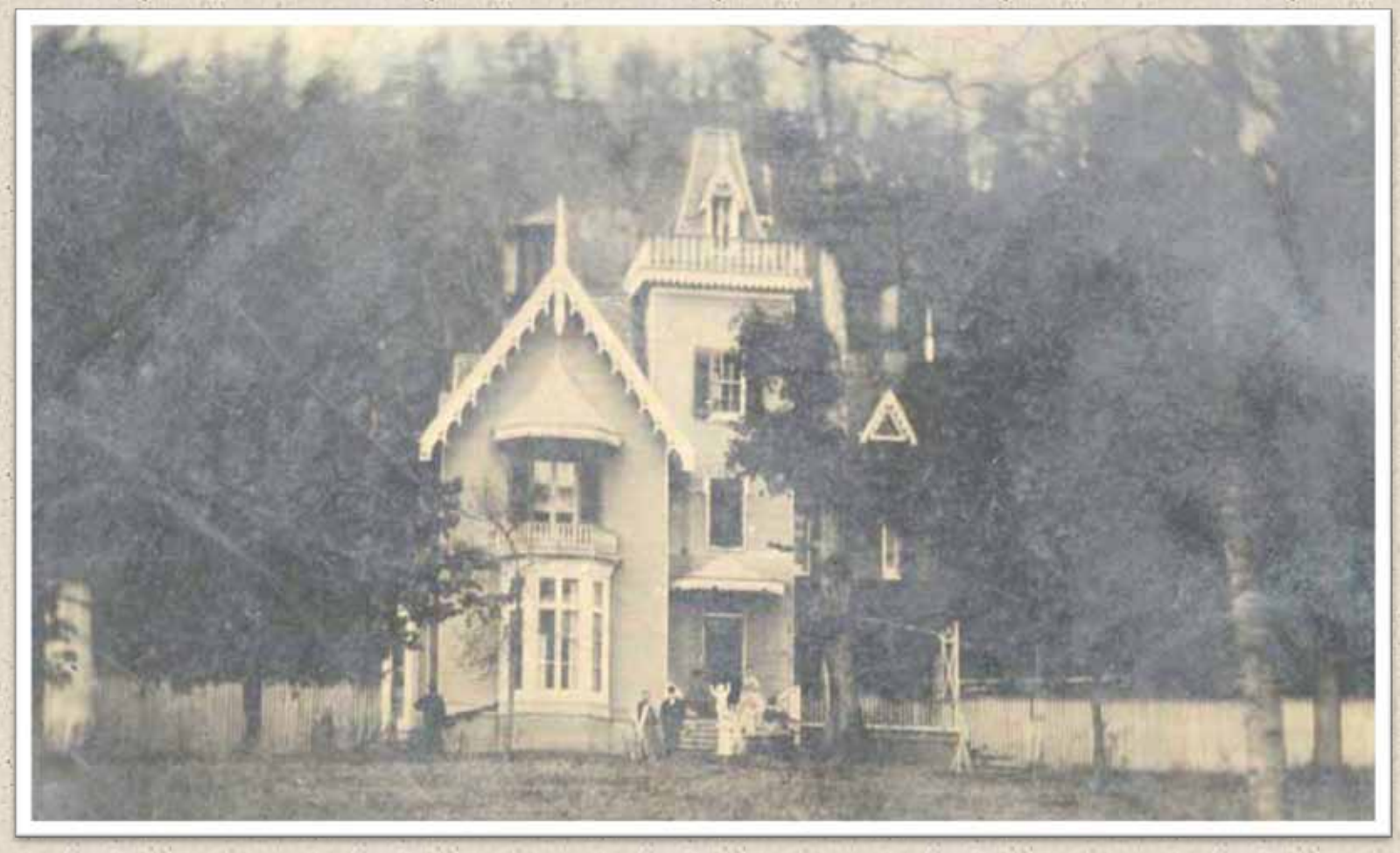


The Red River Furnace

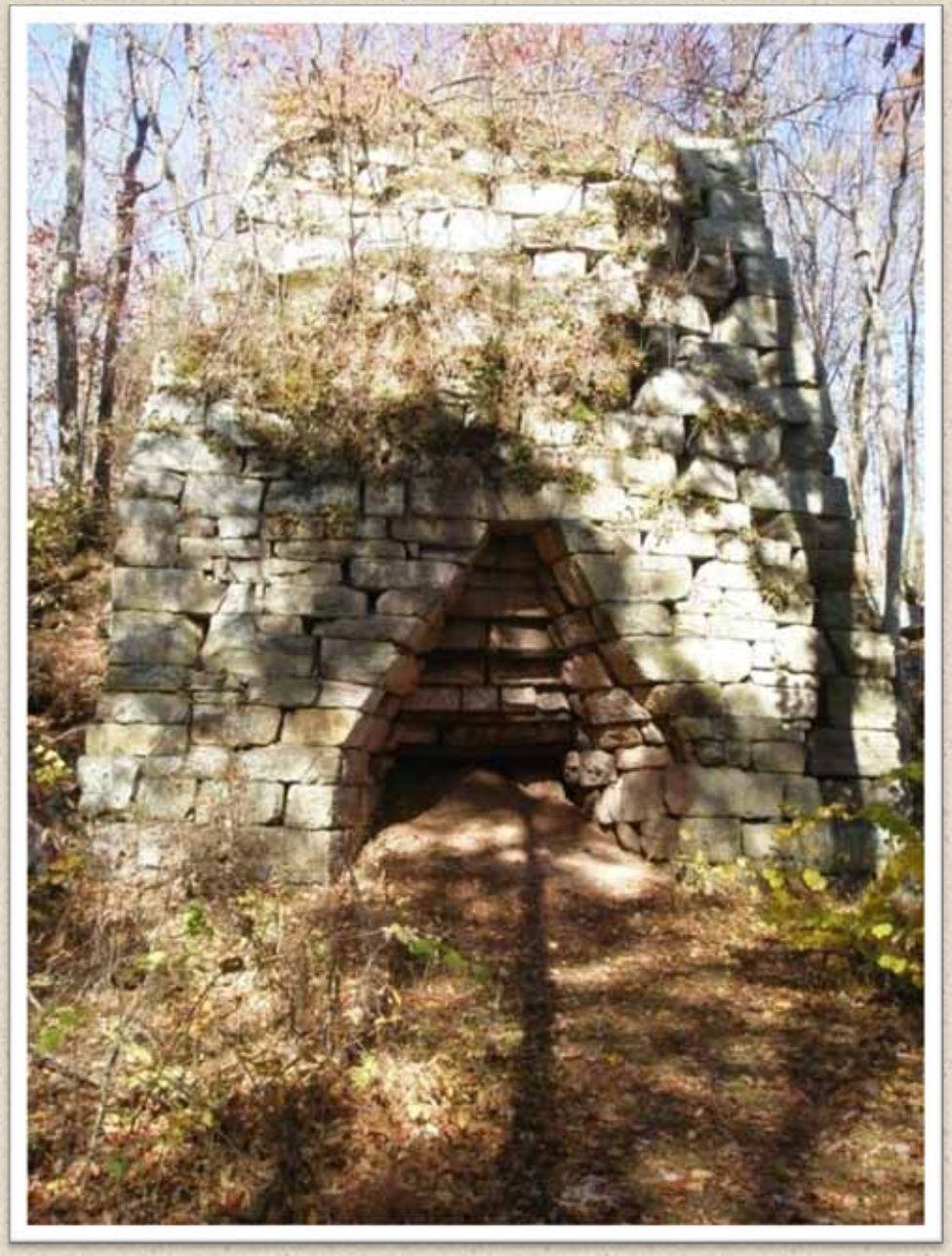
Sketch from 1867 Notebook

Here is a sketch of Frank's vision of the entire furnace complex. There are two important issues to note here; first, this sketch was prepared a year before construction even began on the furnace. Second, the stone furnace, which seems huge to us today, is only a very small part of the overall complex which here includes a casting shed in front, a large building to house boilers and machinery in back, with additional sheds stretching out behind that. Frank Fitch dreamed large.

The House that Frank Built



A photo from the family scrapbook, its caption reads "The home of Frank Fitch at Fitchburg…. He lived here for 3 years and operated the furnace… he had designed. He was assisted by his brother, Fred Fitch. This house burned…." The house was originally located opposite the furnace; today no sign of it remains.



Why Kentucky?

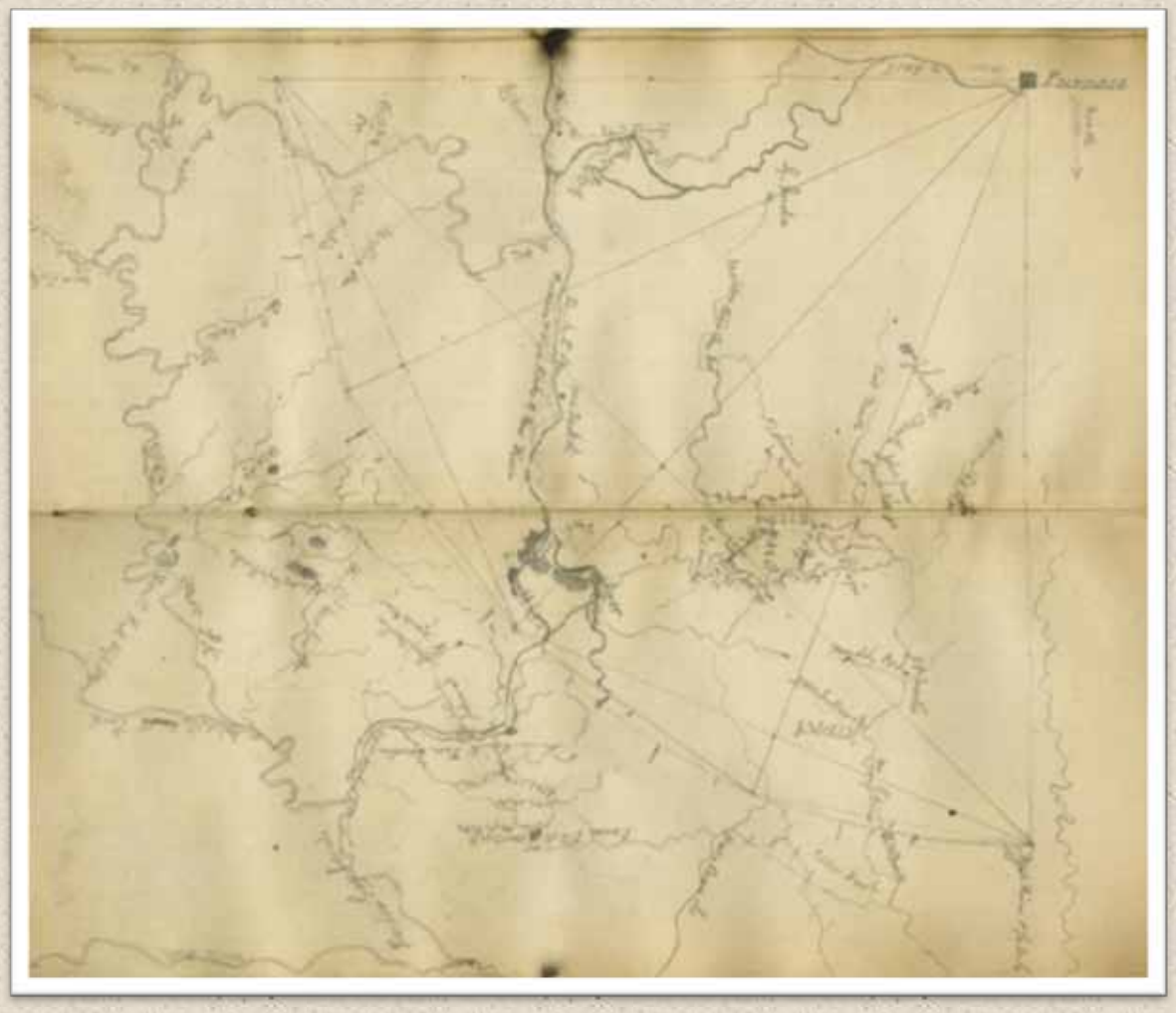
Kentucky was a leading producer of iron in the nineteenth century; the earliest furnace in the state was the Bourbon Furnace built in Bath County in 1791. Many others followed and today the Daniel Boone Forest encompasses several including the Beaver Creek Furnace (established 1819), the Caney Creek Furnace (established 1838), the Clear Creek Furnace (established 1839), and Cottage Furnace (established 1854).

