National Park Service
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Historic Architecture Program
Northeast Region

THE FURNACE GROUP

Hopewell Furnace National Historic Site
Elverson, Pennsylvania

Historic Structure Report

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HISTORIC STRUCTURE REPORT

Hopewell Furnace National Historic Site
Elverson, Pennsylvania

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Cover: Artistic rendering of the Furnace Group entitled "Hopewell Village, French Creek Park," commissioned by the American Bank and Trust Company of Reading, Pennsylvania, in 1973. The scene was executed in watercolors over lithographed penline by Gray's Watercolors, www.grayswatercolors.com.

Unless otherwise noted, all of the subsequently cited documentation is at Hopewell Furnace NHS.

Unless otherwise noted, all of the following are NPS photographs taken by the author in July 2006.

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I. INTRODUCTION

EXECUTIVE SUMMARY

Background

Hopewell Furnace is a charcoal- fueled, cold- blast furnace that was originally constructed by Ironmaster Mark Bird in 1770- 71. Cast iron produced at Hopewell was molded as cannon and shot for use during the American Revolution. The furnace was also known for its stoves, the earliest surviving model dated 1772.[1] Financial difficulties caused Bird and his partner to lose the furnace to a creditor in 1786, and the property passed through several owners between 1786 and 1800. Stability was finally established in 1800, when the furnace was purchased by a partnership of the Buckley and Brooke families. However, legal disputes resulted in the furnace being out of blast from 1808 to 1815, followed by extensive repairs to the works in 1816. Products of the furnace from 1800 to 1845 were pig iron, stove plates, and mixed castings. After 1845, production shifted to pig iron, plus small amounts of mixed castings. Improvements made in the 1880s included repair and rebuilding of the charcoal house and shed, installation of a steam engine and boiler to help drive the water wheel, and introduction of an ore roaster to improve the quality of the iron ore. Despite these betterments, the furnace shut down after extinguishing its final blast on June 15, 1883.

Deterioration of the furnace structures had already commenced when the first known photograph of the works was taken in 1887 (figs. 7 and 17), and had accelerated considerably by 1896 (figs. 18a and 18b). The water wheel and blast machinery were recorded and removed to on- site storage by the Franklin Institute of Philadelphia in 1931. Only the stone furnace stack and charcoal house remained standing in 1935, along with the Ironmaster's House and some tenant houses, when the furnace property was sold by A. Louise Brooke to the federal government. Development of the newly created "French Creek Recreational Demonstration Area" used the labor of both the Civilian Conservation Corps (CCC) and the Works Progress Administration (WPA), under the supervision of the National Park Service. Their work included clearing and drainage of the furnace site, stabilization of the furnace stack (1936- 41), and partial restoration of the east head race (1938- 39). The historical importance of the old furnace was also recognized at this time by CCC Architect Gustavus Mang and NPS Historian Roy Appleman, who advocated restoration and reconstruction similar to John Rockefeller's Colonial Williamsburg and Henry Ford's Greenfield Village.

Hopewell Village National Historic Site was created by Act of Congress on August 3, 1938. Exhaustive archeological and historical research was conducted prior to all reconstruction work. Archeological explorations of the furnace site commenced shortly after the site was created, and continued intermittently through 1963. Historical research began in 1947. Reconstruction commenced with the water wheel, blast machinery, and west head race in 1951- 52. This was followed by restoration of the furnace bank retaining wall in 1956, and rebuilding of the bridge house, wheel house, and cooling shed in 1957- 58. The cast house and east shed

[1] The six- plate stove, cast with "Mark Bird Hopewell Furnace" and "1772" is currently on display in the Visitor Center at Hopewell Furnace NHS (fig. 1).

were reconstructed in 1964- 65. Finally, restoration of the charcoal house in 1965 completed the resurrection of Hopewell's Furnace Group. Except for two cranes installed in the cast house in the late 1970s, all subsequent work can be characterized as maintenance repairs and upkeep. The park's name was changed to Hopewell Furnace National Historic Site in 1985.

The appearance of the Furnace Group today is an interesting mix of time periods. Most components were restored or reconstructed to the time of the furnace's last operation from 1879 to 1883. This was accomplished with a good degree of accuracy by relying on the historic photographs from 1887, 1896, and the early 20th century. Also of great value were the remembrances of the furnace's last manager, Harker Long, who had come to Hopewell in 1867, and other employees and residents of the village. The cast house and east shed, on the other hand, were rebuilt to their ca.- 1840 configuration, as determined by archeology and the photographs of 1887 and 1896. This required much conjecture, and resulted in a final assemblage of structures that never existed historically. Nevertheless, the Furnace Group does provide the visitor with a three- dimensional space in which to visualize the workings of a 19th-century, charcoal- burning furnace.

Methodology

This historic structure report on the Furnace Group at Hopewell Furnace National Historic Site provides a chronology of its historical and physical evolution, describes its various parts, identifies character- defining features, and evaluates the integrity of the structures for the 1820-40 period of significance. It synthesizes and summarizes the information contained in numerous NPS reports written between 1935 and 2005. These research documents address the historical, archeological, architectural, landscape, and administrative aspects of the many components that make up the Furnace Group. Contextual information on Hopewell Furnace was obtained from Joseph E. Walker's book, *Hopewell Village, the Dynamics of a Nineteenth Century Iron- Making Community,* published in 1966. Photographs and architectural drawings from Walker's book and in the archives of Hopewell Furnace were studied, and several were chosen as illustrations. The files and drawing archives of the park's maintenance division were also examined for useful information. None of the original record books of Hopewell Furnace were examined for this project, since they had been extensively researched and referenced in the above- mentioned reports. The final product is an illustrated report that chronicles the history, evolution, and existing appearance of the various structures and elements that make up the Furnace Group. It is hoped that this study will be useful to the park in its ongoing care and stewardship of this significant property.

The Furnace Group is a collection of structures and elements that are both physically and operationally connected. These include the furnace; the furnace bank and retaining wall; the bridge house and connecting shed; the charcoal house and cooling shed; the wheel house, water wheel, and blast machinery; the east head race; the west head race; the tail race; and the cast house. It is important to grasp the interrelationship of these parts to understand the furnace operation. The original scope of this project, which was to address the cast house only, was thus expanded at the suggestion of Superintendent Edie Shean- Hammond to include all components of the Furnace Group.

The names of the various components of the Furnace Group are rendered in this report in lower- case format, for clarity and consistency, except within direct quotations. (The historical record contains significant variations with regard to capitalization.)

Report Organization

This report is divided into four primary sections as follows.

Section I, "Introduction," includes the author's acknowledgements, this executive summary, and administrative data.

Section II, "Developmental History," is divided into two subsections. "Historical Background" briefly chronicles the people and events associated with the Furnace Group at Hopewell Furnace. "Chronology of Development and Use" describes the physical construction, modifications, and uses of the Furnace Group structures. The entire text is illustrated with historical portraits, drawings, and photographs.

Section III, "Physical Descriptions," is a systematic accounting of the individual components of the Furnace Group. These are the furnace; furnace bank and retaining wall; bridge house and connecting shed; charcoal house and cooling shed; wheel house, water wheel, and blast machinery; east head race; west head race; tail race; and cast house. General information for each component is presented, along with a brief historical background, discussion of the restoration date, sources of documentation, List of Classified Structures (LCS) designation, descriptions of the existing features and elements, and a brief accounting of recent repairs and improvements. This section is illustrated with plans and recent photographs.

Section IV, "Conclusions," discusses the character- defining features of the Furnace Group. The existing integrity for the 1820- 40 period of significance and interpretation is also assessed. Finally, three options for future treatments are offered.

Sources of information consulted for this historic structure report are listed in the section "Bibliography." References in the text are also cited in footnotes. All research materials are in the files and archives of Hopewell Furnace NHS, unless otherwise noted.

ADMINISTRATIVE DATA

Hopewell Furnace National Historic Site

The park known today as Hopewell Furnace was established as Hopewell Village National Historic Site on August 3, 1938, by Acting Secretary of the Interior E.K. Burlew under authority of the Historic Sites Act of 1935. The new park included 213.66 acres and the historic structures of the village, which were withdrawn from the French Creek Recreational Demonstration Area previously established in 1935. The enabling legislation declared the site to be of national significance due to its "relationship to the colonial history of the United States."[2] The park was considerably enlarged in 1942 with the addition of the remaining 6,000 acres of the French Creek Recreational Demonstration Area. It achieved its present size of 848.06 acres in 1946 when 5,350 acres were transferred to the Commonwealth of Pennsylvania for recreational use as French Creek State Park. The name of the park was changed by Secretarial Order to the more historically accurate "Hopewell Furnace National Historic Site" in 1985.[3] The park is located in Elverson, PA, in the counties of Berks and Chester.

National Register of Historic Places

Hopewell Village National Historic Site was listed as a district nomination (#66000645) in the National Register of Historic Places in 1966. The nomination was updated in 1985. The defined period of significance spans the years 1771 to 1883. Areas of significance were noted as architecture, industry, and military (the American Revolution). Individual components of the Furnace Group were described in the nomination, including the furnace; furnace bank and retaining wall; bridge house and connecting shed; charcoal house and cooling shed; wheel house, water wheel, and blast machinery; east head race; west head race; tail race; and cast house. All components were considered to be contributing to the historic integrity of the district, despite most being reconstructions dating to the 1950s and 1960s.[4] Each reconstruction was thus found to meet the following three criteria: (1) "accurately executed in a suitable environment,"(2) "presented in a dignified manner as part of a restoration master plan," and (3) "no other building or structure with the same associations survives."

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[2] "Order Designating the Hopewell Village National Historic Site, Hopewell Village, PA," Aug. 3, 1938 – 3 F.R. 2039. Reproduced as Appendix A in the *Statement for Management, Hopewell Furnace NHS* (Pennsylvania: U.S. Dept. of the Interior, National Park Service, Mid- Atlantic Regional Office, Oct. 1993).

[3] *Statement for Management*, p. 9, and Leah Glaser, *Administrative History, Hopewell Furnace NHS* (Philadelphia and Boston: U.S. Dept. of the Interior, NPS, Northeast Regional Office, Aug. 2005), pp. viii and 292- 93.

[4] *National Register Bulletin 15, How to Apply the National Register Criteria for Evaluation,* 1990, revised 1991, p. 37.

List of Classified Structures

The structures comprising the Furnace Group are both physically and functionally connected. These have been documented in separate reports by the NPS because they were researched and reconstructed at different times. Today, the Furnace Group is recorded by the List of Classified Structures as 10 separate elements, each with its own LCS and structure numbers. These include the following:

FURNACE GROUP COMPONENT	LCS NUMBER	STRUCTURE NUMBER
Furnace	000691	07
Furnace bank and retaining wall	012113	08
Bridge house	416851	10
Connecting shed (a component of the bridge house)	416870	10A
Charcoal house and shed	000688	09
Wheel house, water wheel and blast machinery	416885	82
East head race	000692	32
West head race	000693	111
Tail race	000702	110
Cast house	416880	35

Treatment and Use

The Furnace Group is open to the public and interpreted to visitors as a museum. The designated treatment of cultural resources, including the structures of the Furnace Group, is "preservation," as directed by the 1993 Statement for Management and the 1994 Resource Management Plan. The Statement for Management notes that the preservation and interpretive focus of the park is the 1820- 40 period, but more generally defines the park's purpose "to preserve and interpret the site as representative of an iron- making community and a significant

way of life and work in the 18th and 19th centuries."[5] Future guidance is provided by the document titled *Hopewell Furnace National Historic Site Foundation for Planning and Management*, which is being used in the development of the park's first general management plan. This document identifies two areas of significance as follows:

> The period of significance for the iron era reflects the entire period of production from its beginnings in 1770 to the last blast in 1883. A second period of significance extends from 1934 to 1965, including the conceptualization of Hopewell Furnace as a historic park and its implementation as described in the *Restoration Plan for the Old Industrial Village* (1936).[6]

[5] *Statement for Management*, p. 6.

[6] *Hopewell Furnace National Historic Site Foundation for Planning and Management* (Hopewell Village NHS, July 2007), p. 2.

II. DEVELOPMENTAL HISTORY

HISTORICAL BACKGROUND

1769- 1800: Settlement and Development

Mark Bird, 1769- 86

Hopewell Furnace was founded and developed by Marcus ("Mark") B. Bird (1738/39 – 1812).[1] Mark Bird was the eldest surviving son of William Bird, Ironmaster, whose mansion erected in Birdsboro, PA, in 1751 is still standing today.[2] It was father William Bird who built Hopewell Forge on Hay Creek around 1743, often confused by future historians with the later Hopewell Furnace.[3] Mark Bird is said to have inherited his father's ironmaking business upon his death in 1761, although no probate records documenting the disposition of the estate are cited by researchers.[4] Nevertheless, it is known that by 1772, Mark Bird was in possession of three forges, a furnace (Hopewell), a water corn mill, a saw mill, a fulling mill, and 24 tracts of land in the townships of Robeson and Union in Berks County, PA.[5] Mark Bird married Mary Ross on January 6, 1763, with whom he fathered eight children between the years 1763 and 1781. Although it has been assumed that the family occupied the Bird mansion in Birdsboro, little is actually known of its place of residence.[6]

The 33- acre parcel of land on which Hopewell Furnace was constructed was acquired by Mark Bird from Owen Hugh, Yeoman, and his wife Hannah, in March 1769. Bird paid 76 pounds 10 shillings for the property located in Union Township, Berks County. Both Bird and the Hughes were then noted to be residents of Marion, another township in Berks County. The conveyance included "houses, buildings, etc.," which were most likely associated with a small farming operation.[7] Bird had another use in mind, however, transforming the site to an ironmaking furnace and village. Dated stones observed at the base of the existing furnace are physical

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[1] Genealogical information on the Bird family was obtained by Judy Pisano from "Bird and Burd Family Genealogy," website http://homepage.mac.com/jupisano/Menu1.html.Hopewell Furnace.

[2] The William Bird Mansion, located at the corner of Mill and Main Streets in Birdsboro, was recorded by the Historic American Buildings Survey in 1958. It is now used as a YMCA.

[3] Melvin Weig, "Hopewell Village and the Colonial Iron Industry," *The Regional Review*, Vol. II, No. 4, Apr. 1939, p. 2.

[4] William Bird died intestate (without a will), according to a later mortgage document dated Nov. 18, 1772. Mortgage Book BB, p. 199, Berks County Courthouse (BCC); abstract by Charlotte Fairbairn, Jan. 29, 1963, in "Court House Research and Abstracts, 1962- 63."

[5] Mortgage Book BB, p. 199, BCC.

[6] Historian Dennis Kurjack surmised that the Bird family lived in the "Big House" at Hopewell Furnace from 1778 to 1788, based on unspecified "available evidence." Cited by Kurjack in *Hopewell Village National Historic Site* (Washington, DC: NPS Handbook Series No. 8, 1954, revised 1958), p. 22.

[7] Deed Book A- 6, p. 237, Mar. 25, 1769, BCC; abstract by Fairbairn, Nov. 1962, in "Court House Research and Abstracts, 1962- 63."

evidence of construction in "1770" and "1771."[8] Bird was already in possession of thousands of acres of land in Union Township from which hardwood could be harvested for making charcoal to fuel the furnace.[9] Another necessary ingredient was iron ore that was obtained from two nearby mines. Bird acquired rights to mine ore from the Old Hopewell Mine, also known as Birdstown Mine, in 1770, and the Jones Good Luck Mine in 1774.[10] Iron production at Hopewell Furnace appears to have begun around 1770, judging by an advertisement for a later sale of the furnace in 1787 that states it had been in operation for 17 years, and a lawsuit in 1810 in which testimony referred to the furnace having been built about 40 years ago.[11] The furnace also operated as a foundry, casting both pig iron and useful products such as kitchenware and stoves. One of the earliest of these was a six- plate stove plate cast with "Mark Bird Hopewell Furnace" and "1772" (fig. 1).[12]

Figure 1. Six- plate Hopewell stove cast with "Mark Bird Hopewell Furnace" and "1772."

Mark Bird's contributions to the American War of Independence were also considerable, as described by author Joseph Walker:

> Before the outbreak of war Mark Bird served on the Committee on Observation and the Committee of Correspondence and was chosen to the Provincial Conference of 1775. When war came, he was Lieutenant Colonel for the Second Battalion of Berks County militia and later became its Colonel. He was credited with providing uniforms, tents and provisions for three hundred men at his own expense. He was a member

[8] Roy Appleman, *Historical Report, French Creek Area* (Bronxville, NY: Second Regional Office, NPS, 1935), p. 6, fn. 1.

[9] The Union Township Assessment Records for 1763 listed Mark Bird as having 8,050 acres of land. Cited in Joseph Walker, *Hopewell Village: The Dynamics of a Nineteenth Century Iron- Making Community* (Philadelphia: University of Pennsylvania Press, 1966), p. 21.

[10] Walker, *Hopewell Village,* p. 20.

[11] *Pennsylvania Gazette,* April 11, 1787, cited in Walker, H*opewell Village*, p. 23; and Penn's Lessees vs. Kohler, April 10, 1810, cited in Appleman, *Historical Report, French Creek Area*, p. 6, fn. 1.

[12] The stove is now on long- term loan from the Birdsboro Community Center to Hopewell Furnace NHS, according to Hopewell Furnace NHS Cultural Resource Manager Rebecca Ross.

> of the Pennsylvania Assembly; chairman of the General Committee of Berks County which selected eight members, including himself, to serve in the Provincial Convention of 1776; and judge of the Berks County Court. [13]

Hopewell Furnace also played an important role in the war, serving as a foundry for the manufacture of cannon and shells.[14] Entries in the *Journals of the Continental Congress* document contracts made by Mark Bird with the Cannon Committee of the Continental Congress for providing cannon to the United Colonies.[15] Twenty cannon intended for naval use had been delivered to Philadelphia, and 68 were still in production, in September 1776.[16] Gunpowder for proving (testing) the cannon was provided by the Board of War.[17] So important was the work of supplying ordnance that the Board of War recommended the discharge of 11 workmen from the militia who were employed by Colonel Mark Bird in his "cannon foundry and nail works, in Berks county in Pennsylvania" in June 1777.[18] Colonel Bird submitted a bill to the Board of War and Ordnance, and was paid $15,042 in May 1778 for "Cast Iron Cannon delivered and to be delivered," weighing a total of 225,641 pounds.[19] Later in the war, in 1780 and 1781, inventories of outstanding armament at the various furnaces included 21 12-pounders (cannon) and 517 10- inch shells, at Hopewell Furnace.[20] Two remaining "great guns" weighing "2T: 8C" were sold after the war to John Pasmore, as recorded in an entry for August 12, 1784, in Hopewell Furnace's earliest surviving journal (1784- 85).[21]

Little is known about Mark Bird's involvement with the day- to- day administration of Hopewell Furnace. He is said to have hired managers, including a Mr. Markey, later a Mr. Lewis, and William Hayes during the years of the Revolutionary War.[22]

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[13] Walker, *Hopewell Furnace,* pp. 27- 28.

[14] A long- held tradition of cannon manufacture at Hopewell Furnace is supported by documentation in the Library of Congress and the National Archives. Furthermore, Mark Bird was in possession of only one furnace (Hopewell) in Berks County during the war (Tax Book, 1779), the logical place for casting cannon. Bird also owned two forges that produced wrought metal products, such as nails.

[15] *Journals of the Continental Congress,* ed. Worthington C. Ford et al. (Washington, D.C.: Library of Congress, 1904- 37), Vol. 4, entry for May 4, 1776, p. 355; and Vol. 5, entry for Aug. 22, 1776, p. 695. Website http://memory.loc.gov.

[16] Charles Funnell, *The Elusive Ordnance of Colonel Bird* (Philadelphia: U.S. Dept. of the Interior, NPS, Mid- Atlantic Region, Office of Planning and Resource Preservation, Division of Resource Preservation, Mar. 1976). Funnel cites the *Naval Documents of the American Revolution* and the Robert Treat Paine Papers at the Massachusetts Historical Society, Boston.

[17] *Journals,* Vol. 4, entry for May 4, 1776, p. 355; and Vol. 6, entry for Oct. 9, 1776, p. 860. Website http://memory.loc.gov.

[18] *Journals*, Vol. 8, entry for June 24, 1777, pp. 495- 96. Website http://memory.loc.gov.

[19] *Historic Structures Report, Cast House Crane, Hopewell Village NHS*, 1973. Included as an attachment to this report is a copy of the "Abstract of the payments made by Joseph Nourse PayMaster to the Board of War and Ordnance." Original sources: War Dept. Collection of Revolutionary War Records, RG 93, National Archives, Washington, D.C.; also cited as microfilm roll 146 at Hopewell Furnace NHS.

[20] Lawrence H. Jones, "The Restoration of the Furnace Group at Hopewell Village NHS" (Princeton, N.J.: B.A. Thesis, 1981), p. 12. Original source: War Dept. Collection of Revolutionary War Records, RG 93, National Archives, Washington, D.C.

[21] Walker, *Hopewell Village*, p. 27. Original source: Hopewell Furnace day book [sic: journal], 1784- 85, catalog (cat.) number SM- 41. The original journal is at the Historical Society of Pennsylvania; a microfilm copy is at Hopewell Furnace NHS.

[22] Walker, *Hopewell Village,* p. 170. Walker notes that research contained in the *Montgomery Manuscripts,* Book III, p. 39, indicates that Hayes rented the furnace from Bird.

The years following the war were difficult for Mark Bird, who later recalled that he made been made "Bankrupt by the Vile and unnatural war."[23] Contributing factors may have included outstanding debts owed to Bird by the government, the general depression of the economy, and a surplus of iron created by imports. Bird appealed for a reduction of his taxes on Hopewell Furnace in 1784, saying that the ironworks had been out of operation for some time.[24] While production may have been diminished, furnace records indicate it was producing pig iron, pots, kettles, stoves, hammers, anvils, and forge castings.[25] Bird also owned, or was a partner in, several other ironworks, including the Birdsboro Forge, Slitting Mill and Steel Furnace; the Gibralter Forge; the Spring Forge; and the Delaware Falls Iron Works near Trenton, New Jersey.[26]

A need for funds prompted Mark Bird and James Wilson, Bird's business partner at the Delaware Falls Iron Works, to obtain a mortgage for 200,000 "fine Spanish milled silver dollars" from John Nixon, merchant, of Delaware Mills in March 1785.[27] Curiously, Bird attempted to sell a portion of the mortgaged property the following year, including Hopewell Furnace, with no apparent success. An advertisement for the sale published in the *Pennsylvania Gazette* on April 26, 1786, is transcribed below in its entirety:

> *To be Sold by Private Sale*
>
> Hopewell Furnace, the Birdsborough Forges, and Spring Forge, all in the county of Berks. To Hopewell Furnace will be allotted 4000 acres of land, to the Birdsborough Forges 1500 acres, all well timbered, and extending three miles on Hay Creek, to Spring Forge 800 acres. Along with the Furnace will be sold 3 banks of good iron ore, all within a reasonable distance. It will be a term of the sale of the Furnace to supply, during four years, all the foregoing Forges with a certain quantity of pig iron at a stipulated price. Bar iron and castings will be received in payment for the whole iron work estate.
>
> To any person inclining to purchase, the lands, lines and works will be shown, from the 8th to the 15th day of May, by the subscriber, who will attend at Birdsborough for that purpose. The Furnace will be in blast, with a provision of five thousand cords of wood, and eight hundred loads of ore. Two thousand cords of wood are cut for the Birdsborough Forges, and two thousand and two hundred for Spring Forge. Five teams compleat may be purchased along with the Furnace. MARK BIRD[28]

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[23] Mark Bird to Dr. Benjamin Rush, June 1, 1807, quoted in Walker's *Hopewell Village,* p. 33. Bird had moved from Pennsylvania to North Carolina in 1790.

[24] Walker, *Hopewell Village,* p. 29.

[25] Kurjack, *Hopewell Village National Historic Site*, pp. 22 and 25. Although not cited, the probable source for this information is the Hopewell journal for 1784- 85 (SM- 41).

[26] Walker, *Hopewell Village*, p. 29.

[27] Mortgage Book CA, p. 299, BCC; abstract by Fairbairn, Jan. 1963, in "Court House Research and Abstracts, 1962- 63." Wilson, a Philadelphia lawyer, had married Mark Bird's sister Rachel in 1771, and was a signer of the Declaration of Independence.

[28] *Pennsylvania Gazette,* Apr. 26, 1786. Reproduced by Walker in *Hopewell Village*, p. 31.

John Nixon, 1786- 88

The failure of Bird and Wilson to meet their mortgage obligation with John Nixon resulted in a forfeiture of their properties, as recorded in a quitclaim deed transacted August 16, 1786.[29] Nixon was thus legally free to sell the holdings, which right he exercised in the spring of 1788. Public sale of nine parcels making up the "Birdsborough Estate" was held at the Reading Court House on Tuesday April 22, 1788, as advertised in the *Pennsylvania Gazette* earlier that month. The first of these was Hopewell Furnace, described in the *Gazette* as follows.

> 1st. **Hopewell Furnace** (and the land therewith allotted) distant by the present road about five miles from Birdsborough Forges, containing 4338 acres, and allowance of 6 percent, for roads and highways; 800 or 900 acres the timber on which has never been cut, 200 or 300 acres of second growth timber, now fit for cutting, having more on it than ever. The remainder is chiefly second growth chestnut timber, in a very thriving state. It is thought, there is timber enough on the whole tract to serve the furnace for six blasts, 800 or 900 tons each blast, and by the time these are out, it will afford a considerably quantity of timber from the young growth now coming forward, sufficient to supply the furnace for a number of years; there are between 50 and 60 acres of good watered meadow made, which may be increased to 90 acres at small expense. Also an excellent young bearing orchard of about 250 apple trees of the best fruit, with a sufficient number of houses to accommodate the workmen. The mines appertinent to this furnace, one whereof is situated in East- Nantmill township, Chester county, two and a half miles from the furnace, which has supplied the furnace 17 years past, having now as good an appearance as ever, the vein or body of ore being 50 or 60 feet wide, contains 160 acres of land, being a valuable farm. The other is near Jones in Carnarvon township, Berks County, adjoining to Warwick minehole, of excellent quality, and to all appearances a large quantity of ore, distant from the furnace about four miles and an half, containing 40 acres of choice woodland.[30]

Various Owners, 1788- 1800

High bidders for the Hopewell Furnace parcel in 1788 were Ironmasters Cadwallader Morris of Birdsborough, Berks County, who held one- third interest, and James Old of Carnarvaron, Lancaster County, who held two- thirds interest.[31] The two men did not retain ownership for long, however, each selling their shares to Morris's brother, Benjamin Morris of Philadelphia, in

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[29] Deed Book 9, p. 504, BCC; abstract by Fairbairn, Nov. 1962, in "Court House Research and Abstracts, 1962- 63."

[30] *Pennsylvania Gazette,* Wednesday April 2, 1788. Transcript by Jackson Kemper for the French Creek Project, ca. 1930s. The original was then in the Berks County Historical Society (BCHS).

[31] Deed Book A, Vol. II, p. 402, Dec. 30, 1788, BCC; abstract by Fairbairn, Jan. 1963, in "Court House Research and Abstracts, 1962- 63."

1790 and 1791. [32] James Old reacquired the furnace property from Benjamin Morris less than three years later, in December 1793.[33] He then sold it just two months later to Bird's former partner, James Wilson of Philadelphia, in February 1794.[34] Wilson leased several of his ironworks, including Hopewell Furnace, to a partnership in 1795, made up of John Lewis Barde of Berks County, John Rene Barde of Philadelphia, and Paul Henry Provost of New Jersey.[35] This arrangement must have ended in 1796 with the public sale of the Hopewell Furnace property, most likely due to Wilson's inability to make his mortgage payments. An advertisement of the auction dated September 27, 1796, reads as follows:

> … Sale by PUBLIC VENDUE on Monday the Tenth Day of October next, at Two o'Clock in the Afternoon, at the House of George Flieger Innkeeper in the Borough of Reading and County of Berks, viz. All those Tenements, Messuages, and Furnace for Casting of Iron commonly known by the Name of Hopewell Furnace, with the Lands appertinent thereto, situate in the Townships of Union and Caernarvon, in the County aforesaid, containing about Four Thousand Acres, be the same more or less. Seized and taken in Execution as late the Estate of James Wilson Esqr. and to be sold by Peter Frailey, Sheriff.[36]

Although records of the transaction are missing, James Old appears to have reacquired the auctioned property from Wilson's estate in 1796. Old also encountered financial difficulties, and the furnace was seized and sold at public auction on January 6, 1800. Notice of the sale described the offering as "that well known Estate called Hopewell Furnace with the Mine and Lands appurtenant containing upwards of Three Thousand Acres of Land … the property of James Old."[37] The successful bidder was former owner Benjamin Morris, who was then living in Reading, PA.[38]

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[32] Deed Book A, Vol. II, p. 548, Jan. 27, 1790, BCC; and Deed Book A, Vol. 12, p. 324, Apr. 29, 1791, BCC. Abstracts by Fairbairn, Jan. 1963, in "Court House Research and Abstracts, 1962- 63."

[33] Deed Book 13, p. 480, Dec. 31, 1793, BCC; abstract by Fairbairn, Jan. 1963, "Court House Research and Abstracts, 1962- 63."

[34] Deed Book 13, p. 485, Feb. 6, 1794, BCC; and Mortgage Book DE, p. 397, Feb. 6, 1794, BCC. Abstracts by Fairbairn, Jan. 1963, in "Court House Research."

[35] Hopewell document #7950501A, May 1, 1795. Transcript by Fairbairn, Dec. 1962, in "Court House Research and Abstracts, 1962- 63."

[36] Photocopy included with research documents assembled by Charlotte Fairbairn. Another version listing the sales date as Nov. 7, 1796, appears in Walker's *Hopewell Village,* p. 36.

[37] Walker, *Hopewell Village*, 1966, p. 37. Original source: copy of notice of sheriff's sale in the Brooke Family Papers, BCHS.

[38] Hopewell document #8000107; and Deed Book 17, p. 219, BCC, Aug. 21, 1800. Transcript and abstract by Fairbairn, Nov. 1962, in "Court House Research and Abstracts." These documents indicate that Benjamin Morris purchased Hopewell Furnace on Jan. 7, 1800; the deeds were issued by the Sheriffs of Berks and Chester Counties on Mar. 7 and Mar. 18, 1800.

Hopewell Management and Production

Little is known of the actual management and production of Hopewell Furnace for the years 1788- 1800, due to a lack of furnace records for those years. The furnace presumably remained in operation and was reported to have a capacity of 700 tons of iron per annum in 1789, making it the second largest of Pennsylvania's 14 furnaces.[39] A lease agreement for the furnace made with owner James Wilson in 1795 specified that the lessees would provide at least 800 tons of iron per year in the form of pig iron, country and forge castings, stoves, hollow ware, or flask work. The premises and buildings were also to be "put in and kept in repair" by the tenants, with any "improvements" to be assessed for valuation purposes by "disinterested parties."[40] Hopewell is said to have been under the active management of John Bishop and Mathew Brooke during the last few years of the century.[41]

1800- 1845: Growth and Prosperity

Purchase in 1800

The fortunes of Hopewell Furnace changed with its acquisition in 1800 by three partners: Mathew Brooke, Jr., of Berks County; Thomas Brooke of Montgomery, Lancaster County; and Daniel Buckley of Lancaster County (fig. 2). This was a family partnership, Mathew Brooke, Jr., being the older brother of Thomas Brooke, and Daniel Buckley, the husband of Mathew's and Thomas's younger sister Sarah.

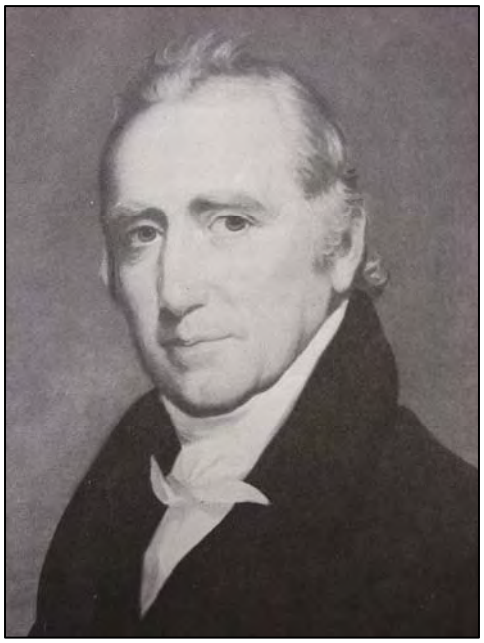

Figure 2. Daniel Buckley, one of three partners who purchased Hopewell Furnace in 1800.

The furnace remained in the ownership of the Brooke and Buckley families throughout the 19th century. Hopewell Furnace was purchased from Benjamin Morris and his wife Frances of Reading, Berks County, PA, on August 21, 1800, for the sum of £10,000. The transaction involved a number of tracts, including "Lot #1 in estate of Mark Bird" that comprised 3,328 acres of furnace land. Also described in the deed was the conveyance of

[39] Walker, *Hopewell Village*, p. 35. Original source: *A Concise History of the Iron Manufacture of the Present Time*, by John B. Pearse, 1876, p. 88.

[40] Hopewell document #8000107. Transcript by Charlotte Fairbairn.

[41] Walker, *Hopewell Village*, p. 37.

"all houses, outhouses, buildings, improvements, mines, minerals, quarries, woods, waters, water courses, rights, liberties, etc."[42] Movable property had also been appraised in an earlier document dated March 20, 1800, and entitled "the Apraisment [sic] of John Bishup [sic] at Hopewell Furnace to Brook [sic] and Buckley." John Bishop was presumably the resident manager, who has also been referred to by previous researchers as a "tenant- operator."[43] Of particular interest in the appraisal are the references to items relating to the Furnace Group, including "Coals in the Coal house," "85 Patterns of wood," and "6 Peces of furnace tuls."[44]

Hopewell Records

Many Hopewell Furnace records survive for the years 1800- 83. These include day books, journals, ledgers, account books, bill books, cash books, time books, and waste books. Most of these books are in the archives of Hopewell Furnace NHS. Those not at the park are available on microfilm.[45] It is these books that document the day- to- day management, workings, and products of the furnace.

Hopewell Owners and Management

The family partnership that owned Hopewell Furnace was known by various names over the years, beginning with "Buckley & Brooke." The company was restructured and renamed "Daniel Buckley & Company" in 1816. Following the death in 1821 of original partner Mathew Brooke, Jr., remaining partners Thomas Brooke and Daniel Buckley carried on as joint owners, officially settling with Matthew's heirs for his one- third share in 1824. Another reorganization in 1827 expanded the partnership by adding sons Clement and Mathew B. Buckley to Daniel Buckley's half share, and children Clement, Charles, Tacy, and Ann Brooke to Thomas Brooke's half share. The original name of "Buckley & Brooke" was also readopted at this time. Daniel Buckley's children inherited their father's half- share upon his death later in 1827, as did Clement and Charles Brooke when their father Thomas died in 1831. A redistribution of assets also occurred in 1831, and the firm name changed to "Clement Brooke & Co." One- third interest was then owned by Mathew B. Buckley, one- third by Clement Brooke, and one- third by Charles Brooke.[46]

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[42] Deed Book 17, p. 219, Aug. 21, 1800, BCC, abstract by Fairbairn, Nov. 1962, "Court House Research and Abstracts, 1962- 63."

[43] Earl Heydinger, *Historic Structures Report, Historical Data Section, Part I, Charcoal House* (Hopewell Village NHS, June 5, 1964), p. 2.

[44] Hopewell document #800320, Hopewell Furnace NHS.

[45] The records are cataloged as SM- 1 through SM- 87 and Acc. 943. Most are in the archives of Hopewell Furnace NHS except SM- 2, which appears to be missing; SM- 33, which is at the Berks County Historical Society; and four that are at the Historical Society of Pennsylvania (SM- 41, 43, 44, and 45).

[46] Walker, *Hopewell Village,* pp. 56- 57 and Appendix A; Kurjack, *Hopewell Village National Historic Site,* p. 31; and Hopewell documents 8730407and 8310111, Hopewell Furnace NHS.

Hopewell Furnace was first managed by partner Thomas Brooke from 1800 to 1801, and later by Matthew Davis 1802- 03, Daniel Knabb 1804- 07, and Mathew M. Brooke circa 1807- 15. Clement Brooke, eldest son of Thomas Brooke, served as manager from 1816 through 1848.[47]

Furnace Production

Hopewell Furnace was in production for the years 1800- 45, with the exception of the period 1808- 15 when it was out of blast. When in operation, the furnace maintained a blast for many months, shutting down when the charcoal fuel was exhausted to make repairs and replace the interior lining and hearth of the furnace.[48] The annual capacity of the furnace was approximately 700 tons of iron per annum before 1828 and 1,000 thereafter – an increase due to a renovation of the furnace stack.[49] The furnace produced cast iron, which was molded into pig iron, stove plates, and mixed castings during the years 1800 to 1845. Pig iron was frequently used by nearby iron forges to be reheated and transformed into wrought iron. Stove plates were sent to stove dealers who supplied connecting rods, bolts, and sheet- iron components and assembled the stoves. Mixed castings included a wide variety of products, such as household and kitchen ware, farm equipment, and forge and mill fittings, to name a few. The furnace was also commissioned in 1825 to supply the new state penitentiary with cast-iron components, including doorway frames and racks.[50]

Figure 3. Ten- plate stove made at Hopewell Furnace, circa 1827- 44.

The years the furnace was out of blast, from 1808 to 1815, has been attributed to the national recession and law suits challenging the partners' rightful ownership of Hopewell Furnace lands. Lack of sufficient wood for making charcoal to fuel the furnace operation resulted in its shutdown and general decay of the works. Repairs costing close to $8,000 had to be expended before operations could resume in 1816.[51]

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[47] Walker, *Hopewell Village*, p. 170. Mathew M. Brooke was a cousin of Thomas and Mathew Brooke, Jr.

[48] Walker, *Hopewell Village,* pp. 146- 49, and Harker Long interview with Mr. Kemper, Apr. 1936. Walker says the average blast was 11 ½ months from 1820 to 1840, and 10 ½ months after 1840.

[49] Walter Hugins, *The Physical History of the Hopewell Furnace Group, 1770- 1883, Hopewell Village NHS*, Feb. 7, 1954, pp. 4- 5.

[50] Walker, *Hopewell Village,* pp. 153- 154.

[51] Walker, *Hopewell Village,* p. 49. Original citation: memorandum in the *Brooke Family Papers,* BCHS, by the lawyer of the Buckley and Brooke Company dated April 1818.

The furnace weathered a severe business depression in 1819 to become profitable again in the 1820s. Its most prosperous period is said to have spanned the years 1820 to 1838, which included a famous blast in 1836- 37 that lasted 445 days and produced 1,169 tons of mixed castings.[52] The tradition of making stoves at Hopewell ended in 1844, when the patterns were sold to a small foundry in Pennsylvania.[53]

1845- 1883: Decline

Hopewell Owners and Management

Hopewell Furnace remained in the ownership of the Brooke and Buckley families during the years 1845- 83. The partners in 1845 consisted of the heirs of two of the three original partners: Thomas Brooke and Daniel Buckley. These were sons Clement and Charles Brooke and Mathew Brooke Buckley, who operated under the name "Clement Brooke and Company." A reorganization in 1852 eliminated Charles Brooke from the partnership, leaving Clement Brooke and Mathew Brooke Buckley each with a half- interest in the firm that was renamed "Brooke and Buckley Company."[54] A third generation of family members inherited the company upon the deaths of Mathew Brooke Buckley in 1856 and Clement Brooke in 1861. The new partners were Edward S. Buckley, son of Mathew Brooke Buckley, and Maria Theresa Brooke Clingan, daughter of Clement Brooke.[55] Interestingly, the firm name of "Clingan and Buckley Company" appears in the Hopewell Furnace records as early as 1857, suggesting a business arrangement with Maria Clingan or her husband, Dr. Charles M. Clingan, prior to her father's death in 1861.[56]

Clement Brooke served as resident manager of Hopewell Furnace from 1816 to 1848, in addition to his role as partner from 1827 to 1861. John Church, nephew of Clement Brooke's wife, was manager for one year in 1849. Church was followed by Dr. Charles M. Clingan, the husband of Clement Brooke's daughter Maria Theresa Brooke, who actively managed Hopewell Furnace from 1850 to 1859. After 1859, supervision of Hopewell Furnace was entrusted to non-family members: first Nathan Care, then John R. Shafer, and finally Harker Long, who came to Hopewell in 1867 and was there at its closure in 1883.[57]

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[52] Kurjack, *Hopewell Village National Historic Site*, p. 27; and Walker, *Hopewell Village*, pp. 57- 58.

[53] Walker, *Hopewell Village*, pp. 58, 60, and 164.

[54] Walker, *Hopewell Village*, pp. 61- 62.

[55] Walker, *Hopewell Village,* pp. 62, 175, and Appendix A; and Fairbairn, "Courthouse Research and Abstracts, 1962- 63."

[56] Teri DeYoung, Museum Specialist working on the Hopewell Furnace NHS archives, to Barbara Yocum.

[57] Walker, *Hopewell Village*, pp. 56 and 60- 62. Also interview with Harker Long.

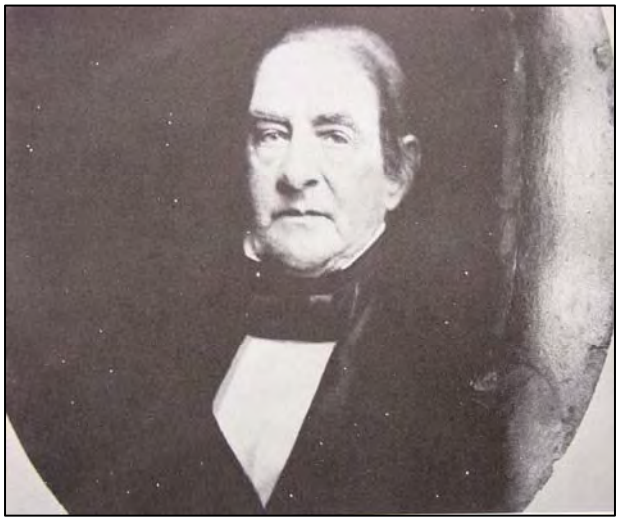

Figure 4. Clement Brooke, second generation partner/owner of Hopewell Furnace 1827- 61, who also served as resident manager 1816- 48.

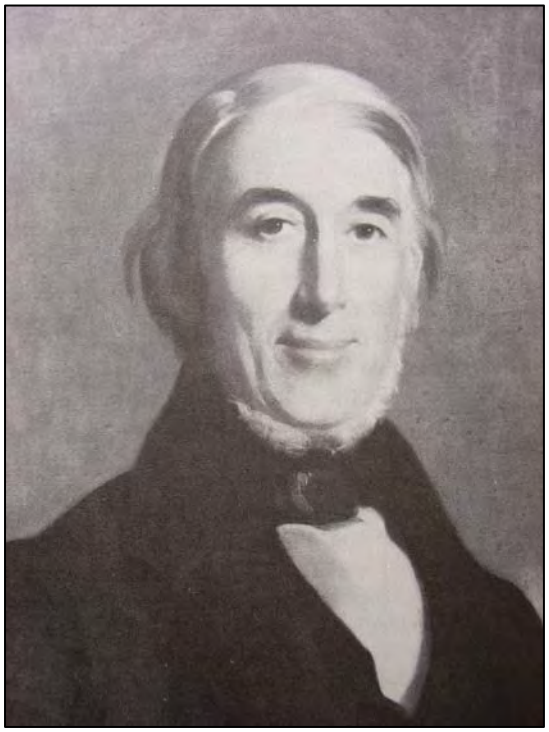

Figure 5. Mathew Brooke Buckley, second- generation partner/owner of Hopewell Furnace 1827- 56.

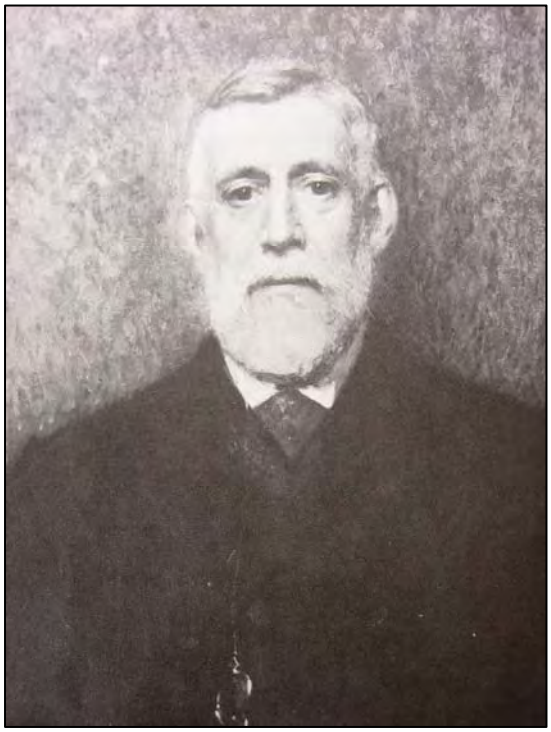

Figure 6. Edward S. Buckley, third-generation partner/owner of Hopewell Furnace 1856- 95.

Furnace Production

The primary product of Hopewell Furnace after it ceased making stoves in 1844 was cast iron molded into pig iron, along with small amounts of mixed castings.[58] Production of the furnace may have been slowed by the construction of a new anthracite- fueled, hot- blast furnace built northwest of the old furnace in 1849. This new venture proved to be unprofitable, however, and the anthracite furnace was abandoned a short time later.[59] Demand for pig iron from the old charcoal furnace increased once again in the 1860s, due to needs created by the Civil War and later by the expansion of the railroads.[60] Railroad companies became the primary clients of the furnace in its final years of operation, 1869- 83.[61] Production slowed in the 1870s, with the furnace being out of blast in 1874 and again in 1877- 78. An increase in the price of iron resulted in one last surge, with the furnace put back in operation in 1880.[62] However, despite the incorporation of technological improvements such as a steam boiler and engine to operate the wheel in 1881, and an ore roaster to improve the quality of the iron ore in 1882, rising costs and slim profits ultimately resulted in the shutdown of Hopewell Furnace.[63] Its final blast is said to have lasted continuously from May 20, 1880, until June 15, 1883.[64]

1883- 1935: Shutdown and Survival

Shutdown, 1883

Hopewell Furnace went out of blast for the last time on June 15, 1883.[65] After this, cast iron was no longer produced at Hopewell, and the furnace buildings fell into disrepair.

Hopewell Owners

Hopewell Furnace was jointly owned by Maria Theresa Brooke Clingan and Edward S. Buckley when the furnace closed in June 1883. Maria was the granddaughter of Mathew Brooke, Jr., and Edward was the grandson of Daniel Buckley – two of the original three partners who had purchased Hopewell Furnace in 1800. Maria was also the daughter of Clement Brooke and the widow of Dr. Charles M. Clingan, both of whom had served as resident managers of Hopewell

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[58] Walker, *Hopewell Village*, p. 58.

[59] Harker Long, *A Short History of the Hopewell Furnace Estate* (Reading, PA: Reading Eagle Press, ca. 1930- 35), p. 11; Harker Long interview with Jackson Kemper, Aug. 1936; Kurjack, *Hopewell Village National Historic Site*, p. 29; and Walker, *Hopewell Village,* p. 63.

[60] Harker Long interview with Kemper, Aug. 1936; and Walker, *Hopewell Village,* p. 59.

[61] Harker Long interview with Kemper, Aug. 1936; Long, *A Short History,* p. 15; and Kurjack, *Hopewell Village National Historic Site,* p. 30.

[62] Walker, *Hopewell Village,* p. 65.

[63] Walker, *Hopewell Village,* pp. 65- 66.

[64] Long, *A Short History*, p. 13.

[65] Long, *A Short History*, p. 13; and Harker Long interview with Kemper, 1936.

Furnace. Edward S. Buckley sold his half share of the Hopewell Furnace property in 1895 to Maria Clingan's three children: Charles B. Clingan, Alan Hunter Clingan, and A. (Anne) Louise Clingan Brooke. The property was then described as six tracts including "Hopewell Furnace" that encompassed 4,222 acres.[66] Upon her death in 1904, Maria Clingan's half- share in the furnace property passed to her two surviving children: Alan Hunter Clingan and A. Louise Brooke.[67] The following year, Brooke became sole owner of the property upon the acquisition of her deceased brothers' shares in 1905.[68]

Use of Hopewell Furnace

The Clingan family used the mansion, or Ironmaster's House, at Hopewell Furnace as a summer retreat until 1915. Furnace records maintained through March 23, 1896, also document several income- producing activities on the property. These included the sales of the remaining pig iron, iron ore, wood harvested for fence posts and rails, wood processed and sold as charcoal, and royalties derived from quarried stone. The farm was also actively maintained, the village houses leased, and the old barn rebuilt in 1926. Caretakers for the property, who lived in the back wing of the mansion, were Harker A. Long until 1896, and later Nathan Care. No use was made of the old furnace buildings, which were allowed to slowly decay. Little remained of the wooden structures of the furnace by 1932, when the Commonwealth of Pennsylvania realigned the old Birdsboro- Warwick road through the core of the village. A sharp curve in the road between the office- store and barn was removed and replaced by a straight stretch that passed close to the furnace, over the foundations of the missing cast house, and through the stone wall of the adjacent furnace bank.[69]

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[66] Deed Book 209, p. 22, Mar. 21, 1895, BCC; abstract by Fairbairn, Nov. 1962, in "Court House Research and Abstracts, 1962- 63."

