National Park Service
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Saugus Iron Works National Historic Site
Saugus, Massachusetts

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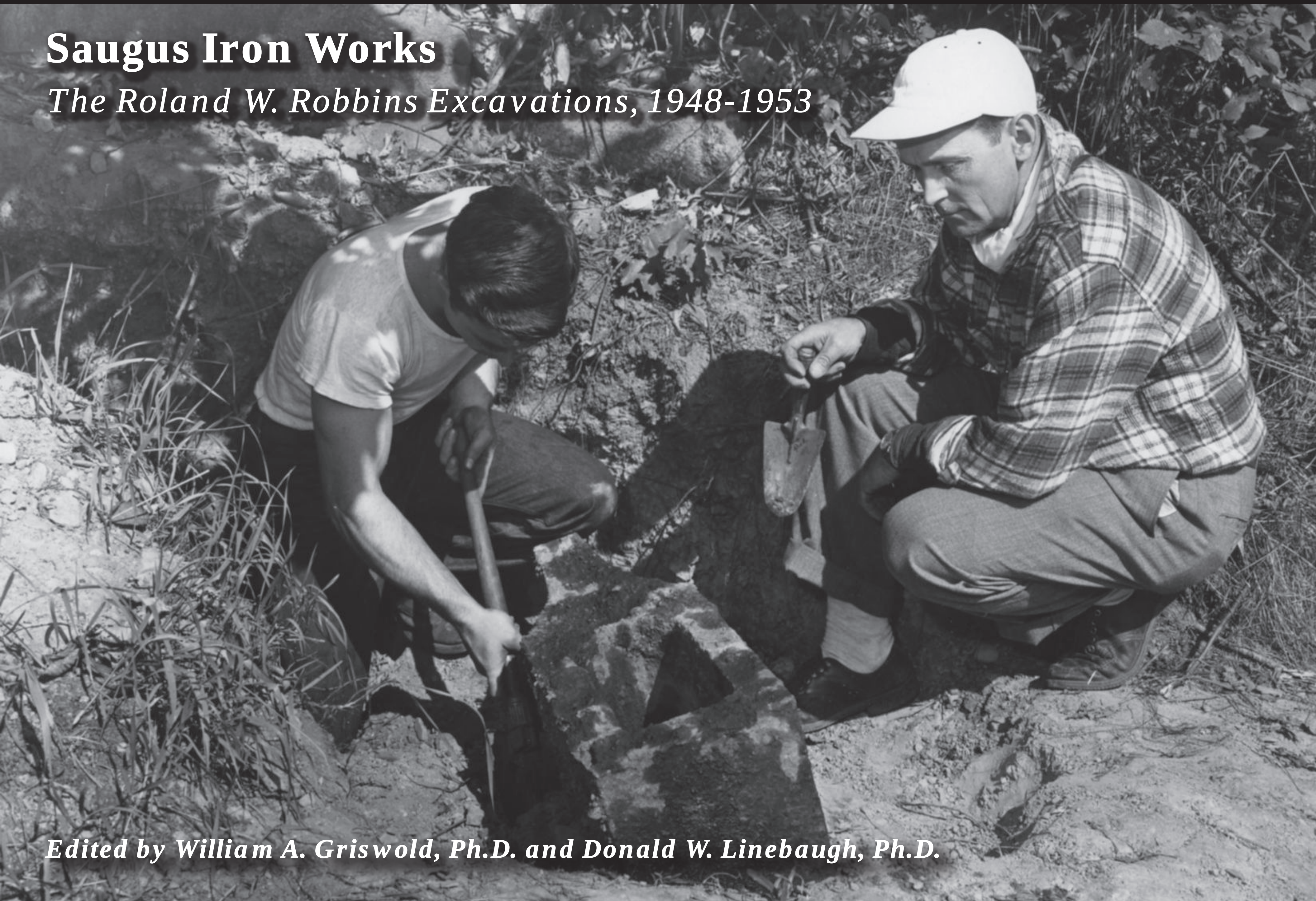
The Roland W. Robbins Excavations, 1948-1953



Edited by William A. Griswold, Ph.D. and Donald W. Linebaugh, Ph.D.

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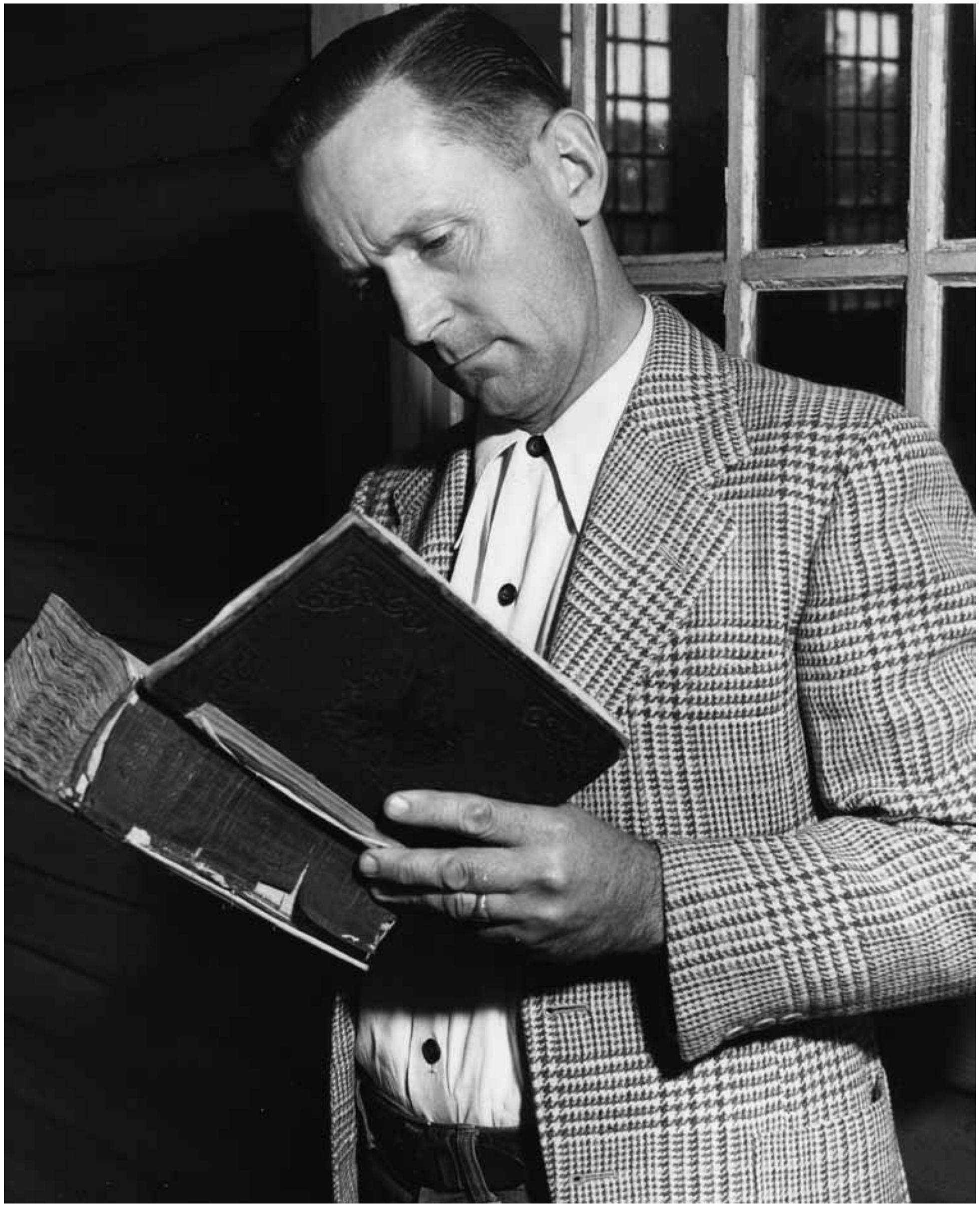
Roland W. Robbins. (Photograph 105 by Richard Merrill, 1949.)



Cover photograph: Saugus Iron Works shortly after the reconstruction was completed. (Photograph 1281 by Richard Merrill, 1954.)

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Massachusetts Bay Colony Tercentenary sign at the Saugus Iron Works. (Photgraph 153 by Richard Merrill, 1950.)

Robbins showing discoveries to a group of Bluebirds and Camp Fire girls. (Photograph 245 by Richard Merrill, 1950.)

Preface

This book had very humble beginnings. Initially, I was simply looking for archeological information about the site in order to plan for some anticipated construction activities at the National Park Service's Saugus Iron Works National Historic Site. The management at Saugus was planning to make the site more accessible to visitors through the construction of Americans with Disabilities Act-compliant paths and internal structural improvements. The accessibility project had the potential to affect archeological resources. As a result, I was asked to draw up an archeological scope of work to comply with the legal requirements of Section 106 of the 1966 National Historic Preservation Act. This was by no means an unusual request, but it was difficult because Roland Wells Robbins, who excavated at the Saugus Iron Works from 1948 to 1953, never published a final report on his work at the site. During his tenure at Saugus, Robbins conducted a very aggressive archeological project, often using heavy machinery to clear large areas of the site. His work provided the foundation for the reconstruction of the Saugus Iron Works in the early 1950s.

Several earlier studies on the Saugus Iron Works had summarized Robbins' work, often identifying areas where he had excavated, but there was still a great deal of ambiguity as to the location of all his excavations and what might remain.[1] As a result, it was very difficult to plan an effective testing strategy for archeological compliance. Speaking from experience, there is nothing worse from an archeological viewpoint than digging a test unit where one has been dug before. It makes for a good deal of expense to cover labor, cataloging, and reporting with little or no reward. Therefore, it became essential for me to delve deeper into the records to try and assess where Robbins had excavated. Ultimately, while I was still unable to map out all of the areas impacted by Robbins, I was able to put together a testing program for the Section 106 review. On the recommendation of the Massachusetts Historical Commission, which reviewed the archeological scope of work for the accessibility project, I contacted Dr. Donald Linebaugh, who had written his dissertation on Roland Robbins and his career in archeology.

Don's dissertation, which focused on Robbins' exploits in industrial archeology, and his subsequent book, *The Man Who Found Thoreau*, made for fascinating reading.[2] The more I read about Robbins and looked into the Saugus project, the more I became convinced that it was time to publish a book on the Saugus excavations. Linebaugh's expertise on Robbins' life and works made him a natural candidate for inclusion in the project and Don graciously agreed to be a co-editor and contributor to the volume. Several individuals at Saugus, including Carl Salmons-Perez, Curator; Janet Regan, Museum Specialist; and Curtis White, Interpretive Ranger, provided extensive and essential knowledge about the earlier project. Naturally, they would also need to be part of the book. Don and I also sought the help of Brigid Sullivan, Chief Collections Conservator for the Northeast Museum Services Center, National Park Service. In addition to these team members, the project would not have been possible without the support of Steven

Kesselman and Patricia S. Trap, retired and current Superintendents of Saugus, who agreed to fund the publication of this book.

In delving into the archives at Saugus Iron Works and the Roland Robbins Collection at the Thoreau Institute, it became clear that there was a huge volume of material pertaining to the earlier excavations. Robbins had captured much of the excavation through daily log entries, maps, drawings, letters, photographs, slides, and movies. Given the amount of information available, I am not quite sure why other enterprising archeologists never published a final report for the project. The large volume of material may have dissuaded interested individuals from tackling the project; even a very devoted, highly-organized graduate student would find the project a daunting one.

Roland Wells Robbins, a part-time house painter, window washer, and jack-of-all-trades turned vocational archeologist, did an extraordinary amount of archeological work in the 1940s, 1950s, 1960s, and 1970s and even into the 1980s. His interest in early industrial sites and his proven ability to produce archeological results meant that he was nearly always in demand for restoration projects, even without any academic credentials. Robbins worked at Saugus early in his archeological career. Prior to beginning the project, he had already gained some notoriety for his excavations of Henry David Thoreau's cabin at Walden Pond.[3] Because of his success at Walden Pond, he was invited by the First Iron Works Association to excavate at Saugus. Even though Robbins left the project before its completion, partly because of health-related issues, he went on to investigate many additional sites within New England, many of them ironworking sites.[4]

Robbins' work at Saugus was supported by the First Iron Works Association (FIWA), a core group of individuals formed to manage the historic Iron Works House. The FIWA was the first group organized, primarily by local supporters, to keep the house and grounds intact. The FIWA Reconstruction Committee, a small subgroup of interested individuals, was led by Quincy Bent, a former vice president of Bethlehem Steel. It is clear from Robbins' logs and associated correspondence that Bent, whose primary mission was the reconstruction of the Iron Works to venerate the American iron and steel industry's beginning, called the shots. While Robbins had some latitude in excavating areas that he found interesting, his primary role was to uncover remains associated with the seventeenth-century ironworks to aid in the reconstruction efforts.

Even though he never produced a final report, Robbins left a well-documented legacy on the Saugus Iron Works excavations. He kept an extensive daily log, noting what he did and where he did it. These detailed entries contain numerous sketch maps and illustrations documenting Robbins' discoveries. In addition to archeological information, the entries contain a great deal of extraneous information about Robbins' health, the weather, thoughts about other people working for the project, contractors, procurement of services, his call to jury duty, etc. To his credit, Robbins took, or had taken, a large number of black and white pictures. The large-format photography done by Richard Merrill, the photographer hired by the FIWA, is truly incredible. Many of the Merrill photographs have been included in this volume. In addition to several thousand still pictures and slides, Robbins also took moving pictures of his excavations, some of which have been incorporated into the visitor orientation movie at Saugus.

In addition to Robbins, the FIWA hired a wealth of experienced professionals to aid in the reconstruction. For example, Dr. E. Neal Hartley, a historian from the Massachusetts Institute of Technology, was hired to write the history of the original ironworks. The result of Hartley's efforts, *Ironworks on the Saugus,* details the history of the facilities at Braintree (now Quincy) and Lynn (now Saugus).[5] Hartley examined the total realm of the Hammersmith ironworks from its inception, through its three managers, and into its eventual decline. However, *Ironworks on the Saugus* also deals with the technology used, the lives of the workers, and the functioning of the company and its sponsors. This exceptionally well done book uses a plethora of historical documents to bring to life the social and legal relationships of the management, workers, and investors in the early iron manufacturing experiment.

I would certainly be remiss if I did not mention others to whom Robbins and the FIWA turned for help, analyses, and advice on the project. Dr. Herbert Uhlig of MIT aided Robbins in metal conservation and analyses and Dr. Elso Barghoorn of Harvard's Biological Laboratory did the same for wooden items. Other individuals included Dr. Laurence LaForge (geology), Barbara Lawrence (faunal analysis), Ruth Watkins (ceramics), Malcolm Watkins (ceramics and artifacts), Jack Lambert (forestry), and many, many others.

Robbins wrote final reports for many of the sites that he excavated and the lack of one at Saugus is somewhat puzzling. Certainly no one would have been in a better position to write a final report than Robbins, but he never produced one. It became clear in the final months of his involvement with the project that he felt intimidated by the management at the First Iron Works Association. This intimidation led Robbins to the conclusion that a final report would never be politically possible, but he never really elaborated on why he thought this way. Robbins' role changed toward the end of his employment with the project. He thought that the archeological discoveries no longer drove the reconstruction effort. Many of the decisions made by the architects and FIWA members flew in the face of the archeological discoveries. The reconstruction of the forge was a case in point. While Robbins found two anvil bases the final reconstruction included only one. Robbins became almost despondent that he could not convince the association that the forge would have had two hammers.

It is perhaps a bit fortuitous that the project is only now coming to fruition. This is not to say that Robbins would have produced a bad report if he had done one (although it may have been short on details), but the advent of computer technology has greatly facilitated and enhanced the completed project. Janet Regan, Carl Salmons-Perez, and park volunteers have scanned and digitized most of the information about the project including Robbins' logs, maps, photographs, and correspondence. This has made the study and assessment of the records and photographs possible at a distance and has allowed the various authors to work on their respective chapters without rummaging through the collection.

Robbins focused on the seventeenth-century remains to the near exclusion of other periods, the precontact period being a case in point. While Robbins' notes occasionally mention the discovery of precontact finds (most from historic-period deposits), Robbins never devoted much time or energy to them. The compliance work done for the accessibility project hints at the importance of the site for the precontact era. For example, in a single one-by-one meter unit, close to 1,000 lithic flakes and tools were identified; other one-by-one meter units exposed intact pit features. Indeed, even briefly comparing the collection housed at Saugus with other systematic archeological collections illustrates the wide variety of tool types and materials that could have been reported more completely.

While Robbins paid only passing attention to the precontact-period resources, he focused on the larger seventeenth-century elements of the site with great success. Robbins unearthed numerous building foundations, waterwheels, and activity areas at Saugus. Although only a select few were reconstructed, Robbins' excavations greatly shaped the reconstruction for the furnace, forge, and to a lesser extent the slitting mill. The three buildings associated with the Jenks' area were never reconstructed, nor were the buildings on the plateau above the ravine, including a charcoal house and other miscellaneous structures.

Trained archeological crews would have recorded the discoveries in greater detail than Robbins did–that is indisputable. However, it is doubtful that trained archeologists would have made as many archeological discoveries or fulfilled the mission of the FIWA as completely as Robbins did. Rarely do archeologists get a chance to excavate as much of a site as he did at Saugus. Usually money and time constrain archeological projects. While some monetary and time constraints were placed upon Robbins, he operated on a budget and schedule that would make most professional archeologists jealous. While a few professional archeologists conducted large projects at the same time in various areas of the world with great proficiency, many of those projects were not nearly as well recorded and documented as Robbins' work at Saugus. His infamous reputation among professional archeologists is not entirely deserved.

In the last couple of years of the project, Robbins began to complain about his health and sought medical help. While no biological abnormality was found, the symptoms that he describes in his log entries seem to be stress related. Often the doctors would tell Robbins to get away for a while and leave Saugus alone. At times Robbins took their advice, if only for a limited time. In some instances, it seemed to help.

In his log entries, Robbins describes a multitude of duties that often required his attention at all hours of the day and on all seven days of the week. This schedule, coupled with the dysfunctional nature of many of the personalities involved with the project (at least as far as Robbins was concerned), would have served to stress almost anyone filling Robbins' shoes. He lived to a ripe old age so it seems that none of the stress that he experienced at this point in his life had any long-term health implications.

The archival collections used for this book primarily come from two places. The Saugus Iron Works contains a large and rich archival collection. This collection includes most of the FIWA papers and correspondence; Roland Robbins' logs, field note cards, maps, and personal slide collection; Richard Merrill's photographs; Charles Rufus Harte's papers and photographs; many of the Perry, Shaw, and Hepburn, Kehoe and Dean drawings and sketches for the reconstruction; the Lencicki and Sherman filmstrip on Saugus ironworks; Charles Overly's paintings; several reels of Robbins' period excavation footage; and taped interviews with Roland Robbins, J. Sanger Attwill, and Conover Fitch. The Thoreau Society/Thoreau Institute in Lincoln, Massachusetts, also has an extensive collection of documents pertaining to the Saugus project and other projects that Robbins engaged in throughout his life. While most of the Saugus Iron Works collections have been cataloged, the Thoreau Institute collections have not. We have tried to provide as much information as possible in the citation of sources to aid researchers who may want to continue the research.

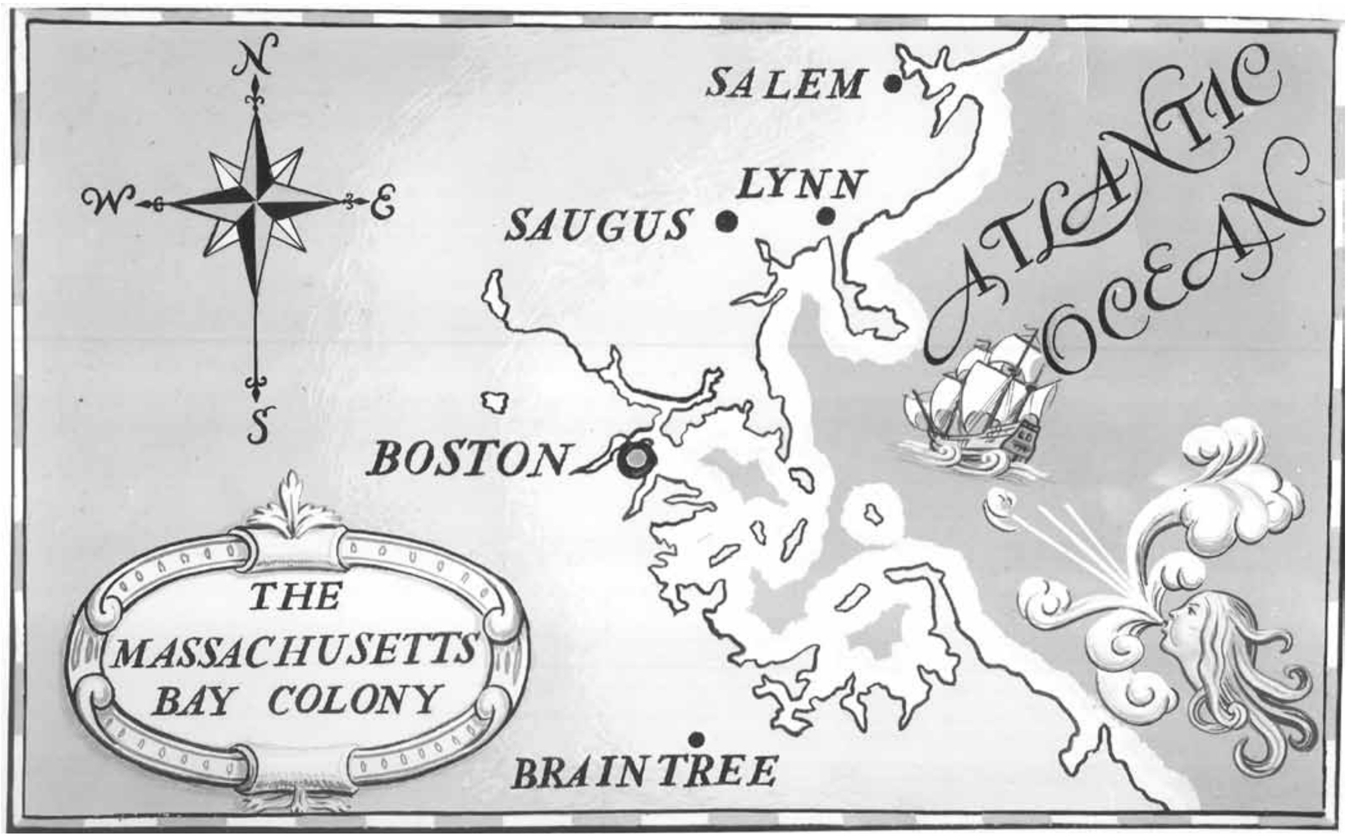
The following chapters tell the story of the Saugus excavations through the lens of over fifty years of hindsight. They depict the dramatic highs and lows of the project and document the thoughts and actions of the individuals involved. As extensive as the book may appear, the reader should realize that this is only the beginning. Numerous studies and theses are concealed within the vast archives, waiting for others researchers to tell more stories. Toward this end, Saugus Iron Works will continue to put these resources on line to spur the interest of individuals willing to undertake the very rewarding task of additional analyses. We hope that the following pages provide as much enjoyment to readers as the team had in putting together the book.

William A. Griswold

Acknowledgments

This book could not have been written without the cooperation of many individuals. The editors would like to extend a word of sincere thanks to those individuals who helped make this book possible including former Saugus Iron Works Superintendent Steven Kesselman, who agreed to support the project, and current Superintendent Patricia S. Trap, who found money to pay for the printing and distribution of the volume. The contributors to this book (Janet Regan and Curtis White of Saugus Iron Works and Brigid Sullivan of the National Park Service's Northeast Museum Services Center) deserve special recognition for their devotion to the cause. The expert knowledge of park resources embodied in these individuals instills completeness to this work. Carl Salmons-Perez, Curator of Saugus Iron Works, and Jeff Cramer, Curator at the Thoreau Institute, both shared their various resources without hindrance. Special thanks are also extended to Suzanne Linebaugh who did the technical editing for the completed manuscript. Thank you all!

We also wish to thank the Thoreau Society for access to the Roland Robbins Collections. Established in 1941, The Thoreau Society is the oldest and largest organization devoted to an American author. The Society has long contributed to the dissemination of knowledge about Thoreau by collecting books, manuscripts, and artifacts relating to Thoreau and his contemporaries, by encouraging the use of its collections at the Thoreau Institute at Walden Woods, and by publishing articles in two Society periodicals. The Thoreau Institute, where the Society's Collections reside, is owned and managed by the Walden Woods Projects (for more information, visit www.walden.org). For more information about The Thoreau Society, visit www.thoreausociety.org.



1.1 Map illustrating the location of Braintree, Lynn, and Saugus from a filmstrip produced for the First Ironworks Association. (Image by John Lencicki and Lee Sherman.)

The History Behind the Iron Works Industry

William A. Griswold

The Europeans who settled in North America from 1607 onward could apply their metallurgical skills to ore, wood fuel, and water-power resources far more abundant than those they had known at home. A few decades after John Winthrop Jr. started his Saugus, Massachusetts, ironworks in 1641, many colonies had smiths, founders, or smelters among their inhabitants. By 1770 the American colonies had made themselves the world's third largest iron producer.

Robert Gordon, *American Iron 1607–1900,* p. 1.

Of all the industries that have contributed to the development of the modern world, few have had as great an impact and lasting effect on society as the iron industry. For millennia, people in various places around the world have used iron to engineer and advance technological change, to solidify social and economic relationships, and to wage war. The effect of iron upon our modern world is so pervasive that life is almost unimaginable without it.

The American entry into the iron industry began early in the colonial period. Early attempts were made at Falling Creek, Virginia (ca. 1621–1622), and at Braintree, Massachusetts (c. 1644–1647), before they were begun at a site known as Hammersmith in what was then Lynn, Massachusetts. What made Hammersmith special was that it was the first site to successfully implement the full range of iron production and refinement at one facility producing cast iron, refined bars, and nails. It was established by a consortium of English and colonial investors, the same ones that had set up the earlier Braintree operation. Hammersmith, now commemorated at the Saugus Iron Works National Historic Site, has been partially reconstructed to educate visitors about colonial iron production and refinement.

This chapter provides readers with background to better understand the following chapters on Hammersmith and Roland Robbins' archeological excavations at the site. Information on iron production, including discussions on ingredients, techniques of manufacture, and spatial layout, are presented to illustrate just how complex the Saugus Iron Works really was and what a truly industrial undertaking it represented.

From Bloomeries to Coal-Fired Furnaces: A Brief Historical Review of Iron Technologies

For many years now, archeologists and historians alike have used an evolutionary framework to describe the development of civilizations based on the utilization of different metals. The Chalcolithic, Bronze, and Iron ages are used to classify civilizations based on the predominant type of metal used. The earliest, the Chalcolithic Age, is a term given to an era in which people developed and used copper and copper tools. Following the Chalcolithic is the Bronze Age, named for its dominant metal, an alloy of tin and copper. Finally, during the Iron Age, people developed and manufactured a metal that, in many cases, was far superior to either bronze or copper for making tools. In addition to providing an evolutionary scheme of development, these terms also reflect the technological complexity required for their namesakes' manufacture; copper is the easiest to manufacture, followed by bronze and then iron.

The technology necessary to manufacture iron has existed for several millennia. While certainly not the dominant form of metal, several iron objects have been dated to contexts prior to the traditional beginning date for the Iron Age in parts of the world.[1] For most of its period of manufacture, iron has traditionally been made in bloomeries. A bloomery is a "furnace in which iron ore is reduced directly to solid iron and liquid slag with charcoal fuel."[2] The key distinction of bloomeries is that they never produce liquid iron. For thousands of years, people produced iron in relatively small quantities using bloomeries. Indeed, the Romans manufactured all of their iron in bloomeries. Some liquid iron had been produced in the earlier bloomeries, but had been discarded because it lacked the desirable ductile qualities.[3]

Beginning sometime during the middle of the second millennium A.D., after uses had been found for cast products, a new manufacturing process known as smelting was introduced.[4] Iron smelting, using a charcoal blast furnace, actually converted the iron into a liquid that could be molded into given shapes as it cooled. This technology represented a significant step forward in the complexity of iron production. While blast furnaces produced much larger amounts of iron, they required greater amounts of raw materials, continuous operation and maintenance while functioning, a more complex division of labor, and a significant investment of capital. The conversion from bloomeries to charcoal blast furnaces did not happen overnight, but took years to complete. Manufacture by bloomery and by blast furnace co-existed for some time, with production largely determined by demand. Once the conversion to charcoal blast furnaces had been completed, most producers lost the incentive to make relatively small quantities of iron for immediate needs with limited sales. Instead, these smaller-scale technologies were replaced by truly industrial operations, years before the coming of the noted industrial age.

The charcoal blast furnace was not the end of the story of the technological development of the iron industry. The charcoal furnaces, as with the bloomeries that preceded them, saw their age of glory come and go. Coked coal replaced charcoal as the primary fuel type for smelting iron in the early eighteenth century after Abraham Darby's successful substitution and steel later replaced iron when Henry Bessemer introduced the process for manufacturing steel that now bears his name.[5] Numerous other technological improvements have been made in the manufacture of iron and steel through the years since Bessemer. While it might be a stretch to say that the production and refinement of iron is the most important technological development in history, the development of the iron-making industry certainly has helped to shape the world we live in.

The story of even so seemingly prosaic a thing as the establishment of the early iron industry in America is in itself an epic. What a lot of persuading, what long and perilous journeys it often required, to get capital for mining and manufacturing of iron in those first hard years in the colonies! What an adventure, what a gamble it was to set them up in the wilderness! And how often the industries were built up only to be totally destroyed, as in that first Virginia venture, or to be abandoned because the ore gave out, or the capital gave out, or the home government legislated against them. Here was a fitting task for heroes.

Albert Sonn, *Early American Wrought Iron*, Vol. III, p. 3.

Essential Elements for Successfully Smelting Iron

When scouting for an area in which to establish a new iron-smelting facility, early ironmasters asked themselves many questions. Did the area have suitable topography for construction of a furnace and

1.2 Workers casting iron. (Photograph 1460 by Richard Merrill, 1958.)

charging bridge? Was there a good and plentiful supply of water? Were the surrounding landforms suitable for constructing water-control features, i.e., dams, canals, headraces, waterwheels, tailraces, penstocks, etc.? Were there plentiful raw materials available in the area, i.e., iron-bearing ore deposits, fluxes, and wood for making charcoal? How close could these supplies be procured if local supplies ran out? Could supplies be brought to the site easily? Could the finished product be transshipped easily and cheaply to markets or refineries? Was there an available labor supply?

Since the establishment of a smelting facility involved considerably larger-scale manufacturing than a bloomery, investors were usually involved to some extent and the answer to many of these questions then became a matter of economics. Theoretically, a company could always get supplies to a facility, produce marketable goods, and then ship them out to markets. The key was to be able to do so and turn a profit. There was a certain economic cutoff at which a corporation produced and shipped a marketable product and yet lost money and failed to remain in business. Therefore, iron-making sites were chosen very selectively. The better the selection process, the more likely that the company would turn a profit. Profit, however, was never a forgone conclusion for these early iron-making ventures, no matter how suitable the location.

Suitable topography was very important for the establishment of an iron-smelting facility. Special landforms, usually a hollow or a valley, were needed to construct a blast furnace so that a charging bridge from an elevated ridge or plateau could reach the top of the furnace structure. Likewise, a facility needed a pond, dam, spillway, and canals to channel water to the furnace and finery. Some of these features could be constructed, especially the water-control and water-delivery systems. However, in most cases the ironmaster sought natural landforms for the site to limit the amount of labor necessary to create the facility. The construction of an iron-production facility already represented a huge investment of time and money and the ironmaster and the investors wanted to limit the amount of work needed to get the facility built and operational.

A plentiful supply of water was essential. In most cases, a river or stream supplied the water. To control for seasonal variation in the water and to ensure an uninterrupted flow of the correct amount of water for months on end, several water-control features had to be created. These included a dam, or a series of dams, spillway(s), canal(s) (variously known as a headrace, flume, and channel), gates, waterwheels and wheel pits, and tailraces. Extraordinary care was used in the construction of the entire water-distribution system. Dams were built for permanency; spillways, headraces, waterwheels, waterwheel pits, and tailraces were constructed out of wood or other durable materials. The dam, or bay as the English call it, served to impound the water. Depending on the location and the topography, this dam and the subsequently created pond could be quite large. Usually, water from a river or stream was diverted through a canal from the river to the pond. Depending on the setting, some sort of water-control device, such as a gate, was usually placed along the canal or in the river or stream to control the amount of water being

We have no record of [Saugus ironmaster Richard] Leader's search for a new and better site. He must have engaged in much the same kind of location surveying that Winthrop and his men had carried out, tracking down reports of ore deposits, checking on availability of water power, pondering the relative merits of wilderness and settled regions, and keeping an eye open for prospects of sales and transportation of finished products. Ten miles north of Boston, on the banks of the Saugus River, in that section of old Lynn which is now Saugus, he found a spot which had been overlooked in Winthrop's survey but which clearly had distinct advantages.

E. Neal Hartley, *Ironworks on the Saugus*, p. 123.

1.3 Exploring a new environment. (Image 2219 by John Lencicki and Lee Sherman.)

diverted into the pond. The dam could fail if too much water accumulated in the pond, so most systems had a spillway to allow water to be released rather than overfill a pond. Breaches still occurred, however, often with devastating results.

Once contained, the water had to be channeled from the pond to the furnace, forge, and other buildings and features that required waterpower to operate. In most instances, a headrace was built from the dam to the buildings requiring waterpower, with a gate or two along the way to regulate the water flow. The penetrations in the dam were usually the weakest point in the water-control and -distribution system. If water was allowed to migrate outside of the various features, the whole system could fail. Provided that the canal was set up correctly and diligently monitored, it would provide enough water to power the facility without interruption for months. Once the water entered the headrace from the pond, it flowed to the waterwheel. When additional water was required, the gates could be opened or flashboards could be added to the dam to raise the level of the pond. When less water was needed, the gates could be closed or the flashboards taken away.

There are three types of waterwheels: the overshot, undershot, and breast wheels. The overshot wheel, as its name implies, was powered by water that was delivered to the top of the wheel. Water fell from the headrace into buckets that were integrally attached to the circumference of the wheel and gravity pulled down the filled buckets to make the wheel turn. At the bottom of the wheel, the water was dumped out of the buckets and was carried away through the tailrace. The water could then either be diverted to another waterwheel or allowed to return to the river or stream of origin. While more expensive to construct because it required a dam and an elevated headrace, an overshot wheel was much more efficient and could deliver approximately twice the power as an undershot wheel.[6]

An undershot wheel delivered water to the bottom of the wheel. The force of the water pushed the flat blades and turned the wheel. The water was then returned to the river or stream from which it was originally drawn. The undershot wheel did not need a headrace to work, but it was much less efficient and provided much less power than the overshot wheel.[7] Water struck the breast wheel midway along its circumference, horizontal to the shaft axis. This wheel can be thought of as something in between the overshot and undershot wheels, in both design and efficiency.

Once a furnace was fired up, the inside of the furnace cured, and iron production begun, it could not be interrupted without great expense. If a furnace was blown out or extinguished, it had to be rebuilt, causing a one-or two-month delay before high-quality iron could again be made. Therefore, it was imperative that the iron-smelting production process not be disrupted. Once begun, smelting operations were continued twenty-four hours a day, seven days a week, for much of the year. If a dam were breached, a headrace system collapsed, a gate failed, or a waterwheel broke, it often represented a great expense in lost manufacturing capacity.

No documentary data on wheel construction have survived. In recent excavations, however, a fair portion of the furnace wheel and essentially all of the pit in which it turned were found intact. The craftsmanship of some colonial wheelwright is abundantly plain in the excavated specimen. The dimensions and type of the other wheels are not definitely known, although it is clear, both from general archeological evidence and from their known or assumed functions, that all were quite large, that one was an undershot, the others overshot or pitch-back.

E. Neal Hartley, *Ironworks on the Saugus*, p. 183.

1.4 The reconstructed overshot waterwheels at the Saugus Iron Works slitting mill. (Photograph 1419b by Richard Merrill, 1957.)

The location of raw materials, iron ore in this case, was another consideration when ironmasters selected the location of an ironworks facility. The ore was usually heavy and was used in large quantities. To cut expenses, it needed to be available within close proximity to the processing facility. A limited supply of local ore created a problem with the Braintree facility; the supply of ore ran out and caused the facility to shut down.[8]

Diderot's eighteenth-century *L'Éncyclopédi*é identifies several ore mining methods. Most were likely used for thousands of years prior to their discussion in *L'Éncyclopédi*é. Mining approaches included shaft mining, a very dangerous method requiring deep excavation into the earth; strip mining of ore-bearing deposits, a much less dangerous technique than shaft mining; and what appears to be a form of wet dredging of ores.[9]

Once the raw ore had been obtained, it had to be washed and in some cases allowed to age. Washing of the ore was necessary to remove material that could not be smelted. Adding too many impurities to the furnace would cause a number of problems, from producing poor-quality iron to creating bears, or blockages, in the furnace that required it to be blown out. Workers separated as many impurities from the raw ore as possible before it was added to the furnace. *L'Éncyclopédi*é documents several methods used to purify the ore, including basket washing, basin washing and water-powered agitation.[10]

Mining of the flux was done in much the same fashion as the raw ore. Flux, when added to the iron ore and charcoal in the furnace, helped to separate impurities into slag and promoted the efficient smelting of the iron. Limestone was one of the most common flux agents used in the production of iron. Other flux agents included coral and gabbro, a dense igneous rock. The Saugus Iron Works used gabbro obtained in Nahant, Massachusetts.[11] Because fluxes were used in smaller percentages than either iron ore or charcoal, their ready availability was not as important. A supply would likely have to be transported to the site by horse-drawn cart or by boat.

Early blast furnaces required large amounts of charcoal to fuel the smelting process. Charcoal was created by the incomplete combustion of wood. Collection and seasoning of wood involved considerable time and forethought. At a typical ironworking site, more people participated in wood chopping for the production of charcoal than any other task.[12] Because wood chopping was not a specialized skill, farmers would often do it during the non-agricultural months, generally November to April.[13] Wood required seasoning before it could be converted into charcoal. In the seventeenth-century, this involved stacking the wood to allow the air to circulate, which prevented the growth of mold. The minimum period for seasoning was half a year, during which time the wood lost much of its sap and became more compact.[14]

After the wood had seasoned it was converted into charcoal, which was a specialized process performed by a collier. The collier oversaw the whole charcoal-production process. The seasoned wood

Washing, whereby the ore was cleansed from earth and clay, was still practiced in the seventeenth and eighteenth centuries in parts of Britain. Another method was weathering: the ore dug up at the mine was left in a heap and exposed to the weather for a considerable time. At Rievaulx, in Yorkshire, it was the rule as early as 1541 that the ore, after it had been "gathered", was exposed to the weather for at least half a year so that it could lose its earthy parts, otherwise "ther will be much losse in cariage" of it to the smelting place.

H. R. Schubert, *History of the British Iron and Steel Industry from c. 450 B.C. to A.D. 1775,* pp. 215-216.

1.5 Costumed interpreters working in the blast furnace. (Photograph 1215 by Richard Merrill, 1954.)

was stacked in a domed pile around a central pole on a large cleared area, usually thirty to fifty feet in diameter.[15] This pile typically contained several layers of wood stacked at various levels approximately twelve feet high. The stack was then covered with leaves and charcoal dust, with several ventilation holes poked through the covering around the base.[16] The pile was ignited and the collier, with the help of his assistants, allowed the wood to burn enough to produce charcoal but not so much that it became ash. In some cases, the pile required additional leaves and coal dust to limit combustion or additional ventilation holes to encourage combustion. The collier was extremely knowledgeable about his craft and would tend the burning pile night and day for two weeks until the process had been completed.[17] The collier then would allow the pile to cool before opening it and removing the charcoal. The charcoal was loaded onto wagons or carts and transported to the furnace or forge. Because the charcoal was easily ignited, it was usually stored in a covered structure near the furnace that protected it from sparks.

Pale blue smoke from the vents meant the pit was burning evenly. Heavy white smoke meant a poorly charring pit, usually from too much draft which caused too fast a burning. Blue smoke spiraling quickly indicated an opening.

Susannah Wilson Brody, *The History of Dowlin Forge*, p. 72.

When making charcoal, colliers selected certain features.[18] Broadleaved trees were preferred because of their higher carbon content and because they gave greater heat than coniferous trees.[19] The size of the charcoal was also a major consideration. Charcoal larger than about five to six centimeters in diameter was more easily reduced to dust when transported or crushed to dust by the furnace charge.[20] Charcoal dust was undesirable because it lowered furnace efficiency. Historically it was either given a very low price or discarded.[21] This served as an incentive to conduct cyclic coppicing or fresh cutting stump growth, in England.[22] Coppicing ensured the regrowth of trees without planting and allowed the selection of smaller-diameter wood for conversion to charcoal.

The fragility of charcoal and the cost of transporting it limited the catchment area for ironworks, at least in Britain, to between three and five miles.[23] According to one study, a five-mile radius covers about 50,000 acres; a big blast furnace and finery could work indefinitely and refine 530 tons of bar iron with about 13,000 acres of woodland.[24] The charcoal needs of the ironmasters, coupled with the charcoal needed for other industries like glass works, potteries, and shipbuilding, necessitated the maintenance of adequate forests; the seemingly endless woodlands of the New World offered a secure resource base compared to England's rapidly declining forests.

Typical Organization of Ironworks Sites

There is no evidence to suggest that early iron-making sites followed a planned organizational layout. However, almost by definition, ironworking sites required certain primary structures and activity areas and other areas relating directly to iron smelting or iron fining or to housing workers, animals, and supplies. Another way to look at the organization of ironworking sites is to break them down into smaller areas or building groups that supported the ironworks (industrial) and those that supported the workers

1.6 Basket of charcoal. (Photograph 1534 by Richard Merrill, unknown date.)

and their families and possessions (domestic). Some overlap in these categories occurred; for example, horses and oxen served both the industrial and domestic sectors.

Industrial Core

The industrial core can be defined as those buildings, structures, or features necessary for the production and fining of the iron. This would include buildings like the blast furnace, finery, chafery, warehouse, and charcoal house, raw material storage piles, curing areas, canals (headraces and tailraces), ponds, dams, spillways, waterwheels, wheel pits, stables, cart and wagon storage areas or buildings, slitting mills, blacksmith's shop, casting shed, roads, boats, etc. All of these would have related directly to the production of cast- or wrought-iron products.

The principal structure for an iron-smelting facility was the blast furnace. Diderot's ***L'Éncyclopédi***é describes a blast furnace as "a stomach which demands feeding steadily, regularly, and endlessly."[25] The analogy to a stomach is a useful one; if the furnace was overfed or fed foods not to its liking, a wide variety of things could happen, ranging from producing poor quality iron to causing a fiery explosion. Once it began eating, the furnace required not only food that it liked, but also around-the-clock feedings. The furnace tenders had to be especially careful to give the furnace what it needed and to quickly treat the symptoms if it showed any signs of illness.

In principal, a seventeenth-century blast furnace was a relatively simple system. Ore, flux, and charcoal were added to the top of the furnace through an aperture. This load would move down though a large chamber where the heat produced by the charcoal, enhanced by regular, forced blasts of air from a bellows, would melt the iron ore. The liquid iron would flow down the furnace, pulled by gravity into a collection chamber. The slag, or impurities from the ore, floated on top of the liquid iron and could be skimmed off at regular intervals. Once enough liquid iron had accumulated in the collection chamber, the tap hole would be opened and liquid iron would rush out to fill whatever casts or molds the iron-casters had prepared. At times, this type of iron was used make firebacks for fireplaces or was dipped and poured into castings. In most cases, however, this melted iron was used to make iron pigs and/or sows.[26] Pigs and sows are the casts of elongated bulk quantities of liquid iron intended for the finery. They are described as such because of their resemblance to a mother pig suckling piglets.

While the smelting process sounds relatively simple, it involved great danger and many things could go wrong. The tuyère, or pipe that directed the bellows blast into the furnace, might get clogged. Additionally clogs might form in the furnace itself, the furnace lining could crack, ingredients might be added in the wrong proportion, or water might come in contact with the liquid iron, all of which might have potentially lethal consequences. Workers had no defense against the danger of explosion. ***L'Éncyclopédi***é notes that for "workmen and plant alike, eruptions are the most terrible danger. They bring death to

Comparison of Ardingly with the only other Wealden forge excavated, at Chingley, reveals the same basic elements on both sites, i.e. power hammer, hearths, and water-channels; what varies is the way in which these elements are arranged. At both forges, the anvil base consisted of a section of tree trunk, but at Chingley it was braced by radial beams, whereas at Ardingly, the tree trunk was held in place by three external beams forming an open triangle.

At both forges, there were two approximately parallel water-channels. At Chingley, one channel supplied power, via different wheels, for the hammer and chafery hearth; a second channel provided power for the finery. At Ardingly, both hearths were operated from the same channel, the hammer by a wheel in the other channel.

Owen Bedwin, "The Excavation of Ardingly Fulling Mill and Forge, 1975-76", *Post-Medieval Archaeology* 10 (1976), p. 50.

1.7 Reconstructed collier's hut from Hopewell Furnace National Historic Site. A structure like this would have sheltered the collier when the charcoaling process was underway. (Photograph by William Griswold, 2004.)

those nearby and spread fire far and wide. In a sudden explosion, a furnace will throw up all its contents, molten and solid. It becomes a volcano vomiting flaming fragments from every opening."[27]

The furnace had to be shut down and rebuilt only once or twice a year under normal conditions. Otherwise, it ran night and day, seven days a week, for months on end. In 1550, furnaces typically ran for 25 continuous weeks. By 1646, Sir James Hope reported that Barden furnace normally ran for 45 continuous weeks. Improvements in the smelting process and the use of better materials for hearth construction allowed for longer periods of operation.[28]

Before the charge was fed into the furnace, the interior had to be well heated in order to get rid of all moisture which might evaporate from the walls. This was termed "seasoning the furnace". It was particularly necessary because of the open top aperture through which rain and snow might fall. According to the available evidence the preliminary heating took from three to eight days, mostly from three to four. The fuel used was charcoal, sometimes with an admixture of peat, or, very frequently, of mineral coal.

H. R. Schubert, *History of the British Iron and Steel Industry from c. 450 B.C. to A.D. 1775*, p. 234.

Because the blast furnace operated continuously, it required a large labor force. While worker's shifts seem long by twenty-first-century standards, replacement crews were needed every day, week in and week out, while the furnace was in blast. Shift work in some form or fashion would have been required to keep the furnace in blast. This represents a quantum step toward industrialization, one that would have been foreign to most agriculturally based societies around the world. This change served as a harbinger of the industrialization that materialized more than a century later.

*L'Éncyclopédi*é indicates that the furnace was replenished with a charge as soon as the old charge had settled enough to make room. The new charge consisted of about 230 pounds of charcoal, 500 pounds of ore, 50 pounds of limestone, and 20 pounds of argillaceous earth as a lubricant. These ingredients were added in a particular order and ration: three baskets of charcoal, half a basket of limestone, and two more of charcoal were added to give the surface a tilt angle of approximately 30°; to this were added ten baskets of ore. The tilt was necessary to prevent the crushing of the fragile charcoal and to prevent the ore from going straight through the center.[29] "A single charge would move through the blast in 12 to 14 hours," according to *L'Éncyclopédi*é, "and in a good week the furnace would produce 6 or 7 tons of pig iron."[30]

The casting house was usually adjacent to, if not integral to, the blast furnace. In the casting house workers cast sows along with a variety of other products like firebacks, kettles, pans, and andirons. These items were cast either in the fine sand that lined the floor of the house or in specially prepared molds. While the liquid iron ran through troughs in the sand to form the sows, it had to be ladled into the various ceramic or sand mold shapes. The sand was moistened with water, but could not be too wet or the gases generated by the liquid iron and water would bubble up through the iron rather than through the sand.[31]

Output from blast furnaces varied from place to place. It was dependent upon the percentage of iron in the ore being smelted, the type of charcoal being used, and the size of the furnace itself. Schubert indicates in his book, *History of the British Iron and Steel Industry from c. 450 B.C. to A.D. 1775*, that output increased from about one ton in twenty-four hours to two to three tons in the same period from

1.8 Blast furnace charging hole. (Photograph 629 by Richard Merrill, 1952.)

the second half of the sixteenth to the mid-seventeenth century.[32] These figures are likely similar for ironworks outside of Britain, especially America where the materials were much more abundant than in England.

Pig iron produced directly from the furnace was brittle because of its relatively high carbon content. To be useful for tools or nails, the carbon content of the metal had to be reduced. A forge (finery and chafery) was not necessarily an integral component of a blast furnace operation. A furnace was really a special operation, because it required tending around the clock, by numerous people, and required a dedicated water flow to power the bellows. It could produce a product (sows or pigs) that could then be sold to various forges for refining. A finery or forge was not nearly as demanding an operation as a furnace. It required many fewer people to run, did not necessarily need around-the-clock attention, and could utilize less stable water sources. For these reasons forges could exist independently of furnaces, purchasing sows for refining. In the finery, the metal sows and pigs were remelted, which burned off more of the carbon, and collected into a loop at the base of the forge; a loop was a mass of partially refined iron. This loop was hammered (by hand and by power) into a bloom, which was then reheated in the chafery hearth and trip hammered, gradually drawing it out into an anchony (dumbbell) and finally into a long bar that could be sold directly to blacksmiths or other metal crafters. The process of refining created flexible and durable wrought iron.

Seventeenth-century colonists brought the fining process to America. A finer melted pig iron in a small hearth containing a charcoal fire blown with a strong air blast. The air oxidized the carbon and silicon in the pig. As did a bloomer, a finer made a loup, a mass of solid iron particles and liquid slag, in the bottom of his hearth. He hammered the loup to consolidate the metal and expel the slag.

Robert Gordon, *American Iron 1607–1900*, p. 125.

In addition to the furnace, casting house, and finery and chafery, ironworks required numerous other buildings or features. A warehouse or storehouse was needed to store the sows, castings, and wrought-iron bars if the facility had a forge. This warehouse was located near a water body if the goods were to be moved by water or by a road if the goods were to be moved overland. It was much less expensive to ship materials by boat than by wagon.

Charcoal would have been housed in a roofed structure to protect it from moisture and fire. The charcoal house would have been large enough to store the huge amount of charcoal needed to supply the furnace and forge. In some cases, the iron ore was also allowed to season in large open-air piles. Whether a seasoning process was involved or not, ironworking sites would have had large numbers of iron ore and flux stockpiles, located close to the charging hole of the furnace. It is highly unlikely that the iron ore or the flux would have come to the site in the sizes needed for the smelting operation. Therefore, facilities were needed to refine the raw materials for the furnace. Logistically, the most appropriate place for such a refining facility would be between the raw material stockpiles and the furnace.

If the raw materials were being transported to the site overland and/or finished products were shipped by horse and wagon, good roads were needed. These roads would have needed to be passable at all times while the blast furnace was in operation. Roads to the site itself and from the charcoal collection points in the wooded areas beyond the site would also have been necessary. A stable would also have

1.9 Costumed interpreter working at forge hammer. (Photograph 1216 by Richard Merrill, 1954.)

been required to house the teams of horses or oxen needed to bring in supplies and ship the finished products. In addition, the horses or oxen would have required pasturage in the warm months and hay or other food in the cold months. If the iron ore, flux, or finished goods were being transported by boat, a dock or wharf would have been necessary. Depending on the size of the operation and the organization of the site, several docks may have been required.

Other structures may also have been found in or around ironworking sites. A blacksmith's shop or work area would have been a likely subsidiary structure, as would a pottery for making molds for the casting products and a carpenter's shop to produce the wooden machinery and buildings. Rolling and slitting mills, where iron was rolled into sheets and then cut into strips, and, later, stamping mills, where slag and cinders were crushed to be resmelted, have also been identified on many ironworking sites.

In addition, dozens of people would have been involved in the ironworking operation: laborers and colliers to chop the wood and to turn it into charcoal; miners to dig up the ore and flux and to process it into usable materials; wagon masters and boatmen to move raw materials to the site and the finished products to market; shipwrights and carpenters to build and maintain the boats, wagons, buildings, dams, races, and equipment at the site; animal handlers to care for the horses and oxen that drew the carts for the raw materials and manufactured products; ironworkers to charge the furnace and smelt, cast, and refine the iron; and accountants and overseers to control and track the production and operation of the facility. Such a complex facility could not operate independently of a settlement that provided the necessities of life. Given its complexity, the seventeenth-century ironworks truly amounted to an industrial operation.

Domestic Core

An extraordinary number of people were required to maintain the industrial operation at a blast furnace. These people, in turn, required numerous buildings, structures, and activity areas for their own maintenance. Buildings and structures like houses or quarters, outhouses, barns, animal pens, grazing or feeding areas, churches, schools, and stores were needed to support the vast array of laborers. Unfortunately, in most of the historical and archeological studies to date, the investigation of the industrial core has far overshadowed the study of the domestic areas.

Worker housing would have been an important component of domestic life at an industrialized facility in the recently settled New World. Workers were paid based on the specialization required for their jobs. While professionalization was still rare, differences in wages were clearly evident. Ultimately, this meant that status differences were manifest in salaries and probably in housing. Both married and single men would have worked at the site. Single men likely earned less money than married men and many may have been indentured, especially in the New World. In certain cases, slaves or war captives also worked at industrial facilities. Worker housing, at least initially, was probably owned by the ironworks, but some

Independence in economic terms meant the creation in New England of native manufactures which could supply the goods hitherto obtainable only in Europe. The settlers needed a great variety of English manufactures, almost all of which were made exclusively of iron or cloth. Cargoes unloaded on the Boston wharves were comprised mainly of iron pots, pans, weapons, and farming and building equipment, side by side with bolts of cloth and piles of stockings, coats, and blankets. If these commodities could be produced in New England, lesser needs such as pottery, leather goods, gunpowder, and salt would present no serious problem. It was the large-scale production of iron and cloth that independence demanded.

Bernard Bailyn, *The New England Merchants in the Seventeenth Century*, p. 61.

1.10 Fred Bonsal and J. Sanger Attwill with reproductions of some of the final products from Saugus. (Photograph 1302 by Richard Merrill, unknown date.)

individuals may have earned enough money to purchase property. Farmers who chopped wood for the colliers may have even owned large tracts of land. Women would have maintained the domestic sector while the men worked in the various ironworking operations.