The furnaces capitalized on the presence of multiple natural resources used to produce iron: these resources were ore beds, timber for charcoal, limestone for flux, and stone for the furnace structure itself. Until the 1870s, Kentucky was the third largest producer of iron in the United States.

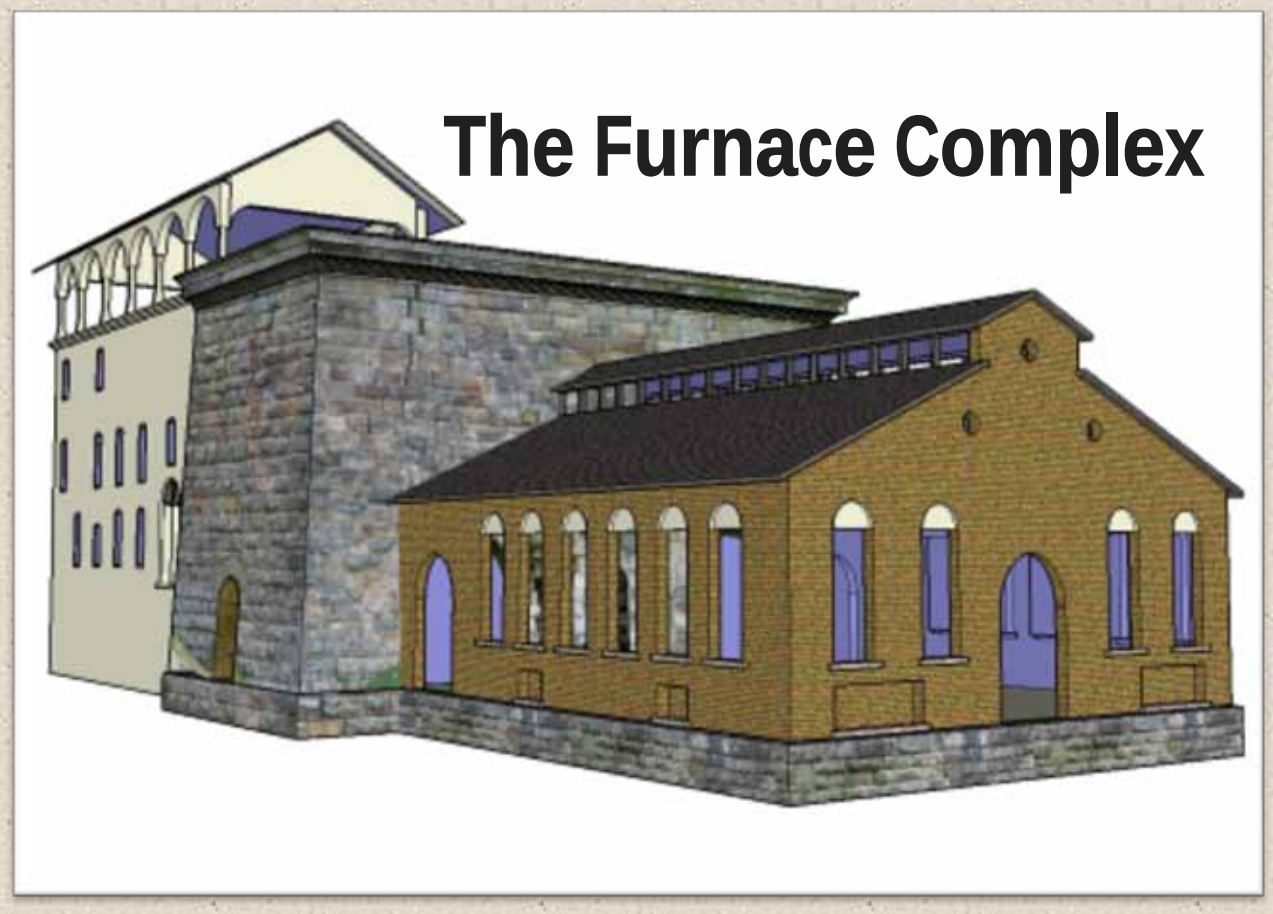
Why this location in Estill County?

Besides the presence of high quality ore beds, plentiful timber and good sandstone for building, this location in Estill County was also close to Miller Creek, which fed directly into the Kentucky River. From here, the finished iron could be shipped downriver to major markets in Louisville.

As part of the research for the furnace, Frank Fitch made detailed maps of the area before selecting a location for the furnace. In this map from his 1867 notebook, Frank has mapped an area just north of where the furnace sits today. The area mapped here was probably not selected because none of the streams drained into a major river.

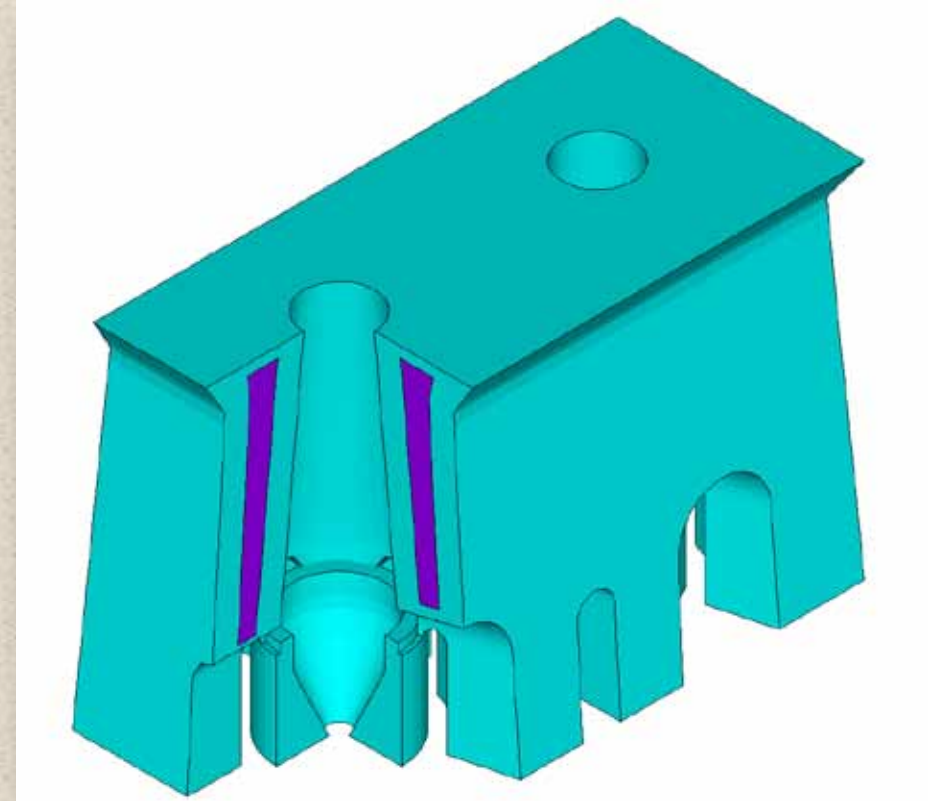


The Fitch brothers spared no expense incorporating the latest technology. Their efforts to build a showcase are also reflected in the construction and workmanship. The massive hand-dressed masonry structure was built from native sandstone by Italian stone masons. The extra efforts are reflected in the quality and details incorporated in the design and apparent in the dressing of the stone and the decorative cornices. .Approximately $100,000 was spent on the construction of the furnace, and another $60,000 went to purchase and import the necessary machinery for the furnace.



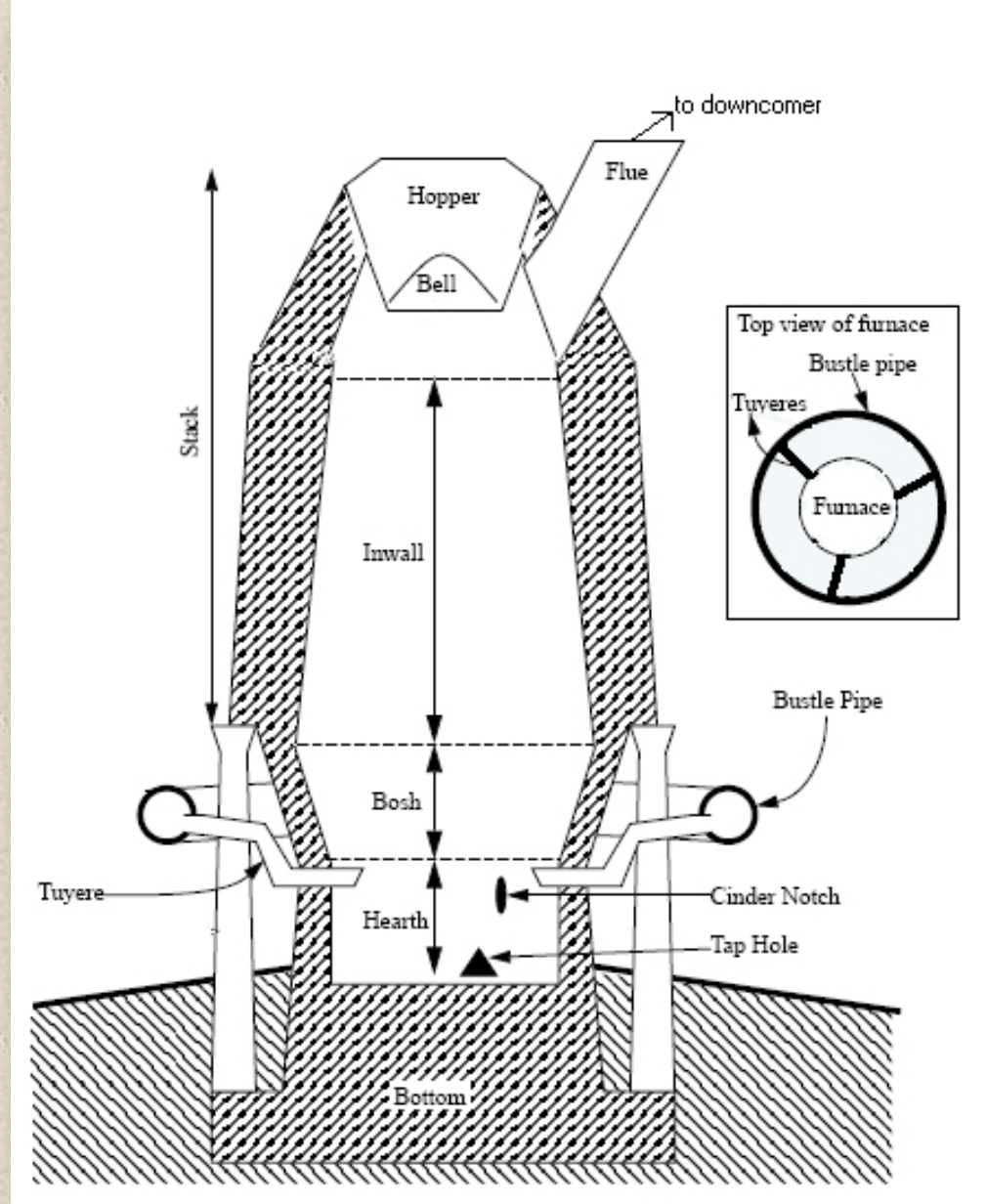
This artist's conception, based on historic photographs and archeological findings, shows the furnace flanked by the four-story power house in back and the casting shed in front. The furnace went into blast for the first time on March 4, 1870.