[67] Will Book 22, p. 355, May 31, 1904, BCC; abstract by Fairbairn, Nov. 1962, in "Court House Research and Abstracts, 1962- 63."

[68] Alan Hunter Clingan died Mar. 19, 1905, leaving as heirs his sister A. Louise Brooke and the children of his brother Charles (Deed Book 768, p. 642, Aug. 13, 1935, BCC; abstract by Fairbairn, Nov. 1962, in "Court House Research and Abstracts, 1962- 63." The heirs of Charles Clingan, "dec'd," conveyed their shares to A. Louise Brooke in Sept. 1905 (Deed Book 332, p. 140, Sept. 18, 1905, BCC; abstract by Fairbairn, "Court House Research and Abstract," n.d.).

[69] Walker, *Hopewell Village*, pp. 67- 69; KFS Cultural Resources Group, in Association with Menke & Menke, Landscape Architects, *Hopewell Furnace Cultural Landscape Report* (Philadelphia and Swarthmore, 1997), pp. 55 and 66- 67; and Leah Glaser, *Administrative History, Hopewell Furnace National Historical Site* (Philadelphia and Boston: U.S. Dept. of the Interior, NPS, Northeast Regional Office, Aug. 2005), p. 16.

Early Photographs

The earliest- known photograph of Hopewell Furnace was taken in 1887, four years after the furnace fired its last blast in 1883 (figs. 7 and 17). This view has come to be known as the "Stokes" photograph because it is in the Stokes collection at Hopewell Furnace NHS. The collection was probably obtained from the family of Mary Brooke Stokes, daughter of A. Louise Brooke and wife of Edward L. Stokes. The photograph may have been one of several described in 1935 by NPS Historian Roy Appleman as having been taken "several years ago when the furnace was pretty largely intact," then in the possession of the E. & G. Brooke's Iron Company of Birdsboro, PA.[70] Knowledge of the photograph appears to have been lost for the next 20 years until 1955, when it was said to have "first" come to the attention of NPS researchers.[71] It is a paper- printed copy mounted on cardboard, with the following handwritten notation on the back side: "Hopewell Furnace, Chester [sic: Berks] Co., Pennsylvania, Oct. 10th, 1887, Edward B. Hardin, Photo[grapher]." The view, looking towards the northwest, features an unidentified man standing next to a small gable building in front of an assemblage of structures of the former Hopewell Furnace.

Figure 7. Earliest known photograph of Hopewell Furnace, October 10, 1887.

Only two other photographs of 19th- century vintage are known, which show the furnace structures in a more advanced state of deterioration in July 1896. These are glass- plate negatives that were discovered by NPS Historian Dennis Kurjack in the Chester County

[70] Appleman, *Historical Report, French Creek Area*, pp. 20- 21. Edward and George Brooke were the brothers of Mary Brooke Stokes.

[71] Russell Apple, *Historical Documentary Report on the Bridge and Wheel Houses, Hopewell Furnace (Buildings 10 and 8), Hopewell Village NHS* (Hopewell Village NHS, Sept. 1956), pp. 21- 22.

Historical Society in 1948.[72] The 1896 views, included in the subsequent section "Chronology of Development and Use" as figures 18a and 18b, are commonly known as the "Bull Photographs," named for the photographer Octavius Bull (1868- 1909). The original 1887 photograph and copies of the 1896 photographs are in the archives of Hopewell Furnace NHS.

The Franklin Institute of Philadelphia

Two components of the old furnace, the water wheel and blast machinery, were offered as a gift in 1930 by A. Louise Brooke to the Franklin Institute of Philadelphia, which specialized in scientific and technological education. The wheel and machinery were first documented by the institute in technical drawings, then disassembled and moved to a nearby storage structure pending transfer to Philadelphia. Here they remained, until they were later claimed and restored by the federal government.[73]

1935- 1938: Civilian Conservation Corps Period

Purchase by the Federal Government

A. Louise Brooke sold the Hopewell Furnace property, which included 4,112.03 acres of Hopewell Tract No. 1, for $86,970.82 to the United States of America on August 13, 1935.[74] This and other parcels had been acquired by authority of the National Industrial Recovery Act of 1933 as part of the Submarginal Land Program, one of the economic relief initiatives of the Franklin D. Roosevelt administration. The purpose of the new project, entitled the "French Creek Recreational Demonstration Area," was to provide jobs to the unemployed through government programs such as the Civilian Conservation Corps (CCC), to improve the land through development as a park, and to eventually transfer ownership of the redeveloped area to the Commonwealth of Pennsylvania.[75]

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[72] The following is written on the back side of one of the photographic prints in the archives of Hopewell Furnace NHS: "Contact print from 4 x 5 negative found at Chester County Historical Society, West Chester, by Historian Kurjack in 1948."

[73] Walker, *Hopewell Village,* p. 69; and Glaser, *Administrative History,* p. 10.

[74] Deed Book 768, p. 642, Aug. 13, 1935, BCC; abstract by Fairbairn, Nov. 1962, in "Court House Research and Abstracts, 1962- 63."

[75] *Statement for Management, Hopewell Furnace National Historic Site* (Pennsylvania: U.S. Dept. of the Interior, National Park Service, Mid- Atlantic Regional Office, Oct. 1993), p. 9; Glaser, *Administration History*, pp. vii and 14; and Teri DeYoung, *Preliminary Finding Aid, French Creek Recreational Demonstration Project Records, 1935- 1942* (Hopewell Furnace NHS, April 2006), p. 13.

Other justifications for acquiring the property included:

> … the restoration of structures of historic interest, the conservation of natural resources, the preservation of scenic beauty, forestation and reforestation and for use in connection with the construction of certain improvements necessary and appropriate to provide public facilities for the purposes of the project.[76]

CCC and WPA

Two camps totaling approximately 400 Civilian Conservation Corps (CCC) workers were established at the French Creek Recreational Demonstration Area in 1935. The initial work undertaken by the workers included construction of camp buildings, clearing underbrush, building roads, constructing foot and bridle paths, laying out campsites, and excavating lakes.[77] A Works Project Administration (WPA) program comprised of local residents worked jointly with the CCC on the French Creek project.[78] The National Park Service Eastern Division, Branch of Engineering, provided oversight and technical supervision.[79] Interviews with former Hopewell Furnace workers, such as last manager Harker Long, were undertaken beginning in 1935.[80] Stabilization of the existing stone foundation walls of the missing wheel house, bridge house, and cast house commenced the following year. Restoration of the east head race was undertaken in 1938.

Historic Hopewell Furnace

It was acknowledged that "structures of historic interest" were within the newly created French Creek Recreational Demonstration Area. These had been noted in a preliminary report by CCC Architect Gustavus Mang dated April 1935. Mang described the remnants of the old furnace as "a valuable heritage, and one of the few remaining structures of this kind that produced the iron of our forefathers."[81] He observed that the historic ruins were already attracting a number of visitors, and suggested that "the old work should all be preserved."[82] Mang was followed by NPS Regional Historian Roy Appleman, who attested to the unique historical significance of the old cold- blast, charcoal- burning furnace as "one of the oldest standing anywhere in the country."[83] In his role as historical researcher and advisor, Appleman prepared two documents that set the course for the future restoration of Hopewell Furnace and Village. The first, dated August 19, 1935, was simply entitled *Historical Report, French Creek Area*. Appleman

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[76] Walker, *Hopewell Village,* p. 70. Original source: "Hopewell Papers, Abstract of Deeds to Hopewell Property."

[77] KFS Cultural Resources Group, *Hopewell Furnace Cultural Landscape Report*, p. 59.

[78] Glaser, *Administrative History*, p. 23.

[79] DeYoung, "Preliminary Finding Aid, French Creek," p. 13.

[80] Transcripts of the interviews with Harker A. Long and others are in the archives of Hopewell Furnace NHS.

[81] Gustavus Mang, *The Hopewell Furnace, French Creek Project* (Birdsboro, PA: Apr. 1935), p. 1.

[82] Mang, *The Hopewell Furnace*, p. 4.

[83] Appleman, *Historical Report, French Creek Area*, p. 33.

recommended restoring Hopewell Furnace to its 1883 appearance in his report, under the assumption that it had remained essentially unchanged from its original appearance in 1770, and urgently recommended the acquisition of the furnace's machinery from the Franklin Institute.[84] More detailed restoration advice was offered in Appleman's second report, *Proposed Restoration Plan for Old Iron Making Village, French Creek Project*, dated January 15, 1936. The proposed restoration target date was changed in this document from 1883 to the time span 1785- 1800, with the justification that "this is the period for which the village can best be restored with substantial historical accuracy."[85]

Appleman's fervent hope was to resurrect Hopewell Village and its furnace in the style of John Rockefeller's Colonial Williamsburg and Henry Ford's Greenfield Village, thus bringing early ironmaking history to life for the American people. His goal for the restoration was to make Hopewell "hum with the activity that was characteristic of it 150 years ago," so it could serve as "a standard against which to measure the distance traveled by the iron industry in 150 years of progress to the gigantic modern iron and steel plant of today."[86]

Harker A. Long

Harker A. Long was the last manager of Hopewell Furnace. He was first employed in the office at the age of 17 in 1867, and was later promoted to furnace manager. Mr. Long remained as resident caretaker following the shutdown of the furnace in 1883, residing in the rear wing of the Ironmaster's House. He moved to Birdsboro in 1896 and died in 1942 at the age of 92.[87]

Mr. Long was both a willing and enthusiastic informant on the physical history of Hopewell Furnace for the years 1867- 96. He was interviewed by Roy Appleman in 1935 and by Jackson Kemper in 1936, and authored and published a booklet in the 1930s entitled *A Short History of the Hopewell Furnace Estate in Union Township, Berks County*. Appleman noted that Mr. Long had "retain[ed] in his memory, through long impressionable years spent at Hopewell, almost every feature of that iron making village, dating from before the Revolution, as it appeared in 1867 and in subsequent years."[88] Appleman further surmised that "no great change took place in primitive industry and small village life from the Revolution to the end of the Civil War," and thus concluded that Hopewell Furnace in 1867 would have been little changed from its appearance in the 1770s.[89] Harker Long was therefore accorded the respect of a valuable historical witness, and his remembrances were incorporated into early restoration plans of Hopewell Furnace.

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[84] Appleman, *Historical Report, French Creek Area*, pp. 31- 32 and 41.

[85] Roy Appleman, *Proposed Restoration Plan for Old Iron Making Village, French Creek Project, Hopewell Pennsylvania* (Bronxville, NY: U.S. Dept. of the Interior, NPS, Branch of Planning and State Cooperation, Second Regional Office, Jan. 15, 1936), p. 3.

[86] Appleman, *Proposed Restoration Plan*, pp. 4- 5.

[87] Appleman, *Proposed Restoration Plan*, p. 2; and Paul Schumacher, *Archeological Explorations at the Furnace Group, 1935 to 1951, Hopewell Village National Historic Site, Pennsylvania* (Hopewell Village NHS, Sept. 1951), p. 49.

[88] Appleman, *Proposed Restoration Plan*, p. 2.

[89] Appleman, *Proposed Restoration Plan*, p. 4.

1938- Present: The National Park Service

National Park Designation

Hopewell Village National Historic Site was established on August 3, 1938, by Acting Secretary of the Interior E.K. Burlew under authority of the Historic Sites Act of 1935. The new park encompassed 213.66 acres and the historic structures of the village, which were withdrawn from the French Creek Recreational Demonstration Area. The enabling legislation declared the site to be of national significance due to its "relationship to the colonial history of the United States."[90] The park was considerably enlarged in 1942 with the addition of the remaining 6,000 acres of the French Creek Recreational Demonstration Area. It achieved its present size of 848.06 acres in 1946, when 5,350 acres were transferred to the Commonwealth of Pennsylvania for recreational use as French Creek State Park. The name of the park was changed by Secretarial Order to the more historically accurate "Hopewell Furnace National Historic Site" in 1985.[91]

Historical Studies and Investigations

The National Park Service continued the research of Regional Historian Roy Appleman on Hopewell Village and Furnace following creation of the park in August 1938. Archeological investigations commenced upon the appointment of Archeologist J.C. Fisher Motz to the staff in April 1940, and they continued intermittently through 1963.[92] The park's first full- time historian was Dennis C. Kurjack, who joined the staff in June 1947. Other park historians who made significant contributions to the research of the Furnace Group were Walter Hugins (1951- 55), Russell Apple (1955- 56), Robert Ronsheim (1956- 64), Earl Heydinger (1958- 76), and Charlotte Fairbairn (1962- 69).[93] Historical information, together with the physical evidence gleaned from the archeological investigations, helped to flesh out the physical history of Hopewell's buildings and structures. Most useful were the surviving handwritten journals of Hopewell Furnace that recorded the accounts, bills, cash, time, and day- to- day operations of the business and village.[94] Adding to this knowledge were glass- plate negatives of the furnace dated July 1896 that were discovered in 1948 by Historian Kurjack in the Chester County Historical Society.[95] These photographs, taken by Octavius Bull, are known today as the "Bull"

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[90] "Order Designating the Hopewell Village National Historic Site, Hopewell Village, PA," Aug. 3, 1938 – 3 F.R. 2039. Reproduced as Appendix A in the *Statement for Management*.

[91] "Order Designating the Hopewell Village NHS," and Glaser, *Administrative History*.

[92] Glaser, *Administrative History*, p. 57. Archeologist Leland Abel investigated the site of the cast house in 1962- 63, as reported in his *Historic Structures Report, Part II, Archeological Excavations at Hopewell Furnace, Hopewell Village National Historic Site* (Hopewell Village NHS, March 1964).

[93] Glaser, *Administrative History*, pp. 116 and 325.

[94] The Hopewell records span the years 1800 to 1883, with one earlier book dated 1784- 85. Most are in the archives of Hopewell Furnace NHS, cataloged as SM [Source Material]- 1 through SM- 83.

[95] Prints from the glass- plate negatives are in the archives of Hopewell Furnace NHS, photograph numbers 101- 7 and 101.07. Discovery of the photographs by Historian Kurjack is documented on the back of one of the prints.

photographs. It was not until 1955 that the earliest- known photograph of Hopewell came to the attention of park staffers, although historian Roy Appleman may have known of it when it was still in the possession of the Brooke family in 1935. This now- famous view, commonly known as the "Stokes" photograph, shows the remains of the wheelwright shop and the Furnace Group four years after its last blast.[96]

Architectural investigations and design services have been provided to Hopewell over the years by NPS architects in service centers or the regional office. Much restoration and reconstruction work was undertaken between 1956 and 1965, coordinated by the Eastern Office, Division of Design and Construction in Philadelphia, PA. Two architects of note who worked out of this office and were involved with the Furnace Group were Richard P. Donohoe (1956) and Norman M. Souder (1963- 65). In addition, existing conditions drawings of the charcoal house were prepared by the Historic American Buildings Survey in 1958.

Exhaustive research generally preceded restoration or reconstruction efforts at Hopewell Village. This took the form of unpublished reports on every component of the Furnace Group, which are in the archives of Hopewell Furnace NHS.

Furnace Group Remains

Little was left of Hopewell's Furnace Group by the time of its acquisition by the National Park Service in 1938. Remnants included the stone furnace, then in the process of being stabilized, the stone charcoal house most recently used as a garage, the disassembled water wheel and blast machinery, and a steam boiler dating to 1881. Stone foundations and some walls were all that survived of the wheel house, the bridge house and connecting shed, and the cast house and east shed. The east head race and west head race had both fallen into disrepair, although their paths were still discernable.

Stabilization, Restoration, and Reconstruction

The stabilization, restoration, and reconstruction of the Furnace Group are described in detail in the following section titled "Chronology of Development and Use." In brief, the activities at the Furnace Group for the early years of the park, from 1938 to 1950, primarily entailed stabilization and archeological explorations, although some restoration of the east head race was achieved in 1938. Reconstruction of the water wheel, blast machinery, and a portion of the west head race was carried out in 1951- 52. The Birdsboro- Warwick road that passed through the village was closed to public traffic in 1955. A major influx of funding was provided by the "Mission '66" program for a 10- year period from 1956 to 1966. This program– intended to

[96] Historian Russell Apple noted that the "Stokes" photograph was found in 1955 (*Historical Documentary Report on the Bridge and Wheel Houses*, pp. 21- 22). This may have been one of several early views of Hopewell Furnace that were described in 1935 by Historian Roy Appleman as then being in the possession of the E[dward]& G[eorge] Brooke's Iron Company of Birdsboro, PA (*Historical Report, French Creek Area*, pp. 20- 21). The photographs were most likely acquired from Mary Brooke Stokes (1897- 1957), daughter of Edward Brooke and Anna Louise Clingan.

modernize and revitalize the national parks in time for the 50th anniversary of the National Park Service in 1966– funded a new visitor center for Hopewell (dedicated in 1959) and several village restorations and reconstructions, including the completion of the Furnace Group.[97] The bridge house, wheel house, and charcoal cooling shed were researched and reconstructed in 1957- 58, and the cast house and east shed in 1964- 65. The existing charcoal house was also restored in 1965. Since 1965, work at the Furnace Group can be characterized as ongoing maintenance, repair, and rehabilitation of the existing structures.

Most of the reconstruction work undertaken in the 1950s on the wheel house and its equipment, the bridge house and connecting shed, and the cooling shed was executed by local contractor Charles S. Painter and his crew of carpenters. Labor to reconstruct the cast house and its east shed in the 1960s, and restore the charcoal house, was provided by a crew of Amish carpenters under the supervision of Christ Beiler of Leola, PA. Ongoing maintenance and repairs in later years have been done by park staff, day labor, or contractors.

Restoration Target Dates

Two periods of restoration and interpretation have been used at Hopewell Village and its furnace since the inception of the park in 1938. One spans the years from the colonial beginnings of the iron- making village in 1770 to its final blast in 1883. The other focuses more narrowly on the peak period of furnace activity from 1820 to 1840. During the early years of the park, from 1940 to 1951, restoration policies were debated among park historians, archeologists, and managers, and set forth in reports and memoranda – most advocating a period of restoration from 1770 to 1883. A restoration target date of 1883 was reaffirmed by the park's first Master Plan development outline in 1952. This policy changed in 1955 with the park's Mission 66 Prospectus, in which Hopewell's period of greatest prosperity, defined as 1820- 40, became the park's treatment and interpretative focus. The 1964 Master Plan reverted to the earlier policy of 1770- 1883, advocating "structural restoration to all periods of furnace operations" and espousing that "each restoration [be] conducted on its own merits." More recently, both the 1973 Interpretive Prospectus and the 1993 Long Range Interpretive Plan have supported the period 1820- 1840, but with the understanding that structures falling outside that period would be preserved.[98] The 1993 Statement for Management also noted that the preservation and interpretive focus was the 1820- 40 period, but more broadly defined the park's purpose "to preserve and interpret the site as representative of an iron- making community and a significant way of life and work in the 18th and 19th centuries."[99]

The park's most recent planning document, entitled *Hopewell Furnace National Historic Site Foundation for Planning and Management* (July 2007), is being used to guide the development of the park's first general management plan. This document identifies two areas of significance: the operation of the furnace from 1770 to 1883, and conceptualization and implementation of Hopewell Furnace as a historic park from 1935 to 1965.

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[97] Glaser, *Administrative History*, pp. 115, 133, 137, and 139.

[98] The park's vacillating treatment and planning policies are well documented in the park's Administrative History.

[99] *Statement for Management*, p. 6.

Listing in the National Register

Hopewell Village National Historic Site was listed as a district nomination to the National Register of Historic Places on October 15, 1966, as nomination #66000645, which was updated in June 1985. The significance of the site was defined by the nomination as encompassing the years 1771- 1883, and described as follows:

> The historical significance of Hopewell Village National Historic Site lies in its association with the American Revolution, as well as its long life as an industrial community, representative of the hundreds of charcoal ironworks which once flourished in the Eastern United States…. Beyond Hopewell's association with the American Revolution, the industrial complex as well as the associated community structures all serve to illustrate life on an iron plantation in the eighteenth and nineteenth centuries.[100]

Buildings and structures identified as contributing to the site's significance included the components of the Furnace Group, despite that fact that most had been reconstructed by the National Park Service in the 1950s and 1960s. Contributing structures included the furnace; wheel house, water wheel, and blast machinery; bridge house and connecting shed; cast house, cleaning shed, and carpenter's shop; charcoal house and cooling shed; furnace bank and retaining wall; and the east head race, west head race, and tail race.

[100] "Hopewell Furnace, National Register of Historic Places Inventory- Nomination Form," Section 8– Statement of Significance, June 1985.

CHRONOLOGY OF DEVELOPMENT AND USE

1769- 1800: The Early Furnace Group

Introduction

Little is known about the actual appearance of Hopewell Furnace during the years 1769- 1800, although it is generally assumed to have included all the components of the existing Furnace Group. These include the furnace; furnace bank and retaining wall; bridge house (later called the bridge house and connecting shed); charcoal house and cooling shed; wheel house, water wheel and blast machinery; east head race; west head race; tail race; and cast house. The furnace, also called the furnace stack, is where charge (iron ore and limestone) was heated with charcoal fuel to produce iron. Charge consisting of iron ore, limestone, and charcoal was stored on the furnace bank to the north of the furnace, the charcoal protected from the weather by a charcoal house and shed. The charge was transported from the furnace bank to the upper furnace via a bridge house. Blasts of cold air generated by bellows, and later by blast machinery, caused the charge within the furnace to burn at a higher temperature. The bellows/machinery was powered by a water wheel that received its water from two races: one to the east, the other to the west of the furnace. A tail race channeled the waste water to French Creek. A cast house at the base of the furnace is where the iron produced by the furnace was cast into pigs and finished products. Original Ironmaster Mark Bird, who owned and developed Hopewell Furnace during the years 1769 to 1786, was casting iron stoves as early as 1772. Cannon and shells were also produced during the American Revolution. Less is known about the furnace's productivity from 1786 to 1800, when it passed through the hands of various other owners.

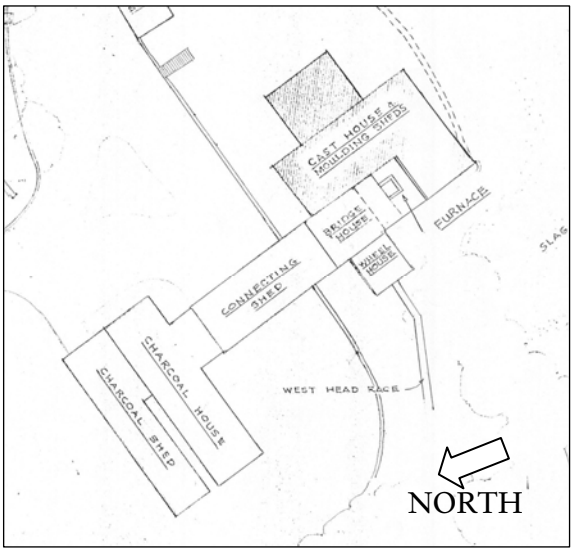

Figure 8. Plan showing the various components of the Furnace Group, 1964. Although the actual structures may have differed in earlier years, their operational and physical relationships are thought to have remained unchanged.

Physical remnants surviving from the time period 1769- 1800 are thought to include the stone furnace, some foundation walls, stone walls of the charcoal house, clay roofing tiles, and the channel of the east head race. That the furnace is original has been surmised based on the dates "1770" and "1771" carved and/or scratched in the stones on the left side of the casting arch (fig. 9). Stone foundation walls thought to be of this vintage were uncovered by archeologists in the vicinity of the furnace in the 1940s- 60s. These foundations are believed to have been the supports for a bridge house that connected with the furnace bank on the north side, and for an early cast house on the south and east sides of the furnace. Retaining walls for the wheel well of an early north- south water wheel were observed during work on the furnace in 1936 and later excavated by Archeologist Paul Schumacher in 1951. The stone walls of the charcoal house have no date stone but may have existed by March 1800, based on an inventory of that date (see Section III, "Charcoal House and Cooling Shed"). Red roofing tiles thought to be from the early cast house were unearthed, along with early foundations, by Archeologist Leland Abel in 1962- 63.

Figure 9. Stone carved with "1771" in the east face of the furnace, south of the cast arch. Photograph taken in 1962- 63.

Furnace

The stone furnace was the focus and center of the Furnace Group, and today is also its largest surviving component. It has been assumed, although is not known for certain, that the furnace has remained essentially unchanged from its original construction in 1770- 71, with the possible exception of repairs, periodic replacement of the interior walls, and heightening in 1828. The furnace is a stone structure with stepped exterior walls measuring roughly 32 feet high, not including the later upper brick walls. The stones are rough- dressed fieldstones. Remnants of early mortar found deep within the walls have been described as a tan color, lime type, with unwashed local sands and pebbles and visible inclusions of white lime.[1] The exterior stonework may also have been covered with a "thick coating of pink- lavender lime plaster," based on traces still preserved on the stones as late as 1964.[2] The steps of the exterior walls appear to have

[1] Thomas & Newswanger, *Hopewell Iron Furnaces Historic Structures Report & Engineering Study* (Philadelphia, PA: 1987), Appendix F – Mortar Analysis by the Clio Group, Inc.

[2] Leland J. Abel, *Historic Structures Report, Part II, Archeological Excavations at Hopewell Furnace, Hopewell Village NHS* (Hopewell Furnace NHS, March 1964), p. 139.

served as supports for wooden girders that were joined at the corners to lend additional support to the walls.[3] An opening on the upper north side of the furnace, called the tunnel head, is where the charge (iron ore, limestone, and charcoal) was loaded from the bridge. From here, the charge descended into the interior bosh where the ore was heated and smelted. The bosh was lined with sandstone (later with firebricks) and insulated with sand in the space between the bosh and the exterior stonework. Blasts of air channeled through a tuyere pipe and nozzle on the lower north side of the furnace, at the tuyere arch, caused the charge to burn hotter. Molten ore and lighter slag next descended to the hearth at the bottom of the furnace and collected in a stone- lined cylindrical reservoir called the crucible. These were tapped at the casting arch on the lower east side of the furnace (see fig. 10.)

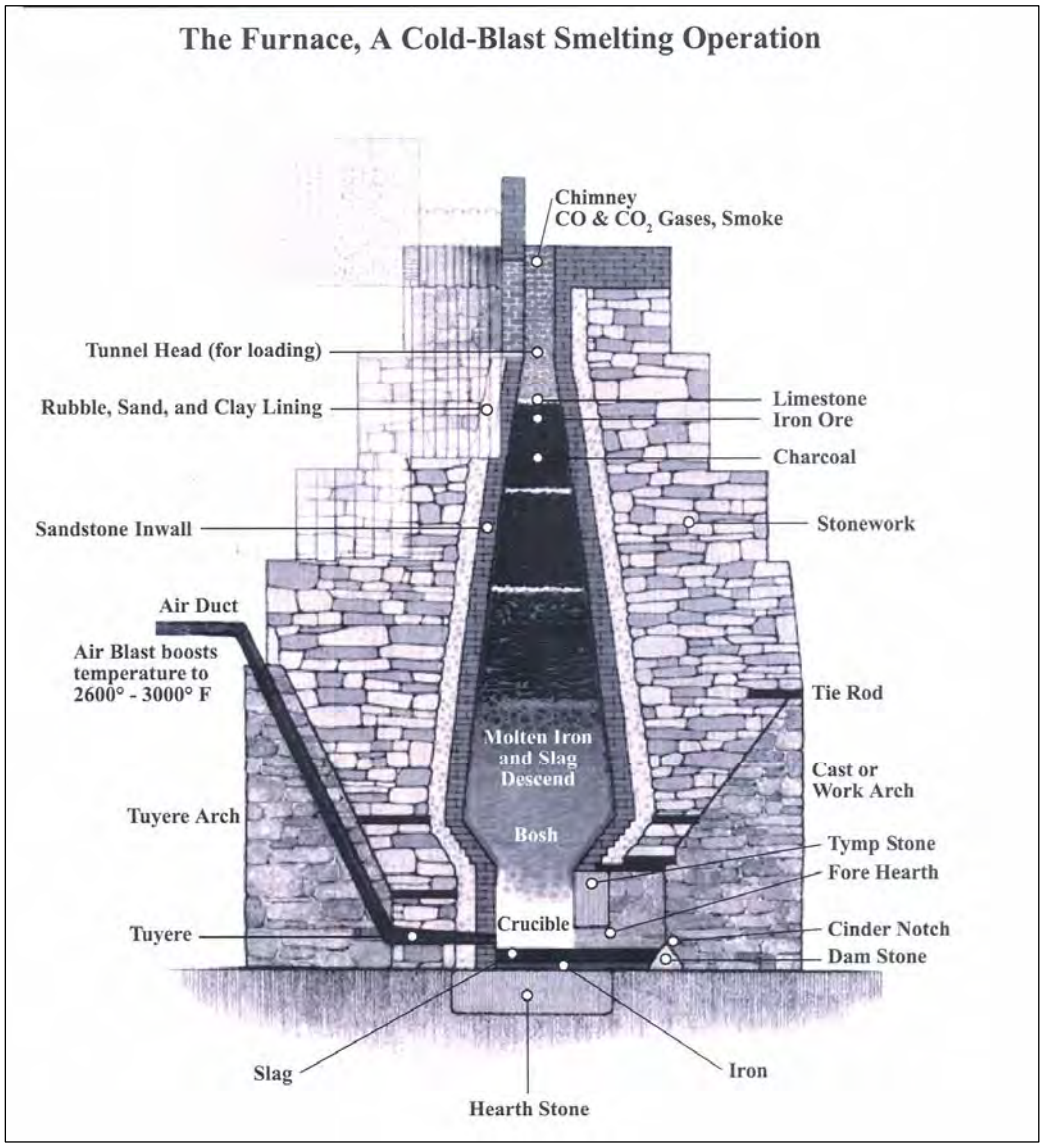

Figure 10. Annotated cross- section of a furnace similar to the one at Hopewell Furnace.

[3] Russell Apple, *Documentation for the Historical Base Maps, 1830- 1840, Part of the Master Plan* (Hopewell Village NHS, June 1956), pp. II- 113- 114.

Bridge House

An elevated walkway, called a "bridge house" or "bridge haus" in later Hopewell records,[4] would have been necessary to convey charge from the furnace bank to the tunnel head at the upper north side of the furnace. All that remains of this early structure are portions of the stone walls that supported it. Archeologists and historians have surmised that the 18th- century walkway was five feet narrower than its 19th- century replacement (the model for the present reconstruction), based on the location of its foundations.[5] The name "house," used as early as 1801, suggests that the bridge was most likely covered by a roof, possibly as early as the 18th century. That the structure was made of wood also seems probable, since later replacements were of wood- frame construction. No early design details are known.

Charcoal House

A covered structure to protect the charcoal from the weather undoubtedly existed from an early date at Hopewell Furnace. Such a structure was mentioned in an inventory of the property in March 1800, which recorded the "Coal in the Coal house," among other items.[6] No descriptions of this building are provided, nor is its location given in the inventory. The existing stone charcoal house is conveniently located on the furnace bank opposite the furnace, and may in fact be the early "coal house." Previous researchers have debated the date of this structure, most thinking it was built in 1801 and substantially reconstructed in 1880, based on entries in the Hopewell records. These entries appear to refer to repairs, however, not substantially new construction, as will be explained later in this report.

Water Wheel and Bellows

The power to deliver a blast of air through the tuyere pipe and nozzle was generated by a water wheel located northwest of the furnace. The only remnants of this wheel are the stone foundation walls of its north- south wheel pit, now partly incorporated into the walls of the later east- west wheel pit.[7] The wheel itself was recalled by former Hopewell manager Harker Long to have been an overshot type that measured 30 feet in diameter.[8] The accuracy of Long's recollections must be questioned, however, since his tenure at Hopewell began in 1867, more

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[4] Apple, *Documentation for the Historical Base Maps, 1830- 1840*, p. II- 85.

[5] Apple, *Historical Documentary Report on the Bridge and Wheel Houses, Hopewell Furnace (Buildings 10 and 8)* (Hopewell Village NHS, Sept. 1956), pp. 5 and 7.

[6] Hopewell document X8000320, "The Appraisement [sic] of John Bishup at Hopewell furnace to Brook [sic] and Buckley."

[7] The walls of the north- south wheel pit, built on undisturbed clay, were uncovered by archeologist Paul Schumacher in 1951. Schumacher documented his findings in the report *Archeological Explorations at the Furnace Group, 1935 to 1951, Hopewell Village NHS, Pennsylvania* (Hopewell Furnace NHS, Sept. 1951), pp. 17 and 24- 26.

[8] Apple, *Documentation for the Historical Base Maps, 1830- 1840*, p. II- 86. Original reference is an interview of Harker Long by Jackson Kemper in 1936.

than 60 years after the demise of the early wheel. The machinery operated by the wheel that provided the blast of air was conjectured by park historians Dennis Kurjack, Walter Hugins, and Russell Apple to have been a large leather bellows, or pair of bellows, situated north of the furnace.[9] Such an arrangement was illustrated in 1938 by WPA artist Robert Larter in a mural painting entitled "Ironworks in Pennsylvania in 1800" (fig. 11).[10] Although of interest, this view must also be viewed with some skepticism, since it was a fictional scene created more than 100 years after the fact.

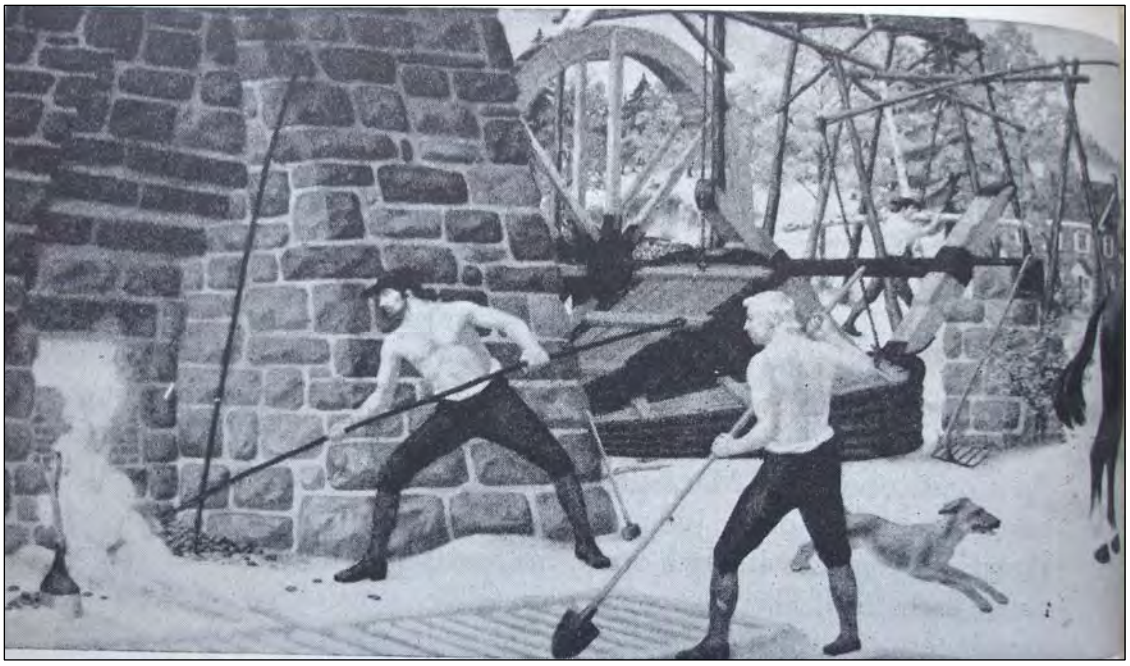

Figure 11. Detail of WPA mural by Robert Larter titled "Ironworks in Pennsylvania in 1800."

East Head Race

Water to power the water wheel was provided by two races: the east race and the west race. Tradition says that the east race was the first race constructed at Hopewell Furnace, and that it was built with slave labor.[11] This race is a mostly open ditch that originates about a mile to the east of the furnace at Baptism Creek. Frequent periodic cleaning was necessary to maintain the race in functioning order, according to entries in the Hopewell records. Several restorations have also been undertaken by the National Park Service over the years. How much, if any, of the race's 18th- century integrity remains is therefore open to question.

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[9] Apple, *Historical Documentary Report on the Bridge and Wheel Houses*, pp. 28 and II- 120; and James Cass and Walter Hugins, *Completion Report on the Restoration of the Water Wheel, Blast Machinery, and West Head Race, Hopewell Village NHS* (Hopewell Village NHS, Aug. 1952), p. 2.

[10] Historian Apple brought this mural to the attention of Hopewell's superintendent in a memorandum dated September 6, 1956.

[11] Apple, *Documentation for the Historical Base Maps, 1830- 1840*, p. II- 9; and Harker Long interview with Mr. Kemper, Aug. 1936.

West Head Race

A second race located west of the furnace is said to have also supplied water to the water wheel in the early years of furnace operation, from 1770 to 1805. This race was approximately two miles long and crossed lands owned by the Warwick Furnace, according to Harker Long. Land disputes led to its eventual abandonment. The existing west race was created around 1805, as it became clear that the water from the east race alone was insufficient to run the water wheel.[12] The path of the original west race had almost completely disappeared by 1935, according to historian Roy Appleman who observed:

> The [old] west race is utterly impossible to trace near the furnace, although its probable course can be marked. In company of Mr. Harker Long and Mr. George Haws I attempted to find evidence of this old race, but a search along half a mile of its known former location did not reveal a single trace .... Farther away, perhaps a mile from the furnace, the course of the old west race can be followed for short distances.[13]

Cast House and East Shed

Archeological excavations of the cast house site were undertaken by Ronald Mason in 1958 and by Leland Abel in 1962- 63. While Mason identified foundations of the missing structure, it was Abel who distinguished early features from later construction. Earlier historical reports had surmised that a cast house existed in the vicinity of the furnace, as documented in legal testimony given in 1810 by a former keeper at Hopewell, who mentioned going into the "Casting House" around 1773.[14] It had also been assumed that the cast house contained pig beds and one or more molding rooms, since both pig iron and finished castings were recorded in the Hopewell Furnace journal of 1784- 85.[15]

Abel concluded that the original cast house had been somewhat smaller than the later structure, based on the finding of two early foundations resting on undisturbed soil: one to the south of the furnace stack, the other to the east. The south foundation was situated about 16- 17 feet from the south face of the furnace (fig. 12). Abel described the wall as made of "mortared, random masonry," measuring 47 feet long by 2.4 feet wide by 2 feet high at its highest point, although it appeared to have been shortened when the upper wall was demolished. The east foundation, to the southeast of the furnace and 33 feet from its east face, was not fully excavated

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[12] Apple, *Documentation for the Historical Base Maps, 1830- 1840*, p. II- 134; and Harker Long interview with Mr. Kemper, Aug. 1936.

[13] Roy E. Appleman, *Historical Report, French Creek Area* (Bronxville, NY: NPS, Second Regional Office, Aug. 19, 1935), p. 26.

[14] Apple, *Documentation for the Historical Base Maps, 1830- 1840*, p. II- 108. Original source: John Kring, sworn testimony, Penn's Lessees vs. Mock, tried Jan. 9, 1810, Montgomery Collection.

[15] Walter Hugins, *The Physical History of the Hopewell Furnace Group, 1770- 1883, Hopewell Village NHS* (Hopewell Village NHS, Feb. 7, 1954), p. 21. Original source: Hopewell Furnace journal, 1784- 85, SM- 41.

because it had been covered by a later stone wall. This early foundation was described as a "crude masonry wall … probably dating from 1771."[16]

Red- clay tiles had covered the roof, as suggested by "many pieces" of the tiles excavated by Abel on either side of the original south wall, and below the later clay floor of the enlarged building. Although the configuration of the roof could not be ascertained, Abel conjectured that it had been a hip- type, in keeping with the prevailing style of the day. Abel also surmised that the floor had been "a relatively thin clay floor" that had mostly washed away. An early layer of stone and iron slabs was also discovered in front of the casting arch, which was believed to have provided a "solid and substantial" foundation for the casting of pig iron.[17]

No physical evidence has been found for the cannon and shot- casting operation that presumably existed at Hopewell during the Revolutionary War. However, a cannon is said to have been exhumed nearby during the Civil War, and several cannon balls have been retrieved from Hopewell's slag piles over the years.[18]

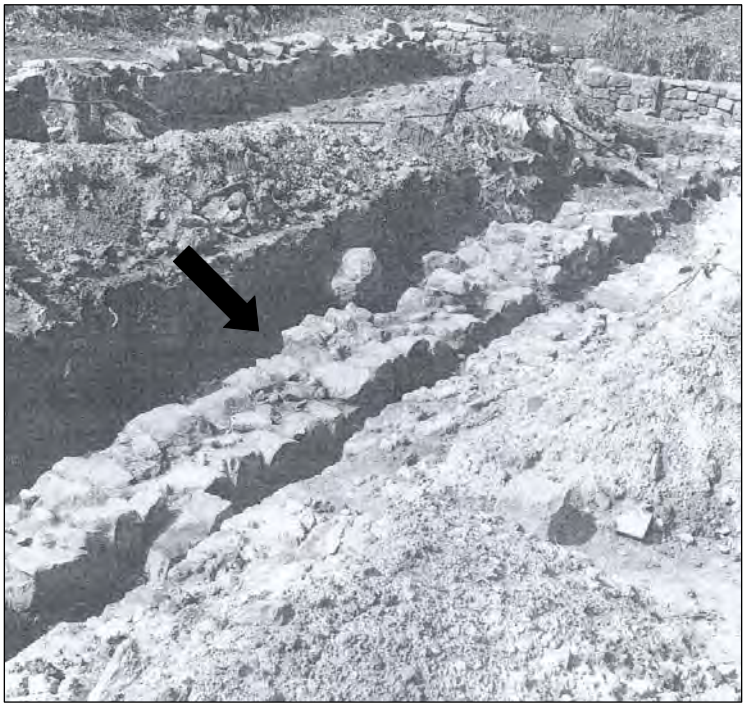

Figure 12. Original south foundation of the cast house (at arrow), excavated in 1962- 63. View is looking southwest.

[16] Abel, *Archeological Excavations at Hopewell Furnace,* pp. 37, 38, 139, and Plates VIII and IX.

[17] Abel, *Archeological Excavations at Hopewell Furnace*, pp. 39, 53, and 139.

[18] Roy Appleman, *Historical Report, French Creek Area* (Bronxville, NY: Second Regional Office, NPS, 1935), pp. 35- 36; and Joseph Walker, *Hopewell Village: The Dynamics of a Nineteenth- Century Iron-Making Community* (Philadelphia: University of Pennsylvania Press, 1966), p. 27.

1800- 1845: Reconstruction and Improvements

Conjectural Appearance of the Furnace Group, Circa 1800

Three sketches illustrating the conjectural appearance of the Furnace Group at Hopewell during the years of Buckley and Brooke ownership in 1800, 1840, and 1880 were prepared by NPS Architect Norman Souder in the early 1960s (figs. 13- 15). These were based on multiple sources of information derived from archeological excavations, historical research, interviews, and early photographs dated 1887 and 1896. The views depicted by Souder were all looking towards the northwest, similar to the earliest known photograph taken in 1887.

The sketch of the furnace stack as it may have looked about 1800 shows a stepped structure mostly enclosed by a wood- framed building that is assumed to be the cast house. Beyond the cast house can be seen the long bridge house with gable roof and open sides that connected with a stone charcoal house on the furnace bank; the cooling shed had not yet been constructed. Hidden from view by the cast house were the early north- south water wheel and bellows that provided a cold blast of air to the furnace.

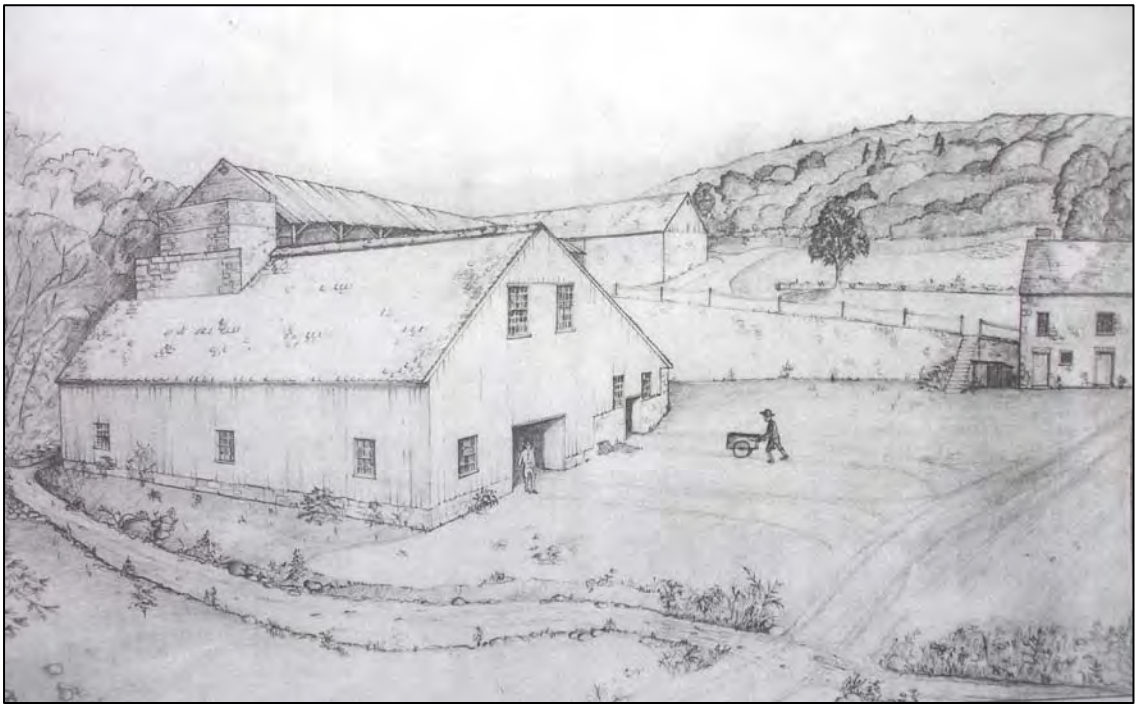

Figure 13. Conjectural sketch of Hopewell Furnace as it may have looked about 1800.

Ironmaster's House Constructed, Circa 1800

Although not the primary subject of this report, an important structure in Hopewell Village was the stone- walled Ironmaster's House, or Ironmaster's Mansion, located east of the Furnace Group. Early NPS studies conjectured that the original (north) portion of the house had been built during Mark Bird's tenure in 1773, with east and south additions constructed later in the 19th century. More definitive information was provided by a dendrochronology (tree- ring) study in 1980 that determined the dates when major structural members in the house had been felled. Wooden beams were thus dated 1799 in the original house (northwest parlor and hall), 1825 in the east wing (dining room and kitchen), and 1829 in the south addition (southwest parlor).[19] Assuming these trees were used shortly after they had been harvested, we can safely guess the main portion of the house was built in 1800, the east wing in 1826, and the south extension in 1830. Thus, it is probable that all early components of the house date to the ownership of the Buckley and Brooke families, which had acquired the property in August 1800.

Charcoal House Repairs, 1801

A single entry in the Hopewell Furnace records for February 28, 1801, suggests the reroofing of a coal house – possibly the stone charcoal house that exists today to the north of the furnace. Thomas Loid [sic: Lloyd?] was noted in the records as having been paid for 15 logs, timber, rafters, shingles, and straw "for the Colehaus."[20] Some researchers have interpreted this entry to mean the construction of an entirely new building. It is also possible, however, that the materials were intended for a new roof for existing building.

Alteration of the West Head Race and Water Wheel, Circa 1805- 10

Alterations to the water wheel and the old west head race at Hopewell Furnace are said to have been made around 1805- 10, although no firm documentation has yet been found for this change. Most of our information comes from interviews with Harker Long in 1935 and 1936, and the Smith brothers in 1940 and 1941. Mr. Long came to work at Hopewell Furnace in 1867, more than 50 years after the events of circa 1805- 10. The historical connection between Hopewell Furnace and the Smith brothers, who lived along the path of the old west head race, is not known.

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[19] Correspondence in the archives of Hopewell Furnace NHS. The dendrochronology study was undertaken by Richard L. Phipps, Research Botanist with the Tree Ring Laboratory, Geological Survey, in Reston, Virginia (letter dated April 10, 1980, from Richard Phipps to Peter Dessauer, NPS Denver Service Center). Results of the study were conveyed by Mr. Phipps to NPS staff via phone on May 16 and June 3, 1980, according to handwritten notes in the file. Mr. Phipps recently recalled that no final report of findings was written due to lack of funding (Richard Phipps to Barbara Yocum, Sept. 18, 2007). Core samples removed for the 1980 study are in the park archives.