Areas for the production of foods and the care of animals also would have been required. Barns would have been necessary to house various farm animals like horses, cows, pigs, and chickens. While many of these animals would have been allowed to graze in the warmer months, they needed stored feed in the winter; some animals required feed throughout the entire year.

While some of the needs of the workers and their families could have been met within the community, other needs had to be procured from outside. This meant either interacting with a local village or settlement or having the goods shipped to the ironworks complex. For early industrial experiments like Hammersmith, no doubt some of both were necessary to support the domestic core.

The Iron Industry of Britain

Saugus Iron Works was a direct descendent of the English ironworks of the period. Centuries of ironworking technological development had taken place in Britain prior to its export to the American continent. An examination of the English ironworks of the seventeenth century and their antecedents sets the stage for the story of the transplantation of the iron industry to the colonies.

Iron smelting in England seems to have been introduced from France as early as the late fifteenth century. During this time, there was an apparent population movement from France and the technological change from bloomery to blast furnace may have occurred as a result of this migration.[33] The industry had grown with such speed as to raise an alarm in the middle of the sixteenth century because the landscape was being deforested quickly as timber was converted into charcoal. As mentioned above, the deforestation in England provided an impetus for colonizing the New World, where vast quantities of timber had been reported.[34]

As with the introduction of many new technologies, the blast furnace did not immediately replace the bloomery. Bloomeries survived in the Barnsley and Sheffield areas until the second quarter of the seventeenth century. [35] Archeologists Crossley and Ashurst comment in their excavation report on Rockley Smithies, a sixteenth- and seventeenth-century water-powered bloomery, that

> there was considerable variation between the main iron-producing areas of Britain. In the Weald of south-east England the first blast furnace was built at Newbridge, Sussex, in 1496, and no bloomeries are known after one referred to in 1606 at Haslemere, Surrey, which itself appears to be an exceptional survival. In the West Midlands the Pagets' furnace at Cannock was

In presently available data no less than 185 men can be identified as having worked for wages or under indenture in, or resided at, or been paid for services to, the ironworks at Lynn and Braintree over the whole span of their operations. Of these, only about one in five was a real ironworker. It is not easy, indeed, to distinguish even among vocational specializations. The neighboring farmers, in addition to the general chores they handled normally, occasionally took on jobs which usually fell to the regular ironworks employees. The latter, particularly in times of plant shutdown, often joined them in the forests, at the mine pits, and in the work of carting and hauling. Even in the activities connected with ironmaking proper, there was little specialization. Many of the workers were Jacks-of-all-trades, worthy sires of a long Yankee strain of specialists in versatility.

E. Neal Hartley, *Ironworks on the Saugus*, pp. 187-188.

1.11 Image of a settler's cabin. (Image 2240 by John Lencicki and Lee Sherman.)

> in operation in 1567, although the Willoughbys built a bloomery in the 1570s and did not adopt the blast furnace on their lands until the 1590s. In South Yorkshire the overlap between the two processes occupies a still later period; the Earl of Shrewsbury's furnace, the first in the Sheffield region, was built in 1587, yet the Barnby bloomery operated until the 1650s, perhaps a decade after the abandonment of Rockley.[36]

Crossley and Ashurst go on to make the argument that the slow adoption of the new technology was directly related to the scale of production, market forces, and setbacks with the new technology. Not only would the early ironmaster have to sell a much larger volume of iron, 150–200 tons produced from a blast furnace compared with the 30 tons from a bloomery, but he would also have had to deal with technological problems inherent with the furnace shaft design and logistical problems of amassing enough raw materials to last a lengthy smelt.[37] These factors worked against the immediate and universal adoption of the new blast furnace technology.

In areas distant from London, such as the Midlands and Yorkshire, the demand for iron could be met by the available technology.[38] However, around London, where the population was rapidly expanding, landowners and ironmasters were more willing to accept the investment risk associated with the increased output of a blast furnace.[39] Not only would the burgeoning London population have use for the iron, the iron and iron products also could be shipped to other areas of the world undergoing development and colonization.

The Crown also affected the demand for iron, especially during wartime. Several ironworking facilities were more or less controlled by the Crown during wars. The English government required cannon and iron ordnance during wars and production from the new blast furnaces was tuned to meet the demand. In times of peace, many of the ironworks relied on the needs of merchants and the export trade. [40] While the sale of cannons or armaments beyond the Crown's needs was expressly forbidden, it may have been attractive to some black market operators.

Schubert and others have demonstrated from primary sources that the forests of England were being quickly depleted of timber by the growing ironworks industry.[41] In 1548, a commission bemoaned the damage being inflicted on the timber industries by the ironmasters. If allowed to continue, the commission reported, there would not be enough timber to build "houses, water mills or windmills, bridges, sluices, ships, crayers, boats, and especially for the King's Majesty's towns and pieces on the other side the sea." The report goes on to note that the continued depletion of timber for charcoal jeopardized the production of "gunstocks, wheels, arrows, pipes, hogheads, barrels, buckets, sieves, saddletrees, 'dossers,' bellows, showles, 'skopets,' bowls, dishes, bills, spears, morrispikes with such like necessaries."[42] Numerous other wooden products and constructions were also mentioned in the report, including the building of piers and jutties.[43] References by the commission also included a case from the Forest of

A growing population in the Mother Country cried out for more and more iron. A charcoal timber shortage had pushed the English iron industry from its ancient centers to ever more remote areas. It had been carried to Ireland and to Scotland, where in certain cases even the ore had to be imported from remote places and much of the finished and weighty product carried back to English markets. The reaching out of far-sighted capitalists to New England thus seems to be little more than an extension of an already well-established trend of economic imperialism fed by the lure of high profits in a generally favorable business situation.

E. Neal Hartley, *Ironworks on the Saugus,* p. 82.

1.12 Casting crucibles. (Photograph 1533 by Richard Merrill, unknown date.)

South Frith in the Weald, where in 1553 the ironworks were allowed access to the land for production of charcoal. An inquiry held in January 1571 noted that the area then was barren. Another example cited by the commission concerned the Cannock wood in Staffordshire. Evidently, Sir Fowke Grevills clear-cut these woods to produce charcoal for what was once Lord Paget's ironworks.[44] Arguing against Schubert, other scholars note that a lack of charcoal, even though severe in some areas, did not lead directly to the demise of the charcoal furnace.[45] Regardless of whether the forests were being managed for charcoal production, they were clearly highly in demand. This is one reason why financiers agreed to undertake the transplantation of the industry to America in the middle of the next century. The New World offered what seemed like an endless supply of timber for the production of charcoal.

Archeological Investigations

In addition to research on historical ironworks, there has also been a great deal of archeological excavation done on English ironworks sites, especially in the Weald. Some of the more important ironworking sites in England to be excavated have included Ardingly Forge (sixteenth and seventeenth centuries), Batsford (sixteenth century), Panningridge (sixteenth and early seventeenth century?), Pippingford (late-seventeenth to early eighteenth century?), Rockley Smithies (bloomery, sixteenth and seventeenth centuries), Dyfi furnace (mid-eighteenth to early nineteenth centuries), Maynard's Gate (sixteenth and seventeenth centuries), Cowden (sixteenth through eighteenth centuries), and Chingley (sixteenth to early eighteenth century).[46] Most of these excavations were conducted in the 1960s, 1970s, and 1980s by two scholars, Owen Bedwin and David Crossley. These excavations in general have taught us much about blast furnaces, waterflow and distribution systems, manufacturing processes, English ironmasters, gun casting, and more. As a result of the archeological labors of these scholars, a great deal is currently known about charcoal iron smelting in England around the time the Saugus Iron Works was in production. Archeological work on these English ironworks has essentially stopped for now, due to preservation concerns.

Few of the latest generation of charcoal blast furnaces have escaped the attentions of excavators in recent years. As the later development of the charcoal blast furnace is now generally well understood and the excavation of further examples is not a high priority for research purposes (see *Society for Post-Medieval Archaeology* 1988, 5), the preservation of those which are untouched is crucial. It is important to ensure that the fragile below ground remains of these structures are protected as thoroughly as the standing buildings and to safeguard a substantial archeological reserve for future generations.[47]

The excavation reports on these sites, which record the discoveries made through archeological investigations, are invaluable as a comparative tool. In later chapters, parallels will be made between these English sites and the Saugus Iron Works discoveries. In many cases these English excavations help us to better understand the Saugus materials.

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2.1 Detail of Massachusetts Bay Charter, 1629. The Massachusetts Bay Colony was formed in England as a joint-stock company. (Courtesy of The Salem Athenæum)

Hammersmith Through the Historical Texts

Janet Regan and Curtis White

But these forsooke a fruitfull Land, stately Buildings, goodly Gardens, Orchards, yea, deare Friends, and neere relations, to goe to a desart Wildernesse, thousands of leagues by Sea.

Edward Johnson, *Wonder-Working Providences of Sion's Saviour in New-England*, p. A2.

Operating in what was considered the "dessart Wildernesse" of the New World, the ironworks at Saugus was a large-scale manufacturing venture using the most advanced production methods of the seventeenth century.[1] The Saugus ironworks worked in concert with an earlier but less sophisticated plant located in Braintree (now Quincy), Massachusetts, about fifteen miles south of Saugus by boat. Both plants were owned by a consortium of twenty English and four Massachusetts Bay Colony investors who called themselves ***The Company of Undertakers of the Iron Works in New England***. The Company's complex investment organization provided a glimpse of the modern corporation to come. As historian E. Neal Hartley stated, "They were big business and heavy industry. In the Bible Commonwealth they stood out as atypical, anachronistic and wonderful."[2]

The heart of the Saugus ironworks contained a blast furnace, a forge, and a rolling and slitting mill, one of only a dozen such mills in the seventeenth-century world. The industrial yard also included two blacksmith shops, a coal house, a warehouse and dock, and sundry ancillary buildings. Workers built an elaborate water-power system, beginning with the construction of a great dam upstream on the Saugus River. The dam measured at least one hundred feet long by 18 feet high and 76 feet wide and was "faced with stone on the waterside from top to bottom."[3]

From the dam, water was channeled through a sixteen-hundred-foot-long canal to a holding pond and on to sluiceways, which fed waterwheels that powered equipment in each of the three main iron-making buildings. Company boats carried the iron products to a Boston warehouse, where a company clerk coordinated their sale and shipment to various domestic and international ports, including London and Barbados. The cast- and wrought-iron goods produced at the ironworks were crucial commodities for the developing economy of the young Massachusetts Bay Colony. Originally called the "iron works at Linn or Hammersmith," the Saugus facility operated from 1646 to about 1670, when mismanagement and litigation brought production to a halt. With the ironwork's closure, skilled workers dispersed across the northeast, building new ironworks and giving rise to America's iron and steel industry.

Because the seventeenth-century Massachusetts Bay Colony was a highly litigious place, the ironworks' bankruptcy is well documented. Surviving court records and other source materials include depositions, correspondence, ironworks inventories, and accounting records. The most notable collection is

Lynn Iron Works Collection, housed at Harvard University's Baker Library.[4] These documents provide invaluable information on early iron-making products and processes. They chronicle the activities of individual workers, agents, investors, and public officials involved in the project and offer descriptions of landscapes at the seventeenth-century ironworks. Professor E. Neal Hartley of the Massachusetts Institute of Technology published a comprehensive study of the ironworks based on documentary sources.[5] Hartley's research, together with the archeological discoveries of Roland Robbins and consultation with world-renown specialists, informed a full-scale reconstruction of the heart of the colonial ironworks plant. The eight-acre site on the Saugus River, was opened to the public in 1954 as the "Saugus Ironworks Restoration." In 1968 the site became a unit of the National Park Service and is known today as Saugus Iron Works National Historic Site.

The ironworks' story is intimately bound to the history of the Massachusetts Bay Colony. The colony was born out of religious and political discontent in England, where dissenters sought to eradicate Catholic influences in the Anglican Church and challenged King Charles I's inflated assertion of royal authority. In 1630, nearly one thousand English Puritan dissenters departed England, and what they believed was the moral corruption of the Old World, and arrived in Massachusetts. Led by the colony's first governor, John Winthrop, the Puritans saw New England's wilderness as an opportunity to build a new society where their religious convictions and political ideals would guide a pure and righteous community. They believed that their holy commonwealth would serve as a model for the world to emulate: "for wee must Consider that wee shall be as a Citty upon a Hill, the eies of all people are upon us; soe that if wee shall deale falsely with our god in this worke wee have undertaken and soe cause him to withdrawe his present help from us, wee shall be made a story and a by-word through the world."[6] Puritans interpreted the devastation of Massachusetts' native population by European contagious diseases as a sign that their mission was divinely ordained. "For the natives, they are neere all dead of the small Poxe, so as the Lord hathe cleared our title to what we posess."[7]

Throughout the 1630s, ships brought English Puritans to New England's shores in seemingly endless waves. A "Great Migration" had begun and the colony's population swelled to twenty thousand in less than a dozen years. Along with passengers, these ships brought much needed supplies to the colony. New immigrants were encouraged to bring "… all manner of carpenter's tools, and a good deal of iron & steel … and glass for windows and many other things."[8] The colony suffered an economic crisis when civil war erupted in England and Puritans planning emigration to the colony chose to stay in England to fight against the king. The "Great Migration" dried up and ships bringing needed commodities came to port far less frequently. Iron, in particular, came to be in critically short supply, effectively halting the growth of the colony.

Our Civill Government is mixt: the freemen choose the magistrats everye year (and for the present they have chosen Tho. Dudly, esqr. Governour) and at 4 Courts in the yeare 3 out of each towne (there being 8 in all) doe assist the magistrates in making of lawes, imposing taxes, and disposing of lands: our Juries are chosen by the freemen of every towne. Our Churches are governed by Pastors, Teachers ruling Elders and Deacons, yet the power lies in the wholl Congregation and not in the Presbirrye further then for order and precedency.

John Winthrop to Sir Nathaniel Rich, *Winthrop Papers,* Vol. III, p. 167.

2.2 Portrait of John Winthrop, by an unknown English artist. John Winthrop, the first Governor of the Massachusetts Bay Colony, provided tax relief and other inducements to promote an ironworks in New England. (Courtesy of Massachusetts Archives.)

Governor Winthrop recognized that iron was essential to the continued commercial success of the colony's farming, fishing, timbering, and shipbuilding industries. For Winthrop, dependence on English iron was a barrier to his vision of religious and political self-determination. Historian Bernard Baylin writes:

> A sense of destiny weighed on the Puritan leaders. They viewed their great adventure as a holy procession into the future, a deliverance from the corruption of the Old World. Trade, any sort of overseas commerce, for all its advantages, was not only replete with moral dangers but also drew the new commonwealth back into close relations with the homeland. Debts to English merchants represented to them a mortgage on their hopes for a free life in the New World. If the harsh demands of economic reality could have been silenced by decree of the Puritan magistrates, New England's economy would have been as independent as its churches and government.[9]

Winthrop resolved that the time had come to develop the colony's native resources. "We acknouledge with yow, yt such a staple comodity as iron is a great meanes to inrich ye place where it is, both by furnishing this place with yt comodity at reasonable rates, & by bringing in other necessary comodityes in exchange of iron exported. . . ."[10] In 1641, Winthrop issued an ordinance "for the encouragement of . . . the discovery of mines" to induce private-sector investment by offering public-sector benefits to prospective adventurers.[11] To begin such a difficult venture, capital investment, specialized materials, and technically skilled workers would need to come from abroad:

> mynes . . . require the assistance of manie ingenious heads hands and full purces, minerall matters being slow in growth and heavy in managing, And all necessaries as men skillfull in finding mynes, contriving watercources stamping mills, ingens for drawing water, refynings, washings etc.[12]

Winthrop's son, the distinguished scientist John Winthrop, Jr., undertook the job of bringing iron-making technology from the Old World to New England. In 1643, Winthrop, Jr., recruited workers from England's woodlands, where deforestation had severely impacted the iron-smelting industry. Faced with work shortages, English ironworkers saw America as an economic opportunity for themselves and their families. Similarly, English ironmasters and merchants came to see New England's vast timber reserves as an excellent business prospect. Winthrop, Jr., brought together investors to form the Company of Undertakers of the Iron Works in New England. The venture was organized as a joint-stock company with shareholders investing varying amounts, from £50 to £2,000, in transferable shares. The largest investor was one of England's foremost iron manufacturers, John Becx, who held power of attorney for the company. The Company raised the extraordinary sum of £15,000 in capital to establish an ironworks in the Massachusetts Bay Colony. As colonial historian Edward Johnson writes: "The Land [in New England]

[B]ut as wee use to say, if a man lives where an oxe is worth but 12d, yet it is neu the cheaper to him who cannot gett 12d to buy one, so if your iron may not be had heere without ready mony, wt advantage will yt be to us, if wee have no mony to purchase it?

Massachusetts Records, Vol. III, p. 92.

2.3 Nahant gabbro quarry. Gabbro was a key ingredient in iron production. (Photograph 698 by Richard Merrill,1952.)

affording very good iron stone, diverse persons of good rank and quality in England were stirred up by the provident hand of the Lord to venture their estates upon an iron works."[13]

The Company appointed John Winthrop, Jr., as the managing agent. Governor Winthrop and the Court of Assistants (up to 18 'godly' men who along with the governor formed the General Court) granted the Company a 21-year monopoly on iron making and issued generous land grants and exemptions from taxes and militia duty. However, the agreement clearly stipulated that local needs were to be met before any iron could be exported and it set price limits at £20 per ton of iron. Governor Winthrop, thereby, insured that Company profits were subordinate to the well being of the commonwealth. A local ironworks was to provide Massachusetts' major producers—shipyards, sawmills, fishing fleets, and farms—with a ready supply of iron. With the new operation, the Colony would shift from a dependent consumer to a producer of heavy industrial commodities. Moreover, Governor Winthrop's ironworks monopoly agreement dictated the building of an integrated ironworks, containing both furnaces and forges rather than "bloomaryes only," which transformed ore into wrought iron in one step.[14] Bloomery operations produce no cast goods and Governor Winthrop intended that the ironworks should provide a full range of iron products for the young colony. The ability to make furnace-cast wares, like pots and kettles, would help to maintain the standard of living to which English immigrants were accustomed. Additionally, it would allow for the production of salt pans; salt was critical for preserving fish for the fishing industry and an essential commodity for the physical health of the Colony.

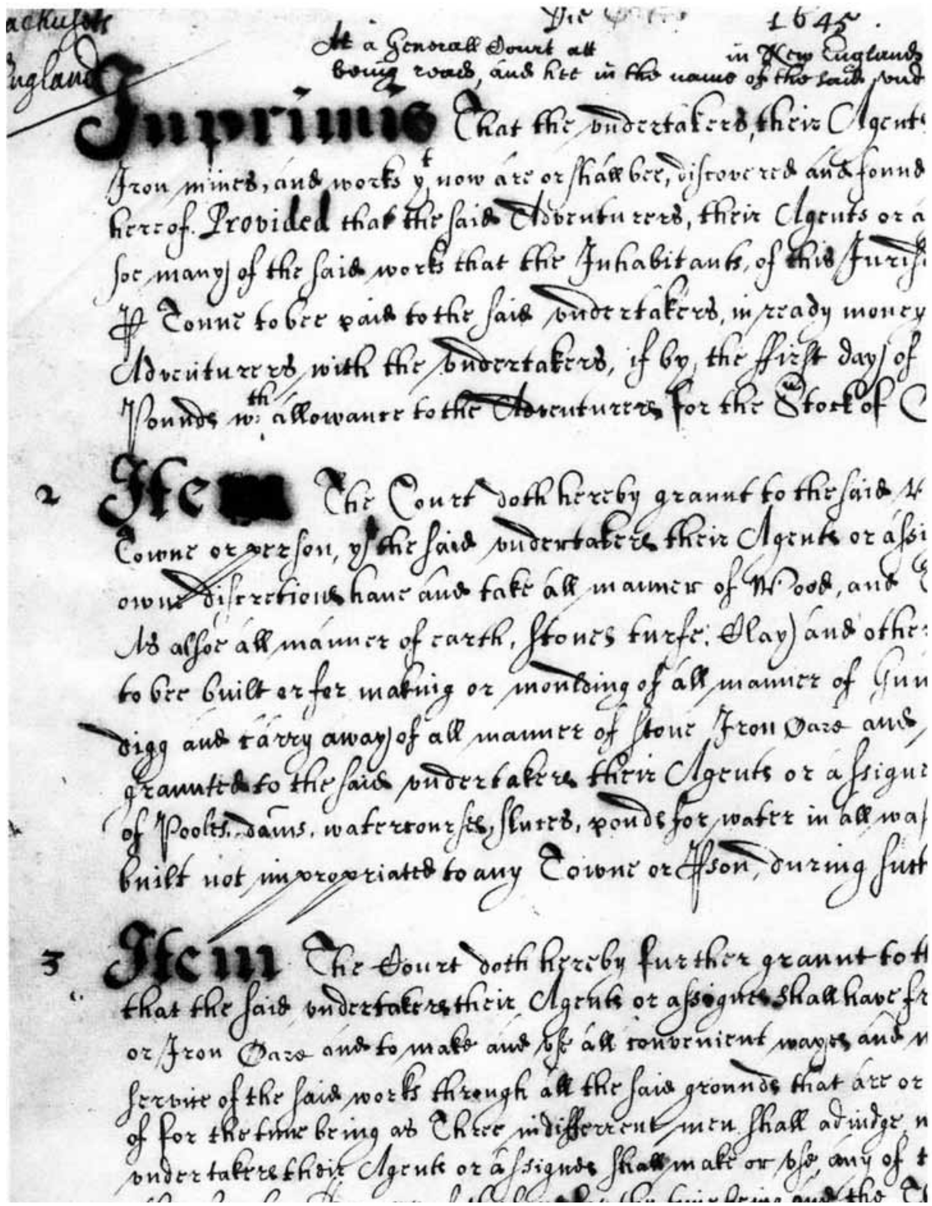
The ironworks agreement actually permitted the establishment of multiple ironworks in the Colony. John Winthrop, Jr., built a plant in Braintree in 1644, but the site lacked sufficient ore and waterpower and was a disappointment to the investors. In the summer of 1645, Winthrop, Jr., resigned his position as ironworks' agent to pursue other ventures. The Braintree forge became a secondary operation after the large-scale ironworks at Saugus was built in 1646.

Winthrop Jr.'s, successor, Richard Leader, designed the Saugus plant. Leader had been "formerly imployed in Ireland about mynes [and] … hath skill in mynes, and tryall of mettalls."[15] His contract with the company was described in a letter to John Winthrop, Jr.: "he hath covenanted to serve them 7 years, his wages is 100 li per annum he is to have passadge for himselfe, his wife, 2 Children, 3 servants, an howse to be built for him, and ground to be allowed him for his horses and a few Cowes."[16]

Leader's 600-acre Saugus site contained ideal topographic features and plentiful natural resources to supply the era's most ambitious manufacturing venture. The setting provided a navigable river and a natural terrace that dropped precipitously to a flood plain below. The steep escarpment gave sufficient elevation to power waterwheels and to provide access to the tall stack of the blast furnace from above. Raw materials were shipped in and finished iron was shipped out with the high tides, while the river's

… that the undertakers, their agents and assigns, are hereby granted the sole priviledge and benefit of making Iron and managing of all iron mines and work … for the term of twenty-one years … that the inhabitants of this jurisdiction be furnished with bar iron of all sorts for their use for… setting up … of forges or furnaces and not bloomaryes only; that what iron is made more than the inhabitants need, they should have liberty to ship to other parts of the world for sale, provided they sell it not to any person or state in actual hostility with us.

"Iron Works Monopoly Agreement," ***Massachusetts Records***, Vol. III, p. 60.


1645.
At a Generall Court att ... in New England
being ... and held in the name of the said ...
Imprimis That the undertakers, their Agents
Iron mines, and works yt now are or shall bee, discovered and found
hereof. Provided that the said Adventurers, their Agents or a
for many of the said works that the Inhabitants of this Jurisd
the Countie to bee paid to the said undertakers, in ready money
Adventurers with the undertakers, if by the first day of
Pounds with allowance to the Adventurers for the Stock of
2 Item The Court doth hereby graunt to the said U
Towne or person, yt the said undertakers their Agents or assi
owne discretion have and take all manner of Wood, and
As also all manner of earth, stones turfe, Clay and othe
to bee built or for making or moulding of all manner of Gun
digg and carry away of all manner of stone Iron Oare and
graunted to the said undertakers their Agents or assigne
of Pooles, dams, watercourses, sluces, ponds for water in all wa
built not impropriated to any Towne or person, during such
3 Item The Court doth hereby further graunt to th
that the said undertakers their Agents or assignes shall have fr
or Iron Oare and to make and use all convenient wayes and w
service of the said works through all the said grounds that are or
of for the time being as Three indifferent men shall adjudge n
undertakers their Agents or assignes shall make or use any of t

2.4 Agreement between the General Court and the agent for the ironworks, 1645. (Massachusetts Archives, microfilm, manuscript, vol. 59, Manufactures 1639-1773, 14. Courtesy of Massachusetts Archives).

freshwater flow was dammed and channeled through a sophisticated system of canals and watercourses. Rich deposits of bog ore were easily accessible. Additionally, Lynn township was able to provide a non-skilled workforce to help meet the labor demands of the ironworks.

Located on land east of the Saugus River, Hammersmith village housed a community of skilled iron-workers and their families. The village contained "workmen's houses and gardens, orchard and field of English grass adjoining the orchard."[17] Hammersmith was a forerunner of America's mill towns built exclusively for the families of an industrial working class. Theirs were modest dwellings valued at between two and twelve pounds, except for a long house with four tenements that was valued at £20. The company paid for maintenance on and improvements to the workers' homes, which sheltered single families and extended families with married adult children. Families often boarded bachelor workers and were reimbursed by the company for providing meals. References to fourteen houses indicate that they were generally clapboarded, probably with thatched or shingled roofs, and that some had cellars and some lean-tos. Many workers raised vegetable gardens, as well as sheep or goats. Four workers, John Vinton, John Francis, John Hardman, and Ralph Russell, were each granted their own two-acre plots of land. Since several workmen were in debt to the company in 1653, it is very possible that workers' families bought goods from the company's storehouse, as did workers of many nineteenth- and twentieth-century factory towns.

The farm work was done by the Scotchmen and Daniel Salmon, and deponent saw two men hilling Indian corn in the orchard that year; the Scotchmen kept Gifford's and the people's cattle, fifty or sixty head, two summers, for which they were to pay 5s. p. cow to the keeper.

"Deposition of William Emery Sworn," *Records of Essex Courts*, Vol. II, p. 96.

The company agent's house, valued at eighty pounds on a 1653 inventory, was situated on a bluff to the west of the river, probably overlooking the plant. Also on the west bank was Dexter's farm, containing the farmhouse, stable, fences, and barns of the land's previous owner. The farm held "28 acres of plow land and marsh" where workers cultivated corn and hay and grazed "fifty or sixty head" of cows.[18] In 1653, "a new ox howse" and a "new Chamber to lodge Corne in ye great barne" were added to the farm.[19] Livestock included horses, oxen, cows, goats, and sheep. The marsh lining both sides of the river was regularly mowed to feed livestock. A vast forest of massive trees stretched to the west of the plant.

The ironworks employed about 35 skilled workers, while as many as 185 individuals were paid for part-time or occasional work at both plants throughout the ironworks' operation.[20] Local farmers, tradesmen, and boatmen provided the bulk of part-time help. Accounting records also include payments to women for washing, mending, and providing medical attention for workers and to two Native Americans for cutting wood. The ironworks may have manufactured iron goods for trade with Native Americans; objects that closely resemble items made at the ironworks, such as pots and kettles, forged iron axes, and a brass ornament, are among trade items found at Native American contact sites.[21]

Iron making was hard, dirty, and dangerous labor and many of the English ironworkers were coarse and unruly. Their inclinations and rough behavior made them outsiders in the staunchly Puritan colony.

2.5 A spade (SAIR 2912) found during excavation. (Photograph by William Griswold.)

While many ironworkers were regularly brought before the court for profanity, Sabbath-breaking, drunkenness, and brawling, others kept the courts busy with far more serious infractions: “John Turner, living at the iron works in Lin, [is] presented [to the court] for stabbing Sara Turner”; “Quentin Pray for striking Nicholas Penion with a staff, having an iron two feet long on the end of it and breaking his head”; “Nicholas Pinnion … [for] beat[ing] [his wife] … and caus[ing] a miscarriage”; and “Richard Prey for beating his wife…” [and saying] “if he had trouble [with the courts] about abusing his wife, he would cripple her … .”[22] English investors wrote with regret that “we have bin necessitated to send some for whose civilitie we cannot under take [to guarantee,] who yet we hope by the good example, and discipline of your Country, with your good assistance may in time be cured of their distempers.”[23] Governor Winthrop anticipated the difficulty of introducing these unruly workers into his sainted community and lobbied for the Company to provide the workers with religious instruction. The Company, however, refused his request and Winthrop eventually withdrew this demand from the monopoly agreement. For Puritan leaders who conceived of the ironworks as a deliberate and indispensable step toward establishing a permanent and self-sufficient economy, tolerating unruly ironworkers was a necessary evil.

Many ironworkers were indentured servants who agreed to work without wages for a period of years to pay off the cost of their transport to Saugus. Because skilled workers were in demand, however, several of the most proficient ironworkers bargained for and received high wages. Tensions grew in the Colony as ironworkers and other laborers began to display a degree of their newfound wealth. Puritan authorities reacted with restrictions such as the 1651 Sumptuary Law, which prohibited the wearing of costly clothing and fined violators ten shillings.[24] For example, an ironworker was charged as an early violator of the Sumptuary Law for wearing great boots. The upward mobility of the laboring class was not part of Puritan authorities’ plan for their holy commonwealth.

Ironmaster Richard Leader also got into trouble with the Massachusetts Bay Colony courts. Unhappy with his relationship with the investors, Leader resigned his position in 1650. “The Company,” he wrote, “are much discontented; and use me not as I have deserved.”[25] On a subsequent voyage to England, Leader gave vent to his bitterness: “… [he] threatened & in high degree reproached & slandrd, the Courts, magistrates, & government of the common weal & defamed the towne & church of Lin.”[26] The court fined Leader £250, a huge sum, but reversed his sentence when the legislature determined that it had no jurisdiction over remarks spoken while at sea.

In 1650, Leader was replaced by John Gifford, a clerk from a large English ironworks in the Forest of Dean that contained three furnaces and three forges. He was from a family of ironworks managers and was well acquainted with the business. Although he was paid less than Leader, he was charged with “the faithful care of the ironworks and their land and timber holdings and for seeking out new mines of iron, lead, tin, silver, and other minerals.”[27]

[W]e canot but accoumpt it our duty to comend unto all sorts of persons a sober & moderate use of those blessings which, beyond our expectation, the Lord hath been pleased to afford unto us in this wildernes, & also to declare our utter detestation & dislike that men or women of meane condition, educations, & callinges should take uppon them the barbe of gentlemen, by the wearing of gold or silver lace, or buttons, or poynts at their knees, to walke in great bootes; or women of the same ranke to weare silke or tiffany hoodes or scarfes, which though allowable to persons of greater estates, or more liberall education, yet we cannot but judge it intollerable in persons of such like conditions; its therefore ordered by this Court & the authoritie thereof, that no person within this jusrisdiction, or any of theire relations depending uppon them, whose visible estates, reall & personall, shall not exceede the true & indeferent value of two hundred pounds, shall weare any gold or silver lace, or gold or silver buttons, or any bone lace above two shillings per yard, or silke hoodes or scarfes, uppon penalty of ten shillings for every such offence & every such delinquent to be presented by the graund jury.

Massachusetts Records, Vol. III, p. 243.

2.6 Replica pattern of the 1636 Leonard fireback. Richard Leonard, an English founder, is pictured at center surrounded by the tools of his trade. (Photograph by Dan Boivin.)

Gifford was to oversee the inclusion of another group of cultural outsiders in the Puritan colony, Scottish prisoners-of-war. These were Scottish soldiers who had been captured by Cromwell's forces at the battle of Dunbar in September 1650. Forced to march 118 miles out of Scotland with little food or water, about sixteen hundred of the Dunbar captives perished of starvation or dysentery on the journey. In England, the survivors were bound into indentured servitude to various enterprises, including the Company of the Undertakers of the Iron Works in New England. The Scots destined for the ironworks arrived in the New World in deplorable physical condition. One man named Davison apparently died en route along the Saugus River before reaching the works. Some of the Scots' indentures were sold to local settlers and by 1653 only 37 Scots were listed as company property on an ironworks inventory. Laboring for the most part at non-skilled jobs, such as woodcutting or farming, they received only food, clothing, and shelter for their efforts. It seems that even these were impinged upon.[28] In court testimony, William Emory testified that in addition to the 13 or more Scots lodged in a house built specifically for them, many other workers were crowded into the space and that their food and soap provisions were often skimmed by Gifford and others before reaching the Scots.[29]

About 17 Scots were subcontracted to the colliers (charcoal makers) and other plant workers. Accounting records show that a few of the Scots received wages from the Company for skilled work. For example, James Adams was paid for managing ox teams, James Gourdan for mining, Thomas Kelton for mining and coaling, and Robert Meany for carpentry work. John Steward was paid as Gifford's house servant, until the investors learned of the arrangement, at which time Steward was "put forth as a smith."[30]

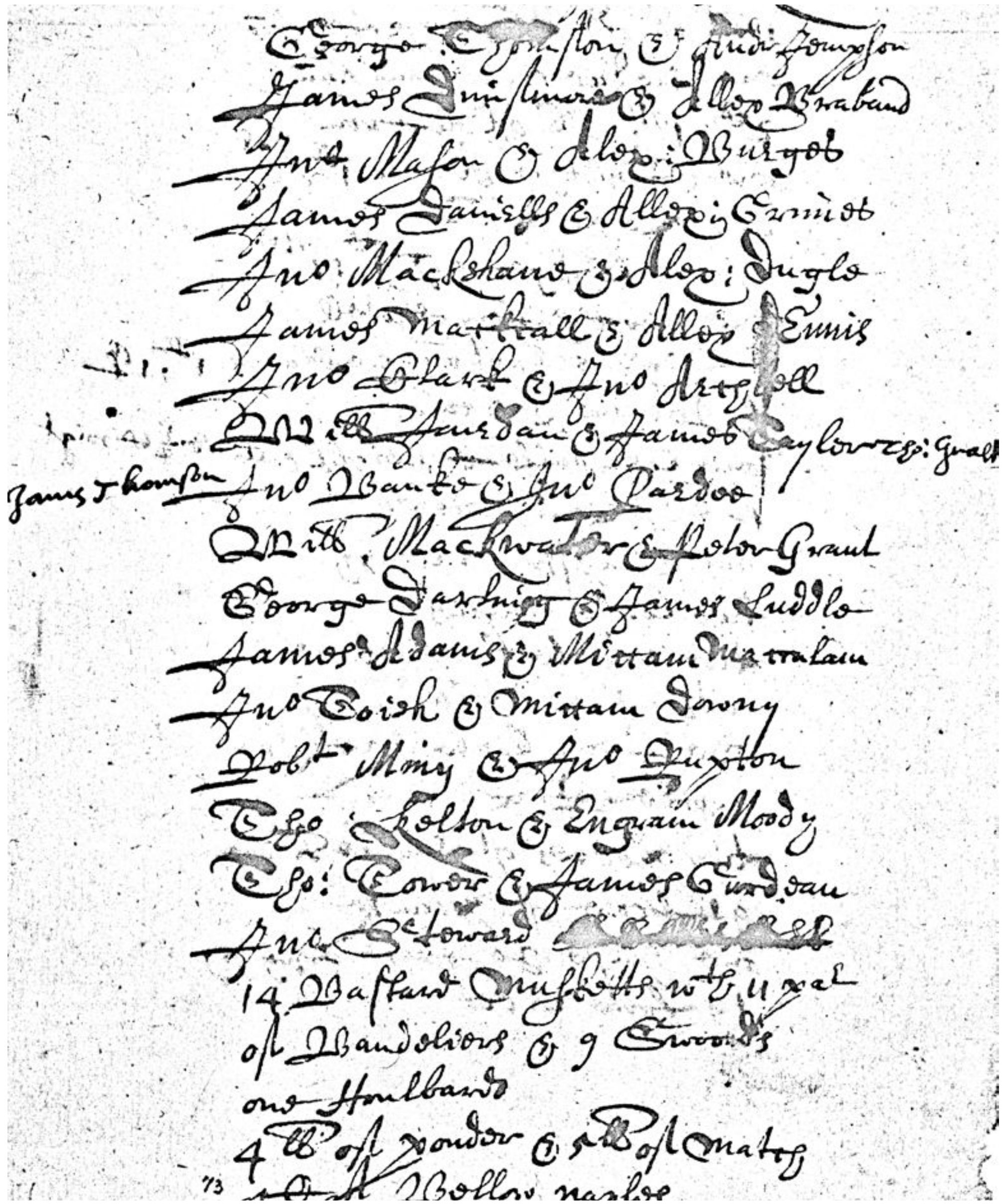
The Iron Works Operation

Iron making was a multifaceted process requiring a complex set of specialized skilled employees and a myriad of support workers. Like other furnace operations, the Saugus plant smelted bog ore charged with charcoal fuel. Unique to the Company was the use of gabbro, an igneous rock, as a flux. Harvesting and processing each of these resources required a different set of skills.

Colliers were critical to the iron-making operation and at least nine men and their Scottish woodcutters worked regularly in this capacity. William Tingle, Henry Tucker, John Francis, Henry Stiche, Richard Green, John Hardman, Thomas Look, Richard Smith, and Richard Prey made charcoal in the nearby forests by burning cords of wood that had been carefully piled into rounded mounds and topped with earth, leaves, and dust. They erected hurdles (woven twig screens) around the mounds as a wind break. The collier lit a fire in the mound's center and thereafter worked to maintain a slow smoldering fire that would char the wood evenly. Danger from fire made this a very hazardous but well-paid job. Such hazard seemed to have little effect on the longevity or energy of Henry Stiche, whose court testimony reads:

Regular ironworkers, neighboring farmers and tradesmen, English and Scots indentured servants—these were the men who staffed America's first successful ironworks. Their jobs, wages, and living conditions outlined, we may turn to consider them as people. We have already mentioned their deviations from the prevailing Puritan standards, which posed problems for managers and magistrates. To the workers themselves such brushes with the law probably were counted as some of the costs of living with the all too godly Puritans, whose religious convictions they did not share.

E. Neal Hartley, *Ironworks on the Saugus,* p. 202.


George [illegible] & Andr Johnson
James Dinsmore & Allex Braband
Jno Mason & Alex: Burgos
James Daniells & Allex: Ermot
Jno Mackshane & Alex: Duglas
James Marshall & Allex Ennis
Jno Clark & Jno Argyll
Wm Jourdan & James Taylor [illegible]
James Thompson Jno Banks & Jno Pardee
Wm Mackwater & Peter Grant
George Darling & James Luddle
James Adams & Micam [illegible]
Jno Toish & Micam Downy
Robt Mcny & Jno Ruxton
Tho: Tolton & Engram Moody
Tho: Tower & James Gurdan
Jno Steward [illegible]
14 Bastard Muskets wth 11 paire
of Bandoliers & 9 Swords
one Hallbarde
4 lb of powder & [illegible] of matches
[illegible] Bellow nayles

2.7 The names of thirty-seven Scottish prisoners of war listed as company property on a 1653 ironworks inventory. (Courtesy of the Baker Library, Historical Collections, Bloomberg Center, Harvard University Business School.)

"Henry Stiche, aged about one hundred and two years . . . testified that he was employed by Mr. John Gifford agent, in the mystery of coaling."[31] Six years prior to this deposition, Stiche had been charged with ". . . breaking the head of Rich. Bayly."[32]

Miners Charles Hook, John Gorham, and Richard Post and their Scottish assistants Thomas Kelton and James Gourdan used picks and shovels to extract bog ore from dry bogs and low-lying areas. Working from boats, they used floating shovels to harvest ore from lake and pond bottoms. Bog ore was mined throughout the Saugus area, as far north as Reading and as far south as Hingham and Weymouth. On the nearby Nahant peninsula, Robert Cootes, Hugh Alleye, and sometimes Charles Phillips mined gabbro by heating rock ledges, then dousing the rock with cold water to help split it into manageable sizes.

The Blast Furnace Operation

The area around the blast furnace was a hive of activity as ox-drawn carts, tip carts (called tumbrels) and coal carts (or wains) continually streamed into the plant, bringing charcoal, gabbro, and ore from the hinterlands. Tons of raw materials were heaped about the area or stored in nearby outbuildings. After an incident when the "Works [were] exposed to the Utmost danger of being all Burnt in one night When the coaleheape did fall on fier," a stone house was built a few hundred feet from the furnace to safely store charcoal.[33] Iron ore was roasted, broken into small chunks, and sieved. The raw materials were then measured, carried across the furnace bridge, and dumped by the basketful into the furnace charging hole. To produce one ton of pig iron, or cast iron bars, the blast furnace consumed about three tons of bog ore, two tons of gabbro, and about 265 bushels of charcoal, roughly 36 cords of wood.[34]

The blast furnace foreman, or founder, Roger Tyler, shouted orders to the furnace fillers Thomas Wiggins and Thomas Beale, who fed the charging hole at the top of the furnace stack. Most seventeenth-century illustrations of blast furnaces depict several feet of flame shooting up from the charging hole, which would have made the furnace filler's task a dangerous and daunting one. The fillers used a gage, or rod, which was inserted into the charging hole as a kind of probe, to determine when more materials were needed. Beneath the charging bridge, Roger Tyler opened the sluice gate on the 16-foot waterwheel that drove a shaft to power the giant bellows. The furnace roared as the bellows' blasts of air fanned the flame. The furnace became an awe-inspiring inferno, conjuring images of hell that would rouse any Puritan minister, "[God's] breath is the bellows, which blows up the flame of hell forever."[35] The giant bellows could produce three hundred cubic feet of air flow per minute, concentrated through a cone-shaped pipe called a tuyere.[36] As the air blasts raised the furnace temperatures to over twenty-five hundred degrees, a gaseous reaction with the carbon in the charcoal converted the bog ore to iron. As the ore and gabbro melted, impurities were drawn out of the ore in the form of slag. Both slag and liquid iron trickled down the stack into the crucible. Because the slag was lighter, it floated on the surface of

[T]he Works [were] exposed to the Utmost danger of being all Burnt in one night When the coaleheape did fall on fier but that it was by the spetial providence of God who kept them and little of yor care you being then at Boston with yor wife . . . .

Lynn Iron Works Collection. Baker Library Historical Collections, Harvard Business School, p. 34.

2.8 Detail of etching showing charcoal baskets and wheelbarrows. (Georgius Agricola's 1550 treatise on metallurgy, *De Re Metallica, p. 389*. Courtesy of Dover Publications, Inc. New York, [1950])

the iron. Workmen used iron rods called ringers to clear slag waste from the furnace fore-hearth. Cooled slag was carted in wheelbarrows to the river's edge and dumped onto the slag pile. Each ton of pig iron produced in the blast furnace created about four tons of slag.

Ore, charcoal, and air were managed by the founder to produce the particular grade of cast iron needed for a casting. Grey iron was used for pots and a mottled iron was preferred for bar iron.[37] Roger Tyler tapped the furnace once or twice a day. Using a great ringer, he broke the clay plug of the crucible's tap-hole and a stream of molten metal gushed into a channel that had been formed in the sand floor. The great ringer was about fifteen feet long, giving the founder enough reach to keep him away from the searing heat of the molten iron. The iron cooled and hardened in the channel, producing a sow bar. Cast-iron bars called pigs or sows were then weighed at the steelyard, a large scale or balance. The bars often ranged between two-hundred-fifty to three-hundred-pounds, with the occasional five-hundred-pound sow produced.[38]

A furnace could be in blast for between thirty and forty weeks. In New England, it is likely that the furnace was blown out during the winter months, when freezing water would naturally halt operations. After each campaign, the furnace would be overhauled. Roger Tyler was paid "for breaking upp ye furnace hearth" and for "making ye furnace hearth of newe … and making cleane ye ffurnace."[39] Tyler would clear slag from the interior walls and chisel out and replace the heat-resistant sandstone lining; it is likely that this sandstone was imported from England and carried as ballast in ships.

At the blast furnace's casting shed, potters made molds into which the molten iron was ladled to make holloware. A worker named John Divan probably served as the company's potter.[40] Period documents list pots, kettles, skillets, boxes, marmeletts (large kettles), mortars, stoves, and weights as some of the cast products; it is also possible that cannons were cast at Braintree. To cast firebacks, workers poured molten iron into molds made by pressing wooden patterns into the sand. To make thirteen-hundred-pound salt pans, molds were made from a mixture of clay and sand, and then buried in the sand floor of the casting shed to await the molten metal. Workers also cast iron replacement fittings for the iron-works plant, which were in constant demand. These important parts included large pieces such as five-hundred-pound hammerheads, gudgeons (large iron pins inserted into the end of shafts), anvils, cams, boytes (pillow blocks), and plates.[41]

The Forge Process

In the forge, cast-iron sow bars were reduced into more malleable wrought-iron bars in a demanding, dangerous, and deafening series of steps. The Saugus forge likely contained two finery hearths, a chafery hearth, and a five-hundred-pound trip-hammer mechanism.[42]

Careful observation of the various signs enabled the founder to exert some influence in producing the kind of iron de-sired . . . . In the first of the above mentioned cases the iron produced would be white cast iron, so called since the fracture of it is white. The carbon contained in this type of iron … is intensely hard … but brittle. In the second case the iron produced would be grey cast iron, the fracture of which is grey. … It is softer and less brittle than white cast iron. At an intermediate state in which the grey and white kinds are visible in the fracture of the same iron, the cast iron was called mottled iron.

H. R. Schubert, *History of the British Iron and Steel Industry from c. 450 B.C. to A.D. 1775,* p. 238.

2.9 Saugus crucible used to collect the molten iron from the furnace, which was then ladled out into various molds. (Photograph 1030a by Richard Merrill, 1953.)

Three waterwheels likely powered the three hearths' bellows, while another wheel worked the trip hammer. To improve production efficiency, an additional hammer may have been installed after 1652, although this conclusion is somewhat controversial. About ten men ran this complex operation. Among the most highly paid were finers John Turner and John Vinton. Other forge workers included John Francis, Nicholas Pinnion, Henry Leonard, James Leonard, Ralph Russell, Thomas Billington, Jonas Fairbanks, and Robert Crossman. Quentin Prey ran the forge at Braintree.[43]

To begin the forging process, workers moved a sow bar into the finery hearth through a hole in the building. Here it melted slowly, trickling drops of molten iron through a layer of slag into the bottom of the hearth. The hearth was lined with cast-iron plates that could be positioned by the finer to control temperature. A 1653 inventory lists "27 plates at ye two finneryes & at ye Chaffery."[44] Workers used a ringer to stir the iron and work it into a semi solid mass. After an alternating series of three heating sessions under the bellows and three cooking sessions at the cooler base of the hearth, workers kneaded the now pasty iron to form a ball called a "loop." Workers removed the loop from the hearth and placed it on a cast-iron plate on the forge floor, where they beat it with a sledge hammer to knock off charcoal and slag particles. Using heavy iron tongs, workers dragged the loop over a route of "9 [cast-iron] plates about ye forge fflower" to the five-hundred-pound trip hammer.[45] Here they beat the loop into a consolidated square shape and then cut it in half to form a half bloom. The half bloom traveled back to the finery to sweat out impurities then back to the trip hammer to be hammered into a dumbbell-shaped bar called an anchony. From this point the bar would be heated at the hotter chafery hearth and subject to repeated power-driven hammerings. Sparks cascaded from the iron with each blow of the hammer as workers arduously turned the bloom from one side to another. The blazing heat, the ear-splitting bang of the hammer, and the imminent danger of crushed limbs made this a very hazardous and demanding job. A mocket head bar was eventually formed as the hammer pounded out one side of the dumbbell-like end. Finally, an elongated merchant bar was produced as the other squared end was hammered out. The merchant bar was the primary product of the ironworks and sold to merchants or to local blacksmiths who would use it to fashion all manner of wrought-iron tools and implements.

The incorporation of the slitting mill in the plans for Hammersmith made perfect sense. The demand for nails in the building of the wooden houses and barns that became and remained standard in New England was enormous. The manufacture of nailer's rod by a drawing out of bar iron under the hammer was most expensive of time and labor. Product demand and industrial efficiency drove the men of Hammersmith to a machine which, while expensive, complicated, and difficult to keep in adjustment, might go a long way toward turning out the "raw material" from which farmers, working in off season by their firesides, and others, might make by hand the nails and spikes basic to frame building.

E. Neal Hartley, *Ironworks on the Saugus,* p. 180.

The Slitting Mill Process

The operation of a slitting mill in the wilds of the Massachusetts Bay Colony at a time when so few operated in the Old World is testimony to the vision and ambition of The Company of Undertakers of the Iron Works in New England. About twelve percent of the wrought-iron stock produced at the forge traveled to the slitting mill where it would be heated for several hours.[46] Once pliable, a bar was drawn through a set of rollers to make flats, which were sold as stock for wheel rims, axes, saws, or scythes. Some flats were slit by large shears into nail rod, which was then bundled for sale to local blacksmiths and other settlers. The demand for nails in the young colony was enormous. Several forge workers were

2.10 Costumed interpreters at forge hearth. (Photograph 1220 taken by Richard Merrill, 1954.)

paid for jobs in the slitting mill, including Joseph Jenks, John Vinton, Ralph Russell, and Nicholas Pinnion.

It appears that equipment replacement occurred regularly at the slitting mill. Accounting records show that in 1651 John Vinton was paid for "making 2 roullrs" and that cash was paid "for Steeleing ye Sheares" and for "mendeing the great Sheares"; in 1653, "a new Cogg wheele [was installed] for ye Slittin mill."[47] It is likely that the cog wheel was paired with a lanternwheel to set the mill's upper and lower rollers and slitters turning in opposite directions. The slitting mill was probably an ingenious bit of engineering.

Supporting Jobs

Counting employees at both plants, and including a few doubtful cases and clerks and managers who are not known to have had a financial stake in the ironworks, we find no more than thirty-five men who seem to qualify as full-time employees handling jobs directly related to the making of iron.

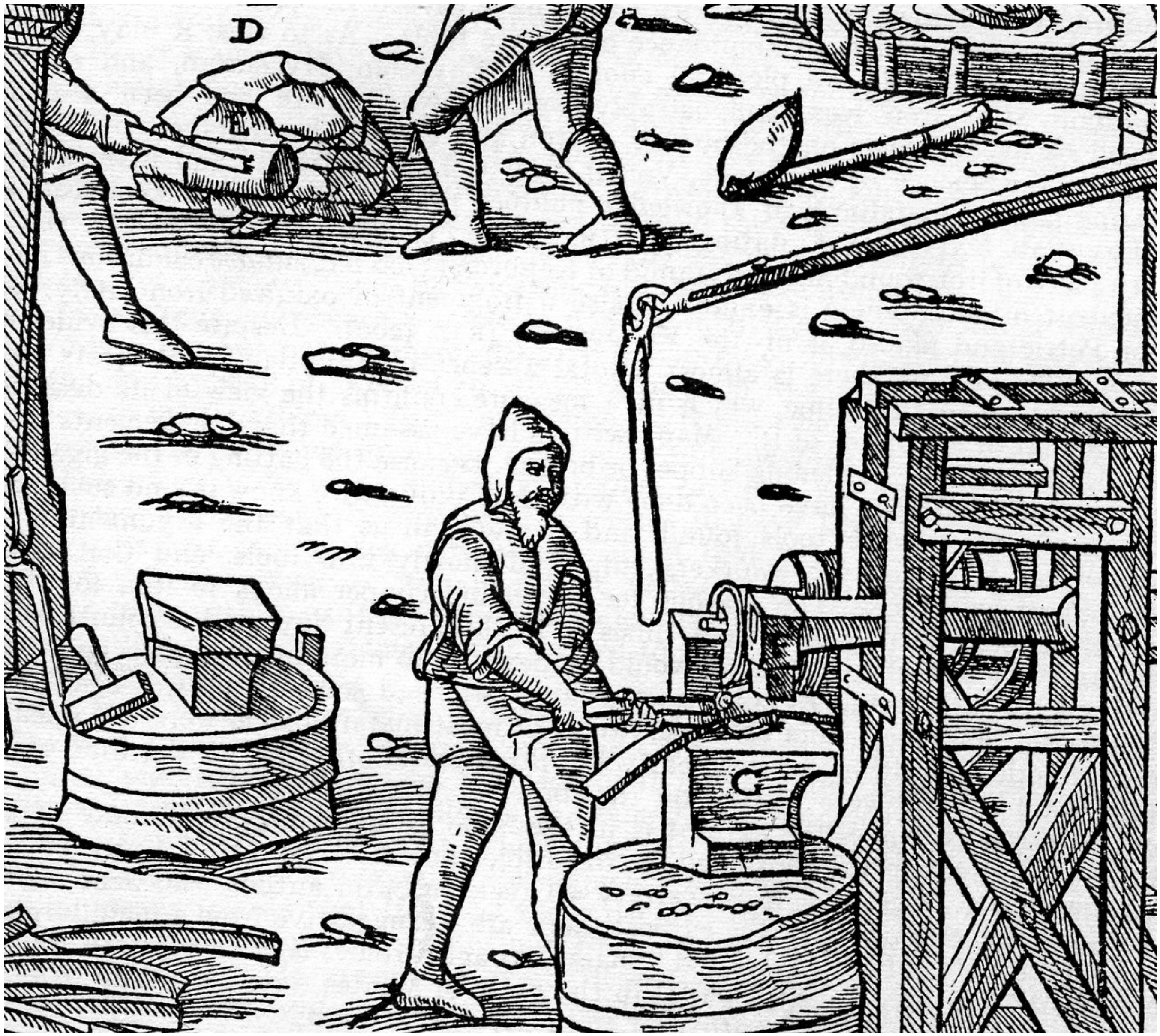
E. Neal Hartley, *Ironworks on the Saugus,* p. 187.