The Blast Furnace Process



Fitchburg Furnace was a blast furnace. A blast furnace operates as follows: first, a crew dumps ore into the furnace stack from the top. The ore is followed by charcoal which serves as fuel, and limestone which acts as flux. Flux ensures the proper chemical reaction occurs inside the stack.

As you can see here, the furnace stack is made in the shape of two cones, with a short cone pointing downward and a longer cone pointing upward.

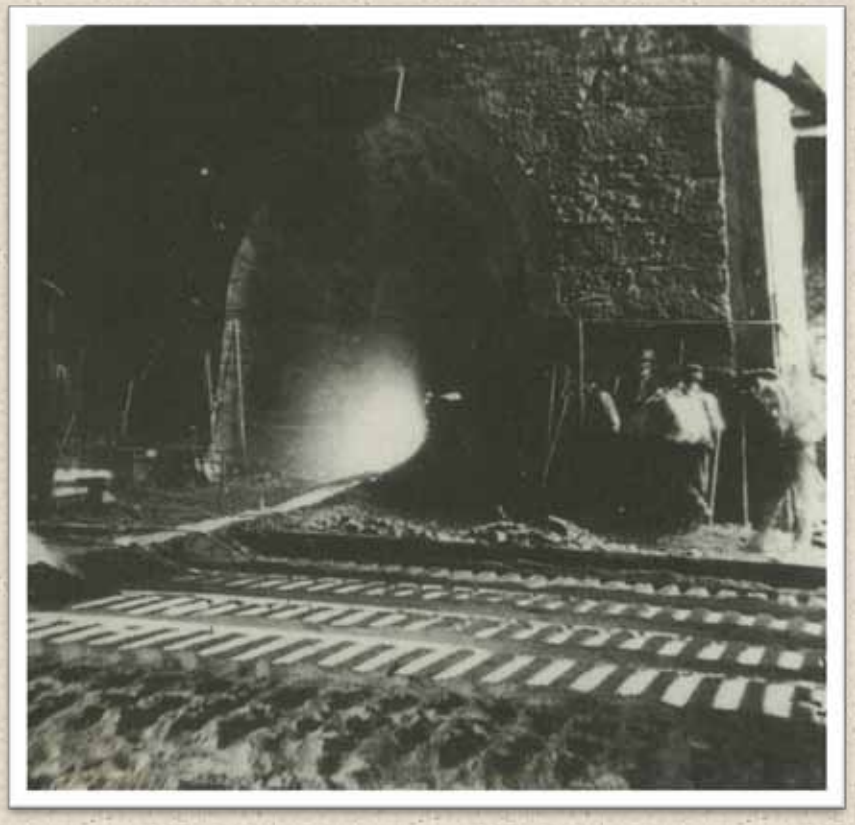


Technological Innovations

The sloping surface of the lower cone supports the weight of the ore, fuel and flux. Bustle pipes encircle the stack at the base and feed air into the stack through tuyeres. The air could be sent in pre-heated by stoves on top of the furnace (making it a hot blast furnace) or not pre-heated (making it a cold blast furnace). As the charcoal burns, it produces carbon monoxide which combines with ore to form liquid iron which collects at the bottom of the stack. The flux reacts with the remaining materials in the ore to form slag, which the crews drain off periodically through the firing process (Gordon 1996: 100-101).

During firing, the molten iron remains puddled behind a dam stone; when ready, a clay plug in the dam stone would be pulled out with long handled tongs, allowing the molten iron to gush out into long, gently sloping channels of sand inside the casting house. Gutter men, equipped with long paddles-like tools, worked in the casting house, diverting the iron from the main channel into smaller, side channels. These side channels would produce iron bars from 4-6 feet in length. The main channel was known as the “sow” while the side channels were called “pigs,” hence the term “pig iron” (Fig n.d.)

Technological Innovations

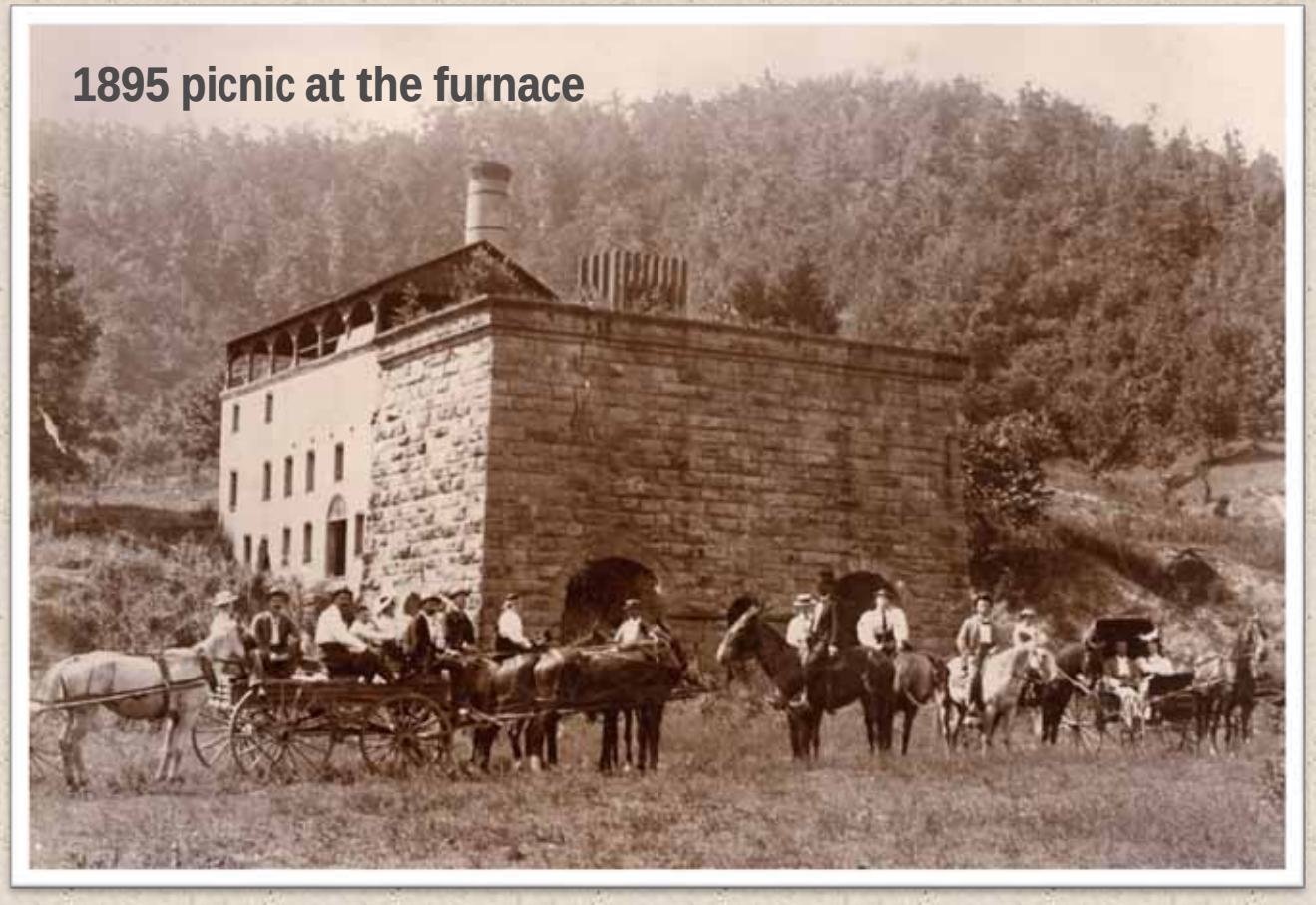


Another feature of the Fitchburg Furnace was the use of a bell and hopper design at the top of the stacks, which served to keep in hot gasses even while workers added material to the stack.

The use of these technologies resulted in a more efficient production process. As a result, Frank was often able to produce a ton of iron using only 155 bushels of charcoal, though at other furnaces 200 bushels or more were required per ton. In 1870, the furnace used 2,700 tons of ore, 162,000 bushels of charcoal and produced 900 tons of pig iron.

Failure of Fitchburg Furnace

Despite all Frank's careful calculations and the innovations, the furnace operated for only 4 years. Several factors were likely to blame. First, there was a major market decline in 1873 during which demand for iron fell dramatically. In addition, when Frank first designed the furnace in 1867 the state had passed a resolution to build a rail line to the area; however, that rail line was never built, and hauling the finished iron to Miller Creek and shipping upriver was proved too difficult to maintain.

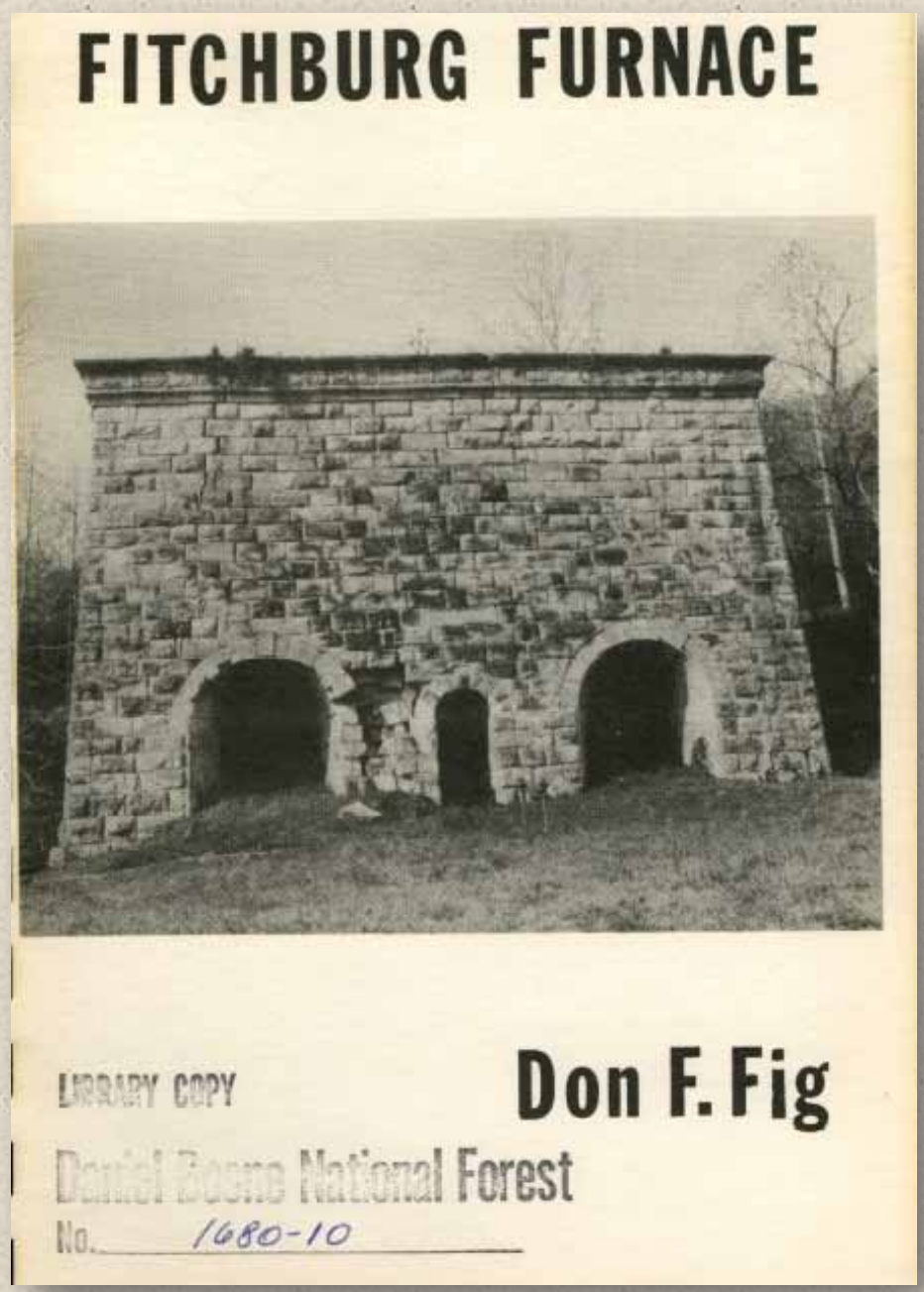


Finally, first quality ores were discovered in Alabama in the early 1870s and the market quickly grew to favor products from Alabama. Some also say that Frank Fitch was not well liked by the workers and that this also contributed to the failure of the workings- however, additional research is needed on this topic. The furnace ceased production in 1874.