[20] Apple, *Documentation for the Historical Base Maps, 1830- 1840*, p. II- 89. Original source: Hopewell Furnace day book, 1800- 02, entry for Feb. 28, 1801, p. 134.

Orientation of the water wheel was reported to have been changed at some point from a north-south direction to an east- west direction, according to a 1936 interview with Long. An existing 30- foot wheel is also said to have been replaced by a smaller 22- foot wheel. The reason for this change has been attributed to a turn- of- the- century land dispute that resulted in the abandonment of the old west race which had, together with the east race, supplied water to the water wheel. French Creek was subsequently dammed to provide a water source for a new west race that was constructed at a lower elevation than the old race. Water from the new race was introduced at the mid- point of the wheel, while the old east race continued to supply water to the top of the wheel. The former overshot wheel thus became a combination "breast" and "overshot" wheel. Leather bellows that were powered by the water wheel to produce a blast of air to the furnace were also believed by Historian Kurjack to have been replaced by early blowing tubs about this time.[21]

Ten days of labor were expended by a millwright on the "furnace wheel" in the spring of 1805, according to an entry in the Hopewell records. This, combined with information suggesting that the dam existed by 1807, led Historian Russell Apple to conclude in 1956 that the work described in the previous paragraph had taken place in 1805.[22] The assumption that the orientation of the water wheel was changed at the same time as the building of the Hopewell dam is purely speculative, however. Additional research in Hopewell's primary sources may one day provide additional information on the date and details of these significant alterations.

Repairs, 1816

During the years the furnace was out of blast, from 1808 to 1816, the works "went into decay," requiring "near $8000 to repair before the furnace could be of any use."[23] No details are available of the exact nature of the repairs that were made at this time. Hopewell records indicate that both carpentry and masonry work was undertaken in 1816. Several thousand feet of pine boards were purchased, more than $200 was expended on carpentry, 262 perches (24.75 cubic feet) of wall were constructed by a mason, and 236 ¾ man- days of millwrighting were recorded. Three days of labor were also noted for cleaning out 3,531 feet of the race "above the house," most likely referring to the east race.[24]

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[21] Jackson Kemper interview with Harker Long, 1936; and Apple, *Documentation for the Historical Base Maps, 1830- 1840,* pp. I- 20, II- 85- 86, II- 118- 120, and II- 134.

[22] Apple, *Documentation for the Historical Base Maps, 1830- 1840*, p. II- 118.

[23] Walker, *Hopewell Village*, p. 49. Original source: memorandum by the lawyer of the Buckley and Brooke Company dated April 1818.

[24] Hugins, *The Physical History of the Hopewell Furnace Group,* p. 29*; Apple, Documentation for the Historical Base Maps, 1830- 1840,* p. II- 121; and Charlotte Fairbairn, *Historic Structures Report, Part I, East Headrace, Historical Data Section, Hopewell Village National Historic Site* (Hopewell Village NHS, 1963), p. 6. Original sources: Hopewell Furnace day book, 1816- 17 (SM- 7), entries for Mar. 20, Apr. 12, May 17, May 30, June 5, July 16, Sept. 11, Nov. 15, Nov. 23, and Dec. 24, 1816; and Hopewell Furnace journal, 1816- 18 (SM- 8), pp. 153b and 160a.

There has been much conjecture among NPS archeologists, historians, and architects as to what work was actually carried out in 1816, not including the cleaning of the east race. There is little doubt that repairs would have been made to the furnace, most likely including replacement of its interior walls and hearth.[25] It is also believed that the bridge house and its supporting foundations were rebuilt,[26] and the old cast house replaced by a new and larger one.[27] Extensive work of an unknown nature on the water wheel and blast equipment is also suggested by the lengthy employment of a millwright.[28]

Physical evidence of the new, enlarged cast house was uncovered by Archeologist Leland Abel during excavations in 1962- 63. Abel distinguished the later stone foundations from the original foundations by their construction on top of several layers of slag and molding sand. One portion of wall, on the east side of the building, had been built on top of the old foundation. Abel surmised that the new cast house had been extended approximately 15 feet to the south, and was enlarged to the east by a shed constructed sometime between 1810 and 1850, based on the nail evidence. The presence of wooden floorboards was suggested by the parallel imprints of wooden sleepers, except in the area of the hearth, where casting sand was used. Red roofing tiles were evidenced by wide scatterings of mostly broken tiles, some possibly reused from the original building. Three or more windows in the south wall were indicated by concentrations of thin window glass.[29] An enclosed room on the south side of the east shed was suggested by physical evidence of an interior partition with windows and a wooden floor.

Wheel House Constructed, 1818

Construction of a wheel house to shelter the water wheel and blast machinery from the weather was undertaken in 1818. This work is documented in the Hopewell records, in which "Michael Sand" was paid for both building the wheel house and his board during construction.[30] No other details of this early structure are known, other than the fact that it appears to have had a roof that was separate from the adjacent bridge house.[31]

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[25] Dennis Kurjack, *Preliminary Report on Walls Adjoining Furnace Bank, Hopewell Village* (Hopewell Village NHS, Feb. 1950), p. 18.

[26] Hugins, *Physical History of the Hopewell Furnace Group*, p. 29.

[27] Abel, *Archeological Excavations at Hopewell Furnace,* pp. 141- 42.

[28] One possibility is that the north- south orientation of the water wheel was changed to its present east- west orientation in 1816, not circa 1805 as has been previously conjectured.

[29] Abel, *Archeological Excavations at Hopewell Furnace*, p. 24.

[30] Apple, *Documentation for the Historical Base Maps, 1830- 1840*, pp. II- 121 and 124; and Apple, *Historical Documentary Report on the Bridge and Wheel Houses*, p. 27. Original source: Hopewell Furnace journal, 1816- 18 (SM- 8), pp. 153b and 160a.

[31] Interview with Harker Long, 1935.

Work on the Furnace, 1828

A considerable amount of work appears to have been undertaken on the furnace in 1828, based on Hopewell records that document 528 ¼ man- days of work credited to the "Furnace Stack," including much masonry.[32] No details of this work are known, although NPS researchers have speculated that the furnace may have been overhauled or completely rebuilt at this time. Available blast data indicates that the annual capacity of cast iron increased after these repairs, suggesting a heightening of the furnace.[33] Harker Long, who had come to Hopewell Furnace in 1867, recalled in an interview in 1936 that "In 1800 [sic: 1828?] the Furnace Stack was reconditioned and made several feet higher.[34]

It has also been proposed that the work on the furnace stack would have necessitated the removal, and possible reconstruction, of the bridge house. Although no documentation for this work exists, it may be reflected in the Hopewell records as unspecified masonry and carpentry projects.[35]

New Water Wheel and Bellows Repairs, 1830s- 40s

Replacement of the water wheel appears to have occurred with some regularity at Hopewell Furnace. A new shaft was crafted by a millwright in 1830- 31, and 2,304 board feet of planks were purchased for the wheel, according to Hopewell records.[36] Problems with this shaft may explain why another was hauled to Hopewell from Hibernia Forge in July 1834. This second shaft measured 2 feet 10 inches "at the butt," and 2 feet 8 inches "at the top," and was worked on by millwright David Lockhard for 14 days in July and August of that year.[37]

Numerous entries also appear for repairs to the blast equipment driven by the water wheel. A "Sett of Bellows Springs," which may have been for the compression tubs, was acquired from Birdsborough in 1831. Some work on the "Piston Stem of the Bellows" was carried out in 1840, and several other entries relating to work on the "Furnace Bellows" are recorded for the years 1842- 45.[38]

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[32] Apple, *Documentation for the Historical Base Maps, 1830- 1840*, p. II- 115. Original source: Hopewell journal, 1827- 30 (SM- 14), pp. 36- 37.

[33] Hugins, *Physical History of the Hopewell Furnace Group*, pp. 4- 5.

[34] Harker Long interview with Jackson Kemper, Aug. 7, 1936.

[35] Apple, *Documentation for the Historical Base Maps, 1830- 1840*, p. 4.

[36] Apple, *Documentation for the Historical Base Maps, 1830- 1840*, p. II- 118. Original source: Hopewell journal, 1931- 37 (SM- 21), pp. 22a, 22b, and 43.

[37] Apple, *Documentation for the Historical Base Maps, 1830- 1840*, p. II- 118. Original source: Hopewell journal, 1831- 37 (SM- 21), pp. 149 and 187- 88.

[38] Apple, *Documentation for the Historical Base Maps, 1830- 1840*, p. II- 122. Original sources: Hopewell journal, 1831- 37 (SM- 21), p. 23a; and Hopewell Cash Book, 1840- 45 (SM- 28), entries for Sept. 7, 1840, Mar. 23, 1843, Apr. 13, 1844, and Apr. 19, 1845.

Conjectural Appearance of the Furnace Group, Circa 1840

Norman Souder's conjectural sketch of circa 1840 shows several changes to the Furnace Group since 1800 (compare figs. 13 and 14). These include an enlarged cast house with a new belfry and east annex, a roofed enclosure over the water wheel, a remodeled bridge house, and a new charcoal- cooling shed north of the charcoal house. While helpful in envisioning the general physical appearance of the furnace about this time, several details merit discussion. First, Archeologist Leland Abel concluded in 1964 that the cast house had been completely rebuilt around 1816. Souder, on the other hand, depicts the building as an existing structure with newly added south extension, east annex, and belfry. Second, the roof of the wheel house is shown as continuous with the roof of the bridge house – a change that did not occur until 1879, according to Harker Long. Third, the enclosed portion of the bridge house nearest the furnace resembles that shown in the earliest known photograph dated 1887. This is more likely the configuration of the bridge house after extensive work was undertaken in 1847- 48, and is therefore not a true representation of its earlier 1840 appearance. Finally, it is possible, but not certain, that the cooling shed existed by 1840.

Figure 14. Conjectural sketch of Hopewell Furnace as it may have looked about 1840.

1845- 1883: More Changes and Improvements

New Bridge House Scales and Alterations, 1847

Scales for weighing the furnace charge were purchased for the bridge house in April 1847 for $35, with $1.50 expended on carpentry to install them. A carpenter was also credited in January of the following year for having performed 53 ¾ days of "carpenter work on Bridge House."[39] Two carpenters working 50 ½ days on unspecified projects between March and December 1847 may also have assisted with the bridge house.[40] Previous studies have speculated that the bridge house was either reconstructed or structurally altered at this time.[41] Possibly the south portion, closest to the furnace, was enlarged and enclosed with sidewalls at this time to provide additional protection to the new scales and furnace charge. This configuration appears to have existed by the time of Harker Long's arrival at Hopewell in 1867, since he had no memory of any other bridge house design.

New Bell, 1849

The only known purchase of a bell in the Hopewell records is found in an entry for July 11, 1849.[42] Interestingly, this coincides with the construction of a new anthracite furnace northwest of the charcoal furnace, although no connection has ever been made between the two events. Rather, previous researchers have assumed that the bell was procured for the belfry on the roof of the cast house, the earliest documentation for which is the photograph of 1887. No details of the bell's intended use or location are provided in the records. Harker Long recalled that cast house bell was rung to announce the start of casting, thus notifying workers on the bridge and residents of the nearby Ironmaster's House.[43]

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[39] Apple, *Documentation for the Historical Base Maps, 1830- 1840*, pp. II- 69 and II- 85. Original source: Hopewell day book, 1846- 51 (SM- 31), entry for Apr. 7, 1847; and Hopewell journal, 1846- 53 (SM- 32), p. 35b.

[40] Kurjack, *Preliminary Report on Walls Adjoining Furnace Bank*, pp. 18- 19; and Apple, *Historical Documentary Report on the Bridge and Wheel Houses*, pp. 10- 11. Original sources not cited.

[41] Hugins, *Physical History of the Hopewell Furnace Group*, p. 29.

[42] Hugins, *Physical History of the Hopewell Furnace Group*, p. 47; and Earl J. Heydinger, *Historic Building Survey Report on Cast House, Part I, Historical Data, Hopewell Village National Historic Site* (Hopewell Village NHS, Nov. 1960), pp. 18- 19. Original source: Hopewell Furnace day book, 1846- 1851 (SM- 31), entry for July 11, 1849.

[43] Harker Long interview with Roy Appleman, Dec. 1935.

Blast Equipment Updated, 1852

Through 1850, Hopewell records referred to the furnace's blast equipment as "bellows." Not until 1852 did the terminology change from "bellows" to "tubs" or "blowing tubs." Opinions are divided as to whether or not an actual change was made to the blast equipment at this time. Historian Russell Apple believed that "bellows" could also have been used to also describe early casks or tubs, which he conjectured had been installed earlier in the century.[44] Supporting this are references to earlier repairs of the "Bellows Springs" in 1831 and the "Piston Stem of the Bellows" in 1840 (see page 44). Archeologist Leland Abel, on the other hand, thought the tubs were installed around 1851. Abel also believed that this change coincided with physical alterations in the size and orientation of the water wheel.[45] Although there is no specific documentation of their installation, "tubs" definitely existed by 1852, based on a description of their repair that year by Isaac Markley in the Hopewell records.[46]

Cast House Altered, Circa 1865

At some unknown date the cast house was reduced in size by removal of the south portion of the building (referred to by NPS as the "south molding shed") and the east shed (fig. 14). This is believed to have occurred sometime after 1845, when Hopewell Furnace ceased its production of cast- iron stoves.[47] It had certainly taken place by 1867, according to Harker Long, who came to Hopewell that year and remembered the cast house only in its reduced state. A smaller cast house, with a wood- shingle roof in place of the clay tiles, is shown in the earliest photograph of the cast house, dated 1887 (figs. 7 and 17).

Furnace Repairs, 1868

The interior of the "old Stack" was replaced in 1868 with a brick liner backed by insulating layers of brick bats and sand, according to Hopewell records. Details of the work were noted by the Hopewell clerk as follows:

> Repaired old Stack and put in new inwalls the inwalls of new fire brick – Started on an iron ring Seven feet wide with a regular taper to the top which is twenty two inches – the new inwall was 9 inch brick backed by

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[44] Apple, *Documentation for the Historical Base Maps, 1830- 1840*, p. II- 120. Research by Historian Dennis Kurjack in 1949 also led him to conclude that the blast equipment consisted of crude, single-action cylinders as early as 1800 ("Monthly Narrative Report," 1949), but no factual basis for this was stated.

[45] Abel, *Archeological Excavations at Hopewell Furnace*, p. 143.

[46] Apple, *Documentation for the Historical Base Maps, 1830- 1840*, pp. II- 120 and II- 123. Original source: Hopewell journal, 1846- 53 (SM- 32), p. 133b.

[47] Abel, *Archeological Excavations at Hopewell Furnace*, p. 143.

> 12 inches of fire brick bats and a Space of four inches between them and the Stone Wall which was filled with Sand.[48]

It is unclear exactly when bricks began to be used to line the furnace instead of stones. As late as 1834, 19 loads of stone had been delivered to Hopewell for "Furnace Hearth inwalls etc…." A large number of fire bricks ordered in 1848 may have been for a new liner, or intended for construction of the new anthracite furnace the following year.[49] The first definite use of bricks for the furnace interior was in 1868.

The furnace is believed to have changed from an open- hearth operation to a closed- hearth design sometime in the 19th century. Historian Earl Heydinger thought this may have occurred around 1868, although no definitive documentation for this alteration has yet been found.[50] In the open- hearth operation, molten iron that pooled behind a dam stone at the bottom of the hearth (the crucible) was accessible through a small opening between the dam stone and the tymp stone above. Slag was manually skimmed off the top and the ore ladled directly into molds. In the closed- hearth operation, this opening was closed. The slag and ore were both drawn off through holes – the slag through an upper opening, and the ore through a lower tap hole. It was this closed- hearth configuration that was remembered by last manager Harker Long, who came to Hopewell Furnace in 1867.

Wheel and Wheel House Renovations, 1879

The water wheel and wheel house were both renovated in 1879. The wheel was replaced by one of the same dimensions in the fall of that year, according to Harker Long. Others remembered that either William Painter or William Houck built the new wheel. The roof of the wheel house was also modified at this time to join with the roof of the east adjacent bridge house. The west siding of the bridge house may have been removed at this time, thus providing an overlook of the wheel and blast equipment from the bridge.[51]

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[48] Walker, *Hopewell Village,* pp. 64- 65. Original source: Hopewell Furnace Account Book, 1852- 1876 (SM- 60), p. 7.

[49] Apple, *Documentation for the Historical Base Maps, 1830- 1840*, p. II- 115. Apple says 5,157 fire bricks were purchased in 1848. Original source: Hopewell journal, 1846- 1853 (SM- 32), pp. 48a and 111a.

[50] Heydinger, *Historic Building Survey Report on Cast House*, p. 11, and *Historic Building Survey Report on Cast House, Additional Historical Data, Hopewell Village National Historic Site* (Hopewell Village NHS, 1964), pp. 6- 7.

[51] Harker Long interview with Mr. Kemper, 1936; Apple, *Documentation for the Historical Base Maps, 1830- 1840*, p. II- 119; and Apple, *Historical Documentary Report on the Bridge and Wheel Houses*, pp. 24, 27, and 29.

Charcoal House and Shed Repaired, 1880

Work on an existing charcoal house and cooling shed in 1880 are documented by entries in the Hopewell Furnace day book covering the years 1851- 1883, and interviews with Hopewell residents and workers in the 1930s, 1940s, and 1950s.[52] The extent of work that was undertaken on the charcoal house at this time has been debated over the years by NPS professionals: some interpreted the documentation to mean that the stone structure was completely reconstructed in 1880, while others thought it underwent extensive repairs. A reexamination for this report has led this author to conclude that an existing structure was both repaired and modified to incorporate new features, as will be explained subsequently.

Harker Long, who had come to Hopewell in 1867 and was still employed in 1880, related to Historian Roy Appleman in 1935 that the "big charcoal house [was] rebuilt 1880; made 2 feet higher." Others interviewed in 1939, 1941, and 1950 recalled that the structure had been "rebuilt" or "built in my time."[53] New construction is also suggested by two entries in the Hopewell day book that referred to work on the "new Coal House" in March and April 1880. It would appear from close examination of the records, however, that while some components of the building were new, such as the roof and south extension, the existing stone walls were only repaired.

Agreements for the coal- house project were negotiated by furnace management in March 1880. Laborer William Durrell was first enlisted to "clean up Coal House ready for masons" and to "cart away stone and rubbish" for $25. John Roberts, a carpenter, next agreed to undertake the carpentry work on the building, which included a new roof. He was also to "make an extension 19 feet long and 29 feet wide on the south side [of the building] and run the roof into the main building" for $75. Roberts was invited to "use all the old plate that is good, also what ties that are good." Furnace management agreed to cut and haul additional timbers at the company's expense. Help would be provided in lifting "the peak and ties" and raising the rafters, but Roberts was responsible for getting up the roofing "lath and shingles." John R. Smith, a mason, agreed to "do the mason work at Coal House for 55 cents per perch," a perch being defined as 24.75 cubic feet. The back wall was to "have three doors left in it from the ground up," and the front wall "an opening 29 feet wide." Smith also agreed to build "six piers," or buttresses, on the south side of the building, and to batter the back foundation wall. John Ackley, possibly a mason working with Smith, offered to "broad point the Coal House" using a mortar of lime and sand.[54]

Work was scheduled to commence on the coal house on April 5, 1880, and appears to have been completed by April 20 – just 15 days later. Hopewell Furnace was recorded as being indebted to Roberts for $75 "for doing the carpenter work at Coal House," along with $2 for "extra"

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[52] Hopewell Furnace day book, 1851- 83 (SM- 34). Entries relating to the coal house and shed have been transcribed as an appendix in a report by Richard Donohoe, *Historic Building Report, Part I, Survey Report (Architectural Data), Restoration of the Charcoal House & Shed (Bldg. 9), Hopewell Village National Historic Site* (Philadelphia, PA: U.S. Dept. of the Interior, NPS, Eastern Office, Div. of Design and Construction, Dec. 7, 1956). Transcripts of interviews are in the archives at Hopewell Furnace NHS.

[53] Harker Long interview with Roy Appleman, Dec. 1935; and Apple, *Documentation for the Historical Base Maps, 1830- 1840*, p. II- 89.

[54] All entries are in the Hopewell Furnace day book, 1851- 83 (SM- 34).

unspecified work. Smith was owed $200.20 "for 364 perch mason work (coal house) at 55 cents/perch." Durrell and Ackley were presumably also paid for their labor.[55]

Later that month, John Roberts was again engaged to "rebuild" the eastern portion (42 feet) of the adjacent charcoal shed, called the "upper Coal House" in the Hopewell day book, for $30. The southern portion of the new roof was to be joined with that of the renovated coal house, providing a covered area between the two buildings. The job was described in detail in the day book as follows:

> … We are to help him raise and put up the rafters. The building is to be 28 feet from out to out [wide]. The south end of the ties are to rest on the rafter plate of the new coal house. On the upper side there is to be four upright posts and one tie. One post is to rest on a stone. He promises to make a good tight substantial job where the roof comes together and at the dormer, also to fasten up the west end where the new and old will unite. Also to board up the east [gable] end from the rafter down to the tie….[56]

Roberts also agreed "to put a dormer window in the upper side of the Coal House,"[57] perhaps referring to a second dormer that was added to the roof of the charcoal house.

That much of this work was accomplished as described in the records is verified by the earliest photograph of the furnace, dated 1887 (figs. 7 and 17). This shows the southeastern portion of the charcoal house with a gable roof in good repair, and a wooden, gable- roofed extension appended to the south elevation. The mortar of the building's upper masonry walls appear to be a darker color than the lower walls, suggesting a rebuilding or repair of the upper walls. North of the charcoal house can be seen the enclosed east gable end of the rebuilt charcoal shed, and a projecting gutter that provided drainage for the valley between the conjoined roofs. Discrepancies are found in the later recollections of Harker Long, who said the roofs of the charcoal house and shed were connected for a distance of only 25 feet, not the 42 feet described in the agreement with Roberts.[58] An examination of the existing charcoal house also indicates that there are only three stone piers on the south elevation of the building, not the six specified in the records.

In summary, the work undertaken in 1880 at the charcoal house and shed was extensive enough to have been remembered by Hopewell residents and workers as a significant building event. An existing charcoal house appears to have had its masonry walls repaired, a new gable roof with two dormers installed (possibly incorporating the old plates and rafter ties), and a new wood- framed extension built on the south side. The same carpenter was employed to rebuild the eastern portion (42 feet) of an existing charcoal shed north of the charcoal house, joining the roof of the new shed with that of the charcoal house at the level of the rafter plates.

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[55] Hopewell Furnace day book, 1851- 83 (SM- 34).

[56] Hopewell Furnace day book, 1851- 83 (SM- 34), entry for ca. April 27, 1880, p. 201; transcribed in Donohoe, *Restoration of the Charcoal House & Shed*.

[57] Hopewell Furnace day book, 1851- 83 (SM- 34).

[58] Harker Long interview with Roy Appleman, Dec. 1935.

Conjectural Appearance of the Furnace Group, Circa 1880

A conjectural sketch of Hopewell Furnace for the year 1880 was prepared by Architect Norman Souder around 1964 (fig. 15). This view was based primarily on the earliest known photograph of Hopewell dated 1887, four years after its last blast in 1883 (figs. 7 and 17). The primary difference between the sketch and the photograph is that the structures of the furnace were depicted by Souder in less- decrepit condition. The south portion of the cast house and its east annex had both been removed by 1867, and therefore do not appear in either the sketch or photograph.[59] A small gable- roofed structure south of the cast house is believed to have been the structure described by Harker Long as the "wheelwright- carpenter shop."[60] The south extension of the charcoal house had been completed by this time, as had the east portion of the cooling shed, both constructed in 1880. Two inaccuracies postdating 1880 are a chimney for a later steam boiler, and an ore roaster situated east of the cast house.

Figure 15. Conjectural sketch of Hopewell Furnace as it may have looked about 1880.

[59] Souder's undated sketch was included as an illustration (Plate XXVIII) in Abel's *Archeological Excavations at Hopewell Furnace* report. Harker Long said the south extension of the cast house was gone when he came to Hopewell in 1867.

[60] Harker Long interview with Roy Appleman, Dec. 1935.

Steam Boiler and Engine Installed, 1881

A steam boiler and engine were installed at Hopewell Furnace in 1881 to supplement the water that drove the wheel, which in turn operated the blast equipment. This was necessitated by freezing of the water during the winter of 1880- 81, which stopped the wheel and forced a shutdown of the furnace. The boiler was contained within a brick- wall enclosure located north of the furnace and beneath the bridge house (figs. 16 and 17). The water of the boiler is said to have been heated by hot gases from the furnace. The steam generated by the boiler operated a small engine that engaged with cogs attached to the wheel. The blast equipment was also modified at this time with the installation of a larger, more efficient receiver between the blowing tubs on the platform above the wheel. The function of the receiver was to regulate the pressurized air generated by the blowing tubs.[61]

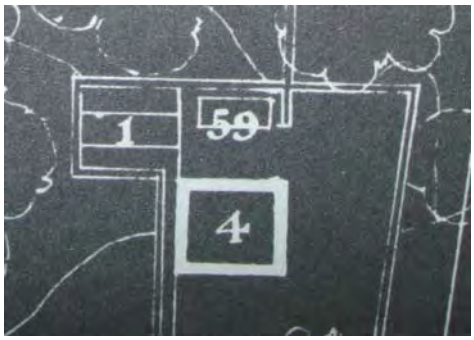

Figure 16. Detail of plan of the Furnace Group, 1935, showing location of the 1881 boiler (59), to the east of the water wheel pit (1) and north of the furnace (4).

Ore Roaster Installed, 1882

A technical improvement said to have been made in 1882 was the installation of an ore roaster. The purpose of the roaster was to remove impurities and improve the texture of the iron ore before being loaded into the furnace for smelting.[62] The ore roaster has been identified in the earliest photograph of Hopewell Furnace as a large kettle- shaped structure located east of the furnace bank (figs. 7 and 17).

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[61] Harker Long interview with Jackson Kemper, 1936; and Apple, *Documentation for the Historical Base Maps, 1830- 1840*, p. II- 123. Note that the hot gases from the furnace may have been supplemented by burning coal to generate steam in the boiler.

[62] Walker, *Hopewell Village,* p. 66. Original source: Franklin Kemper, "J. Lincoln Palsgrove" (unpublished study, n.d.), p. 6, Hopewell Village Library.

1883- 1935: Abandonment and Deterioration

Shutdown, 1883

The last blast at Hopewell Furnace was extinguished on June 15, 1883. Deterioration of the physical plant appears to have progressed rapidly after the closure, as illustrated in the earliest-known photograph of Hopewell Furnace taken just four years later, in 1887 (figs. 7 and 17).

Earliest Photographic Documentation, 1887

The earliest- known photograph of Hopewell Furnace was taken by photographer Edward B. Hardin on October 10, 1887, four years after the furnace fired its last blast in 1883 (figs. 7 and 17).[63] The assemblage of structures captured by Hardin were those making up the Furnace Group, except for a small gable building in the foreground, identified as a wheelwright-carpenter shop, and a kettle- shaped ore roaster adjacent to the furnace bank. The south portion of the cast house had been removed by this time, as had the east annex. Deterioration of the remaining structures is evident by the wide masonry cracks in the furnace stack, missing siding, cracked windows, and patched roofing.

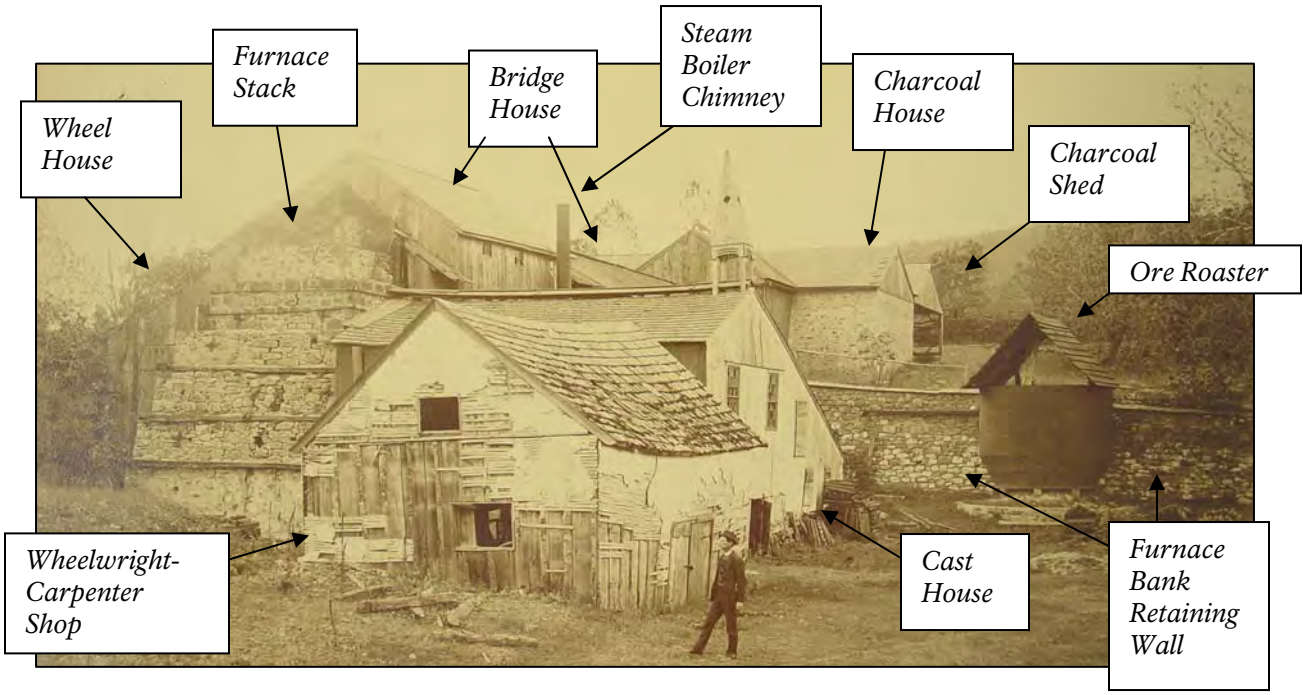

Figure 17. Annotated photograph of the Furnace Group, looking northwest, 1887.

[63] This photograph has come to be known as the "Stokes" photograph because it is in the Stokes collection of Hopewell Furnace NHS.

Furnace

The south side of the furnace stack, which had been covered by the cast house before 1867, is exposed to the weather in the 1887 photograph. The tiered masonry construction is clearly visible, as are three wooden girders in the lower three tiers. The stack is constructed of large, roughly shaped stones, except for the upper tier and north pediment, which are made of bricks. Many of the mortar joints are open, with a wide vertical crack running the length of the stack. Remnants of a light- color finish, possibly whitewash, are visible on the stonework.

Furnace Bank Retaining Wall

A stone retaining wall at the upper terrace, called the furnace bank, is clearly visible behind the cast house and the ore roaster. The wall, with upper coping, appears to be in good repair.

Bridge House

Only the upper portions of the bridge house are visible in the 1887 view. The bridge house provided a covered connection between the charcoal house to the north and the upper furnace stack to the south. This structure appears to have then been composed of two distinctly different sections. The northern portion, closest to the charcoal house, has a low gable roof composed of random- with vertical boards. The side walls, if any, are blocked from view by the cast house. This portion of the bridge house, referred to in NPS reports as the "connecting shed," joined with a taller, gable- roofed structure to the south. The south and east walls of this structure are enclosed with vertical- board siding. Three small windows, each with one six- light sash, are located in the upper east wall. Also appended to the south wall is a small, wood-framed, gable- roofed extension that joined directly with the furnace stack. Vertical- board siding and roofing enclosing this extension appears to have been protected from flying sparks by the previously described brickwork pediment on the north side of the furnace stack.

Charcoal House and Shed

Located in the far distance of the 1887 photograph are the stone- walled charcoal house and open cooling shed. The two structures were built on the furnace bank and at the same approximate height as the bridge house, to which the charcoal house was joined. Both structures appear to be in relatively good condition, having been recently repaired just seven years earlier, according to Hopewell records. Clearly visible are the new gable- roofed extension with vertical- board siding on the south side of the charcoal house, and the rebuilt east gable end of the cooling shed that had been constructed by carpenter John Roberts in 1880. The gable roofs of both buildings are covered with shingles, as had been described in Hopewell records for 1880.

Wheel House

The sloping roof of the wheel house and a small portion of its south wall are visible in the 1887 photograph. The roof by this time had been joined to the roof of the bridge house, which Harker Long recalled had taken place in 1879. The east wall of the wheel house appears to be completely enclosed with vertical- board siding, except for a window opening in the upper wall. Presumably still enclosed within the walls of the wheel house were the water wheel and blast machinery.

Cast House

The cast house had been considerably reduced in size, and its characteristic red- tile roof replaced by wood shingles, by the time of the 1887 photograph. Both the south portion of the building and the east extension are missing, having been removed sometime between 1845 and 1867 (circa 1865 is used in this report). The remaining structure has the appearance of a New England saltbox, with its low shed on the north side. The walls are sheathed with vertical- board siding, similar to other wood- framed components of the Furnace Group. Large window openings in the east elevation were clearly arranged to accommodate the missing gable- roofed extension to the east. Window sashes remaining in the two upper windows have 15- over- 15 lights, although much of the glass is broken and missing. Three lower windows to the north are boarded over. A single doorway in the ground story is centered between the upper windows, its door propped open. No details of the later south wall are visible other than its board siding, this part of the building being mostly blocked from view by the wheelwright- carpenter shop. The south slope of the gable roof is covered with what appear to be wood shingles. The roof ridge has a raised ventilator cap made of boards, the east end of which is straddled by a belfry with four- sided spire that held the furnace's bell, according to Harker Long.

Steam Boiler

All that can be seen in the 1887 photograph of the furnace's 1881 steam boiler is its large sheet-metal chimney. The boiler was located beneath the bridge house; its chimney was on the east side of the bridge house.

Ore Roaster

An ore roaster is shown in the 1887 photograph to the east of the Furnace Group. This is said to have been installed in 1882 "to remove impurities and improve the texture of the ore used in the furnace."[64]

[64] Walker, *Hopewell Village*, p. 66.

Wheelwright- Carpenter Shop

A dilapidated, wood- framed structure located in the foreground of the 1887 photograph has been tentatively identified by NPS researchers as a wheelwright- carpenter shop. This gable-roofed building had been constructed, or moved to this site, by 1867.

Progressive Deterioration, 1896

The next two photographs of the Furnace Group (figs. 18a and 18b) were taken in 1896, nine years after Hardin's 1887 photograph. The main subjects in these views were Carrie Bull and friends, with the furnace serving as an interesting background setting. The cast house by this time had deteriorated to a state of picturesque ruins, with only the main framing timbers and a small amount of siding remaining. The east face of the stone furnace stack and its casting arch are now visible behind the framing of the cast house. The bridge house appears to be in relatively good repair, with both the enclosed portion to the south and the roof of its open walkway to the north still intact. A sheet- metal chimney on the east side of the bridge house connected to the steam boiler below. All that can be seen of the charcoal house is the gable end of its recent south extension. The wheel house and water wheel are completely blocked from view, being located on the back (west) side of the complex.

Figure 18a. Photograph of Carrie Bull and friends in front of the furnace ruins, July 7, 1896.

Figure 18b. Photograph of Carrie Bull in front of the furnace ruins, July 7, 1896.

Early 20th- Century Conditions, Circa 1910- 20s

All traces of the cast house had disappeared by the time of the next photograph, roughly dated "circa 1910" by this report (fig. 19). The open connecting shed of the bridge house also appears to be gone, along with most of the upper brickwork tier of the furnace stack. The two remaining elements of the Furnace Group shown in this view are the stone furnace stack and the enclosed portion of the bridge house, along with the sheet- metal chimney of the steam boiler.

Deterioration of the Furnace Group continued in the ensuing years, as illustrated in two photographs by "Stauffer" taken in April 1920 (figs. 20 and 21). The stone furnace was still standing, as was the enclosed portion of the bridge house. Some boards are missing from the east wall of the bridge house, however, and the sheet metal chimney of the boiler had disappeared. Nature was also beginning to reclaim the site, with a number of trees sprouting in the former location of the cast house and shed. Stauffer also documented the rarely photographed back (west) side of the furnace, showing the wood- framed wheel house (fig. 21). The roof and south side walls of this structure are seen to be surprisingly intact, as is the interior water wheel. The back side of the adjacent furnace stack, on the other hand, exhibits large areas of missing stonework and open mortar joints.

Figure 19. Hopewell Furnace ruins, circa 1910.

Figure 20. East elevation of the furnace ruins, April 1920.

Figure 21. Remains of the wheel house and bridge house, April 1920.

An undated photograph taken sometime after Stauffer's views in 1920, roughly dated "circa 1925" by this report, captures the initial collapse of the wheel- house roof (fig. 22). It also provides the first clear view of the intact water wheel and the platform above it supporting the blast machinery. In a similar state of disrepair is the adjacent furnace stack, which has assumed the appearance of a crumbling mass of stones with a progressively widening vertical crack. By 1926, the roof of the wheel house had completely collapsed, leaving the water wheel and blast machinery exposed to the weather (fig. 23). It remained in this precarious state until the early 1930s.

Figure 22. The wheel house and west elevation of the furnace, circa 1925.

Figure 23. Appearance of the water wheel and blast machinery following the collapse of the wheel-house roof, 1926. Note the cogs on the side of the wheel that were probably installed at the same time as the steam engine in 1881.

Salvaging of the Water Wheel and Blast Equipment, 1931

It was because of the foresight of A. Louise Brooke, the last private owner of Hopewell Furnace, that a few selected wooden components of the Furnace Group were preserved. These were the water wheel and blast machinery that had been protected within the now- dilapidated wheel house. Mrs. Brooke offered these items as a gift to the Franklin Institute of Philadelphia in 1930.[65] The institute accepted, and employed the Philadelphia firm of Bonine & Costa, Engineers, to produce a measured drawing in February 1931 (fig. 24). An agreement to dismantle the equipment, construct a temporary storage structure, and move the equipment to this structure was executed the following month with Sheridan Painter, a contractor from Birdsboro. Mr. Painter removed and stored "the 22 foot wood breast water wheel (22 x 4), the two blowing tubs and the receiving box, the water wheel shaft and two connecting rods (wood), and other supporting timbers."[66] Shortly after, the bridge house and wheel house collapsed completely (fig. 25).

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[65] Walker, *Hopewell Village,* p. 69; and Leah Glaser, *Administrative History, Hopewell Furnace National Historic Site* (Philadelphia and Boston: U.S. Dept. of the Interior, NPS, Northeast Regional Office, Aug. 2005), p. 10.

[66] Appleman, *Historical Report, French Creek Area*, p. 40.

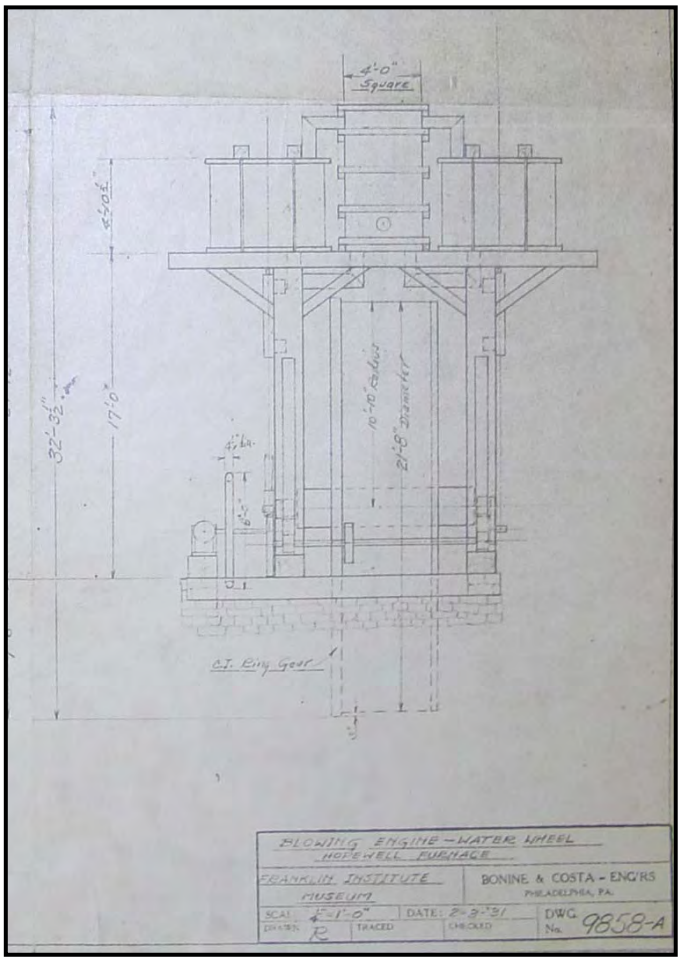

Figure 24. Detail from a technical drawing of the "Blowing Engine- Water Wheel, Hopewell Furnace, Franklin Institute Museum," February 3, 1931.

Figure 25. Final collapse of the wheel house and bridge house following removal of the water wheel and blast machinery (in foreground) by the Franklin Institute of Philadelphia in 1931.

Masonry Survivors and New Road, 1932

Following the collapse of the bridge house and wheel house around 1932, all that remained of the Furnace Group structures were the stone walls of the furnace, the charcoal house, the furnace bank, and some stone foundations. More loss was sustained in 1932 when the old Birdsboro- Warwick road that passed through the village was realigned and paved by the Commonwealth of Pennsylvania.[67] The new path of the straightened road passed to the east of the furnace and over the foundations of the former cast house and wheelwright- carpenter shop. The raised roadbed included a stone retaining wall and gutter (figs. 26- 27). The road also destroyed a large portion of the furnace bank retaining wall northeast of the furnace.

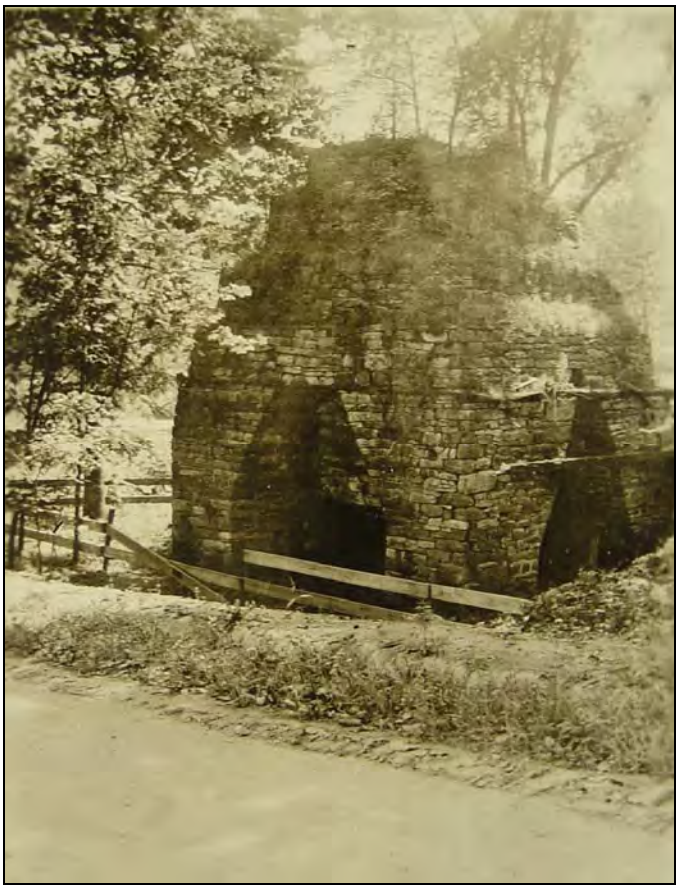

Figure 26. Northeast view of the furnace stack, taken sometime after the old Birdsboro- Warwick road was realigned in 1932, but before the start of furnace stabilization work in 1936.

[67] Appleman described this road in 1936 as "The modern macadam highway, running north and south through Hopewell Village …." *Proposed Restoration Plan for Old Iron Making Village, French Creek Project, Hopewell, Pennsylvania* (Bronxville, NY: U.S. Dept. of the Interior, NPS, Branch of Planning and State Cooperation, Second Regional Office, Jan. 1936), p. 39.

1935- 1938: Stabilization

Historical Remains of the Furnace Group, 1935

Fifty- two years had elapsed from the time of Hopewell Furnace's last blast in 1883 to its acquisition by the federal government in August 1935. Little of the Furnace Group remained by 1935 except the crumbling stone furnace, the stone charcoal house, and various stone walls and foundations. Disassembled and stored in a nearby storage structure were the furnace's 22- foot water wheel, two blowing tubs, and receiver box, then owned by the Franklin Institute. Other wooden structures had completely deteriorated and disappeared; these included the bridge house, wheel house, cast house, and cooling shed. Races that supplied the furnace's wheel with water and carried it away were also important components of the furnace operation. The west head race, which had conveyed water from Hopewell Lake one- quarter of a mile away, was still discernable in most places. Five of the stonework piers that had supported the forebay trough of this race also remained, two in good condition. Less well- defined was the mile- long ditch of the east head race that conveyed water from Baptism Creek, except where it could still clearly be seen in the vicinity of the Ironmaster's House. The tail race that channeled water away from the furnace was still clearly visible.[68]

Early Restoration Plans

A map of the existing "Hopewell Village & Ruins" was prepared December 31, 1935, shortly after acquisition of the site by the federal government in August of that year. Included on this plan was the intact charcoal house, along with the ruins of the furnace, the water- wheel pit, and the races that formerly supplied water to the water wheel. The new state road to Birdsboro, constructed in 1932, was depicted as passing through the village and to the east of the furnace (fig. 27).

[68] Appleman, *Historical Report, French Creek Area*, pp. 24- 27.

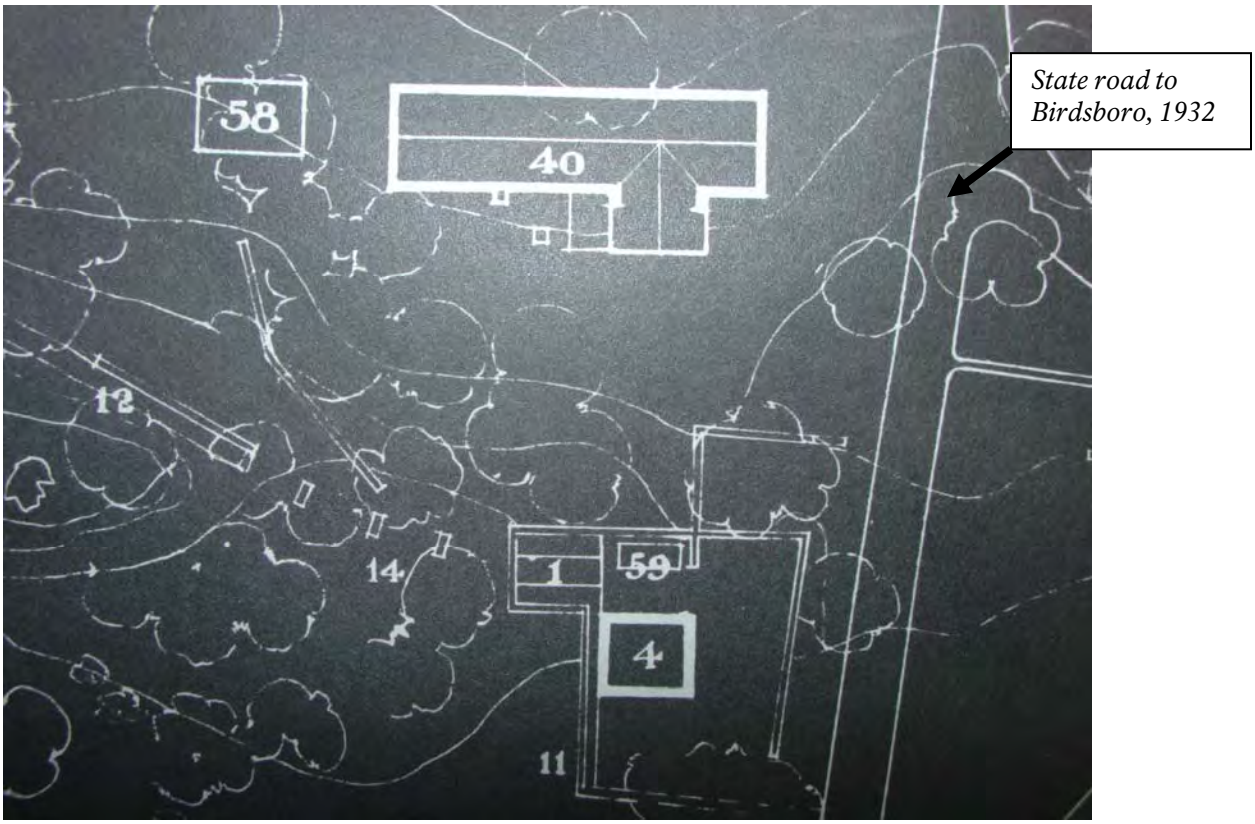

Figure 27. Detail of "Hopewell Village & Ruins" map, December 31, 1935, showing the remnants of the Furnace Group, including the water wheel pit (1), furnace (4), tail race (11), west head race retaining wall (12), forebay piers (14), charcoal house (40), and boiler (59). Located west of the charcoal house was a "temporary blacksmith shop" used by the CCC (58). Not shown in this detail are the "ruins of East Head Race" (50).