The great dam at Saugus impounded about 230 acres of water. Charles Phillips, one of the water drawers managing water levels at the dam testified that he "kept the water at the Iron works … low in order that it might not damage Mr. Haukes' [a neighbor's land]. This the deponent did, and gained the ill-will of the workmen, therby."[48] Other workmen complained that the water was "so low that it caused a great deal of difference between the workmen and the water drawer."[49]

The ironworks operated its own blacksmith shop, located near the warehouse, to manufacture tools and repair iron mechanisms. Blacksmith Samuel Hart and his Scottish assistant John Clark likely produced tongs, ringers, smith's shears, nails, hammers, coal rakes, shovels, cinder hooks, "ships" for making furrows in casting sand, agricultural tools for the farm, and hinges and other hardware for company houses and buildings.

A saw pit or mill produced boards for the construction and repair of buildings, sluiceways, tailraces, and carts. The location of the saw pit or mill is unknown. Sawyers Richard Hood and John Parker produced over 22,800 feet of oak and pine boards from 1651–1653. Several workers were paid for building carts and for weaving baskets and hurdles. The company's carpenter Francis Perry, with help from Nicholas Pinnion and Charles Hook, maintained and replaced waterwheels, shafts, bellows, anvil bases, and other specialized wood structures. Harvesting and transporting large trees was an arduous task; it took "5 days fetching home ye furnace beame [shaft] with 12 oxen & 2 men."[50] Preparing and installing large architectural members was also time consuming; Francis Perry and Roger Tyler were paid for "mackinge and fitteinge ye furnace beame [shaft] & placeing it being 4 Weeckes Worcke."[51]

On the tailrace of the Saugus blast furnace, cutler Joseph Jenks established "a mill for the making of Sithes," saw blades, and other edge tools for which he was granted a Massachusetts patent in 1646.[52] Before emigrating to New England, Jenks had acquired skills at Hounslow, a town in Middlesex County, from exiled German swordsmiths in the mid-1630s, in an effort to develop a domestic sword-making



2.11 Detail of water powered hammer similar to the Jenks blacksmith hammer. (Georgius Agricola's 1550 treatise on metallurgy, *De Re Metallica, p. 422*. Courtesy of Dover Publications, Inc. New York, [1950])

industry in England.[53] In 1639, Jenks petitioned for a plot of ground in Isleworth to construct a "new invented engine or blade mill."[54] After the death of his wife and daughter, Jenks brought his millwright and smithing skills to the banks of the Saugus River. There he forged, hardened, and tempered iron and steel into saw blades and axes for the ironworks.[55] Jenks also manufactured sawmill blades to support a developing timber industry, drew wire for the making of wool cards and fishhooks, and was called in to assess the value of a grist mill after the death of local miller Edmund Farrington in 1677.[56] After the bankruptcy of the Company of Undertakers in the mid-1650s, Jenks mortgaged his shop (for which he previously paid rent), the rolling and slitting mill, and a grist mill.[57] He imparted his blacksmithing skills to his son, Joseph Jenks, Jr., and apprentice William Curtis. Jenks, Jr., established a forge shop and sawmill in Pawtucket, Rhode Island. Iron tool manufacturing continued within this branch of the Jenks family well into the nineteenth century in Rhode Island. William Curtis brought his blacksmithing skills to John Winthrop, Jr's., new ironworks at New Haven, Connecticut.[58]

Daniel Salmon and Scots James Adams, George Darling, Malcolm Maccallum, John Mackshane, and John Pardee ran the ironworks' farming operation. "Daniell Salmon did plow & sow the ground with ye Scotts, & ye Scotts men did make hay & Labor about planting & getting in the Corne."[59] The Scottish workers lived with the Salmon family in Dexter's farmhouse. Providing food for the animals and the people employed by the ironworks was a critical part of the operation.

A warehouse (or iron house) located by the site's dock stored finished iron products for shipment down the Saugus River. The Company owned several boats, including a "great boat."[60] Six boatmen regularly sailed the Saugus River, typically with two men to a boat, carrying products to Boston and beyond. In 1653, Theophellos Bayly and John Lambarte were paid for "thare Severrall voyages with ye Companies boate to Boston, Brantrey, Waymouth and Hinghamm."[61] Although a massive wooden bulkhead held back soil at the dock and warehouse area, the boat basin was probably hand dug periodically to keep the water deep enough for boats to dock. In Boston, William Awbery and his staff of seventeen Scots managed a warehouse and pier to handle the sale and shipment of the iron products to local and overseas markets. Records indicate that Hammersmith iron went to Kittery and Portsmouth, Maine, Connecticut, Barbados, and England.

Several neighbors were paid for "findeinge . . . Bogg myne," wood cutting, hauling timber and charcoal, building roads and bridges, and digging and carting ores, sand, and clay.[62] Surprisingly, the top paid worker was a neighbor, Samuel Bennett. From 1651 to 1653, Bennett was paid £471 for a variety of services to the ironworks but mostly for the carting of charcoal and bog ore. Why Bennett was paid such large amounts for unskilled work is not clear. It is clear that Bennett was a close friend of John Gifford and sometimes received goods skimmed from the Scots' account.

One ironmaking operation with indirect ties to Hammersmith appears to have left but few traces in published records. This was the forge at Pawtucket, Rhode Island, erected by Joseph Jenks, Jr., about 1672. His efforts with a sawmill and slitting mill at Concord clearly unsuccessful, this son of an able father removed to the younger colony in the latter part of 1668.

E. Neal Hartley, *Ironworks on the Saugus*, p. 303.

2.12 The bulkhead for the turning basin under excavation. (Photograph 745 by Richard Merrill, 1952.)

The Decline of Hammersmith

According to E. Neal Hartley, annual production at the ironworks during Gifford's management was 144 tons of pig iron, 20–25 tons of cast and hollow ware, 96 tons of bar iron, and 12 tons of rod iron.[63] Products were sold to at least 85 customers, including merchants, mariners, tradesmen, farmers, and blacksmiths.[64] Although production reached its peak under Gifford's management, debts mounted as he expended considerable amounts refurbishing structures and equipment to bring the works up to optimum condition. He built the coal house, replaced several waterwheels and bellows, "[built] up the End of the forge new," added outbuildings for the farm operation, rehabilitated chimneys and hearths, made improvements to workers' houses, repaired the dam, raised the flume, made new sluiceways, constructed new rollers, shears, and wheels for the slitting mill, and purchased several parcels of land.[65]

Concerns about Gifford's business practices prompted the Company's investors to elect four local commissioners, Robert Bridges, Joshua Foote, Henry Webb, and William Tyng, to supervise the operation. The latter three were given absolute power of attorney to act as "de facto owner-managers" of the ironworks and Gifford resented their oversight.[66] When asked to give a weekly or monthly accounting of his transactions, Gifford refused, saying: "he would not be ther Jack Boye."[67] When he finally agreed to submit an account, there were differences between what Gifford reported and what was actually found in stock. "Ther was mor in bar Iron neer abut five or six ton more then the sayd mr Gefard had giun a Countt of to the Commisoners."[68] It was also apparent that Gifford had no compunction about using Company servants, stock, and materials for his personal benefit.

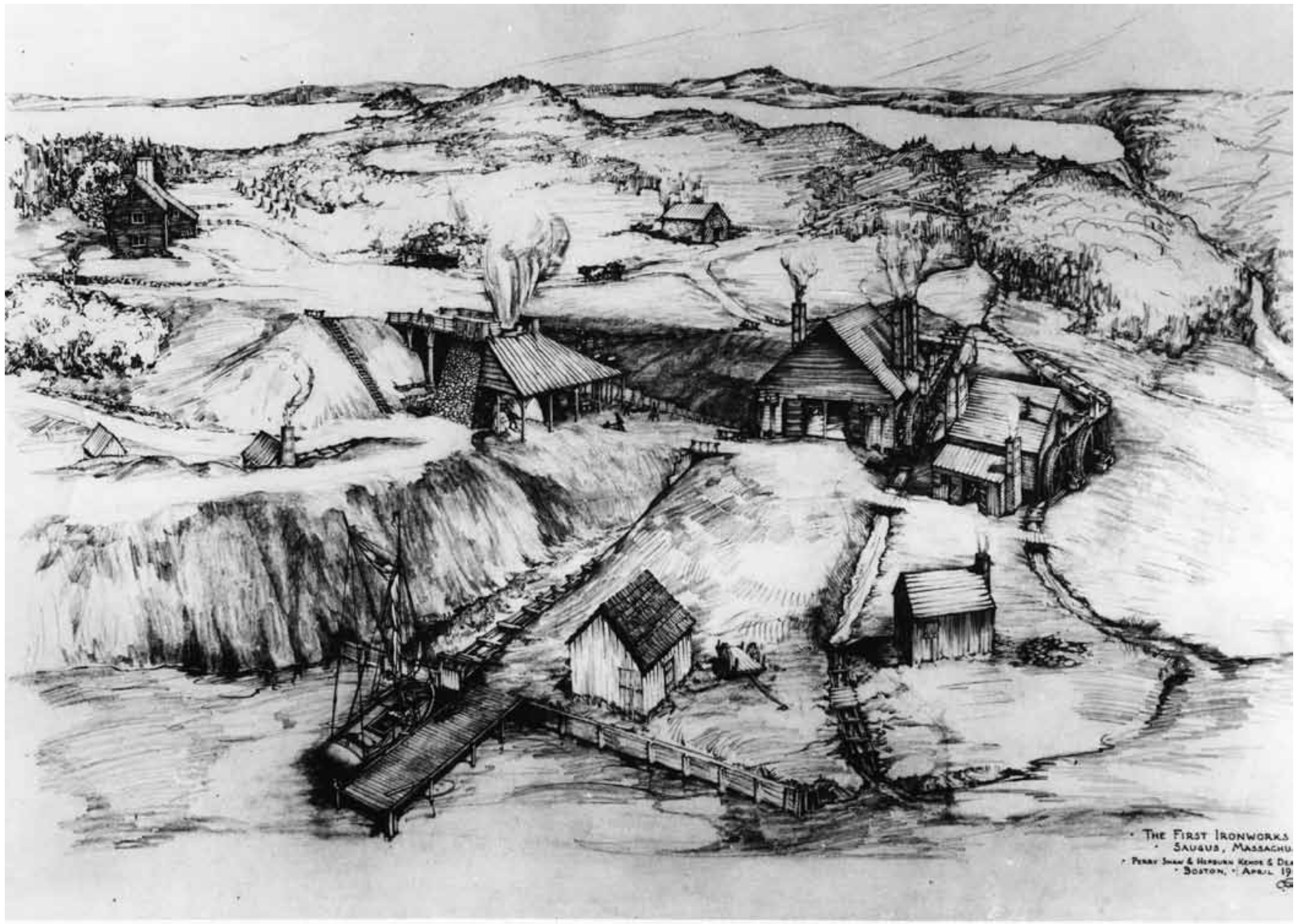
We fynde now such Things but that he hath his senses at Comand so that I feare more knavery then Malloncolly & and in yor Accotts you make noe mention of any thinge more then yor transactions & as if you know him not nor in what Capacity he was only you haue made vse of him to draw money for you soe that in the meane tyme the Company is well serued & yor Accotts are not such as the Company desired of you.

Lynn Iron Works Collection. Baker Library Historical Collections, Harvard Business School, p. *32*.

In 1653, the investors removed Gifford from his post. In his defense, Gifford wrote that his removal was coming at a critical juncture, when the ironworks was poised to generate much revenue.

> The produse of such Stock at present is proper for my credit, the time when I was taken off from the Imployment being in the very prime of all, when as ther was never such a Stock before to be rought out, the worcks fitted, Scotts Servants acquainted with the business by ther seaverall trades, many of the worckmen in debt, which would have helpt to worck out the Stock: I having spent a Compleate yeare at the worcks before I blowed for want of Stock and now having this reddie I was taken off in my prime which had I wrought out, I should have rendred my principals great gaine.[69]

The investors sued Gifford for damages; he was arrested and jailed and his goods were attached. Multiple lawsuits ensued and while large creditors were paid, small creditors and workers were not. Workers petitioned the court for their back wages:



2.13 Artist's conception of the ironworks in 1650 by Charles Overly. (Photograph 1076 by Richard Merrill, 1953.)

> That wheras yor peticoner living by their labors and have wrought some time for the Iron workes whereby more wages is Groune due unto them than at present they can receive or are able to beare and that as wee are Informed the said workes are likely this day to be sentenced for the payment of divers Great Somes wherein your peticoner are not menconed nor related, but themselves theire wives & children are like to suffer greatly If your peticoner should not be paid theire wages so hardly earned; doe most humbly beseech this Honnored Court to be pleased (that before any Judgment be entred) yor peticoners maybe paid theire Just dues or such order taken that they may be paid in some short time.[70]

All parties involved in the lawsuit were sympathetic to the workers' plight. Gifford noted that "the poore laboring men . . . for want of which pay some of them are in a Sadd Condition one at the gates of death."[71] While Company commissioner Henry Webb stated that "there are manie poor workmen, country men mine carriers colliers & cole carters & other workmen do make a grievous complt for paymnt of their wages."[72] The workmen's petition for payment languished, however, as a convoluted series of lawsuits and counter suits dragged through the courts. Hartley writes that eventually "certain workmen had acquired title to certain low value assets," but adds, "It is difficult to escape the conclusion that many of the small claims against the iron works were never satisfied."[73]

A limited liability function of the Company protected Massachusetts commissioner Henry Webb from personal losses from creditors' lawsuits. John Gifford journeyed to England to plead his case to recover his salary in England's courts and was awarded more than £400. Finally, the ironworks itself was awarded to its major Massachusetts creditors, with Boston merchant Thomas Savage as a primary recipient. In 1658, entrepreneur William Paine bought two-thirds shares, with Thomas Savage retaining one-third share. Paine assumed management of the works, which rallied under his guidance. According to Hartley, the ironworks produced "143 tons of bar iron, nearly 15 of hollow ware, some 6 1/4 tons of solid castings, and wrought ware to the value of £290."[74] John Paine took control of the works upon his father's death in 1660. The ironworks faired less well under John Paine's management and production continued sporadically as Paine's agent, Oliver Purchase, tried valiantly to keep the ironworks running. In the latter half of the 1660s Paine's estate was beset by debt and the ironworks slowly ground to a halt.

The demise and failure of the Saugus ironworks caused the disbursal of the "many ingenious heads and hands" recruited in England by the Company of Undertakers and created a lineage of iron production facilities throughout the northeastern United States.[75] Generations of the Leonard family established iron mills throughout eastern Massachusetts and in New Jersey, John Winthrop, Jr., began a new iron-making venture in New Haven, and the Jenks family established its industrial presence on the Blackstone River in Pawtucket, Rhode Island. Each brought along displaced skilled workers from Saugus, includ-

You are required to atach the body & goods, of Mr John Giford to the valew of fifteen thousand pounds, with sufficient surety or suretyes, for his personall appearance, at the next County Court, to be held at Boston, on the 25th day of this instant October, then and there, to giue in a true weekly acompt of all the effects, both of sow Iron, rod Iron, barr iron, & all cast wares, that haue bin made & cast by him, & all other effects of the iron works, since he first came to his place, acording to his covenants & Instructions to Captain Robert Bridges, Mr Henry Webb & Mr Joshua ffoote, as Comissionors & Aturneis of the vndertakers of the iron works; And so make a true return hereof vnder your hand dat 17 (8) 1653.

Lynn Iron Works Collection. Baker Library Historical Collections, Harvard Business School, p. 200.

2.14 Costumed interpreters at the blast furnace. (Photograph 1216 by Richard Merrill, unknown date.)

ing Scottish prisoners, and helped to spread specialized knowledge of ironworking to the new colonies. These new ventures formed the foundation of the American iron and steel industry. Historian Stephen Innes writes:

> Ironworkers helped set the tone for what eventually became known as Yankee ingenuity. Their skills in metalworking and mechanical engineering spread and ramified throughout the province. In the region's growing number of iron-fabrication shops, hammer mills, and smithies, men with the names of Leonard, Pinnion, and Pray passed on to others the mystery of their craft. In doing so they helped provide the Massachusetts economy with one of its most notable features: its complex and diversified human and material infrastructure.[76]

The ironwork's legacy is impressive; by the time of the Revolution, American iron manufacturing "produced some 30,000 tons of ironwares annually (one seventh of the world's yearly iron production)."[77] Its story chronicles the tensions, conflicts, and eventual assimilation of the early industrial working class. According to historian Hartley, the Company's large scale and organization on rudimentary corporate principles including price controls and limited liability, made it a forerunner of American big business.[78] With customers as far away as London and Barbados, the ironworks was one of the earliest exporters of American heavy industrial goods. The manufacture of finished products for local use and overseas trade allowed the Massachusetts Bay Colony to evade to some degree the system of dependency endemic to colonial possessions and helped Puritan leaders reach toward their vision of an economically viable, self-determined settlement.

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3.1 Undated view of Iron Works House before restoration. (Photograph by W. H. Halliday, ca. 1915. Courtesy of Historic New England.)

CHAPTER THREE

The Story of the Saugus Excavations

Donald W. Linebaugh

By the time of Roland W. Robbins' initial involvement in the Saugus Iron Works project in 1948, the ironworks property had a long history within the historic preservation movement. His employer, the First Iron Works Association, incorporated in 1943, was actually the result of preservation efforts begun around the turn of the twentieth century.[1] While the seventeenth-century structure known as the Iron Works House had survived, the remainder of the original industrial complex was deeply buried and largely forgotten. Recorded and published as early as 1879 in Edwin Whitfield's ***Homes of Our Forefathers: Being a Collection of the Oldest and Most Interesting Buildings in Massachusetts***, the house itself was an important shrine that interested many early preservation organizations and was linked to a veritable who's who of preservation figures.[2] When the house was placed on the market in 1911, it quickly drew the attention of William Sumner Appleton, founder of the Society for the Preservation of New England Antiquities (SPNEA).[3] Acting as a historic property broker, Appleton sought to find a buyer who would preserve and restore the house.

The romance of preindustrial craftsmanship again motivated the minister [Wallace Nutting]. Writing of the original Saugus ironworks, he longed for a time when the "age of chivalry had passed away and the modern-time machinery had not come in. Simplicity and strength mark the productions of our forefathers at the forge."

Thomas A. Denenberg, *Wallace Nutting and the Invention of Old America,* p. 97.

After negotiating with the likes of Henry Clay Frick, Andrew Carnegie, and local Daughters of the American Revolution (DAR) and Sons of the American Revolution (SAR) chapters, Appleton finally interested noted antiquarian Wallace Nutting in purchasing the structure in 1915. Thus, Broadhead, as it became known, emerged as the first link in Nutting's famous "Chain of Colonial Picture Houses."[4] Nutting promptly hired Boston architect Henry Charles Dean to "restore" the structure. Dean reworked the interior and exterior to what he felt was their seventeenth-century configuration and finishes, adding dormers and a projecting front porch along with an expanded later-period ell. Broadhead became, according to historian Thomas Denenburg, "the center of Nutting's historical and commercial activities, serving as the 'authentic' façade for a second photography studio, a furniture factory, and a forge."[5] Nutting used the ironworks building as a showroom to display part of his collection of antiques, photography, and reproduction furniture.[6] In 1917, he added a blacksmith shop to the property and hired blacksmith Edward Guy to reproduce early ironwork for sale.[7]

In 1920, failing economically, Nutting sold the property to antiques dealer Charles L. Cooney and in 1925 Cooney's estate sold it to Boston antiques dealer Philip A. Rosenberg. At the time of the purchase, Rosenberg promised M. Louise Hawkes, an officer of the local DAR, that "he would sell the house only to the Daughters of the American Revolution or to the Town of Saugus."[8] In 1930, the town began negotiations to purchase the house and property for a park, but its interest waned due to Rosenberg's "ridiculously high" asking price.[9] After foreclosure proceedings on the adjacent ironworks parcel were begun, Hawkes offered to purchase the property from the bank and in 1938 the Parson Roby Chapter of the DAR obtained title to the land.[10] It was this parcel that contained the slag pile and buried remains of the early ironworks complex, although no one at the time imagined the remarkable archeological discoveries that awaited excavation.

In keeping with his 1929 promise to Hawkes, Rosenberg again offered the Iron Works House property to the town of Saugus and the DAR in 1941, but neither had the money. He therefore sold it to the Alumni Association of the Henry Ford Trade School, which intended to move the "restored" structure to Henry Ford's developing Greenfield Village in Dearborn, Michigan.[11] The initial reaction of the townspeople and preservation community was outrage and after extended discussions Ford agreed to abandon the purchase if the School was reimbursed for all of its expenditures, which amounted to just over $12,000.[12] Fundraising to buy the house back proved disappointing. With little success in the local community, Appleton devised a plan to split the cost evenly among the state, town, and the public. When it became clear that this approach would also fail due to lack of support, Appleton worked to create a nonprofit corporation to acquire the land and run the property. In 1943, a major fund drive, pitched "To Lovers of Old New England," raised $7,000. This, along with $3,000 from the state and town governments, permitted the purchase of the house and property. The First Iron Works Association (FIWA) officially assumed operation of the site that now included both the house and ironworks parcel.[13]

In 1935 Miss Hawkes spoke with the treasurer of the Rochester Trust Co., which had acquired the property by virtue of a mortgage foreclosure. "I offered him fifty dollars for the land if he would sell it to the Daughters [DAR]," she recalled. "He laughed. But before he left he said, if I were you I would not worry too much about it." Three years later she received a letter from the bank stating that "if I would send the money [the] Parson Roby Chapter could have the land."

Stephen P. Carlson, "The Saugus Iron Works Restoration: A Tentative History," p. 3.

In 1948, J. Sanger Attwill, then president of the Lynn Historical Society and an early supporter of the ironworks project, became the FIWA's second president. His local business of reproducing and restoring period furniture provided an excellent network for fundraising and support. Among the FIWA's board of directors was the well-heeled and influential preservationist Louise Dupont Crowninshield. Crowninshield, a founder of the National Trust for Historic Preservation, was both a financial contributor and fundraiser for the project and it was she who approached Quincy Bent, a vice-president of Bethlehem Steel Corporation, for money in 1944.[14] When Bent first visited the site he was generally unimpressed with the Iron Works House, but tremendously excited by the nearby slag pile and the potential of the site to contain buried ironworks remains.[15]

In 1947, the FIWA formed a Reconstruction Committee consisting of iron industry professionals and iron experts, including Quincy Bent, Edward L. Bartholomew, Charles Rufus Harte, John Woodman Higgins, and Walter Renton Ingalls.[16] Higgins, Harte, and other members of the Committee visited the site and, like Bent, saw great potential for exploration. With the forceful and well-connected Bent taking the lead, the Reconstruction Committee approached the officers of the American Iron and Steel Institute in New York for funding support. The Institute, however, felt that it could not underwrite the project

3.2 General view of the iron-works property prior to excavation. (Photograph 782 by Richard Merrill, unknown date.)

without some tangible evidence that the remains of the ironworks actually existed on the site. Therefore, in the summer of 1948, J. Sanger Attwill approached Roland W. Robbins, whom he had seen lecture on his exciting excavations at Thoreau's house at Walden Pond, about a brief exploratory dig at Saugus.[17] Robbins, between seasons in his window-washing and painting business, readily agreed to dig at Saugus in the fall of 1948.

Neither industrial archeology nor much historical interest in industrial sites existed in North America as the FIWA began to investigate the ironworks complex. Formally established in this country in the 1950s, industrial archeology had a long tradition as an avocational pursuit in England.[18] Although several studies on industrial sites would be published in the United States by the late 1960s, not until the late 1970s did it make "itself known in the university curriculum."[19] Like historic sites archeology several decades earlier, the new subdiscipline of industrial archeology became somewhat controversial in the United States, generating a "great debate over its value, direction, and service."[20] In 1969, archeologist Vincent Foley wrote that it was "only reasonable that a person interested in the history of a particular technology or trade, who desires to call himself an archaeologist . . . justify it [his or her research goals] with the addition of his background and degrees in archaeology."[21]

Robbins had neither a background nor a degree in industrial archeology when he arrived at Saugus in 1948, nor any prospect of getting a degree given the lack of interest in industrial archeology by academic archeologists. What Robbins did possess was a visual acuity for unraveling industrial sites that was linked to his interest in how such sites worked and how people used them. His interest in industrial sites can best be understood within the longstanding tradition of Yankee tinkerers. His preoccupation stemmed from his roots as a laborer and from his innate Yankee curiosity in how things worked, particularly mechanical devices and processes. Robbins' work at industrial sites was also informed by his excellent visual skills; one acquaintance noted that "he was very astute visually . . . . [He] saw so much, not just in detail, but in terms of landscape and relationships of landscape."[22] Archeologist Paul Heberling recalled a visit that he and Robbins made to the Greenwood Furnace site in the 1970s: "He just walked around and looked at the terrain. He would see something and get out his probe rod to confirm his suspicions. In this way, he figured out the entire setup . . . . He had such an astute alert awareness of iron complexes that he immediately recognized what he had."[23]

Reflecting on his years of collaboration with Robbins, author Evan Jones commented that Robbins was not particularly interested in the lives of the people at the sites that he excavated. "He was interested in the problem," Jones recalled. "He may have considered how a miller did something or made something, but only in the context of trying to figure out the mechanical setup, and the archaeological problem at hand."[24] Jones' recollection reflects very accurately how Robbins came to approach the Saugus site.

My reason for writing to you at this time is to see if you would like to go on an Antique Treasure Hunt. It seems that now we have acquired the Iron Works House, . . . the . . . Institute have [sic] *agreed to rebuild the Blast Furnace and Mill . . . if we will find the location and foundations. Does this arouse any interest on your part? If you are interested and have the time to tackle this let me know. It needs someone that has interest and will attack the situation with sympathy.*

J. Sanger Attwill to Roland W. Robbins, August 24, 1948.

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3.3 Workers beginning excavation of blast furnace site on September 18, 1948. (Photograph 2 from the Roland W. Robbins slide collection, 1948, Saugus Iron Works. Courtesy The Thoreau Society® Collections at the Thoreau Institute at Walden Woods.)

Robbins, still very much an avocational archeologist at this point, met with FIWA president Attwill at the site on September 10, 1948, and was briefed on the primary objective of the initial work: locating and excavating the blast furnace foundations. Robbins' initial "testing [of] the soil by sinking holes" revealed that the land along the Saugus River was covered with as much as four feet of slag fill.[25] After four days of digging "numerous test holes," Robbins identified the stone blast furnace foundation "buried three feet deep and some fifty feet north of the slag heap which runs north and south."[26] He recorded that

> . . . at one foot and one foot three inch depths, I located small pieces of old chinaware. At two feet six inches a bed of clay with pieces of red (baked) clay and bits of charcoal, as well as good-sized pieces of sandstone mixed with it, was located. This vein was six to nine inches in thickness. Beneath this vein was found a base of medium-sized stones.[27]

After the business meeting Mr. Harte, Mr. Bartholomew, and J. Sanger Attwill again examined the area now excavated. Mr. Harte couldn't determine the reason for the fine sand base found on north side of stone base, nor for the large bed of charcoal found on the south side of stone base. In fact he admitted the stone base may be site of blast furnace.

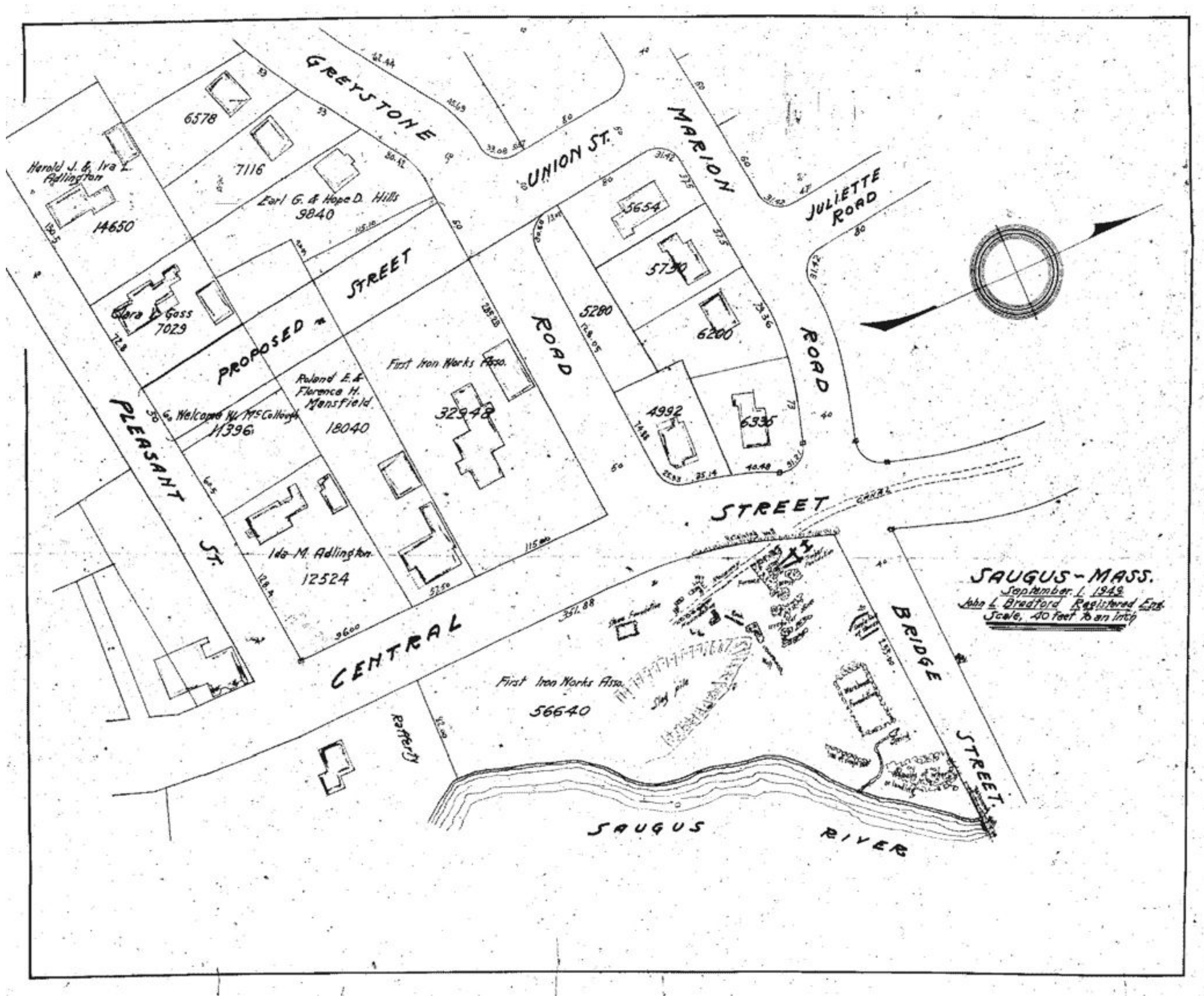
Roland Robbins, "Saugus Ironworks Daily Log - 1948," September 21, 1948.

Attwill and the Reconstruction Committee were so impressed by the success of Robbins' initial excavations that they agreed to finance his work for an additional six weeks, at a cost of $1,500.00.[28] The first evidence of the furnace foundation uncovered by Robbins became the center of his continuing excavations. By mid-October 1948, he had identified the entire "outline of the furnace foundation, the heavy timbered base for the bellows, and the crucible cavity."[29] He also identified several wooden beams at the northwest corner of the foundation, buried eight feet below the ground surface; these he speculated were part of "the waterwheel [and sluiceway]. . . ."[30] The sluiceway, he thought, probably ran along the western side of the furnace, and the furnace waterwheel, he reasoned, would be found north of the furnace under the Central Street roadway.

In December, curious about the sluiceway's construction, Robbins returned to Saugus to check on several details. He noted that he was "impressed with soil at [the] level of [the] base of [the] beams which form [the] sluiceway, it was blue-gray in color. Its bed was about 4 inches deep. Beneath it was a deep bed of fine sand."[31] He also dug a test unit outside the sluiceway and found only a coarse gravelly sand that "seemed to be much more natural . . . ." Robbins collected soil samples from each stratum in glass jars for later examination.[32]

In his report summarizing the 1948 excavations, Robbins described his findings related to work around the blast furnace during the fall, and concluded that:

> Undoubtedly, the pattern formed by the uncovered areas will shed enlightenment on America's first blast furnace, as will the relics and castings advance new knowledge on the methods and theories of that day.



3.4 Plan of excavations in September 1949, showing the original street layout in the vicinity of the site and with notations on general excavation area location. (Drawing by John L. Bradford, 1949.)

> Future research and excavations should prove very fruitful, as should a concerted effort to concentrate on the records of "The Company of Undertakers for the Iron Works" for a thorough study and analysis.
>
> In my opinion, many facts concerning the over-all setup of the first iron works undertaking, its branch at Braintree, Massachusetts, canals, bog iron sites, whether or not a pier existed on the Saugus River for barge service to the iron works, customs, theories, and business philosophy of the era are but a few of the unknown elements of America's first iron works that quite possibly could be answered if the time was exerted to such an undertaking.[33]

Iron expert Charles Rufus Harte also completed a report based on his observations of the 1948 excavations and supported Robbins' call for additional research and excavation: "In my judgment Mr. Robbins has done excellent work, which has disclosed much important information regarding the location and construction of the blast furnace, but there still are lacking important details which only can be secured by additional further excavation of the site."[34]

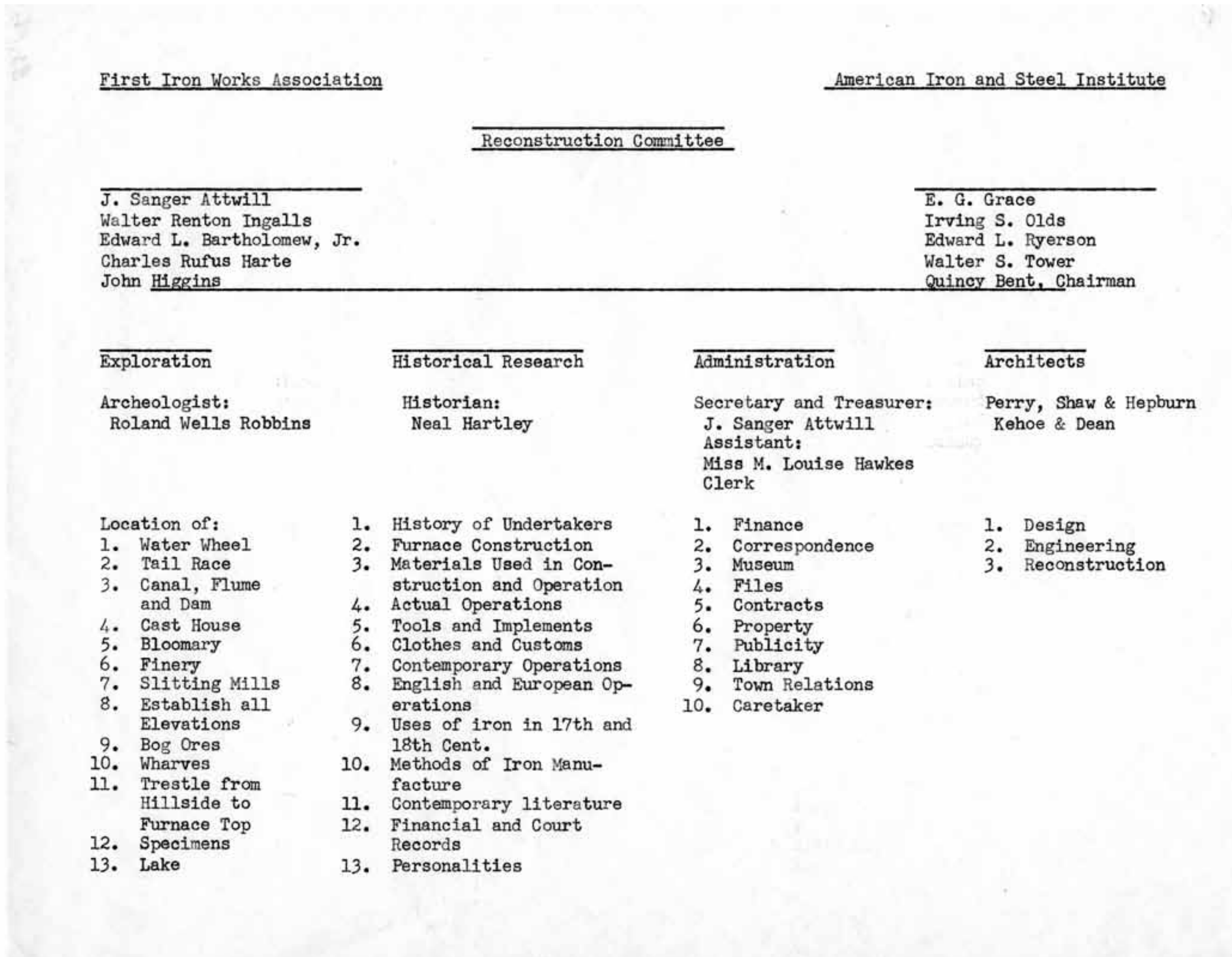
The Reconstruction Committee, fortified by Robbins' success at finding intact ironworks features, once again approached the American Iron and Steel Institute for funding.[35] The Institute, excited by Robbins' report and findings, agreed to finance additional archeological work as part of a larger reconstruction project. In the spring of 1949, the FIWA hired Robbins as the project's archeologist on a full-time basis. Plans to restore the furnace had begun to materialize even before excavations resumed. The FIWA and the American Iron and Steel Institute formed a new, expanded Reconstruction Committee to manage the project in 1949. The new Committee elected Quincy Bent as chairman and hired historian E. Neal Hartley of the Massachusetts Institute of Technology to begin a long-term historical research project on the ironworks.

With the enlarged Reconstruction Committee in place and the project historian on staff, Robbins and a team of local laborers began full-time excavations at Saugus in May 1949.[36] The workers initially cleaned the previous year's furnace excavations, identified the furnace tailrace, and then traced it along the southwest side of the furnace. Within a week, Robbins noted in his daily log that "we are now digging to a depth of nearly seven feet to reach the upper most evidence of the tailrace."[37]

Robbins' field team was quickly expanded to include two new members, surveyor John Bradford and professional photographer Richard Merrill. Robbins noted that he immediately met with Bradford, who worked on an as-needed basis, about making a master plan for cumulatively plotting excavation information.[38] Upon arrival, Bradford began to make detailed, scaled field maps complete with elevations

Sanger Attwill phoned me Mon. evening, March 28, 1949 and said that he talked on the telephone with Mr. Bent, Sunday night. Mr. Bent wants me to start work at Saugus immediately. Sanger said Mr. Bent believes my work should keep me busy until October this year. Sanger said Mr. Bent said it was all right to start a supervised crew with me directing its work by checking on it several times a week. In other words any way that could be worked out by me so that I could get work started at once.

Roland Robbins, "Saugus Ironworks Daily Log - 1949,"March 28, 1949.



First Iron Works Association

American Iron and Steel Institute

Reconstruction Committee

J. Sanger Attwill
Walter Renton Ingalls
Edward L. Bartholomew, Jr.
Charles Rufus Harte
John Higgins

E. G. Grace
Irving S. Olds
Edward L. Ryerson
Walter S. Tower
Quincy Bent, Chairman

Exploration

Archeologist:
Roland Wells Robbins

Location of:
1. Water Wheel
2. Tail Race
3. Canal, Flume and Dam
4. Cast House
5. Bloomary
6. Finery
7. Slitting Mills
8. Establish all Elevations
9. Bog Ores
10. Wharves
11. Trestle from Hillside to Furnace Top
12. Specimens
13. Lake

Historical Research

Historian:
Neal Hartley

1. History of Undertakers
2. Furnace Construction
3. Materials Used in Construction and Operation
4. Actual Operations
5. Tools and Implements
6. Clothes and Customs
7. Contemporary Operations
8. English and European Operations
9. Uses of iron in 17th and 18th Cent.
10. Methods of Iron Manufacture
11. Contemporary literature
12. Financial and Court Records
13. Personalities

Administration

Secretary and Treasurer:
J. Sanger Attwill
Assistant:
Miss M. Louise Hawkes
Clerk

1. Finance
2. Correspondence
3. Museum
4. Files
5. Contracts
6. Property
7. Publicity
8. Library
9. Town Relations
10. Caretaker

Architects

Perry, Shaw & Hepburn
Kehoe & Dean

1. Design
2. Engineering
3. Reconstruction

3.5 Organizational chart of the Reconstruction Committee.

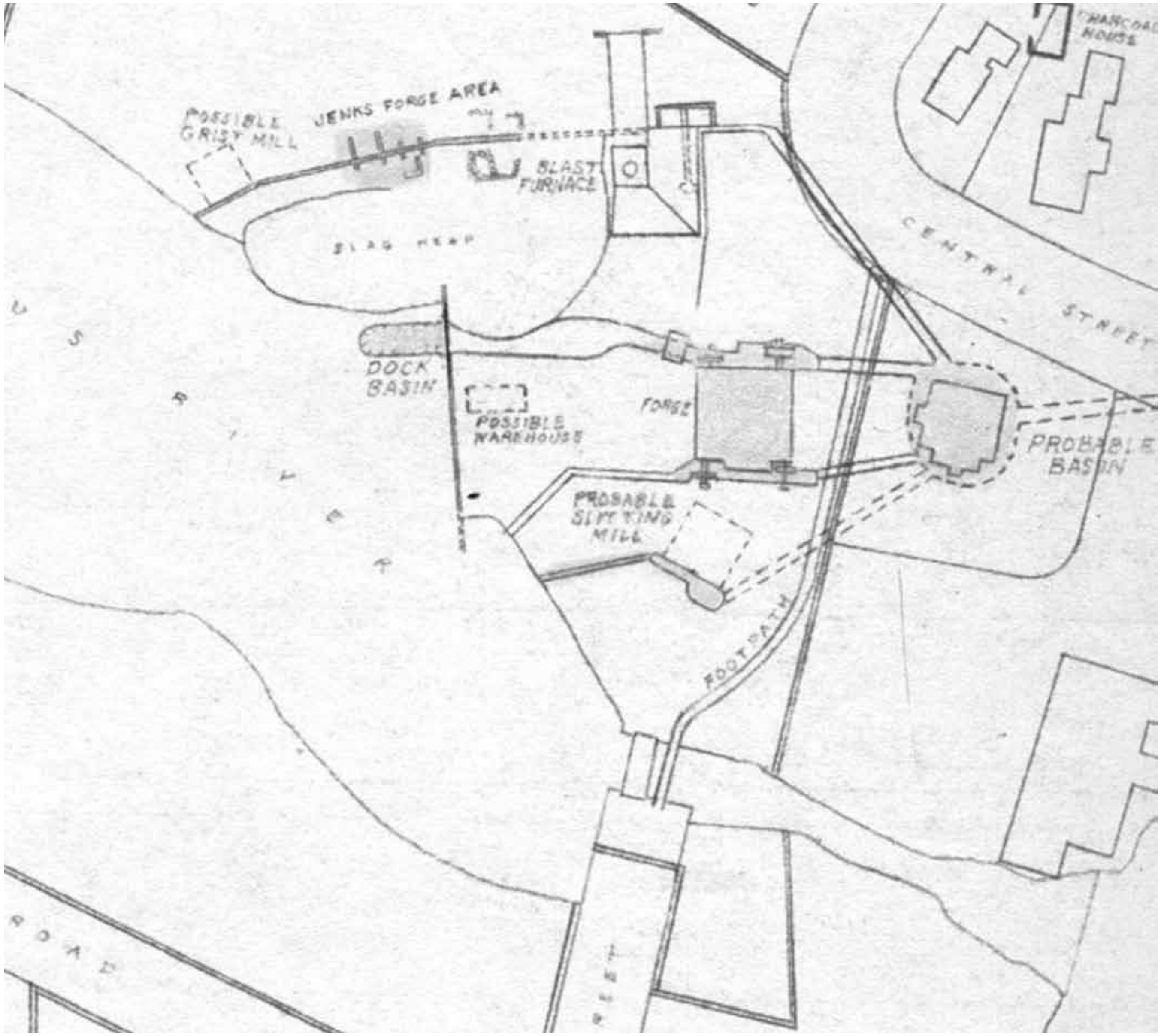
relative to a site datum. Merrill, hired on an intermittent basis like Bradford, began to photograph the excavations and features.[39] The several thousand excellent black and white photographs by Merrill provide a detailed record of the excavation work and later reconstruction. Drawing on his association with specialists like Bradford and Merrill, Robbins greatly expanded his own skills in surveying and photography during the Saugus project. Similarly, when Robbins recovered numerous animal bone and wood specimens, he sought help from Barbara Lawrence, curator of the Museum of Comparative Zoology at Harvard for bone identification, and Fred Orchard at the Peabody Museum for "properly treat[ing] and preserv[ing] the timbers of the tailrace and bellows base."[40] Although Lawrence took on the project of identifying the faunal remains from the project, Orchard explained to Robbins that his museum was not equipped to conserve large wooden artifacts.[41]

By mid-summer 1949, Robbins had located five separate foundations and began identifying them by number, "beginning with [the] furnace foundation as #1, the possible hammer foundation as #3, junction of 2 walls as #2, the possible forge foundation east of #2 and #3 as #4, and the stone evidence running ESE of the 3rd large elm tree site as #5."[42] Robbins also began a search along Central Street for the canal or waterway that had supplied the furnace with waterpower. His first two trenches averaged between 13 and 16 feet wide and 30 to 55 feet long and were oriented perpendicular to Central Street. These hand-excavated trenches each contained portions of a linear feature that measured between four and five feet deep and between ten and twelve feet wide, both with tapering ditchlike sides. Robbins was intrigued by these features but noted that he was "not entirely convinced" that he had found the canal course.[43]

From the very start of his full-time employment at Saugus, Robbins' approach to the excavations began to assume a haphazard appearance, apparently lacking any organized plan. Although archeologist Marley Brown commented in his 1977 review of Robbins' excavations that "in most cases, Robbins' testing proceeded on a rather random and limited basis, reflecting the location of utility trenches and other construction activity, rather than the application of any systematic sampling scheme," a closer look at Robbins' field notes and logs suggests that his work was far from random.[44] Robbins attempted to follow the feature and artifactual evidence in a logical sequence: for instance, he began with the furnace complex and then defined its watercourse and the source for this water. His strategy consisted of tracing identified features and evaluating the landscape, both through testing and topographic clues.[45] Testing north of the ironworks property resulted in the discovery of a series of other watercourses likely flowing out of a central holding basin. The various watercourses were then carefully followed to identify associated features, like wheel pits and raceways, from which he then expanded out to identify building-related features. Finally, he traced the tailrace features of these buildings to the river, where he then investigated the dock or wharf area. While several areas were often under investigation at the same time, Robbins did his best to work through specific areas and features, attempting to complete work in each activity area be-

I checked the Geological Survey map of the Boston North, Mass., 1946 edition, and found . . . the distance between the site of the furnace waterwheel and the nearest section of the "cranberry bog" at the end of Marion Road to be about 500 feet."

Roland Robbins, "Saugus Ironworks Daily Log - 1950," January 9, 1950.



3.6 Detail of plan of site showing basin, watercourses, and principal features, January 1953. (Drawing by Steve Whittlesey.)

fore moving on to a new area. However, numerous management issues and delays challenged Robbins' efforts and in the end he was forced to move around the site to satisfy the demands of the architects, attorneys, and reconstruction crew.

Private property issues, construction demands, and weather all hindered Robbins' attempts to carry out his work in a more systematic and organized fashion. For instance, his testing work around the houses that lined Marion Road, Central Street, and Bridge Street was continuously hampered by difficulties in getting permission to excavate and by landowner complaints.[46] Robbins was frequently promised access to properties by the FIWA's attorney, Laurence Davis, but after preparing for the work he would find that the situation was not properly resolved. In fact, the attorney's reputation with the neighbors was such that Robbins was frequently called upon to act as a negotiator and mediator between Davis and the property owners, particularly when the ironworks wished to buy the land.[47] Lengthy delays in rerouting Central Street, which covered the furnace waterwheel, severely disrupted Robbins' plans for completing work on the furnace complex before moving to other areas.[48] In another instance, his excavations along Bridge Street on several of the watercourses and the refinery forge complex were disrupted when attorneys discovered that they had not obtained permission from the city to work in the Bridge Street right-of-way. They ordered Robbins to backfill his units immediately and abandon the area until they had attended to the problem.[49] This caused a lengthy delay in the recording of features related to the refinery forge building and forced Robbins to refocus the ongoing excavation work on other areas.

Mr. Murray would not permit any more work *at the site of the hammer beam anchorage, anvil base, sites of uprights, or at any point within the 40 ft. right of way. Another day at the site . . . and we would have plotted their details, etc.* This cannot be done, *I was informed by Mr. Murray. Considering the importance of this work surely another day could have been spared to complete it.*

Roland Robbins, "Saugus Ironworks Daily Log - 1950," December 13, 1950.

Robbins' work plans were also disrupted by the demands of the architects and builders who literally followed him across the site during the reconstruction process. They frequently asked him to stop work in one area and move to another to answer a question or respond to a problem that had developed. He was also restricted by the guidelines set by the Reconstruction Committee that directed him to "concentrate his activities on locating and exposing only the major features of the industrial complex of the Iron Works proper."[50] For example, his work on the charcoal house foundation, located on private property north of the ironworks during testing for the watercourses, and his later work on the Jenks Forge area, were terminated by the Committee, which saw these elements as ancillary to the main buildings of the ironworks.

Although his ability to focus on specific archeological areas and features would become increasingly hindered by the overwhelming demands of the managers and the complexity of the site, Robbins initially succeeded in organizing his work around the furnace. He had identified five additional foundations to the southeast of the furnace by August 1949 and was continuing his series of "canal test trenches" along Central Street to locate evidence of the watercourse to the furnace. During the late summer and fall of 1949, he concentrated his excavation efforts on features associated with the furnace foundation, the casting beds, the crucible pit, and the bellows base, along with the area immediately east of the furnace foundation itself.

3.7 Robbins working in forehearth of blast furnace; note intact sow in front and to his right. (Photograph 116 by Richard Merrill, 1949.)

Commenting on the work completed in 1949, Robbins wrote in his report to the Reconstruction Committee that "... my major problems were not the locating and excavating of buried foundations, but rather the association of these foundations one to the other and their functions. This was necessary to determine the original pattern of the plant and its layout."[51]

Robbins went on to set forth some of the questions in his mind regarding the original site plan: "Why was this site decided upon? What was [sic] its geographical advantages? Its source of bog iron ore, and its water power? Where was the site of the stone wharf on the Saugus River?"[52]

Robbins then noted that

> probably the most revealing observation made during the 1949 excavations here at Saugus was the determining of the ravine which existed before the Ironworks were erected. And how the incline of this ravine climbed to a height of some thirty-four feet above the high tide of the Saugus River. Fullest advantage of the elevations provided by the ravine were made use of when the furnace, its bridge and the race were constructed.[53]

The increasingly successful excavations produced large numbers of ironworks-related artifacts, causing Robbins to observe that "our museum is bulging with tons of various artifacts uncovered during past excavations. These visible legacies of the past are being classified and must be preserved for future generations to revere and ponder."[54] While proud of his early accomplishments, Robbins concluded that identification of the ruins and artifacts was not enough: "the fact that many foundations and sites have been located does not indicate that my work with them is done. To locate foundations is one thing—to fit them and their intricacies into the over-all picture is another matter."[55]

From late 1949 to July 1950, Robbins and his crew performed only limited testing, including test units in the furnace crucible pit and the area east of the Central Street retaining wall. Severe winter weather limited work in the field and the Reconstruction Committee decided that he should "terminate present excavations until the middle or last of March." The committee suggested that he spend his time cataloging the artifacts and writing his report for the 1949 excavations. Meanwhile, the group discussed rerouting Central Street for excavations of the furnace waterwheel.[56]

The restricted work around the crucible pit focused on several fill areas containing slag and metal artifacts. Robbins initially speculated that these depressions may have been used for cooling hot slag waste, but felt that the quantity of slag and metal artifacts suggested some other interpretation.[57] Along the Central Street retaining wall above the furnace, Robbins trenched the slope to determine the stratigraphy

The collection includes a wide range of ironworking tools in both complete and broken-in-use forms as well as a range of iron products including cast iron fragments, ceramic casting mold fragments, stock, wasters, and finished products. Other seventeenth-century items with research potential include pipe fragments, Native American trade goods, leather shoe fragments, brass pins, case bottles, flatware, and domestic ceramics.

Eric S. Johnson, *Archeological Overview and Assessment of the Saugus Iron Works, National Historic Site, Saugus, Massachusetts*, p. 64.

3.8 Robbins examining artifacts in the Museum Building on January 7, 1950. (Photograph 139 by Richard Merrill, 1950.)

and in hopes of locating the supports for the furnace charging bridge.[58] He identified a concentration of stones, fire-scorched soil, charcoal, and a large iron sow in the same area; this suggested a possible foundation related to some type of production activity, potentially a bloomery or Catalan forge.[59] Robbins also continued to seek the source of the furnace watercourse, particularly the so-called "cranberry bog" area above the ironworks, during the first half of 1950.[60]

In addition to cataloging "relics" during the extremely cold and snowy winter, Robbins continued his research into appropriate conservation methods.[61] He wrote to Plimoth Plantation archeologist Henry Hornblower about iron artifact conservation. Hornblower suggested that Robbins contact James Bateman of Williamsburg.[62] In late January, Robbins sent Bateman "eight metal specimens" for restoration, but he felt that the results were disappointing and not worth the cost.[63] During this period, Robbins also continued what had already become standard procedure at Saugus: sending samples of iron artifacts and waste, slag, and iron ore to laboratories at several steel companies for analysis.[64] The members of the Reconstruction Committee and their consulting geologist hoped that these tests would provide new information on the specific iron-making process, result in the identification of iron ore sources, and succeed in distinguishing products made at the Saugus operation.

In April 1950, Robbins and historian Hartley traveled to West Quincy, Massachusetts, to investigate an early iron furnace known to be part of the larger "Company of Undertakers for the Iron Works" holdings.[65] Hoping to use this furnace for comparison with the Saugus complex, Robbins dug several small tests in an attempt to verify the furnace location. He succeeded in locating a foundation and evidence of the burned sandstone furnace lining in an area measuring 24 by 21 feet and evidence of a slag deposit; Robbins collected samples of both the sandstone and slag for later testing and comparison with the Saugus materials.[66]

Robbins received an introduction to local community politics during the campaign to relocate Central Street in order to search for the furnace waterwheel.[67] Negotiations between the FIWA members and town officials dragged out over several months due to disagreements over the cost of the project, public safety, and convenience. Town meetings generated heated debate and opposition from homeowners in the ironworks neighborhood and interested town representatives and neighbors visited the site throughout the summer of 1950. Robbins gave them full tours of the excavations, the museum and laboratory, and the artifact collections, while vigorously lobbying for the project.[68] With the help of lobbying efforts by Robbins and Reconstruction Committee members, the road rerouting was approved at a special town meeting on July 27, 1950. Anxious to leave politics behind, Robbins resumed excavation work the following day.[69]

One thing worthy of note about evidence uncovered here (W. Quincy) is that this furnace was lined with sandstone. I found sandstone (burned) pieces that appear to be the same as used in the Saugus furnace lining. Also was found a type of stone similar to what was found at Saugus, but yet unidentified. It was found (both at Saugus and W. Quincy) mixed with the burned sandstone lining. It may be a type of sandstone. It is cataloged under #1-1-16 in 1948 relics.