Failure of Fitchburg Furnace

Following the end of operations, the Red River Company could no longer make payments on its debts and the property passed into other hands. Photographs from 1895 show the furnace and power house intact, but the casting shed already gone.

Over the next 100 years, the furnace sat abandoned and nearly forgotten. A few, including the descendants of Frank Fitch, still remembered what had been hoped for at the furnace, and came to visit. Other visitors came for less sentimental reasons. Sometime in the first half of the twentieth century a blast inside the furnace dislodged a number of stones inside and on the façade of the furnace. Some say the parties responsible were merely removing left over iron that was cemented to the clay liner of the stacks. Others say the damage was intentional and caused by a local moonshiner who resented visitors to the furnace.



Forest Service Era

In 1968, Forest Service employee Don Fig began researching the furnace. Don, an avid historian of the area, played a pivotal role in preserving the furnace. On April 6, 1973 Joyce Broddus and Toska Middleton (descendants of Frank Fitch) donated 1.96 acres containing the furnace to the Forest Service.

Through the continuing efforts of Don Fig, Fitchburg Furnace was placed on the National Register of Historic Places on April 17, 1974.

The Twentieth Century

Some work was undertaken right away. In 1975 and 1976, a Youth Conservation Corps groups cleared brush, constructed a parking lot, installed interpretive signs and constructed a self-guided trail around the furnace.

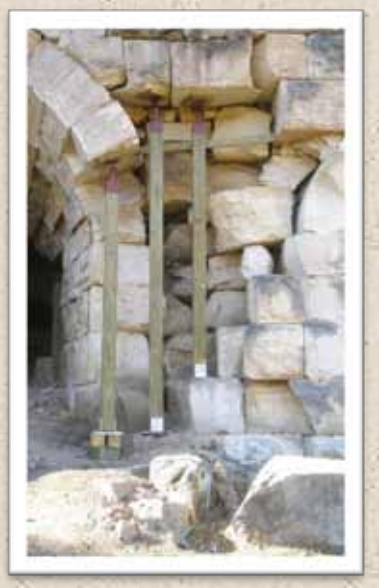
Following the work of the YCC, little more was done for the next 30 years at Fitchburg Furnace. Vegetation and trees grew up on top of the furnace and cracks both large and small developed and grew across the structure. One crack on the south end was especially alarming as it was of some size and seemed to be getting larger when compared to historic photographs.

Stabilization: Round 1

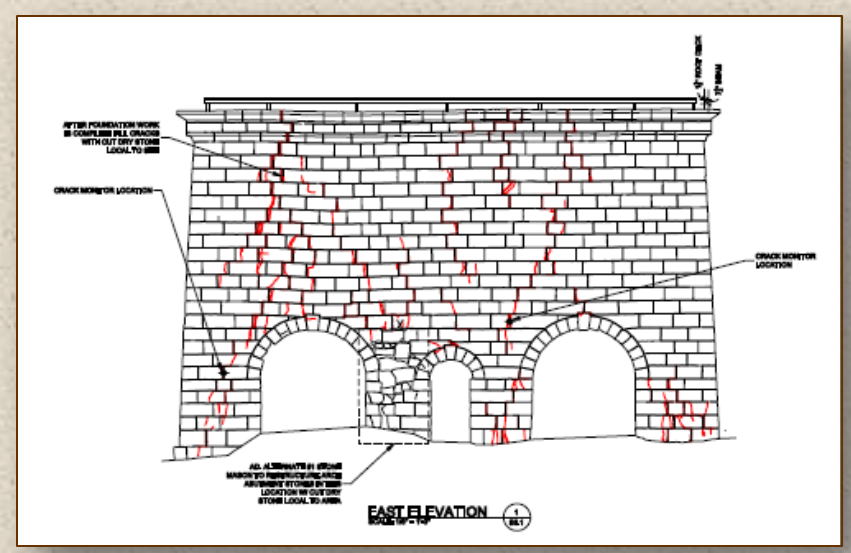
However, there were others who knew about the furnace and were determined to preserve it. These interested parties took note of the deterioration and in 2001 they were instrumental in having an engineer from the University of Pennsylvania examine the structure. That assessment noted there were serious cracks in the structure and stated that "Without at least selective intervention, a collapse of some portion of the structure can be expected to occur within the next five years."

This assessment lent urgency to the need to stabilize the structure. Two years later, U. S Senator Jim Bunning secured $670,000 for preservation of the historic Fitchburg Furnace.

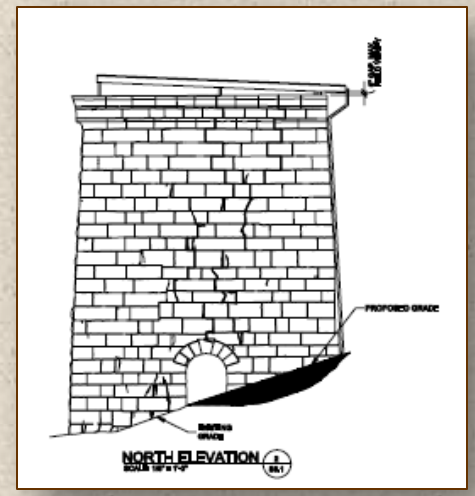
With the Bunning earmark, the non-profit group Friends of the Furnace, the Center for Historic and Architectural Preservation at the University of Kentucky, and the US Forest Service worked together to make the first round of improvements.

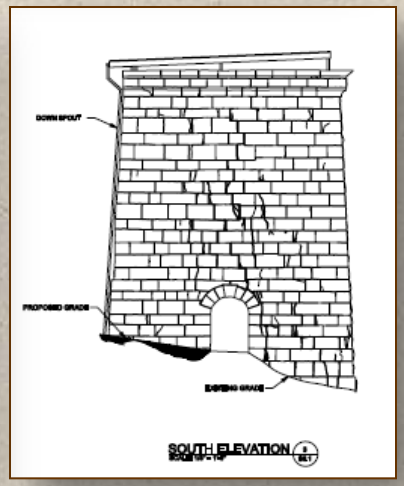


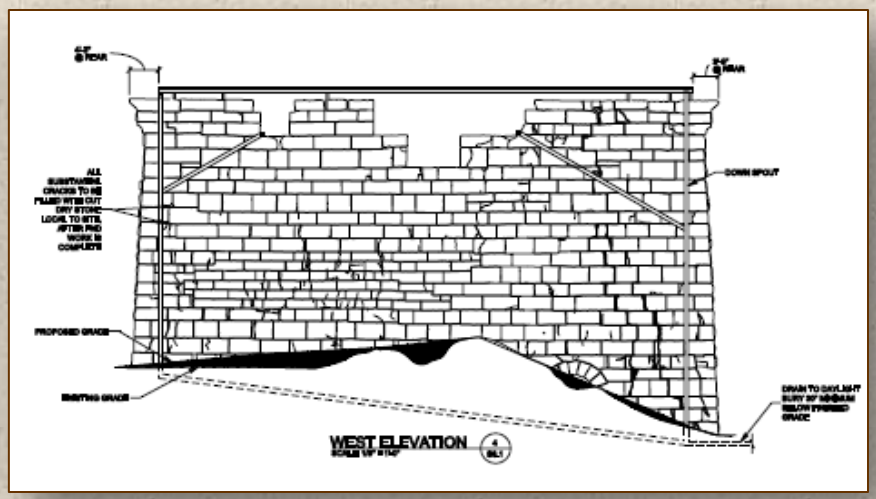
Engineering



First, a very intensive engineering study was undertaken to assess the weakness of the structure and prioritize repairs. As a result of this study, the first actions recommended were buttressing the foundation on the south side, installation of temporary arch supports where stones were missing, and the construction of a protective, translucent roof that would keep water out of the structure but still let in light.



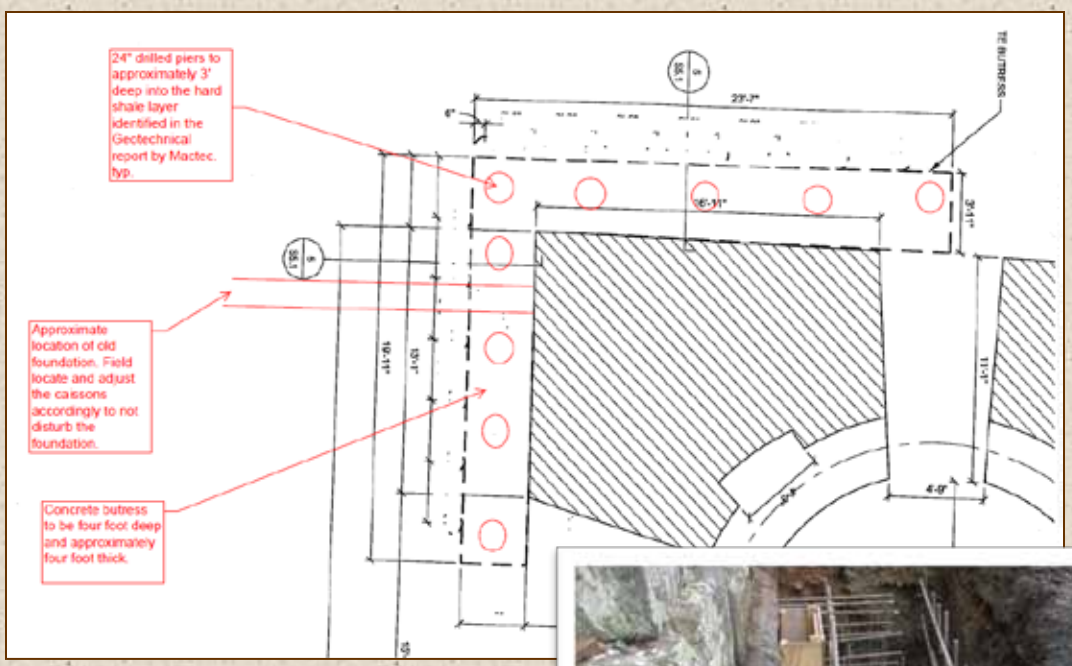




Construction

Before a roof could be installed it was necessary to clear the vegetation, most of which was done by the Friends of the Furnace.