Reconstruction of the Furnace Group was contemplated at this time, as evidenced by early designs that accompanied the existing- conditions map. These included both a plan and conjectural drawings of the furnace's east elevation (figs. 28a, b, and c). The historical basis for these drawings was compiled by Historian Roy Appleman, based on the physical ruins themselves and interviews with former Hopewell residents and workers, such as former manager Harker Long.[69] Photographs may also have been provided to the designers, although the early views of 1887 and 1896 appear not to have been available to researchers at this time.[70]

[69] Appleman, *Historical Report, French Creek Area,* and Appleman, *Proposed Restoration Plan*, 1936.

[70] The 1896 photographs were discovered by Historian Kurjack at the Chester County Historical Society in 1948; the1887 photograph became available to researchers in 1955.

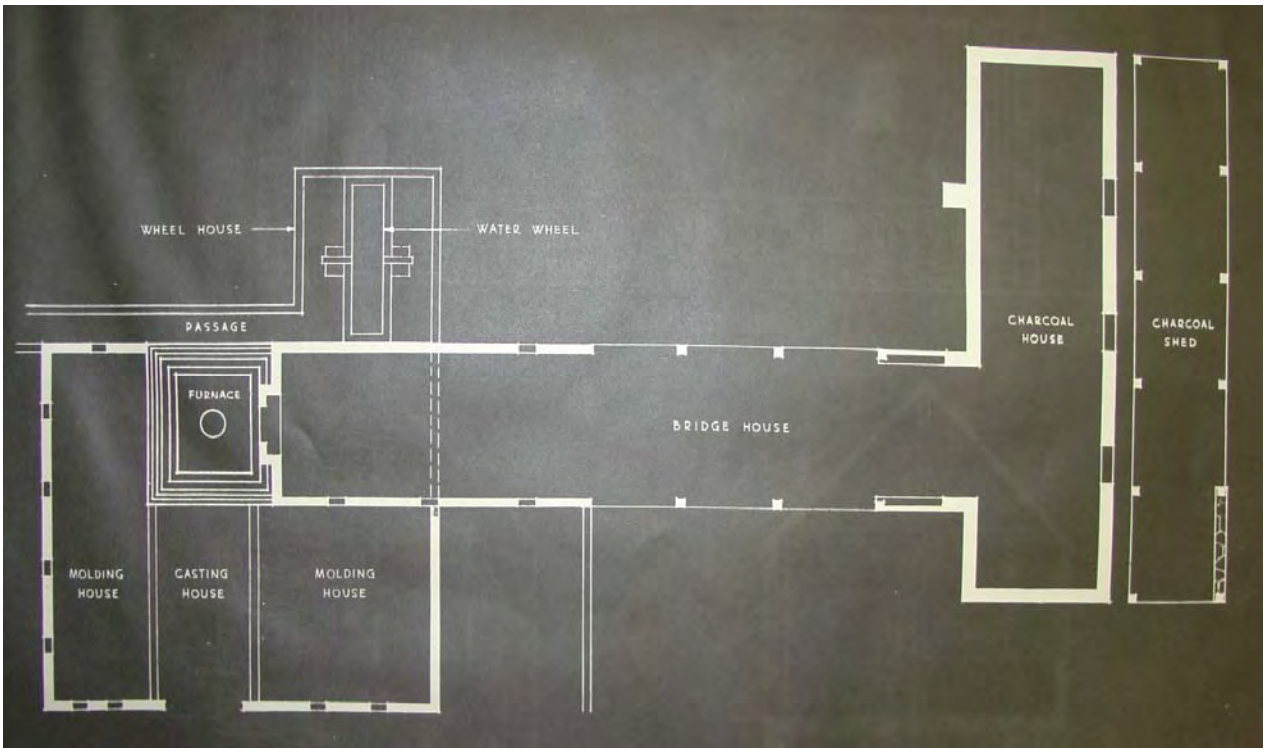

Figure 28a. Conjectural plan of the Furnace Group and cast house, December 31, 1935.

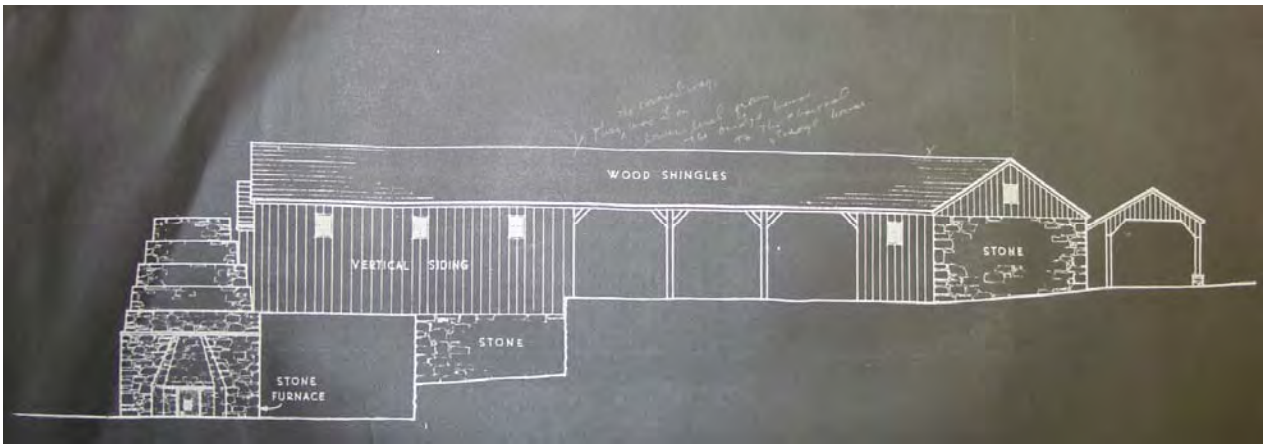

Figure 28b. Conjectural east elevation of the Furnace Group, not including the cast house, which was drawn separately "in order to show the furnace front in elevation," December 31, 1935.

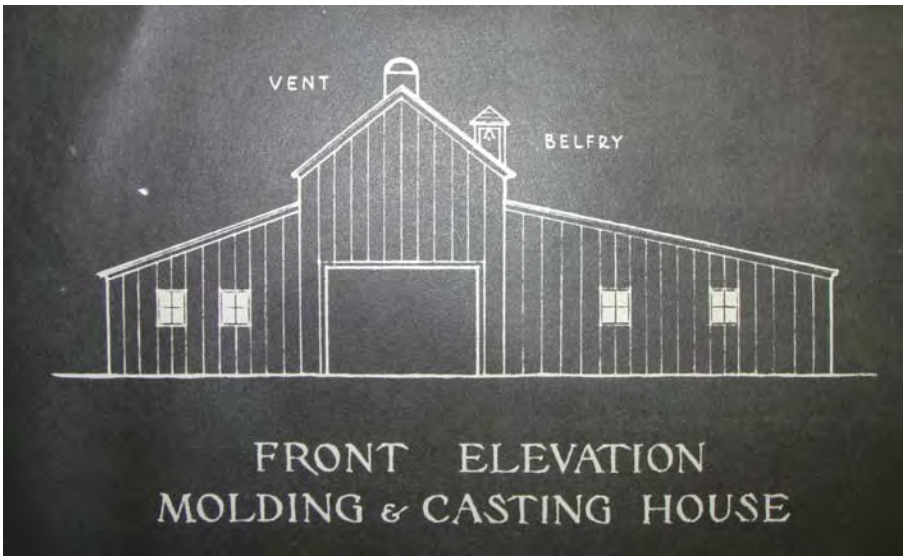

Figure 28c. Conjectural east elevation of the "Molding & Cast House," December 31, 1935.

Wheel Pit Drained, 1936

A tile drain was installed by the CCC to facilitate the drainage of water from the existing east-west wheel pit in 1936. The wheel pit had filled with muck and water following its many years of inactivity since 1883, and the removal of the wheel and supporting structure in 1931. The drain was located at the west end of the wheel pit and drained in a southerly direction to the east bend of the nearby tail race.[71] The drainage system is documented by a one- sheet drawing dated May 12, 1938, and entitled "French Creek Pipe & Tiles Line, Drainage of Furnace Area," by the "U.S. Department of the Interior, National Park Service, Cooperating with the Pennsylvania Department of Forests & Waters."[72]

Furnace Stabilized, 1936- 38

The first major project undertaken at the ruins of Hopewell Furnace was stabilization of the furnace. Historian Roy Appleman warned in his report of January 1936 that "at the present time there is constant danger of falling stones and it will be almost impossible to long preserve the Furnace Stack if left as it is now."[73] Appleman described large vertical fissures on the south and west faces of the stack, trees and shrubs growing on the top and sides, rotting fragments of the former hewn log braces, and two feet of earth and rubbish filling the hearth. He suggested that "the walls should be plumb, solid, and free from the shrubs and trees that have gained a foothold in the past years." Appleman recommended that the restored structure "should represent, as nearly as possible, an old cold blast furnace ready for actual operation."[74] Cost estimates submitted in Appleman's report indicated that it would be slightly less expensive to stabilize rather than tear down and rebuild the old furnace. The idea of stabilizing the stone structure

[71] Schumacher, *Archeological Explorations at the Furnace Group, 1935 to 1951*, p. 22.
[72] A copy of the drawing is in the files of the Maintenance Division of Hopewell Furnace NHS.
[73] Appleman, *Proposed Restoration Plan*, p. 33.
[74] Appleman, *Proposed Restoration Plan*, p. 33.

from the inside- out in order to preserve its existing exterior appearance was conceived by CCC Superintendent M.J. McCarthy and colleagues, and was executed using several experienced CCC workers.[75] The first step was to prepare detailed measured drawings to document the existing appearance of the furnace (fig. 29).[76] Shoring to support the exterior walls was then installed (fig. 30). Although no specifications or completion report of this project are known to exist, a memorandum written in 1946 on the technical aspects of the restoration describes the unusual treatment approach:

> The purpose of the National Park Service in planning for this work was to strengthen the stack without materially altering its appearance…. In order to do this, it was determined to begin work on the stack from the top, working down one tier of masonry at a time, and also in one section of a tier at a time. Beginning with the top tier, all the stones were removed in one corner out to the outer face, and all the old lime mortar and other debris were cleared away from the opening thus created. The stones were then put back in place with good cement mortar and steel reinforcing rods. The same procedure was then followed with that section of the tier next adjoining, then the next adjoining section, etc., until the whole tier had been substantially rebuilt. A concrete inner wall with steel reinforcing rods was then placed to tie the whole tier together.
>
> Beginning work on the second tier, it was of course necessary first to remove the firebrick bosh. This was done one course at a time, and the bricks were carefully stored in order so that they could later be replaced in their proper position. Then the same procedure was followed as in restoring the first or top lift of the stack, except that before the stones were replaced in a section of this tier or lift a reinforced concrete slab was laid to carry the load out from the center. … Each time this was done the ends of the reinforcing rods were left extending beyond the work, so that they could be tied in with the rods used in the next section, and so that the completed platform for the whole lift could be tied in with the reinforced concrete inner wall. The process was carried on in this way right down to the bottom of the stack…. Once it was completed, the inner core or bosh was replaced in its original position. In brief, the whole job was done from the inside, working out. It resulted in a structure of great strength, but the old appearance of the stack was practically unchanged.

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[75] Glaser, *Administrative History*, p. 44. Supervision and direction were provided primarily by Christian F. Eben, Jr., Senior Foreman Engineer, and for a short interval by Paul U. Koch, Architect-Engineer Foreman. Project superintendents were M.J. McCarthy and later Charles Shearer.

[76] "Measured Drawing of Hopewell Furnace, French Creek Project," Job No. 1014, one sheet, Nov. 30, 1936. This drawing was later color- coded to document the progress of the project: progress drawings dated Apr. 36, 1937; June 1, 1937; July 1, 1937; Mar. 1, 1938; Apr. 1, 1938; May 1, 1938; June 1, 1938; July 1, 1938; Sept. 1, 1938; Dec. 1, 1938; May 1, 1939; July 1, 1939; and Sept. 1, 1939. The whereabouts of these progress drawings are unknown; photocopies were included in Thomas & Newswanger, *Hopewell Iron Furnaces*.

> The project as just described required several years for its completion as only two, or at the most, three men could work in the interior of the stack at the same time. Also, in order to protect the men, and to eliminate any danger of possible collapse of the structure, it was necessary to shore up the stack with heavy timbers and bracing before starting restoration work. This shoring operation alone took several months to complete.[77]

Photographs were taken during the project to document the progress of the work, including the construction of a large construction shack erected on top of the furnace stack in 1937 (fig. 31).[78] The shack covered the upper opening to the interior, and was accessed by a wooden ladder or steps on the north side. Work on the furnace was only about halfway completed by August 3, 1938, when Hopewell Village was designated as a National Park Service National Historic Site.

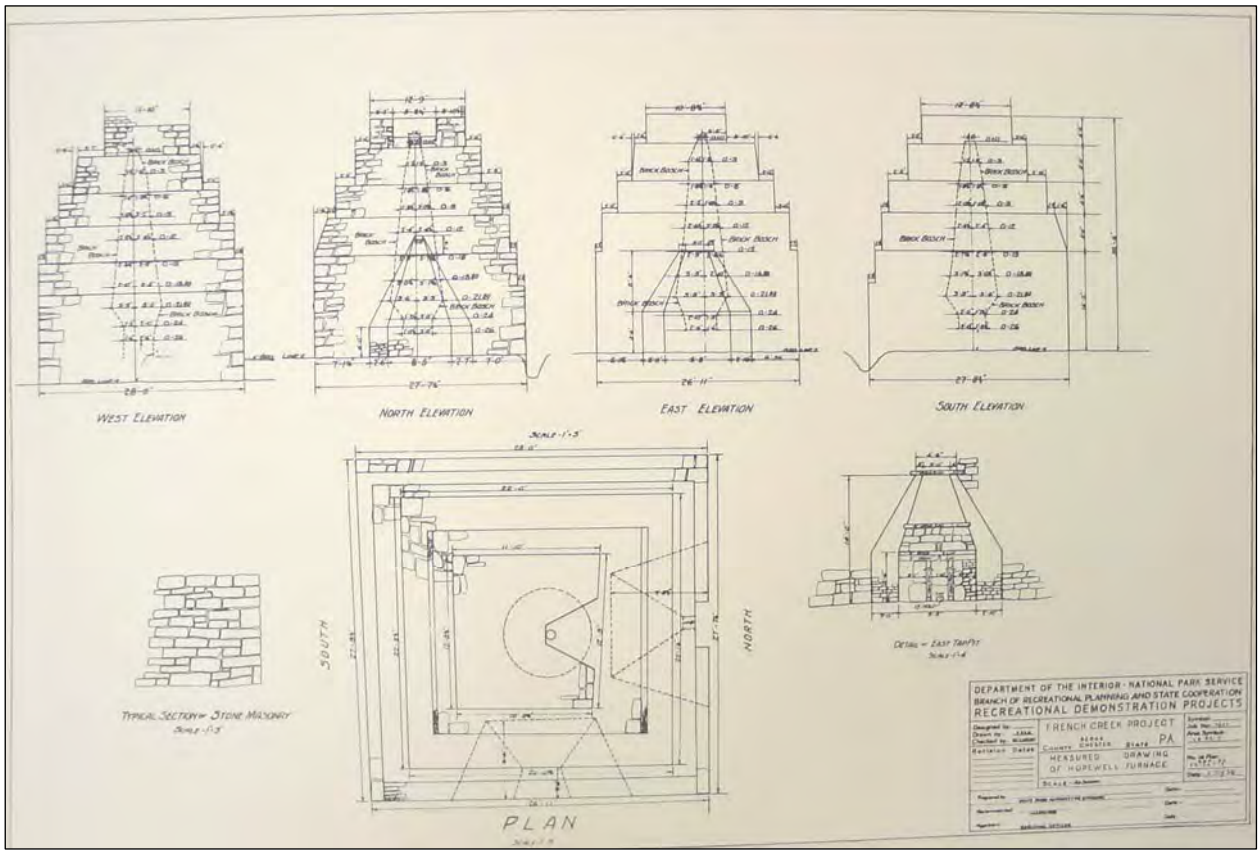

Figure 29. "Measured Drawing of Hopewell Furnace," documenting the existing exterior and interior dimensions of the furnace, November 30, 1936.

[77] Letter from Francis Ronalds, Coordinating Superintendent, Morristown NHP, to Robert Runser, Sept. 12, 1946; included as Attachment L in a report by Thomas & Newswanger, *Hopewell Iron Furnaces*.

[78] "Furnace Restoration, 1935- 37" (44 photographs), Hopewell Furnace NHS archives, French Creek Recreational Demonstration Project Records, Cat. No. 35419, Box 2; and Resource Management Records, Cat. No. 35420, Box 1.

Figure 30. Installation of shoring on the south and west elevations of the furnace stack, October 1936.

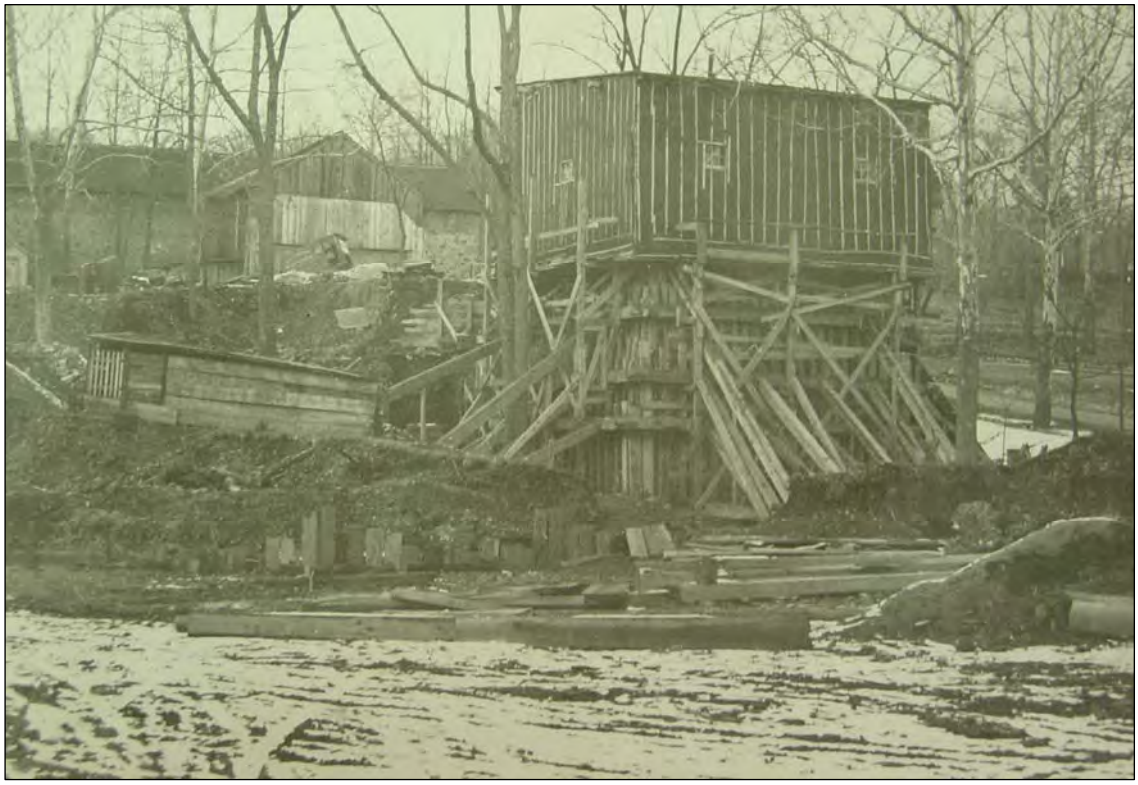

Figure 31. View looking northeast towards the charcoal house, showing temporary construction shed erected on top of the furnace stack, February 26, 1937.

1938- Present: Reconstruction and Renewal

Furnace Stabilization Continued, 1938- 41

Stabilization of the furnace using CCC labor continued following the designation of Hopewell Village as a National Historic Site in August 1938. The large wooden shack on top of the stack had been replaced by a smaller structure by October of that year, judging by a photograph of that date and another taken a short time later (fig. 32).[79] Mortar in the exterior joints of the stonework was deliberately recessed to leave the surface condition "similar in appearance to what it was before start of restoration work" (fig. 33). Great care was also exercised in preserving a broken iron lintel and angle within the casting arch by welding new iron to the broken members and concealing the repair within the stonework.[80] One of the last tasks in 1941 was to rebuild the interior bosh lining, presumably using the firebricks from the disassembled bosh that had been saved for this purpose. How many of the old bricks were actually incorporated into the reconstructed bosh remains a question, however, since a number had been damaged by exposure to the weather before their removal to the nearby charcoal house for storage.[81]

No dedication ceremony is known to have been held to mark the successful completion of the furnace stabilization. That the work had been completed by May 1941 seems certain based on the absence of shoring at the exterior walls as seen in a photograph of that date. A wooden walkway connecting directly with the furnace bank had also been built by this time (figs. 34- 35).

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[79] Forty- eight black- and- white photographs documenting the work on the furnace from 1938 through 1941 are in the Hopewell Furnace NHS Archives, including "Furnace Restoration 1938- 39" (33 photographs) and "Furnace Restoration, CCC, 1941" (15 photographs). Resource Management Records, Cat. No. 35420, Research Projects, Box 2.

[80] Memorandum from Christian F. Eben, Jr., Senior Foreman Engineer, to Superintendent of Hopewell Village NHS, dated Jan. 16, 1941. Reproduced as Attachment J in Thomas & Newswanger, *Hopewell Iron Furnaces*.

[81] Memorandum from Roy Appleman, Acting Regional Historian, to the Regional Director, dated Apr. 12, 1938. Reproduced as Attachment F in Thomas & Newswanger, *Hopewell Iron Furnaces*.

Figure 32. West elevation of the furnace, January 6, 1939.

Figure 33. Detail of the west face of the furnace, showing recessed mortar joints of the completed stonework, January 6, 1939.

Figure 34. View of the stabilized furnace, looking southwest, May 19, 1941.

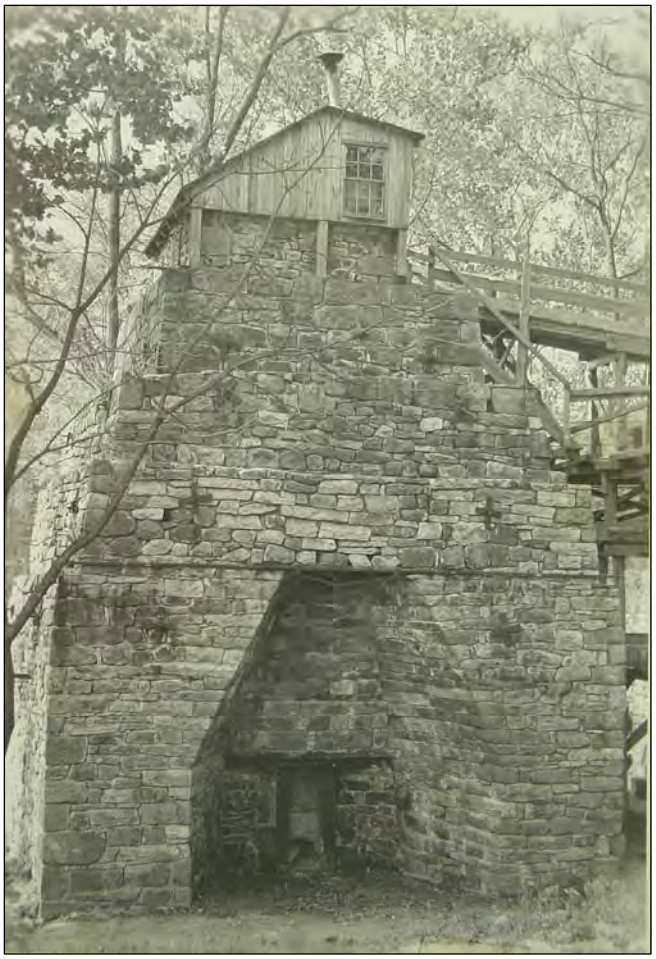

Figure 35. East elevation of the stabilized furnace, showing wooden walkway on the north side, connecting with the furnace bank, October 1941.

East Head Race Documentation and Partial Restoration, 1938- 39

The entire length of the east head race was located and mapped from July 1938 to February 1939.[82] This was followed by partial restoration of the ditch in the fall and winter of 1938- 39, focusing on the portion that ran from Baptism Creek to Spout Creek. CCC laborers removed debris, repaired a stone retaining wall (fig. 36), and built a dam to divert the water into Spout Creek.[83] A culvert to allow passage of the race beneath a new bypass road (now Route 345) was constructed in 1937- 38.[84]

Figure 36. View of the restored retaining wall of the east head race, looking east, May 1939.

Exploratory excavations were next carried out in November 1939 on the portion of the race that extended from Spout Creek south to Saint Peter's Road (now Mark Bird Lane). Eight cross-ditch trenches were dug, and the race was partially cleared by CCC laborers under the direction of CCC Engineer Foreman Chris Eben. Supervision of the project was provided by Assistant Research Technician Thor Borresen. The ditch within this stretch was described as being at the base of a sloping hill, thus accounting for an accumulation of rich black soil. Areas of the ditch that were relatively undisturbed appeared to have been constructed with a tamped, red- clay

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[82] "French Creek Area, Restoration of Historic Structures, East Head Race," by the Pennsylvania Department of Forests & Waters in Cooperation with the U.S. Dept. of the Interior, NPS, one sheet, various versions dated July 1938, Sept. 1938, Nov. 1938, and Feb. 1939.

[83] Fairbairn, *East Headrace, Historical Data Section*, p. 7; photographic illustrations P1938- 14 and - 15 dated 10/16/38, and P1939- 2 and - 3 dated 1/6/39; and Benjamin Zerbey, *Orientation Report for Archeology in the Area of the East Head Race* (Hopewell Village NHS, Jan. 1965), p. 1.

[84] Construction of the new road is described in *Cultural Landscape Report, Hopewell Furnace National Historic Site*, by KFS Cultural Resources Group, in Association with Menke & Menke, Landscape Architects (Philadelphia and Swarthmore, PA), p. 61. A photograph of the new culvert dated Oct. 16, 1938, is in the photograph archives of Hopewell Furnace NHS (photograph by Melvin J. Weig, No. 06533- H).

liner above a thin deposit of charcoal. There was also evidence of multiple episodes of rebuilding and repairs. A deliberate blocking of the ditch with fill in the vicinity of the road was conjectured to have originally coincided with the cessation of water- power use at the furnace circa 1883.[85]

Wheel Pit Cleaned and Walls Stabilized, 1938- 39

The wheel pit was cleaned out and its stone walls stabilized between November 1938 and June 1939. Paul Schumacher refers to this work in a report prepared in 1951 as Job #150, supervised by Technician Melvin J. Weig.[86] The wheel- pit walls are located northwest of the furnace. The work was accomplished using CCC labor. Eight black- and- white photographs taken during the project are the only known record of the work that was actually done (fig. 37).[87]

Figure 37. North and south walls of the wheel pit prior to stabilization work, July 5, 1938; view is looking northeast.

[85] Thor Borresen, *Report on Findings During the Exploratory Excavation of East Head Race, Hopewell Village National Historic Site* (Hopewell Village NHS, Feb. 1940); and drawing titled "Plan of East Head Race, Hopewell Village NHS," U.S. Dept. of the Interior, NPS, Branch of Historic Sites and Buildings, Yorktown Field Office, set of 3 sheets, Jan. 17, 1940.

[86] Schumacher, *Archeological Explorations at the Furnace Group, 1935 to 1951*, pp. 10 and 23.

[87] "Wheel Pit Stabilization, 1938" (8 photographs), Hopewell Furnace NHS archives, Resource Management Records, Cat. No. 35420, Research Projects, Box 1.

Charcoal House Roof Repaired, 1947

Historian Roy Appleman reported in 1935 that the charcoal house, which was then being used as a garage by the CCC, had recently had its roof either repaired or replaced "to prevent damage from rain."[88] A drawing for additional roofing repairs was drawn up 11 years later, by the National Park Service in 1946.[89] The work appears to have entailed replacement of some framing members and installation of a new wood- shingle roof on wood lath (fig. 38).

Figure 38. Reshingling of the charcoal house roof, December 1947.

[88] Appleman, *Historical Report, French Creek Area*, pp. 27 and 30.

[89] "Repairs to Roof, Charcoal House, Hopewell Village NHS," U.S. Dept. of the Interior, NPS Branch of Engineering, Drawing No. NHS- HV/5300, Dec. 30, 1946.

New Furnace Walkway, 1947

The open wooden walkway of circa 1940 that connected the furnace stack with the charcoal house on the furnace bank had partially collapsed by October 1945.[90] Plans for another "Temporary Walkway Approach to [the] Old Iron Furnace" were prepared by the National Park Service in March 1947.[91] The new structure had been constructed by November of that year, as documented in two photographs of that date (fig. 39).

Figure 39. New "temporary" furnace walkway, November 7, 1947.

Figure 40. General view of the Furnace Group with new furnace walkway, as seen from the southeast, April 17, 1948.

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[90] Collapse of the walkway is documented by photograph No. 66- 2 at in the Hopewell Furnace NHS archives. It is one of several photographs filed under "Furnace Restoration CCC, 1941." Writing on the back reads "The walkway to the top of the Furnace, now partly collapsed and closed, 10/19/45." Hopewell Furnace NHS Archives, Resource Management Records, Cat. No. 35420, Research Projects, Box 2.

[91] The one- sheet drawing by the U.S. Dept. of the Interior, NPS Engineering Division, Region One, Drawing No. NHS HV- 5301, is dated Mar. 14, 1947.

Steam Boiler Removed, 1950

A steam boiler that had been installed north of the furnace in 1881 to supplement water power to the water wheel was still in place as late as 1950. This boiler and its brickwork housing were removed by the National Park Service in the spring of 1950 during archeological explorations of the furnace bank.[92] Their appearance prior to demolition and removal are documented by nine black- and- white photographs in the archives of Hopewell Furnace NHS (e.g., fig. 41).[93]

Figure 41. South brick wall enclosing the steam boiler prior to dismantling, 1950. Note also the south extension of the charcoal house in the background.

[92] Schumacher, *Archeological Explorations at the Furnace Group, 1935 to 1951*, pp. 15 and 41.

[93] "Furnace Boiler Before Dismantling, 1950" (9 photographs), Hopewell Furnace NHS Archives, Resource Management Records, Cat. No. 35420, Research Projects, Box 3.

Water Wheel and Blast Machinery Restored, 1950- 51

Restoration of the wheel pit, water wheel, and blast machinery commenced with the acquisition of the deteriorated wheel and machinery by the National Park Service from the Franklin Institute in June 1941.[94] This was followed by archeological explorations of the wheel pit and furnace walls undertaken by Chris Motz and Dr. Paul Gebhard from October 1941 to March 1942.[95] Measured drawings of the ca.- 1879 water wheel and blast machinery were begun by WPA draftsman Robert Hehr and completed by student Jay Harold LeVan, Jr., in 1941.[96] These were based on previous documentation by the Franklin Institute in 1931 and examination of the existing parts. Using these drawings, actual restoration of the water wheel was begun under the direction of CCC Project Superintendent Charles Shearer, using "well- seasoned oak timber."[97] The wheel was never completed, however, due to the lack of funding and subsequent disbandment of the CCC camp in 1942.[98]

Funds to resume the restoration of the water wheel and blast machinery were allocated by the National Park Service in October 1949. [99] The following month, the measured drawings by LeVan were checked and redrawn to NPS standards by the Branch of Plans and Design. The reconstruction project took approximately 1 ½ years and was documented by a completion report and numerous photographs (e.g., figs. 42- 44).[100] The period of interpretation for the park at this time spanned the years 1770 to 1883, allowing an accurate restoration of the water wheel and blast equipment to its last working status in 1883. The work was presumably contracted to local craftsmen, although no mention of the workers is made in the completion report. The names of a few of the carpenters and laborers were found written on the backs of photographs, including Albert and Charles Painter, and Frank and Harold Hoffman. The platform, water wheel, and blast machinery had been installed and a temporary roof erected over them by April 1951. The official dedication ceremony did not place until June 6, 1952, however, pending completion of the west head race that supplied water to the wheel. Details of the reconstruction as described in the completion report are summarized subsequently.

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[94] Glaser, *Administrative History,* p. 68. The acquisition was enabled by Emergency Conservation Work (ECW) funding.

[95] Schumacher, *Archeological Explorations at the Furnace Group, 1935 to 1951*, p. 12. Motz's report, field notes, and drawings are said to be in the archeology files at Hopewell Furnace NHS. Gebhard's findings are documented in *Report of Wheelpit Excavation from December 3, 1941 to March 27, 1942, Hopewell Village National Park* [sic] (Hopewell Village NHS, 1942).

[96] Eight sheets entitled "Hopewell's Blast Machinery, Hopewell, PA, Hopewell Village NHS," by Jay Harold Le Van, Jr., U.S. Dept. of the Interior, NPS, Birdsboro, PA. Note that the drawings also include the water wheel.

[97] Glaser, *Administrative History*, p. 68.

[98] Glaser, *Administrative History,* p. 75.

[99] Cass and Hugins, *Completion Report on the Restoration of the Water Wheel, Blast Machinery, and West Head Race*, p. 5.

[100] Cass and Hugins, *Completion Report*. Eighty- five photographs documenting the reconstruction work are in the archives of Hopewell Furnace NHS, filed under "Water Wheel Construction, 1950- 51." Resource Management Records, Cat. No. 35420, Research Projects, Box 3.

Base Beams

Base beams on the ground supported the framing for the upper platform of the water wheel and blast machinery. The dimensions of these structural members, 16 by 18 inches, were based on remnants of the surviving rotted sills. The new sills were made of reinforced concrete that would be more durable than wood. The concrete was colored to resemble treated wood with an inch- thick pargette consisting of cement, iron oxide, and Germantown lamp black. This pargette was also scored to simulate tree rings and adze marks.

Wood Frame and Platform

A braced wooden frame – consisting of four posts, an upper platform, and mortise- and- tenon connections – straddled the water wheel. Little information is available in the completion report regarding the evidence that was used to reconstruct this frame, other than one reference to early photographs. Dimensions and design details were presumably obtained from the drawing prepared by the Franklin Institute in 1931. One deviation made from the historic photographs involved the use of unspliced members for the four 20- foot posts. What type of wood was used, and whether or not it was treated with creosote, was not mentioned.

Water Wheel

The partially completed water wheel of 1941 was found to have rotted by 1950. A new wheel was therefore constructed, patterned after the last working wheel of 1879 with decagonal shaft, 10 spokes, and 60 buckets. The new wheel was made with a combination of red oak (for the shaft, bucket bottoms and soling), white pine (paddles), and maple (dowel pins). Wooden members were first sawn at the mill, then hewn and shaped by hand. Most of the hardware used, such as nails and bolts, was salvaged from the old wheel and repaired at a local machine shop. Nonhistoric modifications included weep holes cut into each bucket to prevent water from pooling and freezing, and treating the wood with creosote. The creosote was found to interfere with the natural swelling of the pine paddles, however, necessitating the installation of tension rods to hold them in place. Not reproduced at this time were the cogs on the edge of the wheel that may have been contemporary with the steam boiler and engine installed in 1881. No justification for this omission is given in the completion report.

Blast Machinery

Surviving blast machinery, presumably of late 19th - century vintage, consisted of two blast tubs and a receiver. Of these, one tub and the receiver were salvaged and reused. The second tub was in poor condition and required complete rebuilding with well- seasoned white pine boards; only the iron bands were reused. Extensive repairs were made to the salvaged tub, including sanding and cleaning of the interior, gluing canvas strips over the sidewall joints to make them airtight, coating the interior walls to decrease friction and maintain a close fit with the piston, and tightening and readjusting the exterior iron bands (fig. 42).[101] A new laminated piston, valves

[101] The tub interiors were coated with plumbago, or graphite, mixed with soapstone powder and glue.

and leathers, and metal springs were installed. The receiver was also found to be in fair but repairable condition. The interior was re- leathered and sealed with canvas tape, and new wooden yokes and top installed. All wooden components of the rebuilt or repaired equipment were given a preservative treatment of creosote or pentachlorophenol.

Figure 42. Workers installing iron bands around repaired blast tub, September 22, 1950.

A sheet- metal tuyere pipe that conveyed a blast of cold air from the receiver to the furnace was newly constructed by tinsmiths from Reading, PA. This blast pipe and attached nozzle were painted with black graphite paint "to simulate the original," according to the completion report. No other details are provided. Presumably the blast pipe that had been salvaged by the Franklin Institute in 1931 was available for copying in 1950- 51.

Figure 43. Water wheel and one blast tub installed on new platform, March 5, 1951.

Figure 44. The completed water wheel and blast machinery with temporary roof, June 25, 1952. Note that the furnace walkway had been removed for this project and was not reinstalled.

West Head Race and Flume Restored, 1951- 52

The decision to reinstate the west head race, instead of the east head race, as the conduit for supplying water to the water wheel was made at a conference held at the park March 22- 23, 1950. An outside engineering firm was hired to prepare a topographical survey of the race area, and negotiations were initiated with the Commonwealth of Pennsylvania to divert water from Hopewell Lake, which was within the jurisdiction of French Creek State Park.[102]

The work of returning the west head race and flume to operative condition is documented by two drawings and two reports prepared by the National Park Service. One drawing, titled "West Head Race & Flume Restoration," was dated 1950 and revised April 1951. The second drawing, "Intake Headrace West of Furnace, Hopewell Village NHS," was dated May 1951 and revised in 1952. Archeological work conducted in the area of the flume was documented in a report by archeologist Paul Schumacher dated September 1951.[103] A completion report was prepared by Superintendent James Cass and Historian Walter Hugins in August 1952.[104] Finally, photographs taken during the project provided a visual record of the work accomplished (e.g., fig. 45).[105]

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[102] Cass and Hugins, *Completion Report*, p. 12.

[103] Schumacher, *Archeological Explorations at the Furnace Group, 1935 to 1951*.

[104] Cass and Hugins, *Completion Report*.

[105] "West Head Race Reconstruction, 1951" (55 photographs). Hopewell Furnace NHS, Resource Management Records, Cat. No. 35420, Research Projects, Box 3.

The work carried out on the west head race in 1951- 52 restored only the eastern third of the race to its last working status in 1883 as an open ditch (205 feet) and wooden trough or flume (75 feet). The western two- thirds (725 feet) was modified by the installation of a modern, underground pipe that conveyed water from Hopewell Lake to the open ditch. Excavation of the pipe trench was undertaken by park maintenance staffers (fig. 45). The pipe was supplied by the Johns- Manville company, and its installation was awarded to Corbit's, Inc., of Reading, PA, in March 1952. Pipe- laying work commenced at the end of March.

Restoration of the eastern third of the race involved clearing out the ditch and restoring a 60-foot length of dry stone retaining wall on the north side. To the east of this an open, wooden trough 75 feet long was reconstructed on stone piers. The historic dimensions of this structure had been recalled by Harker Long as measuring 4 feet wide by 1 foot high. Due to funding and labor constraints, however, the flume as reconstructed was 2 feet wide by 2 feet high, and used surplus pine lumber from the CCC camp. More authentic were the masonry piers supporting the trough. These were mortared stones, 4 feet wide, which had been recorded as early as 1935 and 1941. The first, or easternmost, of the six original piers had disappeared due to erosion and later excavations by 1951. Piers 3, 4, and 6 were still visible above ground, while the foundations only of piers 2 and 5 remained. Salvaged stones and cement mortar were used to restore piers 2 through 6.[106]

By May 1952, water was once again flowing through the west head race and operating the water wheel. An official dedication ceremony celebrating the completion of this park milestone was held the following month on June 6, 1952.

Figure 45. Work on the new underground pipe for the west head race, May 25, 1951.

[106] Schumacher discusses the stone piers in his report *Archeological Explorations at the Furnace Group, 1935 to 1951*, pp. 30- 31.

Road Closed, 1955

The Birdsboro- Warwick road was closed to public traffic in 1955. This road had been realigned through the north portion of Hopewell Village by the Commonwealth of Pennsylvania in 1932, passing close to the furnace.[107] It had also covered the east foundations of the former cast house, and destroyed a portion of the stone retaining wall of the nearby furnace bank. Removal of the road was an important step in restoring the historic 19th- century appearance of the furnace and village (fig. 46).

Figure 46. View duplicating the angle of the earliest (1887) photograph following closure of the Warwick- Birdsboro road, December 1955.

Charcoal House Researched and Recorded, 1956- 57

The furnace's stone charcoal house was photographically documented and existing- conditions drawings were prepared by a student measuring team in the fall of 1956 (figs. 47- 49).[108] Supporting documentation on the charcoal house and its missing cooling shed was also compiled this year in two historic building reports by NPS Architect Richard P. Donohoe.[109] This was followed in 1957 by several historical studies on the history and proposed restoration of the structures by Superintendent Joseph R. Prentice and Historian Robert D. Ronsheim.[110]

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[107] Glaser, *Administrative History*, pp. 48 and 132.

[108] The measured drawings of 1956 were later redrawn, and a cover sheet added, by the Historic American Buildings Survey in 1958 (Survey No. PA- 5157- C).

[109] Richard P. Donohoe, *The Charcoal House & Shed (Bldg. 9), an Architectural Survey Report, Hopewell Village National Historic Site* (Hopewell Village NHS, Oct. 1956); and Donohoe, *Restoration of the Charcoal House & Shed*.

[110] Joseph Prentice, *Historic Building Report, Part I, Administrative Data, Charcoal House and Charcoal Shed, Hopewell Village National Historic Site* (Hopewell Village NHS, Nov. 1957); and Prentice, *Survey Report (Administrative Data) for Restoration and Rehabilitation of Historic Structures: Charcoal House (Bldg. # 9) [and] Charcoal Shed (Bldg. #91), Hopewell Village National Historic Site* (Hopewell Village NHS, Nov. 1957). Also Robert Ronsheim, *Survey Report (Historical Data), Restoration of the Charcoal House*

Reconstruction of the cooling shed took place in 1958, while restoration of the charcoal house was delayed until 1965.

Figure 47. East elevation of the charcoal house, October 1956.

Figure 48. West and north elevations of the charcoal house, October 1956.

(Bldg. 9) & Shed, Hopewell Village National Historic Site (Hopewell Village NHS, Nov. 1957); and Ronsheim, *Historic Building Report, Part I, Historical Data, Charcoal House and Charcoal Shed, Hopewell Village National Historic Site* (Hopewell Village NHS, Nov. 1957).

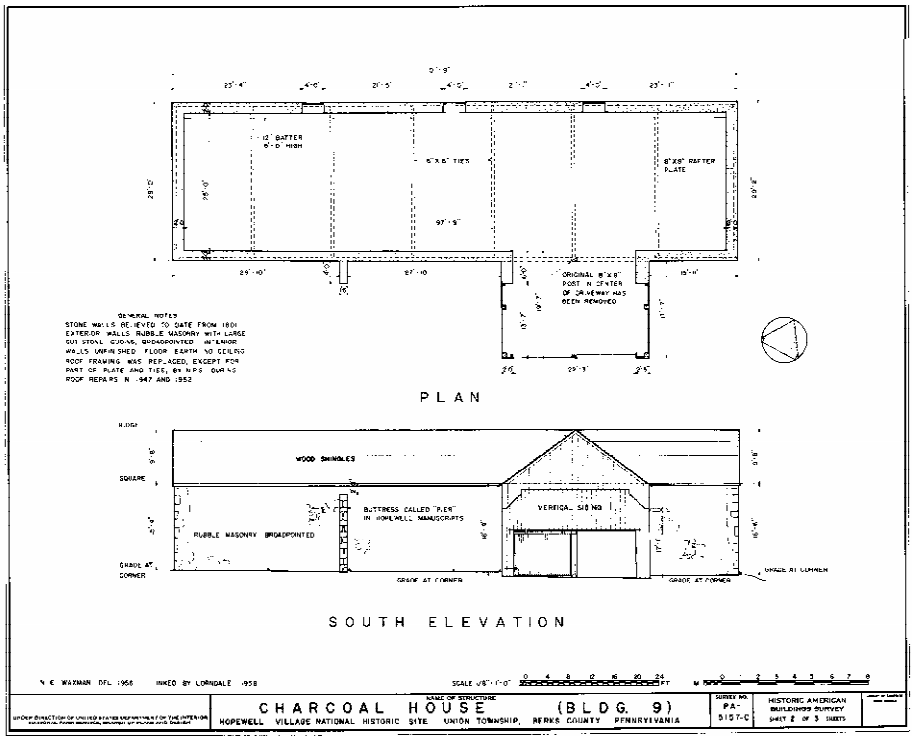

Figure 49a. Existing- conditions drawings: plan and south elevation of the charcoal house, 1956/1958.

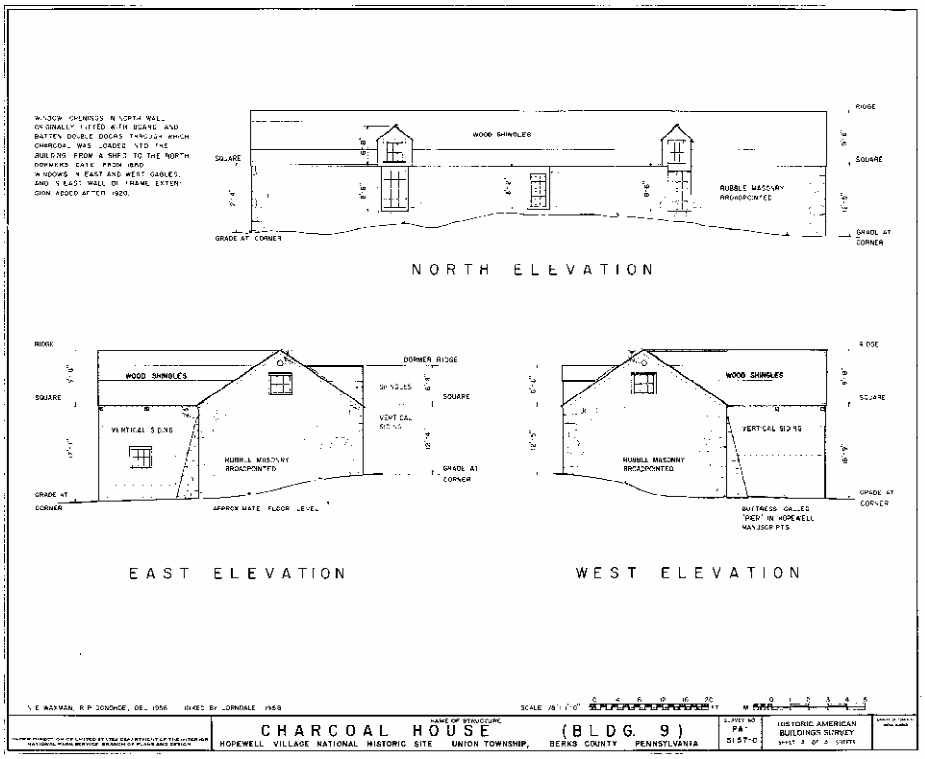

Figure 49b. Existing- conditions drawings: north, east, and west elevations of the charcoal house, 1956/1958.

Bridge and Wheel Houses Reconstructed, 1957- 58

Reconstruction of the missing bridge house (which included the connecting shed) and wheel house in 1957- 58 was preceded by a considerable amount of archeological and historical research. Archeological explorations of the stone foundations of the two structures were undertaken from 1942 through 1951 and the findings recorded in several NPS reports. Archeologist Paul Gebhard excavated in the vicinity of the wheel pit from December 1941 through March 1942. Historian Dennis Kurjack was in charge of excavations at the furnace bank from November 1949 through January 1950, which revealed foundations of the bridge house. Additional work on the bridge- house foundations was undertaken by Archeologist John Cotter in April 1950. Archeologist Paul Schumacher re- excavated both the original and later wheel pits and the foundations of the bridge house in June 1951. Schumacher summarized both his findings and those of previous archeological excavations in his 1951 report.[111]

Proposed work to preserve and stabilize the stone foundation walls was graphically illustrated in two sheets of architectural drawings prepared in July 1952.[112] The masonry walls of the wheel house were reconstructed by NPS in 1954- 55; those of the bridge house were reconstructed in 1956.[113] Photographs in the archives of Hopewell Furnace NHS are the only available documentation of this masonry work, since no completion report is known to exist.[114]

Historical information on the missing structures was subsequently researched and written in two 1956 reports by Historian Russell A. Apple.[115] Emphasis on the architectural details was the focus of a historic building report by Architect Donohoe, also written in 1956.[116] Donohoe stated that although the park's restoration date for Hopewell Village was then 1830- 40, it was planned to reconstruct the 1879 appearance of the bridge and wheel houses, lacking available evidence for 1840. He further explained that the 1879 bridge house was thought to have been last renovated in 1847, with the roof of wheel house joined to the bridge house in 1879.[117]

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[111] Gebhard, *Report of Wheelpit Excavation*; Kurjack, *Preliminary Report on Walls Adjoining Furnace Bank*; John Cotter, *Excavation of Fill Area Between Bridge House and Charcoal House (Operation 1), Hopewell Village Archeological Work* (Hopewell Village NHS, May 11, 1950); and Schumacher, *Archeological Explorations at the Furnace Group, 1935 to 1951*.