Roland Robbins. "Saugus Ironworks Daily Log - 1950," April 7, 1950.

Due to copyright restrictions, this image is not available in the on-line version of this publication.

3.9 Iron artifacts prior to conservation treatment. Note the provenience information on the gear in the upper center of the photo. (Photograph 402 from the Roland W. Robbins slide collection, 1951, Saugus Iron Works. Courtesy The Thoreau Society® Collections at the Thoreau Institute at Walden Woods.)

Moving out from the furnace in hopes of identifying other ironworks structures, Robbins turned his attention to excavating the Bridge Street area and began a series of test trenches along the north side of the street.[70] He had previously determined that this area was a likely candidate for another ironworks structure as it appeared to contain several other watercourses running from the basin to the river's edge. Almost immediately, the digging identified two foundations at depths of approximately three and a half and five feet. Robbins also identified a "large circular affair" along the north side of Bridge Street that appeared to be a hammer base.[71] At a depth of 34 inches, he found a "stump or block of a tree that measured 41 inches in diameter."[72] "The theory at the moment," he recorded, "is that the circular wood base is the base on which the hammer fell and the metal waste about it was the accumulation of the impurities extracted from the iron by the hammer action."[73] Later discoveries would confirm that he had identified a forge hammer base.

During August, Robbins met with architects Conover Fitch and Harrison Schock of Perry, Shaw, and Hepburn, Kehoe and Dean to discuss details of the furnace layout.[74] At this session, and others like it over the next two years, Robbins provided commentaries on the features, plan and profile drawings of the excavations, and relevant photographs, all to aid the reconstruction design process. The work of surveyor Bradford and photographer Merrill also contributed to the discussion.

After identifying the hammer base along Bridge Street, Robbins dug several test trenches "to determine the natural soil line" and guide future excavations.[75] "At this spot," he recorded, "only several inches of surface soil covered a deep deposit of natural clay."[76] His notes for the excavation of these trenches contain clear, detailed descriptions of the soil profiles that note soil color, soil type, disturbances, and the stratigraphic relationships between the various layers and deposits.[77] During late August, Robbins used heavy construction equipment to begin restoring "the slope from Central Street to the area south of the furnace" to the natural contours that existed prior to the construction of the Central Street roadway.[78]

Also in August, Robbins and his men found another wooden feature about 11 feet east of the hammer base that was later identified as the hammer beam base or upright. This feature also appeared to be a section of tree, although in this case squared off and smaller than the first, measuring 21 by 23 inches.[79] Robbins and Hartley were excited about this discovery, believing that it and the hammer base were likely part of the ironworks' refinery forge building.[80] This interpretation was strengthened when, on August 31, Robbins found the head of a trip hammer of the type and size likely used in a refinery forge operation in the immediate vicinity of the bases along Bridge Street. He noted that the 500-pound iron hammerhead was covered with approximately 8 to 10 inches of soil and "appeared to be resting on natural clay."[81]

I excavated the newly located metal waste square sleeve found . . . [east or northeast] of the circular metal waste affair found on the [north]side of Bridge St. It is the same idea as the circular metal affair, only smaller and somewhat square . . . Found in it was an upright section of a tree. It had been squared somewhat, rather than left in its natural . . . shape. Hartley seemed quite pleased about this discovery. Said it enhances the chances of this being the site of a hammer and refinery.

Roland Robbins, "Saugus Ironworks Daily Log - 1950," August 25, 1950.

3.10 Architects from Perry, Shaw, and Hepburn, Kehoe and Dean reviewing drawings. (Photograph 1071 by Richard Merrill, 1953.)

In September 1950, the Central Street detour went into effect and Robbins made arrangements with a backhoe operator to begin removing the street surface as soon as possible.[82] The backhoe work, Robbins reported, entailed "restoring the natural contour here," and began with the removal of the Central Street retaining wall between Bridge Street and Marion Road.[83] After the bulk of the fill was removed from the Central Street slope above the furnace site, Robbins and his crew continued the search for the furnace waterwheel, "removing the fill from the area at the northwest corner of furnace and the easterly slope of the ravine" by hand.[84] He also continued test trenching to establish the natural grade at the intersection of Central and Bridge streets and Marion Road, when utility trenching produced evidence of a possible watercourse and a new foundation.[85] The bottom layer of silt in this trench, Robbins recorded, contained "Indian chips . . . that suggest the possibility of a natural brook having crossed here . . . ."[86] A similar watercourse was found in a trench behind a house at the corner of Marion Road and Central Street. Robbins believed that this watercourse was a direct approach to the furnace waterwheel.[87]

[T]he site of the charcoal house, pit or shed was located! About 3' of fill soil covered this charcoal bed. A test hole through the charcoal found it to be 45" deep. A piece of a brick was found at the bottom of the charcoal. Hartley believes a pit may have stored the charcoal.

Roland Robbins, "Saugus Ironworks Daily Log - 1950," October 19, 1950.

Beginning in mid-October, Robbins initiated a series of test trenches between Marion and Greystone roads west of Central Street.[88] Four of the twelve trenches revealed soil profiles that strongly suggested to him that he had identified a waterway cutting southeast from the "cranberry bog" to the ironworks.[89] He wrote that "information and artifacts revealed by trenches #4, 5, 6, and 7, as well as similar evidence noted in two trenches crossing Union St. near junction of Marion Rd. speak convincingly of a brook or water course leading from the cranberry pit in a somewhat southeasterly direction."[90]

Robbins also identified and partially excavated the site of the probable charcoal house in the rear yard of a house on Marion Road, west of Central Street. He reported that three feet of fill soil covered a stone foundation and charcoal bed that measured 45 inches deep.[91] Ongoing digging at the charcoal house site was unfortunately cut short due to complaints from the tenant living in the house and pressure from Attwill to return to more important features. Robbins was forced to record and photograph the exposed foundation features quickly before backfilling the excavation.[92]

During November 1950, Robbins continued working on restoring the original contours along Bridge Street and testing along Central Street to determine the extent of the ravine.[93] He and his crew then returned to work on the site of the anvil base foundation in the refinery forge area, south of the Bridge Street retaining wall.[94] As Robbins and the crew shoveled down this area, he identified several new features including uprights that supported the hammer beam, a stone foundation north of the retaining wall (the remains of a later tannery), and possible evidence of the waterwheel pit and watercourse for the refinery forge.[95] Shortly after finding these new features, Robbins was informed by the Institute's lawyer that the area would have to be backfilled immediately because it was within the 40-foot Bridge Street right-of-way owned by the city and the FIWA had not yet negotiated access to this area. Before the area was backfilled and fenced, Robbins sketched the evidence and had Richard Merrill take photographs.[96]

3.11 Profile of furnace watercourse at head of Central Street, January 13, 1951. (Photograph 642 from the Roland W. Robbins slide collection, 1951 Saugus Iron Works. Courtesy The Thoreau Society® Collections at the Thoreau Institute at Walden Woods.)

During the 1951 season, Robbins returned his attention to excavation along the recently closed Central Street corridor. Digging in January along the Central Street slope near the furnace and at the intersection of Central Street, Marion Road, and Bridge Street, he identified a stone foundation west of the furnace and a disturbance at the head of the Central Street ravine slope, respectively. Robbins believed that the stone foundation was likely the base of the furnace bridge or at least a retaining wall associated with the bridge support structure. He identified the disturbance as the watercourse leading to the furnace raceway.[97] Using the watercourse as a lead, Robbins concentrated his energies on finding the furnace waterwheel pit, calculated to be some 20 feet below the surface of Central Street. In February 1951, he identified a waterwheel bucket and proceeded to methodically uncover the entire furnace wheel pit and adjacent raceway, carefully documenting the work with his own sketches and photographs and with help from Bradford and Merrill.[98] Robbins excitedly recorded in his log that "today's work hit the jackpot! While I had expected to find about 25% of the waterwheel cradled in the race at least 40% of the wheel was found there . . . . "[99] He calculated the wheel's diameter as 16 feet and determined that it was definitely an overshot wheel.[100] The wood preservation was remarkable and Robbins found the wheel, wheel pit, and a section of the raceway virtually intact. The waterwheel's buckets even retained the original animal hair caulking used to make them watertight.

The almost unbelievable condition of the waterwheel complex brought the issue of wood preservation to a head, prompting Robbins to immediately search for appropriate conservation treatment prior to dismantling the feature. He first consulted Fred Johnson, a curator at the Robert Peabody Museum in Andover. Johnson had few ideas, telling Robbins that "it was so large that it may be impractical to do much with it," but recommended that he talk with Dr. Elso Barghoorn at Harvard's Biological Laboratories or Hugh Hencken at Harvard's Peabody Museum.[101] Robbins met with Barghoorn several days later and Barghoorn became interested in the problem and offered quickly to begin some limited experiments.[102] Robbins reported his finding to the Reconstruction Committee which authorized him to "attend to all arrangements for the dismantling, treating, and preserving of the water wheel."[103] As discussed further in Chapter 11, Barghoorn experimented with several possible treatments before arriving at the process of immersing the wood in hot paraffin wax to drive off the water and provide structure to the wood.[104]

While seeking appropriate treatment for the waterwheel and wheel pit complex, Robbins continued test trenching on the east side of Central Street and along the north side of Bridge Street, searching for the exact paths of the furnace and refinery forge watercourses.[105] This trenching uncovered evidence of watercourses to both the furnace and refinery forge and suggested that the furnace watercourse split off the refinery canal.[106] This evidence convinced Robbins that the furnace waterwheel was supplied from the same source as the refinery and also suggested to him that the furnace and refinery probably were built at the same time.[107]

I estimate the outside measurement of the wheel to have been about 16' when in operation. Inasmuch as the lower area of the race is still full of stones, dirt and various rubble the exact diameter can not be determined until it is cleaned out. It definitely was an overshot wheel! The race at the wheel's center was 29" in width. Schock and Harley down in P.M.; were delighted and surprised at the discovery. I shall try to obtain more knowledge concerning the wheel's diameter and various measurements tomorrow.

Roland Robbins, "Saugus Ironworks Daily Log - 1951," February 23, 1951.

3.12 Intact section of excavated furnace waterwheel, June 13, 1951. (Photograph 362 by Richard Merrill, 1951.)

During the summer of 1951, Robbins and his crew excavated to the south, east, and west of the furnace foundation itself, locating yet another foundation along the furnace tailrace.[108] By June, Robbins was satisfied with Barghoorn's experimental wood treatment process and completely dismantled the furnace waterwheel and wheel pit complex and shipped it to Barghoorn's lab.[109] In July, Robbins resumed testing along Bridge Street near the refinery forge and located a second watercourse along the east side of the structure.[110] About this time, he directed heavy earthmoving equipment into the wharf area, focusing on Foundation #6, the possible warehouse structure.[111] While testing in the area south of Foundation #6 and east of the slag pile, Robbins discovered several round beams over 50 feet long. He interpreted these beams as base sills of cribbing for the wharf or dock.[112] The same day, excavation of a trench along the south side of Bridge Street revealed evidence of a third potential watercourse crossing Bridge Street to the east of the refinery forge site.[113]

During the fall of 1951, Robbins excavated the wharf area and the two refinery waterways identified earlier in the year. In October, he located more evidence of a dock in the wharf area on the east side of the slag pile. He also performed limited excavations among the foundations on the furnace tailrace reportedly associated with a forge belonging to ironworker Joseph Jenks.[114] In late November, Robbins had his crew uncover the hammer anvil base feature within the refinery forge and begin excavating the related hammer watercourse and wheel pit.[115] This work continued into December, when he and the crew also began to investigate the second refinery waterway, located east of the hammer waterway.[116] In particular, he sought evidence of the refinery forge between these two watercourses.[117]

Robbins continued to excavate in the Bridge Street refinery forge area in the new year, working on the second wheel pit on the first, or hammer, refinery waterway.[118] Digging in this area was discontinued when Robbins decided to wait for "more consistent good weather."[119] The weather warmed in a few days and Robbins began excavating "evidence of [an] old retaining wall" at the foot of Central Street. After several weeks in this area, he moved the crew back to the Joseph Jenks forge area "just westerly of [the] south end of [the] slag dump."[120] In mid-February, Robbins' crew identified several base sills and other timbers that suggested the presence of a race or wheel pit feature.[121] Several days later, Robbins found the hub and shaft of a waterwheel buried in the fill and within the next two weeks identified two more waterwheels in their wheel pits.[122] The excavations in the Jenks area also yielded "many interesting artifacts," including shoe leather, slag, iron waste materials, and red clay tobacco pipes.[123] Robbins later found a fourth waterwheel and identified the likely remains of Jenks' forge hearth.[124]

During late March and April 1952, Robbins continued work in the Jenks area and opened up the second refinery waterway crossing Bridge Street.[125] In April and May, he "restored the contours" in the furnace casting beds and the area between the furnace and first refinery waterways.[126] While working in the area

Through the interest and collaboration of Roland W. Robbins . . . precise data concerning present tidal relations have been obtained, as well as useful and important historical information. Critical examination of the field relations exposed in the Saugus excavation indicates that the entire area of the early Iron Works development has been affected since 1650 by an increase in the height of tide in the Saugus estuary of approximately 2½ to 3 feet.

Elso S. Barghoorn, "Recent Changes in Sea Level Along the New England Coast: New Archaeological Evidence," *Science,* Vol. 117, No. 3048 (May 29, 1953), p. 597.

3.13 Robbins (bottom center in white baseball cap) and workmen excavating along waterfront "dock area," December 7, 1951. (Photograph 533 by Richard Merrill, 1951.)

of the second refinery waterway, Robbins also further explored the possible third waterway crossing Bridge Street.[127]

From June through August, Robbins focused his attention on the layout of the refinery forge and two associated waterways.[128] He worked around the anvil base, "cleaned down to [the] working surface of [the] refinery area," and excavated along the second refinery waterway.[129] He identified a second anvil base feature, 42 inches in diameter, similar in width to the other finery anvil base. This led Robbins to argue for a "two hammer setup at the forge."[130] His discovery led to a series of Reconstruction Committee meetings that pitted Robbins against some of the committee members who ultimately decided that the layout had only one hammer that had been replaced.[131] Further work around the second anvil base revealed metal waste evidence indicating that the second hammer, like the first, had been used extensively.[132] Even with this convincing new evidence, the Committee members refused to change their minds. In fact, chairman Quincy Bent commented to Robbins, "What are we going to do? We've got to do some building."[133]

During the fall of 1952, excavation continued at the refinery forge complex, with Robbins "seeking possible evidence of early uprights" that might indicate the structural layout of the actual building.[134] In late October, he resumed his search for the "southerly course of [the] third waterway."[135] At the same time, he dug new trenches in the wharf complex, where he reported that "we are finding a great deal of rich, black . . . soils in the area abutting . . . the stone wall built above the wharf sill. In it are many artifacts, including some very interesting shoe leather."[136] Excavations in the wharf area also located what Robbins believed to be a boat basin for floating boats at low tide.[137] New trenching north of Bridge Street identified "definite evidence of the [impounding] basin" that supplied the ironworks waterwheels.[138] For the remainder of the year Robbins focused primarily on the excavation of the third waterway, thought to be the slitting mill site, and the wharf area.[139]

Little digging occurred during January and February 1953 because of bad weather. When work resumed in March, Robbins turned his attention to the rolling and slitting mill site, "removing all fill soils to the natural sub-surface which can be carefully studied for evidence of gear pits or other slitting mill activity."[140]

The excavation crew also returned to the wharf area after Robbins and assistant Steve Whittlesey had recorded the details of the "yard and dock sills." Following this mapping, Robbins and Whittlesey laid out "a system for numbering the sills intended to be removed."[141] In April and early May, Robbins concentrated his efforts on the slitting mill site, working "about the charcoal bed and stone work located there."[142] He also excavated the "surface directly below the iron works surface with the hope that we might find some evidence of stone work, or locate sites of wooden uprights" that supported equip-

In reading through Roland Robbins' notebooks it can be seen that there was little effective cooperation between the archaeologist, the historian, and the architects. It is obvious that, at least in the case of the refinery forge, archaeological evidence was either entirely ignored or modified in the final design. Assessing the accuracy of the reconstruction then, should utilize not only an architectural historian but also an industrial archaeologist whose task it would be to examine the validity of Robbins' interpretation of the evidence . . . and the specific use of this evidence . . . by the restoration architects.

Marley R. Brown III, "Saugus Iron Works National Historic Site: An Evaluation of Roland Wells Robbins Archaeology," pp. 15-16.

3.14 Excavation of slitting mill area looking east toward Saugus River, December 27, 1952. (Photograph 778 by Richard Merrill, 1952.)

ment or the building itself.[143] In the end, little evidence of the slitting mill structure survived, but Robbins identified the waterwheel that powered the mill, charcoal and stone evidence that he and several Committee members finally interpreted as a heating forge for the mill, and numerous artifacts that were clearly products or scrap from the mill.[144]

During late May and June, Robbins and his crew worked on restoring the "west arm of [the] ravine, to the south of [the] stairway to [the] furnace" along Central Street. Beneath the retaining wall, he again located a stone foundation that after additional excavation was found to contain a possible hearth, cast-iron hearth plate, slag material, and another anvil base. Although historian E. Neal Hartley previously had identified the foundation as a roasting oven, Robbins thought that the evidence suggested smelting activity.[145]

Just prior to Memorial Day, Robbins and his crew also opened seven test trenches around the Iron Works House before having the area regraded. Although the tests "revealed no evidence of stone foundations," Robbins located several "post sites" or postholes. He recorded in his daily log that "possibly these posts originally were pilings for some sort of building structure. To properly evaluate the pattern of the postholes, and to determine how many more exist in this area, it will be necessary to take the entire area down to the sub-soils."[146]

Beginning in late June 1953, Robbins began the removal of additional soil and sections from Central Street, running test trenches to "determine the extent of fill . . ." and "pick up contours that existed there 3 centuries ago."[147] This work continued until late July, when Quincy Bent abruptly ordered him to stop. After discussing Bent's "gruff remark" with architect Conover Fitch and the state of his health with his doctor, Robbins met with Bent several days later and resigned as archeologist and member of the Reconstruction Committee.[148]

With Robbins gone, assistant Steve Whittlesey continued the excavations. Robbins reported that Whittlesey, who had joined the project in April 1952 as Robbins' "civil engineer," was his "logical successor." "He is," Robbins noted, "acquainted with this work, and should be able to work out details." Robbins commented as he left that there was "considerable detail work to be done in certain areas. But this work would not create drastic changes in the basic pattern of the entire layout."[149] Whittlesey remained on site, completing various small excavation projects and final documentation; he resigned his position immediately after the formal dedication of the restoration in September 1954.[150] At this point, with Robbins and Whittlesey gone, the processing and cataloging of the artifacts from the excavation was carried on by others, with little continuity to and no participation from the original excavators.

At Saugus, Robbins attempted to "restore the contours," or literally to return the site to the original ground surface and configuration based on his reading of the early soil strata and evidence for building floors and surfaces. A close reading of Robbins' records suggests that his decisions regarding the historic topographic configuration at Saugus were generally well reasoned and accurate, based as they were on soils data, a host of building-floor levels, watercourses . . . , work area surfaces such as the casting beds, and water levels in the Saugus River. . . . [However], the movement of soils around the site resulted in problematic mixing of soils and artifacts from various areas, along with the general destruction of potentially intact soil layers and artifacts from some portions of the site.

Donald W. Linebaugh, *The Man Who Found Thoreau: Roland W. Robbins and the Rise of Historical Archaeology in America*, pp. 78-79.

Due to copyright restrictions, this image is not available in the on-line version of this publication.

3.15 Lawrence Davis, Harrison Shock, and Quincy Bent view work on April 20, 1951. (Photograph 696 from the Roland W. Robbins slide collection, 1951, Saugus Iron Works. Courtesy The Thoreau Society® Collections at the Thoreau Institute at Walden Woods.)

In a 1975 review of Robbins' work, archeologist Marley Brown writes that "it would appear that Robbins's resignation was triggered in part by an argument with Quincy Bent." Historian Stephen Carlson likewise reports that "increasingly, Robbins came into conflict with Quincy Bent over the extent of the remaining archaeological effort."[151] While Brown and Carlson are correct that conflict with Bent triggered Robbins' resignation, his resentment had been brewing for some time and actually grew out of a variety of obstacles. Among the factors influencing him to quit were his continuing frustration with the decisions of FIWA and Reconstruction Committee members and the architects, an extremely complex and demanding archeological site, overwork caused by responsibility for many non-archeological issues, and the cumulative effects of these problems on his physical and mental health.[152]

Robbins became disenchanted with FIWA president J. Sanger Attwill early in the project because Attwill failed to run a tight ship. Although unhappy with many daily operational problems, Robbins was particularly disgusted with Attwill's repeated failure to pay his crew members' meager salaries on time.[153] Attwill's lax attitude toward the payroll, Robbins recorded, also carried over to his management of the FIWA accounts payable. Robbins reported that he was called repeatedly by suppliers and contractors who had not been paid. Another disagreement, typical of those between Robbins and Attwill, revolved around the installation of a fire alarm system in the museum buildings. Robbins strongly argued for the "utmost precautionary measures where we are exhibiting our original waterwheel, anvil block, and other wooden artifacts, and hundreds of invaluable relics."[154] However, Attwill overruled Robbins' suggestion for the alarm system because the museum buildings were still "temporary."

To my mind, if fire should break out in the old museum building, within five minutes the interior could well be beyond control. In any event, I have made my point, this being the need of utmost precautionary measures where we are exhibiting our original waterwheel, anvil block, other wooden artifacts, and hundreds of invaluable relics.

Roland W. Robbins. "Saugus Ironworks Daily Log - 1953," April 24, 1953.

Robbins was also particularly discouraged by what he felt was the architects' lack of interest in and ignorance of the archeological evidence. On several occasions, Robbins and members of the Reconstruction Committee, including chairman Quincy Bent, questioned the quality of architectural work by staff at Perry, Shaw, and Hepburn, Kehoe and Dean. For instance, in August 1951 Robbins recorded that

> . . . for the past 2 years the architects have had the opportunity to study the detail and features of the furnace . . . etc; and yet are confused and ignorant of desirable furnace foundation data . . . . Making the architects [sic] confusion seem more unusual is the fact that all of Hartley's, Bradford's and my information has been made available to them, as well as Merrill's pictures.[155]

In November 1951, surveyor John Bradford was asked by architect Harrison Schock to provide his drawings of excavations in the wharf site, but Robbins told Bradford to do "no such thing."[156] Robbins commented that "my experience with Schock proves he has not the ability to understand the details of my business . . . . As such I do not intend to have Schock "decipher" and interpret something which is

3.16 Reconstruction Committee meeting in the east room of the Iron Works House, September 11, 1951. (Photograph 437 by Richard Merrill, 1951.)

still in its preliminary state and very complex. Schock will receive a copy of my report on this area when it is prepared, and with other associates."[157]

Writing to committee member and ironworks expert Charles R. Harte about the reconstruction plans for the blast furnace in 1952, Robbins complained that "[they] have had the use of all Hartley's, Bradford's, and my notes, as well as a complete set of our photographer's photographs, as well as material you sent them—yet are at a loss as to certain detail and elevation. What pray tell will they have to offer for the upper section of the furnace for which no evidence was uncovered?"[158]

Robbins was not the only staff member to be irritated by Schock. In a 1951 letter to committee member Charles R. Harte, chairman Quincy Bent wrote that "Mr. Schock's personality leaves much to be desired. He has a rare talent for rubbing people the wrong way, and has clashed on several points with Robbins and Hartley."[159] In early 1952, Robbins noted that Schock was going to complain to Bent that Robbins was not providing the needed data to the architects. Robbins recorded that Schock had not written or phoned to request information since September 1951, adding

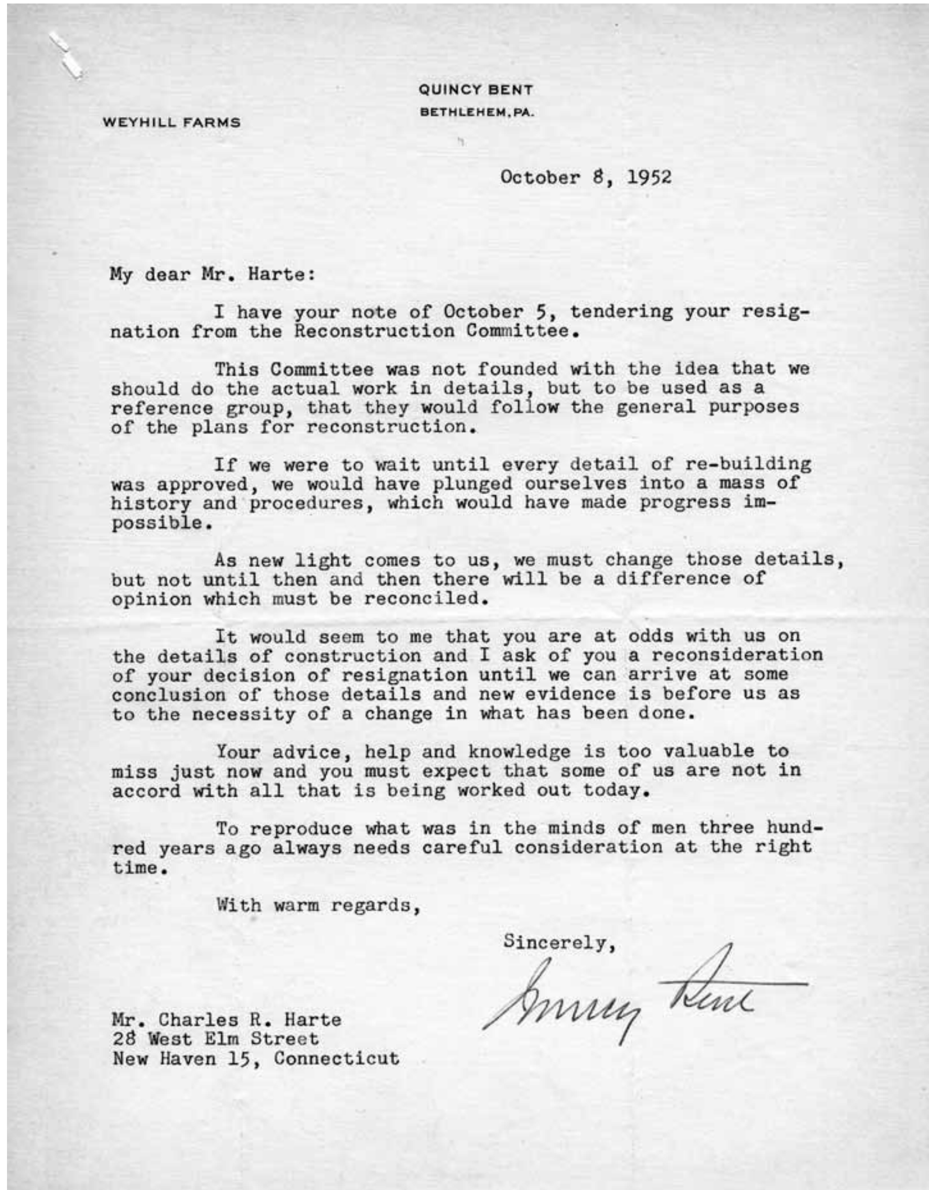
> how can I be refusing him data if he doesn't ask for it. All my work has been with [Conover] Fitch . . . . I have shown the utmost patience with the architects in many respects . . . . Apparently Schock again has his rear in a sling and is going to try and use Robbins as a means of getting out of it.[160]

Mr. Bent was down yesterday. You will be happy to learn that he raised Hell with the architects. Mr. Schock has been called on the carpet by Mr. Hepburn. In other words, we should see constructive progress on the project really taking hold.

Roland W. Robbins to Charles Rufus Harte, August 8, 1951.

Following a meeting of the Reconstruction Committee in 1952, Robbins reported that both he and Hartley had remained silent about problems with the reconstruction, noting that "this silence was our tribute to Fitch, who is a hellava nice fellow—and not personally responsible for the architects' errors."[161] In mid-1953, Charles Harte resigned because of his own frustrations with the reconstruction designs, particularly the forge layout and furnace details.[162]

Problems also existed within the Reconstruction Committee, particularly concerning the free hand given to chairman Quincy Bent by the American Iron and Steel Institute.[163] Robbins came into conflict with Bent, himself a powerful personality, early in the project, and their disagreements escalated rapidly. Bent made it clear to Robbins that he was in control in every regard; Robbins was, to use J. C. Harrington's phrase, their "digging technician." Harrington wrote that "the problems of construction and restoration are so specialized that the archaeologist is not much more than a digging technician, and in most cases the conclusions and interpretation must be left to . . . specialists and architects."[164] In one instance, Robbins was invited to present a lecture on the Saugus excavations to the Eastern States Archaeological Federation and wrote to ask Bent if he should accept.[165] The tone of the salutation in Bent's reply, "My dear Robbins," suggests Bent's dismissive attitude toward him. Bent went on to explain that Robbins re-



QUINCY BENT
BETHLEHEM, PA.

WEYHILL FARMS

October 8, 1952

My dear Mr. Harte:

I have your note of October 5, tendering your resignation from the Reconstruction Committee.

This Committee was not founded with the idea that we should do the actual work in details, but to be used as a reference group, that they would follow the general purposes of the plans for reconstruction.

If we were to wait until every detail of re-building was approved, we would have plunged ourselves into a mass of history and procedures, which would have made progress impossible.

As new light comes to us, we must change those details, but not until then and then there will be a difference of opinion which must be reconciled.

It would seem to me that you are at odds with us on the details of construction and I ask of you a reconsideration of your decision of resignation until we can arrive at some conclusion of those details and new evidence is before us as to the necessity of a change in what has been done.

Your advice, help and knowledge is too valuable to miss just now and you must expect that some of us are not in accord with all that is being worked out today.

To reproduce what was in the minds of men three hundred years ago always needs careful consideration at the right time.

With warm regards,

Sincerely,

Quincy Bent

Mr. Charles R. Harte
28 West Elm Street
New Haven 15, Connecticut

3.17 Quincy Bent's reply to Charles Rufus Harte's resignation.

ally should be spending his time digging and indicated that he would need to get the "concurrance [sic] of Hartley and the Institute" to proceed with the lecture.[166]

Another early example of Robbins' conflict with Bent was an argument over staffing. In 1950, Bent had visited the ironworks over a weekend and found that no one was available to show visitors through the excavations and house. The next Monday, Attwill informed Robbins that Bent wanted him at the ironworks over the weekends for this purpose. Robbins was incensed that Bent expected him to do this in addition to his many other responsibilities. Like the lecture dispute it reinforced Robbins' "staff" position as opposed to the status conferred on other consultants like Hartley.[167] After talking with his wife, Robbins decided to resign "because of the consistent lack of cooperation my department gets from Bent and Attwill"; clearly he was also feeling used and under appreciated.[168] Before actually resigning, Robbins discussed the situation with Charles Parker and Walter S. Tower of the American Iron and Steel Institute in New York and both "wouldn't hear of it [the resignation] . . . . Mr. Tower then told me to sit tight—everything would be taken care of."[169]

Robbins and Bent clashed again a few months later over the issue of Robbins' salary and car expenses. Tower had told Robbins that he would get a salary increase and should also request car expense reimbursement.[170] Robbins followed this discussion up with a letter to Tower, but when Bent heard about it he believed that Robbins had deliberately gone over his head. "Obviously Mr. Bent was irritated by the incident . . ., " Robbins recorded.[171] Bent also told Robbins that he was not to lecture to groups during the work day. This exasperated Robbins because most of these engagements were pro bono lectures for local groups and clubs to "create interest and spread goodwill!" He noted that "after Mr. Bent's acid remark I have no designs on continuing this goodwill work in the future."[172]

Interestingly, Robbins saw the tensions between himself and Bent, and among Committee members in general, as healthy for a project of this magnitude and complexity. Writing to Bent after his resignation, he explained that "[t]he Saugus Restoration is a monumental work. The personalities responsible for its success have every right to do a bit of hair pulling among themselves. It is healthy, and brings problems and misunderstandings out into the opening *[sic]*. But it should be done behind closed doors, not made an undignified public spectacle."[173] Robbins realized that conflict and disagreement were inevitable and even acceptable for this type of interdisciplinary project. However, he was clear that there were specific rules of engagement and these had, he felt, been breached.

While dealing with Bent was problematic, Robbins generally enjoyed a good relationship with the staff of the American Iron and Steel Institute. Unlike Bent, these individuals treated Robbins as a professional consultant and accorded him the respect he thought he deserved. For example, Institute president Walter S. Tower counseled patience, urging Robbins to work at maintaining a good relationship with Bent. He added in the letter that he hoped that "life's little irritations will not in any way detract from interest

I enclose a letter with an invitation to present the Saugus Restoration project to members and guests of the Eastern States Archaeological Federation at the University of North Carolina, October 26-27, 1951. Dr. William Ritchie, who suggested this paper, is with Yale University's Archaeological School. While this talk would be of an academic nature, it may also be favorable for public relations. Would you kindly let me know your views on this matter, whether or not you would like to have me accept this invitation.

Roland W. Robbins to Quincy Bent, August 19, 1951.

3.18 Edward Ryerson, Walter S. Tower, J. Sanger Attwill, and Quincy Bent at a June 30, 1951 meeting. (Photograph 379 by Richard Merrill, 1951.)

in the job which you have managed so well . . . ."[174] Tower was always very supportive of Robbins's archeological work and frequently commended him for his extra efforts and achievements.[175]

As a consequence of the enormous archeological task and the problems associated with working for multiple project managers, Robbins had been "driving himself beyond all reasonable limits."[176] The often complex, varying objectives and the inexperience of restoration-minded organizations and their sponsors made planning and implementing excavations like Saugus difficult and required Robbins to do far more than excavate. At Saugus, for instance, he served simultaneously as a consultant to the restoration planning committee, primary archeologist, exhibit planner, site interpreter, museum curator, landscaper and landscape restorer, maintenance chief, and often day-to-day manager of the site. These multiple responsibilities and the intense pressure to move the reconstruction work to completion, clearly created daily stress for Robbins. His wife Geraldine reported to Quincy Bent that "in a desperate effort to keep going he went from doctor to doctor and specialist to specialist. The diagnosis in every case was the same—overwork."[177] Robbins came to realize the problem himself, writing to Quincy Bent that

> as complex as my archaeological work was it presented no problem which would wear me out, both physically and mentally. But to mix this work with sundry duties ranging from overseer of all problems to caretaker of washrooms, interspersed with two museums to study and carefully prepare appropriate exhibits for, as well as public relations and goodwill, research which developed mediums for restoring our priceless artifacts, both metals and wood, annual meetings which necessitated careful planning and many late evenings, as well as numerous other time absorbing details, was more than my strength could contend with after dieting on it for five years.[178]

Robbins felt demoralized that so much of this extra effort was "just taken for granted."[179]

All of these factors had an effect on Robbins' physical and mental health. By fall of 1952, he was complaining of "touchy nerves and irritableness." After a complete physical, his doctor recommended that he take a vacation and forget about Saugus. He wrote to an associate in Philadelphia that "two days after returning from my vacation, I found myself bordering on the rim of a possible nervous breakdown. I am under doctors *[sic]* orders to take things much more quietly, as well as a full dose of pills and medicine three times daily."[180]

Several months later he complained about his "damn nerves . . . kicking up again" and the doctor increased his dose of medication.[181] In late December, Robbins visited another doctor for continuing nerve problems, who also advised a vacation.[182] A visit to yet another doctor in early January 1953 con-

I have a definite interest in the Saugus Project, but I make no apologies for the fact that my primary interest is in the health and welfare of one Roland W. Robbins. There has been more than one occasion when he finished a job at a loss physically and financially. He is as fanatic in this as he is in details, as boring and unnecessary as they may seem to be to others. It is ironic that the assets which made him successful in his profession are the very factors which broke his health.

Geraldine Robbins to Quincy Bent, October 29, 1953.

3.19 Robbins displaying a shovel recovered from the excavations. (Photograph 479 taken by Richard Merrill, 1951.)

firmed the earlier diagnoses and treatments and in February Robbins finally took a much needed one-month vacation.[183]

While the vacation helped renew his strength, he returned to the same set of circumstances that had precipitated his earlier problems. The confrontation between Bent and Robbins over the Central Street excavations in July 1953 was the final straw. Robbins felt he had dealt with the "human elements" and overwork for too long and was "completely worn out."[184] Even so, he remained characteristically resilient about his troubles at Saugus: "Of course there were certain human elements that saw to it that my life was unpleasant. But that happens wherever you go."[185]

I do not know how things are progressing at Saugus, having not been there since the day I talked with you [and resigned]. If conditions are such that I can be of any assistance to help insure the success of the Saugus Restoration, my sincerest desire is to cooperate in any manner I can . . . . If in assaying the progress of the Saugus Restoration you feel there is no longer need of my services, nor interest in my articles or lectures, I would like to be so informed so that I can feel free to pursue new interests. Though my health necessitated my dropping from the picture for a few weeks, my thoughts were always with the work.

Roland W. Robbins to Quincy Bent, November 16, 1953.

Robbins' excavations at the Saugus Iron Works clearly fit into the restoration tradition typical of much postwar historical archeology.[186] In his 1975 review of Robbins' excavations, archeologist Marley Brown reports that he effectively "located and excavated the major industrial components of the Iron Works."[187] Robbins' work went beyond the typical levels of restoration archeology in many ways. This is particularly true considering the lack of a comparative database from excavations of other iron works.[188] In addition, Robbins collaborated with an interdisciplinary team, drawing on the work of full-time historian E. Neal Hartley, metallurgical experts from the iron industry, a consulting geologist, and several members of the Harvard Biological Laboratories and Botany Museum. To the extent possible, he approached his work at Saugus in a very logical and organized manner.

Excavating roughly by natural strata, Robbins utilized general vertical and horizontal controls within test units and trenches. He excavated many small units across the site to determine the overall stratigraphy and identify ironworks features prior to more extensive mechanical excavation.[189] In seeking stone foundations and other solid features, Robbins utilized his trademark probe rod or "prodding rod."[190] His plan and profile drawings provide quite accurate information on the locations of both features and selected artifacts.[191]

Robbins' decisions to excavate at Saugus were based on documentary evidence and following features such as the furnace base, anvil bases and hammers, watercourses, and waterwheel pits to determine building locations or activity areas.[192] He used a wide range of documentary sources gathered by himself and historian Hartley to direct his fieldwork at Saugus, including early illustrations of ironworks by Diderot, plats and maps, and contemporary accounts.[193] Archeologist Mary C. Beaudry, who analyzed the use of documentary sources for the project as part of the 1975 review of Robbins' work, writes "Robbins was able to make fairly accurate statements about the remains he uncovered, based on the small-scale research which he personally conducted."[194]

3.20 Robbins looking over the shoulders of dendrochronologists examining the anvil base in the museum, April 1953. (Photograph 871 by Richard Merrill, 1953.)

Robbins supplemented his documentary research with visits to other iron-making sites in the area and throughout New England. These opportunities for comparative research were very important for Robbins in that little descriptive information was available through written sources. Robbins also conferred with other archeologists and historians working on historic sites around the country, particularly those excavating iron-making sites such as the National Park Service's project at Hopewell Village in Pennsylvania.[195]

The Saugus site produced thousands of artifacts and exhibited excellent preservation of metal, wood, and leather. The survival of these materials presented enormous conservation problems that concerned Robbins from the very beginning of the excavations. He contacted several iron conservation specialists and eventually began a series of experiments with Professor Herbert Uhlig, director of the Massachusetts Institute of Technology Corrosion Laboratory.[196] In 1952, Robbins hired a worker to begin a series of metal-cleaning experiments with brushes, grinding wheels, and electrolytic reduction.[197] Even more problematic than metals were wooden artifacts. Robbins voiced his concerns with wood preservation problems in early 1949 and quickly began searching for help with this conservation challenge.[198] Many sections of the furnace waterwheel pit and flume and the waterwheel itself were successfully preserved and remain on display at Saugus.

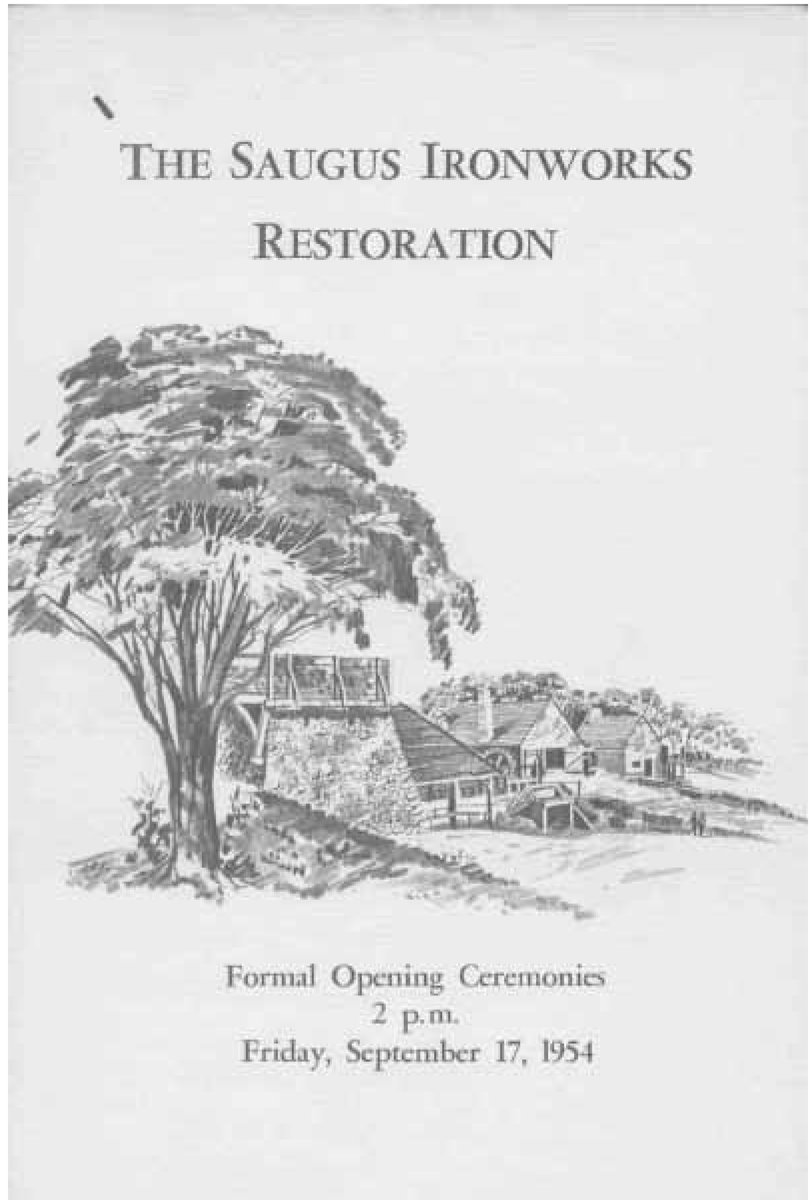
Robbins' use of a host of special studies, particularly in regard to faunal remains (animal bone), tree ring dating and geoarchaeology, metals and materials analysis, and artifact conservation was very advanced for this period in historical archaeology and also provides important comparative data for future study.

Donald W. Linebaugh, *The Man Who Found Thoreau*, pp. 79-80.

Although Robbins prepared a series of annual reports on his excavations at Saugus, he never wrote his final report on the work because of his abrupt resignation in 1953.[199] The record of his work is thoroughly documented, however, in his detailed daily logs, numerous letter reports on specific features and excavation areas produced for the Reconstruction Committee and the architects, and excellent mapping and photographic documentation by Robbins, Bradford, and Merrill; these records form the basis of the present volume.

The restoration goals of the Saugus project drove the overall research, particularly the archeology. This is reflected clearly in the Reconstruction Committee's organizational chart, which shows that Robbins was responsible for locating and excavating the major ironworks structures and restoring the landscape. The chart delineates Hartley's focus on the documentary records dealing with the construction and operation of ironworks and the tools and implements used and defines the architects' role as providing plans for the restoration and supervising the construction.[200] The FIWA's managers pushed Robbins' work and the physical reconstruction as fast as possible. Funding was not unlimited and both the FIWA and the American Iron and Steel Institute had their own agendas for the finished complex. In large part, these agendas arose out of the increasing use of the past, specifically historic sites, for political and commercial purposes, including the burgeoning tourism industry.[201]

Understood in its proper context, the story of Robbins' Saugus excavations points to the relative lack of any organized focus on either historical or industrial sites archeology in the United States in the late



3.21 Cover of the program given out at the formal dedication, September 17, 1954.

1940s and early 1950s. Robbins was largely untrained and unprepared for the monumental task of excavating a complex iron-making site. In spite of this, his work at Saugus is remarkable for its thoroughness, innovation, and contribution to the finished reconstruction.

4.1 Robbins and crew member uncovering the hammerhead, September 1950. (Photograph 225 by Richard Merrill,1950.)

Roland Robbins in Context

William A. Griswold

Roland Wells Robbins was never accepted by the academic community as a bona fide archeologist. Most academic archeologists found his methods brutish and quickly dismissed him because he was never formally schooled in archeology. Nevertheless, Robbins managed to do what few academic archeologists are ever able to do: successfully investigate an early industrial site buried by huge amounts of fill, gather archeological information that supplemented and informed a privately-funded reconstruction, create a large amount of public interest in the project, and launch a career in archeology that lasted throughout his lifetime. This chapter takes a critical look at Robbins' intellectual training, recordation proficiency, project management skills, and focus on public involvement during the Saugus project.

It was curiosity about my own community that led me to dig in Massachusetts when I had no more equipment than a shovel and a questioning mind. At the time I had a thriving business as a house painter and handy man—and no archaeological training whatsoever. But I found that simple tools and the rudiments of a scientific approach, cautiously exercised, could ferret out history that had evaded others; and, as time passed, the opportunities to do so became so demanding that I ceased to be an expert at washing other people's windows and renovating other people's houses, and was established as a working archaeologist.

Roland Robbins and Evan Jones, *Hidden America*, pp. 11-12.

Background

Robbins came to the Saugus Iron Works project following his success in finding and excavating remnants of Henry David Thoreau's cabin on the shore of Walden Pond near Concord, Massachusetts. This discovery and Robbins' earlier investigation of Daniel Chester French's Minute Man statue at the Old North Bridge in Concord, Massachusetts, had brought Robbins notice and credibility as an amateur historical investigator.[1] It was as a direct result of his discovery of Thoreau's cabin that J. Sanger Attwill, president of the First Iron Works Association (FIWA), offered Robbins a role in what Attwill termed an "antique treasure hunt" at Saugus: looking for any trace of the old ironworking facility.[2] Unschooled in traditional archeological method and theory, Robbins brought his experiences at Walden, an inquisitive mind, and a skilled eye to bear on the project. His early discoveries during this "treasure hunt" were enough to continue his long-term employment with the project.

Having dropped out of high school, Robbins lacked any formal instruction in archeology or archeological excavation methods. This lack of formal education in the field dogged him throughout his career. Professional archeologists never accepted Robbins because of his perceived crude and damaging excavation methods and his willingness to embrace public participation in his projects.[3] Some of his harshest critics became some of the most respected scholars in the young discipline of historical archeology, including James Deetz and John Cotter. However, by the end of his life, Robbins had not only managed to stay actively employed in the field, but had developed a field résumé that would make many current practitioners of the craft envious. Regardless of how the academic community perceived Robbins, he was in fact one of the first excavators to embrace investigations of early industrial sites. His eye for discoveries, his project management skills, his charisma, and his excitement about the various projects he completed seem to have vastly outpaced his lack of formal training as an archeologist, at least among his admirers.

During the early years of the Saugus project, roughly between 1948 and 1951, Robbins was very engaged in the day-to-day fieldwork and conducted much of it either by himself or by working closely with his crew. He spent long hours with the crew, enveloped in the exciting discoveries that were being made. In his book *Hidden America*, Robbins notes he hired "three talented diggers from the Saugus Water Department" and explained to them "that archaeological digging required even greater caution than they were accustomed to use in their excavation of the city's plumbing system."[4] Crew numbers ebbed and flowed throughout the five-year-long archeological excavation that usually went on year round.

Robbins dealt with many individuals on a day-to-day basis. Among those connected with the project were J. Sanger Attwill, president of the FIWA; Quincy Bent, the chairman of the Reconstruction Committee; Walter S. Tower, the president of the American Iron and Steel Institute; Conover Fitch, architect for Perry, Shaw and Hepburn, Kehoe and Dean; and Laurence Davis, the attorney for the project. As with other diverse work groups, relations between these individuals were complicated and mixed. Robbins enjoyed very good relations with those who encouraged his research, while at times his interactions with others almost lacked civility.

Robbins made detailed entries for the project in notebooks. His daily logs record some archeological elements but also contain information about the management of the project. He kept these daily logs for the duration of his tenure, between 1948 and 1953. He used the daily logs as a vehicle to present his excavation rationale, interpretation of discoveries and, sometimes, contradictory information. Numerous sketch maps, field plans, and various illustrations were also done to supplement the log entries and thousands of photographs were taken to document the project. Around 1951, Robbins also began files on various features and topics that he encountered at Saugus, such as canals and docks. Today these records are located in at least two locations. The Saugus Iron Works National Historic Site cares for Robbins' daily logs while the Thoreau Society/Thoreau Institute curates some of the feature files and most of the correspondence related to the project.

Robbins' detailed descriptions of the discoveries and the methods used to make the discoveries illustrate his mastery of one of the most important parts of archeology, recordation, at least in the early years of the project (1948–1951). After that time, much of the recordation was handed off to Stephen Whittlesey, an engineer hired to professionally document the project, as Robbins was forced to focus more on management issues. After Whittlesey's hire, Robbins' daily logs still contain some archeological information, including notes, description, and sketches, but not to the same degree as before.

It rained hard all morning. I wrote Mr. Bent a letter detailing the work to date in a.m. Sent him Hick's picture of me at buried road site and of Higgins in tailrace site. Boy named English looked me up at Saugus Library where I was writing report. Said Sanger said we could give him a job. Said he couldn't make it until June 20th. Sanger paid the men too late for them to cash their checks. I had to telephone him at 1:10 p.m. to ask if he intended to pay the men so they could reach bank before closing time. Said he would be right over. Didn't make it before 2:00 p.m. Gave Miss Hawkes $32.35 cash to give to me for money I have spent on equipment. I had Miss Hawkes to ask him about truck for removing dirt. Said he hadn't gotten to it. Letter from Barbara Lawrence, Museum of Comparative Zoology, Harvard College, stating that bone specimens left for examination were of a cow. (These specimens were from hair and bone evidence found just north of most northern side of bellows base last fall). No men worked today because of bad weather.

Roland Robbins, "Saugus Ironworks Daily Log - 1949," May 27, 1949.

4.2 Robbins (right) discussing an artifact with J. Sanger Attwill (left) and unknown visitor. (Photograph 751 by Richard Merrill, November 1952.)

While Robbins recorded what he did in his daily logs there are problems with his entries. One problem concerns Robbins' use of triangulation for plotting and mapping his work. Triangulation is a system of measurement that records the three-dimensional location of a feature or artifact using known locations and is a fundamental recording concept used by archeological excavators around the world. Very few of the landscape features that Robbins triangulated from are still present and no overall grid system was used to relate one map to another. This makes it very difficult to know exactly where features and artifacts were found.

Another problem, more serious than the first, lies in Robbins' failure to always record where he excavated. The daily logs describe the general areas where the excavations took place (e.g., east of the forge) but in some cases exact locations were never recorded. Ultimately, without this information, a reconstructed base map can never be fully complete in terms of illustrating the impacts Robbins made to the site. Likewise, Robbins' use of profiles was often erratic. He illustrated sections only on occasion and then he only illustrated features or deposits about which he wanted to convey specific information. In several cases, the locations of illustrated profiles are unclear.

Even with these shortcomings, the entries show Robbins to be a complex and inquisitive thinker. He obviously spent many hours reflecting on his discoveries and on their interpretation. His early notes are replete with questions that he was attempting to answer. For example, in one entry on Tuesday, September 14, 1948, Robbins asked "How come there is charcoal under the stones? Wouldn't this hurt their chance of being the foundation to the blast furnace?"[5] When such questions arose Robbins invariably suggested additional fieldwork to resolve the vexing question or contradiction. In some cases the additional excavations solved the dilemma but not always.

Two of the most important strengths of the Saugus Iron Works excavations are the photographic collection made by Robbins, Richard Merrill, and others and the contributions of collaborating experts. Richard Merrill was the photographer for the project hired by the FIWA. His photographs are simply stunning and many of them have been included in this book. Overall, Merrill took several thousand photographs. These, plus several thousand Kodachrome slides taken by Robbins, are in the Saugus Iron Works collection. Robbins and the FIWA must have realized the importance of their work for posterity and fortunately recorded much of what they did with excellent photographic images.

Robbins also recognized his limitations and realized early on that he would have to enlist the help of individuals representing many different disciplines to unravel the clues contained in the excavations. Dr. E. Neal Hartley (history), Dr. Herbert Uhlig (metals conservation), Dr. Elso Barghoorn (wood conservation), Dr. Laurence LaForge (geology), Barbara Lawrence (faunal analysis), Jack Lambert (forestry), and John Bradford (surveying and mapping) were just a few of the many experts who aided Robbins in

Men continued work at slitting mill site, particularly digging out the stones buried in what might be natural clays at the northwest area of the 3rd waterway. These soils are being used to regrade the approach to the yard area south of the forge along the easterly side. Fitch and I spent part of the A.M. going over data relative to the casting beds, gravel fill to the south of the furnace, and rubble found on the slope to [the] front of the furnace.

Roland Robbins, "Saugus Ironworks Daily Log - 1953," April 22, 1953.