Following this, a low pitched roof set back from the front and sides of the furnace was built and covered with plexiglass. The roof design minimized the visual effect for visitors and the plexiglass allowed enough light to enter the furnace stacks so that visitors could see the original architecture.

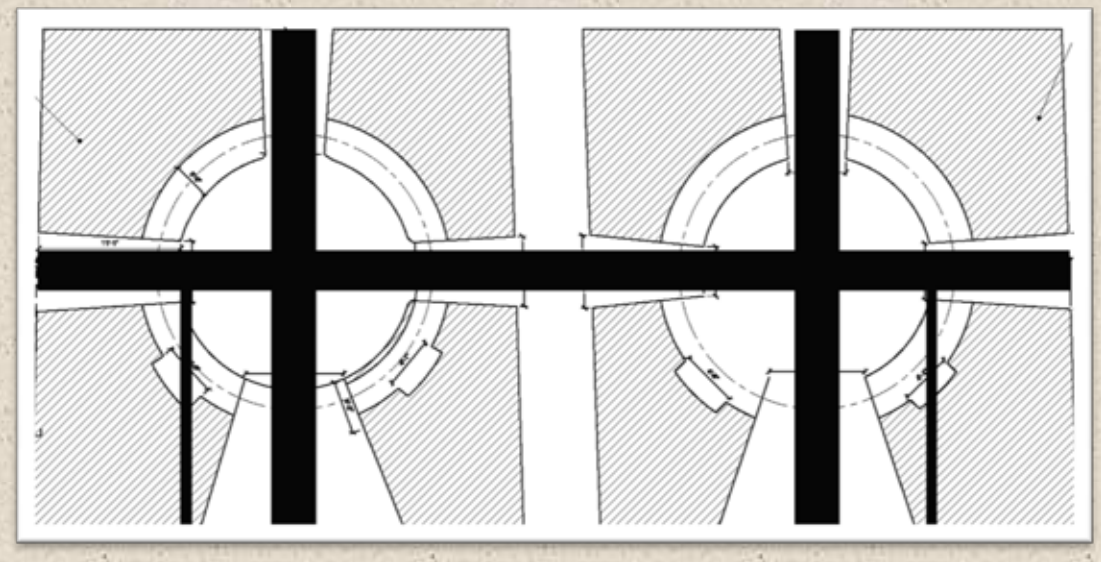


Foundation

The engineering assessments concluded that the southeast corner of the furnace was slipping and settling. To address this problem a concrete buttress was built around the corner. The buttress was anchored to the underlying bedrock with nine 24” casions set 20’ deep. The casions were tied to a rebar framework, which is anchored into the sides of the foundation.

Discoveries

A number of interesting discoveries were made during installation of the roof and buttressing. Work on the roof revealed vents, low walls, and iron splatter (splash iron). Work around the foundation uncovered slag deposits and previously undiscovered channels under the furnace.



Further exploration determined that there are likely five channels built into the foundation with a primary channel running the length of the structure. Smaller, auxiliary channels run perpendicular to the primary channel.

Exploring the Primary Channel

Chris Jenkins – braver than me

The channels are relatively free of debris. They are primarily filled with dirt and small stone fragments. The only artifacts found were a few small pieces of iron. A few erosion channels were found in the fill. These drain toward the front and side of the furnace.

The function of the channels is not known. We think they provided ventilation to help keep the furnace from over heating. The hottest temperatures are at the base of the hearth and the largest channels pass directly under this area of the furnace.

Further issues: Drainage

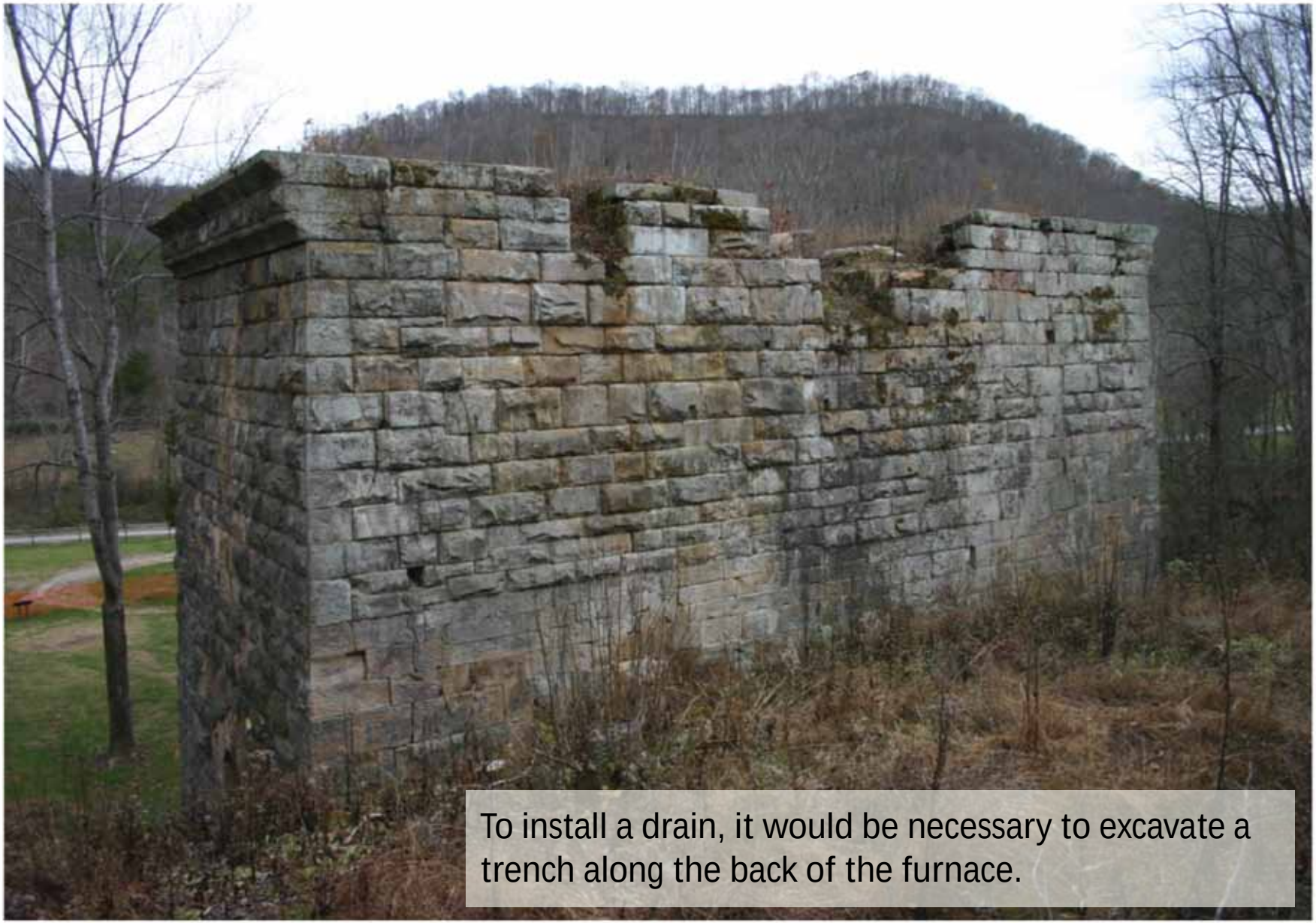
Work around the foundation also revealed that water percolated out of the hillside behind the furnace on a constant basis. Therefore, until a drain could be installed, the possibility remained that water could collect behind the buttress and run into the foundation via the newly discovered channels under the furnace.

Missing Stone

Despite attempts to blow up the furnace, the interlocking nature of the construction resulted in a very stable structure. However, the arch supports were installed until funds could be procured to and the missing stone. To aid in this effort, the original stone quarry was located and permission obtained to quarry additional stone.

Stabilization: Round 2

In 2008, American Recovery and Reinvestment Act (ARRA) funding was secured to proceed with the installation of a drain along the back of the furnace and to replace the missing stonework.



To install a drain, it would be necessary to excavate a trench along the back of the furnace.

Power House

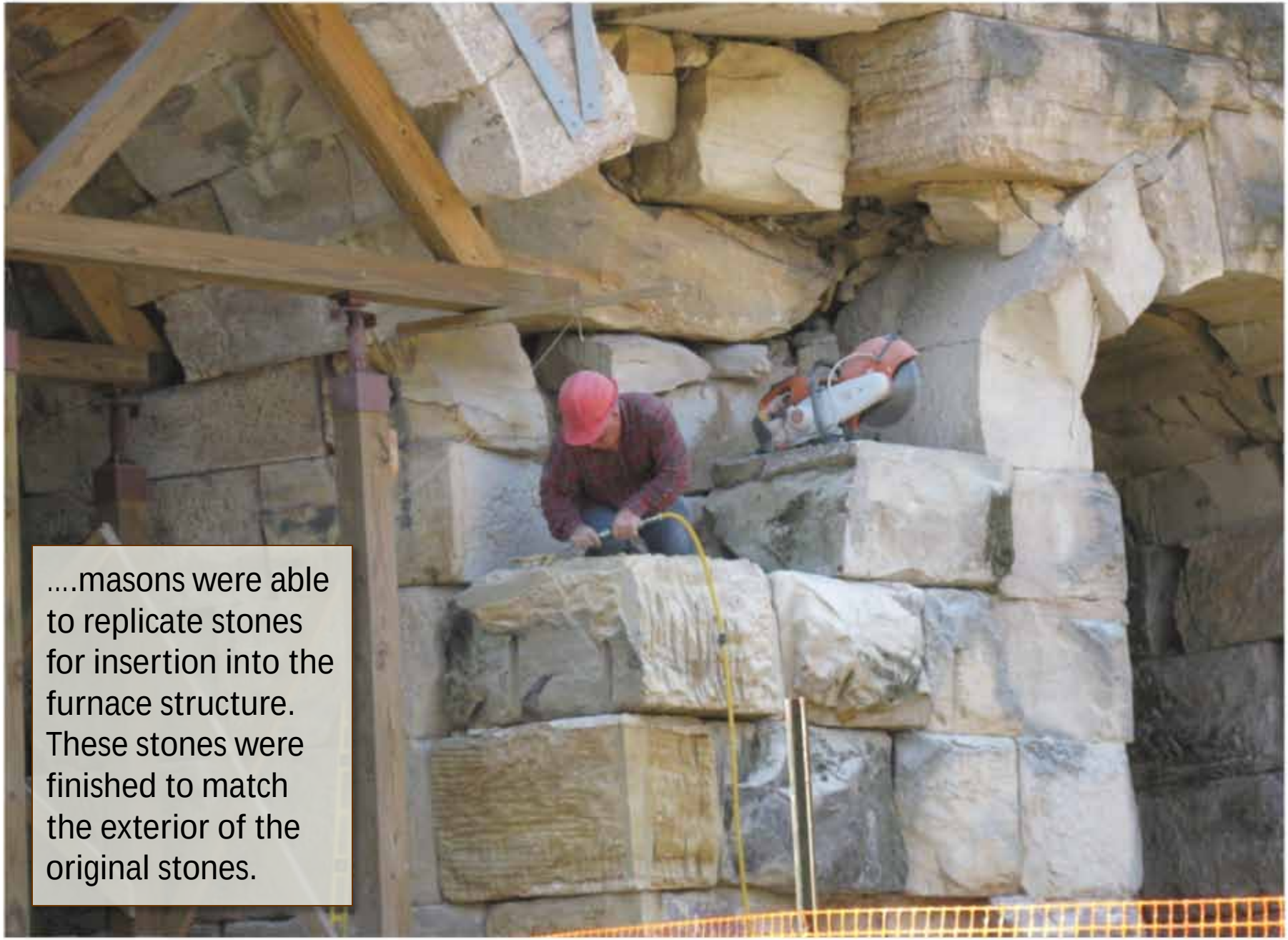
However, we knew that we should expect to encounter additional features in this area since this is where the power house had been located. The power house once contained the steam boilers that ran the blast machines and provided access to top of the furnace. This building had a sandstone foundation and brick walls.