[112] "Preservation and Stabilization of Historic Structures, Furnace Group – Bridge House Walls, Hopewell Village NHS," Drawing No. NHS- HV/2016A, one sheet, July 1952 (revised 9/1/1956); and "Preservation and Stabilization of Historic Structures, Furnace Group – Wheel Pit Walls, Hopewell Village NHS," Drawing No. NHS- HV/2015, one sheet, July 1952.

[113] Richard P. Donohoe, *Architectural Survey Report for the Bridge House (Bldg. 10) and Wheel House (Bldg. 8), Hopewell Village National Historic Site* (Philadelphia: U.S. Dept. of the Interior, NPS, Eastern Office, Division of Design and Construction, Dec. 7, 1956), p. 8.

[114] Reconstruction of the wheel house walls may have actually been carried out in 1952- 53, based on 31 photographs in the archives of Hopewell Furnace NHS, filed under "Wheel Pit Wall Restoration, 1952- 53." Resource Management Records, Cat. No. 35420, Research Projects, Box 3.

[115] Apple, *Historical Documentary Report on the Bridge and Wheel Houses*; and Apple, *Survey Report for Restoration and Rehabilitation of Historic Structures: Bridge House (Bldg. 10) and Wheel House (Bldg. 8), Hopewell Village National Historic Site (Administrative Data)* (Hopewell Village National Historic Site, Dec. 1956).

[116] Donohoe, *Architectural Survey Report for the Bridge House and Wheel House*.

[117] Donohoe, *Architectural Survey Report for the Bridge House and Wheel House*.

Architectural drawings for the proposed reconstructions of the wood- framed bridge house and wheel house were prepared between 1954 and 1957 by the NPS Division of Planning and Construction and the Division of Design and Construction.[118] While traditional materials such as wood (hemlock) and slate were to be used, the design also incorporated a concealed concrete slab floor supported by steel I- beams in the center section of the bridge house. No written specifications, other than notes included on the drawings, could be found.

Surprisingly, no report on the work that was actually undertaken to reconstruct the bridge and wheel houses appears to have been prepared. The only known documentation, other than the architectural drawings, is a collection of 131 photographs taken during the course of the project now in the archives of Hopewell Furnace NHS. These black- and- white views date from the beginning of the project in June 1957 to its completion in April 1958 (e.g., figs. 50 and 51).[119] It is obvious that the reconstruction relied heavily on the early photographic documentation of 1887, 1896, circa 1910, and the 1920s. This, together with information gleaned from archeology and interviews with Harker Long and others, resulted in the recreation of the bridge house and wheel house as they appeared during the last working status of the furnace in 1879, and prior to the installation of the steam boiler and engine in 1881.

Figure 50. Reconstruction of the wheel house, November 7, 1957.

[118] "Sketches, Bridge House Framing," Drawing No. NHS- HV/2019A, set of 2 sheets, March 1954; "Bridge House Restoration, Furnace Group, Hopewell Village," Drawing No. NHS- HV/2064, set of 3 sheets, ca. 1957; "Structural [Concrete] Floor Slab, Bridge House, Hopewell Village NHS," Drawing No. NHS- HV/30:20, one sheet, May 1957; and "Superstructure of Bridge and Wheel House and Portico, Building #10, Blast Furnace, Hopewell Village NHS," Drawing No. NHS- HV/3021, set of 6 sheets, July 1957).

[119] "Bridge and Wheel House Reconstruction, 1957- 1958" (131 photographs), Hopewell Furnace NHS Archives, Resource Management Records, Cat. No. 35420, Research Projects, Box 4.

Figure 51. View of the Furnace Group from the southeast, showing the reconstructed bridge and wheel houses, March 4, 1958.

Furnace Heightened, Circa 1957- 58

Brick walls were added to the upper tier of the furnace stack when the adjacent bridge house was reconstructed circa 1957- 58. Although no written description of this work was found, it is clearly shown in the photographic documentation of the bridge- house project (fig. 51). The design and historical precedent for these walls, which had disappeared by the 1930s, were based on early photographs of the furnace dated 1887 through circa 1920 (figs. 17- 21). The brick walls both heightened the furnace stack and provided a protective firewall on the north side adjacent to the wooden Bridge House.

Charcoal Cooling Shed Reconstructed, 1958

The cooling shed that had historically been located on the north side of the charcoal house was restored by the NPS in 1958. The east end of the shed is shown in the early photograph of 1887 (fig. 17), but the structure had disappeared by 1935 (fig. 27). Preliminary research undertaken by Architect Richard Donohoe had been written in two historic building reports in 1956, as mentioned in a previous section on recording of the charcoal house. Three other reports prepared in November 1957 by Superintendent Joseph Prentice and Historian Robert Ronsheim provided additional historical information on both the shed and charcoal house.[120]

[120] Prentice, *Restoration and Rehabilitation of Historic Structures: Charcoal House [and] Charcoal Shed*; Ronsheim, *Restoration of the Charcoal House & Shed*; and Ronsheim, *Historic Building Report, Part I, Historical Data, Charcoal House and Charcoal Shed* (Hopewell Village NHS, 1957).

Excavations uncovering the foundations and footings of the shed in 1957 were documented in a report by Archeologist Benjamin Powell.[121]

Two sheets of architectural drawings dated July 17, 1957, provided details for the proposed reconstruction of the cooling shed.[122] The restoration date for this reconstruction was 1880, lacking evidence for the earlier (1820- 40) period of significance that was then in use by the park.[123] The work that was actually carried out is documented by a set of 22 project photographs in the archives of Hopewell Furnace NHS (e.g., figs. 52- 53), and a completion report by Architect Norman Souder dated 1962.[124] This information is summarized below.

The labor of reconstructing the open cooling shed was provided by the carpentry crew of Charles S. Painter. Work started May 23, 1958, and was completed the week of November 14, 1958. Surviving stone foundation walls and piers identified by archeology were incorporated in the reconstruction. The low wall at the northeast corner of the shed was heightened by park mason Russell Bowen. Several remaining sandstone, obelisk- shaped piers were reused, and duplicate stones were provided where they were found to be missing. Holes drilled in the stones anchored iron pins driven into the bottoms of the wooden posts. Restoration of the floor was achieved by removing an accumulation of later fill to reveal a heavy layer of charcoal. Since no detailed information or physical evidence of the shed's framing remained – other than the stone piers that suggested a five- bay frame – typical construction methods of the period were used in the reconstruction. Wood was obtained from local sources, including white oak for most framing members, poplar for the pole rafters, and red oak for secondary members. The framing was first sawn, then hand- planed, and finally assembled with mortise- and- tenon joints. Hand-split shingles were chosen to replicate the "primitive industrial character" of the shed and attached to oak lath. The first eastern bay of the shed's roof was joined to the plate of the charcoal house, as described in Hopewell records for 1880. The valley between the roofs was sheathed with copper flashing sloped to drain in an easterly direction. The gable ends of the roof were enclosed with vertical boards, each end embellished with a decorative cutout similar to the charcoal house – a star motif in the east gable and a diamond in the west. The exterior gables only were painted with iron- oxide paint. The remainder of the shed was treated with a 5% solution of pentachlorophenol, with an additional protective coating of creosote applied to the posts resting on stone piers.

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[121] Benjamin Powell, *Hopewell Village National Historic Site Excavations, The Charcoal House Shed Site and The Office- Store Site* (Philadelphia: U.S. Dept. of the Interior NPS, Independence NHP, Oct. 1957).

[122] NPS Division of Design and Construction, Eastern Office, "Proposed Reconstruction of Charcoal Shed, Hopewell Village NHS," Drawing No. NHS- HV/3025, set of 2 sheets, July 17, 1957.

[123] Donohoe, *Restoration of the Charcoal House & Shed,* p. 11.

[124] "Charcoal Shed Reconstruction, 1958" (22 photographs), Hopewell Furnace NHS Archives, Resource Management Records, Cat. No. 35420, Research Projects, Box 5; and Norman Souder, *Historic Structure Report, Part III, on Charcoal Shed, Hopewell Village National Historic Site* (Philadelphia: U.S. Dept. of the Interior, NPS, Eastern Office, Division of Design and Construction, Oct. 1962).

Figure 52. Reconstruction of the cooling shed, October 29, 1958.

Figure 53. Northeast view of the completed cooling shed, November 29, 1958.

Postcard Views of the Furnace Group, Circa 1960

Two color postcards in the archives of Hopewell Furnace NHS document the appearance of the Furnace Group circa 1960. One view shows the east elevation (fig. 54), the other the less-photographed south elevation (fig. 55). Reconstruction of several of the furnace's missing elements had been completed by this time, including the water wheel and blast machinery, the east portion of the west head race and flume, the bridge and wheel houses, and the cooling shed. Dating of these views is based on the presence of the cooling shed, completed in 1958, and the two- story configuration of the office- store in the foreground of figure 54, which was restored by NPS to its earlier one- story height in 1961.

Figure 54. Postcard showing the east elevation of the Furnace Group, circa 1960.

Figure 55. Postcard showing the south elevation of the Furnace Group, circa 1960.

West Head Race Flume Reconstructed, 1964

A more authentic reconstruction of the west head- race flume was carried out in 1964 to replace the rotted and inappropriately sized trough constructed by the NPS in 1951- 52. The work was preceded by three historic structure reports prepared in 1961 and 1963 by Superintendent Joseph Prentice, Historian Earl Heydinger, and Architect Norman Souder.[125]

The work of reconstructing the flume was documented in a completion report by Superintendent Benjamin Zerbey dated October 1964, and 13 photographs in the archives of Hopewell Furnace NHS (e.g., fig. 56).[126] It was carried out by a day- labor crew under the direction of Charles H. Seidel, NPS Building Restoration Specialist. Work commenced on April 27, 1964, and was completed the following month on May 14. A stone retaining wall on the north side was straightened to enable widening of the flume to its historic dimensions of four feet wide by one foot high.[127] Six previously restored stonework piers were again used as supports for the flume's trough with no major modifications. The bottom and sides of the wooden trough were built of longleaf yellow pine, which were fabricated at the local mill with tongue- and- groove detailing. Oak was used for the 8- by 8- inch supporting timbers and the 4- by 4- inch yokes, with mortise- and- tenon connections. Brush and spray applications of creosote provided a protective coating to the wood.

Figure 56. Reconstructed flume of the west head race, July 1964.

[125] Joseph Prentice, *Historic Structures Report, Part I, Administrative Date, West Headrace Flume* (Hopewell Village NHS, 1961); Earl Heydinger, *Historic Structures Report, Part I, West Headrace Trough-Flume, Need for Replacement of 1952 Reconstruction* (Hopewell Village NHS, 1961); and Norman Souder, *Historic Structures Report, Part I, Architectural Data Section on West Head Race Flume, Hopewell Village NHS* (Philadelphia: U.S. Dept. of the Interior, NPS, Eastern Office, Division of design and Construction, Oct. 1963).

[126] Benjamin Zerbey, *Historic Structures Report, Part III, Administrative Data, West Headrace Flume, Hopewell Village National Historic Site* (Hopewell Village NHS, Oct. 1964). The 13 photographs are filed under "Flume Construction, 1964" in the Hopewell Furnace NHS Archives, Resource Management Records, Cat. No. 35420, Research Projects, Boxes 8 and 9.

[127] The dimensions had previously been provided by Harker Long in an interview with Roy Appleman in 1935. Detailed dimensions and sketches were obtained from Sheridan Painter in an interview on Feb. 3, 1961.

Cast House and East Shed Reconstructed, 1964- 65

Reconstruction of the wooden superstructure of the missing cast house and east shed took place in 1964 and 1965.[128] This was preceded by extensive archeological investigations, historical research, and stabilization and rebuilding of the structure's stone walls that took place from 1950 through 1963. Debris had been removed from the site by the CCC in 1936, but it was not until 1950 that a cursory excavation was undertaken July 25- 28 by Archeologist J.C. Harrington, who recommended a more comprehensive archeological program. Archeologist Ronald Mason next explored the site September 2- 10, 1958, and he succeeded in locating the front wall and corners of the cast house. This was followed by stabilization of the south wall and the southerly portion of the east wall using a portland- cement mortar mixed with a purple coloring agent. Other reconstruction projects at the Furnace Group took priority in the intervening years before Archeologist Leland Abel commenced his explorations of the cast house site in 1962 and 1963. Abel removed approximately 2 feet of fill to uncover the ca.- 1820- 40 level of the interior floor and a stone- lined drain; he unearthed the foundations of a previously unknown east shed with a south enclosed room; and he distinguished original foundations from later additions. He thus determined that the original structure had been smaller and was considerably enlarged or rebuilt around 1816 (fig. 57). As foundations were exposed, a stone mason was employed to repoint and rebuild the walls (figs. 58- 59). One of the larger walls on the north side was completely dismantled and rebuilt from the base up due to its unstable condition. As in 1958, a portland- cement mortar was used, but this time with a more subtle red coloring. The stone drain was restored by installing 4- inch clay tile pipe inside the drain. In addition, a 4- inch tile drain was buried in the charcoal fill along the exterior north and east sides of the building, to capture runoff from the future roof.[129]

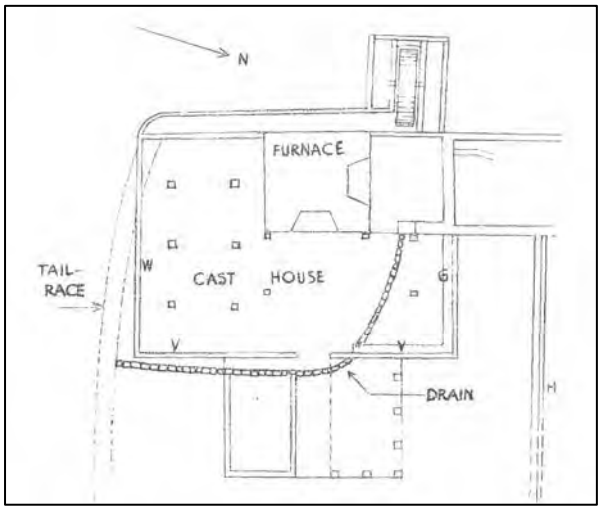

Figure 57. Plan of Hopewell Furnace, showing the 1962- 63 archeological findings of the cast house and east shed after the 1816 enlargement, including stone walls and a stone drain.

[128] The north and south sides of the unpartitioned cast house were called the "north molding shed" and the "south molding shed" by the NPS. There was no historical precedent for these names.

[129] Schumacher, *Archeological Explorations at the Furnace Group, 1935 to 1951*, pp. 9, 15, and 16; Ronald Mason, *Archeological Exploration of the Site of the Casting House, Hopewell Furnace, Hopewell National Historic Site* (Hopewell Village NHS, 1958); Benjamin Zerbey, *Completion Report Narrative, Emergency Stabilization of Casting House and Molding Sheds* (Hopewell Village NHS, 1963), pp. 2- 7 and 9; Zerbey, *Completion Report Narrative, Reconstruction and Rehabilitation of Historic Structures [Casting House and Molding Sheds] Including Archeological Research* (Hopewell Village NHS, ca. 1963), pp. 1- 2; and Abel, *Archeological Excavations at Hopewell Furnace*.

Figure 58. Rebuilt stone foundation walls of the cast house, south of the furnace, October 1962.

Figure 59. Partially rebuilt west wall of the cast house, north of the furnace, September 1963. The new wall is left of window below the bridge house.

A considerable amount of historical research on the cast house also preceded the reconstruction work of 1964- 65. This was documented in several reports prepared between 1959 and 1964 by Superintendent Joseph R. Prentice, Superintendent Benjamin Zerbey, Historian Earl J. Heydinger, and Architect Norman M. Souder.[130] Architectural drawings for the reconstruction were prepared by the Eastern Office, Division of Design and Construction, National Park Service, in April 1964.[131] The restoration target date for the project was 1840, unlike other components of the Furnace Group that had been restored to the time of the furnace's last working status from 1879 to 1883. Reconstruction of the wood- frame superstructure of the cast house and east shed was based primarily on the physical archeological evidence, early photographs of 1887 and 1896, and interviews with Harker Long and others.

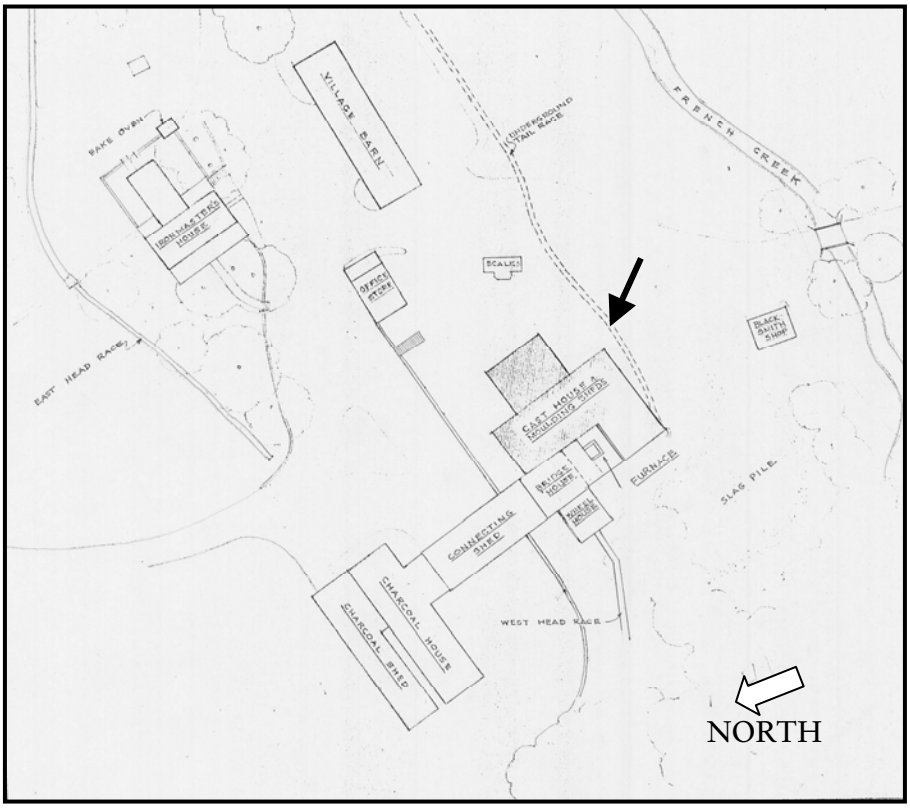

Figure 60. Plan showing the proposed reconstruction of the cast house and east shed, April 1964.

[130] Norman Souder, *Historic Structures Report, Part I, Architectural Data Section, Preliminary to the Restoration of the Cast House and Moulding Sheds, Hopewell Village National Historic Site* (Philadelphia: U.S. Dept. of the Interior, NPS, Eastern Office, Division of Design and Construction, Apr. 1959); Joseph Prentice, *Historic Building Survey Report on Cast House, Part I, Administrative Data Section, Hopewell Village National Historic Site* (Hopewell Village NHS, Nov. 1960); Earl Heydinger, *Historic Building Survey Report on Cast House, Part I, Historical Data, Hopewell Village National Historic Site* (Hopewell Village NHS, Nov. 1960); Zerbey, *Historic Building Survey Report on Cast House, Part II, Administrative Data, Hopewell Village National Historic Site* (Hopewell Village NHS, 1964); Heydinger, *Historic Building Survey Report on Cast House, Additional Historical Data, Hopewell Village National Historic Site* (Hopewell Village NHS, ca. 1964); and Souder, *Historic Structures Report, Part II, Architectural Data Section on the Cast House and Moulding Sheds, Hopewell Village National Historic Site* (Philadelphia: U.S. Dept. of the Interior, NPS, Eastern Office, Division of Design and Construction, Jan. 1964).

[131] "Reconstruction of Cast House and Moulding Sheds," Drawing No. NHS- HV/3040, set of 8 sheets, April 1964.

Work commenced in August 1964 and was completed in March 1965. Labor was provided by a crew of Amish carpenters working under foreman Christ Beiler, with daily supervision provided by Hopewell Maintenance Foreman Charles H. Seidel. Details of the project are documented in several completion reports,[132] and a set of 94 project photographs in the archives of Hopewell Furnace NHS.[133] This information is summarized subsequently.

General Description

The reconstructed cast house was a large, gable- roofed structure built on the east and south sides of the furnace. The center portion of this building was designated the "Cast House," in the 1964 reconstruction drawings, the south side the "South Molding Shed," and the north side the "North Molding Shed." Attached to the east side is a smaller gable- roofed structure called the "East Shed."

Foundations

Exterior walls were supported by existing stone foundations; interior posts by stone piers. Where missing, stones walls or piers were repaired or replaced to match existing.

Framing

The wood framing members were primarily white oak, with a small amount of red oak, and poplar pole rafters obtained from the Hilltop Lumber Company of Elverson, PA. The wood was first milled then hand- planed to remove saw marks. The frame was joined using mortise- and-tenon joinery (fig. 61). A solution of 5% pentachlorophenol was applied to all structural timbers and rafters. Structural members in contact with masonry were treated with creosote.

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[132] Norman Souder, *Historic Structures Report, Part III, Architectural Data Section on Cast and Moulding Sheds, Hopewell Village National Historic Site* (Philadelphia: U.S. Dept. of the Interior, NPS, Eastern Office, Division of Design and Construction, Oct. 1965); John C. Riddle, *Historic Structures Report, Part III, Administrative Data, Cast House and Moulding Shed – Buildings #33 and #37, Hopewell Village National Historic Site* (Hopewell Village NHS, Aug. 1966); and Earl Heydinger, *Historic Structures Report, Part III, Historical Data Section, Cast House and Moulding Shed – Buildings #33 and #37, Hopewell Village National Historic Site* (Hopewell Village NHS, Sept. 1966).

[133] "Cast House Reconstruction, 1964- 65" (94 photographs), Hopewell Furnace NHS Archives, Resource Management Records, Cat. No. 35420, Research Projects, Box 9.

Figure 61. Commencement of framing the cast house, September 12, 1964.

Siding

Siding was Idaho white pine, tongue- and- groove boarding, of random widths (6 inches minimum), 1 inch thick, installed vertically and slightly overlapping the stone foundation walls.

Doorways

Locations of most doorways were based on archeological and photographic evidence. One notable exception was the east doorway of the east shed. The archeological evidence indicated a smaller doorway- and- window arrangement at this wall. However, the doorway was made large enough to accommodate the passage of wagons. All doors were board- and- batten style, made of tongue- and- groove, white pine boards 1 inch thick and of random widths. The battens were attached using machine- made nails with hand- forged heads to simulate wrought-iron nails. Hinges were old, strap- type, wrought- iron hinges that had been salvaged from a demolished barn in Gibralter, PA. Wrought- iron Suffolk thumb latches were reproduced for the doors by Donald Streeter of Iona, NJ, based on similar old latches in Hopewell buildings.

Windows

Like the doorways, locations of most windows were based on archeological and photographic evidence; placement of the west- elevation windows was conjectural. Window frames were a board type typical of frame structures of the period. Photographic evidence was the basis for the window sashes, most being double- hung with six- over- six or 15- over- 15 lights; a single

nine- light sash was installed in the rebuilt stone wall beneath the bridge house. The sashes were fabricated to specifications by the Northeastern Lumber Company of Reading, PA. Old distorted glass salvaged from a collection of old sashes collected by the Hopewell maintenance staff was installed in most of the windows. Where modern glass was used, the plan was to replace it with old glass when it became available. The windows as installed had fixed upper sashes and movable lower sashes with no sash cords, weights, or springs; the nine- light sash was fixed.

Roofing

The use of red- clay tiles on the roofs of the cast house and east shed was based on the archeological evidence. Hand- made tiles were manufactured under contract by the Ludowici-Celadon Company of New York, to replicate an original intact tile unearthed at the site by Archeologist Leland Abel. This tile measured 15 inches long by 5 ½ to 6 inches wide by approximately five- eighths of an inch thick, and had a slightly rounded lower edge and hand-scored detailing on the upper surface. The tiles were installed on 1- by 3- inch oak lath spaced on 6- inch centers attached to the pole rafters (fig. 62). A clay lug on the back of each tile was laid on the upper edge of the roofing lath. This lug, and the weight of successive courses, held the tiles in place; no other attachments were used. The joints of the tiles were vertically aligned, rather than staggered, based on research of local practices. Vertical joints between the tiles were made watertight by the installation of wooden strips beneath the tiles, based on a similar treatment observed on a building at the ca.- 1740s High (Knittle) Farm opposite the Metropolitan Edison Generating plant. At Hopewell, the strips were said to have been fashioned from surplus shingles that were cut and planed to measure 1 ½ inches wide by about an eighth of an inch thick.[134] Where the roof abutted vertical surfaces, copper flashing was used.

Figure 62. Installing tile shingles on the south slope of the cast house roof, November 17, 1964.

[134] Norman Souder identified the surplus shingles as "oak" cut 1 ½ inches wide in his completion report. Recent examination by NPS Exhibit Specialist Jeff Finch, however, has identified the wood as red cedar that measures 2 ½ inches wide (Finch to Yocum, Sept. 20, 2007).

Belfry

Design of the belfry at the peak of the cast house roof was based on the photograph of 1887. The belfry was constructed of white pine, and the roof was 1- inch, tongue- and- groove pine applied vertically. A brass bell identified as the one that had hung in the original belfry was reinstalled, with a new lever action and rope that reached almost to the floor of the cast house.

Chimney

A sheet- metal chimney was erected at the east elevation of the east shed, based on archeological evidence.

Flooring

Wood floorboards were installed in the cast house and the south room of the east shed, based on archeological evidence. A layer of plastic was first laid on the clay floor to provide a vapor barrier. Log sleepers made of white oak, 6 to 8 inches in diameter, supported white- pine floorboards 1 ½ inches thick, 8 to 14 inches wide, with tongue- and- groove edges. A light protective coating of creosote was applied to the floorboards.

No floorboards were installed in front of the cast arch of the cast house, where casting sand was specified. Likewise, the north side of the east shed was left as a plain dirt floor.

Painted Finishes

The exterior and selected interior portions of the cast house and east shed were painted white (fig. 63). Whitewash was applied to the exterior and interior stone walls of the cast house, and to the interior south face of the stone furnace stack. Due to the difficulty of maintaining whitewash on new wood, a simulated whitewash was used on the wooden portions of the building. This consisted of a primer coat of white oil- based primer, followed by a second coat of white oil paint with an additive of fine sand. The simulated whitewash was applied to the exterior wooden portions of the building, and the interior wall sheathing, sills, and plates of the cast house and north side of the east shed.

Electrical Service

A preliminary report by Norman Souder noted plans to run a 110- volt electrical line underground from the office- store to the cast house to provide unobtrusive lighting. However, no documentation of this installation is provided in the completion report.

Figure 63. The completed cast house and east shed, March 29, 1965.

Structural Stabilization of the Cast House, 1965

A sag was detected in the roof of the cast house shortly after its reconstruction in March 1965. Investigation found that the stone- pier foundations of three interior posts in the south side of the building had settled from 2 to 2 ½ inches due to water infiltration from the tail race. This caused the braces and other structural members to pull apart, resulting in settlement of the heavy tile roof and deflection of the belfry. A company (Intrusion Prepakt) was contracted to pressure- grout the area in the vicinity of the three posts. Photographs indicate this work was carried out in September 1965 (fig. 64). A completion report prepared the following year described the process as follows:

> Sixty cubic foot of grout was forced through 21 pipes which had been driven approximately 4' in the ground, under 125 lbs. pressure psi, and then into the soil. Basic ingredients of the material called "neat mix" are applied by formula in the following mixture – 94 lbs. of cement, 5 lbs of Chemix, and 30 gallons of water. "Chemix" is an admixture which controls consistency, penetration, pumping pressures, bleeding, stiffening rate, and setting time. One of its main ingredients is Calcium Chloride.[135]

The treatment was declared successful, although was obviously detrimental to surviving archeological resources.

Figure 64. Contractor pumping grout into the ground beneath three posts of the cast house, September 1965.

[135] Riddle, *Administrative Data, Part III, Cast House and Moulding Shed*, p. 2.

Charcoal House Restored, 1965

The last significant work on the reconstruction of the Furnace Group was the restoration of the existing charcoal house. This had been preceded by a considerable amount of documentation and historical research undertaken in 1956 and 1957, as described earlier in this report. Archeological testing in several areas of the park, including the entrance to the charcoal house, was done by Archeologist John L. Cotter in 1958.[136] Additional historical research for the restoration was also carried out in 1964 and 1965 by Superintendent Benjamin J. Zerbey, Historian Earl J. Heydinger, and Architect Norman M. Souder.[137]

Two sheets of architectural drawings dated February 19, 1965, provided details for the proposed restoration of the charcoal house. The aim of this project was to remove known alterations to the building dating to 1880. Work commenced in March 1965 and was completed by August of that same year. Labor was provided by the same crew of Amish carpenters that had recently completed the reconstruction of the cast house and east shed under foreman Christ Beiler, supervised by Hopewell Maintenance Foreman Charles H. Seidel. Also involved were Hopewell employees Russell Bowen (stone mason) and Exhibits Specialist Warren Dungan. The actual restoration is documented by a set of 28 project photographs in the archives of Hopewell Furnace NHS (e.g., figs.65- 67) and two completion reports – one by Architect Norman Souder dated 1965, the other by Historian Earl Heydinger in 1966.[138] This information is summarized subsequently.

General Description

The restoration of the charcoal house attempted to return the building to its pre- 1880 appearance. This involved removing most wooden components, including the south extension, window sashes and frames in the north elevation, and the entire roof structure. The stone walls were then repaired, the south doorway reconfigured and fitted with new doors, wooden shutters installed in the former window openings, and the roof rebuilt with no dormers and no windows in the gables.

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[136] John Cotter, *Archeological Tests, Hopewell Village NHS: Site 1. Garden Area of Ironmaster's House, 2. Parking Lot Extension, 3. Entrance to Charcoal House* (Hopewell Village NHS, July 1958).

[137] Earl Heydinger, *Historic Structures Report, Historical Data Section, Part I, Charcoal House* (Hopewell Village NHS, June 1964); Benjamin Zerbey, *Historic Structures Report, Administrative Data, Part I, Charcoal House, Hopewell Village National Historic Site* (Hopewell Village NHS, Oct. 1964); Norman Souder, *Historic Structures Report, Part I, Architectural Data Section on Charcoal House, Hopewell Village NHS* (Philadelphia: U.S. Dept. of the Interior, NPS, Eastern Office, Design and Construction, Division of Architecture, Oct. 1964); Souder, *Historic Structures Report, Part II, Architectural Data Section on the Charcoal House, Hopewell Village NHS* (Philadelphia: U.S. Dept. of the Interior, NPS, Eastern Office, Division of Design and Construction, Division of Architecture, Oct. 1964); and Zerbey, *Historic Structures Report, Part II, Charcoal House, Building #9, Administrative Data, Hopewell Village National Historic Site* (Hopewell Village NHS, Jan. 1965).

[138] Norman Souder, *Historic Structures Report, Part III, Architectural Data Section on Charcoal House, Hopewell Village National Historic Site* (Philadelphia: U.S. Dept. of the Interior, NPS, Eastern Office, Division of Design and Construction, Division of Architecture, Oct. 1965); and Earl Heydinger, *Historic Structures Report, Historical Data Section, Part III, Charcoal House, Hopewell Village National Historic Site* (Hopewell Village NHS, Sept. 1966).

Walls

The stone walls were found to be sound and required only minimal repairs. Mason Russell Bowen repaired the upper walls in the vicinity of the roof plate,and repointed areas where mortar had spalled. No attempt was made to unify the various shades of mortar that had been used at different times throughout the building.

Doorways

A large void was left in the south masonry wall upon removal of the 1880 south extension. Although no physical evidence remained of earlier construction, it was decided to enclose the upper part of the opening with vertical siding and the lower part with two pairs of large doors, for protection and security purposes. Random- width boards (8 inches +) of Idaho white pine boards were used for the siding. The doors below were fabricated as board- and- batten type with tongue- and- groove white pine 1 inch thick. Hinges were long straps with iron hasps and staples. These were a combination of old hinges from the Hopewell collection and wrought-iron reproductions made by Donald Streeter.

The three openings in the north wall were restored by first removing the later window sashes and frames from the center and west openings. The frame of the east opening was found to be earlier and retained physical evidence (mortises) of earlier board- and- batten shutters. This mortise- and- tenon frame was restored, reinstalled, and used as a template for reproducing oak frames for the center and west openings. Three pairs of board- and- batten shutters were reproduced using the same white- pine stock as the south doors. Battens were attached with clinched nails with hammered heads to simulate wrought- iron nails. Reproduction wrought-iron strap hinges and pintles were made by Donald Streeter, as were wall staples that held the shutter panels in the open position. One of these early staples had remained on the east side of the east opening, and was left in place.

Roof

The roof of the charcoal house in 1965 was supported by temporary bracing and shoring. This had been installed in 1958 following a heavy snowfall that caused structural damage. Dry rot and infestation by powder- post beetles had also taken their toll. The entire roof structure was therefore removed down to the stone walls. Several sections of the roof plates were all that appeared to be old, possibly predating 1880, although nothing was salvaged due to the poor condition of the wood. The reconstructed roof framing used white oak from the Hilltop Lumber Company and poplar pole rafters. All millwork was hand- planed to remove modern saw marks, and the pole rafters were stripped of bark. All wood was treated with a solution of pentachlorophenol, and the base of the roof plate was coated with creosote. Roof plates measured 8 by 10 inches and were secured to the stone walls with anchor bolts spaced 4 feet on center. Other framing elements included oak ties (8 inches square), purlins (8 inches square), and braces (4 inches square). Shingle lath measuring 1 by 3 inches was spaced 9 inches on center. The lath supported red cedar shingles that were thought to most closely resemble the smooth texture of early pine shingles. The gable ends of the roof were vertically sheathed with the same white pine boards installed over the south doorway, and trimmed with a 1 inch- wide

fascia board with beaded lower edge. Decorative cutouts in the peaks of the gables – a star motif in the east elevation and a diamond in the west – replicated those of the existing roof. Lead-coated copper flashing was used in the valley between the attached roofs of the charcoal house and the cooling shed.

Gutters

No gutters or leaders were installed on the charcoal house, nor does the building appear to have had gutters historically.

Painted Finishes

Two coats of iron oxide red oil paint were applied to the siding above the south doorway and in the gables, the doors in the south wall, and the shutters and frames in the north wall. Although some traces of early whitewash remained on the exterior stone walls, the walls were not whitewashed.

Connecting Shed Extension

The south extension of the charcoal house that had been constructed in 1880 was removed in 1965. The connecting shed of the bridge house was then lengthened one bay to fill the void (fig. 66). This work replicated the existing materials of the connecting shed, which had been previously reconstructed by the NPS in 1957- 58.

Figure 65. South and east elevations of the charcoal house following demolition of the roof and south extension, June 1965.

Figure 66. South and east elevations of the partially completed charcoal house, July 1965.

Figure 67. New south doors of the charcoal house, July 1965.

Figure 68. The completed Furnace Group at Hopewell Furnace NHS, 1967.

Maintenance, Repairs, Etc., 1971- 2007

Bridge House Vestibule Reroofed, 1971

The tunnel- head vestibule of the bridge house adjacent to the furnace was reroofed with new wooden planks in 1971. The only known documentation for this work is a set of photographs in the archives of Hopewell Furnace NHS (fig. 69).[139]

Figure 69. Reroofing the tunnel- head vestibule of the bridge house, November 1971.

[139] "New Roof for Section of Bridge House Closest to Furnace, 1971" (6 photographs), Hopewell Furnace NHS Archives, Resource Management Records, Cat. No. 35420, Research Projects, Box 11.

Connecting Shed Roof Replaced, 1977

A new roof was installed on the connecting shed roof in 1977 under contract CX4000- 6- 0025, "Roof Repairs, Connecting Shed." Contract files indicate that white pine lumber was used. The contractor was the Roberts Construction Company of Frederick, MD. [140] Photographs of the completed project were taken November 11, 1977 (e.g., fig. 70).

Figure 70. New roof on the connecting shed, Nov. 11, 1977.

New Water Wheel, 1978

The reproduction water wheel of 1951 appears to have been replaced by a new wheel in 1978. The contractor for the work was Ken Reitz, who took eight photographs that are in the archives of Hopewell Furnace NHS (fig. 71).[141] Reitz, who lives in Birdsboro, recently told Cultural Resource Manager Rebecca Ross that he "totally rebuilt the wheel" and had "made all the wooden parts himself."[142] No other information on the 1978 water wheel could be found in the files and archives of Hopewell Furnace NHS.

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[140] Hopewell Furnace NHS Cultural Resource Manager Rebecca Ross to Barbara Yocum, e- mail dated Nov. 8, 2007.

[141] "Reconstruction of Wheel, 1978" (8 photographs), Hopewell Furnace NHS Archives, Resource Management Records, Cat. No. 35420, Research Projects, Box 11.

[142] Ross to Yocum, e- mail dated Dec. 12, 2007.

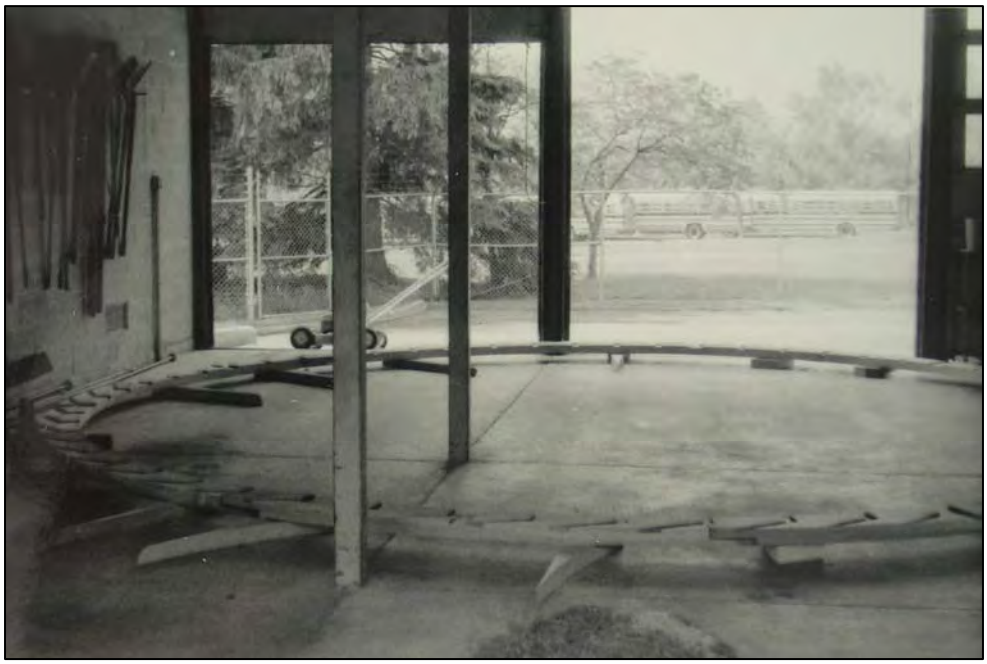

Figure 71. Construction of new water wheel, May 30, 1978.

Cast House Cranes Installed, Circa 1978

It is not known exactly when two existing timber frames for block- and- tackle cranes were installed in Hopewell Furnace's cast house, positioned on either side of the cast arch. A short report advocating the installation of a crane was prepared in 1973.[143] Detailed drawings for the construction of two cranes and their accessories are dated 1974, 1975, and 1978.[144] The cranes were presumably installed shortly thereafter, or around 1978.

Fire and Intrusion Detectors Installed, 1981- 82

Architectural plans detailing the installation of fire- and intrusion- detection systems in several buildings at Hopewell Furnace NHS are dated 1981.[145] This included detectors for the cast house, bridge house, and charcoal house, and underground electrical service. The work was executed by Harrington and Sons, Inc., of Wagontown, PA, under contract no. CX- 4000- 1- 9003. A completion report at the park dated July 26, 1982, verifies that the work was actually done.[146]

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[143] *Historic Structures Report, Cast House Crane, Hopewell Village National Historic Site* (Hopewell Village NHS, 1973).

[144] "Timber Cranes, Cast House, Hopewell Village NHS," Drawing No. 376/80,002, one sheet, Feb. and Apr. 1974; "Crane Accessories, Cast House, Hopewell Village NHS," Drawing No. 376/8003, set of 6 sheets, March 1975; and "Timber Cranes, Cast House, Hopewell Village NHS," Drawing No. 376/80,0002, one sheet, Jan. 28, 1978.

[145] "Hopewell Village NHS, Intrusion and Fire Alarm System," Jacobs /Smith, Drawing No. 376/41,0005B, 1981. Hopewell Furnace NHS Maintenance Division, Drawing Files.

[146] Ross to Yocum, e- mail dated Oct. 27, 2007.

East Head Race Wall Restored, 1984

A complete rebuilding of the stone retaining wall of the east head race west of Route 345 was carried out in 1984 by the NPS Williamsport Preservation Training Center of Williamsport, MD. Documentation of the project can be found in the park's central file H3015, and in the archives accessioned as HOFU- 936. Black- and- white photographs documenting the deteriorated condition of the wall in 1983, and its reconstruction in 1984, are also filed in the park's photograph archives (e.g., fig. 72). [147] Contract documents indicate that the principal work involved "the dismantling and the reconstruction of the dry- laid fieldstone masonry retaining walls bordering the northern side of the East Head Race."[148] Although the wall was described as dry- laid, bedding mortar and a mortared cap were specified, using "one part of white, non-staining portland cement; seven parts of clean, sharp, dark brown ungraded sand; and two parts of hydrated lime."[149] The existing deteriorated condition of the wall on the east side of Route 345 suggests that no work was done on that portion of the wall in 1984.

Figure 72. Wall restoration at the east head race, on the west side of Route 345, spring 1984.

Reroofing of Charcoal House, 1986

The charcoal house was reroofed with red- cedar shingles in 1986.[150] The work was executed under contract, as described in "Specifications for Replacement of Charcoal House Roof" dated

[147] "East Headrace Crumbled Wall, 1983" (14 photographs) and "East Headrace Wall Restoration, 1984" (16 photographs), Hopewell Furnace NHS Archives, Resource Management Records, Cat. No. 35420, Research Projects, Boxes 11and 12.

[148] Contract specifications for "East Head Race, Stone Wall Reconstruction," transmitted in a memorandum dated Sept. 1, 1983, from Branch Chief, Williamsport Preservation Training Center, to Superintendent, Hopewell Village NHS.

[149] Contract specifications, "East Head Race."

[150] Ross to Yocum, e- mail dated Oct. 27, 2007.

May 7, 1986. Additional research is required to determine the contract number and the name of the contractor.

Post- Hurricane Cleanup, 1987

Flooding caused by Hurricane Floyd in October 1987 resulted in damage to several buildings at Hopewell Furnace NHS, including the cast house (fig. 73).[151] Details of this damage, and the work that was undertaken to repair it, have not been found.

Figure 73. Post- hurricane damage in the cast house, 1987.

Furnace Evaluated and Repointed, 1987- 88

Signs of deterioration observed in 1983 at Hopewell's original furnace and later anthracite furnace resulted in a study of the two furnaces in 1986- 87. This was undertaken by Thomas & Newswanger, Architects, of Philadelphia, PA, under contract no. CX 4000- 6- 0036. Their findings were written in a report titled "Hopewell Iron Furnaces, Historic Structures Report and Engineering Study," prepared in 1987. Thomas & Newswanger employed several subcontractors, including Keast & Hood Co., to conduct an engineering assessment, and the Clio Group, Inc., to do mortar analysis. Approximately 70% of the original furnace was observed to be protected by the wood- framed cast house. Of the exposed portions, the south and west elevations were found to have suffered more severe weathering than the less- exposed north and east elevations, where some remnants of what appeared to be early construction

[151] "Hurricane Floyd Damage, 1987" (39 photographs), Hopewell Furnace NHS Archives, Resource Management Records, Cat. No. 35420, Research Projects, Box 12.

mortar were observed.[152] Water infiltration through the furnace's exposed surfaces was identified as the primary problem, causing deterioration of mortar joints, brick and stone masonry, and cast- iron elements. Winter's freeze- thaw cycles were also acknowledged to be a contributing factor, since the cast house was unheated. The study resulted in eight drawings for the masonry restoration of the furnace stack, prepared in July 1987. [153] The work appears to have been carried out in 1988, based on photographic documentation in the archives of Hopewell Furnace NHS.[154] Repointing work was done under contract by Vincent Bruno, Inc., of Oreland, PA.[155] No completion report appears to exist.

New Water Wheel, 1987- 88

The furnace's water wheel was reconstructed a third time by the NPS in 1987- 88, replacing the wheel of 1978.[156] The new wheel was constructed by the Williamsport Preservation Training Center. Documentation of the wheel is provided by a proposal prepared by the training center in 1987, correspondence, and 534 photographs in the archives of Hopewell Furnace NHS (e.g., fig. 74).[157] The goals of the project, according to the 1987 proposal, were to correct historical inaccuracies in the construction of the existing wheel, and to improve its structural strength and durability. To this end, a surviving fragment of the ca.- 1879 water wheel – a section of the inner wheel rim – was examined, and photographs and drawings of the wheel dating to the 1930s were studied. The proposed design incorporated a more historically appropriate double (vs. single) rim, larger spokes, and dimensionally stable white oak for the hub, rim, spokes, and buckets. The existing hardware was to be reconditioned and reused, including the gudgeons, bearing caps, hub rims, iron tires, bolts, and nails. Missing or deteriorated hardware was to be replaced with forged replacements. The correspondence indicates that white oak was a major component in the reconstructed wheel, and that "tank- grade cypress" was also used. The extent of existing hardware that was incorporated in the new wheel is not known absent a completion report. The new wheel was installed in June 1988, and a dedication ceremony was held on August 7, 1988, coinciding with the 50th anniversary of the establishment of Hopewell Village NHS in August 1958.

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[152] This early mortar was described as a brownish- color composed of unwashed local sands and lime (crushed and lumps) that had been raked or struck into the stone joints. Thomas & Newswanger, *Hopewell Iron Furnaces*," Appendix F.

[153] "Masonry Restoration, Charcoal Furnace, Hopewell Village NHS," set of 8 sheets, July 1, 1987.

[154] "Water Wheel Construction and Furnace Re- pointing, 1988" (534 photographs), Hopewell Furnace NHS Archives, Resource Management Records, Cat. No. 35420, Research Projects, Box 12.

[155] Ross to Yocum, e- mail dated Nov. 8, 2007.

[156] Interestingly, it was assumed by park staff that the existing deteriorated water wheel had been last replaced in 1951, not in 1978, as is suggested by photographic documentation in the archives of Hopewell Furnace NHS – "Reconstruction of Wheel, 1978" (8 photographs), Hopewell Furnace NHS Archives, Resource Management Records, Cat. No. 35420, Research Projects, Box 11.

[157] Williamsport Preservation Training Center, "Proposal: Reconstruction of the Waterwheel, Hopewell Furnace National Historic Site, Elverson, Pennsylvania" (NPS, Oct. 1987); and 534 photographs in the archives at Hopewell Furnace NHS, Resource Management Records, Cat. No. 35420, Research Projects, Box 12.

Figure 74. Installation of the new water wheel, 1988.

New Flume for West Head Race, 1989

A third reconstruction of the west- head- race flume was undertaken by NPS in the summer of 1989, replacing the wooden structure of 1964. The work is documented by nine photographs in the archives of Hopewell Furnace NHS (fig. 75).[158]

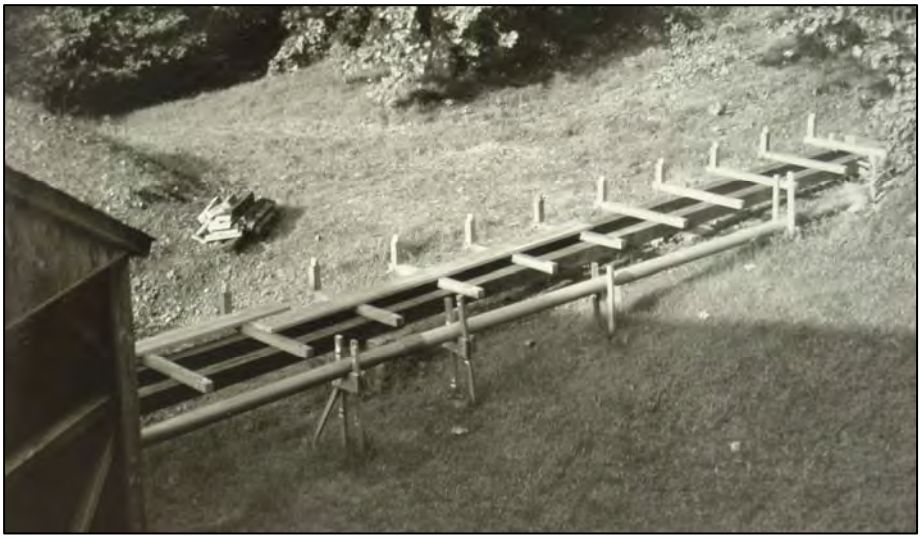

Figure 75. Reconstructing the flume of the west head race, August 1989.