4.3 Robbins in his museum writing in his notebook in March 1953. (Photograph 840 by Richard Merrill, 1953.)

the Saugus investigations. Robbins sought the assistance of many others during his excavations; in this respect the project was a harbinger of formal interdisciplinary research.

The daily logs provide overwhelming evidence that Robbins understood the concepts of stratigraphy and stratigraphic association of artifacts. Many of his drawings, both plan and profile, illustrate what he discusses fully in his notes, i.e., that older deposits, on the whole, are more deeply buried than younger deposits and that artifacts and features from the same deposit are similar in age. While Robbins understood these basic archeological concepts, he did not always use them to his advantage as effectively as he needed to tackle a project as large and as context dependent as the Saugus Iron Works excavations. Instead of relying on these concepts and using stratigraphy as a tool to interpret the deposits, features, and artifacts, Robbins would at times use the composition of the soil matrix or, even more problematically, topographic elevations to determine dates. For example, on Friday, August 26, 1949, he commented,

> To commute to Jenk's operations along tailrace south of furnace from the low controversial area easterly of furnace is beyond reasonable conjecture—because of the steep rise in the terrain from the low level area easterly of furnace to the area to south of furnace which was filled considerably at time of furnace construction. Also the slag pile as we know it is 7'–9' higher than the southerly side of foundation #8 and only 19' south of foundation #8. It is only 15' from the south side of foundation #8 to the stone wall just northerly of north end of slag pile. And yet the walls elevation is 6'–7' higher than is foundation #8![6]

As many professional archeologists have learned, interpretation of features based on elevation alone is fraught with pitfalls. Good interpretations are made by using stratigraphy to help sort out complex sites like Saugus. Interpretations about the relationship between features at different elevations, even when it seems logical to assume a relationship, are often disproved by examination of the stratigraphic association. By evaluating deposits and levels according to a preconceived notion of how things looked or functioned, Robbins used only complementary information to support his conjectures. While Robbins was far from the first person to use this approach, it may have compromised the collection of information; for example, this method makes it very difficult to evaluate alternative explanations. Ideally, Robbins would have been more systematic about his excavations and evaluated the data against multiple hypotheses so that much more could have been learned about the site.

Based on today's standards, Robbins' field methods were unsystematic and certainly resulted in the destruction of important data. Often, his trenches and test units were irregular in size and shape and, while he recovered artifacts, especially museum pieces, he never intended for his collection to be systematic. Rather than systematically sifting soil and collecting artifacts, Robbins removed tons of soil using heavy

At the northermost end of tailrace and at a depth lacking about 1' from its bottom, I removed one slab very similar to those used in the wooden wheel affair that had a wooden round shaft and the wheels were joined with these slats. No large boulders were found in the filled tailrace. Inasmuch as no large stones are being found at the tailrace level or in the tailrace; also the fact that the tailrace is caved towards the west wall of [the] furnace, and its timbers show signs of having been exposed to fire, it seems likely that after the termination of the furnace's use it was exposed to fire. Later, fill used at its west wall crushed its timbers and sprung them towards [the] furnace. This fill, or a later fill, then crushed in the floor planking across its top. The dismantling *of the furnace must have taken place* after *the tailrace was filled in and over.*

Roland Robbins, "Saugus Ironworks Daily Log - 1949," May 20, 1949.

4.4 Robbins excavating in a trench in the slitting mill area in January 1953. (Photograph 793 by Richard Merrill, 1953.)

machinery and often sifted or sorted through this soil only by eye or by using large-scale sorting equipment.

It is important that history not judge Robbins by standards that were not yet available at the time that the Saugus excavations were being conducted. While earlier professional archeologists like General Augustus Henry Lane Fox Pitt-Rivers (who excavated Cranborne Chase, England) and George Reisner (who worked in Giza, Egypt, and Nubia) had conducted meticulous, controlled, systematic excavations much earlier, it was not until the mid-to-late 1950s that the Wheeler-Kenyon method of stratigraphic excavation caught on as the preferred method for archeological site excavation.[7] Many professional archeologists had only recently discontinued using arbitrary levels in their excavations at the time Robbins excavated at Saugus. It is appropriate to use professional archeological standards to judge Robbins' later work when such standards were widely accepted and practiced by professional archeologists, but that goes well beyond the scope of this book.

Robbins was an active consumer of products designed to aid in the location of artifacts and features. This proved to be a double-edged sword as he experimented with good products as well as bad ones. For example, he used mine detectors of World War II vintage for locating metal objects. As prolific as iron objects were on a former ironworking site, Robbins still managed to find iron artifacts with the mine detector. More questionably he also experimented with divination. However, since Colonial Williamsbur's Ivor Noel Hume, one of the founders of historical archeology, also experimented with divination, one can only assume that at the time it did not have the negative reputation it does today among professional archeologists.[8] Robbins notes:

> Friday, Oct. 12th [1951] . . . Ernie (?) Gaudet Malden 2-7297 and his friend who is so capable with the divining rods, were at Saugus from 9:45 to 11 A.M. I saw his friend work his rods. And although they were "too dry" to perform to best advantage, and the diathermy treatments he is taking for a broken ankle apparently are cutting down his efficiency, his still was able to get results. The rods would point down at iron relics in my museum—and at a gold watch—this was his "gold rod." They would not work for me. But I could hold one hand on the rod and hold his hand, he holding the other end of the rod, and it would turn down over iron. I had him go down Bridge St. He picked the gas main whenever he crossed it. When I told him it was an iron gas main he was quite surprised. He was using his "water divining" rod. It was the first time it had worked on metal. Where the refinery waterway outlet leaves Bridge St.—I should say 4'–5' before it leaves Bridge St.—he received a strong pull on his iron "divining rod." Said we should find metal there. I shall wait until we excavate there to determine whether he was right or wrong. I did not have the time to spend with them that I would have liked. I shall have them down at a later date . . . .[9]

Perhaps my unique wheel might also have been lost had I not been fortunate in getting together with a biologist, Dr. Elso Barghoorn of Harvard. First testing smaller pieces of wood taken from the wheel pit, Barghoorn found that 87.7 per cent of the content was water. After considerable experiment, we arrived at a method in which each wooden member of the wheel was immersed in specially constructed vats filled with paraffin heated to 245 degrees. As the wet pieces were dropped in they sizzled like French-fried potatoes going into hot grease—as the moisture sizzled out of the wood, the paraffin seeped in to take its place, and when, after about seven hours, the sizzling stopped, the treatment was complete.

Roland Robbins and Evan Jones, ***Hidden America***, p. 58.

4.5 Robbins using mine detector with volunteer assistance. (Photograph 457 by Richard Merrill, 1950.)

Day-to-Day Excavations

The Saugus project, like most large archeological projects, was anything but dull. In his daily logs Robbins points out many non-archeological curiosities including a salvage man offering to buy iron found at the site, deaths, sicknesses, injuries, disagreements, break-ins, salary disputes, and even hearsay that the excavation was actually a cover operation for uranium mining. In many cases, Robbins' daily logs read more like a private diary. On one occasion, on Wednesday, September 15, 1948, Robbins even notes his aid in extinguishing a fire at a Mr. Guy's workshop. He notes that

> . . . I continued my work of uncovering the stone base. At about 12:40 noon I had just finished my lunch and was starting back to work when I saw Mr. Guy running from his house to his workshop with a pan of water. I hastened over and found his shop aflame. I rushed to the Old Iron House and found two fire extinguishers and took them to the shop. With the help of neighbors the fire was brought under control. It was a miracle that it was saved![10]

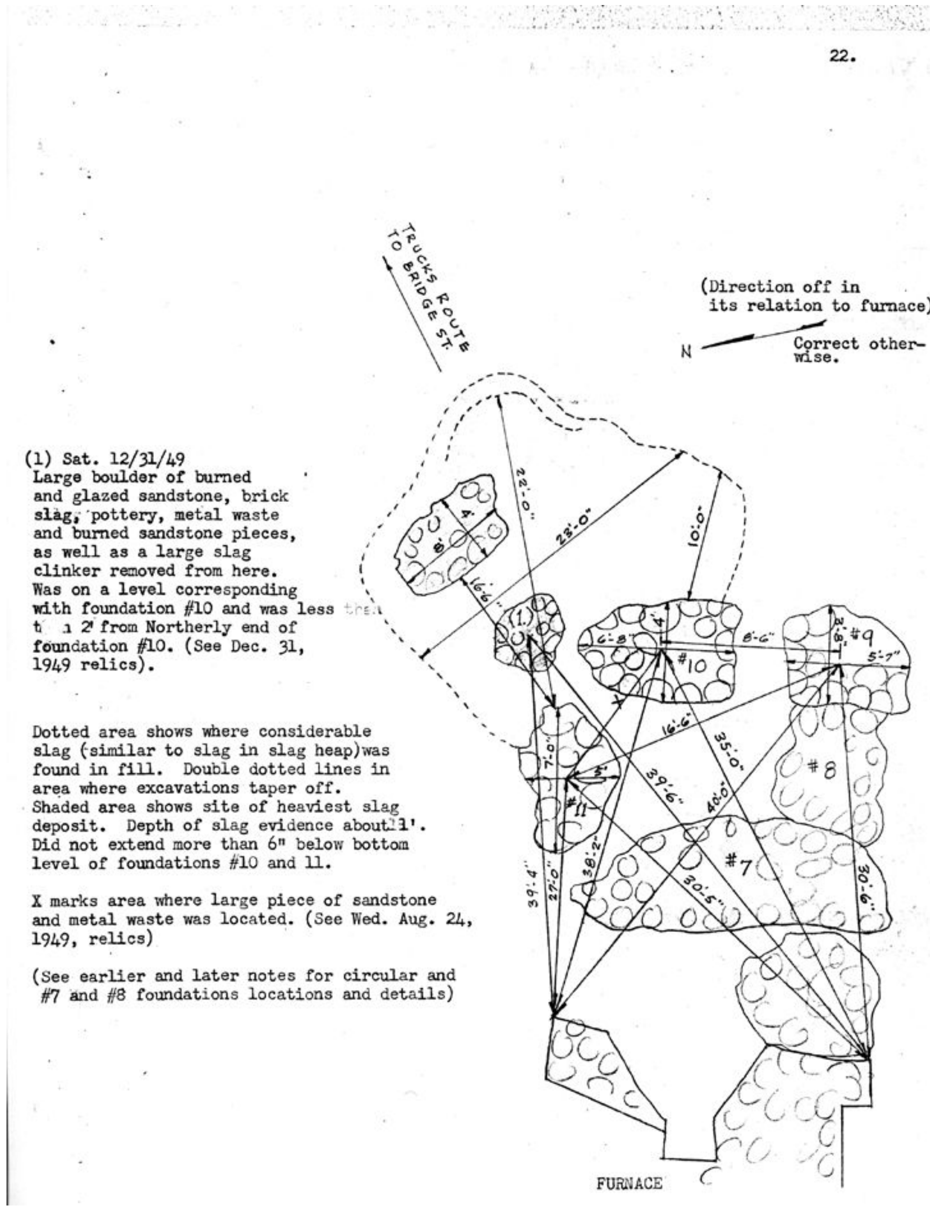
Rarely are notes left by professional archeologists ever this interesting.

The daily logs indicate that Robbins did a great deal of historical research for the project. His notes reflect that he made numerous trips to libraries all across the area. For example, on Monday, September 20, 1948, Robbins reports that he went to Baker Library at Harvard's Graduate School of Business to consult legal papers pertaining to the ironworks held in Harvard's collection. Hartley, the historian hired for the project, was instrumental in discussing the historical records with Robbins. Hartley's book *Ironworks on the Saugus* represents a thorough, if not exhaustive, effort to collect historical sources about the ironworks facility, the people who worked there, the Undertakers who financed the experiment, and the legal morass that eventually developed and led to the dissolution of the facility. While Hartley dealt with the primary and secondary historical source material, Robbins visited many other ironworking archeological sites within the U.S. By the end of his career, Robbins would have excavated at over twenty of them.[11]

The Hammersmith operation contained two components, one in Saugus (then known as Lynn) and the other south of Boston in Quincy, (then Braintree) Massachusetts. In April 1950, while Robbins was still deeply involved with the Saugus Iron Works project, he began limited excavations on one site in Braintree, along the Monatiquot River, in hopes of locating the other component of the Undertaker's financial experiment. For several reasons, Robbins quickly dismissed the site as the southern component of the corporation and moved on to a site along Furnace Brook in Hall Cemetery. Here Robbins met with much success identifying the furnace base and obtaining slag and metal samples for analysis and comparison with materials from Saugus. In fact, he went on to excavate the site more thoroughly in 1956 after he had resigned from the Saugus project.[12] While not nearly as large or complex as the Saugus ex-

I was talking to Dr. Schubert and Hartley and remarked that the forge hammer base was seated upon a large horizontal beam. He remarked, "It couldn't be, they always placed a metal plate, or sow bars, at bottom of anvil base." I had to take him down to the site to prove my point . . . . In P.M. I was telling Dr. Schubert how I found the casting beds clinging to south side of furnace breast. He insisted that that could not be the case, "They ran out from center of casting arch." I told him I had the sands from these beds. He said that that wasn't possible. "They wouldn't last that long." I told him I had these sands and pictures of the casting beds. He didn't seem interested in this evidence, he felt certain that this was never the case with the English furnaces. I told him the sow bed abutted the hollow-ware casting bed. Again I was wrong. "The molds were filled from ladles." He implied the molds were placed upon the ground, or higher, were never placed in a sand bed. He was certain *that the Saugus furnace had a* forge hearth. . . . *He seems entirely convinced that Saugus was a prototype of English Iron Works. Dr. Schubert should have been brought over 3-1/2 years ago. With his knowledge of English Iron Works there would have been no need of engaging an archaeologist to determine the basic pattern of the Saugus Iron Works.*

Roland Robbins, "Saugus Ironworks Daily Log - 1952," June 19, 1952.


22.

(1) Sat. 12/31/49
Large boulder of burned and glazed sandstone, brick slag, pottery, metal waste and burned sandstone pieces, as well as a large slag clinker removed from here. Was on a level corresponding with foundation #10 and was less than 1 2' from Northerly end of foundation #10. (See Dec. 31, 1949 relics).

Dotted area shows where considerable slag (similar to slag in slag heap)was found in fill. Double dotted lines in area where excavations taper off. Shaded area shows site of heaviest slag deposit. Depth of slag evidence about 1'. Did not extend more than 6" below bottom level of foundations #10 and 11.

X marks area where large piece of sandstone and metal waste was located. (See Wed. Aug. 24, 1949, relics)

(See earlier and later notes for circular and #7 and #8 foundations locations and details)

4.6 Drawing from Robbins' December 31, 1949, daily log. In the sketch Robbins identifies many of the features to the east of the furnace breastwork. The numbers on the feature were given by Robbins to simplify the narrative.

cavations, the eventual excavations at the Quincy blast furnace, Robbins produced much better records there than he did at Saugus. The report that Robbins prepared for the City of Quincy illustrates that he had matured in both his knowledge of blast furnaces and in his recordation and management of an archeological project; notably, he did not suffer from the pressure of an imminent and ongoing restoration at this site as he did at the complex Saugus operation.

While no individual living at the time that Robbins did his work at Saugus would have been alive at the time the ironworks was operational, Robbins conducted some ethnographic interviews with various longtime residents and property owners who lived near the site. For example, he summarizes his discussions with Charles W. Davis on Tuesday, May 31, 1949:

> Ralph Barrett brought old Charles W. Davis to see me in the afternoon. Mr. Davis (colored) is now 90 years of age. He said he came to Saugus to work for Scott (of Scott's Mill) when he was 28 years of age. Was Scott's coachman. (This was about 1887). Worked for Scott for 14 years (till Scott died). Then worked one more year for Scott's widow. During the 15 years he worked for Scott and family, he lived in the Old Iron Works House, then owned by Scott. Mr. Davis could not recall any evidence of a fill or of a depression across Scott's property (in line from the blast furnace to Pranker's Pond) which might indicate the course of the old canal. Nor could he recall having ever heard anyone speak of the old canal having taken such a course. However he did say that Scott had done much to beautify this land many years before he (Davis) came to work for him. It is possible Scott may have earlier filled in any evidence of the old canal that may have remained.[13]

As personal experience has shown, ethnographic interviews of neighbors or former tenants can provide clues to earlier landscape or archeological features. They can also often turn out to be wild goose chases. Robbins, however, like a thorough detective, followed up on most of these stories. In several cases, these ethnographic accounts provided key information for site investigation and interpretation.

Robbins not only enjoyed talking with neighbors about the property but also loved public forums at which he could present his discoveries. For the most part, he was very personable and excelled in his public lectures and tours of discoveries at the site. His daily logs are full of references to his public lectures. For example, at the end of his 1953 entries, he notes giving lectures to the Antique Club of New Jersey; Jamaica Plain Tuesday Club; Round Table Club of the Baptist Church in Lexington Center; 20th Century Club; Couples Club at the First Parish Church, Fitchburg; Princeton Historical Society; Saugus Garden Club; Commonwealth Men's Bible Class at the Belmont Methodist Church; William Sutton Masonic Lodge; and the Connecticut AMC.[14] These lectures, coupled with his work at Saugus, meant a profoundly busy schedule for Robbins. During his tenure with the Saugus project, Robbins informed thousands of people about the discoveries.

Spent part of morning with Mr. Eckert going over our property and lines. He gave me permission to do any test digging I want at any time on his property. Paul, Mike and I cleaned up around the furnace and laid out the casting beds and forge or bloomery site at high elevation where Iron Works sign stood. I talked with Mrs. Hogle for some time in p.m. Mr. Albert Rohnbacker, Juliette Rd, gave me a 17?7 coin that his son, Richard, aged 10, found on excavated soil piled to rear of I.W.H. Said some years ago he saw *dump cart removing slag from south end of slag heap taking it to the dam at Prankers Pond where it was used for base purposes.*

Roland Robbins, "Saugus Ironworks Daily Log - 1950," April 28, 1950.

4.7 Robbins talking with Rufus Zimmerman, a museum visitor in June 1952. (Photograph 684 by Richard Merrill, 1952.)

Robbins' daily logs indicate that he, by necessity, kept odd hours to accommodate his speaking engagements. All of the time that he spent in publicizing the project paid off greatly. Not only did the excavation itself increase awareness of the important resources at the site, but Robbins' public involvement aided in the reconstruction. Several members of the community and local governing boards supported the reconstruction and the movement of streets and utilities, particularly Central and Bridge streets, because of Robbins' efforts.

When one looks at the audience Robbins tried to reach, one thing becomes apparent: he attempted to communicate with the general public and not with the academic community. His lectures were designed to excite the imagination of audience members and get them interested in history and archeology. People who visited the site were often met by Robbins and taken on tours. He even went so far as to allow members of the general public to join in the discoveries being made at the site. This irritated many in the scholarly community. Archeology was struggling to be a science and many academics thought that direct involvement of the public would diminish the discipline. In the post war era, archeology still bordered on the exotic and many trained archeologists wanted to keep it that way. Today, the discipline involves both academic archeologists and public historians, who devote most of their efforts to teaching history to the general public. In this respect, Robbins served as a trailblazer for public history and archeology.

For a rather prolific log writer and recorder of daily detail, Robbins mentions extraordinarily little about his family or life outside of the excavations. Occasionally he refers to a birthday, a weekend in Vermont, holiday plans, a baseball team, or a tennis game. One notable exception is an entry made on April 29, 1952. Here Robbins mentions his wife and children and their horseback riding lessons.

> Gerry drove Jean, Bonnie and me to the Pine Banks riding school, 90 Main Street, Melrose. There Bonnie, Jean and I had our 1st riding lesson. It lasted until 5:35 p.m. Decided to have another lesson next Tuesday. Dick preferred to play ball. In the evening I spoke at a P.T.A. meeting at the Woodville School, Farm Street, Wakefield. I did this for Harold Hanson . . . .[15]

In other instances Robbins, mentions events like the opening of Route 128 and how it helped cut time off his commute from Lincoln to Saugus, various bugs that occasionally infected him, grand jury duty, and his perceived results from his evening and weekend lectures. While these brief examples illustrate a man with a happy family life and mundane encounters which much of humanity experiences, they are not detailed enough to describe Robbins off the job. Instead, observations on his personality must be derived from his daily on-the-job dealings. From what he left in his notes, Robbins seems to be a likeable, practical person with good project management skills, a good sense of humor, and exceptionally good interpersonal skills, when he chose to use them. He also must have been very charismatic to accomplish what he ultimately was able to in archeology.

10:00 a.m. the Iron Works played the Saugus Police Department a game of softball. This was the first game we have played. It was played at Anna Parker playground. It started at about 10:30 and ended a few minutes before noon. The Iron Works won by a score of 12 to 10. Manny, Tommy Sheehan and Charlie Sanford, Jr. were the only employees of the Iron Works available. Sanford's brother played, and Manny brought a fellow along to pitch for us. I brought Dick Robbins, Charlie Campobasso and Georgie Gordan along and they played the entire game. And it was a good game they played. Charlie caught, Georgie played 2nd base, and Dick played short-stop. They each got three for five. Dick drove in one run, Georgie and Charlie each drove in two runs and Georgie scored two more. It was raw, dark day. I could not play because of my back.

Roland Robbins, "Saugus Ironworks Daily Log - 1952," September 14, 1952.

4.8 Saugus High School students attending the premiere of the Saugus filmstrip "The Cradle of an American Industry" in November 1951. (Photograph 509 by Richard Merrill, 1951.)

While some of the personal interplay between the various characters in the Saugus drama entered into the daily log entries, it seems clear that Robbins attempted to refrain from overtly criticizing project members; architect Harrison Shock, Quincy Bent, and ironworks historian H. R. Schubert seem to be an exception to this rule, particularly in the last two years of the project as the pressure rose to finish.

> Friday, August 3 [, 1951] … Jones tells me that she [Mrs. Kingsbury hired to aid the architects in the furnace reconstruction] is to supervise the laying of the furnace stones. Apparently they (the architects) are not sure of themselves (per usual) and have arranged for Mrs. Kingsbury to get them out of their dilemma—or to hold their bag. Too bad Mrs. Kingsbury did [not] have the advantage of inspecting the furnace stones and marking them, if necessary, before the furnace was torn down. Too bad, also, that Schock did *not appreciate* the importance of plotting the furnace stones at an earlier date.[16] In view of the fact that for the past *2 years* the architects have had the opportunity to study the detail and features of the furnace foundation, bellows base timbers and more recently the tailrace, wheel pit, etc; and yet are confused and ignorant of desirable furnace foundation data, not now available because of its dismantling, make it seem entirely unlikely that they will be capable of conceiving a true perspective of the upper structure of the furnace, of which we found no evidence. [17]

As time progressed, Robbins became less involved in the day-to-day fieldwork and more involved with the management of what had become a very large, very demanding project. His notes indicate that he was corresponding with numerous individuals about everything including conservation of wooden and metal artifacts, obtaining estimates for the purchase of water pumps, mediating disputes between adjacent property owners and the project's attorney, and lecturing to local civic groups. It is clear from his log entries that his interactions with several individuals, especially Attwill and Bent, began to wear him down. His usually excellent health and unbounded energy began to suffer and he frequently notes stress related ailments in his daily logs. Documentation of archeological discoveries lessened as time wore on, especially in his post-1951 daily logs. Ultimately Robbins resigned from the project on July 31, 1953, after a final confrontation with Bent.

Regardless of academics' critiques of Robbins and the Saugus Iron Works project, several things are clear. While complex to unravel, Robbins' notes, drawings, photographs, films, and correspondence provide enough information to document the early excavations at Saugus. While a site map cannot be constructed illustrating all of the places in which Robbins excavated, enough information is available in the Saugus archives and other repositories to piece together a final report on the project.

5.1 The excavation of the blast furnace in July 1949. Notice the prominent retaining wall for Central Street at the left of the photograph. The waterwheel and wheel pit were found below the retaining wall. (Photograph 99 by Richard Merrill, 1949.)

Excavating the Blast Furnace

William A. Griswold

In 1948, Roland Robbins began his notable excavations on an area of land between what was then Central Street and the Saugus River, just south of Bridge Street. Much of the area was completely overgrown with thick vegetation and several old and very large trees. Robbins' excavations proved fruitful almost immediately. He and a small crew of workmen quickly began uncovering the remains of the blast furnace, arguably the most important feature of the Saugus ironworks. Unlike many of the remains uncovered during the project, several elements of the blast furnace were buried by only a small amount of earth and were in relatively well-preserved and complete condition. In these early days of the project, it seemed as though each and every day held a new discovery surrounding the blast furnace and its operation. These discoveries excited not only Robbins, but also surpassed the hopes and expectations of the members of the First Iron Works Association (FIWA), who were determined to reconstruct and memorialize the first successful ironworks operation in America.

At 2'6" a bed of baked clay (now red) with sandstone and some small pieces of charcoal was found. The red clay vein averaged about 6"–9" in thickness. Beneath this clay bed, on the Saugus River side, medium size stones were found. Beneath the clay bed, on the side nearer the Central St. retaining wall, a very fine, pure, white sand was found. I pushed my prod rod down through this sand until it had reached a depth of 5'6" from surface and found no evidence of a foundation. Then I began trenching towards the Saugus River, following the stone base beneath the clay bed. By the end of day I had followed this stone base about 10' from where my digging began. Sod with charcoal in it found under stone 2'10" deep at line where stones and sand met.

Roland Robbins, "Saugus Ironworks Daily Log - 1948," September 14, 1948.

The Furnace Stack

It appeared from Robbins' initial excavations that the majority of the substructure, or below-ground portion, of the blast furnace remained in situ and had not been disturbed. Deposits of baked clay and charcoal were uncovered, as were stones that Robbins would later identify as part of the superstructure, or above-ground portion, of the furnace.[1] While much of the furnace's substructure had been preserved, most of the superstructure was completely gone, having been dismantled intentionally or lost as a result of collapse and decay. Several in-ground features associated with the furnace had also survived nearly intact, including the crucible cavity, casting beds, bellows base, waterwheel, and wheel pit; evidence for other features, like the furnace bridge supports and casting shed uprights, was less intact but also identified by Robbins.

Robbins' excavations revealed that the base of the furnace was approximately 26 feet square, plus or minus a few inches, with two triangular-shaped openings typical of a seventeenth-century blast furnace.[2] He mentions in his log that the base may have been laid out using a link measuring system.[3] The northern opening partially covered the large bellows that injected the blasts of air needed to heat the fire enough to liquefy the iron. This bellows was powered by water that fell from a race and turned a large overshot waterwheel, which Robbins later located just northwest of the furnace.

The eastern aperture opened onto the main work area, which would have been covered to protect the workmen and their casting operation. Once a sufficient amount of liquid iron had been obtained in the crucible at the base of the furnace, the furnace was tapped via a small opening and the resulting flow of liquid iron was channeled into molds of various shapes and sizes in sand casting beds. The members of the Reconstruction Committee debated certain questions. Did the furnace have a forehearth? Was the crucible cavity above or below the level of the casting area?

Robbins identified several drainage features under and around the furnace. These important drain systems were designed to keep the furnace dry during operation. The critical need for an effective drainage system at ironworks was noted in the Winthrop Papers by Sir Charles Coote, who advised: "Chiefly take care so to place your furnace that there be no water springs or damps under her for it will spoil all which if your ground will not admit, you must make a false bottom with several pipes to carry away the damps and water or springs."[4] Water seepage from both natural groundwater and the water in the raceway and wheelpit was extraordinarily dangerous to those casting iron; the consequences were explosive and catastrophic. As Hartley notes from a passage in ***The Natural History of Stafford-shire:*** "Tis also of importance in melting of Iron Ore, that there be five or six soughs made under the Furnace . . . to drain away the moisture from the furnace, for should the least drop of water come into the Metall, it would blow up the furnace, and the Metall would fly about the Workmens ears."[5]

Midway along west foundation we dug to a 7' depth on foundation and found the possibility of a canal running from west side of crucible cavity. In the presence of Sanger and son and Blackie, I took two pails of water, colored with bluing and emptied them in the new hole on the west side of the blast furnace foundation. In several moments the color appeared flowing into the bottom of the crucible pit from the base of west wall. It is quite evident that we have located a channel running beneath the furnace . . . .

Roland Robbins, "Saugus Ironworks Daily Log - 1949," April 10, 1949.

Robbins notes the presence of a stone-lined chamber directly below the stone floor of the crucible pit which served to channel water away from the inner workings of the furnace. A western drainage channel, discovered in April 1949, led out of the western exterior wall of the furnace and into the tailrace.[6] This western drainage channel seemed linked to a northern channel that went beneath the crucible pit to the bellows area.[7] Furnace drains have been found at several English furnaces including Batsford II, Chingley, Maynards Gate, Pippingford, and Pippingford II. However, construction of drains was not universal. No furnace hearth drains were found at either Panningridge or Batsford I.[8]

The exterior structure of the Saugus furnace was constructed from locally available granite, as identified by the project's consulting geologist, Dr. Laurence LaForge.[9] The interior portion, or lining, of the furnace was, however, constructed out of heat-resistant sedimentary sandstone, possibly imported from England. On numerous occasions, Robbins notes finding hexagonal spikes which, according to a later analysis by H. M. Kraner of the Bethlehem Steel Company, were an arkose, a sandstone containing feldspar. When intense heat was applied to the stone the feldspar melted and the sandstone shrunk and cracked to produce the spikes, similar to the spikes of Devil Post Pile near Lake Tahoe in California.[10] A very thick deposit of clay separated the sandstone lining of the crucible and the exterior wall of the

5.2 During the excavations, Robbins discovered drains below the blast furnace. (Photograph 456 by Richard Merrill, 1948.)

furnace.[11] Robbins noted that approximately 28" of the clay filling at the Saugus furnace had been baked by the intense heat from the furnace. While showing signs of heating, the permanent exterior wall of the furnace looked unaffected by the heat generated on the inside of the furnace; the clay acted as an insulator keeping the intense heat of the crucible and furnace interior from reaching the permanent exterior wall. [12]

Some liberties were taken for the reconstructed furnace stack since many of the details for the above-ground portion of the reconstruction were not available from the archeological record. To fill in the incomplete details, the Reconstruction Committee relied on examples from elsewhere in the U.S. and from England and consulted specialists on behalf of the project. Although different designs for the furnace openings, the casting arch, and bellows arch existed in other locations (oval, angular, etc.) a rounded half-circle arch design was used for the reconstruction of the Saugus furnace. Some of the surviving furnaces in England of similar date have cast-iron lintels over these openings, but this design element was not incorporated into the Saugus reconstruction.[13] Based on other furnaces, the Saugus furnace stack was reconstructed to a height of approximately 23 feet and the exterior dimension of the stack decreased in circumference from bottom to top; this last detail did have some archeological support.

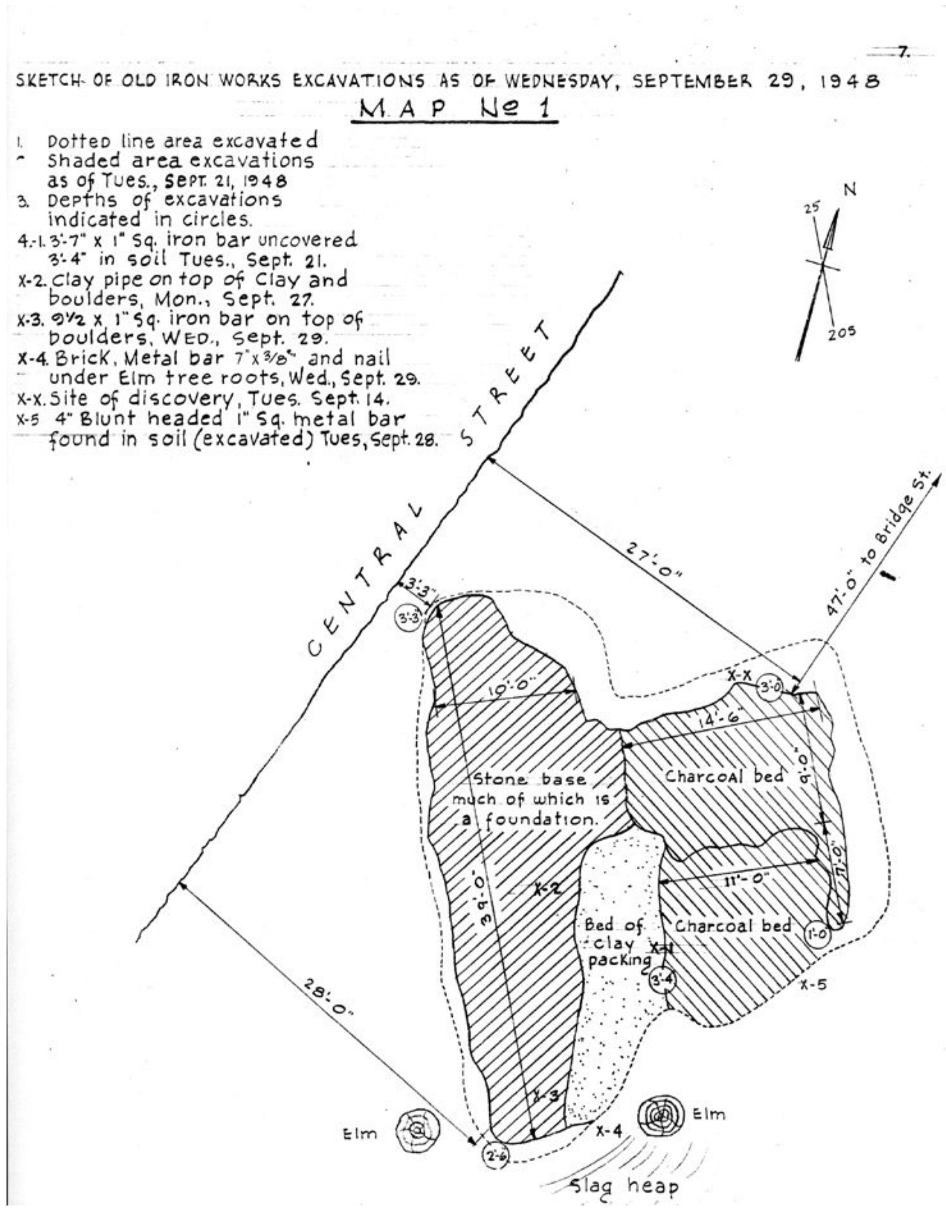
While it was never clear in Robbins' notes that any supports or holes for supports for the furnace were found, many early English blast furnaces, including those at Batsford, Chingley, Maynards Gate, and Panningridge, were additionally supported at the top by wooden cribbing that extended down into the ground, especially at the pillar, or corner between the two arches.[14] The pillar was known to have been one of the weakest and most problematic elements of the furnace structure. These wooden supports have been documented archeologically, historically, and in some instances on cast-iron firebacks.[15] The casting shed, where the casting would have been conducted, was almost certainly roofed to control moisture. Evidence of roofing has likewise been found at other iron furnaces like Pippingford I and Chingley.[16]

The top aperture of the furnace, or charging hole, had also undergone development in England by the time the Saugus furnace was originally constructed. During the smelting of iron, the top aperture, where all of the ingredients were loaded, commonly belched heated materials that damaged the top stonework. At first the platform of these furnaces around the opening was covered with tiles, but cast-iron plates had replaced these tiles by the end of the sixteenth century. The earliest use of cast-iron metal plates for this purpose is noted in 1591 at Rievaulx in Yorkshire. [17] While no physical evidence existed for the Saugus ironworks aperture, the furnace was reconstructed with cast-iron plates over the charging hole in keeping with the English examples of the period.

Men continued to dismantle the furnace. Joe and I worked along with them. I took pictures of the permanent furnace wall just to rear of face wall about crucible pit. (While the face wall had been repaired from time to time, the permanent wall to its west and south sides showed no evidence of repair work. It did show red clay (burned) extending to the rear of the front of the face walls for 42". But this clay had been discolored, or burned, by the intense heat from the furnace crucible and hearth areas. It was similar in appearance to the clay which had packed the furnace sandstone lining—but it was still soft in texture not solidified as was the clay which packed the furnace lining. *The face wall was about 14" in width. The heat penetrated beyond this for about 28" depth. Even at el. of crucible pits stone floor the furnace heat penetrated beyond permanent wall for some distance, burning the clay about stones of furnace structure. However heat appeared to lack several inches from reaching the depth of penetration noted about 3' above the crucible pit floor.*

Roland Robbins, *"Saugus Ironworks Daily Log - 1951," July 20, 1951.*

5.3 Drawing in Robbins' daily log, September 28, 1948, showing his 1948 excavations at the blast furnace. Note the level of detail Robbins presents concerning the various features and deposits encountered.



The Bellows, Waterwheel, and Wheelpit

In mid-October 1948, shortly after Robbins had identified the furnace base, he began excavating the remnants of the bellows on the north side of the furnace. The remains consisted of large, intact timbers laid in a V-shaped arrangement with the narrow portion of the V ending near the "pipe," as Robbins called it, and crucible. Several leather pieces "in as good shape as the day they were buried" were also uncovered in the area, as were nails, wooden wedges, and a hinge-like piece.[18] Robbins also found wooden fragments of what he considered to be either cams for the bellows or fragments of the paddles for the waterwheel. Below the timbers, Robbins also found a layer of blue-gray clay and sand, possibly used to control drainage.[19]

The bottom timbers for the bellows formed a roughly wedged-shaped, plank-sided base. The two primary north-south supports were double plank-sided members approximately 17 feet long.[20] These two members were connected by another timber measuring approximately 14 feet, 2 inches in length, and 14 inches in thickness. Another, shorter timber, approximately 7 feet, 8 inches in length, had fallen across the north-south supports, but evidently was not part of the base construction. Robbins speculated that this cross member and others around it had fallen into these positions after the blast furnace had been abandoned.[21]

Correspondence between members of the Reconstruction Committee indicates that there was some initial confusion as to the identification of the bellows support.[22] For a time, Robbins thought that the bellows base might have been some sort of sluice, or drainage feature.[23] Its shape seemed to indicate that it might have been used to channel water into the drainage channel discovered below the crucible cavity. This analysis was further supported by the location of the tuyère, or 37-inch-long connecting funnel, between the bellows and the crucible cavity, which had been found out of position. [24]

Robbins found the tuyère near the blast furnace at Saugus with its larger end covering one of the channels under the crucible cavity.[25] This led some individuals involved with the project to speculate that this odd-shaped pipe might have been involved with the drainage system. However, a number of the members of the Reconstruction Committee believed that this "pipe" was the furnace tuyère that had simply been moved out of position.[26] Ultimately, those who believed the pipe was a tuyère and those who believed the wooden frame was a support feature for the bellows convinced the others.

A shaft-driven waterwheel powered the bellows. While the cams on the shaft would have raised, or expanded, the bellows, heavy counterweights attached to the bellows would have compressed it and forced air out through the spout and tuyère and into the furnace. While no evidence of the huge wooden shaft was found during the excavation, much of the waterwheel, wheel pit, and tailrace were discovered in situ. The preservation of approximately forty percent of the waterwheel and most of the wheel

The iron pipe at the pit was removed today and placed in the attic of the Old Iron Works House. It was found to be funnel shaped, 3' long with a 2" diameter at one end and a 5 3/4" by 4 1/2", egg shaped, diameter at opposite end. It was a metal piece that had been folded round and had had a metal band placed around its middle. I placed a stone in the hole it had occupied and larger boulders upon it. The iron pipe apparently had set on the top of the channel that ran from pit to the converged end of the beam and plank trough. The base of channel is stone. While clay and soil had partially obstructed this channel, nevertheless by pouring water in the soil at the converged end of the trough it ran through the channel and into the pit. This would indicate that such were the intentions at the time of the construction. Further excavation at the converged end of trough may locate the other end of a channel cut through the pit's walls . . . . So the outline of the blast furnace has been determined and many of its mysteries solved, however, the purpose of the plank and beam trough shall have to be determined. There seems but little doubt but that the bellows were located above the trough. Whether water drained beneath them thru the channel or thru the iron pipe, or whether the blast from the bellows was dispersed thru the iron pipe into the channel and up from the bottom of pit shall have to be determined.

Roland Robbins, "Saugus Ironworks Daily Log - 1948," October 16,1948.

5.4 The blast furnace and bellows base October 1949. The view is to the south. (Photograph 110 by Richard Merrill, 1949.)

pit and tailrace was phenomenal.[27] Even more fantastic, Robbins found several other waterwheels and wheel pits during the next few years (see Chapters 6, 7, 11, and 13). Robbins was elated when the waterwheel was discovered, as he notes in his later book ***Hidden America*** (1959):

> That weekend it rained, which helped to make the water-wheel site more easily workable. So on Monday I went to work with spade, putty knife, and trowel in the charcoal-strewn vein. In mid-afternoon I struck wood. Pushing my hands into the freezing, waterlogged earth, I felt the contours of a thin board, and as I scooped away the soil I felt other surfaces, angling off from the first board. The first image that occurred to me was a box, and then, as I cleared away more of the wood, I dared to hope that my dream of finding at least part of the water wheel preserved had come true. I looked down at the ancient saturated boards, gummy with mud; they seemed to form a water-wheel bucket. I dug on until long after darkness closed in and found a three-foot wooden arm extending into the furnace wheelpit; my bucket was twenty inches by fourteen inches by ten inches deep. Even if I found no more, these dimensions could help to establish the size of the wheel which had helped to get this pioneer industry started.[28]

The overshot wooden waterwheel was estimated to be approximately 16 feet in diameter when discovered by Robbins in February 1951.[29] The spokes that radiated out from the center of the wheel supported the buckets, which were used to catch the water and turn the wheel. One of Robbins' March 1951 log entries indicates that each of the buckets were approximately 12 inches apart and supported by wooden rungs that ran from one side to the other on the wheel.[30] Animal hair had been used to caulk the joints of the buckets.[31] The wheel itself was estimated to be approximately 30 inches wide; water would have been delivered to the wheel from a penstock at the top. The overshot waterwheel was quite popular at ironworks of Saugus' vintage. As noted above, the overshot wheel was the most efficient of the various waterwheel types, compared with the breast wheel and the undershot wheel, and thus capable of providing more power to the bellows.

Today's work hit the jackpot! While I had expected to find about 25% of the waterwheel cradled in the race at least 40% of the wheel was found there today! Also 2 more spokes were found protruding up from the section of wheel resting at bottom of the race. That makes total of 3 known spokes. The spokes found today were the 2 large base timbers which held the waterwheel's bearing structure. At the northerly end of the race I located the other end of the remains of the wheel. The distance between the both ends of the wheel was between 12'-13'.

Roland Robbins, "Saugus Ironworks Daily Log - 1951," February 23, 1951.

The remains of the original furnace waterwheel were found in a wooden wheel pit large enough to accommodate the bottom portion of the 16-foot-tall by 30-inch-wide waterwheel. Because water backup could actually slow the wheel, the wheel pit would have been cut significantly deeper than the waterwheel required to allow water to flow freely to the tailrace once it had been released from the buckets on the waterwheel. The rectangular wheelpit was solidly constructed of wood and contained internal supports to allow it to retain the soil all around it.[32]

Robbins excavated the soils that had collected in the wheelpit as he uncovered the waterwheel remnant. The fill had either washed in or had been purposefully deposited after the facility went out of use. Rob-

5.5 Robbins excavating the furnace waterwheel in March 1951. Two of the spokes projecting from the interior diameter of the wheel can clearly be seen as can much of the wheel pit. (Photograph 309 by Richard Merrill, 1956.)

bins noted numerous artifacts and artifact fragments in the fill, along with a large charcoal deposit that he speculated had accumulated outside of the wheel pit during the operation of the furnace. After the furnace was abandoned and the retaining walls on the north and west of the wheel pit had collapsed, this charcoal had been washed into the pit.[33] The fill supported the remnants of the waterwheel; as soon as the fill began to be removed, the various parts of the waterwheel and wheel pit began to disintegrate. The waterwheel was conserved by Professor Elso Barghoorn and is currently on exhibit in the museum at Saugus Iron Works NHS (see Chapter 11).

To the north of the furnace, Robbins found the remains of retaining walls used to stabilize the soils and prevent soil migration into the furnace area. [34] The only element remaining from the northern portion of the retaining wall was a beam. However, it showed signs of having joined a north-south beam at a perpendicular angle. Robbins speculated that this beam would have been part of another retaining wall, which may have kept material from washing into the bellows and waterwheel area. It is likely that the revetment wall may have also channeled free-flowing water away from the furnace as at Astly, Worchestershire.[35]

Earlier work along the west side of the furnace had offered a harbinger that the waterwheel, wheel pit, and tailrace might be found. An April 1949 log entry by Robbins notes that he had discovered a portion of the tailrace. [36] The trench that Robbins excavated on the west side of the furnace was 10 feet below the working surface of the casting area. At this depth, Robbins uncovered a portion of the bottom of the tailrace that appeared to be four feet deep and three feet wide. Constructed out of wooden planks on the sides and bottom, Robbins speculated that the top of the tailrace may also have been covered with wood. He noted in a later May entry that the tailrace was supported by upright and cross beams.[37] No large stones were discovered in the fill of the tailrace, which led Robbins to conclude that the furnace had been dismantled after the tailrace had been filled. Several of the timbers used in the tailrace construction also showed signs of fire, indicating that a conflagration of some sort may have occurred before the tailrace had gone out of use.[38]

The digging to west of furnace wall penetrated to a depth of 10' below apparent floor level of furnace. Located was evidence of a possible tailrace running parallel with west foundation and flush to it. It is possible its construction consisted of planking flush against bottom of foundation, held in place with beam uprights. Its width seemed to tapper [sic] *towards south end of west foundation. It was about 3' in width. Its depth appears to have been about 4'. The bottom being lined with wood, possibly beams or planks. Indications are that wood planking covered its top. The distance from the top of furnace foundation to the apparent top of this wooden structure was about 6'. This and the structures 4' depth places a depth of 10' from top of foundation to present knowledge of its depth.*

Roland Robbins, "Saugus Ironworks Daily Log - 1949," April 24, 1949.

The Charging Bridge

Two elements possibly connected with the charging bridge were found by Robbins in January 1951. The charging bridge provided access to the furnace opening, allowing workers to move raw materials from the higher ground above the furnace to the top of the furnace stack. Robbins first unearthed a stone wall on the ravine, just west of the furnace.[39] This is the location in which one would expect to find a charging bridge support feature, given the configuration of the Saugus furnace. The wall section was 28 feet west of the western edge of the furnace and was built on the same loam surface on which the other buildings associated with the ironworks were constructed. Robbins did not record the dimensions of the wall nor what type of stone was used in its construction. The second element possibly connected to the

5.6 Robbins working in the tailrace in July 1951. Notice the depth of preservation on the western side of the blast furnace and the upright members of the tailrace. (Photograph 384 by Richard Merrill, 1951.)

charging bridge was a wooden sill.[40] This sill lay just west of the other wall and was constructed parallel to it, but did not contain any mortises. Robbins noted that if it served as a sill, the corresponding vertical members would have been held in position by fill soils that had buried the sill some three feet, six inches below the present surface. Since burying timbers in the ground rather than elevating them on some kind of stone foundation would have fostered quicker decay of the timbers and greater instability for the bridge, this interpretation seems questionable. Robbins noted the unusual shape of the beam, but the discovery of adze marks indicated to him that the timber had not been misshapen by natural elements. These were the only two features mentioned by Robbins connected to the charging bridge.

The reconstructed charging bridge, therefore, was not based on a great deal of archeological evidence. The fact that one would have existed and would have been constructed out of wood did little to inform the reconstruction. Most of the historical examples in both America and England had covered bridges, making the Reconstruction Committee's decision to reconstruct the bridge with an open rather than a covered bridge somewhat controversial.[41] The Reconstruction Committee chose the open bridge because the historical inventories about the ironworks never mentioned a charging house.[42]

Other Features

Robbins uncovered numerous additional features while he was excavating in the vicinity of the furnace, including several amorphous groups of stone. One of the first mentioned was uncovered in the northwest corner of the furnace.[43] Robbins rather quickly attributed this feature to the dismantling of the furnace. Likewise, after much contemplation, Robbins ultimately dismissed a large pile of stones off the southeast corner of the furnace as related to dismantling activities.[44] However, he associated other stone piles and features with specific functions.

Several other amorphous stone features were found to the east of the furnace. Numbered 7, 8 and 9 by Robbins, these stone features were similar to the stone piles found on the southeast and northwest corners of the furnace, except that they did not form well-defined piles. Hartley suggested later casting beds had been rebuilt over the earlier casting beds and that the stone below the new beds would have acted as a sort of dry well, pulling moisture away from the casting area.[45] He noted that the original area used for casting likely would have gotten wet and muddy and that the insertion of the stones would have prevented that. Robbins argued against this idea, noting that no higher casting beds had been found. He instead speculated that Features 7 and 8 may have been the remains of one of the furnace lining reconstructions, performed after the furnace went out of blast.[46]

Robbins also discovered what he believed to be the casting beds at the southeast corner of the furnace. He notes that this area had been dug out and the spoil had been replaced with sand.[47] Such casting beds

This a.m. I located stone evidence on the slope of the ravine just west of the west wall of the furnace. It was resting on the loam surface which existed during furnace operations. (This loam having considerable charcoal in it.) This stone evidence could well have been the foundation of the bridge to the furnace! *From the base of these stones to the west wall of the furnace was 28'. Assuming the furnace tapered from its top, and the stone evidence at the site of the bridge may have been graded rather than constructed (built up) vertically, we could add several feet to this distance. When the old water line was laid it ran across this area, undoubtedly destroying evidence we seek.*

Roland Robbins, "Saugus Ironworks Daily Log - 1951," January 10, 1951.

5.7 Several stone piles uncovered during the blast furnace excavations in September 1950. (Photograph 219 by Richard Merrill, 1950.)

would have accommodated sow, holloware, and flat castings. When the furnace was tapped, the liquid iron would have flowed out and filled depressions in the sand that had been created using hoes or molds. Once these castings had cooled, they would have been broken from the main channels created to distribute the iron. Molten iron also would have been ladled out and poured into molds. Robbins discovered a ladle or two in his excavations, as well as several "ladle-skulls," or the remains of the liquid iron that cooled and stuck to the ladle before it could be poured into the molds.[48]

Robbins was convinced that he could identify particular activity areas within the casting beds based on the artifacts that he recovered.[49] The discovery of a large sow southeast of the furnace opening led him to believe that this area was used for casting sows. He speculated that the area just north of the alleged sow-casting area was the hollowware-casting area because of the fragments of pots and kettles that he discovered in the sand. His conclusions are probably accurate, although the ironworkers easily could have moved the sand around, almost at will, and cast forms anywhere in the casting bed. English furnace sites also have identified activity areas within the casting sheds and beds. Furrows for sows, without branches for pigs, were also found at Panningridge I and Pippingford II.[50]

Almost directly south of the furnace was the slag pile. This pile contained the by-products of numerous seasons of smelting and was visible from the very start of the project, even without archeological examination. Its size and the fact that it would have contained few if any architectural features probably contributed to its survival. During Robbins' excavations at Saugus, he sampled the pile and collected pieces of slag for analysis, but only reconfigured the extreme northern end pile's. Today, the slag pile represents one of the only surviving, and largely unaltered, cultural resources from the original operation of the ironworks.[51]

Some disagreement existed between Robbins and members of the Reconstruction Committee concerning the access route from the casting shed area to the slag dump. Robbins reasoned that some kind of stone ramp must have led from the casting area to the slag pile, as there was quite a difference in elevation between the two. The Reconstruction Committee did not necessarily agree. Evidently, Robbins and Hartley had a spirited debate about this, which Robbins notes several times in his daily logs. For example, on Friday, August 10, 1951, Robbins comments,

> Phoned Hartley in p.m. and pointed out the fact that if the stone ramp was not used as a walkway to the slag dump—then they had to walk out and ***circle around*** the circular foundation [Feature 12] to front of furnace breast, crossing the easterly side of it when swinging back towards slag dump. This would bring them to the foot of the bank which slopes north-easterly from the developed plateau at south of furnace. Here they would find themselves 6' lower than the plateau and slag dump. Are we to twist

This morning I located the casting bed (for sows and pigs) to the front of the hearth, and running along the southern wall of the breast for about 6'. Preliminary examination indicates it to be about 3' wide at hearth and about 4'–4 1/2' wide at its outer extremes. It appears that its top surface was at a level corresponding with the bottom of the lower breast stones. (Possibly these lower breast stones were placed along the bottom of the furnace breast to keep the casting activity 9"–10" away from main breast stones, making for better working room.) For a depth of 8"–9" into this casting bed the sand was red from exposure to heat. It was crusted with metal waste or splatterings. Beneath this evidence the sand was fine and pure (this on a loam surface) for a depth of 4". (This indicates the possibility of a sow casting bed built on loam surface of about 1'.) Specimens of the top sand of casting bed and the bottom sand of this bed have been removed to my museum.

Roland Robbins, "Saugus Ironworks Daily Log - 1949," October 14, 1949.

5.8 Robbins' identification of the various activity areas within the casting beds in 1949. View to the southeast. Notice the "stone ramp" just to the right of the center of the picture. (Photograph 405 by Richard Merrill, 1949.)

> our thinking to imagine that a series of steps (of which no evidence was ever located) existed up which they would carry their basket or barrows of slag?[52]

Hartley maintained that the stonework that Robbins referred to as a ramp was really only additional buttressing for the southern furnace wall.[53] Ultimately, the Reconstruction Committee overruled Robbins and did not reconstruct any kind of stone ramp.

The archeological excavations of the blast furnace and attached features clarified the design of the area for reconstruction. The British ironworks historian, H.R. Schubert, ardently believed that the Saugus furnace, and indeed Hammersmith in general, emulated English design. Robbins contended that the design did not necessarily slavishly follow the English plan. Fifty years of archeological research on blast furnaces in England has shown that the Saugus furnace contained some elements of English derivation but at the same time incorporated elements not found on all English sites.

6.1 The corner of the refinery forge. (Photograph 131 by Richard Merrill, December 1949.)

The Forge and Slitting Mill

Donald W. Linebaugh

Following Robbins' identification of the blast furnace foundation and its various elements, including the bellows, charging bridge, and casting beds, he continued his excavations to the south and east in search of other ironworks features, particularly the refinery forge and slitting mill. From 1950 to 1953, Robbins excavated features east of the furnace that he confidently interpreted as the refinery forge. From 1952 to 1953, he worked in an area east of the refinery forge that he came to interpret as the slitting mill. These two buildings, clearly documented in the ironworks' business records (see Chapter 2), were central elements in the integrated ironworking operation at Saugus.