Eventually excavation would uncover all three of the arch openings in the back and go down over 15 feet below the 2009 ground surface level in back.

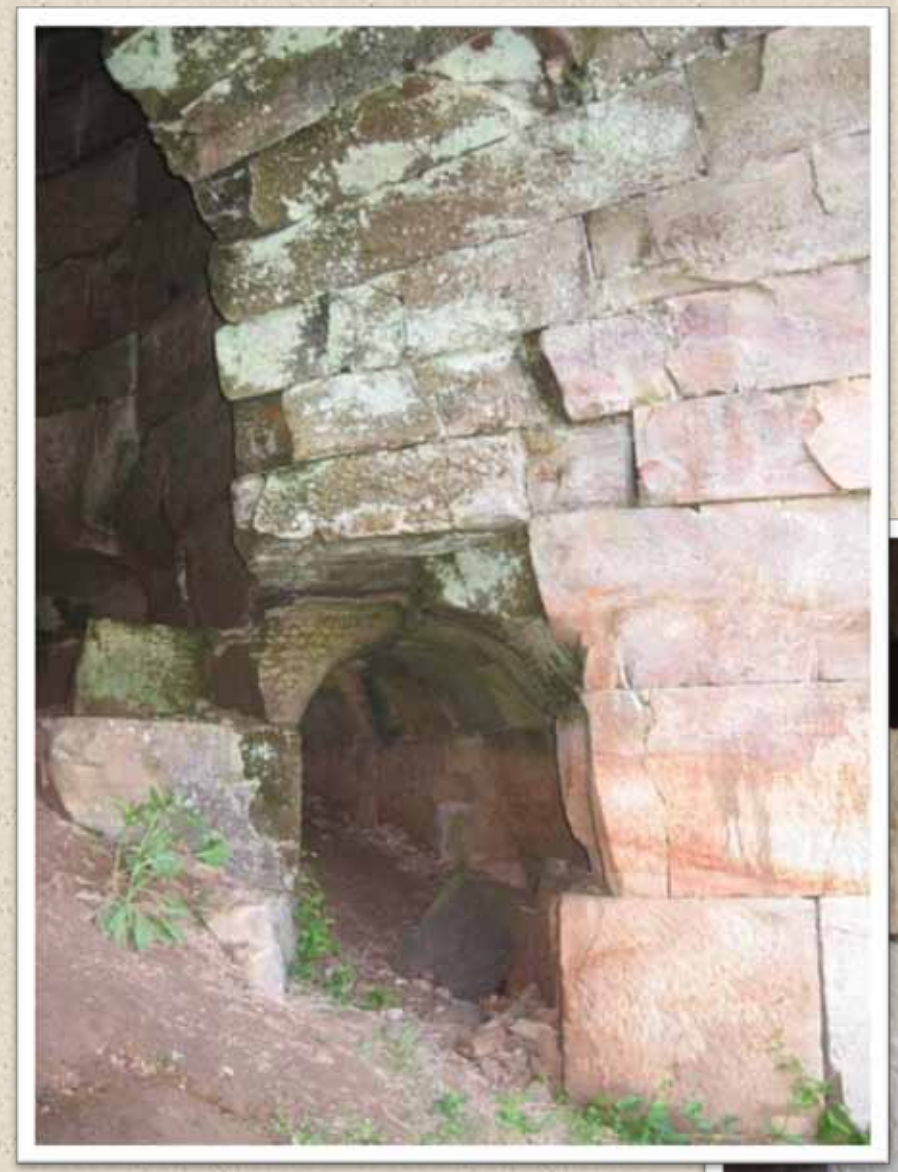
The natural spring was permanently diverted to the south. The trench remains open to allow visitors to see the newly uncovered foundation of the power house and back of the furnace.

A wooden superstructure has been put in place to ensure the safety of visitors.

With stones from the original quarry, …..



….masons were able to replicate stones for insertion into the furnace structure. These stones were finished to match the exterior of the original stones.



Some additional excavation was conducted inside the south stack to inform the placement of stones inside the north stack.

Before and after stone restoration

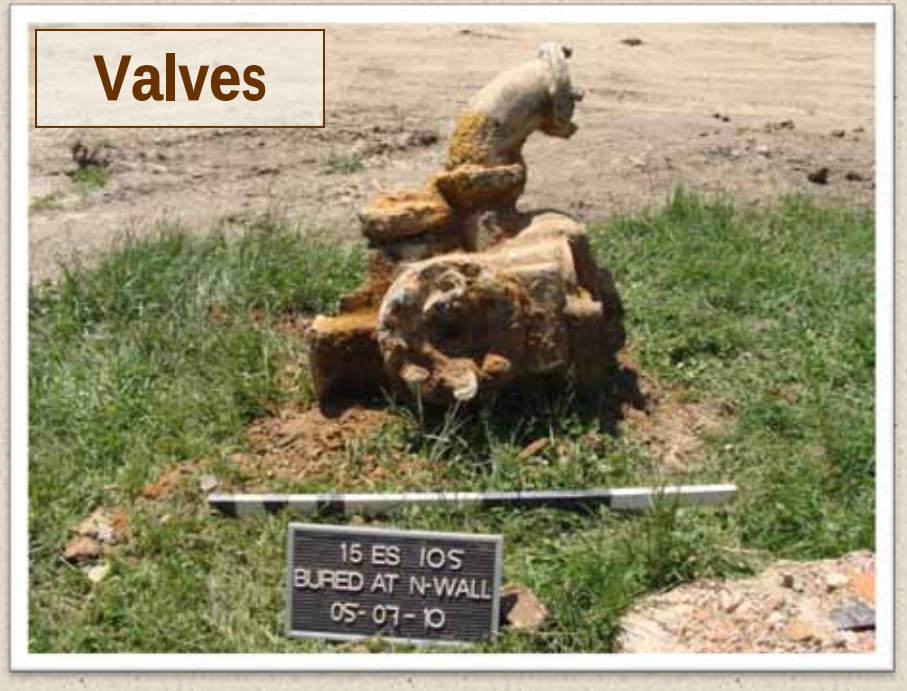
Discoveries

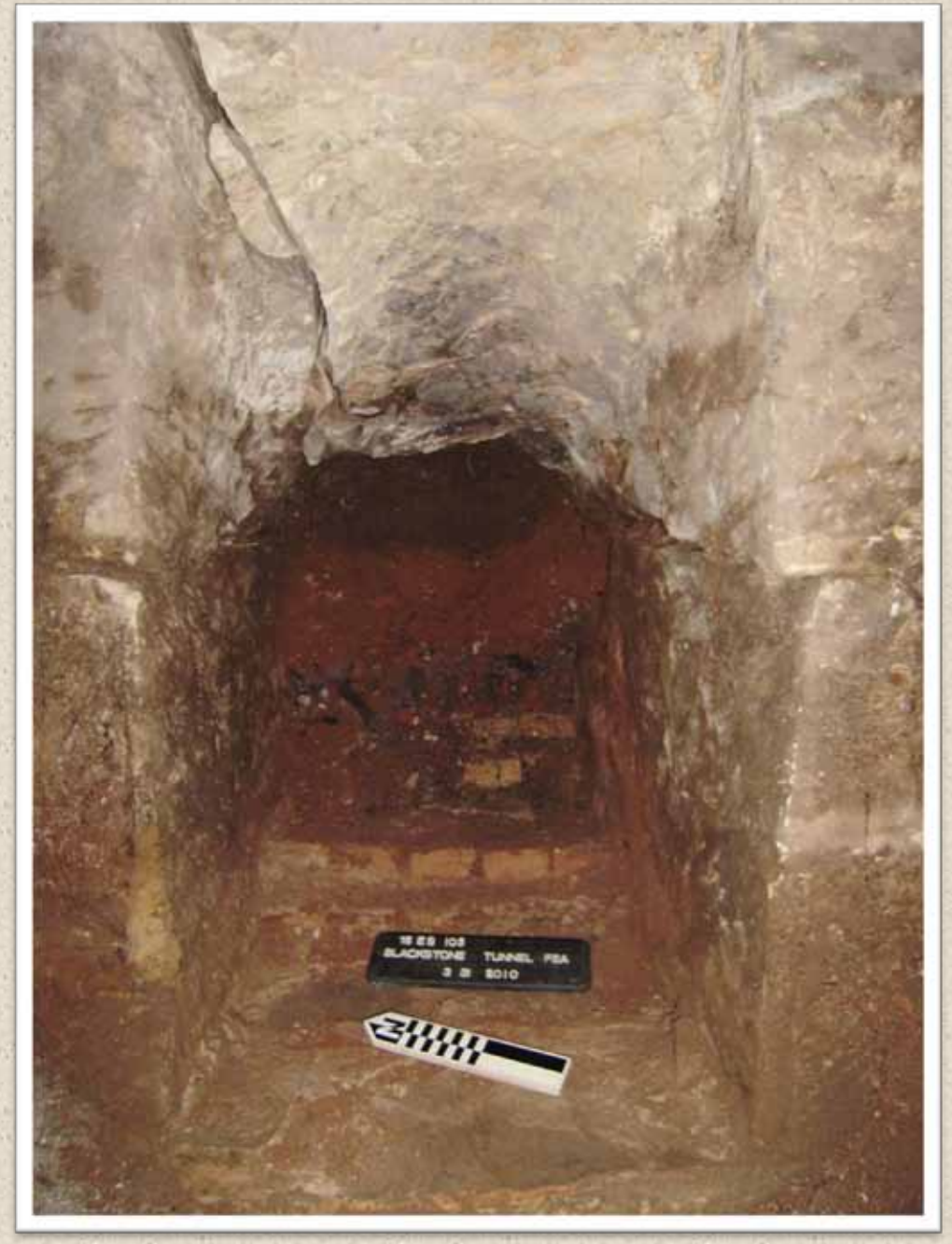
A large amount of machinery and piping was recovered from the excavation in back of the furnace. Many of the pieces were impossible to identify and all were simply fragments of larger pieces.

Boiler

However, recognizable pieces include a boiler tank,.....

.... a piston, counter weights, and pieces of a large flywheel. It is not surprising to find these pieces behind the furnace as they would have been originally contained in the power house; however, it is unclear why they are so fragmented.