[158] "West Headrace Reconstruction, 1989" (9 photographs), Hopewell Furnace NHS, Resource Management Records, Cat. No. 35420, Research Projects, Box 12.

East Head Race Engineering Study, 1992

A study of the east head race was carried out in 1992, according to the 1994 Resource Management Plan. The study was described as follows:

> An informal engineering survey was conducted in 1992 to determine whether the east race could be used to supply water to the waterwheel during a drawdown of Hopewell Lake. It was believed at that time that the race could be utilized if small dams were restored at Baptism Creek and Spout Run, a small wooden race constructed to carry the race over Spout Run at their intersection, and a siphon mechanism was constructed to carry the water under the park entrance road. This alternative was discarded after another much simpler alternative temporary method for providing water to the wheel was found. However, it appeared that the restoration of the east race was much more feasible than previously believed.[159]

No written report or drawings documenting the findings of the 1992 study could be found during the research for this historic structure report.

Cast House Belfry and Roof Repaired, 1997

Repairs to the cast house belfry and roof were undertaken by the NPS Historic Preservation Training Center of Frederick, Maryland, in 1997. The work was documented by a completion report prepared that same year.[160] The purpose of the project was to repair damage to the belfry and structural supports caused by water infiltration at failed flashings. Details of the work, as recorded in the completion report, are summarized subsequently.

Belfry repairs included replacement of three of the four support columns (northeast, southeast, and northwest), the cove molding, three slotted fascia boards, and three roof boards. New lead- coated copper flashing was installed at the intersection of the column bases with the cast-house roof. The roof of the belfry was finished with an Allacite paint system, consisting of a self- adhesive fiberglass mesh coated with a white polymer paint. All other elements of the belfry were painted with Benjamin Moore's "MoorGlo Soft Gloss Latex House and Trim Paint" in stock color "Brilliant White."

Also undertaken at this time were repairs to the structural supports of the belfry and the cast house roof. Two cross braces supporting the belfry were replaced, as was one collar tie and the upper sections of two rafters. The main roof girt in the east elevation was repaired with epoxy. Other roof repairs included replacement of one rafter on the west side of the cast house and installation of new lead- coated copper flashing at the intersection of the cast house and bridge house.

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[159] *Resource Management Plan, Hopewell Furnace NHS* (Hopewell Furnace NHS, 1994), PS (Project Statement) page 0005.

[160] Historic Preservation Training Center, *Cast House Roof and Tower Preservation Project, Hopewell Furnace National Historic Site, Elverson, Pennsylvania* (Frederick, MD: U.S. Dept. of the Interior, NPS, 1997).

Connecting Shed Roof Replaced, Circa 1999

Plans to replace the board- and- batten roofing on the connecting shed of the bridge house were prepared in March 1999.[161] The contract was awarded to R. Corey Rosentel, president of Lone Tree Archaeology and Environmental, Inc., of Swoyersville, PA. Lumber for the project (southern yellow pine) was supplied by the Elverson Supply Company of Elverson, PA.

Fire- and Intrusion- Detection Systems Upgraded, 2004

The existing fire- and intrusion- detection systems replaced earlier equipment in the cast house, bridge house, and charcoal house in 2004. The system was installed by American Alarm Technologies under contract number C4430- 03- 0005.[162]

New Water Wheel, 2005- 06

The reconstructed water wheel of 1988 was most recently replaced in 2005- 06 under NPS contract number C4526- 05- 0031. The contract was awarded to Stan Graton II, 3- G Construction, Inc., of Holderness, NH. The work accomplished was documented in a two-page narrative description and seven sheets of detailed drawings.[163] The components of the existing wheel were tagged; the wheel was then dismantled, and the pieces removed to the contractor's shop in New Hampshire in the fall of 2005. The reconstruction used #1 white oak for the rim segments, spokes, and wedges. Soling boards and buckets were made of barrel- grade cypress. The existing oak hub was repaired, soaked in a preservative mixture of linseed oil and turpentine, and reused. Nuts and bolts, special made with square heads, and 3 ½- inch cut nails were used. The new wheel was reassembled on site and its completion celebrated in a dedication ceremony August 5, 2006 (fig. 76).

Figure 76. Dedication of the new water wheel at Hopewell Furnace NHS, August 5, 2006.

The tail race was also cleaned and repaired as part of the water wheel contract by subcontractor New England Basin Cleaners.
Rip- rap was added to fill in areas of the bed where scouring had occurred in the vicinity of storm drains. A large stone was place in at least

[161] "Roof Plan, Elevation & Details, Connecting Shed, Hopewell Furnace NHS," Drawing No. 376/80029, 1 sheet, March 26, 1999. Also specifications entitled "Replace Connecting Shed Roof," March 1999.

[162] Finch to Yocum, e- mail dated Sept. 20, 2007, and Ross to Yocum, e- mail dated Nov. 6, 2007.

[163] Hopewell Furnace NHS, Maintenance Files.

one of these areas to prevent future erosion. The depth of water in the wheel pit was lowered as a result of the work in the tail race.

Cast House Siding Repairs and Painting, 2007

Deteriorated siding on the exterior east elevation of the east shed of the cast house was replaced in 2007 by NPS Exhibit Specialist Jeff Finch. Finch observed that the existing siding consisted of random- width, tongue- and- groove pine boards installed vertically. The siding covering the north portion of the wall appeared to be the original, 1- inch- thick pine boards installed in 1964- 65, while the south portion of the wall had thinner replacement boards installed by the park sometime in the past 15 years. Finch documented all existing board widths with written measurements prior to their removal. Red cedar was chosen to replace the pine boards because it is more rot- resistant than pine, dimensionally stable, and holds paint well. The red- cedar boards were rough on one side; they measured 11 ¼ inches wide by seven- eighths of an inch thick; and they were cut to replicate, but not exactly duplicate, the random widths of the original siding. The bottom ends of the boards were treated before installation with a preservative mixture of sterilized raw linseed oil, naphtha, and mineral spirits. Galvanized cut nails were used to attach the new siding. Other work included replacing the rotted sill at the east window, and fashioning a tin thimble for the sheet- metal chimney. The old pine siding was saved, and will be used as needed for siding repairs elsewhere on the cast house.

The exterior siding of the entire cast house was painted following the siding repairs under NPS contract P4430- 07- 00014. The contractor was Kalimex, Inc., of Ocean View, NJ. The paint used was white "Allback Linseed Paint." Some repairs to the siding and flashing of the belfry were also accomplished under this contract.

Cast House Structural and Roofing Repairs, 2007- 08

The roof structure and clay roofing tiles of the cast house and east shed were repaired in 2007-08 under contract # C4430070008 to correct problems with water infiltration. Work commenced in December 2007 and continued through March 2008. The general contractor was the Citadell Construction Company, Inc. of Lansdale, PA. The existing clay tiles were removed in sections, and selected structural repairs were made. One poplar log rafter and one 4 x 4 support post were replaced in kind in the northwest corner of the roof where the furnace stack abuts the bridge house. Approximately 35 percent of the eave decking was replaced, as was a very small amount of roofing lath in various places on the roof.[164] The roof cricket in this area was also enlarged to prevent accumulation of organic matter. Wooden strips covering the joints beneath the clay roofing tiles were removed and replaced by terne- coated stainless steel. Broken and cracked tiles were replaced by new tiles from a stockpile of extra tiles stored at the park.[165] Finally, roofing cement at the intersection of the roof and furnace stack was removed and replaced with sheet- metal flashing (lead- coated copper and lead), and gutters and leaders were installed.

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[164] Finch to Sharon Ofenstein, e- mail dated Apr. 21, 2008.

[165] There are some 1,100 tiles from the 1964- 65 reconstruction still in their original boxes. In addition, approximately 200 salvaged tiles are available, according to Finch.

III. PHYSICAL DESCRIPTIONS

FURNACE

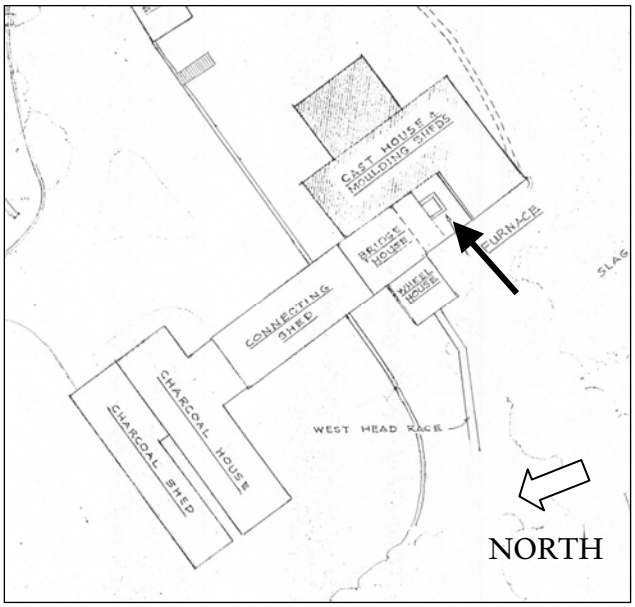

Figure 77. Plan of the reconstructed Furnace Group, showing the location of the furnace (at black arrow).

General Information

The furnace, also called the furnace stack, is where charge was heated to produce iron. The date of the stonework walls of the furnace remains a question, lacking definitive documentation of its construction and later repairs. It is likely that the base is early, assuming the carved date "1771" to the left of the cast arch is authentic. Extensive rebuilding of the walls above this stone may have occurred in 1828, as suggested by entries in the Hopewell records for that year. The exterior appearance of the furnace stack was preserved, and its interior completely rebuilt, during stabilization by the Civilian Conservation Corps (CCC) in 1936- 41.

Brief Historical Background

The furnace was the heart of Hopewell Furnace during its operation from circa 1771 to 1883. It was here that iron ore was smelted using charcoal fuel and limestone, transforming it into iron. The furnace is the only early physical remainder of the Furnace Group with significant integrity, based on the date "1771"carved in one of the stones (figs. 9 and 80). An earlier date, "1770," observed by NPS Historian Melvin Weig in 1939, is no longer discernable today. A considerable amount of work of an unknown nature appears to have taken place in 1828, based on entries in the Hopewell records crediting 528 ¼ man- days of work on the "Furnace Stack," including

much masonry.[1] Hopewell records also document the periodic replacement of the lining of the furnace's interior bosch – in early years with sandstone, and in later years with firebricks. The furnace's last blast was extinguished on June 15, 1883. The earliest photograph of the furnace is dated 1887 (figs. 7 and 17), with later photographs taken through 1936 showing its progressive deterioration (figs. 18- 22 and 25- 26). The furnace was stabilized by the CCC from 1936 to 1941, using reinforced concrete and cement mortar. Not installed were wooden girders that had historically provided additional strength to the exterior walls of the furnace stack. The upper brickwork portions of the furnace stack, including the tunnel head and firewall, were reconstructed at the same time as the bridge house in 1957- 58. Recreation of the cast house in 1964- 65 enclosed most of the furnace except its west wall and upper stack. The recent practice of whitewashing the exposed stonework dates to this time.

Restoration Date

The goal of stabilizing the furnace during the years 1936 to 1941 was to preserve its existing antiquated appearance. Since the furnace had not been used or repaired since its last blast in 1883, this essentially entailed preserving the furnace as it existed in that year. This was in keeping with the park's broad period of interpretation that covered the years 1770 to 1883.

Documentation

Unlike other components of the Furnace Group, no reports documenting the furnace were prepared prior to the 1936- 41 stabilization. The furnace was mentioned, however, in general reports written by Historian Roy Appleman on the French Creek area(1935) and the proposed restoration of Hopewell Village (1936). A measured drawing of the furnace's existing appearance was prepared in 1936, which was annotated in 1937, 1938, and 1939 as repair work progressed (fig. 29). For detailed listings of these reports and drawings, see the bibliography at the end of this report. Project photographs of the furnace stabilization are also in the archives of Hopewell Village NHS. Although no completion report of the work is known to exist, a memorandum written in 1946 described the technical aspects of the stabilization project (see "Chronology of Development and Use; 1935- 1938: Stabilization; Furnace Stabilized, 1936- 38").

[1] Russell Apple, *Documentation for the Historical Base Maps, 1830- 1840, Part of the Master Plan* (Hopewell Village NHS, June 1956), p. II- 115. Original source: Hopewell Journal, 1827- 30 (SM- 14), pp. 36- 37. Last manager Harker Long said that the furnace was reconditioned and made higher around 1800, which may have referred to the 1828 work.

LCS Designation

The furnace is assigned LCS number 00069, and park structure number 7, in the NPS List of Classified Structures.

Descriptions

Furnace Stack

The exterior of the furnace is constructed of rough- dressed fieldstones that rise in steps to a height of approximately 38 feet, from a base measuring 28 feet wide on the north side by 27 feet wide on the east side. The stone walls at the base were estimated in 1939 to measure about 10 or 12 feet thick, indented on the east side by a cast arch and on the north side by a tuyere arch with tunnel head above (figs. 79, 81, and 91).[2] Of these thick walls, only the outer layer of stones and iron lintels remain unchanged, the interior having been completely rebuilt by the CCC with reinforced concrete and cement mortar during the years 1936 to 1941. The brickwork walls of the upper furnace stack (fig. 78) and the tunnel head were rebuilt at the same time as the bridge house, in 1957- 58. Repointing of the furnace was undertaken in 1988.[3]

Furnace Interior and Bosch

The original interior stones of the furnace were removed and reinstalled during the stabilization of 1936- 41, as were the ca.- 1879 firebricks lining the bosh. No attempt appears to have been made, however, to exactly replicate the placement of the interior stones and bricks. Thus the furnace was strengthened from within using both old and new materials, while preserving its old exterior appearance. The space between the interior bosh and the stone walls of the furnace stack was cushioned with sand in the mid- 19th century, according to a Hopewell clerk's report written in 1869.[4] This insulating layer was undoubtedly replaced with new material during the stabilization of 1936- 41.

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[2] The cast arch is where the molten iron and slag was drawn off from the furnace; the tuyere arch is where a cold blast of air was delivered through a tuyere pipe; and the tunnel head is where the charge (charcoal, iron ore, and limestone) was loaded into the furnace from the bridge house.

[3] No information has been found on the mortar mix used to repoint the furnace in 1988.

[4] Joseph Walker, *Hopewell Village: The Dynamics of a Nineteenth Century Iron- Making Community* (Philadelphia: University of Pennsylvania Press, 1966), p. 65.

Cast Arch

A large recessed arch on the east side of the furnace is the "cast arch," through which smelted iron was drawn (fig. 79). Molten iron collected in the crucible at the bottom of the bosch. The cast arch is supported and framed by iron lintels and jambs, which were preserved during the 1936- 41 stabilization and presumably predate 1883. A stone with the carved date "1771" is located at the lower left side of the cast arch opening (fig. 80). The lower portion of the furnace stack, including the cast arch, was historically protected within a structure during its many years of operation, but was exposed to the weather following the collapse of the cast house in the 1890s. It remained that way until reconstruction of the existing cast house in 1964- 65.
The furnace is believed to have changed from an open- hearth operation to a closed- hearth design around 1868, although no definitive documentation has been found for this alteration. The hearth as it exists today is a modified open hearth, with an arched opening framed by the iron lintel and jambs. This is unchanged from the pre- stabilization appearance of the hearth in 1936, as documented in measured drawings of the furnace stack (fig. 29). The arched opening is a nonhistoric alteration of the tymp stone, which may have been chiseled by early 20th- century visitors to gain access to the interior of the furnace stack. A dam stone was added by the NPS sometime after 1938. Missing elements of the closed hearth that existed during the later operation of the furnace in 1879- 83 are the stonework that enclosed the opening, a slag hole, and a tap hole.[5]

A modern crucible for heating aluminum currently sits in front of the cast arch and is vented through the bosch of the furnace stack (fig. 79). The molten aluminum is used by NPS interpreters and volunteers to demonstrate flask casting. During periods when no casting demonstrations are being given, the small furnace is moved to storage. Two wooden cranes flanking the cast arch were installed by the NPS sometime after 1978.

Tuyere Arch

A large recessed arch on the north side of the furnace is the "tuyere arch," through which a blast of cold air was delivered via a pipe and nozzle from the nearby blast machinery. The tuyere pipe enters the furnace through a small opening in the lower back wall of the tuyere arch (fig. 81). An iron lintel above the opening was preserved during the stabilization of 1936- 41, and presumably predates 1883. Like the cast arch, the tuyere arch has historically been sheltered from the elements. By 1883, the arch was enclosed within a room defined by the stone foundation walls and decking of the bridge house above. It became exposed to the elements upon the collapse of the bridge house in 1931. The existing reconstructed bridge house and stone foundation walls date to 1957- 58 and 1963- 64.

[5] Harker Long, last manager of Hopewell Furnace who came to Hopewell in 1867, described the furnace as a closed- hearth operation during interviews in the 1930s.

Tunnel Head

A tunnel head for loading charge into the furnace is located above the tuyere arch (fig. 91). Access to the tunnel head was via the bridge house. This is an opening in the floor, 16 inches wide, into which wheelbarrows could easily deposit their loads of charcoal, iron ore, and limestone. The opening is covered today with metal grating for safety purposes. The tunnel head and adjacent brick firewall were rebuilt at the same time as the bridge house in 1957- 58. The historical accuracy of some details, such as the size of the tunnel head opening, requires additional research.

Repairs and Improvements

The following repairs and improvements have been made to the furnace since construction of the cast house in 1965. For details of this work, see "Chronology of Development and Use."

1988: The furnace was repointed following an engineering study undertaken in 1986- 87.[6]

Periodic:

- Roofing cement was periodically applied to the top surface of the furnace stack.
- Painting of the upper furnace stack coincided with exterior painting of the cast house.

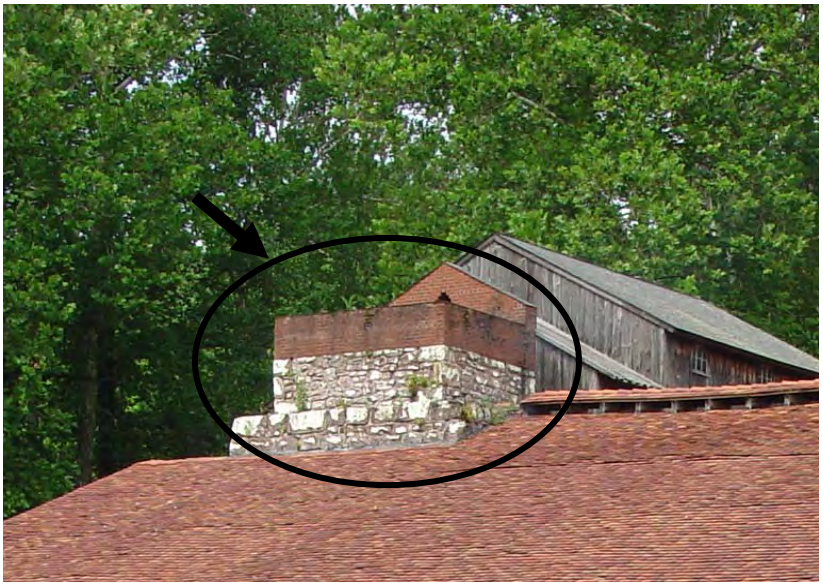

Figure 78. South and east exterior elevations of the upper furnace stack, July 2006.

[6] Thomas & Newswanger, Architects, *Hopewell Iron Furnaces Historic Structures Report & Engineering Study* (Philadelphia: 1987). The scope of the repair work was detailed in a set of 8 drawings titled Masonry Restoration, Charcoal Furnace, Hopewell Village NHS, July 1, 1987.

Figure 79. Cast arch on the east side of the furnace, July 2006.

Figure 80. Detail of carved date "1771" on the south side of the cast arch, September 2007.

Figure 81. Tuyere arch on the north side of the furnace, July 2006.

FURNACE BANK AND RETAINING WALL

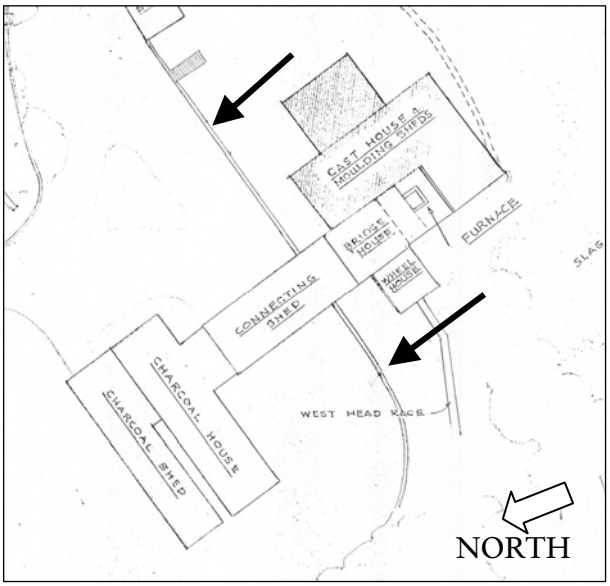

Figure 82. Plan of the reconstructed Furnace Group, showing locations of the furnace bank and retaining wall (at black arrows).

General Information

The furnace bank is a natural ridge located north of the furnace and cast house, on which the charcoal house, cooling shed, and connecting shed are located. Hopewell records and photographs suggest that the stone furnace bank retaining wall may date to 1816, and definitely existed by 1887. The wall east of the furnace was destroyed by a road in 1932 and was reconstructed by the NPS in 1956.

Brief Historical Background

A natural landscape feature known today as the furnace bank was an important component in the siting of Hopewell Furnace in 1770- 71. Such a configuration enabled the furnace to be constructed on the lower level, with the charge stored on the bank above. The charge could therefore be easily loaded into the tunnel head of the upper furnace stack via a bridge from the furnace bank. Charge consisted of iron ore, limestone flux, and charcoal fuel. The charcoal was usually stored in a roofed structure to keep it dry; piles of iron ore and limestone were deposited

nearby. At Hopewell Furnace, former manager Harker Long recalled the "ore bed" as being in the vicinity of the charcoal house.[7]

There are few entries in the Hopewell records that mention the furnace bank and its retaining wall. A description in 1816 of a mason building 262 perches of wall has been interpreted by some researchers to refer to the construction of the stone retaining wall of the furnace bank.[8] A later entry for one day of "dry mason work … at the wall" in 1878 may also have referred to the stone retaining wall.[9] The earliest known photograph showing the furnace bank and its stone retaining wall was taken in 1887 (figs. 7 and 17). The upper courses of the wall were removed east of the furnace to accommodate the realigned Birdsboro- Warwick road in 1932. The road was closed to public traffic in 1955, and the furnace bank and wall were restored the following year by the NPS.[10]

Archeological excavations were undertaken in 1950 of the furnace bank extension beneath the connecting shed of the bridge house. These studies labeled the retaining wall of the adjacent furnace bank as "Wall H."

Restoration Date

The prevailing period of significance for Hopewell Village NHS was 1820- 40, when the furnace bank and retaining wall were reconstructed east of the furnace in 1956. However, since no information was available on the historic appearance for this time period, it appears that the wall was reconstructed to the time of the furnace's last working status (1879- 83).

Documentation

No separate reports or reconstruction drawings are known to have been prepared on the furnace bank and retaining wall at Hopewell Furnace.

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[7] Harker Long interview with Roy Appleman, December 1935.

[8] Dennis Kurjack, *Preliminary Report on Walls Adjoining Furnace Bank, Hopewell Village* (Hopewell Village NHS, Feb. 1950), p. 17, and Walter Hugins, *The Physical History of The Hopewell Furnace Group, 1770- 1883, Hopewell Village National Historic Site* (Hopewell Village NHS, Feb. 1954), p. 30. Other researchers have suggested that the work may have involved rebuilding of the furnace stack or the foundations of the bridge house or wheel house.

[9] Kurjack, *Preliminary Report on Walls Adjoining Furnace Bank*, p. 17.

[10] Russell Apple, *Historical Documentary Report on the Bridge and Wheel Houses, Hopewell Furnace (Bldgs. 10 and 8), Hopewell Village NHS* (Hopewell Village NHS, Sept. 1956), p. 22.

LSC Designation

The furnace bank and retaining wall are assigned LCS number 012113, and park structure number 8, in the NPS List of Classified Structures.

Description

A complete description of the furnace bank and retaining wall was written by Architect John Dodd in March 1976 for the "Classified Structure Field Inventory Report."[11] Since no significant changes have been made to these features since 1976, Mr. Dodd's description is transcribed here in its entirety:

> A terrace cut- back, stabilized by a masonry retaining wall, created out of a natural feature provided by a hill slope to produce an access for men and wagons to the furnace head and for communication between other buildings of the furnace complex. Built, with the Furnace, in 1771; reconstructed 1957 [sic: 1956].
>
> Retaining wall of red sandstone, ca. 2'- 0" thick, varying in height from about 8'- 0" to 18'- 6", for a total length of 184 ft., 128 ft. being east of the Connecting Shed embankment, 56 ft. on the west; a curved section at the western end running for another 83 ft. and decreasing from about 8 ft. to 2 ft., is not historically documented.
>
> A flight of non- historic access steps to the west of the Connecting Shed consists of 8 risers, the stair being 1'- 6" wide at the top and 5'- 0" wide at the bottom comprising a drop of about 5'- 6" in 9'- 0"; gate in post & rail fence at top.
>
> To the east of the Connecting Shed, the wall is canted from bottom to top and capped with sandstone blocks, roughly tapered; the 6" to 8" spaces appearing in the wall in a somewhat irregular pattern were caused by the masons' scaffolding.
>
> At the east end, another flight of steps is constructed from dressed sandstone blocks; 4'- 6" wide, 19 risers 8- 1/2" high, blocks overlapped leaving up to 15" exposed tread; sandstone slab at foot, 24 x 51- 1/2" x 4".[12]

[11] John B. Dodd, *Classified Structure Field Inventory Report* (Hopewell Village NHS, Mar. 1976).

[12] No information was provided by Mr. Dodd on the date of the east steps. These may have been constructed by the NPS in 1956 following removal of the Birdsboro- Warwick road.

Culvert between steps and west end of Office & Store Building, stone faced, stone lined; 3'- 6" wide, 20" above grade at south side, opening 30" high; it carried the East Head Race under Bank.[13]

Repairs and Improvements

No records of recent repairs and improvements to the furnace bank and retaining wall were found in the files and archives of Hopewell Furnace NHS.

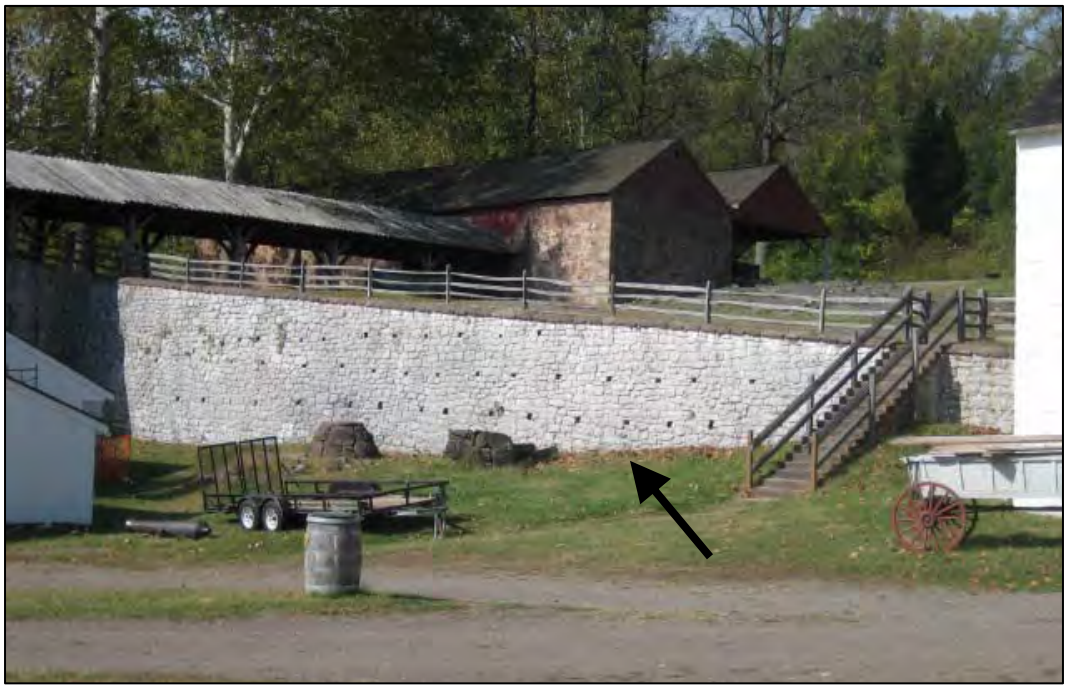

Figure 83. The furnace bank and retaining wall (at arrow), east of the furnace, October 2007.

[13] No information is available on the date and significance of this culvert. Similar to the steps, the culvert may have been created by the NPS in 1956 as a diversion for water that collected in the open ditches of the east head race south of Mark Bird Lane.

BRIDGE HOUSE AND CONNECTING SHED

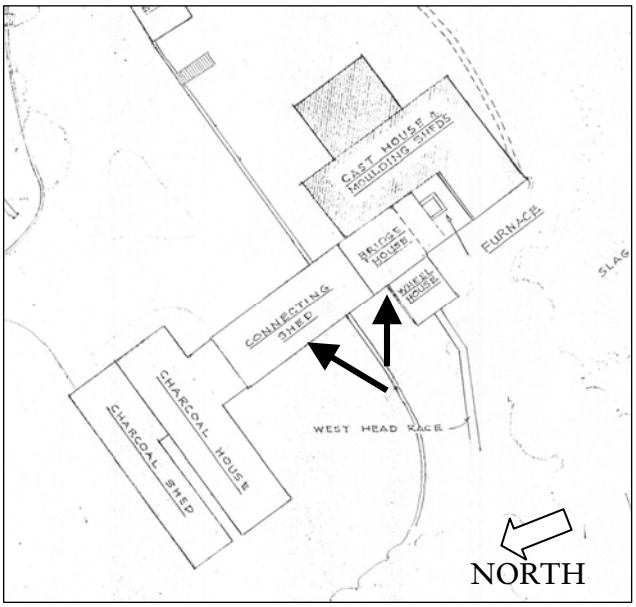

Figure 84. Plan of the reconstructed Furnace Group, showing locations of the bridge house and connecting shed (at black arrows).

General Information

The bridge house and connecting shed are wood- framed structures that join the charcoal house with the upper furnace stack. Both are reconstructions built by the NPS in 1957- 58 to replicate their ca.- 1879 appearance; the north bay of the connecting shed was added in 1965.

Brief Historical Background

The bridge house was a wood- frame structure that connected the charcoal house on the furnace bank with the upper furnace stack, enabling the loading of charcoal fuel, iron ore, and limestone. That such a structure existed as early as 1771 is assumed, based on historical precedent at other early furnaces and the functional need for such an arrangement. The structure was referred to historically in Hopewell records as early as 1801, and by interviewees such as Harker Long in the 1930s, as the "bridge house." It is shown in historic photographs dated 1887, 1896, circa 1910, 1920, and circa 1925 (figs. 17- 22). What was left of the bridge house had collapsed in 1931 (fig. 25). Its wooden superstructure had completely disappeared by 1935.

It was not until the 1950s that NPS professionals began distinguishing the enclosed portion of the "bridge house" and its south "vestibule" from the open "portico," which was later called the "connecting shed." For the purposes of this report, the terms "enclosed bridge house," "tunnel- head vestibule," and "connecting shed" will be used. The bridge house and connecting shed were reconstructed by the NPS at the same time as the wheel house in 1957- 58, following stabilization and rebuilding of the stone foundation walls in 1956. Additional reconstruction of the east stone foundation took place in 1963. Finally, an additional bay was added to the north end of the connecting shed in 1965, replacing the 1880 south extension of the charcoal house.

Restoration Date

The reconstruction of 1957- 58 restored the bridge house and connecting shed to their appearance in 1879 in all respects except one. (The north end of the connecting shed abutted not the south wall of the charcoal house, but rather a south extension of the charcoal house known to have been built in 1880.) NPS historians believed this was the appearance of the bridge house after its last major renovation in 1847, thus roughly fitting the village's restoration target date of 1840. None of the wood- framed superstructure remained by 1935. The design was therefore based on information obtained from the archeological excavations, interviews with last Hopewell manager Harker Long and others, and historic photographs dated 1887, 1896, and 1920. The subsequent, 1965 restoration of the charcoal house included the removal of the 1880 south extension, and the connecting shed was at that time extended northward to joining it directly to the charcoal house.

Documentation

Reports documenting archeological, historical, and architectural research on Hopewell's historic bridge house were written by NPS professionals in 1950 and 1956. Architectural drawings for the reconstruction were prepared by the NPS Planning and Construction Division in 1954 and the NPS Division of Design and Construction in 1957. For complete listings, see the bibliography at the end of this report. Project photographs of the 1957- 58 reconstruction are also in the archives of Hopewell Furnace NHS. No completion report of the reconstruction is known to exist.

LCS Designation

The enclosed bridge house is assigned LCS number 416851, and park structure number 10, in the NPS List of Classified Structures. The connecting shed is assigned LCS number 416870, and park structure number is 10A. Historically, however, the two structures were called the "bridge house." There is no separate LCS number or park structure number for the tunnel head vestibule.

Descriptions

Connecting Shed

The connecting shed provided a covered passageway for the carting of charcoal from the charcoal house on the north side to the enclosed bridge house on the south side (figs. 85- 86). It is a reconstruction built by the NPS in 1957- 58 to reflect the appearance of the building circa 1879. The connecting shed is six bays long, with the bays defined by 10 timber posts and beams (five on each side) supporting a gable roof.[14] The northern four bays are located on the furnace bank, and the southern two bays on an extension of the furnace bank created by tall stone retaining walls that were reconstructed in 1956. The northernmost bay, adjacent to the charcoal house, was added in 1965, increasing the total length of the connecting shed to 45 feet. The flooring is compacted charcoal dust, gravel, and slag covering a subfloor of earth at the furnace bank, and a modern concrete slab supported by steel I- beams at the south extension (figs. 89- 90 and 93). The floor of the south extension slopes gently upwards to the south to meet the elevated floor of the enclosed bridge house. The connecting shed has no walls, the gable roof providing the only protection from the elements. Design of the roof with board- and- batten roofing was based on the historic photographs of 1887 and 1896 (figs. 17 and 18), while the framing of pole rafters and roof lath was most likely conjectural (figs. 89- 90).[15] The board- and- batten roofing was replaced in 1977 and again in 1999. Hemlock was specified for the roof in 1957, white pine for the roof replacement in 1977, and southern yellow pine that was pressure-treated for the most recent roof in 1999. The existing roof boards consist of uniform 2 x 10 stock, whereas the historic photographs of 1887 and 1896 show what appear to be thinner boards of random widths.

Enclosed Bridge House

The enclosed bridge house is where charge was temporarily stored and weighed before loading into the furnace. It is located between the connecting shed to the north and the tunnel- head vestibule to the south, and measures 28 feet long. The existing structure is a reconstruction built by the NPS in 1957- 58 to reflect the appearance of the building circa 1879. The design was based primarily on the historic photographs of 1887, 1896, circa 1910, and 1920 (figs. 17- 21). It is a simple, gable- roofed structure supported by four floor trusses anchored on the south side by the furnace, and by a stone wall reconstructed in 1956 on the north side[16] (figs. 92 and 94).

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[14] Locations of seven of the 10 posts were based on archeology.

[15] The 1957 drawings specified the board- and- batten roofing to be made of hemlock, the boards measuring 16 feet long by 10 inches wide by 1 ¼ inches thick. The battens were to measure 3 inches wide by 1 ¼ inches thick.

[16] This wall, thought to be original, was labeled "Wall A" by archeologists. NPS reports and photographs indicate that: (a) it was stabilized with cribbing in the late 1930s; (b) it was excavated and studied by Dennis Kurjack in 1949- 50; (c) the upper portion was demolished in 1951; and (d) the entire wall was reconstructed in 1956. The reconstruction recreated two openings in the upper wall recorded by Kurjack as being 4 feet apart and measuring 4 feet high by 2 ½ wide that had been filled in with rubble masonry (fig. 89). The original purpose of these openings was conjectured by NPS professionals to have

Floorboards resting on heavy wood joists were installed in a north- south direction, thought by NPS professionals to have permitted easy movement of the charge carts. The walls are sheathed with vertical- board siding made of white pine, applied to heavy timber framing that is exposed within.[17] Natural light is provided by three small windows in the upper east wall, each fitted with a stationary six- light sash. Wide doorway openings with no doors provide access to the connecting shed on the north side and the small vestibule at the furnace's tunnel head on the south side (figs. 90- 91). Framing of the gable roof was improvised, lacking both historical and physical evidence, using canted- post trusses, rafters, and purlins (fig. 91). The roof on the west side was made continuous with that of the adjacent wheel house, an alteration said by Harker Long to have occurred in 1879. Slate roofing tiles applied to wooden laths were chosen for the bridge house, based on interviews, historical photographs, and slates salvaged during the archeological excavations. The bridge house has no painted finishes, also based on the historic photographs.

Tunnel- Head Vestibule

A small covered space fills the gap between the enclosed bridge house and the tunnel head, or opening, into which charge was loaded into the furnace. This space, designated the "tunnel-head vestibule" by this report, is supported by the same wooden- truss system as the enclosed bridge house (fig. 92). The design of the 1957- 58 reconstruction was based primarily on the previously mentioned historic photographs. The wood floorboards of the vestibule are continuous with those of the north adjacent bridge house. The vestibule abuts and shares the north wall of the bridge house; the east and west exterior walls are sheathed with the same vertical wide- pine boards. The south wall is masonry, the lower portion made up of the stonework of the furnace and the upper portion the brickwork of the protective firewall[18] (fig. 78). A wide doorway in the north wall connects with the enclosed bridge house, and an arched opening in the south masonry wall opens to the tunnel head where charge was loaded through a hole in the floor. The gable roof of the vestibule sits lower than the roof of the adjacent bridge house, and is covered with the same board- and- batten roofing as the connecting shed. Like the enclosed bridge house, the vestibule has no painted finishes.

Repairs and Improvements

The following repairs and improvements have been made to the bridge house, connecting shed, and tunnel head vestibule since their reconstruction by NPS in 1956- 57. For details of this work, see "Chronology of Development and Use."

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been for light and ventilation. Historian Melvin Weig, in a memorandum dated Sept. 6, 1956, also thought that the openings may have been related to the functioning of the counterweight system for the early bellows.

[17] An interview with Charles S. Painter in 1953 gave the dimensions of the boards as 1 by 12 inches. Painter also recalled battens, but apparently these were not installed, since they are not visible in the historic photographs (Apple, *Historical Documentary Report on the Bridge and Wheel Houses*, p. 25.)

[18] The stonework of the furnace stack was stabilized 1939- 41; the firewall was reconstructed at the same time as the bridge house.

1965 Connecting shed was lengthened following the demolition of the south extension of the charcoal house added in 1880.

1971 Roof of the tunnel- head vestibule was replaced with new board- and- batten roofing.

1977 A new roof was installed on the connecting shed under contract CX4000- 6- 0025.

1981 Fire detectors were installed in the bridge house.

1999 Roof of the connecting shed was again replaced with new board- and- batten roofing.

2004 Fire- detection system was updated.

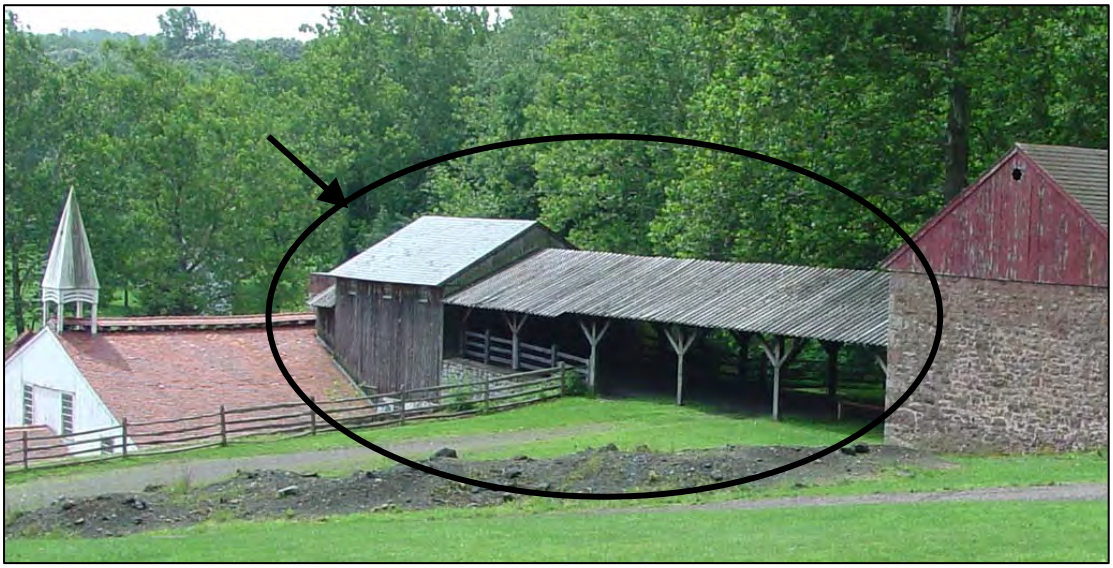

Figure 85. General view showing the east elevation of the bridge house and connecting shed, July 2006.

Figure 86. East elevation of the connecting shed, July 2006.

Figure 87. East elevation of the connecting shed, bridge house, and tunnel- head vestibule, July 2006.

Figure 88. West elevation of the connecting shed, July 2006.

Figure 89. Interior view of the connecting shed, looking north towards the charcoal house, September 2006.

Figure 90. Interior view of the connecting shed, looking south towards the enclosed bridge house, September 2006.

Figure 91. Interior view of the bridge house, looking south towards the tunnel-head vestibule, September 2006.

Figure 92. View of floor framing of the enclosed bridge house and tunnel- head vestibule, looking west, July 2006.

Figure 93. Steel I- beams (at arrows) supporting the modern concrete floor slab at the south end of the connecting shed, September 2007.

Figure 94. Reconstructed north wall ("Wall A") supporting the north end of the enclosed bridge house, July 2006.

CHARCOAL HOUSE AND COOLING SHED

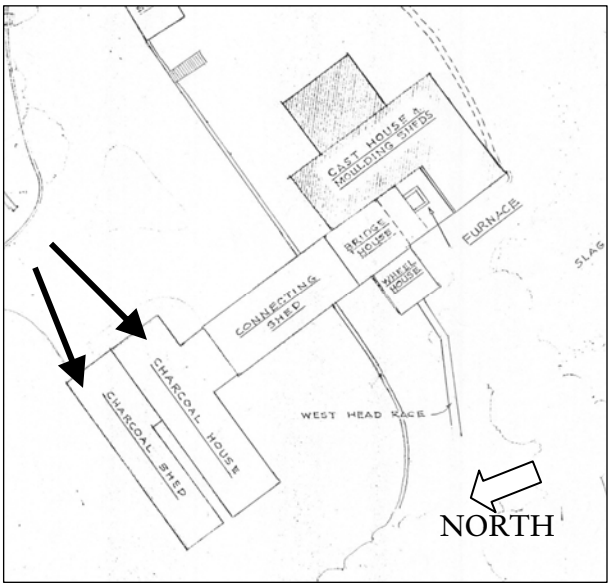

Figure 95. Plan of the Furnace Group, showing the locations of the charcoal house and cooling shed (at black arrows).

General Information

The charcoal house and cooling shed are located on the furnace bank to the north of the furnace, the bridge house, and the connecting shed. The charcoal house is an old structure, possibly dating to 1770- 71, that was restored to its circa- 1879 appearance by NPS in 1965. The cooling shed is a reconstruction built by the NPS in 1958 reflecting the appearance of the shed in 1880.

Brief Historical Background

The purpose of an enclosed charcoal house at Hopewell Furnace was to provide dry storage for the charcoal before it was transferred to the furnace. The coals were initially deposited by the colliers at an open shed, allowing warm embers to cool completely before being transferred to the enclosed charcoal house. The stone charcoal house and furnace were the only intact remnants of the Furnace Group in 1935; the shed had disappeared by this time.

The earliest known reference to a building for storing charcoal is an inventory undertaken in March 1800 that recorded the "Coal in the Coal house" pending transfer of Hopewell Furnace to new owners Buckley and Brooke.[19] Whether or not this referred to the existing stone building or an earlier structure is not known. However, one cannot discount the possibility that the stone walls of the charcoal house could be as early as those of the stone furnace. Work described in Hopewell records on the "Colehaus" by Thomas Loid in 1801 appears to have been for a new roof for an existing structure, while work in 1880 involved masonry repairs, a new roof and dormers, and a wood- framed south extension. The earliest known photograph showing both the charcoal house and cooling shed is dated 1887 (figs. 7 and 17). The existing appearance of the building was recorded in measured drawings in 1956, which were later redrawn by the Historic American Buildings Survey in 1958 (figs. 49a and b). The charcoal house was restored by the NPS to its ca.- 1879 appearance in 1965.

A wood- framed cooling shed is known to have existed on the north side of the charcoal house by 1880, based on specifications for repairing the "upper Coal House" in Hopewell records. No earlier accounts are known. The shed was reconstructed by the NPS in 1958.

Restoration Date

The missing cooling shed was reconstructed by the NPS in 1958 to replicate its appearance in 1880, absent evidence for the earlier (1820- 40) period of significance. Work on the existing charcoal house in 1965 restored that structure to an earlier, ca.- 1879, appearance – again lacking evidence for an earlier time. This was achieved by removing alterations made in 1880, including roof dormers and a wood- framed extension on the south side. Window openings that had been added by the 1920s were also removed from the roof gables, and window sashes were removed from three historic openings in the north wall.

Documentation

Reports documenting archeological, historical, and architectural research on the charcoal house and cooling shed were prepared by NPS professionals in 1956, 1957, 1958, 1964, and 1965. Architectural drawings for the reconstructions by the NPS Division of Design and Construction are dated 1957 and 1965. Completion reports describing the work that was actually accomplished were written in 1962, 1965, and 1966. For complete listings, see the bibliography of this report. Project photographs of the 1958 and 1965 reconstructions are also in the archives of Hopewell Furnace NHS.

[19] For additional information, see the "Chronology of Development and Use" section of this report.

LCS Designation

Although they are separate structures built at different times, the charcoal house and cooling shed are assigned one LCS number in the NPS List of Classified Structures, and one park structure number. The LCS number is 000688; the structure number is 9.

Descriptions

Charcoal House

The charcoal house is a long structure measuring approximately 102 feet long, 29 feet wide, and one story tall, with an estimated capacity of 90,000 bushels of charcoal (figs. 96- 99). Only the exterior south wall is fully exposed, the building having been constructed against a bank to facilitate the loading of coal from the upper (north) side. The walls consist of rough- hewn fieldstone (mostly red sandstone) about 2 feet thick, with large stone quoins at the four corners. Three stone buttresses at the south wall provide additional lateral stability. The stone walls are the oldest portion of the building, possibly dating to the beginnings of Hopewell Furnace in 1770- 71. Many episodes of mortar repointing are evident, most with pink- beige coloring.

There are four openings in the stone walls: a large doorway in the north wall, and three window- size openings for loading charcoal in the upper north wall. The doorway is enclosed with board- and- batten doors beneath vertical- board sheathing, which is a conjectural design that replaced the 1880 shed extension in 1965. Mortise- and- tenon frames and board- and- batten shutters in the north openings were modeled on one surviving frame that retained physical evidence of shutters.

Little, if any, of the pre- 1880 roof had survived four episodes of reroofing in 1880, 1935, 1947, and 1952, along with extensive rot and insect damage. The existing gable roof was therefore completely rebuilt in 1965, using white oak, poplar- pole rafters, red- cedar shingles, and vertical white- pine sheathing at the gable ends. Cutouts in the gable peaks are in the shape of a star in the east elevation and a diamond in the west elevation, which may or may not have existed before 1880.[20] A short section of roof on the north side joins with the cooling shed roof, recreating an alteration dating to 1880.[21]

Inside, the charcoal house is a large, uninterrupted space with an earthen floor covered by charcoal and charcoal dust. Red paint is applied to exterior wooden elements only, including the vertical- board siding and both sides of the board- and- batten doors, shutters, and frames.