In the inventory of Newbridge, Sussex, of 1509 the three essential parts of an English forge are indicated: finery, chafery, and hammer. They were all in one building and equipped with water wheels. The building of the early forge consisted of a wooden framework the interstices of which were boarded with planks of wood; the roof was tiled.

H. R. Schubert, *History of the British Iron and Steel Industry from c. 450 B.C. to A.D. 1775*, p. 273.

A forge, consisting of a finery and chafery, was not always associated with a blast furnace operation; it could be a separate business that simply purchased pig iron from a furnace for refining and processing into wrought iron. The inclusion of a forge in the Saugus operation allowed for the production of a broad range of products sought after by blacksmiths and ironworkers. In the finery, a metal sow (or cast-iron bar) was remelted to burn off additional carbon and then collected into a ball called a loop. The loop was then hammered by hand and by trip hammer into a bloom. The bloom was then reheated in the chafery hearth and trip hammered into the shape of a dumbbell, a process that removed more impurities in the metal. The dumbbell was then heated again and trip hammered into a long bar that could be sold to blacksmiths. Thus, the brittle pig iron of the furnace casting was converted into a refined bar of more flexible and durable wrought iron.

The rolling and slitting mill allowed the wrought iron to be further processed in terms of size and shape to make it more usable by metal crafters. In this building, the long wrought-iron bars could be rolled into thinner sheets and then cut into bars and rods of various sizes and diameters. For example, one of the products of the ironworks was rod iron or nail rod, which is bar iron cut into sizes suitable for blacksmiths to produce nails. The financial records of the ironworks contain numerous references to the sale of various sizes of bar iron and nail rod.

The Refinery Forge

Although Robbins had reported that he identified a "forge or foundry" foundation early in the excavations along the tailrace south of the furnace, he later came to the conclusion that this series of features was likely related to the works of Joseph Jenks. Robbins records in his daily log on July 19, 1949, that "Jenks bought of Undertakers a corn mill, a forge and a slitting mill at the tail of the furnace."[1] Later in the year, Robbins identified a foundation (#6) east of the furnace along Bridge Street; he reports that "slag fill southerly of foundation No. 6, is refuse from forge activity (possibly hammer activity)."[2] While there was clearly no consensus as to the exact location of the refinery forge, Robbins suspected that it was located in the Bridge Street area of the site, east of the furnace.

Robbins got a better sense of what he was actually looking for in terms of the refinery forge equipment when, in April 1950, he met with ironworks expert Earle Smith. Smith helped him understand many aspects of this type of ironworks facility and also provided interpretive ideas about the features that Robbins had identified to date. Robbins notes that Smith told him that "the site of the hammer should produce a wooden block in its center on which the anvil rested. Said the trip hammer's wooden shaft or arm might be about 4-6' in length."[3]

Thus, when Robbins identified a "large circular affair" along Bridge Street in August 1950, he was able to quickly connect it to the refinery operation based on Smith's description. Robbins explains in his daily log that he excavated

> within the large circular affair found handy to the large retaining wall on the northerly side of Bridge St. About 34" down from the top of the circular affair I found the base, stump or block of a tree which was 41" in diameter. It appears that this may be the base of a hammer—the block on which the hammer fell. The circular affair about it, while it appeared to be metal, actually is a metal waste. The theory at the moment is that the circular wood base is the anvil base on which the hammer fell and the metal waste about it was the accumulation of the impurities extracted from the iron by hammer action.[4]

After identifying the anvil base along Bridge Street, Robbins dug several test trenches "to determine the natural soil line" and guide future excavations.[5] Later in August, Robbins and his crew discovered another feature about 11 feet east-northeast of the "circular affair" or anvil base. This feature also appeared to be a section of tree trunk, although in this case squared off and somewhat smaller than the first, measuring 21 by 23 inches.[6] Robbins and Hartley were excited about this discovery, believing that it and the other anvil base were likely part of the ironworks refinery building.[7] This interpretation was strengthened when, on August 31, Robbins found the head of a trip hammer in the immediate vicinity of the anvil base and hammer features along Bridge Street. He notes that the 500-pound iron hammerhead was recovered north of Bridge Street Trench #1; covered with approximately eight to ten inches of soil, it "appeared to be resting on natural clay."[8] "The soil above and handy to the hammerhead," he notes,

To ditto [Francis Perry] cuttinte ye Anuil blocke.

Lynn Iron Works Collection. Baker Library Historical Collections, Harvard Business School, p. 115.

6.2 The first anvil base block at the refinery forge site. (Photograph 189 by Richard Merrill, August 1950.)

"was somewhat loamy etc. for a 5" depth. Then mostly sandy-clay. Some metal waste pieces were evident here, extending to a level corresponding with the under surface of the hammerhead. The surface below the hammer head appears to be natural clay." [9] A chemical analysis of metal samples from the hammerhead indicated a total carbon content of 2.98 percent. This finding, along with spectrographic and microscopic analysis, according to the materials scientists who examined the samples, "clearly indicates the specimens were of cast iron."[10] Robbins also records that "at the broad, southerly end of the hammerhead a 4 ¾" length of pig bar was found."[11]

With the approval of the Central Street detour in September 1950, Robbins and his crew moved from the Bridge Street area to excavate along Central Street in search of the furnace waterwheel. During November and December, they briefly moved back to the excavations along Bridge Street, where they located several new features, including an upright that might have supported the hammer beam, a stone foundation north of the retaining wall (that proved to be a later, post-ironworks structure), and possible evidence of the waterwheel pit and watercourse that powered the refinery.[12] Writing about the stratigraphic profile of the possible watercourse, Robbins comments that

> in this watercourse there was about 42" of metal waste, etc. material, the top several inches being of soil fill. Below the base of the metal waste was encountered 28" of sand and slay. This soil appeared to be natural when first examined. At the bottom of this fill the stone floor was located. This evidence would indicate that after the cessation of iron works operations this area was exposed to the washings from storms etc. This accounting for the 28" of sand and clay found upon the stone floor. Being washed in from the natural soils which abutted the area, particularly from the knoll which abutted the northerly end of the stone evidence, this soil would build up in time, and convey a false impression of natural soil. This would also account for the fact that but little iron works evidence was noted in this sand and clay fill. As for the deep deposit of metal waste material etc. found above the sand and clay, this appears to have been a concerted effort by some later generation to clean up the area and fill in the low spots with refuse left by the iron works activity. Possibly this was done at a period when a new manufacturing development was being set up.[13]

The following day, Robbins reports that while the description of the disturbed soil likely indicated a watercourse, additional digging suggested that it was not a wheel pit as he had hoped.[14]

Shortly after finding these new and tantalizing features, Robbins was informed by the American Iron and Steel Institute's lawyer that the area would have to be backfilled immediately because it was within the forty-foot Bridge Street right-of-way and permission had not been obtained to work in the right-of-way.

The hammer generally used in Britain from the sixteenth to the early eighteenth century was a helve- or tilt-hammer. The helve or shaft was about 8 or 9 feet long and 30 or 40 inches in circumference. It was made of stout wood and clamped at intervals with iron hoops. The hammer head through which the shaft passed was made of cast iron. At the opposite extremity the shaft passed through, and was fastened with wedges into a cast-iron collar called the hurst. The pivots of the hurst constituted an axis for the hammer, and worked horizontally between the limbs of the support.

H. R. Schubert, *History of the British Iron and Steel Industry from c. 450 B.C. to A.D. 1775,* pp. 280-281.

6.3 The discovery of the refinery hammer. (Photograph 58B from the Roland W. Robbins slide collection, 1950, Saugus Iron Works. Courtesy The Thoreau Society® Collections at the Thoreau Institute at Walden Woods.)

Due to copyright restrictions, this image is not available in the on-line version of this publication.

Robbins lamented, "[A]ll this work for naught! Another day at the site . . . and we would have plotted [the] details [that had been uncovered]."[15] Before the area was backfilled and fenced, however, Robbins and his crew managed to sketch the evidence and have Richard Merrill take photographs. He notes that architect Harrison "Schock plotted the anvil base, hammer beam anchorage and upright sites making possible their layout and relation to one another."[16] Robbins also relates that

> before filling in the low excavations at northerly end of possible water course, just east of sites of uprights, I drove a stake and a rod into the westerly side of the possible water course marking the site of a large metal waste clinker found there. Whether or not metal waste clinker speaks for the bed of a forge etc. fire, or a development created by 3 centuries of oxidation, there is no way of knowing at the moment.[17]

Robbins labeled this possible eastern watercourse the second waterway crossing Bridge Street and assumed it was related to the refinery forge.

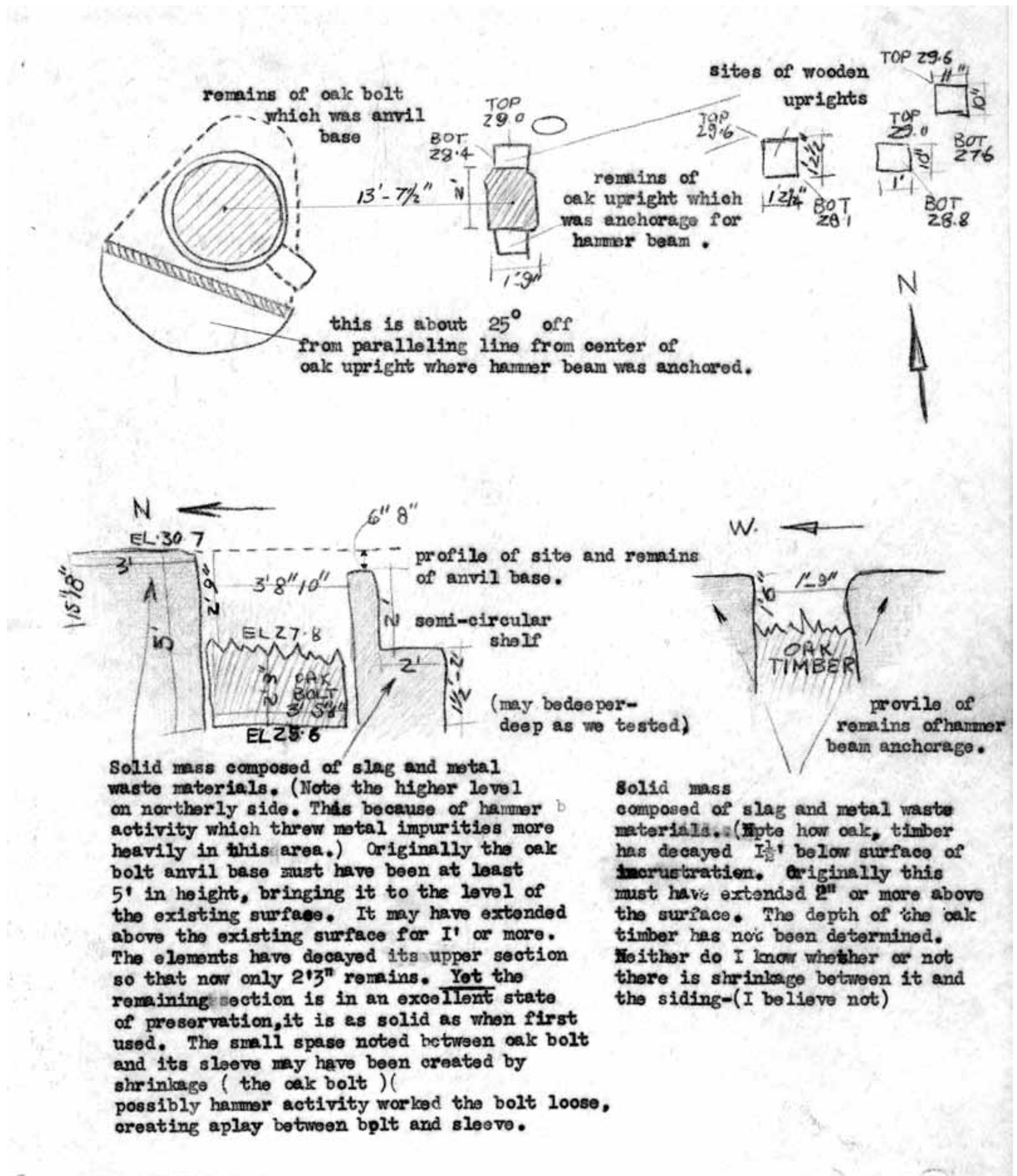
With the refinery forge site temporarily off limits, Robbins and crew moved their excavation work back to the Central Street area. For much of early 1951, they focused on the identification and excavation of the furnace watercourse and waterwheel pit buried beneath Central Street. Subsequently they uncovered evidence of several waterwheels, a power hammer, and a forge, likely part of the Joseph Jenks operation (see Chapter 7), on the furnace tailrace.

In April and May 1951, Robbins was able to again turn his attention to the refinery forge site, focusing on the identification of possible watercourses to the refinery.[18] His excavations on the furnace watercourse and waterwheel pit indicated to him that the refinery watercourse likely was supplied by the same source. Working along the north edge of the ironworks property, the crew dug several test trenches in search of the refinery watercourse. A test trench "to the north side of Chesley's driveway" provided the evidence that Robbins sought: "we found the course. Much iron waste material was found in the disturbed area."[19] His profile sketch of the watercourse includes the notation that the fill contained "large chunks of metal waste from refinery activity, also some stones and charcoal."[20]

In July, Robbins resumed testing near the refinery site and positively identified a second watercourse that crossed Bridge Street approximately fifty feet east of the first watercourse.[21] Subsequent work along this watercourse and below the refinery site identified several large timbers that were interpreted as the wharf or dock area for the ironworks. Robbins and his crew focused their work on the wharf area for the next several months.

The operation in the English finery proceeded in several stages; melting down the pig, refining proper, and lastly working the refined iron into a lump or ball generally termed a "bloom." The whole process of melting, refining and balling took one hour. Success was judged by sounding the metallic mass with a finger.

H. R. Schubert, *History of the British Iron and Steel Industry from c. 450 B.C. to A.D. 1775*, p. 285.



6.4 **Sketch of the first anvil base and associated upright posts from Robbins' daily log, December 15, 1950.**

In early December, Robbins returned to the Bridge Street area to work on the refinery forge setup. He had the crew excavate test trenches to the east of the hammer wheel pit and begin excavation of the site of the anvil base. Robbins notes that they were “removing fill from the refinery hammer wheel pit in Bridge Street.” He drew a cross-section sketch of the “most southerly evidence of waterway to hammer waterwheel,” showing

> its width [7’ 3”] and elevation [37’]. Originally it was sheathed in this section. This is based on the vertical line between natural, stratified sands and disturbed soils. This sheathing which probably extended to [the] flume . . . [supplying the] hammer waterwheel may have started in this area.[22]

Robbins records in his daily log that he shot 16-millimeter film of the excavation of the hammer waterwheel pit and the anvil base in mid-December.[23] Snow and ice necessitated that Robbins have his men erect a “structure over [the] hammer wheel pit . . . so that the area can be heated, its frost thawed and excavations there continued.”[24]

In early January, his crew was excavating “what may be a second wheel pit just southern of above mentioned pit.”[25] This would have been a second wheel pit on the first or western watercourse across Bridge Street. Robbins reports that they

> found a great deal of Iron works activity below the timbers found at second wheel pit. Many nails, broken casting pieces, wedges, metal pieces, etc., found amid metal waste, stones, etc. About 3 ½’ below the top of the timber evidence a 26” section of pig found, handy by a 6” point of pig found.[26]

Robbins and his crew also resumed work on the Jenks forge site (see Chapter 7), located on the furnace tailrace.[27] Robbins notes that

> Hartley is amazed with developments here. Believes this may be the site of the *Forge the Iron Works* are known to have had. If so, then Jenks concessions must be south of this. While digging about the end of the wheel, Neal found a piece of leather. It had no stitching marks but it is similar to the abundance of leather found southerly of this site. Most of the evidence has been located in this area.[28]

While the discoveries in the Jenks area were indeed amazing and absorbed much of Robbins’ energy and attention, he also had his men continue to work on the second waterway crossing Bridge Street in the vicinity of the refinery forge.[29]

The remainder of the process (following the finery operation) was conducted in the chafery with intermittent hammering. As the hardest and most carbonaceous particles were still in the iron after it had left the finery, a higher temperature was required for sweating them out. The temperature was generated by a stronger blast produced by bellows larger than those at the finery. The heated iron was consolidated by the power hammer, and forged into the final shape of the bar. . . .

H. R. Schubert, *History of the British Iron and Steel Industry from c. 450 B.C. to A.D. 1775*, p. 287.

6.5 Soil profile of the first refinery waterway. (Photograph 746 from the Roland W. Robbins slide collection, August 1951, Saugus Iron Works. Courtesy The Thoreau Society® Collections at the Thoreau Institute at Walden Woods.)

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In April 1952, after several months of focusing primarily on the Jenk's forge area, Robbins received "a copy of Bent's letter to Attwill where he shows concern for 'forge-finery, slitting mill and wharf' restoration, not Jenk's area."[30] Although Robbins began to slowly refocus his work on the Bridge Street site, it wasn't until June that he seriously began to reexamine the refinery forge site along Bridge Street. His log records that he "had men run trenches between 2 waterways crossing Bridge Street, near possible forge site, to determine if these soils are all natural."[31] Robbins' work in this area was pushed along by the architects who were engaged in designing the reconstructed refinery forge building.[32] Work in the refinery area focused on obtaining details of the features discovered to date, as well as more systematically examining the area between the two refinery waterways. For example, Robbins' investigation of the first wheel pit on the first waterway crossing Bridge Street showed "that its overall dimensions [were] . . . about 12' side by 30' in length."[33] Likewise, he notes that additional work around the anvil base "uncovered another beam running beneath base for refinery hammer. This was at a right angle to beam already located."[34] The following day, the crew "removed [a] wooden mallet from beneath forge anvil base."[35]

In early July, the Reconstruction Committee held a series of meetings to "work out [an] acceptable plan for forge, chaffery and two refineries."[36] Although Robbins notes that all were in agreement about the plans, he comments that he hoped "future excavations westerly and south-easterly of second waterway, as well as final work on upper Bridge St. west of first wheel pit, will not prove to have found us having made a premature decision concerning the two refineries and chaffery layout."[37]

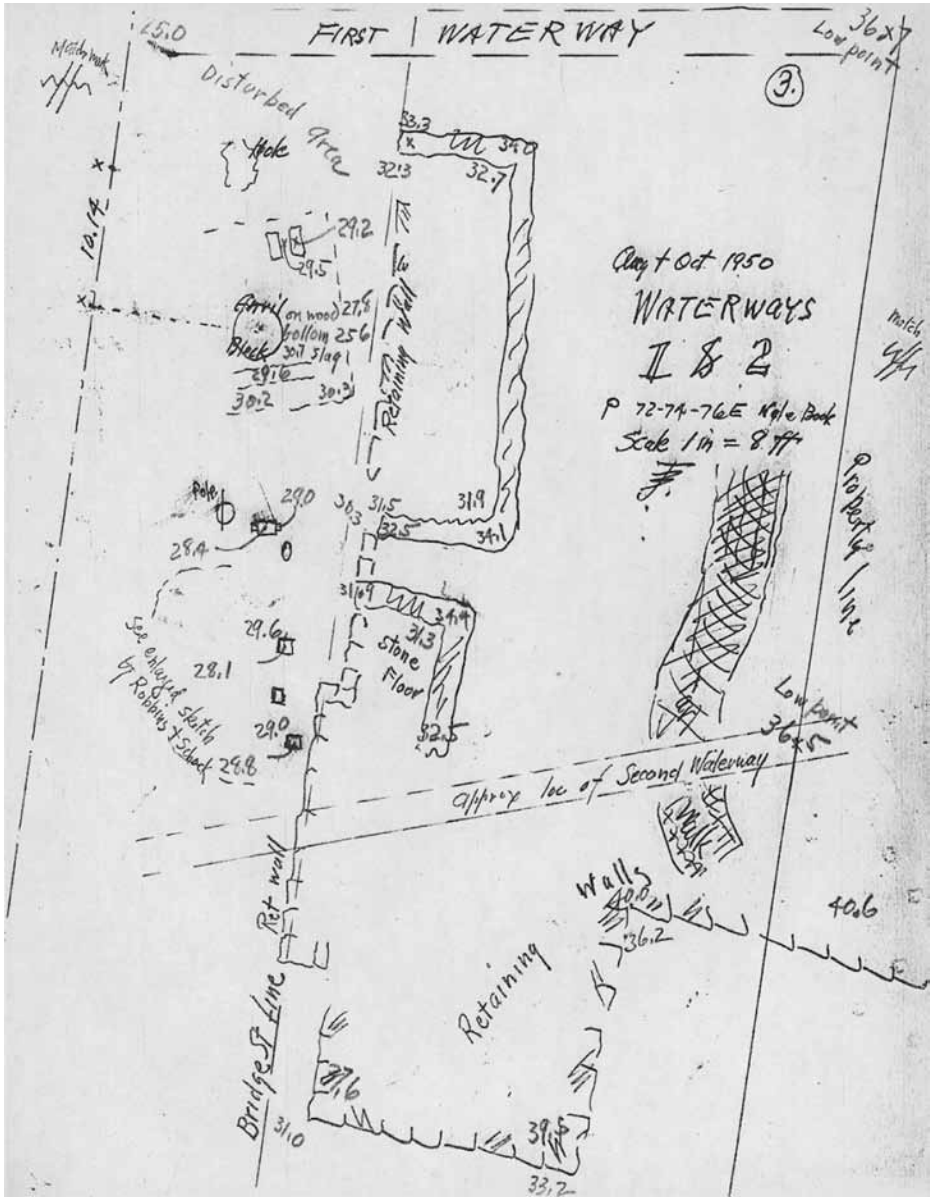
As if in answer to his concerns regarding the refinery forge layout, Robbins and his crew discovered a second anvil base at the site of the forge operation in late July 1952.[38] "It appears," Robbins writes, "to have a 42" diameter, similar in width with the other finery anvil base. This was found handy to the southwest corner of the hutch of the wheel pit of the second waterway crossing Bridge Street."[39] Robbins reported the find to Bent, who replied, "that's right where it should be."[40] Robbins records the details of this new find in his daily log, commenting that the second anvil base was

> 30' 7" from center of the first forge anvil base . . . . Along the northwest side of the second anvil base was found 8" of Iron Works activity above the natural stratified sands. This Iron Works activity appears to be an accumulation from activity here. This area originally had been cut to the sub-soils when being developed. This anvil base compares favorably with the other forge anvil base in diameter. Its northerly-southerly diameter is 43"; its easterly-westerly diameter is 46." We have evidence suggesting this base to be resting upon cross timbers similar to the members on which the first anvil base was placed. However, these timbers do not seem to be as substantial in size as the others. This anvil base did not have packed about it the thick band of slag and iron impurities found about and beneath the first anvil base. At first, it appeared that a hole

Work is to proceed as rapidly as possible on the single-hammer layout based on Scheme "H", SK 324. . . . Robbins is to clarify all evidence in the forge area and attempt to find new pertinent evidence. It was agreed that in putting in the concrete retaining and foundation work the south end of the Forge would be left open as long as possible for further exploration.

Mr. Bent emphasized that we must proceed with construction now even though it may later be proved that we have made mistakes and have not interpreted the evidence properly.

Minutes, Meeting at Saugus, August 28, 1952.



6.6 Field sketch of refinery waterways 1 & 2 by John Bradford, August and October 1950.

> had been dug in the clay, the base sills set in place, with the second anvil base placed upon them. Then the clays that had been removed during this work were used for back fill. However, a closer inspection of these clays notes slag evidence and possibly other Iron Works impurities. This evidence is nowhere nearly as extensive as the evidence found about the first anvil base. It does prove at least furnace production had been conducted to make possible slag in the back fill used here.[41]

Although most of the team members were initially elated by the discovery of the second anvil base, its presence became problematic when the architects sought to integrate it into the plans for the reconstructed refinery forge building. At a meeting on August 6, according to Robbins, "we spent the morning going over forge layout and trying to determine some manner whereby we could incorporate 2 hammers, 2 fineries, and a chaffery within the limited space we have to work with. Didn't arrive at any definite conclusion."[42] In a follow-up discussion with historian Hartley, Robbins notes Hartley had "not been able to figure out any way whereby two hammers, two fineries and a chaffery could be set up in the limitations of the forge area we now have."[43] Hartley, Robbins continues, is "in accord with its north, east and west bounds and does not believe that the actual working area would have extended southerly to any appreciable distance beyond the southerly end of the hutch area on the second waterway crossing Bridge St."[44] Robbins notes further that "I still believe this anvil base was one of a two hammer setup at the forge. My reasons for this belief are based on the fact that it is located ***just where it should be located for a two hammer setup!***"[45] At an August 14 meeting, Robbins reports "the group, ***excepting myself***, decided that the forge layout had but *one* hammer. They talked themselves into believing that the original hammer site was the second anvil base found recently. They thought that this was discarded, for some unknown reason and was replaced with the first anvil site, found in 1950."[46]

Work on the refinery forge site in late August provided further detail on the construction of the second anvil base. Robbins records that the work

> revealed the outline of the original base sills, which were very large being 18" in width. This work also showed where the bottom of the anvil base itself had a tenon which fitted a mortised area where the two base sills were interlocked. This method prevented a slipping or skidding of the base from position where placed. About an inch above the bottom of the anvil base a metal band encircled it. Apparently seepage carried oxidation from the surface about the anvil base down and about the sides of the anvil block itself as well as about the base sills on which the block was seated. This oxidation impregnated the soils around the base sills and anvil base creating a form which gave us the true outline and original size of the evidence.[47]

I am, of course, disturbed about the discovery of a second anvil foundation but on account of the room within the building, I doubt very much if both hammers were operated at the same time. It rather appeals to me to think of one of the hammers having been abandoned and that the large hammer was, at least in the later years, the one operable unit within the plant. Certainly there is ample precedent for assuming that this was the case particularly as I believe there is some documentary evidence to think that later on a new hammer was installed within the operation.

Quincy Bent to J. Sanger Attwill, August 26, 1952.

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6.7 The second anvil base block at the refinery forge site. (Photograph 1430 from the Roland W. Robbins slide collection, April 1952, Saugus Iron Works. Courtesy The Thoreau Society® Collections at the Thoreau Institute at Walden Woods.)

Although the new discovery clearly added to the interpretive difficulties of the refinery forge site, Quincy Bent instructed the architects to "go ahead with the building work on the refinery and on chaffery starting with the one hammer layout . . . . It is true that Robbins' discoveries subsequently made, may make some changes but I think we are fairly safe as far as the building is concerned and the one hammer installation with the chaffery division."[48]

At an August 28th meeting, the decision was approved to "proceed as rapidly as possible on the single-hammer layout . . . ."[49] This decision was bolstered by a mid-September letter from English ironworks expert H. R. Schubert. The second anvil, he argued, was typically used for making and repairing by hand the various tools and implements needed for finery and chaffery operations.[50]

I was pleased about the discovery of the second anvil base because it fits in very well with the plan of the forges we all approved on July 7th, & the plan I received from Mr. Fitch last week confirms it. Just near the fineries—where it should be! It is quite in keeping with many 17th-century inventories in which 2 anvils are referred to. Such a second anvil however most certainly does not require a second power hammer.

H. R. Schubert to E. Neal Hartley, September 10, 1952.

Architect Andrew Hepburn replied to Schubert in late September regarding the second anvil feature, noting that Robbins had subsequently "found the imprint of a very large upright post about 14 feet west of the new anvil base. This upright bears the same relation to this base as does a similar upright to the anvil base found earlier, and they both would appear to have been end supports for large overhead 'dromes' for power hammers."[51]

Hepburn admitted that everyone agreed that they "were faced with the fact that there had been two power hammers in the forge area at Saugus."[52] After further discussion, the group decided that the southwest hammer must have been built first and then abandoned ca. 1652 when a new hammer was built in the northwest corner of the structure.[53] "The best single reason for deciding that one of them must have been abandoned in favor of the other," wrote Hepburn, "is the fact that the physical limitations in the size of the forge area and the arrangement of the water courses and wheel pits prevent us from working out a two-hammer layout in which two fineries and a chaffery are also included and arranged in a manner satisfactory to us all."[54] Schubert was quick to adopt this new interpretation, writing that "I heard from the architects & I am completely agreeing to the view that one power hammer was abandoned in favour of a new one placed at a different spot . . . ."[55]

In September, Robbins notes that he and his crew "continued excavations at forge layout, taking the existing surface down to determine whether or not sites of any uprights, fulcrum, etc., still exist." He hoped to discover evidence that might support the architect's and historian's theory that the two anvils never operated at the same time.[56] Excavation around the first anvil base revealed that

> the base did not have a tenon on it, similar to what was found on bottom of 2nd anvil block at forge. Nor did it have any metal bands about it . . . . Beneath the block itself was . . . about 2-1/2" of metal materials, as well as pieces of metal. This evidence

6.8 The second anvil base sills and metal band after block's removal. (Photograph 1888 from the Roland W. Robbins slide collection, December 1952, Saugus Iron Works. Courtesy The Thoreau Society® Collections at the Thoreau Institute at Walden Woods.)

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> could not have been accumulation of seepage action because of the metal pieces being found here. The 2-1/2" thick incrustation was noted below the outer diameter of the block . . . . At the junction of the base sills . . . [the incrustation] was about 11-1/2" thick, making its way to the bottom of the base sills. . . . I noted that blue clay was used for fill between the base sills, coming to their surface. The slag and other I.W. impurities being seated upon the clay and beams, as well as the metal materials below the anvil block.[57]

In mid-September, Robbins and architect Conover Fitch further examined the clay soils removed from below the base sills of the first anvil base. Robbins reasoned that

> . . . they may have dug out several inches of the natural yellow clays where the large base sills were to be seated. Then they used blue clay (which was foreign to this area) with considerable slag and other I.W. impurities for a fill on which to place the base sills. Inasmuch as they used blue clay for packing between the base sills and for footing below the base sills, it suggests that they found the blue clays more suitable for the job than the natural yellow clays in this area. Actually the area is made up mostly of yellow clay. They may have found from experience that the blue clay had greater binding qualities than yellow clay. In any event Fitch and I were particularly concerned about the I.W. materials found in the soils on which the base sills rested. To find slag there proves that furnace activity took place before this work was done. But had forge activity taken place before these sills were set in place? We broke into a piece of the soils on which the junction of the two beams rested. The surface of these soils had considerable slag. About 3" below the surface, Fitch found a piece embedded in clay which was quite heavy and appeared to be iron. I had it buffed down and it proved to be iron. We do not know whether or not it is cast iron or wrought iron. If an analysis shows it to be wrought iron conforming with the wrought iron pieces we know to have been made there, then we will have evidence that suggests that forge activity had taken place before this anvil base was erected. He found other evidence that seemed to have the qualities of impurities from forge activity. This evidence also was found about 3" below the surface on which the base sill of the anvil rested, and had considerable blue clay about them. Buffing these pieces revealed particles of iron amid them. If this proves to be impurities from forge activity, and later examinations of the soils found below the base sills of the 1st anvil base supplement it, then we could assume that *forge activity took place before this anvil was set up.*[58]

By cutting one Anuell block. By Sawing one tree for hamer beame.

Lynn Iron Works Collection. Baker Library Historical Collections, Harvard Business School, p. 151.

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6.9 The "fulcrum" posthole related to the second anvil base. (Photograph 1712 from the Roland W. Robbins slide collection, September 1952, Saugus Iron Works. Courtesy The Thoreau Society® Collections at the Thoreau Institute at Walden Woods.)

Throughout late October and November, Robbins and his crew worked on clarifying the course of the third waterway crossing Bridge Street, in what was suspected to be the area of the slitting mill.[59] In early December, with work on the refinery forge area nearing completion, Robbins began to explore the area east of the refinery forge site and west of the third watercourse. He notes that he wanted to examine that area by trenching along Bridge Street from the third waterway to the bridge before conducting more intensive work.[60] Robbins and Fitch had speculated that the third watercourse might have powered the as yet unidentified slitting mill.[61]

In mid-December, Robbins followed up on his findings regarding the soils below the first anvil base by examining "the soils on which the base sills below the 2nd anvil base rested."[62] He details this work in his daily log for December 12:

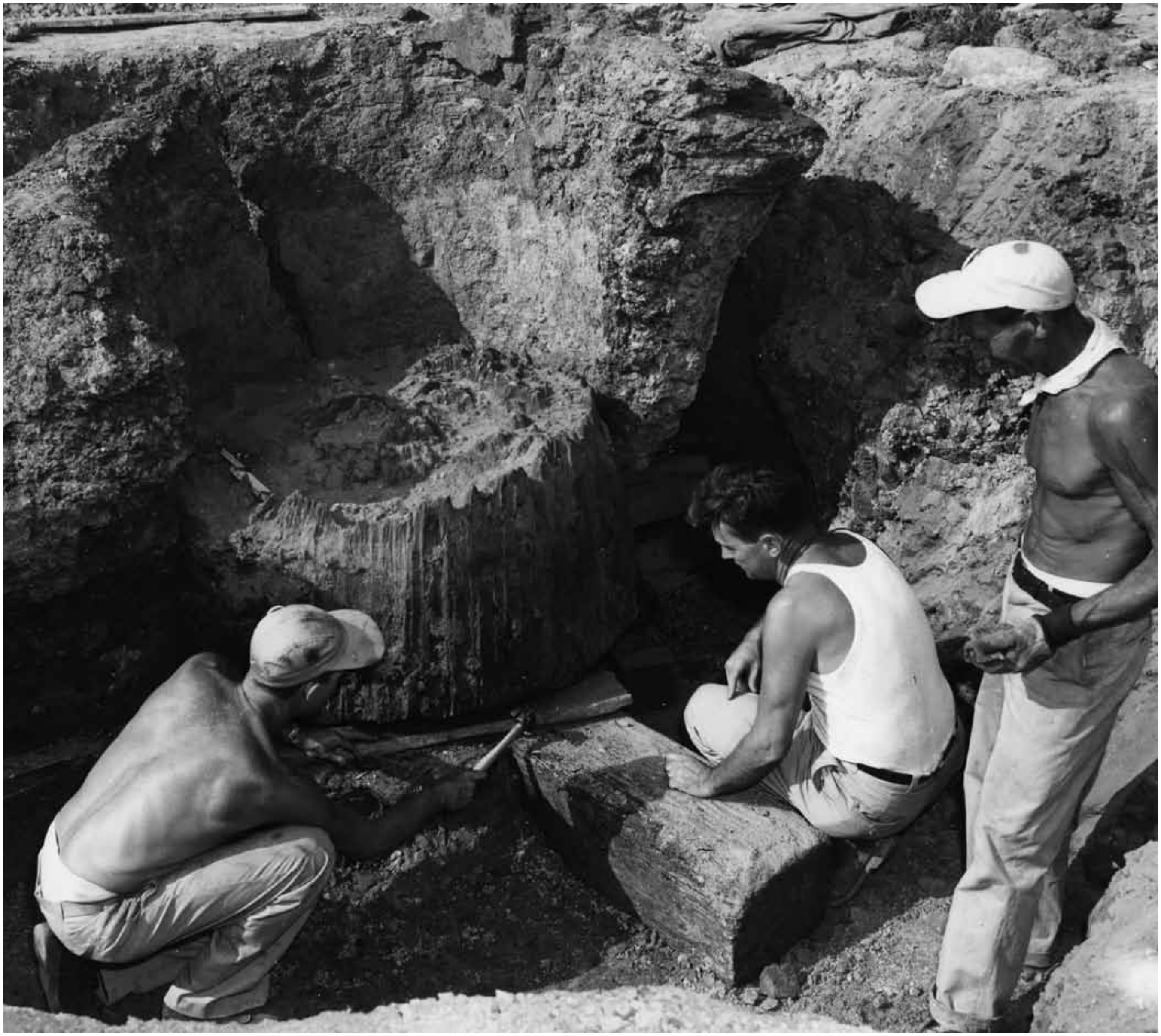
> The soils were of a yellow clay. Yet, the surface on which the base sills of the 1st anvil at the forge rested was a blue clay fill. This blue clay replacing the natural yellow clays that predominated in that area. (See notes for September 11th and 16th.) Why were blue clays not used beneath the base sills of the 2nd anvil block? It would be difficult to determine whether the clays below the base sills of the 2nd anvil block were not disturbed, or were a back fill. I have just examined these clays, they suggest that they are of a natural nature, only their surface having been disturbed slightly. Is it possible that the 2nd anvil site found at the forge was the original forge anvil? When it was set up they utilized the natural yellow clays below and from this experience they found that the yellow were not as beneficial as the blue clays for stabilizing their anvil block. As such, assuming this to be the case, when they got around to building a 2nd anvil at the forge, they remedied this situation by replacing the natural yellow clays with a blue clay fill.[63]

Robbins goes on to note that these findings provide some "interesting speculation" and wonders what the different clays beneath the anvil bases might indicate.

> *I do find* that directly below the junction of the base sills of the 2nd anvil base, ***slag!*** It appears as though the slag was sprinkled about on the surface where the base sills were to be seated. Then the sills were set in place. This slag evidence does not penetrate to a depth exceeding an inch to an inch and one half, most of it being not more than an inch. (See relics for this day, for this slag evidence.) An examination of the surface below the base sills of this 2nd anvil base, while producing slag evidence, produces no evidence of impurities from forge activity or possible wrought iron specimens, such as was found in the soils below the junction to the base sills at the 1st

The water tapped from a river some distance away was first led in a leat to a pond where it was stored. From the pond it ran to the wheel through a channel called the head-race. The channel, either in its whole length or only at the end approaching the wheel, was a wooden trough with a sluice at one end which was operated by a cog on a shaft turned by a handle. If the sluice is down, the overflow of water runs through a shoot at the side of the trough above the sluice. If the sluice is raised the overflow stops and the water, discharged from the bottom of the sluice to the top of the wheel, keeps it turning. By the quantity of water allowed to flow from the sluice the speed of the wheel can be regulated. The water falls into the wheel pit whence it is carried away by a channel called the tail-race that joins the river at a lower level.

H. R. Schubert, *History of the British Iron and Steel Industry from c. 450 B.C. to A.D. 1775*, pp. 134-135.



6.10 Removal of the first anvil base block at the refinery forge site. Note shim between block and sills. (Photograph 725 by Richard Merrill, September 1952.)

anvil site. This could be quite revealing, first, if an analysis of the slags found beneath the base sills of both of the anvils excavated at the forge site proves this slag to be the impurities from smelting activity at the Saugus furnace, it would show that this forge activity didn't get set up until sometime after the furnace had begun production. It would also suggest that the 2nd anvil base probably was the 1st to be erected at the forge. I base this on the fact that no evidence of impurities from forge activity or wrought iron specimens were found in the fill below the base sills of the 2nd anvil block. Inasmuch as both slag and what appears to be impurities from forge activity, as well as pieces of wrought iron, were found below the base sills of 1st anvil block at the forge, it suggests that this anvil block was set up not only after the Saugus furnace began operations but also after some forge activity had taken place. If analysis on the impurities and wrought iron pieces found below the base sills of the forge 1st anvil block compared favorably with the impurities and wrought iron pieces we know to be from the forge area, and forge activity, we could assume that the 1st anvil was set up after both furnace and some forge activity had gotten underway here at Saugus. In checking the back fill soils which went about the base sills of the forge 2nd anvil block after they had been set in place, I noted that this back fill appeared to be some of the clay that had been dug from this area during this work. These back fill clays, beneath and on the north-westerly section of the anvil block, were about 13" in depth. Slag evidence here penetrated to a depth of about 3". I also noticed that this 13" of back fill appeared to have been thrown onto stratified natural clay. This evidence again suggests that this area was dug only to the depth desired for the seating of the base sills. Here again no evidence of forge impurities or wrought iron particles was found in any of this fill. I have no accurate measurement of the back fill that surrounded the anvil block itself. However, the clay back fill contained a bit of slag evidence. This evidence was quite remote compared to the slag and other impurities used in the clay for the back fill around the 1st anvil base. I don't know whether or not this back fill may have contained impurities from forge production, I rather doubt it. The back fill about the sides of the anvil block at its bottom didn't contain slag extending from it more than 4½". This slag was quite scattered. I also noticed that back fill about the base sills of the 2nd anvil block, while made up of clays, presumably the clays removed during these excavations, contained evidence of slag not throughout them but only in the clay that packed the sills themselves. In other words, particles of slag were found in the fill that packed the sides of the sills to a depth of only 3". Beyond that, I noted only clay soils. It appears as though a sprinkling of slag took place where the base sills were seated. Then a mixture of clay with some slag was daubed to the sides of the base sills to a thickness of about 3". The fill between the base sills beyond this 3" packing was com-

The clay fill found here, as well as the deep clay fill found directly to the south of the forge, where it is three or more feet in depth, is the type of natural sub-soils found at the site of the forge building. I believe that when the slope was being leveled for the forge building the clay sub-soils were used to elevate the low natural slope to the south of the forge, as well as the area southeasterly of the forge where we find the abundant evidence of iron works activity. None of this clay fill, nor the natural loam line below it contains any evidence of iron works activity.

Roland W. Robbins to E. Neal Hartley, May 4, 1953.

6.11 Aerial view of the refinery forge excavation; the water wheel pits are at the far right and left of the photo. (Photograph 1762 from the Roland W. Robbins slide collection, September 1952, Saugus Iron Works. Courtesy The Thoreau Society® Collections at the Thoreau Institute at Walden Woods.)

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> prised of what appears to be the natural yellow clays which were disturbed at a time this area was being prepared for the anvil block and its base sills.[64]

Although Robbins and crew continued to finalize the excavation of the refinery forge as December progressed, most of their effort was redirected toward the search for the slitting mill in the area east of the refinery forge and the wharf or dock site to the south. In mid-December, Robbins noted that he and Fitch "agreed that extensive digging should be done now at 3rd water way crossing Bridge St, to determine the possibilities of wheel pits having been in that area."[65] Robbins and Fitch examined a test trench in this area in late December; Robbins reports that Fitch "thinks the chances are good that the slitting mill was just east of the forge."[66]

Summary of Refinery Forge Features

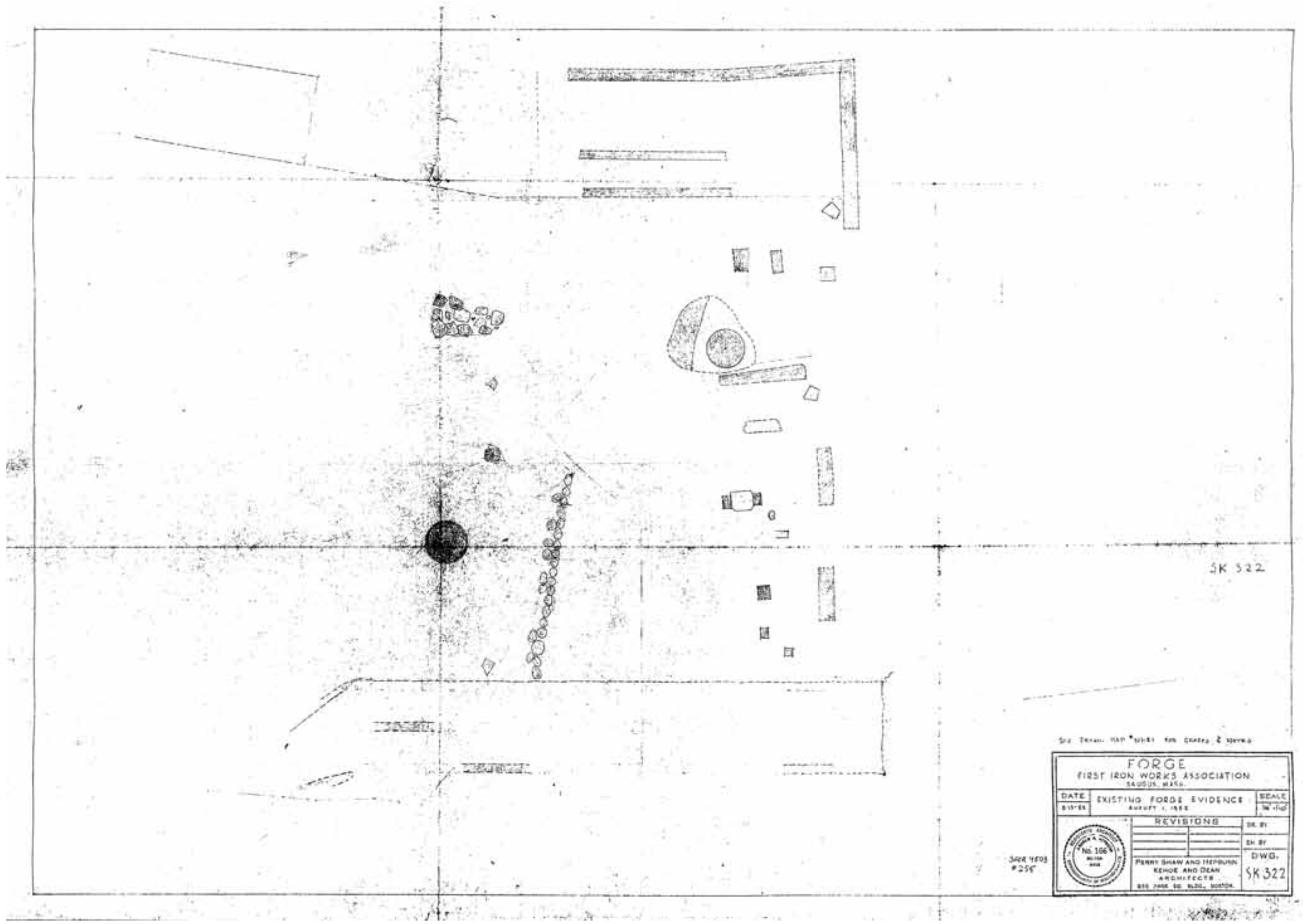
The final list of features associated with the refinery forge building is impressive and includes the two watercourses and associated wheel pits, the two large anvil bases, a series of posts or "uprights," and two stone features, one west of the second anvil base at the southeast corner of the building and the other a linear feature running east-west and located just north of the second anvil base.

Robbins identified two watercourses or waterways that powered the refinery forge operation. Trenching uncovered clear stratigraphic evidence for linear features that were approximately seven feet wide and shaped like a canal for carrying water. He found evidence of waterwheel pits on both the first and second waterway crossing Bridge Street; the second waterway was approximately fifty feet east of the first waterway, so that the two waterways essentially framed the west and east sides of the refinery forge building. The first or western waterway had two wheel pits, while the second or eastern waterway had only one. Evidence for the upper wheel pit on the first waterway included sections of wooden sills and impressions of sills that outlined the pit; the lower pit was identified primarily based on soils evidence from a large wheel pit-like feature.[67] Like the upper wheel pit on the first waterway, the wheel pit on the second waterway was identified through soils evidence, as well as the remains of several wooden sill fragments for the wheel pit.[68] Although both wheel pits contained fill that held ironworks artifacts and later materials, neither contained remnants of the waterwheels themselves.

The first anvil base was identified in the northwestern corner of the forge building, about twenty feet east of the first wheel pit on the "1st waterway" crossing Bridge Street. This base was a large section of an oak tree, measuring approximately three feet, six inches in diameter, that sat upon two large oak beams. These beams were joined with a lap joint and crossed at a ninety-degree angle. A hard shell of metal impurities, waste from the hammer process, encased the anvil base.

In the forge 2 pair of smyths fondry bellows, 30 li; 1 pair chafery belloes, 20 li; 7 Anville, 38 hamers, 10 hursts, all waying about 275 C. at 10s. per C, 137 li.; plates at all the 3 hearths fitted, way about 60C. at 6 li.; 8 workeing furgins & ringers, 1C. waight, 1 li. 8s.; 1 Turne sow Ringer, 13s.; 2 Iron shovels, 16d.; 2 Cole wheele barroes, -; the beame and scales, 2 li. . . .

"An Inventory of the stock and tools at the forge at Hammersmith taken Dec. 20, 1650," ***Records and Files of the Quarterly Court of Essex County, Massachusetts***, Vol. 1, p. 294.



6.12 Plan of existing forge evidence by Perry, Shaw, and Hepburn, Kehoe and Dean, August 1, 1952.

Archeological assistant Stephen Whittlesey counted the tree rings of this first anvil base to determine its approximately age. He found 324 actual growth rings and estimated that there were another 10 to 12 rings in center. Thus, he speculated, when the tree was cut in 1647, it was approximately 336 years old.[69] Forester Jack Lambert of the Massachusetts Division of Forestry subsequently examined the base and counted 285 discernible rings and an estimated 10 additional rings between last identifiable ring and pith of the tree, "giving it an overall age of about 295 years."[70]

Approximately 13 feet, 7.5 inches east of the anvil base lay the remains of an intact wooden upright measuring approximately one foot, nine inches by two feet and identified on plans drawn in December 1950 as the "hammer beam anchorage." Another eight feet, four inches east of this feature were a series of postholes, or "sites of upright foundations" as noted in the 1950 plan, that were spaced several feet apart. These postholes ranged in size from one foot square to one foot, two and a half inches square.[71] A 1952 drawing of the same area included several additional postholes that had subsequently been identified just north of the larger posts; these measured approximately six inches square.[72] Only two of these posts appear on a slightly earlier drawing of the forge evidence dated August 13, 1952.[73] The function of these smaller posts was never firmly established.

The second anvil base feature was identified in the southeastern corner of the forge building, just west of the wheel pit on the second waterway and about thirty feet southeast of the first anvil base feature.[74] Robbins notes that along the northwest side of the feature was an eight-inch deposit of "Iron Works activity above the natural stratified sands."[75] The base was a section of oak tree trunk measuring between 43 and 46 inches in diameter. Like the first anvil base, this one rested on large base sills, approximately 18 inches in width, which were crossed at a ninety degree angle. Robbins notes that the second anvil base had a tenon in the bottom that locked it into the point at which the sills lapped over each other.[76] This anvil base was not encased in the same thick shell of metallic impurities from the hammer operation found at the first anvil base; however, subsequent investigations did identify some metallic waste and impurities surrounding the second anvil base. Unlike the first anvil base, the second had a metal band, approximately two inches wide, running around the base near its bottom.

Several other small post or posthole features were found in the vicinity of the second anvil base. In particular, a large posthole was identified about 12 feet west of the base that was thought to be the post for the "fulcrum" for the hammer; this post would have been similar in size and location to the intact wooden post identified as the "hammer beam anchorage" east of the first anvil base.[77] Just west of the posthole was a "pile of stone" measuring about five by two feet; this feature was not identified as to possible function. To the north of the second anvil base, a narrow, linear feature of stones ran from the edge of the wheel pit on the second waterway to the west for approximately 20 feet.[78] This possible wall fea-

A second anvil was indispensable for making and repairing the various implements required for fineries and chafery. It is frequently termed "an anvil to mend the tools upon." The implements were made by the finers and hammermen themselves, not to forget the iron bars such as morris bars which required frequent restitution and all the smaller pieces of iron laid into the chimneys to strengthen the structure. Implements used at the furnace such as the various kinds of ringers, also were made at the forge.

H. R. Schubert to Neal Hartley, September 15, 1952.

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6.13 The first wheel pit at the refinery forge excavation. (Photograph 1697 from the Roland W. Robbins slide collection, Saugus Iron Works. August 1952. Courtesy The Thoreau Society® Collections at the Thoreau Institute at Walden Woods.)

ture, two stones wide in some places, appeared to divide the area between the second anvil base and the post features in the northeastern corner of the building.

Finally, the excavation of the forge area revealed the impressions of several possible wooden sill elements along the northern edge of the building. These elements, along with the waterwheel pits framing the east and west sides, helped to determine the approximate footprint of the refinery forge building.

The Slitting Mill

As noted above, excavation of the area thought to contain the slitting mill was begun in October 1952, as Robbins and crew worked east from the refinery forge site and along the Bridge Street right-of-way.[79] Throughout November and December, Robbins focused on identifying the slitting mill site and on excavating the wharf or dock area to the south.[80] In early December 1952, he noted that he "did a bit of work in the slitting mill area. [I] outlined the remains of the charcoal bed in the northerly area of possible slitting mill site."[81] He also excavated a test trench "through to the side of the middle stone well in the slitting mill area to determine the possible period of this well."[82] In mid-December, Robbins and Fitch spent several days going "over details of slitting mill and forge layouts." Robbins notes that they "agreed that extensive digging should be done now at 3rd water way crossing Bridge St, to determine the possibilities of wheel pits having been in that area."[83] A little later in the month, excavations along the third waterway caused Robbins to speculate on the size of the waterwheel and pit, noting the

> possibility of an 18' overshot wheel at the slitting mill area. I told him [Fitch] that if we are to accept what appears to be wheel pits in the 3rd waterway on lower Bridge Street for possible slitting mill activity, then I believe its wheel or wheels may have had a diameter of nearly 18'. This is based on the known elevations of the bottom of the waterway, the bottom of the water basin in Chesley's backyard and the minimum elevation for a working surface to the west of the 3rd waterway.[84]

As December ended, Robbins reports he and Fitch examined the "3rd waterway area, test trench easterly from its possible slitting mill site to west of 3rd waterway, etc." Fitch, he writes, "thinks the chances are good that the slitting mill was just east of the forge."[85]

In January 1953, Robbins met with Hartley, Fitch, and Attwill to discuss the third waterway crossing Bridge Street.[86] The group worked with the evidence of the waterway and wheel pits and the negative results of testing east of the waterway and "all agreed that undoubtedly the wheel pits found there were for slitting mill activity. It was also agreed that the working units were to the west of the wheel pits, just east of the forge."[87] The discussion also helped to confirm Robbins' speculation that a slitting mill in this

Whereof those [bars of iron] they intend to be cut into rodds, are carried to the slitting Mills, where they first break or cut them cold with the force of one of the Wheels into short lengths; then they are put into a furnace to be heated red hot to a good height, and then brought singly to the Rollers, by which they are drawn even, and to a greater length; after this another Workman takes them whilst hot and puts them through the Cutters, which are of divers sizes, and may be put on and off, according to pleasure; then another lays them straight also whilst hot, and when cold binds them into faggots, and then they are fitting for sale.

Robert Plott, *The Natural History of Staffordshire,* 1686, p. 163.