Tuyere Openings

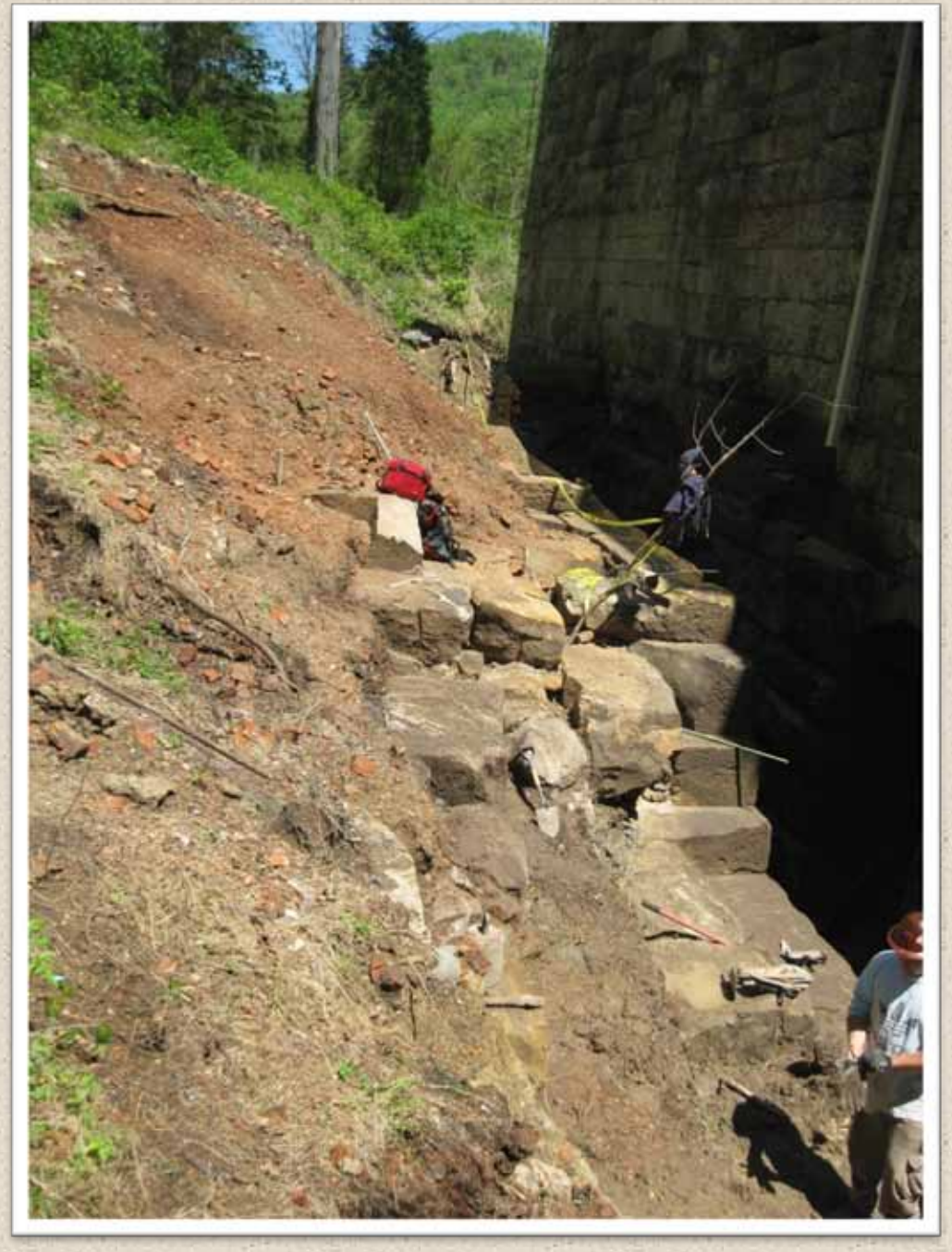
Excavation inside the stacks in preparation for stone work also revealed new information. Several bricked up openings were discovered in the channel surrounding the interior crucible. These openings were likely where the tuyere blasted air into the stack.

Niches

Everywhere we turned, we began to see niches carved into the stone structure of the furnace. They were in the stacks, in the powerhouse wall, and in the tunnel surrounding the stack where the bustle pipes were once located. There was once much more to see at the furnace, and we believe these niches held beams and supports for all of the piping that once encircled the furnace.

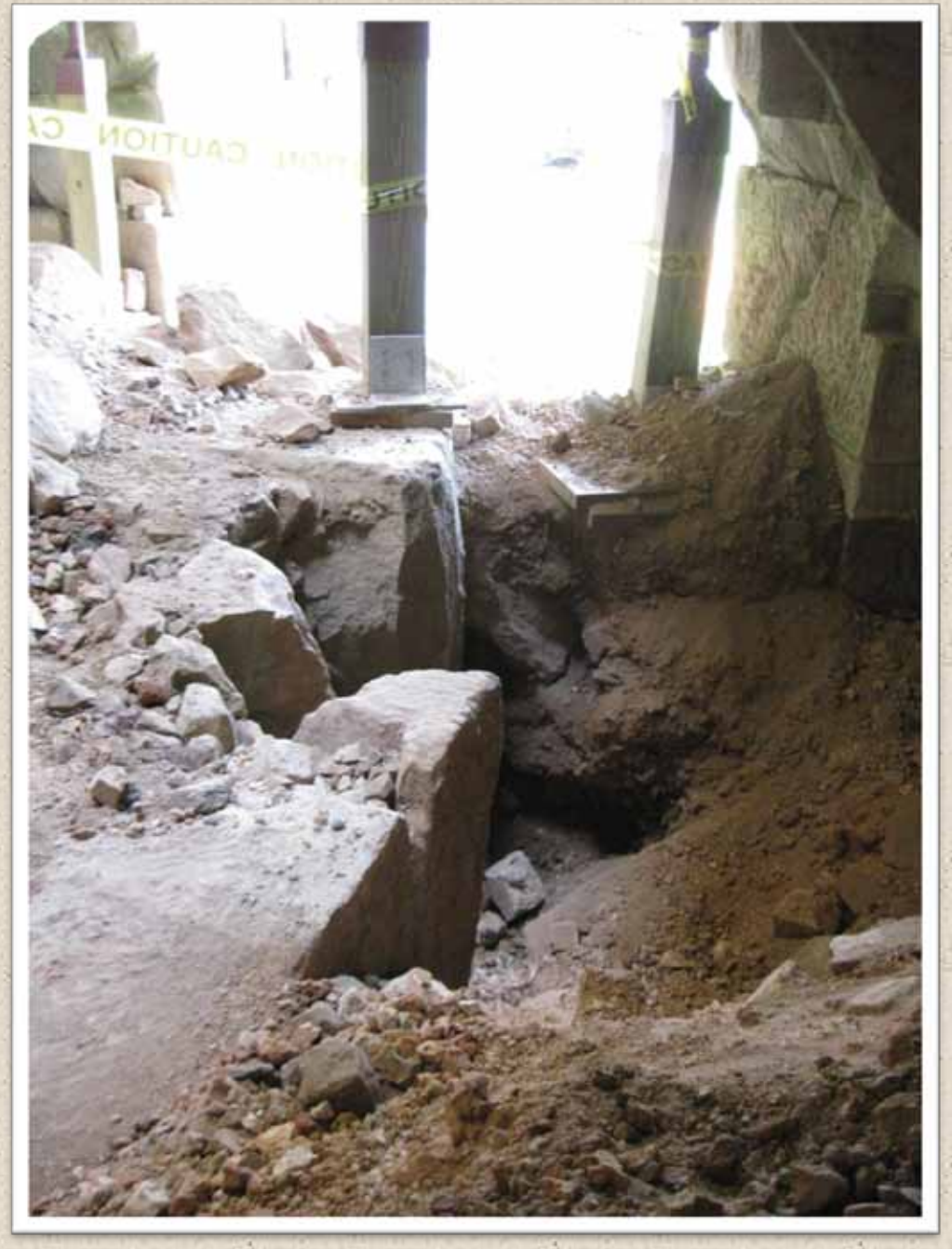
Power House Foundation

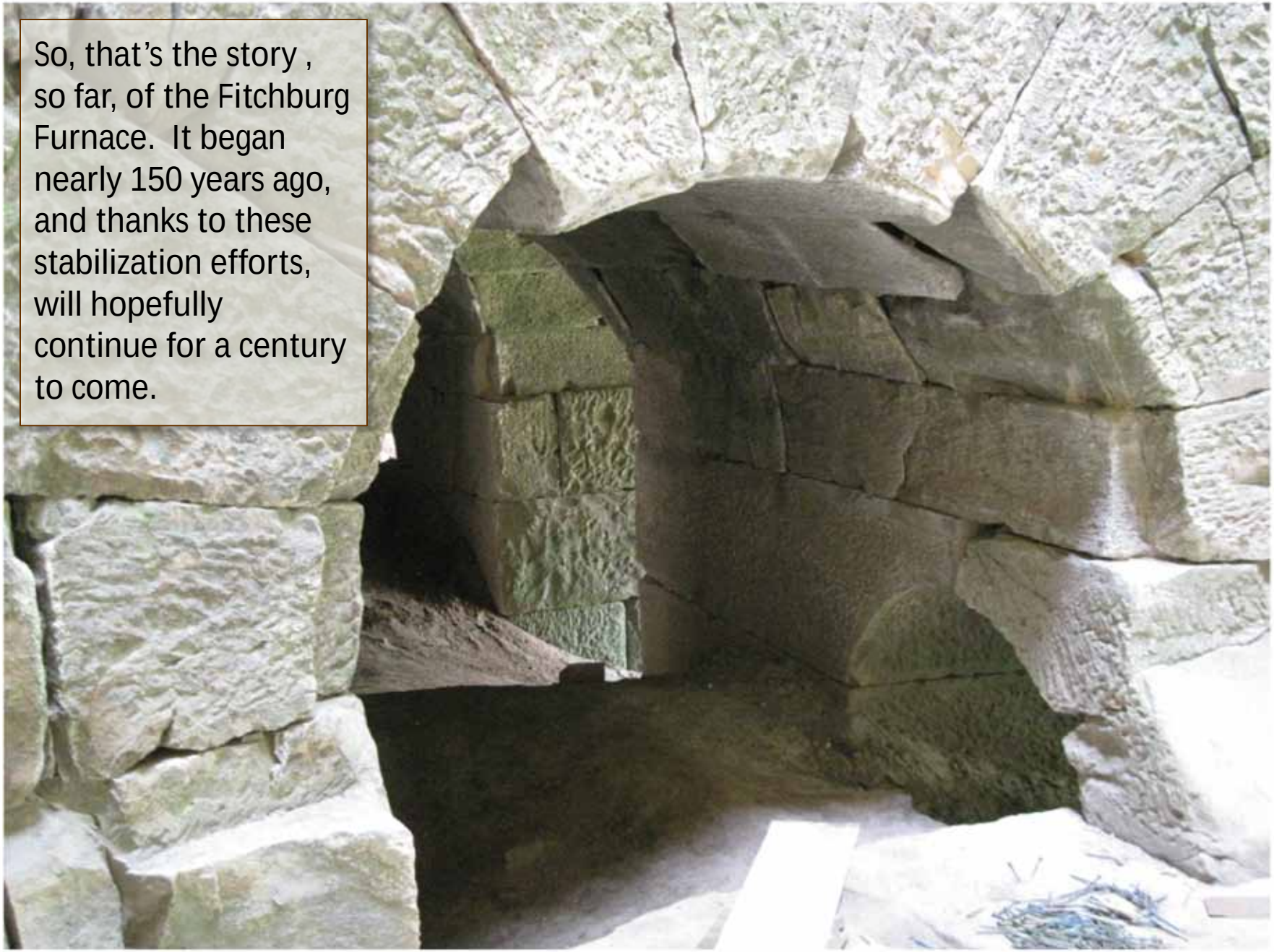
It also became very apparent that much of the foundation of the power house remains in place, just below the surface and running uphill behind the furnace.