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[20] The cutout in the east gable end is based on the 1887 photograph; the west cutout appears to be conjectural.

[21] The roofs are joined for approximately 20 feet at the east end of the buildings. There are two inaccuracies with this connection. First, it is incongruous with the ca.- 1879 restoration of the charcoal house. Second, historical records indicate the roofs were joined for a length of 42 feet, not 20 feet.

Cooling Shed

The cooling shed is a reconstruction of the 1880 "upper Coal House" undertaken by the NPS in 1958 (figs. 96, 97 and 99). This structure mirrors the south adjacent charcoal house, measuring approximately 102 feet long by 27 feet wide, but with no sidewalls. Wooden posts supporting the roof are placed approximately 20 feet apart, creating five bays. Locations of the posts were determined by archeology that identified stone piers, some of which were reused in 1958. The floor is a compacted layer of gravel and charcoal. The roof is a gable type with pole rafters and wood shingles, framed using typical construction methods of the 1880s. The gable ends are enclosed with vertical sheathing and have decorative cutouts similar to the charcoal house. The eastern bay only is joined with the roof of the charcoal house to create a protected area approximately 20 feet long between the buildings. Historical records for 1880 indicate, however, that the roof was to be joined for 42 feet, corresponding to about two bays. Red paint is applied to the exterior gables only.

Post- 1965 Repairs and Improvements

Few records of repairs and ongoing maintenance of the charcoal house and cooling shed were found in the files and archives of Hopewell Furnace NHS. There is little doubt that the wood-shingle roofing has been replaced at least once since the restorations of 1958 and 1965, and that periodic painting has occurred.

1981 Fire detectors were installed in the charcoal house.

1986 Roof of charcoal house was reshingled with red- cedar shingles.

2004 Fire- detection system was updated.

Figure 96. North and east elevations of the charcoal house and cooling shed, July 2006.

Figure 97. West elevations of the charcoal house (right) and cooling shed (left), September 2006.

Figure 98. West and south elevations of the charcoal house, September 2006.

Figure 99. Interior view of the cooling shed and the north elevation of the adjacent charcoal house, September 2006.

WHEEL HOUSE, WATER WHEEL, AND BLAST MACHINERY

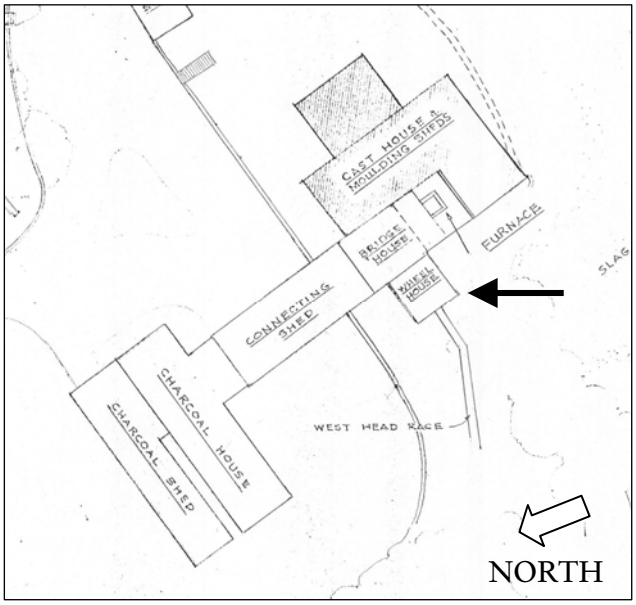

Figure 100. Plan of the reconstructed Furnace Group, showing the location of the wheel house (at black arrow).

General Information

The wheel house is located west of the enclosed bridge house to which it is attached. Both are wood- framed reconstructions built by the NPS in 1957- 58 to replicate their ca.- 1879 appearance. Located within the wheel house are a water wheel and blast machinery, which were restored to operational condition in 1951- 52.

Brief Historical Background

The function of a wheel house was to provide protection to the water wheel, blast tubs, and receiver that generated blasts of cold air to the furnace. The air was transmitted through a pipe and nozzle, called the "tuyere," to the furnace's tuyere arch. The existing east- west wheel pit with its 22- foot water wheel is thought to have replaced an earlier north- south wheel pit with a 30- foot wheel around 1805, which coincided with an alteration to the west race.[22] The west race

[22] Former Hopewell manager Harker Long said in an interview with Jackson Kemper in Aug. 1936 that this change occurred around 1805- 10. Later NPS historians suggested an earlier date of circa 1800- 05 for this alteration. Research in 1997 determined that the dam existed by 1807, based on references in Hopewell records, and was thus assigned a date of circa 1805 (KFS Cultural Resources Group, in

was one of two races that concurrently provided water to the wheel, the second race drawing water from the east. The furnace's last new wheel before the final blast of 1883 was installed in 1879, according to last manager Harker Long. A shut- down of the furnace caused by freezing of the races resulted in the installation of a new steam boiler and engine in 1881 to power the wheel, along with a larger, more efficient receiver. The wheel was stilled for a final time upon the closing of the furnace in 1883. The wheel house and its machinery then sat unused for almost 50 years. Early photographs showing the wheel house and its machinery are dated 1887, 1920, and 1926; the structure had collapsed by 1931 (figs. 17, 21- 23, and 25).

The wheel house was gone by 1935, but its 22- foot water wheel, blast tubs, and receiver had been salvaged, recorded, and stored on- site by the Franklin Institute of Philadelphia in 1931. Drainage of the then- empty wheel well was facilitated by the installation of a tile drain by the Civilian Conservation Corps in 1936. The CCC returned in 1938- 39 to clean out the wheel pit and shore its stone walls. Archeological explorations by the NPS followed in 1941- 42 and 1951. Meanwhile, efforts by the NPS to reclaim the deteriorating water wheel and blast equipment from the Franklin Institute were finally achieved in 1941. Initial efforts to replicate the water wheel were stalled by the disbandment of Hopewell's CCC camp in 1942. Funding for a new wheel and restoration of the blast equipment was obtained in 1949, and the work was finally completed in 1952, protected by a temporary roof. Reconstruction of the wheel house proceeded in stages, beginning with the masonry walls in 1954- 55. Construction of the superstructure and roof was carried out in 1957- 58, at the same time as the adjacent bridge house. Since then, the water wheel has been replaced three times: in 1978, 1988, and 2006.

Restoration Date

The period of interpretation for the park when the water wheel and blast machinery were replicated and restored in 1950- 51 spanned the years 1770 to 1883. These elements were therefore restored to their appearance during their last working status in 1883. By the time the wheel house reconstruction was undertaken in 1957- 58, the period of significance had narrowed to the peak period of furnace activity from 1820 to 1840. Insufficient information was available, however, to achieve an accurate restoration to this early period. It was therefore decided to reconstruct its ca.- 1879 appearance.

Association with Menke & Menke, Landscape Architects, *Cultural Landscape Report, Hopewell Furnace National Historic Site* (Philadelphia and Swarthmore: Dec. 1997), p. 30.

Documentation

Reports documenting archeological, historical, and architectural research on the wheel house, water wheel, and blast machinery were written by NPS professionals in 1942 and 1956. Measured drawings of the 1879 wheel and machinery by the Franklin Institute and NPS are dated 1931, 1941, and 1949. Descriptions of the first wheel that was constructed using these drawings are included in a 1952 completion report. Architectural drawings for the reconstruction of the stone walls and superstructure of the wheel house were prepared by the NPS Division of Design and Construction in 1952 and 1957. For detailed listings of these reports and drawings, see the bibliography of this report. Project photographs of the reconstruction work are also in the archives of Hopewell Furnace NHS.

LCS Designation

The wheel house, water wheel, and blast machinery are assigned LCS number 416885, and park structure number 82, in the NPS List of Classified Structures.

Descriptions

Wheel House

The existing wheel house is a 1958 reconstruction of the structure's ca.- 1879 appearance (figs. 101- 102). It is a heavy braced- frame structure resting on tall stone foundation walls with a steeply pitched shed roof. The walls are partially sheathed with vertical- board siding, with large areas left exposed on the north and south sides to enable visitors a view of the water wheel within. A small opening in the west wall allows the passage of water from the flume of the west head race (fig. 101). The roof, which connects with the lower roof of the east adjacent bridge house, is covered with slate shingles, based on archeological findings. Stairways connecting the various levels of the wheel house, which were described in interviews with Hopewell workers and residents, were not reconstructed in 1958.

Blast Equipment Platform

A braced wooden frame supporting the blast machinery (blast tubs, receiver, and tuyere) is a reconstruction dating to 1950- 51. It is supported on reinforced concrete base beams of the same date, which were cast and scored to resemble wood. The wood frame has four 20- foot posts, an upper platform, and mortise- and- tenon braces. The design was presumably based on the measured technical drawing made by the Franklin Institute in 1931 (fig. 24).

Water Wheel

The existing water wheel, 22 feet in diameter with 10 spokes and 60 buckets, is a reconstruction installed in 2006 (fig. 103). This is the fourth replication of the furnace's last working water wheel of 1879. Three previous wheels were constructed and installed by the NPS in 1952, 1978, and 1988. The existing wheel was contracted to Stan Graton II of 3- G Construction in Holderness, NH (contract #C4526- 05- 0031). The contract was overseen by on- site NPS Exhibit Specialist Jeff Finch. The rim segments, spokes, and associated wedges are made of #1 white oak, and the tongue- and- groove soling boards and buckets are barrel- grade cypress. The existing white- oak, decagonal hub was salvaged from the existing (1988) wheel and restored by soaking in linseed oil and turpentine. Some hardware items may have been reused from the 1879 wheel, although all provenance has been lost during the multiple wheel reconstructions. Nuts and bolts with square heads were specially made for this project. Lead bars attached to some of the buckets with stainless- steel screws and washers are used for balance. Dedication of the water wheel took place on August 5, 2006 (fig. 76). The water wheel operates seasonally, adding a dynamic component to the visitor experience.

All that remains of the1879 water wheel salvaged by the Franklin Institute in 1931 are three fragments and one gear section that are in the collection of Hopewell Furnace NHS.[23] Early photographs and measured drawings made by the Franklin Institute in 1931 and by NPS in 1941 also provide valuable documentation of the early wheel.

Blast Tubs

Two wooden blast tubs sit on the platform above the water wheel (fig. 103). Records indicate that one of the old tubs salvaged by the Franklin Institute in 1931 was repaired and reinstalled in 1951. The second tub, which was in poor condition, was reconstructed using well- seasoned white pine; only the iron bands were reused. No major work is known to have been done on the blast tubs since 1951. It is therefore assumed that one tub is of ca.- 1879 vintage, while the other dates to 1951 (except for the iron bands, which are older). Which tub is old and which is the reproduction is not known. These tubs work as they did historically, with sounds of wheezing and thumping, when the water wheel is in operation.

[23] The water wheel fragments have accession number HOFU- 00358. The accession record describes the collection as "boxes of salvage from Charcoal House," which were cataloged on Sept. 1, 1962. The four fragments are assigned catalog numbers 33325 (gear section), 33949 (thin curved side of wheel approximately 6 feet 4 inches long), 33950 (bucket section), and 33951 (thick inside curve of wheel approx. 6 feet 6 inches long). However, no. 33949, which was used as a guide for the 1988 wheel, cannot now be found, according to Exhibit Specialist Finch.

Receiver

The receiver is a large wooden box flanked by the blast tubs on the platform above the water wheel (fig. 103). Its function is to regulate the pressurized air generated by the adjacent blast tubs prior to its transmission to the tuyere pipe. A larger, more efficient receiver was recalled by last manager Harker Long to have been installed at the same time as the steam boiler and engine in 1881. It was presumably this receiver that was salvaged by the Franklin Institute in 1931 and restored by the NPS in 1951- 52, with new wooden yokes, top, leathers, and canvas sealing tape. No major alterations are known to have been made to the receiver since 1952. The receiver functions as it did historically when the water wheel is in operation.

Tuyere

The tuyere is the pipe and attached nozzle that conveys the blast of cold air from the receiver to the tuyere arch of the furnace. A reproduction pipe was fashioned by tinsmiths from Reading, PA, in 1952 from sheet metal, which was painted with black graphite paint to simulate the "original." Design of the tuyere had presumably been based on pieces salvaged by the Franklin Institute in 1931 and acquired by the NPS in 1941. Nine pieces of the tuyere are currently in the cataloged collection of Hopewell Furnace NHS.[24] The existing tuyere is assumed to date to 1952, lacking any references to its later replacement. It was recorded by NPS Architect John Dodd in 1976 as measuring 10 ½ inches in diameter, tapering to 7 inches where it enters the stone furnace.

Steam Boiler and Engine

Nothing remains of the 1881 steam boiler and its brickwork housing, which were removed by the NPS in 1950 from the enclosed area north of the tuyere arch (figs. 27 and 41). No information was found on the disposal of the steam engine, either, which was recalled by last manager Harker Long to have been attached to the water wheel.

Original Wheel Pit

Physical remnants of stone walls enclosing an early north- south wheel pit located to the east of, and at right angles to, the existing wheel pit were uncovered by CCC laborers in 1936 and excavated by archeologist Paul Schumacher in 1951. Schumacher surmised that these walls were contemporary with the original (ca.- 1771) furnace because they rested on undisturbed

[24] Hopewell Furnace NHS Cultural Resource Manager Rebecca Ross, review comments Mar. 26, 2008.

clay. Last manager Harker Long recalled that this wheel pit housed a 30- foot overshot wheel.[25] When the north- south wheel was replaced by the existing east- west wheel is not known for certain, but previous researchers have conjectured that the change occurred around 1800- 1805. A portion of the existing wheel pit (the east end) incorporates a part of the early pit, according to the archeological findings. Remnants of the early wheel- pit walls identified by Schumacher survive below grade to the north and south of the existing wheel pit. Some of these early walls have recently become exposed by erosion in the existing wheel pit. A catch basin is slated for this location.

Recent Repairs and Improvements

The following repairs and improvements have been made to the wheel house, water wheel, and blast equipment since their restoration and reconstruction in 1950- 51 and 1957- 58.

1978 New water wheel was constructed and installed by contractor Ken Reitz. No details, other than project photographs in the archives of Hopewell Furnace NHS and a recent interview with Mr. Reitz, have been found regarding this work.

1988 New water wheel was constructed and installed by the NPS Williamsport Preservation Training Center.

2006 Existing water wheel was constructed and installed by contractor Stan Graton II of 3- G Construction in Holderness, New Hampshire (contract #C4526- 05- 0031).

[25] The accuracy of Harker Long's assertion is questionable, however, since he did not come to Hopewell Furnace until 1867.

Figure 101. North and west elevations of the wheel house, September 2006.

Figure 102. South elevation of the wheel house, July 2006.

Figure 103a. Interior view of the wheel house, looking west and showing the water wheel and blast machinery, July 2006.

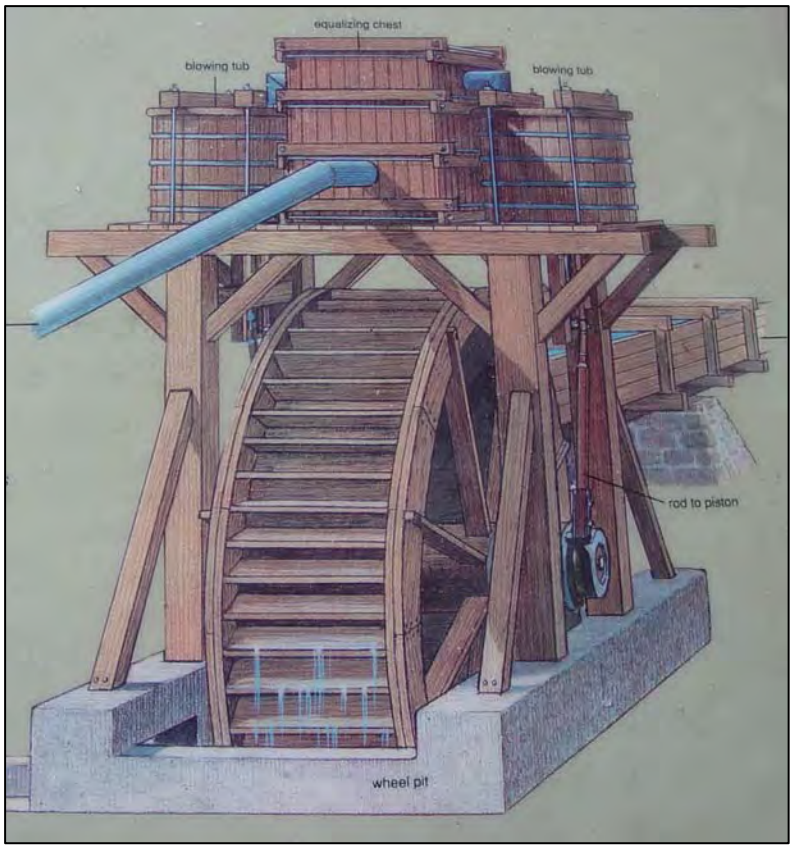

Figure 103b. Schematic view of the water wheel and blast machinery.

EAST HEAD RACE

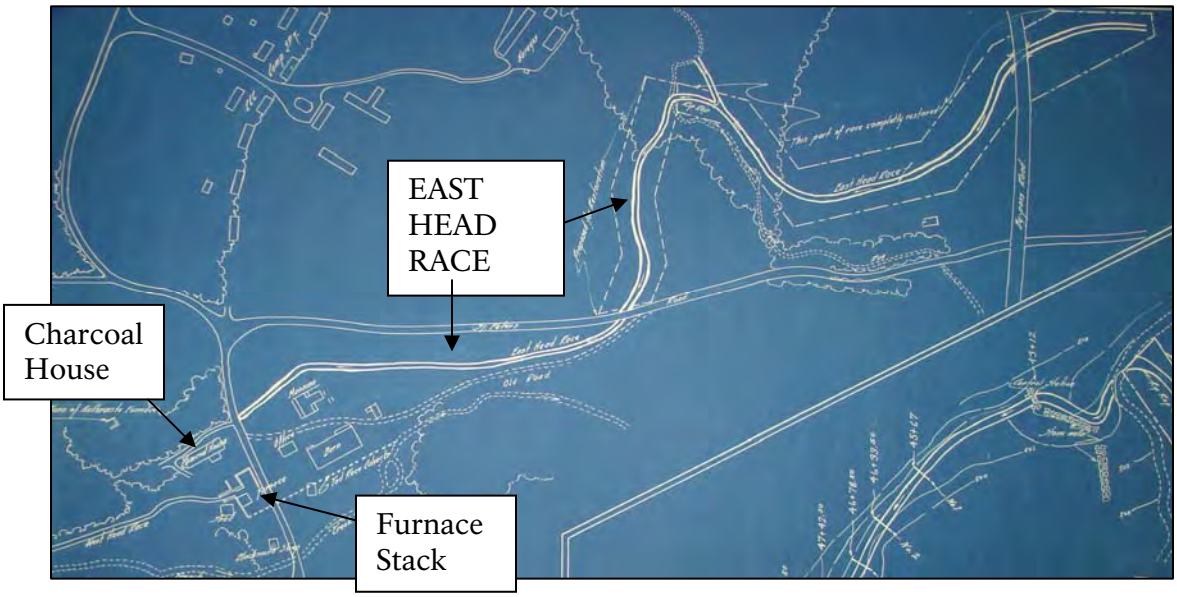

Figure 104. Site plan of Hopewell Furnace, showing the location of the east head race, 1940.

General Information

The east head race is a manmade feature that links the Furnace Group to the surrounding landscape. This race was one of two races that concurrently conveyed water to the furnace's water wheel. It is thought to be an original feature of the furnace, dating to circa 1770- 71. The east race is approximately 6,100 feet, or just over a mile long. It is mostly an open ditch, except for the portion closest to the furnace, where the water flowed through an underground pipe. The east race was made inoperative around 1883, after the closing of Hopewell Furnace, by a dam that blocked it in the vicinity of today's Mark Bird Lane. Since 1952, water to operate the water wheel has been supplied exclusively by the reconstructed west head race.

Brief Historical Background

The earliest known mention of the east race is in a 1798 agreement for plowing that was to be repaid in "two third of the Corn above the furnace race."[26] Hopewell records later recorded Charles Eliot as being credited for three days labor cleaning 3,531 feet of "the race above the house" in November 1816.[27] Other general references in the 19th- century records to work on the races may have referred to the east or west race. The need for the waterpower provided by the races ended in 1883 with the closing of Hopewell Furnace.

It was not until acquisition of the site by the federal government in 1935 that the race acquired the name "east water race," and later the name by which it is known today, the "east head race." Remembrances of the race were obtained in 1935 and 1936 from last manager Harker Long, who called it the "east race." Construction of a new north- south bypass road (now Route 345) in 1937- 38 included a culvert to enable passage of the race beneath the road. The entire length of the race was surveyed and mapped up to the now- missing Birdsboro- Warwick Road in 1938- 39 by the Pennsylvania Department of Forests and Waters, in cooperation with the U.S. Department of the Interior, National Park Service. A partial restoration of the eastern portion, from Baptist Creek to Spout Creek, was also undertaken at this time using Civilian Conservation Corps labor. Debris was removed, a stone retaining wall repaired, and a dam constructed to divert water into Spout Creek. Physical exploration of the southern stretch of the race between Spout Creek and St. Peter's Road (now Mark Bird Lane) was undertaken the following year using CCC labor.[28] Eight exploratory trenches found that this portion of the open ditch had been lined with tamped red clay over a thin deposit of charcoal. Multiple episodes of rebuilding and repairs were also identified, along with the previously described dam blocking the race in the vicinity of today's Mark Bird Lane.

The western end of the east race flowed through the garden north of the Ironmaster's House and on to the furnace. Harker Long recalled that the garden race was contained in a "gutter," which transitioned to an "iron pipe" that passed under an "ore bed," finally depositing the water in a "wood trough 1 foot wide, 6 inches high" positioned over the water wheel.[29] The "iron pipe" was found and recorded in archeological excavations undertaken by John Cotter in 1950 and Paul Schumacher in 1955. The subterranean pipe passed south of the charcoal house, beneath the then- missing connecting shed of the bridge house, and exited through the stone retaining wall of the furnace bank north of the wheel pit (fig. 105). A cracked section of the 6-inch cast- iron pipe was analyzed and determined to predate 1850, based on its high phosphorus content and horizontal casting.[30] In September 1955, the old pipe was flushed out and left in place, and broken sections were repaired. A grate was placed over the eastern end at the transition between the open ditch and pipe.[31] No attempt was made, however, to replicate the wooden "trough" or flume. The open ditch in the garden of the Ironmaster's House, measuring about 80 feet long by 2 feet wide – with its stone retaining wall – was also restored in 1955.[32]

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[26] Charlotte Fairbairn, *Historic Structures Report, Part I, East Headrace, Historical Data Section, Hopewell Village National Historic Site* (Hopewell Village NHS, Apr. 1963), p. 1.

[27] Fairbairn, *Historic Structure Report, East Headrace*, p. 6.

[28] The work was supervised by Assistant Research Technician Thor Borresen.

[29] Interviews with Harker Long by Roy Appleman in1935 and Jackson Kemper in 1936.

[30] Fairbairn, *Historic Structures Report, East Headrace*, p. 15.

[31] Fairbairn, *Historic Structures Report, East Headrace*, p. 15.

[32] Fairbairn, *Historic structures Report, East Headrace*, p. 16.

Restoration Date

No particular restoration date was cited for work carried out on the eastern portion of the east head race in 1938, and subsequently on the cast- iron pipe conduit in 1955. The park's prevailing period of restoration in 1938 covered the years 1770 to 1883; by 1955 the more focused "period of prosperity," 1820 to 1840, was in use. It seems to have been generally assumed that the east head race had remained essentially unchanged, except for periodic cleaning and repairs, since its original construction in 1771. Although installation of a pipe conduit closest to the furnace may have been a later alteration, analysis of the pipe determined that it had been manufactured sometime before 1850.

Documentation

Reports documenting archeological and historical research on the east head race were prepared by NPS professionals in 1940, 1965, and 1966. Plans of the race, some with notations for its repair, are dated 1938, 1939, 1940, and 1983. For a detailed listing of these reports and plans, see the bibliography of this report.

LCS Designations

The east head race is assigned LCS number 000692, and park structure number 32, in the NPS List of Classified Structures.

Descriptions

Open Ditch

The east head race originates east of the furnace at Baptism Creek, crosses beneath Route 345 through a culvert constructed in 1937- 38, and joins with the waters of Spout Creek. That portion of the ditch that runs from Spout Creek to Mark Bird Lane is blocked, since no culvert was provided when the road was reconstructed for the new visitor center in 1954. South of the road, the westerly course of the race's open ditch is again visible in the garden to the north of the Ironmaster's house. It then disappears underground east of the charcoal house, where it is channeled through a cast- iron pipe to the water wheel.

Stone Walls

The sides of the open ditch are retained by both earth and stone walls. Stone walls line portions of the north bank of the race from Baptism Creek to Route 345, and from 345 to Spout Creek. Repairs to these walls were made in 1939 and again in 1984.[33] A stone wall also retains the south side of the east race where it flows through the garden of the Ironmaster's House. This wall was uncovered by archeologists in 1955 and restored that same year. It was determined to have originally measured 80 feet long by 20 inches wide by 5 feet high.

Underground Pipe

The path of the east race is not visible in the vicinity of the Furnace Group because it was conveyed underground in a 6- inch, cast- iron pipe. This pipe, which was recorded by archeologists in 1950 and 1955, and restored in 1955, presumably remains buried beginning at a point east of the unpaved road (the old Birdsboro- Warwick road). The pipe is aligned in a southeasterly direction, passing beneath the road and the north end of the connecting shed. It emerges from the furnace bank opposite the wheel house (fig. 105). Not yet reconstructed by the NPS is the wooden trough that conveyed the water from the protruding pipe to the water wheel.

Road Crossings

The east race flows through a culvert beneath Route 345, formerly called the "bypass road." The road and culvert were constructed by the CCC in 1937- 38. Both exist today.

There is no culvert or other means of passage for the east race at Mark Bird Lane, the visitor-center access road for Hopewell Furnace NHS. This road follows the path of the earlier Reading- Valley Forge Road, later called St. Peter's Road, which existed by the early- 19th century. A bridge most likely spanned the race in early years. No provision was made for the race when the road was reconstructed for the new park visitor center in 1954, since there were no plans to recreate the race.

A third road crossing occurs at the unpaved road between the Ironmaster's House and the Furnace Group. This is the old Birdsboro- Warwick road that existed in the early 19th century, was realigned by the Commonwealth of Pennsylvania in 1932, and closed to public traffic in 1955. The east race passes beneath this road through a cast- iron pipe that was restored and repaired by the NPS in 1955. The pipe presumably remains beneath the road today.

[33] The exact locations of these repairs were not determined for this report.

Recent Repairs and Improvements

Little information is available on recent repairs and improvements to the east head race. For details of the 1984 work, see the section "Chronology of Development and Use."

1975- 76 The Youth Conservation Corps worked on the restoration of the east head race. No details of this work are known.

1984 The "crumbled" stone retaining wall of the east head race (northerly portion) was reconstructed by the NPS Williamsport Preservation Training Center.

1992 An informal engineering study was undertaken of the east head race.

Figure 105. Truncated pipe (at arrow) that conveyed water from the east head race to a wooden flume (now missing) north of the water wheel, July 2006.

WEST HEAD RACE

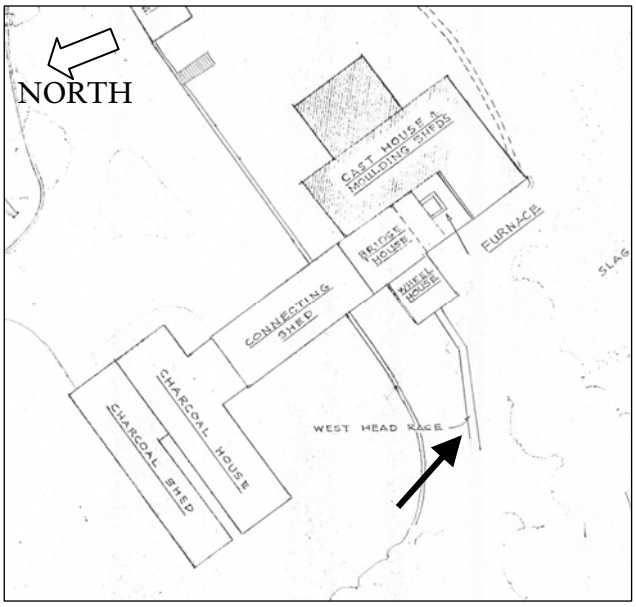

Figure 106. Plan of the reconstructed Furnace Group, showing the eastern terminus of the west head race (at black arrow).

General Information

The west head race, like the east head race, is a manmade feature that links the Furnace Group to the surrounding landscape. During the operation of the furnace, both races supplied water to the water wheel. Only the west head race is operational today. It is a re- creation and restoration of the furnace's second west race of circa 1805. The race is slightly less than one-quarter of a mile long. Its existing configuration, with underground pipe and open ditch flowing to a wooden flume, dates to 1951- 52.

Brief Historical Background

A race on the west side of the furnace was one of two races, one on the west side of the furnace the other on the east side, that concurrently conveyed water to the furnace's water wheel. The first west race is thought to have been an original feature of the furnace, dating to circa 1770- 71. This early race, said to have been about two miles long, was eventually abandoned in a dispute over property and water rights. It was replaced around 1805 with the existing west race, about one- quarter of a mile in length, which obtained its water from a pond created by the damming

of French Creek.[34] References in the Hopewell records to a "trough" in 1815 and 1834, a "new trunk" in 1848, and "forebay repairs" in 1878, may have been describing the flumes of either the west or east race.

Enlargement of the dam by the Civilian Conservation Corps in 1936 destroyed the connection of the west race with the dam. The eastern terminus of the race near the furnace was later buried in 1938- 39 by materials excavated from the adjacent wheel pit. This debris was removed from 300 yards of the race during archeological excavations in 1941- 42, which uncovered a north retaining wall and several stonework piers of the missing flume. A decision to restore the west race as the primary source of water for the water wheel was made by the park in 1950, followed by additional archeology, surveys, and reconstruction plans in 1950- 1952. In a departure from the race's historic configuration, the western two- thirds closest to the dam were buried in an underground pipe, with only the eastern one- third maintained as an open ditch. The wooden trough of the flume was replicated and supported on the original stonework piers that were restored to their original height. Water was once again flowing through the west head race and operating the reconstructed water wheel by May 1952. A dedication ceremony marking this significant park achievement was held on June 6, 1952.

Deterioration of the reconstructed flume resulted in a complete rebuilding to more exacting historical standards in 1964. The new flume measured 4 feet wide by 1 foot tall, as specified by Harker Long in 1935. Other detailed dimensions had been provided in 1961 in a sketch by Sheridan Painter, who had spent his boyhood at Hopewell Village. The stone retaining wall of the race was also straightened at this time to accommodate the wider flume. Frequent repairs and rebuilding of the wooden flume have been necessary to maintain it in operating order.

Restoration Date

The period of interpretation for the park when the west head race was reconstructed in 1952 spanned the years 1770 to 1883. It was decided, however, to restore only the eastern one- third of the west race to its appearance during the time of its last working status in 1883. The deteriorated wooden trough of the race's flume was rebuilt in 1964 to its proper historic (ca.- 1883) dimensions, even though the park's prevailing interpretive focus had by then narrowed to the earlier time period 1820 to 1840.

Documentation

Reports documenting the archeological, historical, and architectural research on the west head race were prepared by NPS professionals in 1950, 1961, 1963, and 1964. Drawings for the

[34]Former Hopewell manager Harker Long said in an interview with Jackson Kemper in August 1936 that the dam was built and a new race constructed between 1805 and 1810. Later NPS historians suggested an earlier date of ca. 1800- 05 for this work. Recent research in 1997 determined that the dam existed by 1807, based on reference s in the Hopewell records, and was thus assigned a date of circa 1805 (*Cultural Landscape Report*, p. 30).

reconstruction of the race by the NPS Division of Planning and Construction are dated 1950 and 1951. Completion reports describing the work that was actually accomplished were written in 1952 and 1964. For detailed listings of these reports and drawings, see the bibliography of this report. Project photographs of the 1951 and 1964 reconstructions are also in the archives of Hopewell Furnace NHS.

LSC Designation

The west head race is assigned LCS number 000693, and park structure number 111, in the NPS List of Classified Structures.

Descriptions

Hopewell Lake and Dam

Water is supplied to the west head race by Hopewell Lake, located less than a quarter mile west of the furnace. The lake was enlarged by the construction of the existing dam in 1936- 38, which destroyed the original connection with the ca.- 1805 west head race. The existing connection dates to the reconstruction and restoration of the west head race in 1951- 52.

Underground Pipe

Water flows through an underground pipe from the dam for a distance of approximately 725 feet, or about two- thirds the length of the west head race. This pipe, installed in 1951, is a nonhistoric alteration of the original open ditch of the ca.- 1805 race. Water is deposited from the pipe into the previously described open ditch.

Open Ditch

Approximately one- third the length of the west head race closest to the furnace, or about 205 feet, retains its historic appearance as an open ditch. The ditch was recorded by NPS Architect John Dodd in 1976 as measuring 3 feet wide at the bottom, 10 feet wide at the top, and 3 to 4 feet deep.[35] The banks of the ditch are mostly soil, except for a short section on the north side, where there is a stone retaining wall.

[35] Dodd, *Classified Structure Field Inventory Report, West Head Race*.

Stone Wall

A stone retaining wall is located on the north side of the open ditch west of the flume. The wall is presumably historic, although it was repaired and later straightened by the NPS in 1964. NPS Architect John Dodd recorded the wall in 1976 as measuring about 60 feet long by 20 inches thick, and 4 feet to 1 foot high, diminishing in height from west to east.[36]

Flume

The flume is an open wooden trough approximately 75 feet long, the design for which was based on the remembrances of former Hopewell manager Harker Long and resident Sheridan Painter. It was most recently reconstructed in 1989 and repaired in 2006 (fig. 107). Six stonework piers supporting the flume were identified by archeology in 1941- 42 and 1951, and restored to their original height in 1951- 52. Each pier measures approximately 4 feet wide by 1 foot thick by 2 to 3 feet tall; the flume is 4 feet wide by 1 foot tall. The framing and sides of the existing flume are made of oak and the bottom of southern yellow pine, the edges of which are sealed with silicone caulk.

Repairs and Improvements

The following repairs and improvements have been made to the west head race since its reconstructions by the NPS in 1950- 51 and 1964. For details of this work, see the section "Chronology of Development and Use."

1989 West head race flume was reconstructed in the summer of 1989.

2006 Repairs were made to the flume of the west head race in conjunction with reconstruction and installation of the new water wheel.

[36] Dodd, *Classified Structure Field Inventory Report, West Head Race*.

Figure 107. Flume of the west head race, view looking east towards the wheel house, July 2006.

TAIL RACE

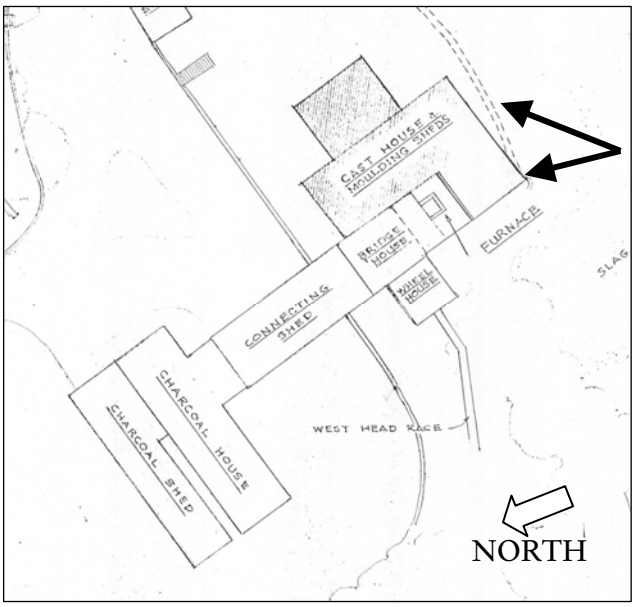

Figure 108. Plan of the reconstructed Furnace Group, showing the location of the tail race (at black arrows).

General Information

The tail race carries water from the furnace's water wheel pit to French Creek through a stone-lined ditch and an underground conduit. It was abandoned in 1883 and restored to working condition by the NPS in 1951- 52.

Brief Historical Background

A tail race that carried water away from the water wheel was presumably a feature of the furnace from its earliest operation in 1771. A tail race is said to have been first mentioned in Hopewell records in 1802, and to have been extensively repaired or rebuilt in 1830.[37] Archeologist Leland Abel conjectured that the tail race was rerouted underground through a new vaulted drain around 1816 or shortly thereafter.[38] The tail race was one of the few early features of the Furnace Group remaining in 1935. It was presumably restored to working order when the west head race was put back in operation in 1951- 52. Additional work may have been undertaken on

[37] Hugins, *The Physical History of the Hopewell Furnace Group, 1770- 1883*, pp. 9- 10.

[38] Leland Abel, *Historic Structures Report, Part II, Archeological Excavations at Hopewell Furnace, Hopewell Village National Historic Site* (Hopewell Village NHS, Mar. 1964), p. 141.

the tail race when the adjacent cast house was reconstructed in 1964- 65. Architect John Dodd described the tail race in 1976 as then being "completely restored and in good condition."[39]

Restoration Date

No significant alterations are known have been made to the tail race after closure of the furnace in 1883. Its appearance therefore is most likely little changed from the last period of furnace operation from 1779 to 1883.

Documentation

No reports specifically addressing the tail race of Hopewell Furnace are known to have been written.

LSC Designation

The tail race is assigned number 000702, and park structure number 110, in the NPS List of Classified Structures.

Description

The tail race is a stone- lined conduit that channels the water from the wheel pit of the furnace to French Creek. A small section is open along the west side of the cast house (fig. 109). At the southwest corner of the cast house, the tail race turns towards the east and is concealed in an underground tunnel of cut stones with vaulted stone ceiling.[40] Alteration of the ceiling from a vaulted type to flat stone slabs suggests a later construction date at a point east of the stone bridge.[41] The vaulted portion of the underground drain is 135 feet long, and the slab- ceiling portion is 195 feet long. The tail race empties into French Creek southeast of the furnace.[42] Modern, cast- iron gratings described by Architect John Dodd in 1976 may date to work undertaken by NPS in 1951- 52 or 1964- 65.

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[39] Dodd, *Classified Structure Field Inventory Report: Tail Race*.

[40] Archeologist Abel suggested that the vaulted section of the tail race tunnel was constructed in 1816 or shortly after.

[41] This extension may be the extensive work on the tail race mentioned in Hopewell records for 1830.

[42] Measurements are from NPS Architect John Dodd's *Classified Structure Field Inventory Report*.

Repairs and Improvements

Repairs were recently undertaken on the tail race in 2006. For details of this work, see the section "Chronology of Development and Use."

2006 The tail race was cleaned and repaired in conjunction with the reconstruction and installation of the new water wheel.

Figure 109. Open portion of the tail race (at arrow), on the west side of the cast house, July 2006.

CAST HOUSE

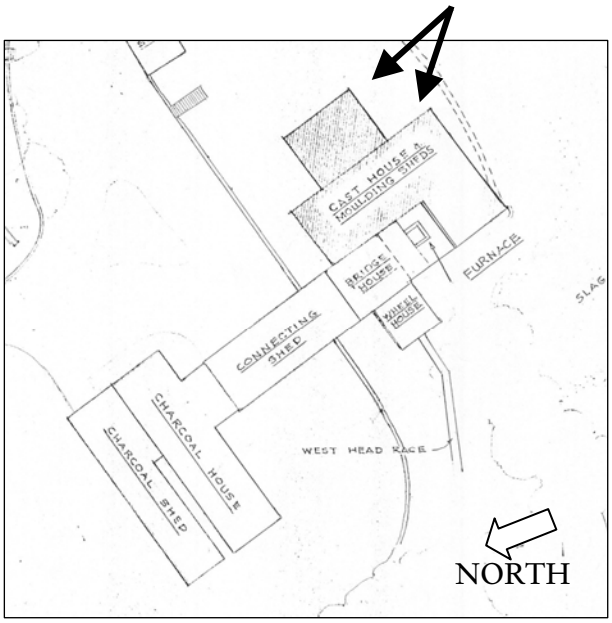

Figure 110. Plan of the reconstructed Furnace Group, showing locations of the cast house and east shed (at black arrows).

General Information

The cast house and attached east shed are reconstructions built by NPS in 1964- 65 to replicate the ca.- 1840 appearance of these missing structures. The cast house envelops the east and south sides of the stone furnace stack. It was here that iron from the furnace was cast into pigs and finished products, such as stoves and other useful items. Stone foundations and walls were restored and/or rebuilt between 1958 and 1963; the wood- framed superstructure is a reconstruction dating to 1964- 65. The large cast house has no interior partitions, but has been functionally divided into three areas by the NPS. Occupying the center space east of the cast arch is the "cast house," which is flanked on the south side by the "south molding shed" and on the north side by the "north molding shed." A smaller wing to the east, called the "east shed" or "east annex," is unfinished on the north side and partitioned as an enclosed room on the south side. No documentary or physical evidence has been found that explains how this structure was used historically. The north side is currently interpreted as a loading and storage area. Several uses suggested for the enclosed south room have included a pattern shop, carpenter's shop, cleaning area, or office.

Brief Historical Background

Hopewell Furnace is assumed to have had from its earliest construction in 1770- 71 a structure to shelter casting operations. Early stone foundations for such a structure were uncovered by Archeologist Leland Abel during excavations in 1962- 63, measuring approximately 33 feet east of the furnace's cast arch and 18 feet to the south. The earliest known reference to a cast house is found in the 1810 sworn testimony of Hopewell keeper John Kring, who recalled going "into the Casting House" around 1773. Extensive repairs costing $8,000 were made to the furnace following a prolonged shutdown from 1808 through 1815 due to property disputes. These repairs are believed to have included replacement of the old cast house with a new and larger structure around 1816. This new structure extended approximately 15 feet farther to the south and included an attached shed on the east side, according to archeological findings. The east shed and the south portion of the cast house may have been removed shortly after the casting of stoves was discontinued in 1844; they were definitely gone by 1867 when last manager Harker Long first came to work at Hopewell Furnace. The earliest photograph of the furnace, taken in 1887 (figs. 7 and 17), shows a dilapidated structure east of the furnace with vertical board siding, a gable roof covered with wood shingles, and a belfry. The east wing was missing by this time, as was the south portion of the building. The next photographs, taken in 1896, chronicle the rapid deterioration of the cast house (figs. 18a and 18b). Most of the siding and roof were gone, exposing the heavy braced frame within. The remaining structure had completely disappeared by April 1920 (fig. 20). Twelve years later, the foundations were partially covered by the rerouted Birdsboro- Warwick road (fig. 26).

An early conjectural drawing of the cast house made in 1935 shows a barn- like structure with two lower shed- roof extensions on the north and south sides (fig. 28c). This design appears to have been based on an interview conducted that same year by Historian Roy Appleman with last Hopewell manager Harker Long. Debris was removed from the site by the Civilian Conversation Corps in 1936 in preparation for the stabilization of the furnace stack. More accurate information on the appearance of the missing cast house was obtained in 1948 upon the discovery of the 1896 photographs in the Chester County Historical Society, and in 1955 when the 1887 photograph became available to researchers. A preliminary archeological excavation was conducted in 1950, but it was not until removal of the Birdsboro- Warwick road in 1955 that the entire site could be studied. More extensive archeological investigations followed in 1958 and 1962- 63, combined with stabilization and rebuilding of the remaining stone walls. Reconstruction of the cast house and east shed to their ca.- 1840 appearance was carried out in 1964- 65.

Restoration Date

The reconstruction of 1964- 65 restored the ca.- 1840 appearance of the cast house and attached east shed. This created an interesting anomaly, since all other components of the Furnace Group had been previously restored to their appearance during the last operation of the furnace, from 1879 to 1883.

Documentation

Reports documenting archeological, historical, and architectural research on the cast house and east shed were prepared by NPS professionals in 1958, 1959, 1960, 1963, and 1964. Architectural drawings for the reconstruction by the NPS Division of Design and Construction, Eastern Office, are dated 1964. Completion reports describing the work that was actually accomplished were written in 1965 and 1966. Reports and drawings on the cast house cranes are dated 1973, 1974, and 1978. For detailed listings of these reports and drawings, see the bibliography of this report. Project photographs for the 1964 reconstruction are in the archives of Hopewell Furnace NHS.

LSC Designation

The cast house and east shed are assigned LCS number 416880, and park structure number 33, in the NPS List of Classified Structures.

Descriptions

Foundations

Rubble- stone foundations identified by archeologists in 1950, 1958, and 1962- 63 support the upper stone walls and wood- framed construction of the reconstructed cast house. [43] These were believed by Archeologist Leland Abel to date to the newly rebuilt cast house of circa 1816. The perimeter foundations of the cast house support upper stone walls, described in the following section "Stone Walls." Stones piers supporting the interior posts were also identified by archeologists and restored in 1962- 63. Cement grout injected in the floor to stabilize settlement of three of the piers in the south side of the building dates to 1965.

The ca.- 1816 stone foundations of the east shed support the wooden superstructure above.[44] Two types were identified and restored in 1962- 63: solid stone walls on the south and southeast sides, and stone piers spaced 7 to 8 feet apart on the north and northeast sides. No foundation exists at the west wall of the east shed, due to the construction of a ditch that drains water from the north side of the cast house to the tail race. The solid foundation was found to be intact, requiring only repointing with cement mortar in 1962- 63. This wall rises approximately 11

[43] Archeologists labeled the stone foundations and walls of the cast house as follows: the east wall was "V," the south wall "W," the west wall south of the furnace "Q," the west wall north of the furnace "K" and "F," and the west wall "G."

[44] Archeologists labeled the stone foundations of the east shed as follows: the south wall was "AJ," the south side of the east wall "AI," the north side of the west wall "AG," and the north wall "AR."

inches above the interior floor. Concrete pads were poured under the stone piers for structural stability.

Earlier foundations possibly dating to 1771 were also identified in the vicinity of the cast house. Both of these early foundations presumably remain below grade. The original east foundation is located beneath the ca.- 1816 foundation. It is left of the wide east doorway, and extends approximately 18 feet to the south. The original south foundation was identified by Leland Abel as approximately 18 feet south of the furnace stack and measuring 47 feet long by 2.4 feet wide by 2 feet high.[45] The upper portion of this early wall is believed to have been removed when the new cast house was built circa 1816.

Stone Walls

Stone walls of various heights are visible above grade in the cast house (figs. 114- 118). The south portion of the building, also called the south molding shed, has low stone walls measuring approximately 4 feet 6 inches high. The north portion of the building, also called the north molding shed, has floor- to- ceiling stone walls on the north and west sides, and a shorter (6- foot, 6- inch) wall on the east side. The walls are rubble masonry made of medium- sized unshaped or roughly shaped blocks of brown and purple sandstone. Of these walls, only the tall north wall (approximately 11 feet high) and its northeast corner remained standing in 1962. These were in poor structural condition, however, and so were completely rebuilt from the base up in 1962- 63.[46] Reconstruction of the adjacent west wall, which also serves as the base of the bridge house, occurred in 1963. Portions of the south and southeast walls were rebuilt in 1958, their original height estimated by the amount of fallen stones at the base of the walls. Reconstruction of the walls was completed in 1962- 63 in preparation for building of the wood-framed superstructure of the cast house. The existing cement mortar in most of the walls presumably dates to 1962- 63 (see "Mortar," below).

Mortar

Remnants of early lime mortar were replaced by cement mortar during restoration and rebuilding of the stone foundations and walls in 1958 and 1962- 63. Pigmented mortar mixes containing cement were used in both 1958 and 1962- 63. The following formula for the 1962- 63 work was recorded in a completion report:[47]

- 1 bag (94 pounds net) portland cement;
- 282 pounds sand (thoroughly mixed with the cement before adding water); and
- 14 ounces pigment (No. 500 "red tile" mortar color, purchased from the Tomkins Brothers, Philadelphia).

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[45] Called "Wall AC" by archeologists.

[46] Holes on the interior side of the north wall and west walls were presumably made by the masons' scaffolding.

[47] Benjamin Zerbey, *Completion Report Narrative, Emergency Stabilization of Casting House and Molding Sheds* (Hopewell Village NHS, Dec. 1963), p. 10.

Framing

The wooden braced frames of the cast house and east shed date to the reconstruction of 1964-65 (fig. 61). All lumber dimensions and framing details were conjectural, based primarily on the historic photographs of 1896 (figs. 18a and 18b) and archeological findings of stone piers that supported the posts. The completion report identifies the frame as primarily white oak with some red oak, which was hand- planed to remove modern saw marks. Poplar pole rafters were stripped of their bark prior to installation. The frame was assembled using mortise- and- tenon joinery.