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6.14 The first anvil base and sills after removal from the refinery forge site. (Photograph 1521 from the Roland W. Robbins slide collection, September 1952, Saugus Iron Works. Courtesy The Thoreau Society® Collections at the Thoreau Institute at Walden Woods.)

location would have "had but one waterway."[88] H. R. Schubert comments on the single waterway in a February letter to Hartley:

> I am extremely interested in the discovery of one single watercourse for the slitting mill. This would coincide with an idea of mine that the early slitting mill which is mostly termed here a cutting mill, was a much simpler device than the publ. by Swedenborg & Emerson.[89]

In March, Robbins began excavations in the area east of the forge and west of the third waterway. He notes that "this work will be done manually, removing all fill soils to the natural sub-surface which can be carefully studied for evidence of gear pits or other slitting mill activity."[90] This work turned up a stone feature running roughly east–west across the suspected site of the slitting mill.[91] In early April, he spent much of a day examining the south side of the slitting mill site, concentrating on the "charcoal bed and stone work located there."[92] The "large" charcoal bed feature was located at the south edge of the slitting mill site and described by Robbins as "a bowled-out area here, having no evidence of hearth stones about it."[93] The bottom of this feature contained a layer of "clinker material [remains from burning coal] . . . about six inches thick in some places."[94] Robbins also reported examining a "semi-circular stone formation just southerly of the charcoal bed."[95] The charcoal bed, or firebed, as he came to call it, was 20 ½ inches deep. Robbins notes that

> at the very bottom was the 5" of clinkers from earlier activity; on top of this was the 1"-1 ½" bed of charcoal, on top of which was the ½" – 1 ½" strata of lime, which had the 13 ½" of burned materials, including slag, metal waste impurities and clinkers with considerable metal in them.[96]

Robbins interpreted this feature as "some form of open-pit fire activity," but its actual purpose remained a mystery.[97]

Robbins and his colleagues puzzled over the charcoal bed feature as they believed that charcoal was not typically used for the heating processes necessary in a slitting mill. Moreover, this activity did not typically produce clinker or waste impurities of the type found beneath the charcoal. Because of this they initially considered the feature to be related to forge activities.[98] Subsequent research indicated that charcoal was definitely used for heating metals for slitting and rolling activities and a reference in Diderot's encyclopedia indicated that "heating activity at slitting mill ***did*** create an impurity."[99] Thus, while it appeared that this feature could be related to the slitting mill operation, its purpose remained unclear.

Despite the obvious advantages of the water hammer, there were limits to what it could do. It could not draw bars to less than ¾ inches square, because they were too flexible when hot and cooled quickly. For this reason, if small bars were required, it was necessary to have recourse to a slitting mill.

H. R. Schubert, *History of the British Iron and Steel Industry from c. 450 B.C. to A.D. 1775,* p. 304.

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6.15 The clay mound and stone hearth features at the slitting mill site. (Photograph 2147 from the Roland W. Robbins slide collection, May 1953, Saugus Iron Works. Courtesy The Thoreau Society® Collections at the Thoreau Institute at Walden Woods.)

By late May, Robbins was identifying the "semi-circular stone formation," located south of the charcoal bed, as a "stone hearth."[100] In a meeting with Robbins, Fitch "said the stone hearth suggested to him the blacksmith activity which was associated with the slitting mill, this work repaired the cutters, etc., and other slitting mill machinery."[101] Robbins discussed a new feature that he identified as a "clay mound, about 7 ½ feet northwest of the stone hearth. . . ."[102] In June, Robbins reports that he had identified several "Indian ash pits" to the south side of the slitting mill; they were found below the "working surface" of the area.[103] He continued to examine the slitting mill site over the next month with particular focus on the group of features to the south of the site area. Project engineer Steve Whittlesey took over this work upon Robbins' abrupt resignation on July 31, 1953, and assisted the architects with finalizing a plan for the reconstructed slitting mill building. Although Whittlesey clearly continued to work in this area after Robbins' departure, few records of his excavation activities survive.[104]

Summary of Slitting Mill Features

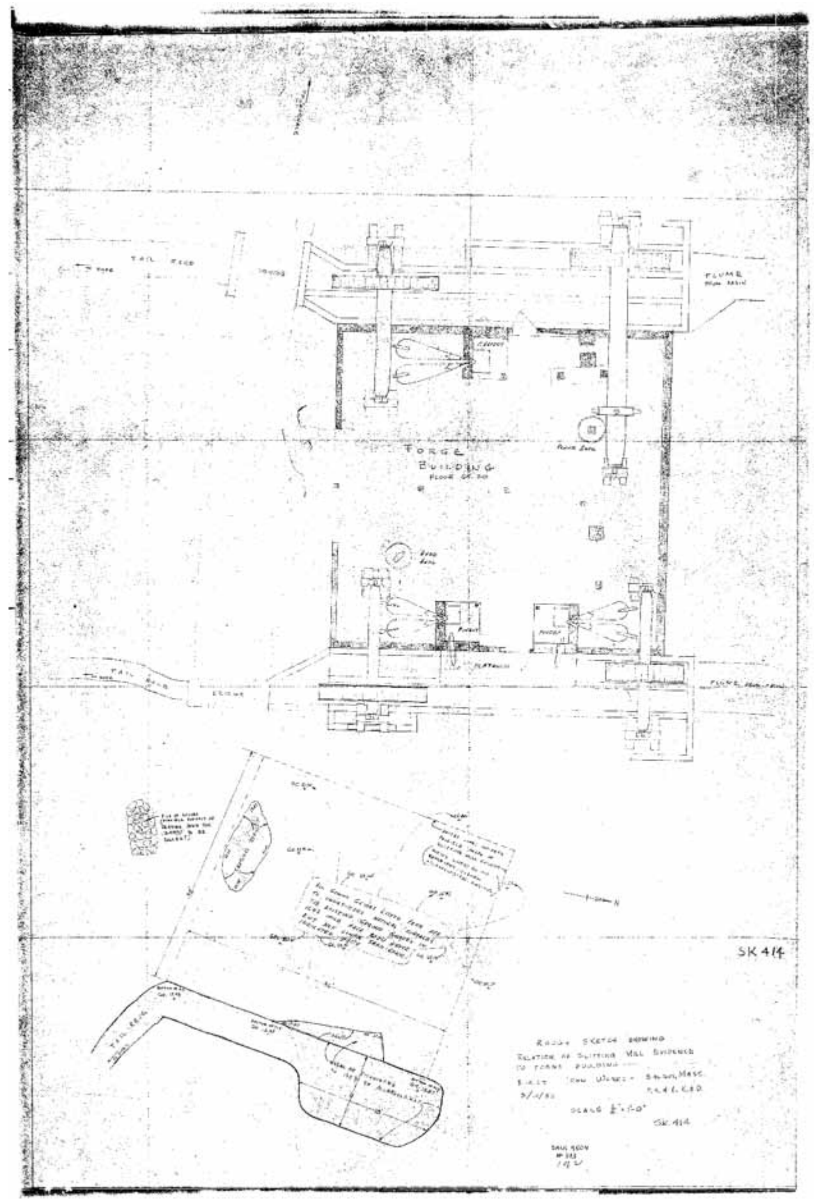
In marked contrast to the refinery forge excavations, the examination of the suspected slitting mill site revealed few features that could be definitively linked with a slitting and rolling mill operation. In addition to the third waterway crossing Bridge Street and its wheel pit, the excavations revealed a linear stone feature, a large charcoal bed, a possible stone hearth, and an unidentified clay mound feature. Several artifacts in the collection also speak clearly to the operation of a slitting mill, although no specific provenience information is available for these objects.

The principal evidence guiding the exploration of the slitting mill site was the location of the third waterway. It crossed Bridge Street approximately fifty feet east of the second refinery forge waterway, suggesting that the third watercourse must have powered the slitting mill. This interpretation was reinforced by the identification of a sizable waterwheel pit in early 1953. However, the watercourse and wheel pit presented some interpretive questions because they were not parallel with the refinery forge watercourses, but at an angle of approximately thirty degrees with these features. The wheel pit itself measured approximately 18 feet north-south by ten feet east-west; no intact wooden elements were found in association with this wheel pit.[105] Subsequent work east of the wheel pit failed to identify any other features. Work to the west and south provided additional clues that supported the speculation that the building stood west of the wheel pit, between it and the 2nd forge watercourse. However, the location and angle of the wheel pit would have required squeezing the building into an awkward space immediately adjacent to the forge.

The only substantial feature in what eventually was interpreted as the footprint of the reconstructed slitting mill building was a linear stone feature. This feature ran east-west across the site, starting from the southern end of the wheel pit feature. Although its function was never determined, this feature might

In the slitting mill: 1 pair of Rowles, 1 pair of Cutters wth Collers and geers Compleat at work, 2 pair of spare Rowles, 12s.; 1 pair of great Cutters four corner Collers[,] 1 li 6s. 8d.; 3 greate brasses, a li; 2 lesser brasses, 13s . . . .

"An Inventory of the stock and tools at the forge at Hammersmith taken Dec. 20, 1650," ***Records and Files of the Quarterly Court of Essex County, Massachusetts***, Vol. 1, p. 294.



6.16 Rough sketch showing relation of slitting mill evidence to forge building by Perry, Shaw, and Hepburn, Kehoe and Dean, March 10, 1953.

have been some type of support wall for the building or a support for an internal wooden frame that carried the slitting machinery (like a hurst frame in a grist mill).

A "charcoal bed" feature was identified south of the linear stone feature, approximately halfway between the second and third watercourses. This feature measured 12 feet east-west by five feet north-south, and had a bowl-shaped profile. Although Robbins labeled the feature "charcoal bed," the stratigraphic profile revealed several layers of differing material including a five-inch layer of clinkers at the bottom, a one and-a-half-inch layer of charcoal, a thin stratum of lime, and some 13 inches of various types of burned matter, including metal waste and slag.[106] Robbins interpreted this feature as "some form of open-pit fire activity" and came to see it as related to the nearby "stone hearth" feature.[107]

Approximately ten feet south of the "charcoal bed" was a feature consisting of stones and measuring about eight feet east-west by three feet north-south. Robbins thought that the feature might be some type of heating oven or furnace used to heat bars for the slitting mill or for some type of "blacksmith activity which was associated with the slitting mill, this work repaired the cutters, etc., and other slitting mill machinery."[108] The close association of the stone feature with the charcoal bed and its evidence of heating activity lend themselves to this sort of interpretation, although a specific function was never agreed upon by Robbins and the other researchers.

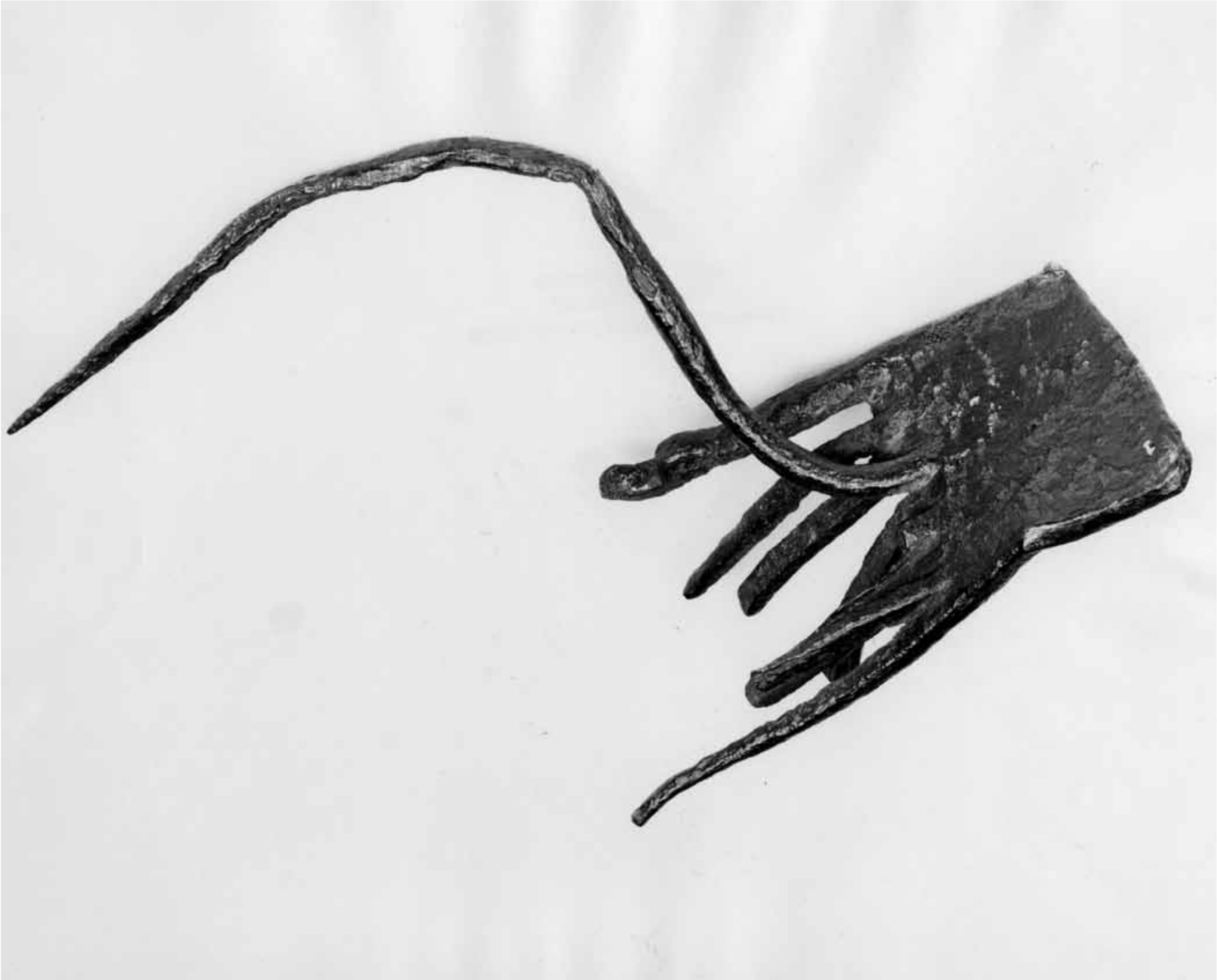
Robbins identified another feature of uncertain purpose as a "clay mound, about seven and a half feet northwest of the stone hearth . . . ."[109] Measuring approximately three feet in diameter and about 20–24 inches high, this feature was located about halfway between and at the western edge of the "stone hearth" and the "charcoal bed" and may have been related to this feature grouping.

In addition to these features, two artifacts in the collection, a spacer (SAIR # 2916) and a "squid" (SAIR #2463), relate specifically to the slitting mill operation. The "squid" provides absolute proof that a slitting mill operated at Saugus. The "squid" is actually a flat bar of metal that has been partially slit in a slitting mill; it has a solid flat body and nine thin "tentacles" or partially cut metal rods. Researcher Cyril Stanley Smith examined the Saugus squid and reported that it was the result of being jammed in the mill while it was being cut. "Since it was only partially slit," Smith notes, "it has preserved impressions of the cutters and gives other evidence as to the design of the mill."[110] No exact provenience information exists for this artifact, although Smith's report includes a photograph of the squid with the caption "found on the site of the slitting mill at Saugus."[111]

Smith's careful analysis concludes that the piece demonstrates that the slitting mill at Saugus "produced nail rod by slitting a forged and perhaps rolled flat bar (about 2.55 inches wide and 0.29 inches thick) into nine nail rods averaging about 0.26 inches wide."[112] He further notes that "there were five cutting

At Professor Hartley's request, we are sending you a very rough diagrammatic plan showing the relation of our "Slitting Mill" evidence to the forge and giving a few dimensions and elevations. It is very hard to explain the peculiar angle taken by what appears to be quite definitely a wheel pit and the only wheel pit which has turned up in the evidence anywhere on the site (slitting mill). We also enclose a print of Drawing SK 15 which shows at smaller scale the location of the possible Slitting Mill. On this latter drawing, the Slitting Mill is indicated as having two wheels on one side and mechanism similar to that shown by Swedenborg. Professor Hartley is quite reluctant to adopt such a plan as yet.

Conover Fitch, Jr., to H. R. Schubert, March 10, 1953.



6.17 The partially slit bar (known as the squid) from the slitting mill operation. (Photograph 1180 by Richard Merrill, 1954.)

discs mounted into one of the intermeshing slitting rolls and six in the other. The discs were perhaps 12 inches diameter and were fitted with considerable slack, which resulted in a 40 percent variation in the width of the slit rod."[113] The distance between the cutting discs, which regulated the thickness of the rod being produced, was controlled by spacers that were inserted between the discs. One of these spacers was discovered in the Saugus collection and fits both the description offered by Smith and an illustrated example in Diderot's mid-eighteenth-century *L'Éncyclopédi*é. Smith describes the cutting discs as ten inches in diameter, with "6 ½-inch diameter spacing discs between them, the assembly being held together by four round pins."[114] Although it is not provenienced in the Saugus collection, this object exactly matches the description, down to the holes for the four pins used to hold the cutters and spacers in place.[115]

Summary

From 1950 to 1953, Robbins and his crew excavated a series of features east of the furnace that were interpreted as the remains of the refinery forge. This evidence, including two watercourses and associated wheel pits, two large anvil bases, a series of posts or "uprights," and two stone features, provided conclusive evidence of the refinery forge operation. From 1952 to 1953, Robbins, and later Whittlesey, worked in an area east of the refinery forge that came to be interpreted as the slitting mill. The evidence for the slitting mill, although much less conclusive than the forge features, included the third waterway crossing Bridge Street and its wheel pit, a linear stone feature, a large charcoal bed, a possible stone hearth, and an unidentified clay mound feature. In addition, two artifacts, the squid and a spacer, in the collection point to the operation of a slitting mill.

These two buildings were central elements in the integrated ironworking operation at Saugus and the First Iron Works Association and American Iron and Steel Institute strongly desired to include them in the reconstructed ironworks. Although both reconstructed buildings are based on archeological and historical evidence, the refinery forge is clearly the more accurate because of the level of information available to the architects. Nevertheless, in both cases, the architects ignored some archeological features that could have informed their designs. Other aspects of the design were very speculative due to a lack of archeological evidence.

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7.1 The Jenks site at the end of the blast furnace tailrace. (Photograph 2399 from the Roland W. Robbins slide collection, unknown date, Saugus Iron Works. Courtesy The Thoreau Society® Collections at the Thoreau Institute at Walden Woods.)

The Jenks Area and the Tailrace

Curtis White

Among the many "ingenious heads and hands" at Saugus was blacksmith/millwright Joseph Jenks. Like many other craftsmen and tradesmen of the period, his decision to leave England and cross the Atlantic was surely a difficult one to make. Once he settled at Hammersmith in the mid-1640s, Jenks remained there until his death. During his thirty-five-year tenure at Saugus, he witnessed the construction, operation, and demise of the ironworks itself. The manufacturing skills Jenks brought with him to New England were disseminated through generations of his descendants. As Jenks' manufacturing skills spread, the water-powered shop he built on the tail of the blast furnace faded into archeological remains, to be uncovered and celebrated by Roland Robbins in 1952.

Deserted site of Joseph Jenks' 1646 blacksmith forge being reclaimed by nature.

Roland Robbins, Miscellaneous Papers, 1977. The Roland Wells Robbins Collection in the Thoreau Society Collections at the Thoreau Institute at Walden Woods.

Prior to the start of archeological work at Saugus in 1948, Jenks was well known to local historians. An historic marker installed just above the site of the blast furnace in 1898 bore the title "THE FIRST IRON WORKS" and reported that "JOSEPH JENKS BUILT A FORGE HERE IN 1647 AND IN 1652 MADE THE DIES FOR THE FIRST SILVER MONEY COINED IN NEW ENGLAND." When the Massachusetts Tercentenary Commission commemorated the site in 1930, it erected a marker that claimed that Joseph Jenks had built a forge at the site in 1647 and had "invented the modern type of scythe." These pronouncements beg questions about Jenks' identity, his part in the development and growth of the ironworks, and what the archeology at Saugus revealed about him. What made Jenks, as Roland Robbins said near the end of his career, "the most exciting pioneer in America's industrial history I have ever met"?[1]

A rich collection of primary archival materials tells much of Joseph Jenks' story. Albert E. Jenks, a Jenks descendant and creator of the Department of Anthropology at the University of Minnesota, wrote to the York (Maine) Historical Society six months before his death in June 1953 to reveal that "I have 89 authentic documents which name him."[2] Albert Jenks' interest in Joseph Jenks kept him in regular contact with the First Iron Works Association from 1941 until his death. Between 1949 and November 1950, Roland Robbins corresponded with Albert, who provided a great deal of information about Joseph Jenks' time in America. At the time of the archeological excavations at Saugus, however, little was known about Jenks' life in England. It wouldn't be until Merideth B. Colket published *The Jenks Family of England* in the mid-1950s that the world learned of Joseph Jenks' English origins.

Joseph Jenks was born about August 1599 to John Jenks, cutler, and Sarah Fulwater, the daughter of Henry Fulwater, an immigrant German cutler. Joseph was baptized in the parish of St. Anne, Blackfriars, London, which was about an eighth of a mile southwest of St. Paul's Cathedral.[3] By his late twenties, Jenks had married Jone Hearn. In 1628, they had a son, Joseph Jenks, Junior, who was born in Colnbrook, Buckinghamshire, about fourteen miles west of St. Anne, Blackfriars.

About this time, in an effort to improve the English manufacture of swords, the government set up several German swordsmiths in a shop at Hounslow, about nine miles away from St. Anne. Swordmakers Henry Hoppie and Peter English wrote that

> in the yeare 1629 by reason of the warrs then in Germany the Artificers being disperst, Sr William Heydon, then employed in his late Ma[jesty']s Service in Holland designing to bring the Manufactorie of swordblademaking from thence, through much importunity persuaded severall of the workmen to come over into England, and his late Ma[jes]tie to encourage those artificers caused severall Mills to be erected at Hounslowheath for there use, where they made swordblades for his Ma[jes]ties stores and for the Gentryes wearing as good and as sharp as any in the world.[4]

A swordsmith named Benjamin Stone built the Hounslow sword mill. In July 1636, Stone was granted a patent for military stores he made there:

> A spiall priviledge graunted to BENJAMIN STONE, swordblade maker, and his assignes for the terme of 14 yeares next ensuing, wthin England, Ireland, and Wales and town of Barwicke, to make and worke all maner of sword blades, fauchines, skeynes, rapier blades, and blasts serving as rests for muskets of any fashion or kinde whatsoever, according to a way and invencon, by him devised, by the helpe of mill or mills, and the same to sell at moderate rates–paying therefore yearelie to the Crowne Xls during the said terme; with the ordinary provisio for making this graunt voide in case it shall be found to be contrary to the lawe and inconvenient to the state.[5]

Jenks began working for Stone sometime in the 1630s. Whether Jenks worked directly in Stone's mill or forged blades in a separate shop and brought them to Stone for grinding is unclear. A single basket-hilted broadsword in the Powysland Museum in Welshpool, Wales, attests to Jenks' participation in this venture. On one side, the sword bears the inscription "IENCKES IOSEPH" and on the other side "ME FECIT HOVNSLO."[6]

[H]e hopeth by this meanes to raise upp more English to the same Trade, and that wee shall not have hereafter so much need of Strangers, wch wilbe a further benefitte to the Comon Wealth.

"The humble peticon of Joseph Jinks, sworde blade maker," Archives of the Duke of Northumberland at Alnwick Castle, England, 1639.

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7.2 Detail of the ca. 1635 Joseph Jenkes sword. (Courtesy of the Powysland Museum, Welshpool, Powys, Wales, UK.)

By 1635, Jenks apparently lived on the eastern side of Isleworth Hundred, a 6,883-acre administrative division of Middlesex County, which lay west of London and was bordered on the east by the Thames River. The parish records for Isleworth contain the burial entries for his wife, Jone Jeankes, on February 29, 1634/35, and his daughter, [Eliza?]beth, on November 2, 1638.[7]

At the time, Isleworth Hundred consisted of four towns, Isleworth, Heston, Twickenham, and Hounslow, and a dozen villages. The Isleworth River winds through Isleworth Hundred from west to east, entering the Thames River at Isleworth. It powered a paper mill at Hounslow and a copper mill at Isleworth. The copper mill was built by "that famous Metallist, John Broad" between 1581 and 1587 for working copper and brass.[8] Broad claimed to have employed processes involving a rolling mill to make copper plates, a technique that had never before been used in England.[9]

Having gained swordsmithing skills working for Benjamin Stone, Joseph Jenks petitioned Algernon Percy, Lord High Admiral of England and the tenth Earl of Northumberland, to "graunt unto him a smale peece of worst ground . . . upon the [Isleworth] river at Worton Bridge . . . to sett up a smale shedd or workehouse" on August 7, 1639. On that small piece of ground, Jenks proposed to build "a new invented engine or blade mill." Jenks shrewdly pointed out that "there is never an Englishman in the kingdome that cann use that profession but himselfe (except the Dutch) and he hopeth by this meanes to raise upp more English to the same Trade, and that wee shall not have hereafter so much need of Strangers, wch wilbe a further benefit to the Comon Wealth."[10] It is not known whether Jenks ever built the mill at Worton Bridge and the prospects to excavate the site are dim as it is currently a large sewage treatment plant.

That yor peticonr is intended (wth yor Honors favour) to sett upp a new invented engine or blade mille upon the River, at Woorten Bridge.

"The humble peticon of Joseph Jinks, sworde blade maker," Archives of the Duke of Northumberland at Alnwick Castle, England, 1639.

In 1642, escalating tensions between King Charles I and Parliament erupted into civil war. The war would test the loyalties of all England's citizens in the early 1640s. Oliver Cromwell took control of parliamentarian forces and formed the New Model Army. This army changed the way future English armies would be formed. Unlike traditional military forces led by nobility and outfitted locally, the New Model Army promoted its most capable leaders and centralized management of its military stores. This centralization no doubt benefitted sword mills chosen to supply the army. Stone and his swordmakers Henry Hoppie and Peter English sided with King Charles and moved their operations to Oxford. Cromwell took control of Stone's mill in Hounslow and had it converted into a gunpowder mill.

One can only wonder if the deaths of Jenks' wife and daughter, the test of his loyalties as war developed, or the enticement of new opportunity led Jenks to leave for New England. He next appears in court records in the Kittery area of Maine, perhaps in relation to the construction or maintenance of saw mills. Unlike England, where hand sawyers opposed the construction of powered sawmills, forests in the New World were not depleted. New England proved very hospitable to such mills.[11] Forests offered vast

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7.3 Detail of Moses Glover's mid-1630s map of Isleworth Hundred during the period that Jenks was living there. All Saints Church, the Isleworth parish church, is in the lower left. Worton Bridge, where Jenks had petitioned to build a sword mill, is in the upper right. (Courtesy of Collections and Archives, Alnwick Castle, Northumberland, England.)

quantities of timber ready for the taking, but labor was in short supply. Water-powered sawmills were built in the 1630s to take advantage of the abundant timber resources and to compensate for the shortage of laborers.[12] These mills needed straight, sharp blades, which Jenks was capable of providing.

In May 1646, Joseph Jenks petitioned the Massachusetts General Court for the exclusive right to "Build a Mill for making of Sithes; and alsoe a new Invented Saw Mill, and divers other Engines for making of edge tooles." Once again, Jenks pursued a new business opportunity, this time in Lynn, Massachusetts. He told the court of his "knowledge in Making and erecting of Engines of Mills to goe by water for the speedy dispatch of much worke with few mens labour in litle time," clearly recognizing the importance of water-powered machinery in supplementing the sparse labor available in the new colony. Perhaps in anticipation of setting up a mill at the tail of the brand-new Saugus blast furnace, he asked that no other person be allowed to set up and use any such new invention or trade for fourteen years. The protection he requested was similar, he said, to "the usuall priveleg and liberty Granted by the high Court of Parliament in England to men that doe first sett upon workes of this nature." He argued for patent protection by further stating that he had "expended his estate, study, and labour, and have brought things to perfection; Another when he seeth it makes the like; and soe I loose the benefit of that I have studied for many yeeres before; which will tend to my Great damadg if not my utter undoeing." As he did in his petition to the Earl of Northumberland in 1639, Jenks set forth his willingness to "[i]mprove this talent for the public good and benefit and Service of this Country." Jenks' petition convinced the magistrates of his ability to implement his work; they granted his request while retaining the power to restrain the exportation of such manufactures if the situation required it. Jenks now saw himself "[i]ncoraged forthwith to sett on the worke."[13]

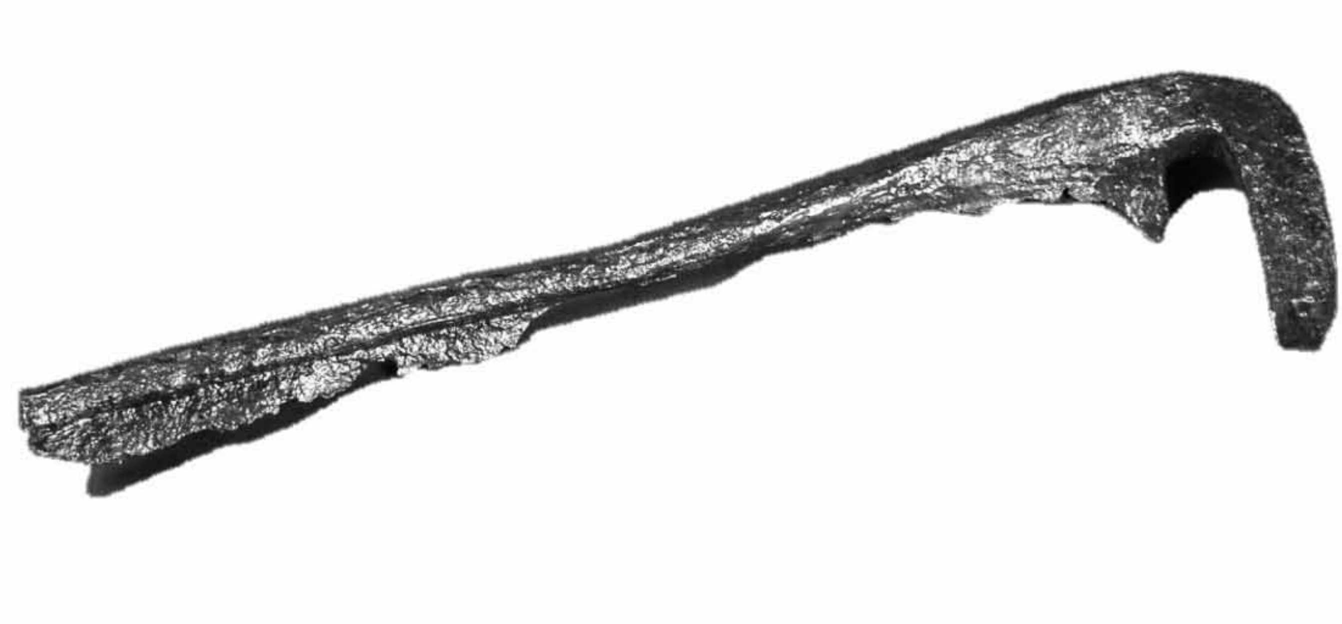
The Magistrates considering the necessity of raising such manufactures as are mentioned in the Pet[ition] and being sufficiently informed of the ability of the Petitioner to perform such works; doe conceive it fit (with relation to the Depties concurrence herin) that this Petition be granted, so far as concerns any newe such Inventions; and so far as it shalbe always in the power of this Court to restrain the exportation of such manufactures and the prizes of them to moderation if occasion so require.

"The Humble Petition of Joseph Jenkes, May 10, 1646," Massachusetts Archives, microfilm, manuscript, vol. 59, Manufacturers 1639-1773, 26.

A blacksmith on site at the Saugus Iron Works would be vital for the production of tools in high demand. Steel-edged axes and two-man felling saws supplied woodcutters with the implements to harvest the over 3,600 cords of wood fuel needed each year to run the ironworks.[14] Scythes provided farmers with sharp reaping tools needed for harvesting the grain that would feed the workers. On January 20, 1647, ironworks agent Richard Leader made an agreement with Joseph Jenks that allowed the millwright to

> have ye libertie to build & erect a mill or hamer for the forging and making of sithes or any other Iron ware by water at the taile of ye furnace & to have full benefit of the furnace water when the furnace goes provided he damnifie not any works that may hereafter be erected at the taile of the forge. [15]

In order to help Jenks start up his mill, the ironworks promised to "allow to the sd. Jenckes barr iron & cast iron for gudgins shafts & hookes for sd mill." In return, Jenks had to keep the mill in good repair and "p[er]fict ye sd mill by the 24th day June next." If he failed to meet those stipulations, the ironworks



7.4 Scythe blade (SAIR 2585) found at the Joseph Jenks site. In use, a ring held the tang (on the right) of the blade in its wooden handle or snath. A solid mass of iron formed the chine that strengthened the back of the blade. The thin web and edge have rusted away. (Photograph by Curtis White.)

could reenter the agreement, presumably with someone else.[16] Leader's 21-year agreement with Jenks was similar to the Massachusetts Bay Colony's agreement with the Company of Undertakers which protected the grantor's goals in case of failure. The ironworks ultimately wanted to secure a blacksmith; the company owned the shop and Jenks paid rent to the company to work in it.[17]

On first reading, the phrasing of Jenks' patent petition seems clear. A closer look, however, suggests that perhaps it wasn't. Jenks wished to "Build a Mill for making of Sithes; and alsoe a new Invented Saw Mill, and divers other Engines for making of edge tooles."[18] Since Jenks was a millwright, one would tend to think he had a new design for a mill to saw wood. Although Jenks clearly understood the mechanical technology, his "new Invented Saw Mill" actually may have been a mechanized way of making saw blades. When Richard Leader left the ironworks, he was building a sawmill near Piscattaway that reportedly would work "nere 20 sawes at once."[19] It is logical to assume that Jenks made the saw blades.

In the early 1650s, during the Hammersmith management term of John Gifford, Jenks continued to serve as the ironwork's blacksmith. As the length of the slag pile crept slowly past the east side of his shop, Jenks was paid for making four saws, two pairs of steelyards (graduated balances for weighing objects), and a "reste" to set saws.[20] Making saw blades required long, straight, and smooth pieces of iron. These iron blanks could be made in two different ways with the technology then in use at Saugus. One way involved beating pieces of iron under the hammer of a plate mill. This hammer would have to produce many blows quickly in order to take advantage of the heat in the thin pieces of iron before they cooled. The hammer marks would then be carefully ground out to produce the flat surface required for a saw blade to pass smoothly through the wood being milled. Iron finishers could also produce blanks by passing an iron bar through the rolling mill, getting the same results with less effort.

[Y]ou may put two or three or four saws at least up on the sam[e] fram[e], so far asunder as the thickness of the Boards which are to be sawn require . . . .

Isaak DeCaus, *New and Rare Inventions of Water Works,* p. 25.

Even when made with smooth iron, a blade could still become bound as it cut through a piece of wood. For this reason, the smith would set the teeth after cutting them into the blade.

> This Setting of the Teeth of the Saw is to make the Kerf [cut in the wood] wide enough for the Back to follow the Edge . . . . With the Saw-wrest . . . they set the Teeth of the Saw: That is, they put one of the Notches of the Wrest between the first two Teeth on the Blade of the Saw, and then turn the Handle Horizontally a little upon the Notch towards the end of the Saw; and that at once turns the Tooth somewhat towards you, and the second tooth from you: Then skipping two Teeth, they again put one end of the Notches of the Wrest between the third and fourth Teeth of the Blade of the Saw.[21]

7.5 This broken saw blade was made for a saw mill and found in ruins of the Jenks shop. An iron rod would have passed through the square hole to attach the blade to a sash that reciprocated with the help of a pitman arm attached to the waterwheel. Saw blades such as these could be ganged together to make multiple cuts with a single pass through the mill (Photograph by Dan Boivin.)

The smith continued the process until he set all of the teeth. Although it is not completely clear, Jenks' "New Invented" process of making saws may have been the use of the rolling mill to produce blanks or some mechanism for shearing the teeth from the blank.

The most definitive documentary evidence for Jenks' saw-making success comes from a letter written in late 1652, when former ironworks agent John Winthrop, Jr., was building a sawmill at the head of the Mystic River in Connecticut. Winthrop's uncle, Emmanuel Downing, wrote to him from his home in Salem: "When I understood that John Gallop was come to Boston, I went to the Iron Works, and told Goodman Jenks of the present opportunitye to send your sawes who told me he had tooe [two] ready which he would send you. I hope you have received [them] . . . ."[22] This letter clearly indicates that Jenks made saw blades not only for hand saws used in the ironworks but also for commercial, water-powered sawmills being set up throughout New England.

Large saw found resting on top of 2nd wheel pit's top west sill. Was directly east of plumb blocks. Handle end was south and the teeth were to east side.

Robbins artifact note card, SAIR 1004, April 12, 1952.

The future of Jenks and the ironworks became uncertain when the Company of Undertakers entered bankruptcy in the mid-1650s. As part of the settlement, the Company's part of the shop where Jenks worked, the rolling and slitting mill, and a corn mill located below Jenks' shop were awarded to local tailor and tavern keeper, Joseph Armitage, as compensation for debts due to him. On September 12, 1656, Jenks purchased Armitage's share of the shop and corn mill and on October 27 he purchased the rolling and slitting mill with all the appurtenances.[23] To pay for his newly acquired properties, Jenks secured a mortgage from future Massachusetts Bay Colony governor Simon Bradstreet of Andover. In addition, Jenks mortgaged his dwelling house and a nearby house lot. After two initial payments, Jenks was to pay in "good English Commodities bar Iron or Nayles at prices current" in six-month increments over the course of four years until the mortgage was "fully satisfied."[24]

In May 1666, Jenks used his expertise in mill construction to help inventory the estate of Lynn miller John Farrington. Farrington's corn mill included a water mill, dam, floodgates, and a mill house. The mill operation, valued at £190, was separated from the rest of Farrington's estate because he and his brother Edmund owned the mill jointly.[25]

In October 1667, Jenks once again sought to apply waterpower to start a new entrepreneurial venture: the production of wire. Just a little more than a year after the Great Fire of London destroyed the St. Anne, Blackfriars, church where Jenks was baptized, he was "not only weakened through age and some of the infirmities thereof but also very weak in estate." He petitioned the General Court once again, this time for £50 for a workroom and a stock of coals and iron to make wire. Iron wire, he said, was "much wanting at this day to the help of the country in spinning to make cloth of all sorts of wool as also for making hooks for the supply and furtherance of the trade of fishing and all other trades that has any dependence on or necessity of wire for its completion." This "poor petitioner" presented his "humble ser-

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7.6 A downspout carried excess water around the excavation site of Jenks' blacksmith shop. The shop included overshot and undershot waterwheels with their wooden hutches, vertical supports for a tail-helve hammer, a wooden anvil base, a stone forge, and wooden floor boards. (Photograph 1356 from the Roland W. Robbins slide collection,1952, Saugus Iron Works. Courtesy The Thoreau Society® Collections at the Thoreau Institute at Walden Woods.)

vice and readiness to this work as his desire to promote the general good of this Country, while he lives as a member thereof." The location of his blacksmith shop at the tailrace of the blast furnace, Jenks argued, made him "more capable in respect of a convenient place in respect of water for the easier affecting of the work with the lesser charge both of purse and hands than any other that does now present."[26]

To produce or draw wire, the desired metal is hammered into a round rod and annealed. Almost any metal can be used. Gold, silver, iron, copper, and brass were most commonly used in the seventeenth-century. Annealing softens the metal so it can be easily pulled through a steel draw plate. The annealing process varies depending upon the metal used. In the case of brass, the metal is slowly heated to a red color and plunged directly into water. To anneal iron, the iron is heated to an orange color and then cooled very slowly. Annealing needs to be repeated during the wire-drawing process because the greased or waxed metal becomes work-hardened and brittle as it is pulled through the draw plate. The plates

> are half palmo long with several rows of holes of successive sizes. In addition, a pair of large tongs with flat, serrated mouths and open legs are needed. These should be held by a stirrup-shaped iron ring which has a hook at the foot to which is attached the end of a belt or rope, the rest of which is wrapped around the small windlass or the large one by turning. In this way the tongs close when you pull them . . . . Then by turning the levers of these instruments with the force of men, the little bars of the said metals are pulled and caused to pass through all the holes of the drawplate one by one.[27]

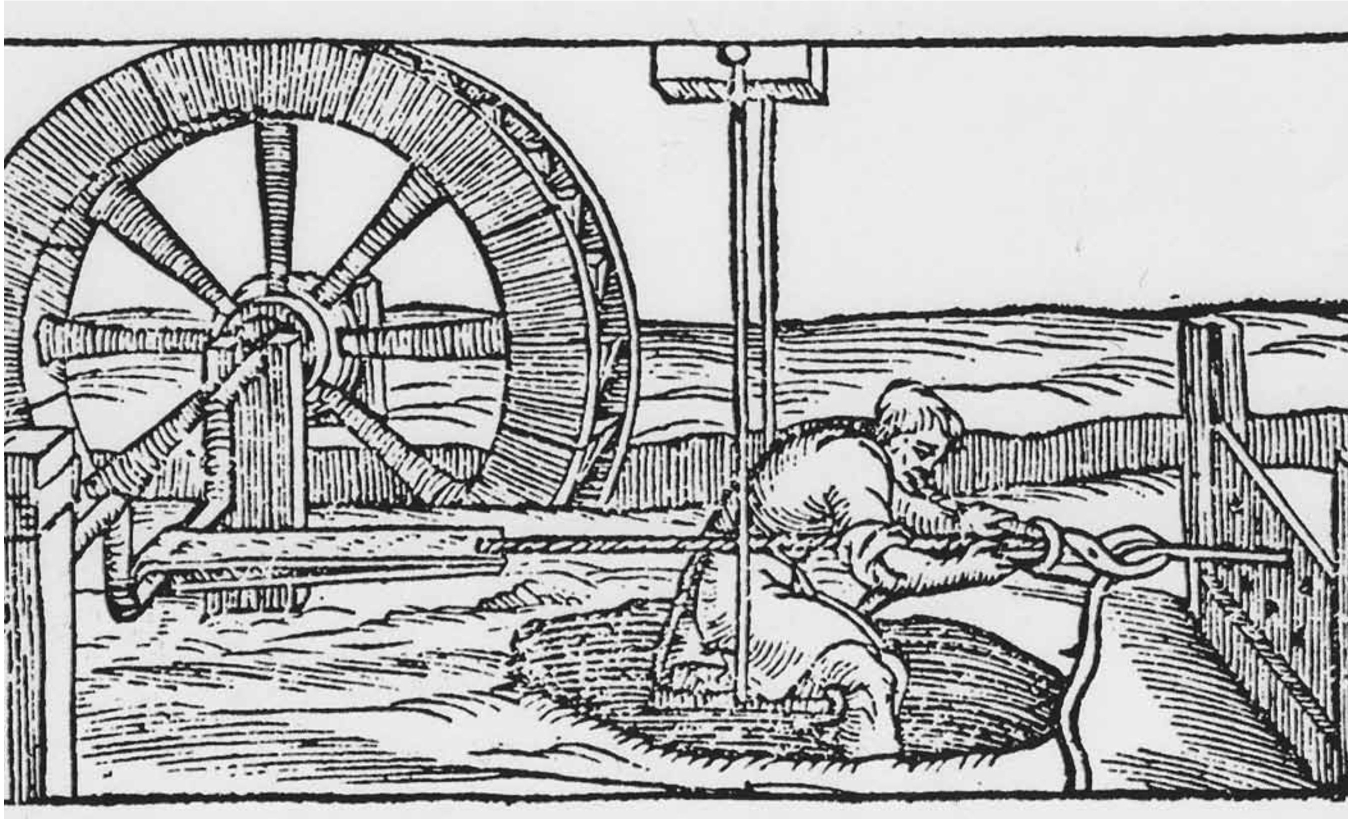
Letting the water run the wheel, the man, who has tied the band in the middle of the bent axle, lets himself be drawn backward and then pushes forward. His only care is to seize with the jaws of the tongs the end of the wire that issues from the drawplate with every return that he makes.

The Pirotechnia of Vannochio Biringuccio, p. 381.

Soft metals such as gold, silver, and brass could be pulled through the draw plate with manually powered windlass machines, but iron required more force such as that provided by water power.

> The finding of "the commite" that judged Jenks petition is not clear. At the bottom of his petition, someone added "The committe se not sufficint grounds to Incoridge the Country to adventure an Estate on ye design: yet finding ye Petitioner desirous of fifty Pounds to enable him to the worke we shall leave it with ye honored court if they se reson so for to advance upon it."[28]

By 1678, the ironworks no longer produced iron and had begun a steady decline. Local inhabitants petitioned the Massachusetts Bay Colony for permission to remove the ironworks dam.[29] At the same time, Samuel Appleton, Jr., and Thomas Savage were in dispute regarding ownership of the ironworks. Appleton had the "great furnace bellows" dismantled. Jenks and his 17-year-old son, John, had apparently been at the Jenks shop just below the furnace in time to witness the removal of eight bolts and a bellows pipe. The Jenkses testified that the bolts "cost the proprietors of the works at Hamersmith five pence pr pound" and that the bellows pipe "cost thirty shillings when new." Jenks' knowledge of the cost of these



7.7 This sixteenth-century woodcut illustrates a water-powered wire-drawing operation similar to what may have been in the Jenks shop to draw wire. (From *The Pirotechnia of Vannoccia Biringuccio,* p. 380. Courtesy Dover Publications)

materials suggests that he may have made them himself for the ironworks.[30] Finally, in May 1682, after three attempts, the great dam that held back the water that supplied power to the old ironworks was destroyed.[31] The canal that had supplied the furnace may have still provided power to Jenks' shop. Less than a year later, in March 1683, Joseph Jenks died.[32]

After Joseph's death, ownership and operation of the Jenks blacksmith shop becomes unclear. Joseph Jenks, Jr., had come to Massachusetts, probably in the early 1640s, and established an ironworks in Concord, Massachusetts. By the end of the 1660s he had founded an ironworks and sawmill in Pawtucket, Rhode Island.[33] After immigrating to New England Joseph Jenks, Sr., had married a second time and had three more sons: Samuel in 1654, John in 1660, and Daniel in 1663. Daniel built mills in Cumberland, Massachusetts. At least three more Jenks progeny were blacksmiths in Lynn: son Samuel and grandsons John and Samuel, Jr. Samuel Jenks, Jr., died on March 16, 1745, and was buried in the Old Burial Ground in Saugus Center.[34]

Two hundred sixty-five years after the death of Joseph Jenks, Sr., Roland Robbins' began work at the ironworks and encountered the Massachusetts tercentenary sign that implied that Joseph Jenks had built the Saugus Iron Works. While Robbins knew of Jenks' involvement with the ironworks from the start of the Saugus excavations in 1948, he did not begin to explore the Jenks site until 1952.

On September 10, 1948, Robbins met blacksmith Edward Guy, who had been part of early efforts to preserve the Iron Works House (see Chapter 3). Prior to his purchase of the house, preservationist Wallace Nutting hired Guy to make reproduction hardware for the restoration. Nutting's work crew added a six-room cottage onto the back of the restored house where Guy would live with his family. Working first out of an old chicken coop, Guy later disassembled his old shop in Newburyport, had it shipped to Saugus, and built a new shop from the salvaged lumber. He attached the chicken coop for additional space. From this shop, Guy contributed his classical blacksmithing skills to the Colonial Revival era by making quality reproduction hardware for sale through Nutting's catalog.[35]

Despite a falling out with Nutting, Guy continued to live and work at the site and continued to work in his shop as the property changed hands twice. He still was there 34 years later when Robbins began his "work of locating the original site of the blast furnace erected in 1643 (or there abouts) by Joseph Jenks." After being introduced to the site by First Iron Works Association president J. Sanger Atwill, Robbins talked to Guy about his knowledge of the site. Guy recalled that "when he came to his shop a John Patcher, then some 80 years of age, told him that when he, Patcher, was a very little boy, he remembered the older boys playing in the ruins of the old Jenk's mill. Later these ruins were torn down (while Patcher was still a small lad.) Mr. Guy pointed out signs of the original Jenk's mill as pointed out to him by Mr. Patcher." According to Robbins' maps documenting the next few days' work, it appears that Patcher

Mr. Robbins was it? Came there, came in the shop and asked if we knew where the original foundry would be. Well we walked across the street to the cinder bank and my father said look there's the slag here. Where would they haul the slag to or from? The foundry. So, naturally we followed that . . . . And my father says well I presume it was down in this hollow. . . . And they dug there. And right where my father suggested was the forge [furnace] they found the blowpipe . . . . The original blowpipe! By gosh you hit it right on the nail!

NPS Interview with Edward Guy's son, Edward L. Guy, June 6, 1974.

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7.8 Blacksmith Edward Guy working in his shop. The building would soon house the site's archeological collections. Robbins took this photograph through an open window on September 1, 1949. (Photograph 123 from the Roland W. Robbins slide collection, 1949, Saugus Iron Works. Courtesy The Thoreau Society® Collections at the Thoreau Institute at Walden Woods.)

had actually pointed out the site of the blast furnace.[36] Robbins believed that the blast furnace was part of the Jenks operation until he received a letter from Albert Jenks dated March 11, 1949. Albert Jenks made Robbins aware of the September 12, 1656, purchase by Joseph Jenks of a "corne mill and forge situated at the taille of the forge and furnace."[37] Robbins would not discover the Jenks shop for almost another three years.

During the week of February 10, 1952, Robbins' crew began to explore the area between the west side of the slag pile and the east side of the Central Street retaining wall, using freshly sharpened grub hoes. Metal stakes were cut and driven into the ground at strategic locations. The stakes, numbered one through seven, were benchmarks to help document any findings along the furnace tailrace that had come to be known as the Jenks area. On Valentine's Day, a bulldozer pushed back the southerly end of the slag pile almost ten feet to extend the road and dam from the wharf excavation area to just south of the Jenks area. The road was patched and filled with gravel so that dump trucks could remove excavated fill from the site. Robbins began to excavate from the river northward toward the blast furnace. Work progressed all week, with crane operator Roy Bacon removing large quantities of fill with his "clam shell" as Robbins' men worked with hand tools. Sixty-four inches below the surface, the men found two "base sills" among other timbers and rubble. Robbins speculated that the sills, which lay forty inches apart, were part of either a race or wheel pit.[38]

I had Charlie cut me 7 stakes. I had them driven at various places along both sides of Jenk's activity on tail of furnace. They shall be numbered and will be used for bench marks to locate relics found during future excavations in this area.

Roland Robbins, "Saugus Ironworks Daily Log - 1952, February 13, 1952.

On Friday, February 15, Robbins called in photographer Richard Merrill to take pictures of the Jenks area before heavy earth removal took place to uncover the sills. Surveyor John Bradford was also called to take elevations of the sills but was unable to do so because of the cold weather. A crew member took the elevations instead, noting that the top surfaces of the timbers lay at a depth of nine-and-a-quarter-feet. Robbins noted that the "sill is about 3" to 5" below average high tide . . . . [I]f this evidence is a race, or wheel pit, or leads to the same, it will be quite evident that there has been a land recession, or tidal change—or both—during the past three centuries."

Robbins made the next big discovery related to the Jenks area late in the afternoon on February 20, 1952, when he uncovered "the hub and a section of the shaft of a waterwheel." Based on the evidence he had found to date, Robbins believed this was the right size and place for a waterwheel, although he didn't think the shaft was in its original position. "It is too early to tell, but this may be some of Jenks' 'engine to go by water,' for which the first patent in America was issued." The next day, as excavations continued, historian Hartley stopped by to see the hub and shaft. He believed the hub had paddles in the mortises rather than spokes. Perhaps because Jenks at one time owned the slitting mill, Hartley also believed the slitting mill may have been located in the Jenks area. Later the same day, Merrill photographed the shaft *in situ* and then the shaft was plotted and removed. Robbins notes that he wrapped it in a blanket and suspended it by rope above the bottom of a test trench filled with water.[39]

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7.9 The end of the slag pile cut off and spread out to provide a service road for Jenks area excavation vehicles, February 14, 1952. (Photograph 1204 from the Roland W. Robbins slide collection,1952, Saugus Iron Works. Courtesy The Thoreau Society® Collections at the Thoreau Institute at Walden Woods.)

A week later Robbins reports finding many more timbers along with "an abundance of artifacts," among them an "excellent, ancient iron axe." On Friday, February 29, 1952, Robbins writes, "At 1:45 p.m. I located a section of a waterwheel shroud, spoke, and sole resting in what may prove to be its wheel pit. This is in Jenk's [sic] area." Atwill was on the site when the spoke was found and in the afternoon Robbins called Hartley about the exciting find and made arrangements for him to visit the site the following morning.[40]

The next day, Robbins and Hartley looked over the wood evidence that Robbins had uncovered the previous day. After lunch, they checked the deeds concerning the area. At about two in the afternoon, Robbins found another wheel spoke just a few feet north of the one found on the day before. At that point,

> Hartley changed into rubber boots and sweaters and helped me clean it off. It's [sic] design (what could be seen) is somewhat similar to the furnace waterwheel. It is quite different than the spoke, sole, and shroud found south of it. It appears as though I have found the remains of two waterwheels in their wheel pits, and close together. I doubt the hub and its spoke, found February 20th, has any connection with the two wheels just found. It appears likely that a series of waterwheels existed here—maybe they all utilized the same wheel pit. Hartley is amazed with the developments here.[41]

Hartley is amazed with developments here. Believes this may be the site of the Forge the Iron Works are known to have had. If so, then Jenks' concessions must be south of this.

Hartley, Robbins continues, "believes this may be the site of the Forge the Iron Works are known to have had. If so, then Jenks' concessions must be south of this."[42]

Roland Robbins, "Saugus Ironworks Daily Log - 1952," March 1, 1952.

During the first week of March, excavations continued at the Jenks area on the northern and southern ends of the site. Robbins made arrangements for the removed fill to be brought to the Anna Parker Playground on Essex Street, Saugus. Architect Conover Fitch introduced his colleague Herb Bogen to Robbins on March 6. The next day, Bogen made his first drawings of the Jenks shop waterwheel finds. Surveyor John Bradford measured the waterwheel components and documented their elevations and Robbins, for the first time, began using the term "first wheel" for the northern wheel and "second wheel" for the southern wheel to indicate the order in which the wheels were situated on the blast furnace tailrace. Robbins writes in his notes that Hartley visited the site again and "feels convinced that the evidence I am uncovering in Jenks' area, particularly the first wheel and large timbers handy by, are not Jenks' works but belonged to the Undertakers."[43] By early May 1952, Hartley would change his opinion regarding this area.

On March 18, 1952, Robbins began to find large numbers of brass sewing pins, mostly on the east side of the waterwheel sluiceways from the first wheel all the way down to the third wheel pit, even underneath the sluiceways.[44] These pins may confirm that Jenks drew wire at the site. To make such pins, a

Due to copyright restrictions, this image is not available in the on-line version of this publication.