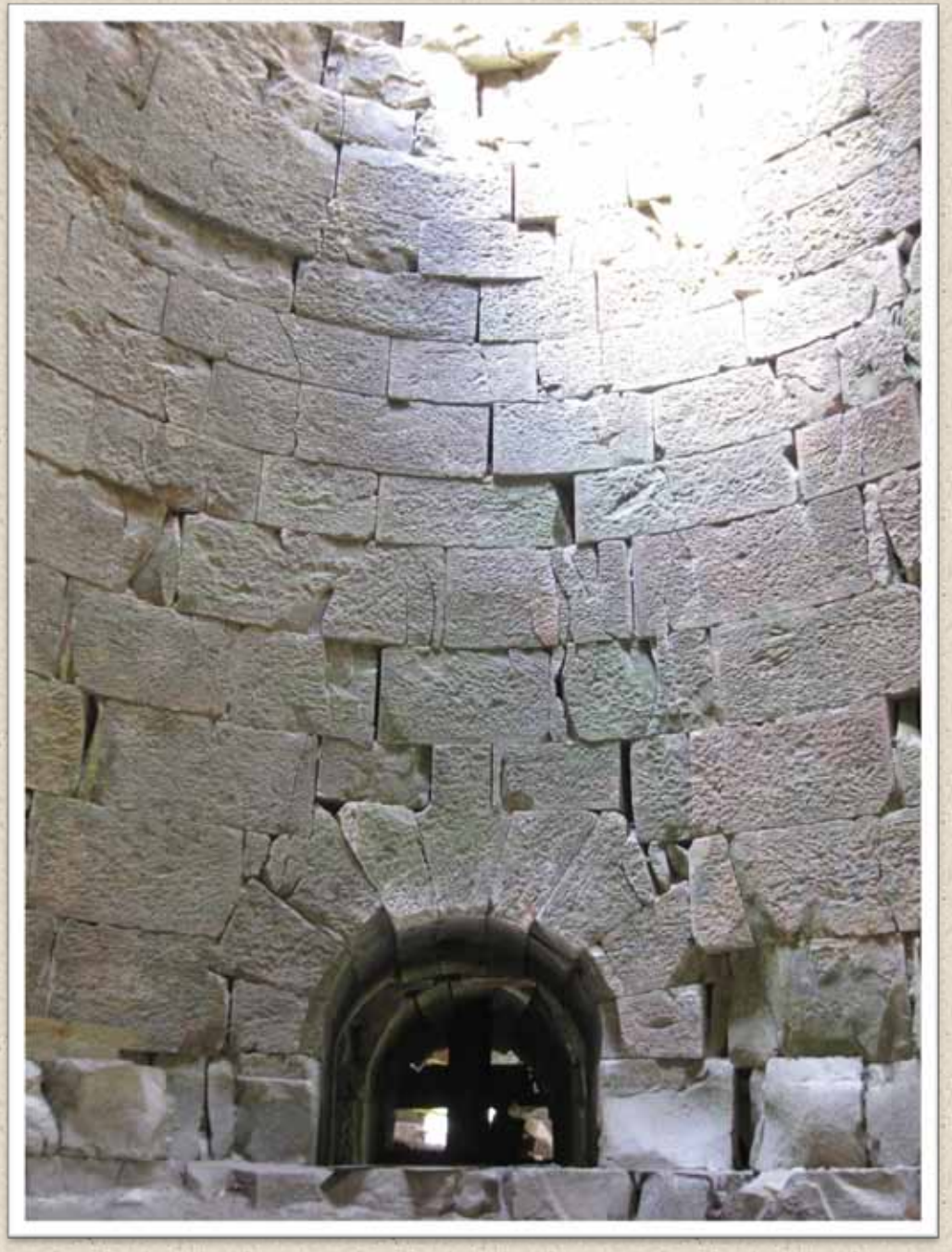
Additional Missing Stone

Excavations were carried out around the stones to be replaced. In several cases, we found more missing stones below the ground surface. The south arch of the northern stack was especially challenging as stone was missing for more than 3 feet below the current ground surface. Another loose stone was encountered in the south stack when soils were removed from a rear archway. That stone has now fallen from its place and additional stabilization measures are being designed for that area.





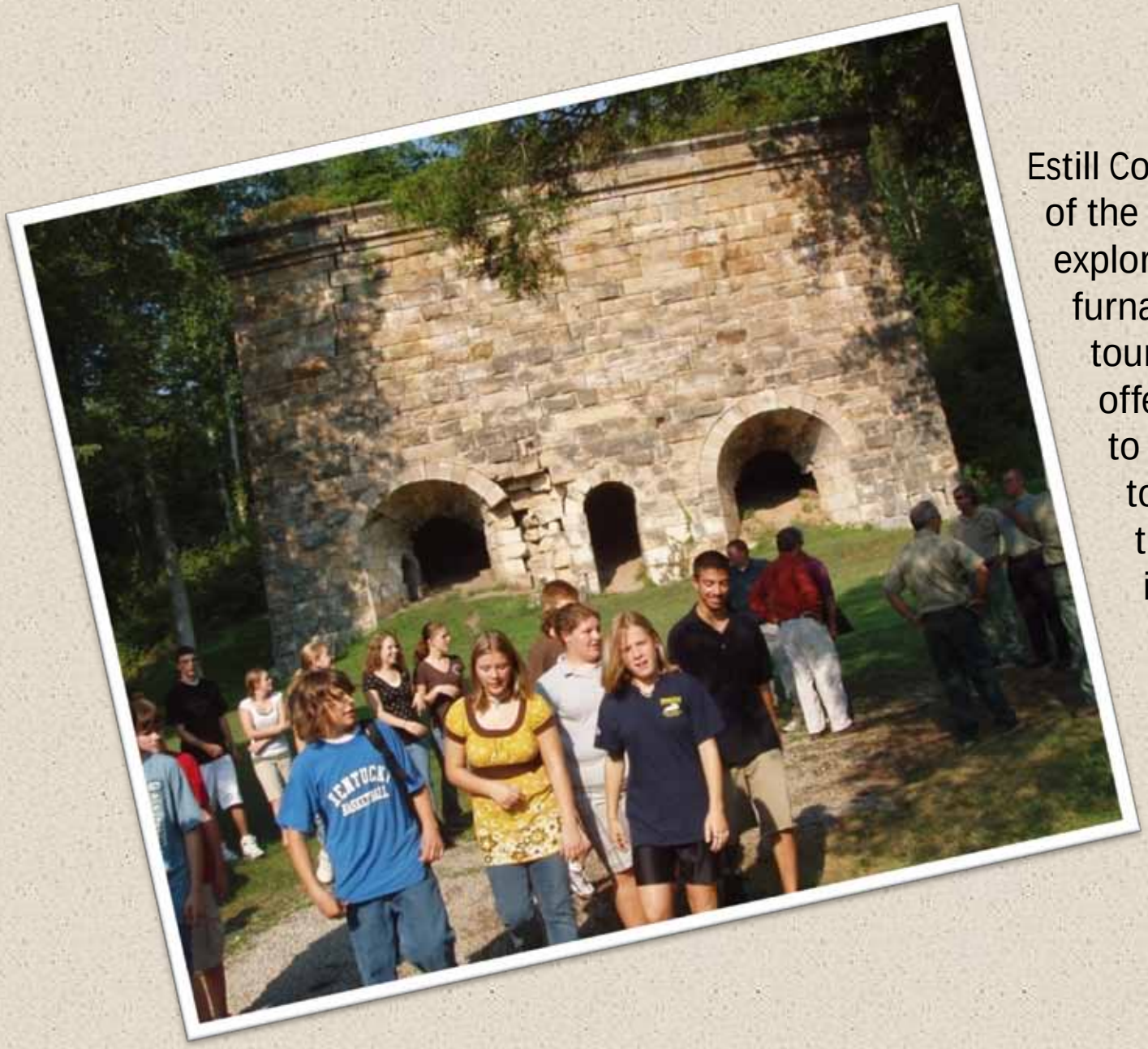
So, that's the story , so far, of the Fitchburg Furnace. It began nearly 150 years ago, and thanks to these stabilization efforts, will hopefully continue for a century to come.



Much work remains to be done, not only to further restore the furnace, but also to better interpret it for visitors.

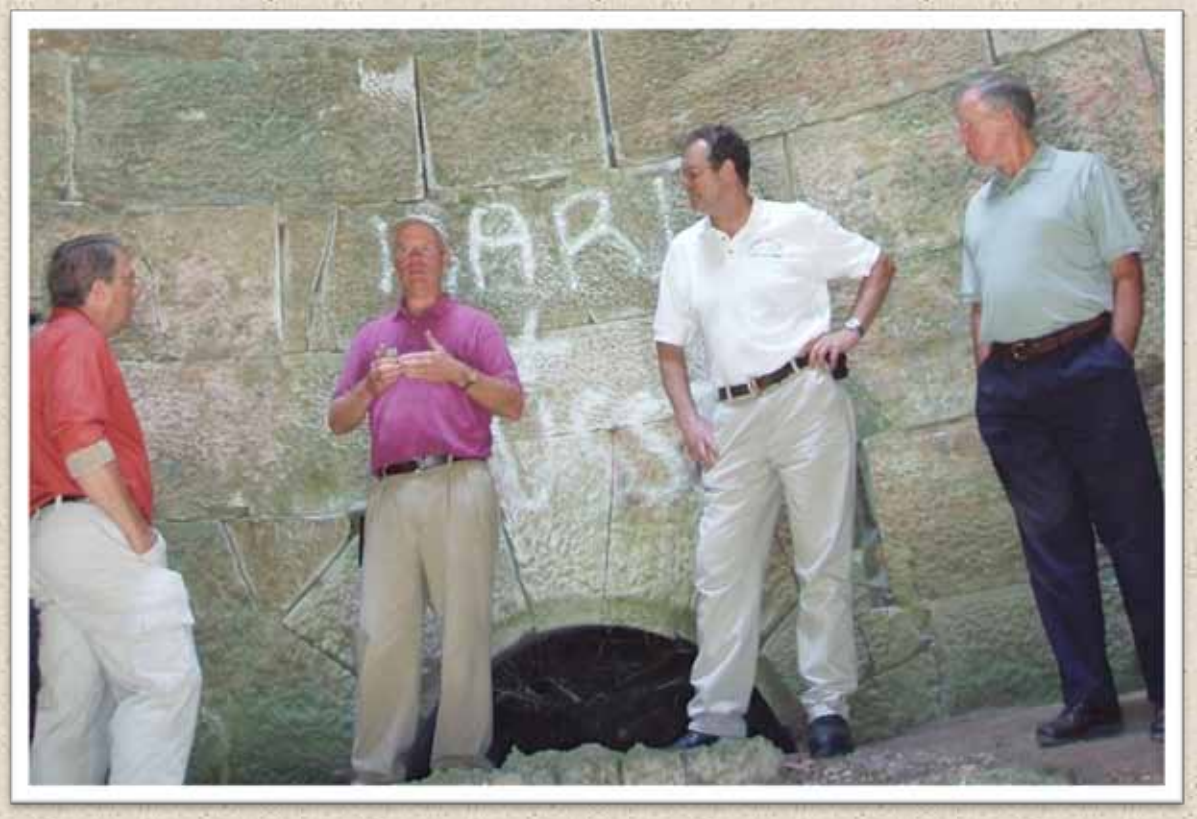
In the near future, we hope to develop permanent displays for the tank and other machinery recovered.

Further out, we hope to develop long-term management plans in cooperation with our long-standing partners in this project, the Friends of the Furnace.



Estill County and the Friends of the Fitchburg Furnace are exploring ways to use the furnaces to enhance tourism. The furnaces offer a good opportunity to develop a driving tour based on the theme of the iron industry in Kentucky.

Thank You!



I want to close by acknowledging the efforts of Lee Padgett and Skip Johnson, key members of the Friends of the Furnace. I would also like to thank the former Forest Archaeologist, Chris Jenkins, for passing the torch and the Forest Engineer, Gene Baker for providing the know-how.

Frankie Simpson of Spectrum and Kim McBride with the University of Kentucky Program for Archaeological Research were also spot-on in their work during 2009-2010. I would also like to thank my co-author, Frank Bodkin, for ensuring I got the facts straight.
Thank you all.