Siding

The vertical siding of the cast house, and the north and south walls of the east shed, date to the reconstruction of 1964- 65. The completion report identifies this siding as tongue- and- groove boards of Idaho white pine, of random widths (6- inch minimum) and 1 inch thick. This vertical- board siding was chosen based on the photographs of 1887 and 1896.

The east elevation of the east shed was resided in 2007 with red- cedar, tongue- and- groove boards of random widths. The cedar boards replaced the pine boards, the bottom ends of which had rotted. Red cedar was chosen for its rot- resistance, dimensional stability, and ability to hold a painted finish. The pine boards that were removed were saved for future siding repairs elsewhere on the building.

Doorways

The existing exterior and interior doorways of the cast house and east shed date to the reconstruction of 1964- 65. Some of the doorway locations are based on photographic and archeological evidence; others are conjectural. The design of the doors, where they exist, is conjectural. All doors are a board- and- batten type, made with white- pine, tongue- and groove boards. Hardware consists of simulated wrought- iron nails, Suffolk latches, and strap hinges. Details of each doorway are given subsequently.

Wide Interior Doorway Connecting the Cast House and East Shed

The wide interior doorway connecting the cast house with the east shed (fig. 114) is documented by the 1887 photograph and the archeological finding of no foundation wall in this location. The opening measured 9.6 feet wide, according to Archeologist Leland Abel. A pair of board- and- batten doors is conjectural.

Exterior West Doorway at Tail- Race Bridge

No physical or documentary evidence remained for a doorway in the west wall south of the furnace (figs. 109 and 118). No historic photographs of this elevation are known, and the stone wall had disappeared to ground level by 1962. A doorway was nevertheless installed here in 1964- 65, based on evidence that used molding sand had been discarded along the exterior south wall of the cast house. The doorway was thought to provide convenient access to both the south wall and the slag pile to the west. The board- and- batten door is also conjectural.

West Opening to Tuyere Arch and Water Wheel

Although not technically a doorway, a wide opening in the west stone wall north of the furnace enables access to the tuyere arch and the water wheel (fig. 116). This configuration was based on historic photographs taken circa 1910 and 1920 (figs. 19 and 20), prior to the wall's deterioration and removal. The wall was reconstructed in two phases, in 1957- 58 and 1962- 63, leaving the previously described opening.

Exterior East Doorway of East Shed

A wide doorway in the east exterior wall of the east shed is a historically inaccurate reconstruction dating to 1964- 65 (fig. 111). This doorway, 15 feet 3 inches wide, enables a wagon and team to be driven into the unfinished north side of the shed. The archeological evidence indicated, however, that a narrower opening, flanked by two windows, was in this wall. Such a configuration, with a doorway 7 feet 3 ½ inches wide, appears on the original plans for the reconstruction dated 1964, but was later changed to a wider opening with only one window. The doorway has no doors.

Exterior South Doorway of East Shed

A smaller exterior doorway is located in the south wall of the east shed (fig. 112). This doorway is placed at the west end of the wall, close to the cast house; it accesses the enclosed room on the south side of the shed. No documentary or physical evidence exists for this doorway. Both the opening and its board- and- batten door are therefore conjectural. Placement of the doorway over the drainage ditch also necessitated the building of a conjectural wooden deck.

Doorway in the Interior Partition of the East Shed

The enclosed room on the south side of the east shed formed by an east/west interior partition wall. A doorway is located at the west end of the partition, opposite the exterior doorway described above. Again, no physical or documentary evidence exists for this doorway. Both the opening and the board- and- batten door are therefore conjectural. The placement at the west end of the wall was presumably chosen because sherds of window glass found by archeology in 1962- 63 suggest the placement of windows elsewhere in the wall.

Windows

Window openings and sashes in the cast house and east shed date to the reconstruction of 1964- 65. Window placements and detailing were based on the historic photographs of 1887 and 1896 (figs. 7, 17, and 18) and physical evidence of broken window glass found by archeology in 1962- 63. Window trim is a simple board type, thought to have been typical of the ca.- 1840 period. Most sashes are double- hung, with top fixed sash and movable bottom sash. Old distorted glass, salvaged from old windows, is installed in most of the sashes. Specific information on individual windows follows.

Windows in the East Wall of the Cast House

Eight windows are in the east exterior wall of the cast house (figs. 111- 112). These windows appear to have existed at the same time as the attached east shed, based on the staggered placement of the upper openings in the 1887 photograph. Four windows in the upper two tiers are large, with 15- over- 15 sashes, as documented in the 1887 view. Four windows in the lower story are smaller and covered with boards in the 1887 view. These were presumed to have had six- over- six sashes, judging by the size of the window openings. The symmetrical placement of the three southernmost windows was also a conjectural design in 1964, since this portion of the building was missing by 1887.

Windows in the South Wall of the Cast House

Four windows with six- over- six sashes are in the south wall of the cast house (fig. 112). No photographic documentation exists for these windows, since this portion of the building was missing by 1887. Three of the windows were identified by archeology based on three concentrations of window glass along the missing wall. Although no written justification has been found for the fourth window, it appears to have been based on the four- bay framing of the south wall, which was also determined by archeology. Thus each bay was given a window in the reconstruction.

Windows in the West Wall of the Cast House

Four windows are in the west wall of the cast house south of the furnace. Two windows flank a doorway in the first story, and two are in the upper, or loft, story. Three of the windows have six- over- six sashes; the upper window over the doorway has a nine- light fixed sash. The placement and design of all four windows was conjectural in 1964, lacking both photographic documentation and archeological evidence. The stated intention of the window placements was to provide additional light for the interior working area and storage loft of the cast house.

Windows in the Exterior Walls of the East Shed

Five windows with six- over- six sashes are in the exterior walls of the east shed (figs. 111- 112). Two each are in the north and south walls, and one is in the east wall. Archeological evidence suggested a different window configuration, however, based on concentrations of window glass found along the foundations. This indicated there were no windows in the north wall, two windows flanking a center doorway in the east wall, and one window centered in the south wall. Photographic documentation provided no additional information, because the east shed had disappeared by 1887. The reconstruction of 1964- 65 eliminated one window from the east elevation to allow widening of the doorway for interpretive purposes. No written justification for the additional windows in the north and south walls has been found. One possibility is that additional light was considered necessary for visitor safety.

Windows in the Interior Partition of the East Shed

Three windows with six- over- six sashes are in the east/west partition of the east shed (fig. 114). Physical evidence for these windows was found by Archeologist Leland Abel in 1962- 63, who described "plentiful" concentrations of broken glass along the entire length of the missing wall.[48] The partition and its windows were reconstructed by the NPS in 1964- 65.

Roof

Roof Framing

The framing for the gable roofs of the cast house and east shed consist of 6- inch poplar- pole rafters, 8- by 8- inch purlins, and oak roofing lath spaced 6 inches on center (fig. 119). Most of the roof framing dates almost entirely to the reconstruction of 1964- 65. Selected repairs were made in the vicinity of the belfry in 1997. One short log rafter in the northwest corner of the roof where the furnace stack abuts the bridge house was replaced in- kind during the 2007- 08 roof- repair project, as was the 4 x 4 post supporting one end of that rafter. Approximately 35 percent of the eave decking also dates to this work, and a very small amount of roofing lath in various places. This work has been described in "Chronology of Development and Use, Cast House Structural and Roofing Repairs, 2007- 08."

Ventilator

A ridge ventilator covered with clay roofing tiles runs the length of the cast house roof (figs. 111- 113). This feature is documented by the 1887 photograph (figs. 7 and 17), and was described by last Hopewell manager Harker Long in 1935 as the "ventilator in center top, 2 feet higher than roof for escape of gas."[49] The existing ventilator dates to the reconstruction of the cast house in 1964- 65.

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[48] The interior wall was labeled "AK" in the archeology report.
[49] Interview with Harker Long by Roy E. Appleman, Dec. 1935.

Clay Roofing Tiles

Red clay roofing tiles cover the roof and ridge ventilator of the cast house and east shed (figs. 111- 113). The choice of tiles was based on the findings of Archeologist Leland Abel, who had unearthed numerous tiles and tile fragments at the cast- house site during excavations in 1962-63.[50] Abel concluded that tiles had been used on both the original cast house in 1771 and its larger replacement and east annex/shed circa 1816.[51] Wood shingles had replaced the tiles by 1887, as seen in the photograph of that date, and were most likely on the building when the furnace closed in 1883. The existing tiles are custom reproductions of an intact tile that was supplied by the park for the 1964- 65 reconstruction. The tiles are aligned vertically and held in place by a clay lug on the back side. The lug is laid against the upper edge of the roofing lath and secured by the collective weight of the tiles. During the reconstruction of the cast house and shed, the joints between the tiles were made watertight by means of wooden strips placed under the shingles. The 2007- 08 roof- repair contract replaced the wooden strips with new terne-coated stainless strips. (See "Chronology of Development and Use, Cast House Structural and Roofing Repairs, 2007- 08.")

Belfry and Bell

A wood- framed belfry straddles the peak at the east end of the cast- house roof (figs. 111- 113). This reconstruction of 1964- 65 was based on the only known photograph of the belfry (figs. 7 and 17, dated 1887) and descriptions by last Hopewell manager Harker Long. The belfry is supported on four slender posts, and has a steep pent roof with slotted fascia boards. Extensive repairs of the belfry were carried out by the NPS Historic Preservation Training Center in 1997, the details of which are described in the "Chronology of Development and Use" section of this report.

A small brass bell with iron clapper hangs in the belfry. This bell was donated to the park by Jackson Kemper III in 1949.[52] It measures 14 inches high by 8 inches wide and weights 55 pounds; the clapper is 12 inches long. There are no visible markings to indicate the manufacturer or casting date. It is therefore not known if this is the bell that was purchased for the furnace in 1849 or a later replacement. Harker Long recalled that the cast- house bell was rung when it was time to run off the iron. Visitors were originally encouraged to ring the bell following its installation in 1965. The practice was discontinued in later years, however, for fear of causing damage to the historic artifact.

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[50] The tiles, including one that is mostly intact, are cataloged as archeological accession #360 in the archives of Hopewell Furnace NHS.

[51] Abel makes many references to the clay roofing tiles in his report *Archeological Excavations at Hopewell Furnace*. See pages 24, 28, 39, 46- 50, 58, 67, 121- 26, 139, and 142.

[52] The bell is assigned catalog number 732 and accession number HOFU- 00174. The accession record describes Jackson Kemper as the great- grandson of Clement Brooke, who served as Hopewell manager from 1816 through 1848.

Gutters

Wooden gutters were installed on the cast house at some unknown date after the reconstruction of 1964- 65. Three were on the building in 2006: one on the south side of the cast house, one on the north side of the east shed, and one above the south exterior doorway of the east shed (figs. 111- 112). The gutters were a "V" design with no leaders. These were removed as part of the roofing contract in 2007- 08 and replaced by gutters along the entire length of the north and south eaves of both the cast house and east shed. The new gutters are a "V" design with leaders in five locations. They are fabricated out of red cedar, and lined with lead- coated copper with soldered seams.

Chimney

A sheet- metal chimney is located on the east wall of the east shed (figs. 111- 112). Physical evidence for the base of the chimney was found by Archeologist Leland Abel at the east stone foundation during excavations in 1962- 63.

Bridge and Deck

A bridge spanning the tail race west of the cast house is conjectural (fig. 109), as is a deck spanning the stone drain at the south doorway of the east shed. No documentary or physical evidence exists for either the bridge or deck. Both were constructed in 1964- 65 using oak timbers and pine planking. No records of their ongoing maintenance or subsequent repairs have been found.

Flooring

The flooring in the cast house and east shed consists of wooden floorboards and clay (figs. 79 and 114- 118). Pine floorboards supported by log sleepers resting on clay are located in the cast house and in the south room of the east shed, based on archeological evidence. The floorboards are random widths with tongue- and- groove edges. A layer of plastic laid between the clay floor and sleepers in 1964- 65 may still exist. How much of the 1964- 65 flooring has been replaced due to damage caused by periodic flooding is not known. Some of the flooring has been temporarily removed in the area north of the furnace due to recent flooding. Remaining log joists in this vicinity are pressure- treated, indicating that these are replacement materials. A small area in front of the cast arch is clay, beneath which are preserved historic iron plates uncovered by Archeologist Leland Abel in 1962- 63. Clay flooring is also exposed in the unfinished north room of the east shed.

Loft

A loft is located on the south side of the furnace in the cast house (figs. 117- 118). The loft is an open platform measuring approximately 22 feet wide by 30 feet long, made of pine floorboards supported on exposed poplar pole joists. Access is by means of a detached ladder. Physical evidence for the loft was noted by Archeologist Leland Abel in his 1964 report to include the following: holes in the clay floor for support posts; remnants of three iron pigs in the south face of the furnace, at an approximate height of 10.7 feet above the clay floor, to support the loft framing; and absence of whitewash above the level of the iron pigs. Abel conjectured the use of the loft as a warm, dry place to store wooden patterns.

Cranes

Two reproduction wooden cranes flank the cast arch in the cast house (fig. 79). Drawings for their construction are dated 1974, 1975, and 1978. The cranes were presumably installed in 1978 or shortly thereafter. They are currently rigged with ropes, which is historically inappropriate for the high- heat environment of the furnace.

Drainage

Problems with water infiltration in the cast house have been a problem both historically and in recent years. A completion report written in 1963 indicates that there are two drainage systems in the cast house: one historic, the other not. A historic stone- lined drain topped by stone slabs was discovered by archeologists in the 1950s and 60s on the north side of the cast house (fig. 57). This drain captured water infiltrating through the north wall, and diverted it around the casting bed, and under and along the exterior east wall, depositing it in the tail race to the south. This drain was cleared of silt in 1963 and made operative by the installation of a 4- inch tile pipe and gravel within the stone drain. A new 4- inch tile drain was also buried in the exterior charcoal fill along the north and east walls to capture runoff from the roof.[53] The existing status of these drains is unknown.

Painted Finishes

The exterior and selected interior elements of the cast house and east shed are painted white today. Exterior painted elements include the stone walls, wood siding, doors, windows, gutters, stones of the upper furnace stack, and the entire belfry (figs. 111- 113). Inside the cast house, white paint finishes the perimeter stone walls, the lower south face of the furnace stack (below the loft), doors and door way trim, window sashes and trim, and the sills, plates, and siding at the level of the first story. Inside the east shed, only the unfinished north room is painted white.

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[53] Zerbey, *Completion Report Narrative*, pp. 6- 7.

Whitewash was used on the stonework in 1965, while an oil- based white paint to simulate whitewash was applied to the woodwork. Only white paint appears to have been applied to the cast house and east shed since their reconstruction in 1965. It is not known what types of paint were applied after 1965; possibilities include whitewash, oil- based paints, and/or latex paints. The most recent painting of the exterior, in 2007, used "Allback Linseed Paint."

Repairs and Improvements

The following repairs and improvements have been made to the cast house and east shed since NPS reconstruction in 1964. Details are cited in "Chronology of Development and Use."

Ca. 1978	Cast- house cranes were installed in front of the cast arch.
1981	Fire and instruction detectors were installed.
1987	Cleanup and unspecified repairs were performed following Hurricane Floyd.
1997	Cast house belfry and roof were repaired.
Ca. 2004	Fire- and intrusion- detection systems were upgraded.
2007	Exterior siding was repaired and painted.
2007- 08	Roof was repaired, including roof framing and clay tiles. Existing gutters were replaced by new gutters and leaders.

Figure 111. North and east elevations of the cast house and east shed, July 2006.

Figure 112. South and east elevations of the cast house and east shed, July 2006.

Figure 113. Detail of the cast house roof and belfry, September 2006.

Figure 114. Interior north side of the cast house, view looking east, July 2006.

Figure 115. Interior north side of the cast house, view looking north, July 2006.

Figure 116. Interior north side of the cast house, view looking west, July 2006.

Figure 117. Interior south side of the cast house, view looking east, July 2006.

Figure 118. Interior south side of the cast house, view looking west, July 2006.

Figure 119. Detail of interior roof framing of the cast house at main ridge, July 2006.

IV. CONCLUSIONS

CHARACTER- DEFINING FEATURES

Definition

"Character- defining features" (CDFs), are defined in the National Park Service's *D.O./NPS- 28: Cultural Resource Management Guideline* as follows:

> A prominent or distinctive aspect, quality, or characteristic of a historic property that contributes significantly to its physical character. Structures, objects, vegetation, spatial relationships, views, furnishings, decorative details, and materials may be such features.[1]

By this definition, a CDF can date from any period in the history of a property. In the case of a building or structure, this could span the time period from its date of construction to the present day.

A more restrictive definition is cited in *The Secretary of the Interior's Standards for the Treatment of Historic Properties,* in which CDFs are tied to the "historic character" of a building or structure:

> Character- defining features...[are] those architectural materials and features that are important in defining the building's historic character…. The character of a historic building may be defined by the form and detailing of exterior materials, such as masonry, wood, and metal; exterior features, such as roofs, porches, and windows; interior materials, such as plaster and paint; and interior features, such as moldings and stairways, room configuration and spatial relationships, as well as structural and mechanical systems.[2]

"Historic character" is thereby tied to historical significance, which *D.O./NPS- 28* defines as "the meaning or value ascribed to a structure, landscape, object, or site based on the National Register criteria for evaluation. It normally stems from a combination of association and integrity."[3]

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[1] *D.O./NPS- 28, Cultural Resources Management Guideline,* Release No. 5 (U.S. Dept. of the Interior, National Park Service, History Division, 1997), Appendix A, p. 178.

[2] Kay E. Weeks and Anne E. Grimmer, *The Secretary of the Interior's Standards for the Treatment of Historic Properties, with Guidelines for Preserving, Rehabilitating, Restoring and Reconstructing Historic Buildings* (U.S. Dept. of the Interior, National Park Service, Cultural Resource Stewardship and Partnerships, Historic Preservation Services, 1995), p. 63.

[3] *D.O./NPS- 28,* Appendix A, p. 193.

Character- defining features are also tied to integrity, the aspects of which include location, design, setting, materials, workmanship, feeling, and association.[4] The CDFs of the Furnace Group were therefore evaluated using the aspects of integrity.

Hopewell Furnace Group: Character- Defining Features

The following have been identified as character- defining features (CDFs) of the Furnace Group at Hopewell Furnace National Historic Site.

Site Orientation

The site of Hopewell Furnace was deliberately chosen to facilitate its operation as a cold- blast, iron- smelting work. The placement of the furnace stack at the foot of a steep terraced hill enabled the loading of charge into the upper stack from the hill above. The presence of nearby streams (French Creek, Baptism Creek, and Spout Creek) provided water to power a water wheel that generated a blast of cold air to the furnace, producing hotter and more efficient combustion. Forested acres surrounding the site were also an important component in the operation of the furnace. Hardwood trees were harvested and burned to produce the charcoal that fueled the furnace. For these reasons, the site orientation of Hopewell Furnace qualifies as a character- defining feature.

Overall Design and Form

The overall design and form of the Furnace Group at Hopewell Furnace can be characterized as having many related and far- reaching parts that operated together in the production of iron. This interconnected design is a character- defining feature. At the heart of the operation was the stone furnace stack. The furnace was filled with charge via the wood- framed bridge house and connecting shed above. The bridge house was joined to the connecting shed, which in turn abutted the charcoal house where charcoal fuel was stored. Connected to the charcoal house on the north side was the cooling shed, where charcoal was cooled prior to being moved to covered storage in the charcoal house. A wheel house is positioned to the west side of, and shares a roof with, the bridge house. Sheltered within the wheel house were the water wheel and blast machinery. This machinery, including two blast tubs and a receiver, produced a blast of cold compressed air for delivery to the furnace via a tuyere pipe. The machinery was operated by the water wheel, which was powered by two races: the east head race and the west head race. Water from the races was carried away from the wheel pit in a stone- lined tail race. Nestled within this

[4] *National Register Bulletin 15: How to Apply the National Register Criteria for Evaluation* (U.S. Dept. of the Interior, National Park Service, Interagency Resources Division, 1990, revised 1991), pp. 44- 45.

grouping of structures at the base of the furnace stack was the cast house. The function of the cast house was to shelter the casting operations when iron was drawn from the furnace.

Construction Materials

The wide variety of materials used in the construction of the Furnace Group is a character-defining feature. These materials include native stone, brick, wood, clay tiles, slate shingles, and wrought- iron hardware. Fieldstones and roughly shaped stones make up the outer walls of the furnace stack, the retaining walls of the furnace bank and connecting shed, the foundations and walls of the charcoal house, and the foundations and lower walls of the wheel house and the cast house. Stone retaining walls are also part of the east head race and west head race, and they line the channel of the tail race. Brick is found exclusively at the furnace stack, where it makes up the upper tier of the stack, the walls of the tunnel head and its fire wall, and the walls of the interior bosch. Wood was milled and used as framing, vertical- board siding, roofing boards, shingles, floorboards, board- and- batten doors, and window sashes. Distinctive red clay tiles cover the roof of the cast house and its east shed; black slates are on the roof of the bridge and wheel houses. Wrought- iron is used for the mostly reproduction strap- style door hinges and Suffolk latches.

Spatial Configurations

The spatial configurations of the Furnace Group were designed to accommodate the functional needs of the furnace operation, and are therefore character- defining features. Most are large open spaces with no interior partitions. Enclosed structures include the bridge house, charcoal house, wheel house, and cast house. The bridge house was the location of the scale where charge was weighed prior to loading into the furnace. Charge was also temporarily stored here prior to loading. The charcoal house, with its thick stone walls, served as a large fireproof storehouse for the charcoal fuel. The wheel house provided protection from the weather for the water wheel and the platform- mounted blast machinery. The cast house is where the molten iron was tapped and cast into pigs or flasks. It was also here that the molds and casting sand were stored. The east shed of the cast house is notable for being the only structure with a partitioned room. The open space of the cooling shed enabled hot charcoal embers deposited by the colliers to cool prior to being transferred into the adjacent charcoal house. The connecting shed also has no walls, functioning primarily as a covered corridor between the charcoal house and the bridge house.

Belfry and Bell

A belfry crowning the expansive gable roof of the cast house is both a striking visual and functional element of the Furnace Group. The belfry housed a brass bell that was rung when the iron was ready to be tapped, according to last Hopewell manager Harker Long. The existing belfry is a reproduction based on the photograph of 1887. The bell housed within the belfry may be as early as 1849. Both the belfry and its bell are character- defining features.

Water Wheel and Blast Machinery

A working water wheel and blast machinery provide a dynamic demonstration of one component of the furnace operation, and thus are character- defining features. The display is both visual and auditory. The 22- foot water wheel is rotated by the force of water from the west head race. The wheel operates two blast tubs to generate compressed air that is transferred to the receiver, and then to the furnace through a tuyere pipe. The wheezing and thumping of the blast tubs are a characteristic of this antiquated equipment.

Painted Finishes

Painted finishes, where they exist, are white and red to simulate utilitarian whitewash and iron-oxide paint. These paint colors are character- defining features, as are the utilitarian unpainted surfaces of the bridge house, wheel house, connecting shed, and cooling shed.

ASSESSMENT OF RECONSTRUCTIONS FOR THE PERIOD 1820- 40

Introduction

Two periods of significance are suggested by the *Hopewell Furnace National Historic Site Foundation for Planning and Management* document of July 2007, which is being used to guide the development of the park's first general management plan. The first period encompasses the years 1770 to 1883, when Hopewell operated as an active furnace. The second period covers the years 1934 to 1965, when Hopewell Furnace was conceptualized and implemented as a historic park. The National Register nomination also defines the period of significance of Hopewell Furnace site as spanning the years 1771 to 1883. Other planning documents for Hopewell Furnace NHS have espoused a narrower period of significance and interpretation, 1820- 40, which is considered to be the peak period of furnace activity. This section evaluates the structures of the Furnace Group to determine how accurately they fit with the park's early and later historic scenes.

Reconstructions to Circa 1879- 83

Most components of the Furnace Group have been stabilized, restored, or reconstructed to their appearance during the last operation of Hopewell Furnace in 1879- 83, based primarily on historic photographs and interviews. These include the furnace; furnace bank and retaining wall; bridge house and connecting shed; charcoal house and cooling shed; wheel house, water wheel and blast machinery; east head race; west head race; and tail race. Notable exceptions are cited here.

Furnace Group	Deviations from Circa 1879- 83 Appearance
Furnace	Wooden girders that historically provided additional strength to the exterior walls of the furnace stack were omitted from the stabilization of 1936- 41. The existing cast arch has the appearance of an open hearth, whereas by 1879 the casting operation was a closed hearth, according to last Hopewell manager Harker Long.
Furnace bank and retaining wall	The historic authenticity of the stone steps located east of the furnace is questionable.

Furnace Group	Deviations from Circa 1879- 83 Appearance
Charcoal house and cooling shed	Although most alterations made to the charcoal house and cooling shed in 1880 have been removed, the connection between their roofs remains today. The two structures were not connected prior to 1880.
Wheel house	The north and south side walls of the wheel house have been opened by NPS for interpretive purposes; they were historically covered with vertical- board siding. A stairway accessing the platform supporting the blast machinery was never reconstructed. A steam boiler and brick housing installed in 1881 to supplement water power were removed in 1950. A large receiver (between the blast tubs) that replaced a smaller receiver in 1881 still survives, however.
East head race	The east head race is inoperative because no culvert has been provided beneath Mark Bird Lane. A flume directing the water from the pipe at the furnace bank to the water wheel was never reconstructed.
West head race	Only the eastern portion of the race closest to the furnace has been restored as an open ditch. The western portion was buried in an underground pipe, with a new connection to the dam at Hopewell Lake, in 1951.
Ore roaster	Although the ore roaster installed in 1882 has been removed, its foundation remains to the east of the cast house.
Cast house	The cast house and its east shed were reconstructed to an earlier (circa-1840) appearance in 1965.

Reconstruction to Circa 1840

The cast house is a 1965 reconstruction of that structure's ca.- 1840 appearance, based primarily on archeological evidence and the photograph of 1887. This reconstruction is less authentic than those of the later time period due to the lack of definitive information. Where evidence was completely missing, conjectural designs were devised. In addition, archeological evidence was ignored in the placement of doorway and window openings in the east shed.[5] These conjectural elements and inaccuracies are listed on the following page.

[5] Concentrations of broken window glass were thought to indicate window locations.

Cast House	Conjectural Reconstructions
West elevation	Doorways and windows in the west wall south of the furnace stack are conjectural, as is the bridge over the tail race.
East shed doorways	Archeological excavations by Leland Abel in 1962- 63 uncovered evidence for one doorway in the east wall flanked by two windows. For the reconstruction in 1965, one window was eliminated and the doorway widened to enable passage of carts. A second exterior doorway, for which no evidence was found, was also installed at the west end of the south wall.
East shed windows	As mentioned previously, archeological evidence suggested the presence of two windows in the east wall flanking a center doorway. Evidence was also found for one window centered in the south wall, but none in the north wall. As reconstructed, however, one window was installed in the east wall, two windows in the north wall, and two windows in the south wall. These nonhistoric windows may have been added to increase interior lighting for visitor safety.

Assessment of Historical Accuracy

All components of the Furnace Group except the cast house and its east shed have been stabilized, restored, or reconstructed to their 1879- 83 appearance. This time was chosen because insufficient information was available to achieve an accurate restoration to the earlier 1820- 40 period. No significant findings have since been made that would provide additional information for earlier reconstructions. An argument could be made that few alterations were made to the structures of the Furnace Group in the 39 years after 1840. This, however, is not known for certain, lacking definitive documentation. It can be said that the existing 1879- 83 reconstructions portray the historic scene for that time with good accuracy. This is because of the availability of documentation, which included photographs, interviews with surviving Hopewell workers and residents, written records, and archeological findings.

Less information was available to researchers on the appearance of the cast house for the years 1820- 40. No photographs exist from that time, and records describe only nonspecific building projects for that period. The earliest memories belonged to last manager Harker Long who had come to Hopewell in 1867. The reconstruction was therefore based primarily on archeological evidence and later photographs taken in 1887 and 1896. A good deal of conjecture was by necessity incorporated into the design, making the cast house a less- authentic reconstruction than the other (later) components of the Furnace Group. Furthermore, liberties were taken in the placement of windows and doorways in the attached east shed, which deviated from the archeological evidence.

TREATMENT OPTIONS

General Observations

The Furnace Group as it exists today is a mixture of time periods. Most components have been stabilized, restored, or reconstructed to represent the furnace's last period of operation from 1879 to 1883. Only the cast house and its attached east shed have been reconstructed to their 1820- 40 appearance. The present Furnace Group therefore never existed historically, but more generally represents the workings of an early charcoal- fueled iron works. As such, the reconstruction has achieved Historian Roy Appleman's goals – to capture "some flavor of our past," and to more specifically serve as "a standard against which to measure the distance traveled by the iron industry in 150 years of progress to the gigantic modern iron and steel plant of today."[6]

Several treatment options are suggested subsequently for the Furnace Group. With any option, it is important to consider the preservation of previously described character- defining features.

Maintain Existing Structures

The Furnace Group as it exists today helps visitors visualize and experience the physical plant of an early American iron- making operation. While the structures themselves are not of one cohesive time period, they are nevertheless representative of the functions that were carried out at Hopewell Furnace. The National Register of Historic Places has determined that all components of the Furnace Group, including its various reconstructions, contribute to the significance of the historic site. They are therefore worthy of maintenance and preservation treatments. Reconciliation of the differing time periods could be explained by interpretive means rather than reconstructive treatments.

It was discovered while researching this historic structure report that no complete record of maintenance exists for the Furnace Group. Documentation was found scattered in various locations throughout the park, including the maintenance office, archives, and general files. Records of contract work, preservation treatments, and cyclical maintenance should be assembled in one location. The information contained in such a database would be helpful in planning for future maintenance, preservation, and monitoring programs. It would also provide a valuable record of the ongoing physical history of this historically significant grouping of structures.

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[6] Roy Appleman, *Proposed Restoration Plan for Old Iron Making Village, French Creek Project, Hopewell Pennsylvania* (Bronxville, NY: U.S. Dept. of the Interior, NPS, Branch of Planning and State Cooperation, Second Regional Office, 1936), p. 5.

Restore East Shed Openings

Reconstruction of the east shed adjacent to the cast house in 1965 did not follow the archeological evidence of doorway and window locations. These included one doorway flanked by two windows in the east wall and one window centered in the south wall. As reconstructed, the shed has two windows in the north wall, one window and a wide doorway in the east wall, and two windows and a doorway in the south wall. Reconstruction of these openings to more accurately reflect the physical evidence is advised if the east shed is retained. Details of the archeological findings are described in a 1964 report by Archeologist Leland Abel.[7]

Restore Cast House to 1879- 83 Appearance

A more drastic treatment option would be to restore the cast house to its 1879- 83 configuration. This would result in a more accurate portrayal of the Furnace Group's historic appearance during its last period of operation from 1879 to 1883. Restoration would involve removing the east shed, removing the south portion of the cast house, and replacing the clay roofing tiles with wood shingles. Primary documentation for this restoration would be the photograph of 1887, together with the archeological findings of Leland Abel, who located the foundation of the post- 1845 south wall. [8] Some conjecture would be entailed in locating window openings in the new south wall, since it is not visible in the 1887 photograph. Consideration should also be given to reconstructing the missing building shown in the foreground of the 1887 view, which has been called the "wheelwright shop" by NPS researchers.

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[7] Leland Abel, *Historic Structures Report, Part II, Archeological Excavations at Hopewell Furnace, Hopewell Village NHS* (Hopewell Village NHS, March 1964), pp. 67 and 71.

[8] Abel, *Archeological Excavations at Hopewell Furnace*, pp. 41- 42. Abel labeled the crude stone foundation for this wall as "Wall Y," and described it as having been built sometime after 1845. It roughly aligned with the south face of the furnace stack.

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Wheel House, Water Wheel, and Blast Machinery

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Cast House

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1973 *Historic Structures Report, Cast House Crane, Hopewell Village National Historic Site*. Hopewell Village NHS, 1973.

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Architectural Drawings

(Drawings are in chronological order)

Furnace Group

1935 "Plan of Hopewell Village & Ruins." Includes a sheet showing conjectural restoration of the "Old Iron Furnace and Related Buildings at Hopewell," Dec. 31, 1935. Hopewell Furnace NHS Archives, French Creek Recreational Demonstration Project Records, Cat. No. 35419, Drawings and Plans, Drawer 1, Folder 3.

1938 "French Creek Pipe & Tile Line, Drainage of Furnace Area." U.S. Dept. of the Interior, NPS, Cooperating with the Pennsylvania Dept. of Forests & Waters, 1 sheet, May 12, 1938. Hopewell Furnace NHS Maintenance Division, Drawing Files.

1950 "Topographical Survey – Vicinity of Furnace." Reading, PA: Walter E. Spots, Registered Professional Engineer, Drawing No. NHS- HV/5309, 3 sheets, Aug. 1950. Hopewell Furnace NHS Maintenance Division, Drawing Files.

1951 "Ground Plan of Furnace Group Showing Archeological Remains and Extent of Excavations." Archeology Division, Region One, NPS, Drawing No. NHS- HV/10,701, Sept. 1951. Northeast Regional Office in Philadelphia, Drawing Files.

Ca. 1964 "Plan of Hopewell Furnace & Casting House about 1840." Included as Figure 1 in the 1964 report by Leland Abel, "Historic Structures Report, Part II, and Archeological Excavations at Hopewell Furnace." Hopewell Furnace NHS Archives, Resource Management Records, Cat. No. 35420, Drawings and Plans, Drawer 29, Folder 9.

1981 "Hopewell Village NHS, Intrusion and Fire Alarm System." Jacobs / Smith, Drawing No. 376/41,0005B, 1981. Hopewell Furnace NHS Maintenance Division, Drawing Files.

Furnace

1936-39 "Measured Drawing of Hopewell Furnace, French Creek Project." U.S. Dept. of the Interior, NPS, Branch of Recreational Planning and State Cooperation, Recreational Demonstration Projects," Job No. 1014, 1 sheet, Nov. 30, 1936. Updated with restoration progress drawings dated Apr. 36, 1937; June 1, 1937; July 1, 1937; Mar. 1, 1938; Apr. 1, 1938; May 1, 1938; June 1, 1938; July 1, 1938; Sept. 1, 1938; Dec. 1, 1938; May 1, 1939; July 1, 1939; and Sept. 1, 1939. The original drawing of Nov. 30, 1936, is in the archives of Hopewell Furnace NHS, French Creek Recreational Demonstration Project Records, and Cat. No. 35419, Series I. Plans and Drawings, Drawer 1, Folder 3. Photocopies of the subsequent progress drawings are included in "Hopewell Iron Furnaces Historic structures Report & Engineering Study," 1987; the location of the drawings is not cited.

1940 "Copy of Furnace Drawing, Original Probably Drawn by Edward Brooke." One sheet, June 6, 1940. Hopewell Furnace NHS Archives, Resource Management Records, Cat. No. 35420, Drawings and Plans, Drawer 29, Folder 10.

1941 "Restoration of Historic Structures, Furnace, Hopewell Village NHS." U.S. Dept. of the Interior, NPS, Branch of Engineering, French Creek, PA, NP- 7, Drawing No. NHS-HV/5359, 1 sheet, Jan. 24, 1941. Hopewell Furnace NHS Archives, Resource Management Records, Cat. No. 35420, Maintenance Files, Drawings and Plans, Drawer 5, Folder 8.

1987 "Masonry Restoration, Charcoal Furnace, Hopewell Village NHS." U. S. Dept. of the Interior, NPS Mid- Atlantic Regional Office, 8 sheets, July 1, 1987. Hopewell Furnace NHS Maintenance Division, Drawing Files; and Hopewell Furnace NHS Archives, Resource Management Records, Cat. No. 35420, Maintenance Files, Drawings and Plans, Drawer 17, Folder 7.)

Bridge House

1942 "Bridge House Restoration, Furnace Group, Hopewell Village NHS." Archeologist J.C. Fisher Motz, Drawing No. NHS- HV/2064, 3 sheets, Apr. 11, 1942. Hopewell Furnace NHS Archives, Resource Management Records, Cat. No. 35420, Maintenance Files, Drawings and Plans, Drawer 3, Folder 1.

1947 "Temporary Walkway Approach to Old Iron Furnace, Hopewell Village NHS." U.S. Dept. of the Interior, NPS Engineering Division, Region One, Drawing No. NHS-HV/5301, 1 sheet, Mar. 14, 1947. Hopewell Furnace NHS Archives, Resource Management Records, Cat. No. 35420, Maintenance Files, Drawings and Plans, Drawer 5, Folder 3.

1952 "Preservation and Stabilization of Historic Structures, Furnace Group – Bridge House Walls, Hopewell Village NHS." Drawing No. NHS- HV/2016A, 1 sheet, July 1952, Revised Sept. 1, 1956. Hopewell Furnace NHS, Maintenance Division, Drawing Files; and Hopewell Furnace NHS Archives, Resource Management Records, Cat. No. 35420, Maintenance Files, Drawings and Plans, Drawer 2, Folder 6.

1954 "Sketches, Bridge House Framing, Hopewell Village NHS." U.S. Dept. of the Interior, NPS, Planning & Construction Division, Region 1, Drawing No. NHS- HV/2019A, 2 sheets, Mar. 1954; preliminary sketches by "Stabler" are dated 1951. Hopewell Furnace NHS Archives, Resource Management Records, Cat. No. 35420, Drawings and Plans, Drawer 22, Folder 9.

Ca. 1957 "Bridge House Restoration, Furnace Group, Hopewell Village." Drawing No. NHS HV/2064, 3 sheets, n.d. Hopewell Furnace NHS Maintenance Division, Drawing Files. *Note that only sheets 2 and 3 are in this set.*

1957 "Structural [Concrete] Floor Slab, Bridge- House, Hopewell Village NHS." Drawing No. NHS:- HV/30:20, 1 sheet, May 1957. Hopewell Furnace NHS Archives, Resource Management Records, Cat. No. 35420, Maintenance Files, Drawings and Plans, Drawer 3, Folder 4.

1957 "Superstructure of Bridge and Wheel House and Portico, Building #10, Blast Furnace, Hopewell Village NHS, Pennsylvania." U.S. Dept. of the Interior, NPS, Division of Design and Construction, Drawing No. NHS- HV/3021, 6 sheets, July 1957. Hopewell Furnace NHS Maintenance Division, Drawing Files; and Hopewell Furnace NHS Archives, Resource Management Records, Cat. No. 35420, Maintenance Files, Drawings and Plans, Drawer 20, Folder 5.

1976 "Roof Repairs – Connecting Shed, Furnace Group, Hopewell Village NHS." U.S. Dept. of the Interior, NPS, Mid- Atlantic Region, Division of Park Operations, 2 sheets, July 1976. Hopewell Furnace NHS Maintenance Division, Drawing Files.

1999 "Roof Plan, Elevation & Details, Connecting Shed, Hopewell Furnace NHS." U.S. Dept. of the Interior, Northeast Region System Support Office, Drawing No. 376/80029, 1 sheet, Mar. 26, 1999. Hopewell Furnace NHS Maintenance Division, Drawing Files.

Charcoal House and Shed

1946 "Repairs to Roof, Charcoal House, Hopewell Village NHS." U.S. Dept. of the Interior, NPS, Branch of Engineering, Drawing No. NHS- HV/5300, Dec. 30, 1946. Hopewell Furnace NHS Archives, Resource Management Records, Cat. No. 35420, Maintenance Files, Drawings and Plans, Drawer 5, Folder 3.

1956 "Charcoal House (Building 9) Existing Conditions, Hopewell Village NHS, Pennsylvania." U.S. Dept. of the Interior, NPS, Division of Design and Construction, Eastern Office, Drawing No. NHS- HV/3054, 4 sheets, by Student Measuring Team, Nov. 2, 1956. Hopewell Furnace NHS Maintenance Division, Drawing Files; and Hopewell Furnace NHS Archives, Resource Management Records, Cat. No. 35420, Maintenance Files, Drawings and Plans, Drawer 20, Folder 10.

1957 "Proposed Reconstruction of Charcoal Shed, Hopewell Village NHS." U.S. Dept. of the Interior, NPS, Division of Design and Construction, Eastern Office, Drawing No. NHS-HV/3025, 2 sheets, July 17, 1957. Hopewell Furnace NHS Maintenance Division, Drawing Files; and Hopewell Furnace NHS Archives, Resource Management Records, Cat. No. 35420, Maintenance Files, Drawings and Plans, Drawer 21, Folder 21.

1958 "Charcoal House (Bldg. 9), Hopewell Village NHS, Union Township, Berks County, Pennsylvania." Historic American Buildings Survey, set of 3 sheets, Survey No. PA-5157- C, 1958, Library of Congress. *Note: adapted from the existing conditions drawings of 1956.*

1965 "Plan and Elevations, Charcoal House Restoration, Hopewell Village NHS." U.S. Dept. of the Interior, NPS Regional Office, Division of Design and Construction, 2 sheets, Feb. 19, 1965. Hopewell Furnace NHS Maintenance Division, Drawing Files; and Hopewell Furnace NHS Archives, Resource Management Records, Cat. No. 35420, Maintenance Files, Drawings and Plans, Drawer 4, Folder 4.

Wheel House, Water Wheel, and Blast Machinery

1931 "Blowing Engine- Water Wheel, Hopewell Furnace, Franklin Institute Museum." Philadelphia: Franklin Institute Museum, Bonine & Costa- Eng'rs, Drawing No. 9858A, 1 sheet, Feb. 2, 1931. Hopewell Furnace NHS Maintenance Division, Drawing Files; and Hopewell Furnace NHS Archives, Resource Management Records, Cat. No. 35420, Drawings and Plans, Drawer 28, Folder 8.

Circa 1941 "Hopewell's Blast Machinery [and Water Wheel], Hopewell, PA, Hopewell Village NHS," by Jay Harold Le Van, Jr. U.S. Dept. of the Interior, NPS, 8 sheets, n.d. Hopewell m Furnace NHS Archives, Resource Management Records, Cat. No. 35420, Drawings and Plans, Drawer 29, Folder 9.

1949 "Hopewell's Blast Machinery [and Water Wheel], Hopewell Village NHS." U.S. Dept. of the Interior, NPS, Branch of Plans and Design, Drawing No. NHS- HV/2062A, 8 sheets, Nov. 1949. Hopewell Furnace NHS Maintenance Division, Drawing Files; and Hopewell Furnace NHS Archives, Resource Management Records, Cat. No. 35420, Drawings and Plans, Drawer 23, Folders 4 and 5.

1952 "Preservation and Stabilization of Historic Structures, Furnace Group – Wheel Pit Walls, Hopewell Village NHS." Drawing No. NHS- HV/2015, 1 sheet, July 1952. Hopewell Furnace NHS Archives, Resource Management Records, Cat. No. 35420, Maintenance Files, Drawings and Plans, Drawer 2, Folder 6.

1956 "Plan, Conjectural Restoration of Early Blast Machinery." Russell A. Apple, Historian, Drawing No. NHS- HV/3060, 2 sheets, Aug. 10, 1956. Hopewell Furnace NHS Archives, Resource Management Records, Cat. No. 35420, Maintenance Files, Drawings and Plans, Drawer 20, Folder 3.

1957 "Superstructure of Bridge and Wheel House and Portico, Building #10, Blast Furnace, Hopewell Village NHS, Pennsylvania." U.S. Dept. of the Interior, NPS, Division of Design and Construction, Drawing No. NHS- HV/3021, 6 sheets, July 1957. Hopewell Furnace NHS Maintenance Division, Drawing Files; and Hopewell Furnace NHS Archives, Resource Management Records, Cat. No. 35420, Maintenance Files, Drawings and Plans, Drawer 20, Folder 5.

2006 Water Wheel Restoration: "Water Wheel Assembly," "Water Wheel Sub Assembly," "Inner Segment," "Outer Segment," "Spoke," "Water Wheel Bucket Boards," and "Tie Bar." Holderness, NH: 3- G Construction, Jul. 21, 2006. Hopewell Furnace NHS Maintenance Division, Drawing Files.

East Head Race

1938-39 "French Creek Area, Restoration of Historic Structures, East Head Race." Pennsylvania Dept. of Forests & Waters in Cooperation with the U.S. Dept. of the Interior, NPS, 1 sheet, various versions dated July 1938, Sept. 1938, Nov. 1938, and Feb. 1938. Hopewell Furnace NHS Maintenance Division, Drawing Files.

1939 "French Creek Area, Restoration of Historic Structures, East Head Race." Pennsylvania Dept. of Forests & Waters in Cooperation with the U.S. Dept. of the Interior, NPS, 1 sheet, Feb. 1939. Hopewell Furnace NHS Maintenance Division, Drawing Files.

1939 "Pipe, Tile Lines & Conduit, East Head Race, Hopewell Historic Site." U.S. Dept. of the Interior, NPS, Branch of Plans and Design, French Creek, PA SP- 7, Drawing No. NHS-HV/8001, 2 sheets, Nov. 7, 1939. Hopewell Furnace NHS Maintenance Division, Drawing Files.

1939 "Contour Plan of Control Features, East Head Race, Hopewell Village NHS." Prepared under the direction of Asst. Research Technician Thor Borresen, 1 sheet, Dec. 1939. Hopewell Furnace NHS Archives, Resource Management Records, Cat. No. 35420, Drawings and Plans, Drawer 29, Folder 11.

1940 "Plan of East Head Race, Hopewell Village NHS." U.S. Dept. of the Interior, NPS, Branch of Historic Sites & Buildings, Yorktown Field Office, 3 sheets, Jan. 17, 1940. Hopewell Furnace NHS Archives, Resource Management Records, Cat. No. 35420, Drawings and Plans, Drawer 30, Folder 1.

West Head Race

1950-51 "West Head Race & Flume Restoration, Hopewell Village NHS. U.S. Dept. of the Interior, NPS Planning & Construction Division, Regional Office, Drawing No. NHS-HV/2013, 1 sheet, 1950, revised Apr. 1951." Hopewell Furnace NHS Archives, Resource Management Records, Cat. No. 35420, Maintenance Files, Drawings and Plans, Drawer 2, Folder 5.

1951-52 "Intake for Headrace West of Furnace, Hopewell Village NHS. "U.S. Dept. of the Interior, NPS, Planning & Construction Division, Region One, Drawing No. NHS-HV/2014, 1 sheet, May 1951; revised as Drawing No. NHS- HV/2014A, 1952. Hopewell Furnace NHS Archives, Resource Management Records, Cat. No. 35420, Maintenance Files, Drawings and Plans, Drawer 2, Folder 5.

Cast House and East Shed

1959 "Proposed Conjectural Restoration of Cast House and Moulding Sheds, Hopewell Village NHS," by Architect Norman M. Souder; shows the east elevation with no east shed. U.S. Dept. of the Interior, NPS, Division of Design and Construction, Eastern Office, Mar. 20, 1959. Hopewell Furnace NHS Maintenance Division, Drawing Files; and Hopewell Furnace NHS Archives, Resource Management Records, Cat. No. 35420, Maintenance Files, Drawings and Plans, Drawer 20, Folder 9. *Note there are 10 drawings in pencil in Folder 9 showing various restoration scenarios (three by Souder).*

1964 "Reconstruction of Cast House and Moulding Sheds." U.S. Dept. of the Interior, NPS Division of Design and Construction, Eastern Office, Drawing No. NHS- HV/3040, 8 sheets, Apr. 1964. Hopewell Furnace NHS Maintenance Division, Drawing Files; and Hopewell Furnace NHS Archives, Resource Management Records, Cat. No. 35420, Maintenance Files, Drawings and Plans, Drawer 4, Folder 3.

1974 "Timber Cranes, Cast House, Hopewell Village NHS." NPS, Drawing No. 376/80,002, 1 sheet, Feb. and Apr. 1974. Hopewell Furnace NHS Maintenance Division, Drawing Files.

1975 "Crane Accessories, Cast House, Hopewell Village NHS." Philadelphia: U.S. Dept. of the Interior, NPS, Mid- Atlantic Regional Office, Drawing No. 376/8003, 6 sheets, Mar. 1975. Hopewell Furnace NHS Maintenance Division, Drawing Files; and Hopewell Furnace NHS Archives, Resource Management Records, Cat. No. 35420, Drawings and Plans, Drawer 25, Folder 10.

1978 "Timber Cranes, Cast House, Hopewell Village NHS." U.S. Dept. of the Interior, NPS, Mid- Atlantic Regional Office, Drawing No. 376/80,0002, 1 sheet, Jan. 28, 1978. Hopewell Furnace NHS Archives, Resource Management Records, Cat. No. 35420, Drawings and Plans, Drawer 25, Folder 10.

1981 "Hopewell Village NHS, Intrusion and Fire Alarm System. Smith- Jacobs, Drawing No. 376/41,0005B, Mar. 1981. Sheet 4 features the cast house and bridge house.

National Park Service
U.S.Department of the Interior

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"Hopewell Village, French Creek Park," 1973. Courtesy Gray's Watercolors, www.grayswatercolors.com.