7.10 Looking westward, the remains of Jenks' overshot waterwheel shows signs of extended use, May 16, 1952. A cast-iron boit in the background supported the shaft and water-wheel that provided power to a tail-helve hammer. (Photograph 1483 from the Roland Robbins slide collection, 1952, Saugus Iron Works. Courtesy The Thoreau Society® Collections at the Thoreau Institute at Walden Woods.)

blacksmith would first have to form the pin shank from a short section of wire. He would then anneal a smaller gauge wire and wrap it around a wire the same gauge as the pin shank. This created a long coil that looked very much like a spring. Two revolutions of the coil were cut off as a single piece and slid over what would become the head end of the pin. The head was formed into a ball by placing the coiled-wrapped end of the pin into a precisely made forming die. These dies had small, semi-spherical cavities and pressed the coils around the shank in a manner similar to forming a snowball between two cupped hands.[45] Many times, pins were coated with tin, which soldered the heads fast and provided a protective coating. The pins were then polished to harden them for greater durability.

Given the precision required to make pins, it seems unlikely that Jenks, by then in his sixties, would have had the dexterity and eyesight to do this fine work. Perhaps Jenks drew the wire and built the machinery to produce the pins and a younger member of his family actually made the pins. Typically, women and children made pins. Large iron fishhooks were also found at the ironworks site. Unfortunately, Robbins did not document where they were found. In any case, archeology at Saugus seems to reinforce the seventeenth-century documentation. Both brass and iron wire were drawn by Jenks' machinery built in the tailrace of the blast furnace.

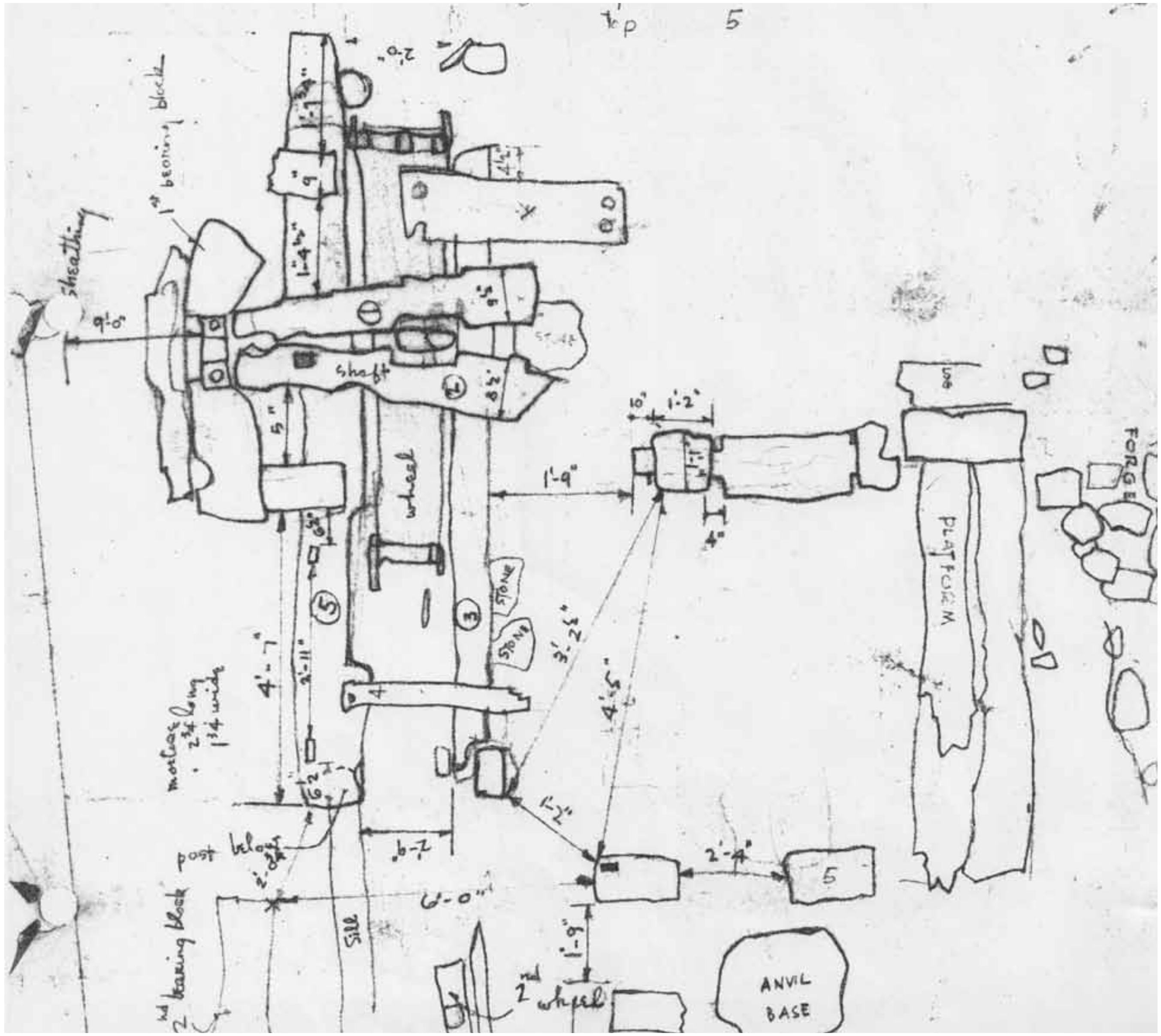
Bradford here this A.M. and plotted and took el[evations] of timbers and wheel pit sills along furnace tailrace excavations, etc. Hepburn here this A.M. with Fitch and Bogen. Fitch and Bogen stayed for the day. In P.M. they did considerable measuring of timbers, sills, plumb blocks, etc. on the furnace tailrace.

Roland Robbins, "Saugus Ironworks Daily Log - 1952," March 26, 1952.

In early March 1952, Robbins was introduced to renowned Harvard paleontologist Percy Raymond. Although Raymond had made a name for himself identifying fossil species and their relationships within stratigraphic zones, in his retirement he had become an expert on colonial pewter and spoons.[46] In mid-March, Raymond commented on a number of spoons that had been discovered at Saugus. Two seal-top spoons had been found just south of the blast furnace near the tailrace. Based on their shape and touch marks, Raymond estimated that the spoons dated to about 1660. The first spoon, found during the 1949 excavations, had an elliptical bowl and was marked with a Tudor rose; Raymond dated it to 1680–1690. He identified another spoon, found on the furnace tailrace at the Jenks shop, as a French slip-top spoon dating to about 1660.

Hartley researched the "goldish" material that comprised the spoons and pins and reported to Robbins that it was brass with considerable lead. Robbins called Raymond, who now thought his original dates had been conservative and that the spoons were much older than he had originally suggested.[47] Because the First Iron Works Association called a halt to research on the Jenks site in mid-April 1952, many questions remain regarding spoons, spurs, and other brass objects found there. Where did the brass come from? Did Jenks recycle brass to make wire? Did he cast other brass implements? Future study of maker's marks on these spoons and of the composition of the brass may suggest answers.

Robbins and his crew continued to systematically dig, measure, draw, photograph, and remove the timbers and machinery of the Jenks site. On April 10, Robbins ordered 500 numbered fiber tags that he



7.11 Detail of drawing of Jenks' hammer assembly including: an overshot waterwheel and shaft, hutch, bearing block, fulcrum (as Robbins called it)and anvil base. Forge and floorboards can be seen on the right. (Perry, Shaw and Hepburn, Kehoe and Dean drawing, March 26, 1952.)

would use to "number wood evidence removed in the future."[48] Until this time Robbins had used raised-numbered tacks like those used to label railroad ties or storm windows.

Excavations continued on the southwest and west sides of what Robbins referred to as Jenks' third wheel pit. The artifacts discovered there include a cannon ball, a metal slab with holes through it, many pins, a metal weight with a ring through it, and a thirty-three-and-three-quarter-inch wrought-iron tuyere, or bellows pipe, in excellent condition. Two spoons were also found.[49]

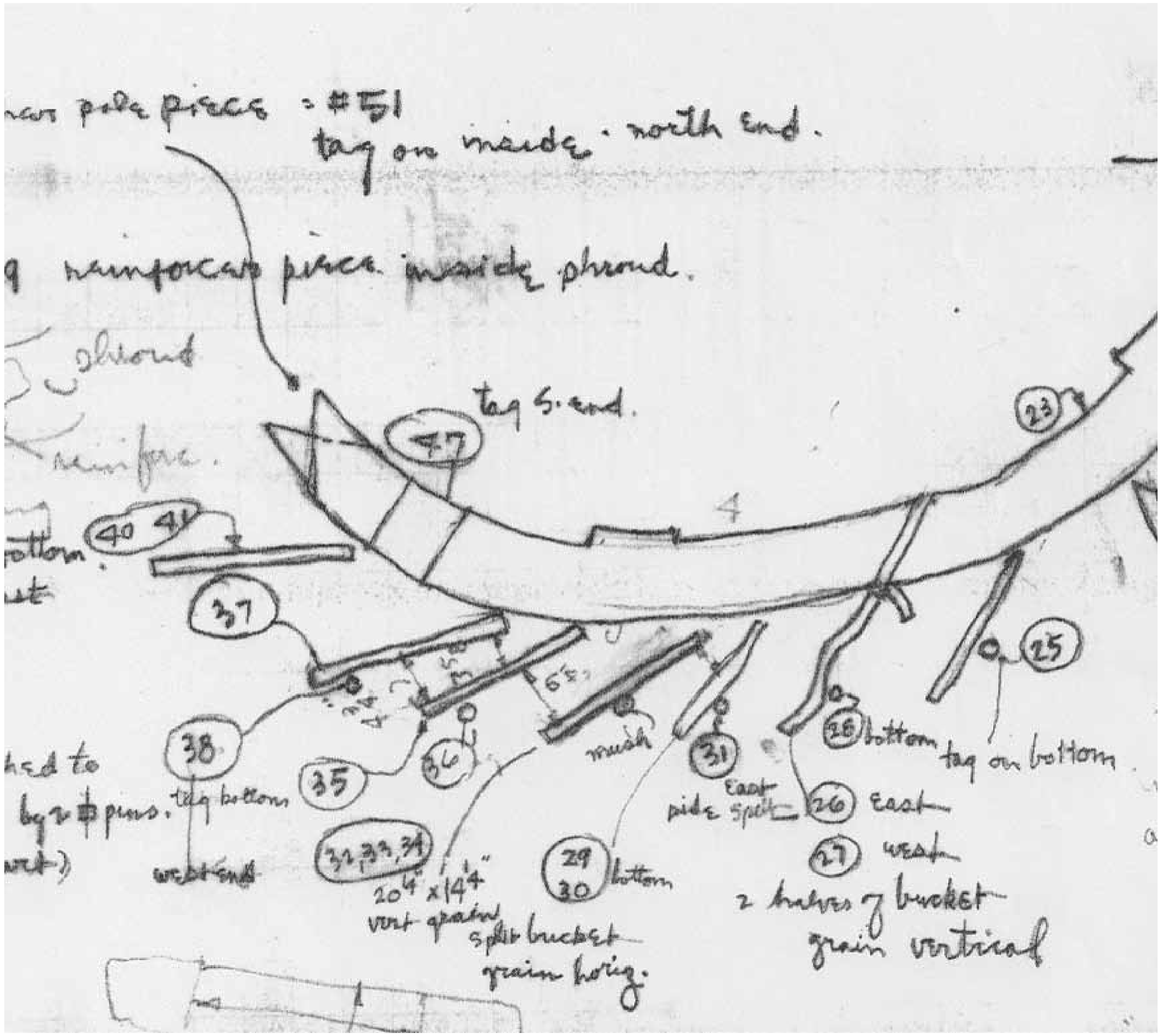
On April 12, Robbins had at least four men clean out the second and third wheel pits, which enabled him to locate the floor and sheathing of the second wheel pit. Robbins himself cleaned the tuyere he had found and was very happy with the finished product. He made one of his most significant finds, a broken saw blade about two feet long, on the west side of the second wheel pit, lying on the top sill. He labeled the saw blade with an index card that carefully mapped its location and north-south orientation.[50] A square hole at the top of the blade indicates that it was meant to be installed in a sash frame and held in place with a square-shank bolt. This technique for attaching a saw blade to a reciprocating sash is shown in an illustration of sawmill construction in a book on waterworks published in London in 1659.[51] It is the same type of blade that would likely have been used in Richard Leader's Great Works in Maine and the Connecticut mill of John Winthrop, Jr.

I reviewed work of furnace, casting beds, etc., excavations with Bogen. In P.M. we dismantled part of 1st wheel on furnace tailrace.

Roland Robbins, "Saugus Ironworks Daily Log - 1952," April 14, 1952.

About a month after Robbins submitted a four-page report to Quincy Bent about the finds at the Jenks site, Atwill received a letter from Bent intended to redirect the focus of archeological excavations. His letter dated April 18 reads in part:

> Our work at Saugus should be quite definite:
>
> 1. To restore the complete blast furnace unit.
>
> 2. To plan for the restoration of the forge-finery, slitting mill and wharf.
>
> I regard the Jenks' area finds interesting, but not too important as to our main objectives. Someday we might want to complete the whole job, but now our attention must be focused on the main works restoration.
>
> I am sending a copy of this letter to Robbins, Fitch, and Hartley, so there ought not to be any misunderstanding as to our main objective.[52]



7.12 **Jenks hammer wheel showing the location of the fiber tags that Robbins applied to individual wooden parts. (Perry, Shaw, and Hepburn, Kehoe and Dean drawing, May 15 and 16, 1952.)**

Shortly after receiving this notice to redirect excavations on April 30, 1952, Robbins' crew discovered a die, a long tool with the initials stamped in reverse on the face. A blacksmith would use such a tool to stamp his maker's mark into his finished work to identify himself. The finished piece was typically cold when stamped and the tool would have probably been made of steel to resist deformation. When a maker's mark was imprinted on any surface of silver, gold, pewter, or iron, it was done using this common technology. In fact, a similar die was used on silver blanks to make the New England Shilling in 1652. "It looked like a chisel," writes Robbins about the tool. "However, on close examination I noted the initials W.C. Phoned Neal."[53] Hartley had some immediate ideas but followed up with more research and replied to Robbins in a letter dated May 14. "I've done some checking in the meanwhile and my first impulse seems to have been confirmed in a way which I think you will find interesting. William Curtis was Joseph Jenks' apprentice, living with him, and eventually became, apparently, a highly skilled toolmaking smith. Somewhere along about 1657–1658 he wrote to young Winthrop offering to go to work for him at the Connecticut ironworks. The letter is rather cute." Transposed into modern English it reads:

> Master John Winthrop, I remember my loving service to you hoping you are in good health as I am at this present and will be your smith, if you please, to make all your iron ware which belongs to forge or furnace, and I know there is none that can do it so well as they that are used to it, and to make all sorts of ware that the Country has need both for Englishmen and Indians and I hope to be profitable for you and I rest you as your loving friend.[54]

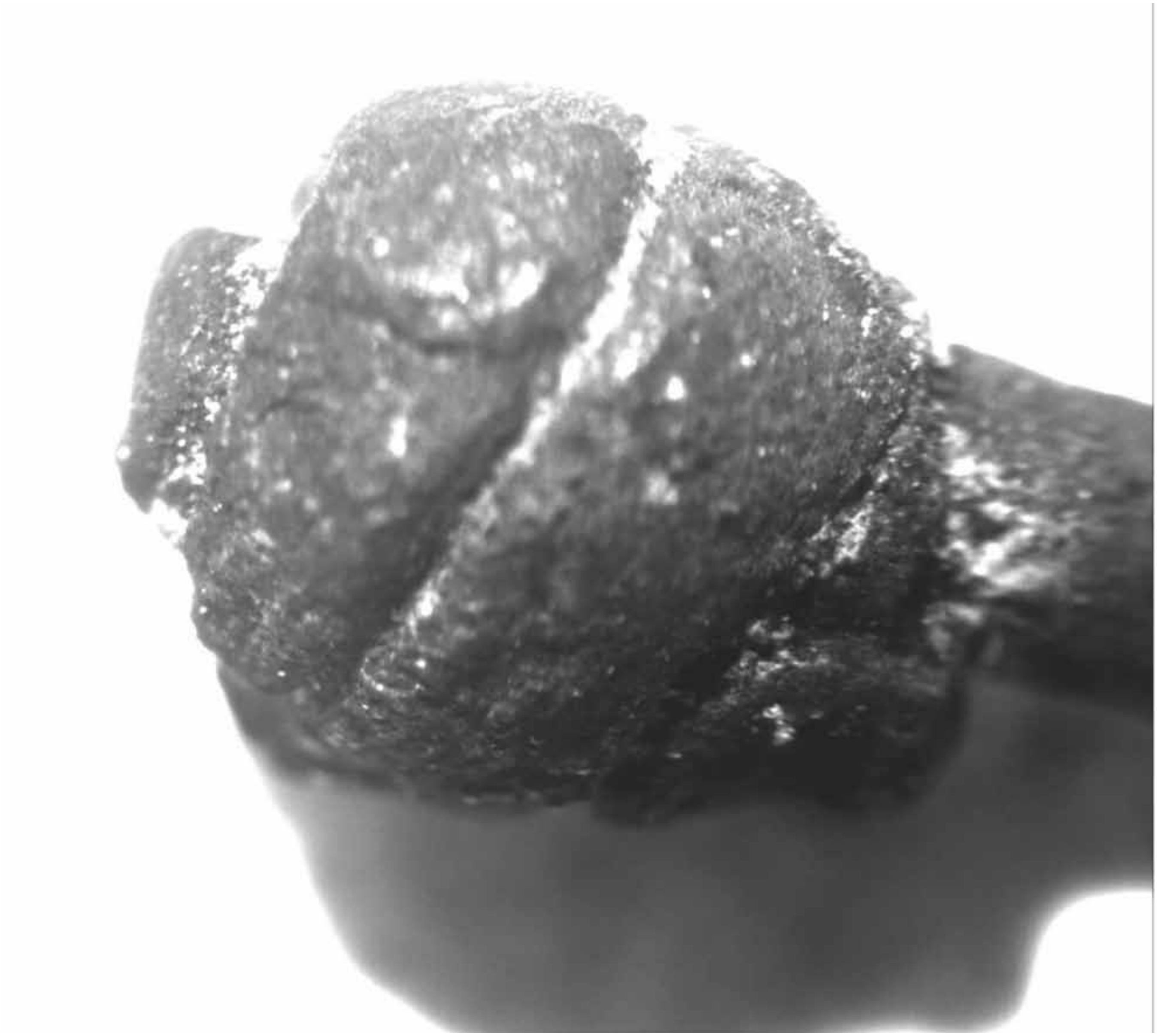
Hartley continues, "It carries the designation 'living with Joseph Jenks' and was endorsed by Winthrop 'William Curtis forge smith.'" Another letter, from John Francis to Winthrop, reveals "that Curtis had been Jenks' apprentice." Still another letter, from John Vinton, provides further evidence "Also here is a young man named William Curtis, a smith, one that wrought with Joseph Jenks senior, which will be beneficial to your works."[55]

Hartley's final comment reveals his and Robbins' disappointment regarding the decision to suspend work at the Jenks site. Hartley concludes his letter to Robbins by stating, "All of which suggests to me that short of the initials 'JJ' [Joseph Jenks] this 'WC' was the best thing you could hope to find in the digging area that Q.B. [Quincy Bent] tends to regard as secondary."[56] Hartley was finally convinced of the location of the Jenks shop, and so too was Quincy Bent.

Almost immediately after Robbins received his copy of Bent's letter, exploratory excavations of the Jenks shop ceased and became a mission of recovery and preservation. For the next few months, retrieval

[Of] the trade of the pin-maker; a workman not educated to this business . . . , nor acquainted with the use of the machinery employed in it . . . , could scarce, perhaps, with his utmost industry, make one pin in a day.

Adam Smith, *The Wealth of Nations, http://www.econlib.org/library/Smith/smWN1.html#I.1.3* (Accessed November 8, 2009.)



7.13 Microscopic view of a small brass pin from Jenks area. A small gauge wire was wrapped around a larger gauge wire and forged with hemispherical dies into a small ball. (Photograph by Curtis White.)

of large and small Jenks timbers, anvil base, waterwheels and artifacts continued. Robbins shifted his exploratory work to the forge but always remained fascinated with the Joseph Jenks story.

Since his discovery of the Jenks shop in 1952, Robbins had been frustrated that nobody seemed to care. He visited the Iron Works in July 1966 while giving a tour to students from the University of New Hampshire. While there, he photographed the Jenks site and labeled it, "Deserted site of Joseph Jenks' 1646 blacksmith forge being reclaimed by nature." Later, in a red three-ring binder, Robbins collected many photographs of the Jenks excavations and introduced them with a short, typewritten account. Dated May 11, 1977, and written on his personal letterhead, the account read in part, "Through all of this my greatest satisfaction and inspiration was derived from the excavations of the site of Joseph Jenks' Blacksmith Forge, for which he received America's first patent in 1646 for 'Engins of mils to go by water for speedy dispatch of much worke with few hands –'". It appears that Robbins had written this with "posterity" as the intended audience, to keep interest in the Jenks story alive. Even after Robbins' death, at a dedication of the Samuel Parris parsonage site in Danvers, Robbins' widow expressed "Rolie's" disappointment that the Jenks shop was never reconstructed.

Robbins' excavations of the Jenks shop provide valuable confirmation and clarification to the Joseph Jenks story. He took over 200 photographs of the excavations as they progressed. Over forty measured drawings document each piece of machinery as it was removed from the ground between March 7 and June 3, 1952. Combined with the documentary evidence available today, the archeological evidence unearthed by Robbins continues to provide a rare glimpse at the transfer of technology from England to New England in the mid-seventeenth century.

8.1 Photograph illustrating the power of water to move the waterwheels at the slitting mill. (Photograph 1400 by Richard Merrill, 1957.)

CHAPTER EIGHT

Search for the Canals

William A. Griswold

July 21 [, 1950]. . . .This p.m. I investigated what appeared to be an old canal course at the foot of the rear of Miss Rogers['] property which is on Central St., nearly opposite Appleton Street. This investigation was very revealing for it proved to be a canal leading from a dam site to rear of a partially burned barn on the northerly side of Miss Rogers['] property. This may prove to be the dam associated with the I.W.'s . . . .

Roland Robbins, "Saugus Ironworks Daily Log - 1950," July 21, 1950.

Ironworks like Saugus depended on falling and running water to power the machinery needed for the various stages of manufacture. The waterwheels at the furnace, forge, and slitting mills, not to mention the Jenks enterprise, required a large volume of water. It was no easy matter to get and keep the water flowing in the correct volume for months on end to all of these different facilities. The success or failure of the enterprise rested on the continuous delivery of water power. This took a great deal of planning and indicated the complexity of thought Richard Leader and the Undertakers must have brought to the new ironworks; this was engineering on a large scale. The planners and builders of Saugus had to contend with seasonal fluctuations—high water in the spring and low water in the summer—not to mention the unending maintenance requirements of the hydrologic system.

To contain water in sufficient quantities and to channel it to the industrial core of the ironworks, various structural features were needed, including a dam, spillway, headrace, tailrace, and penstock. Each of these specific features required individual construction. Moreover, once constructed, all of these features had to work together as a functioning system. Problems with any single element could impact the efficiency of another element. To compound the complexity, once the water got to the area of the ironworks via a canal or channel, it was impounded in a smaller holding pond and then redirected to various facilities by multiple raceways, each of which required the necessary hydrologic features to control and release the water. Ultimately, a system like this would have required a lot of planning to create and continuous maintenance to keep it functioning.

Dam construction and maintenance at Saugus would have required a detailed knowledge of construction and engineering. Dams have been known since at least the early third millennium B.C. in Egypt.[1] By 1086, the *Domesday Book* mentions that there were 5,624 mills in Great Britain, some of which were almost certainly powered by water. However, it was not until 1189 in Great Britain that a documented dam was built at Winchester-Alresford in Hampshire.[2] By the seventeenth and eighteenth centuries, the Thames, Wey, Kennet, Aire, and Calder rivers all contained sets of dams and locks.[3] Richard Leader, or the people that he brought over to help build Saugus, must have had extensive knowledge of hydrologic design and construction. Dams in principle are relatively simple, basically a barrier erected to collect and hold water. Once the water is collected, associated features are constructed that allow a controlled flow of water, either for flood control or for power. However, as simple as they sound, dams are complex features that require knowledge of many disciplines including geology, hydrology, and engineering. Dam construction is not as simple as just piling stones or earth in the water to erect a barrier.

The Papers of Charles Rufus Harte at Saugus Iron Works contain a letter written in April 1949 by Mr. Fred Lebeler, Assistant Keeper, The Science Museum, South Kensington, England, to Roland Robbins. Lebeler discusses dam construction in the Weald and writes:

> During the period under discussion [the seventeenth century], the iron industry of England was largely concentrated in the Weald and it is generally in this area that hammerponds are discovered.[4] The method of constructing a hammerpond was to throw up a large clay dam, or "bay" (a Wealden term) across a nearby valley. At one end of the dam, an overflow or spillway was constructed with hatches, which could be raised or lowered to regulate the height of water and to facilitate easement of pressure on the bay at flood time . . . .[5]

The dam needed to be strong enough to contain the required amount of water and must have had some way to discharge excess water if the need arose. If constructed incorrectly, water would find a way through or under the dam, forming a breech which, if not checked, might lead to a complete dam failure. A good historical example of a catastrophic dam failure is the infamous Johnstown flood in Pennsylvania, which washed away everything in its path. Even if a breech did not lead to a full-blown dam failure, it could compromise the regular water flow required by any associated waterworks. In the case of the ironworks, water powered the furnace bellows. If a water flow problem was not corrected quickly, the furnace would need to be shut down or taken out of blast. This could mean several weeks, if not months, of inactivity and lost revenue because the lining of the furnace would need to be completely rebuilt before restarting the furnace.

Dams created other problems. Sedimentation behind the dam often built up over time and decreased the amount of water contained by the dam. Dredging is used in many present-day situations to get rid of the accumulated sediments, but was probably not an option at Saugus. As the impoundment capacity of the pond was reduced, so too was the availability of power to drive iron production. Diverting water also affects the transporting capacity of the river just below the dam. Unless corrective action is taken, sediment deposition may also occur downstream.[6] Dams can also affect the property rights of upstream and downstream property owners. Collecting too much water behind a dam can flood fields and render land unusable for upstream neighbors, as was the case for Adam Hawkes, a neighbor who repeatedly sued the

Wealden ironmasters were faced with problems of water supply more severe than in most other regions of Britian for the availability of water was restricted by the relatively small size and catchment areas of most of the streams. The difficulties are illustrated on the ground by the means used to impound water. It was common practice to build a dam, locally known as a bay, right across a valley, collecting the entire flow of a stream. Surplus water was released over a spillway weir. This practice contrasts with layouts common in districts where the flow of water is both greater and more certain: in many Midland and northern valleys it was usual to set ponds parallel to a stream, diverting water into the pond when needed, but otherwise maintaining the natural flow in the stream-bed. There are indeed certain examples of this by-pass layout in the Weald, but they are relatively rare, and seen only on the lower reaches of streams where flows are adequate and where a cross-valley bay would be impossibly long.

Henry Cleere and David Crossley, *The Iron Industry of the Weald,* p. 222.

8.2 Dam at the Head of the Pawtucket Falls, Lowell, Massachusetts, September 20, 1875. This photograph illustrates the complexity of dam construction over two centuries after the construction of the dam at Saugus. (Photograph HAER MASS, 9-LOW, 8A-1 from the Library of Congress.)

Saugus ironworking operation for flooding his land (see Chapter 2).[7] Likewise, reducing the discharge of water can drastically affect power and navigation needs for downstream neighbors.

Several early ironworking dams in England's Weald have been investigated archeologically by cutting sections through them to reveal their construction. The dams at Ardingly, Chingley, Maynards Gate, and Panningridge have been explored in this fashion.[8] The engineers at Panningridge used logs in a marshy area as support for the base of clay and sand, while at Maynards Gate clay and sand were dumped upon an area without any other base after the topsoil had been stripped.[9] The evidence indicates that these dams were at times enlarged, strengthened, or repaired using slag from the furnace. Usually, these early dams had one if not two spillways to control the amount of water in the pond. At Ashburnham one spillway was set in the center of the dam, while at Gosden and Socknersh a single weir (small dam) was set at only one end. At Panningridge, two spillways were constructed, one at each end of the bay.[10]

The typical Wealden pond layout, suited though it was to the terrain, posed problems of maintenance which account for later decay. The bay and its spillways had to be sufficiently robust to withstand the force of storm water. Winter floods could break through, and there are references to considerable damage being done.

Henry Cleere and David Crossley, *The Iron Industry of the Weald*, p. 225.

Historical sources indicate that the dam at Saugus measured at least 100 feet long by 18 feet high and 76 feet wide (see Chapter 2). It dammed the water from the Saugus River and created what later became known as Pranker's Pond. Vestiges of this dam remain, but it is not possible to determine from these vestigial elements how and out of what materials the dam was constructed. Plentiful supplies of stone, wood, and clay were available in the immediate area. The addition of large amounts of clay would have aided in making the dam watertight. The location of the spillway is not clear. Historical documents indicate that a covering of stone was added to the exterior of the dam on the water side to control erosion due to waves and weather. Sources indicate that the dam would have impounded approximately 230 acres of water, which could then be used by the industrial operation (see Chapter 2).

After the water was contained by the great dam, it needed to be channeled to the various industrial buildings at the site, including the furnace, forge, slitting mill, and Jenks area. The channel needed to be stable so as to supply a sufficient amount of water to the various buildings. This supply system was the subject of a great deal of speculation by several individuals involved with the First Iron Works Association (FIWA). They sought a detailed explanation of how the hydrologic system worked and its impact on the operation at Saugus.

Walter Renton Ingalls, one of the directors of the FIWA and a member of the Reconstruction Committee, speculated about the dam, Pranker's Pond, and the hydrologic system at Saugus in a June 26, 1949, letter to fellow Reconstruction Committee member Charles Rufus Harte. In the letter Ingalls writes:

> According to the U.S.G.S. map of 1946 the water level of Pranker's Pond is 39 ft. above mean sea-level. Presumably this is the level established by Edward Pranker, when in 1846 he raised the dam by 2 ft. The outline of Pranker's Pond in the map of U.S.G.S is

8.3 This 1949 aerial photograph shows the location of the ironworks (bottom right), Pranker's Pond (top center), and the cranberry bog (left center). Notice how developed the area was in 1949. (Photograph 1719 by Laurence Lowry, 1949.)

> the same as in the Walker county atlas published in 1884, the surveys for which must have been several years antecedent.
>
> Scaling from the U.S.G.S. map the direct distance from the pond to the site of the blast furnace is about 1600 ft., but following the 40 ft. contour the distance would have been about 2200 ft. We may assume the water level in the pond after the final raising by John Becx & Co. to have been 37 ft. An ordinary gradient for running water in a ditch is a fall of 1 ft. in 200. On these assumptions there would at the iron works have been a loss of head of somewhere between 8 and 11 ft.
>
> Deductions from these data are that the overshot wheel that actuated the bellows was not very different from ± 16 ft. and that the reason for raising the dam at Pranker's Pond, when done by John Gifford, was for quantity rather than for head . . . .[11]

Fred Lebeler explained some generalities of Wealden hydrologic systems in his April 1949 letter to Robbins:

> The furnaces were erected as near as possible to the source of ore and fuel and in consequence were most generally found near the smaller streams . . . . In the event of large streams being available, these were tapped at some distance from the furnace and the water was brought down by means of a leat to the pond feeding the works. This method was more frequently used in the case of the forge.[12]

Ingalls continued speculating on the hydrologic system at Saugus in a June 27, 1950, letter to Harte:

> My recollections of 70 years ago are not strong evidence and may be colored by later knowledge. However, the contours of the latest mapping by U.S.G.S. lead me to think that the water level of Pranker's Pond has not been changed since about 1850. Around that time steam was being substituted for water power and there was no reason to fuss with dams anyhow. I have an atlas of about 1852 showing a canal running southerly, nearly to Appleton Street. Allowing for gradient there was sufficient head at the works for a 16 ft. overshot wheel. I figure that a 16 ft. wheel, 4 ft. wide would have furnished all necessary power for the bellows. I imagine that for minor requirements for power there were undershot wheels in the tail races. An account of repairs in 1653 speaks explicitly of wheels in the plural. [13]

The forges at Dedisham, Kitchenham, and Sheffield, and Ashurst furnaces, are good examples, sited where water supply was better than usual. Where this layout was used, a long leat could give an appreciable advantage, enabling the water of a pond to be maintained well above stream level.

Henry Cleere and David Crossley, *The Iron Industry of the Weald*, pp. 222-224.

8.4 Visible remnants of the canal, December 30, 1949. (Photograph 308 from the Roland W. Robbins slide collection, 1949, Saugus Iron Works. Courtesy The Thoreau Society® Collections at the Thoreau Institute at Walden Woods.)

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Less than a year later, Robbins uncovered the remains of the 16-foot diameter waterwheel for the bellows, although it was only about two and one half feet wide (see Chapters 3 and 5).

The historical and archeological records do not adequately address how or when the sides of the water channel were stabilized. A statement of indebtedness from the Salem Records and Files for 1653 was copied by someone associated with the FIWA and now resides in the Charles Rufus Harte Collection at Saugus. The statement mentions that "Thomas Wiggins" was owed money "for 5 days cartinge gravel to mend the flume, 1 li. 18s."[14] It is unclear why the gravel was needed, but one could speculate that it might be for repairing an open channel unlined with either wood or stone. Early historical documents record a large amount of lumber cut for the construction of the ironworks. Indeed, the tailraces and wheel pits were constructed out of wood. It is highly likely that some wood was used along the channel, although how much and where is not known. Robbins found some evidence for planking in a few places that is suggestive. While the wood itself was not preserved, straight vertical lines separating two soils may indicate a wood lining. In the nineteenth century, during the heyday of transportation canal building, canal builders used a technique called puddling. A coating of clay was spread on the sloping sides and bottoms of canals, making them impervious to water.[15] However, based on some archeological examples in England, the channels connecting the buildings to the water supply at Saugus may have been little more than ditches with large cinders used to strengthen the sides of the channel.[16]

As long as the dam held water and required a minimum of maintenance; as long as the water channels conveyed the water to their intended destinations smoothly, without silting up or eroding the sides of the channel; and as long as the penstock, waterwheel, wheel pit, and tailrace transferred the kinetic energy of the water to the machinery and discharged it through the hydrologic system in an efficient manner, multiple materials could be used. Availability of materials and price of construction probably affected the composition of these features at Saugus more than anything.

Drawing on his reading of landscape clues at Saugus, Robbins began exploring the location for the origin, containment, and distribution of the water at Saugus early in the project. In the second year, he started trenching in an effort to identify the various watercourses connected to the ironworks system. Robbins was successful in trenching on property owned by the FIWA as well as on neighboring land. This was no small undertaking; he excavated numerous trenches to establish the positions of the various watercourses for the complex. Some of this work was made easier because some suspected vestigial elements of the watercourses were still visible on the ground surface and because some of the neighbors around the project area provided anecdotal evidence for the channels.

One of Robbins' strengths must have been his personality, because he managed to convince many of the neighbors to let him excavate on their property. This would be very difficult to do today in a suburban

Monday, August 15 [, 1949]. . . . In P.M. I had four men begin a test trench for canal course at junction of Appleton and Central Streets. In surveying the visible end of canal at Appleton Street, I note that it appears to be heading quite straight for the junction of Appleton and Central Streets. Mrs. Mitchell who lives at 199 Central Street informed me that when they built their house the land at the rear of house site was in keeping with the canal. She said that this depression extended some 25' or more beyond the rear left corner of their house heading towards the junction of Central and Appleton Streets. This ties in with the direction that the visible end of canal appears to take. If our test trench finds the canal heading entirely straight then I shall try to get permission to pick it up again on the other side of Central Street.

Roland Robbins, "Saugus Ironworks Daily Log - 1949," August 15, 1949.

8.5 A cross section of one of the water channels unearthed during the excavations, January 12, 1951. (Photograph 916 from the Roland W. Robbins slide collection, 1951, Saugus Iron Works. Courtesy The Thoreau Society® Collections at the Thoreau Institute at Walden Woods.)

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community. One of the first trenches that Robbins mentions in his July 7, 1949, notes is a trench oriented north to northeast that he had five men dig across the property at 223 Central Street.[17] Robbins notes that the purpose of the trench was merely to find the old canal (singular) that connected Pranker's Pond to the ironworks. At this early stage of the project, Robbins believed that the original design was a very simple one. It was only later in his work that Robbins began to understand the complexity of design.

The first trench provided ambiguous information, as did the second one excavated 18 feet north-northeast of the first and adjacent to Central Street. Robbins' July 8, 1949, entry indicates that he was not quite sure that the feature he had found the day before was actually the old canal.[18] Visible remains of the old canal could evidently be seen in some locations around the neighborhood. These observations indicated that the canal was approximately 11–12 feet wide at its narrowest and 20 feet wide at its greatest expanse. Robbins thought that it probably averaged between 15 and 18 feet wide and had a four-to-five-foot-deep channel.[19]

Many additional trenches were dug to locate the course of the furnace canal. A third trench, dug by Robbins in the backyard of Jim Wilson at 219 Central Street, began 59 feet in from Central Street at the end of the driveway and extended to the rear of the property.[20] Robbins notes that he also had his men test at the corner of Appleton and Central streets, where visible remains of the canal could be seen.[21] Robbins notes that Mrs. Mitchell, of 199 Central Street, reported having seen remnants of the canal in her backyard when her house was built that headed toward the junction of Appleton and Central streets.[22] In mid-August 1949, Robbins continued trenching in search of the furnace canal. He dug Trench 5 on the east side of Central Street at the Scott Mill across from Jim Wilson's property.[23] Gravelly fill was noted within the trench. While Robbins notes that the elevation of the fill (37.5 feet) was about what the surveyors working for the FIWA had projected for a canal, he comments that the width of the fill and its gradual rise were wrong for a canal. He also felt that the feature was too easterly to be part of a canal system.[24] On July 21, 1950, Robbins investigated what appeared to be an old canal course behind Miss Rogers' house on Central Street, opposite Appleton Street.[25] A canal was noted in this location leading from a dam site that Robbins speculated may have been the dam associated with the early ironworks.

Late in 1950, Robbins began tinkering with the notion that a canal of some sort may have also extended from an area that he called the cranberry bog. He believed that water may have been channeled from this bog, located to the northwest of the furnace, and used as a secondary source to power some of the buildings in the ironworks.[26] Numerous trenches were excavated behind the Iron Works House over the course of the next year in pursuit of this theory.

Friday, July 8 [, 1949.] Continued to trench for course of old canal. Sunk 2nd trench 18' NNE of trench dug yesterday in lot NNE of house of 223 Central St. seeking confirming evidence of canal course found yesterday. Mr. Bradford down in morning and took canal elevations near pond and elevation of our canal trench #1. . . . Night men filled canal test trenches #1 & 2 in the lot NNE of house at 223 Central St. For information and locations of canal test trenches sunk yesterday and today see next page: I am not entirely convinced that what we have found is truly the canal course. The visible remains of the old canal are wider (11'–12' at narrowest point, and as wide as 20') Probably averaging 15'–18'. I doubt its water was deeper than 4'–5', its bank being but 6' above canal bottom. Bottom may have been stone lined.

Roland Robbins, "Saugus Ironworks Daily Log - 1951," May 24, 1951.

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8.6 The excavation of a trench at 219 Central Street on August 10, 1949. (Photograph 95 from the Roland W. Robbins slide collection, 1949, Saugus Iron Works. Courtesy The Thoreau Society® Collections at the Thoreau Institute at Walden Woods.)

The idea that a canal may have connected the cranberry bog to the ironworks first appears in Robbins' notes in December 1949.[27] The canal would have been relatively short, easily dug, and fairly level. He reasoned that if the bog was used for water containment then the canal would need to have approached the furnace wheel from the north. How it would have functioned and where it was located was not as clear. After rather extensive testing and trenching behind the Iron Works House, under and around Greystone Road, and in the backyards of some of the abutting neighbors, Robbins became convinced that there was evidence to support the existence of a stream or canal from the bog to the industrial complex. He was certain that it traveled in a southeasterly direction.[28] Subsequent archeological excavations by John Milner Associates and Brown University in the 1970s likewise identified what was believed to be a canal or waterway used to carry water from the bog to the Jenks area. [29]

During Robbins' excavations, he and others tried to determine whether or not the cranberry bog may have been used by the ironworks. Mr. Fullerton, described by Robbins as a local undertaker, took Robbins to an area of the bog that he knew had been filled.[30] Fullerton told Robbins that as a child he and other neighborhood children had considered the bog pond to be bottomless. He showed Robbins where the pond had been fed by a small brook, which was dry at the time they visited. Even Hartley acknowledged that the bog pond may have been used to contain water for the ironworks although Robbins seems to have been the primary proponent of the idea.[31]

Several other neighbors spoke to Robbins about their memories of the area and about clues that might help to unravel the secrets of the early ironworks. In his April 5, 1950, log entry, Robbins mentions talking with a Mr. Goss of Pleasant Street who told him about a stream that used to cross his property but was no longer there.[32] When Robbins asked him how he knew about the stream, Goss replied that moisture would rise up from a filled-in watercourse and create a different kind of frost pattern. Goss told Robbins of a frost line near his garage.[33] While on its face, this may seem to be far-fetched, in practicality it is a very interesting observation. This may in fact be astute, considering that archeologists often discern sites based on crop marks visible in aerial photographs; why not also frost lines?

Robbins strongly advocated that the bog was used as a pond. However, others believed that the bog may have been the source of the bog ore for the ironworks. Robbins had a deep trench excavated in October 1950 to investigate this possible use.[34] The trench was ten-and-a-half feet deep and contained strata of surface loam, gravel, rubbish, and then approximately three and a half feet of rich muck. The muck smelled like a mud flat and Robbins, Hartley, and geologist LaForge all agreed that this muck was indicative of a pond bed.[35] No bog ore was noted in the muck and Robbins used this fact to attempt to dismiss "hear-say" historians who believed the bog was a bog ore pit.

Thursday, May 24th [, 1951] . . . On next page I have sketched and recorded data showing the water canal to the furnace water wheel. This information has been obtained during the past several days and it traces the course to the finery water course from which it originates. This recent discovery suggests that the furnace wheel was not fed from the cranberry pit originally, such as I had thought possibly the case, but was fed by a canal leading from the finery water course. *My supposition had been based on my belief that the furnace* may *have operated a year or more before finery activity was developed. If such had been the case I did not believe that an extensive canal was dug from the area of Pranker's Pond for only furnace activity. I believe that the Cranberry pit could very well have provided sufficient water for operating the furnace wheel—I still believe this. However it could supply sufficient water for powering the finery machinery, apparently.* But the locating of a section of the old canal leading directly to the finery with a branch to the furnace wheel leading from it coupled with Hartley's belief that the refinery was built at the time the furnace was erected (possibly in 1646, not 1644) strongly suggests that that was the case.

Roland Robbins, "Saugus Ironworks Daily Log - 1951," May 24, 1951.

8.7 A southwest view across the cranberry bog, January 8, 1950. (Photograph 340 from the Roland W. Robbins slide collection, 1950, Saugus iron Works. Courtesy The Thoreau Society® Collections at the Thoreau Institute at Walden Woods.)

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Robbins' dismissal of this bog as an ore source is still not convincing. If the bog ore had been mined, one would not expect to find the ore. Lack of iron ore in the bog is not the strongest of arguments for its original presence; moreover, the testing for bog ore by Robbins was not extensive. The bog would have been an ideal location for iron ore to form and its close proximity to the industrial complex may have been one of the reasons that this location was selected for establishment of the ironworks. Iron ore would have been the heaviest and most logistically challenging raw material to obtain. Far more iron ore was required for manufacture of iron than flux (Nahant gabbro) and a nearby source would have been a requisite for keeping production costs down. Interestingly, modern scholars have noted that often iron ore pits were converted to cranberry bogs after their raw material stocks were exhausted.[36] Future investigation at the site should evaluate its suitability as a bog ore source more thoroughly.

As the 1951 field season began, Robbins was again hunting for the main channel to the north of the site. By May, he had discounted earlier conclusions that he had made about the channel and the bog.[37] He had discovered the channel leading to the furnace waterwheel which, rather than extending directly north of the wheel, had actually branched off from the channel leading to the forge. Robbins had believed that the furnace had been in existence for at least a year prior to the construction of the forge.[38] Evidence that the main channel had led to the forge and that the watercourse leading to the furnace was actually a branch of this channel meant that the furnace and the forge had been built at approximately the same time. The discovery indicated that the Undertakers had had a grand design, probably for the entire industrial complex. In contrast to Robbins' changing interpretations, Hartley had believed all along that the furnace and forge were constructed at the same time.[39]

In May 1951, Robbins realized that he had probably discovered remnants of the furnace channel branch in January of that year.[40] At that time, he and his crew had been forced to refill the excavations at the head of Central Street to prevent a cave-in, but not before Robbins had noted a clean vertical line between the natural and fill soils. He had concluded that the line could not have been formed by the installation of dry masonry but was more probably the result of a board having been inserted as a lining.[41]

On several occasions, Robbins noted such vertical or near vertical lines separating the loam from fill soils. He correctly identified these as features and noted that they were watercourses that probably had been sheathed with wood to prevent the sides from washing in. However, in some cases Robbins never found sheathing on the opposite side of the canal and speculated that they may not have been sheathed.[42] This would have made for a very haphazard form of construction, one that would have been subject to various complications.

Robbins also discovered the remnants of what might best be described of as a holding and/or distribution basin, just north of Bridge Street.[43] Evidently, the water was originally contained in Pranker's Pond,

Friday, May 18th [, 1951]. . . . Paul and I worked in trench dug by Mogavero for the relocation of the water gate, located near light pole at corner of Bridge St. and Central St. We were seeking water course to furnace. It begins to look as though the low disturbed area at the head of ravine, found when we dug there in January of this year, may be the water course to furnace wheel. If so it would be leading from the refinery water course which I located recently. There are several perplexing angles to this possibility . . . .

Roland Robbins, "Saugus Ironworks Daily Log - 1951," May 18, 1951.

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8.8 A section through the channel leading to the furnace, May 19, 1951. (Photograph 710 from the Roland W. Robbins slide collection, 1951, Saugus Iron Works. Courtesy The Thoreau Society® Collections at the Thoreau Institute at Walden Woods.)

diverted into a channel that flowed to the south for hundreds of feet and deposited in a secondary holding area. From there, it was conveyed to the various buildings in separate channels. Eventually, Robbins discovered evidence for four channels crossing Bridge Street: one to the blast furnace, two to the forge, and a final one to the rolling/slitting mill. This design was complex, yet it efficiently regulated and distributed the waterflow to various buildings. Use of a basin in the hydrologic design significantly reduced the amount of excavation necessary to construct the system and would have made maintenance easier because each of the channels from the holding pond could be shut down without taking the entire system out of operation. Use of basins in hydrologic systems has also been documented archeologically in the Weald.[44]

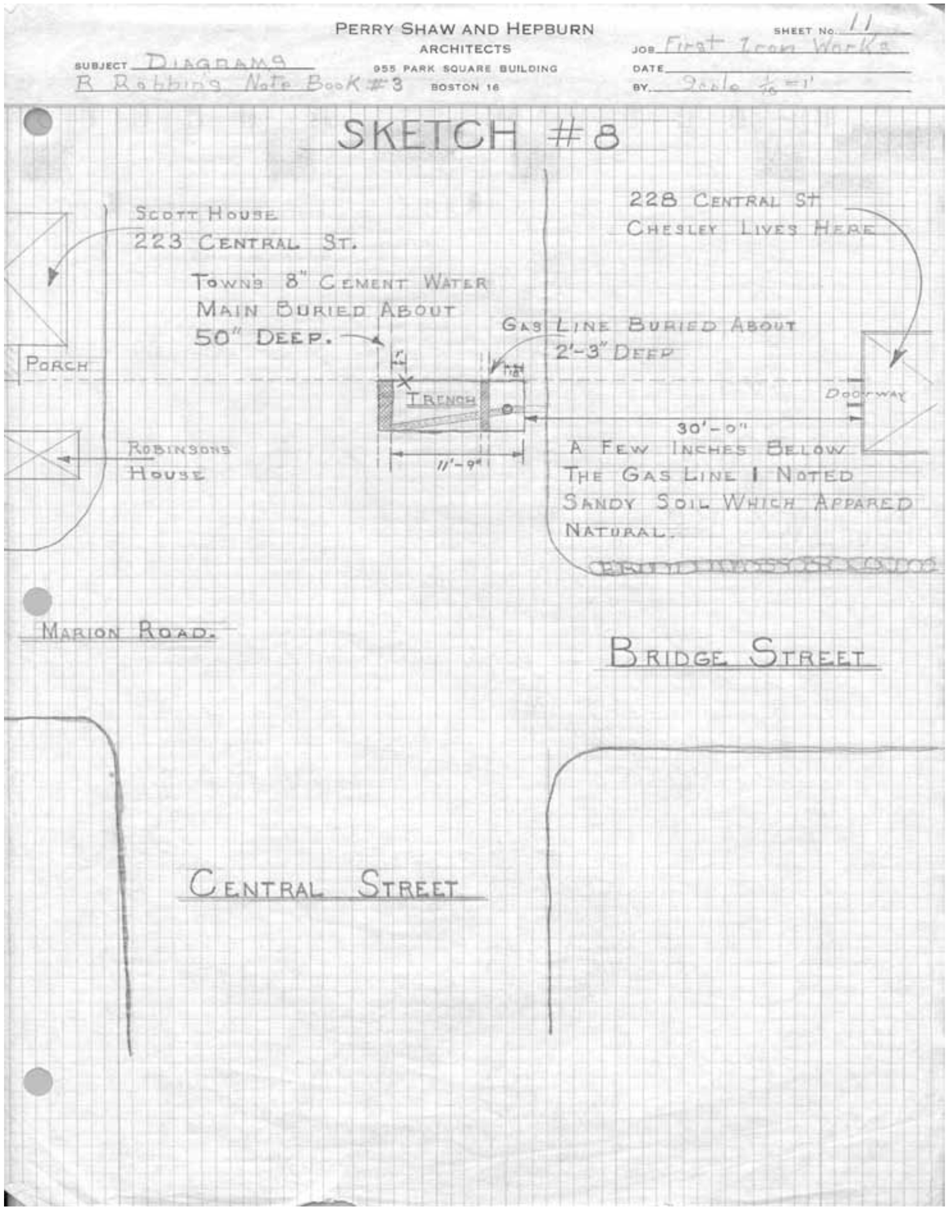
By December 1952, Robbins was speculating that the holding basin for the site may have extended all the way to Chesley's house, just north of the furnace, forge, and rolling/slitting mill. Benjamin F. Newhall, who wrote an article about the ironworks for the March 19, 1859, edition of the ***Lynn Weekly Reporter,*** stated that "the basin near the works was situated upon the ground which now marks the site of the dwelling house of Daniel A. Ames, Esquire. It was probably large enough to take also the ground in front of his house, extending into the highways."[45] Robbins was intrigued by the article and found out from Lawrence Davis, the attorney for the FIWA, that Ames had lived in the house now owned by Chesley. Robbins noted the discovery of added fill material in the trenches that he had dug on Chesley's property and concluded that it could be indicative of banking to contain a body of water.[46]

As part of his work on the canal system, Robbins also occasionally examined excavations by the Public Works Department of Saugus. In July 1952, he records that the town put in a new watergate just east of Hargrave's Court. In his daily log he notes that to positively identify a canal in cross section, the trench would have to be made perpendicular to the canal and not at odd angles.[47] Previously installed utilities for the then growing town of Saugus served to complicate any stratigraphic interpretation. Documenting archeological features within city-excavated units was not always easy. Robbins thought, however, that he saw evidence for the western side of a canal during the installation of this watergate.[48]

Discoveries made in the Jenks area of the site added another level of complexity to the discussion of waterpower features. Most of the excavations done in this area of the site were conducted in 1952. The photographs taken at the time indicate that the excavations took place in less than ideal conditions. The excitement of the discoveries and the pressure to stay focused on the principal ironworks features must have prompted Robbins and others to excavate through the snow and the cold. By the time the excavations were concluded, Robbins had discovered parts of four waterwheels, three of which he contended were located in wheel pits (see Chapter 7).

Wednesday, Dec. 10th [, 1952] . . . Also this a.m., we went over the possible site of the water basin at the Iron Works. Benjamin F. Newhall, in the account he wrote for the Lynn Weekly Reporter of March 19th, 1859, stated "the basin near the works was situated upon the ground which now marks the site of the dwelling house of Daniel A. Ames, Esquire. It was probably large enough to take also the ground in front of his house, extending into the highways." I have thought that Ames' house may have been the house that is now Chesley's. Inasmuch as the two water ways to the forge pass to the south-west and the south-east and to the east of the house we have discovered evidence of a built up area, indicative of a banking containing a body of water, it seemed likely that the basin was in this area. I phoned Lawrence Davis this a.m. and asked him about the location of Daniel Ames' house. He checked it and said that Daniel A. Ames moved into what is now Chesley's house, in 1836 and lived there until 1852. In 1845, he incorporated, at which time he called himself Daniel A. Ames. I told him that I had noted a name, J. Emes attached to this location on some maps. He told me that that was Joseph Ames and that he lived in that house in 1833. He was not certain, but he believed that Daniel may have been Joseph's son.

Roland Robbins, "Saugus Ironworks Daily Log - 1952," December 10, 1952.



8.9 Robbins' drawing illustrating one of the excavations monitored during utility installation by the town.

The complexity of the system becomes even more apparent when one considers the technological sophistication of the design. One of the waterwheels in the Jenks area was an overshot wheel (see Chapter 7). After the water was discharged from the furnace waterwheel into the tailrace, it flowed down the tailrace to the Jenks area, where it dropped again from a penstock onto a waterwheel. The other waterwheels were undershot wheels that used the water discharged from the overshot wheel. The Jenks area was thus much lower than the furnace area, which led Robbins and biologist Elso Barghoorn at one point to question whether the present-day sea levels were not in fact much higher than when the ironworks was in operation.[49]

By 1953, as the opening date of the reconstruction drew nearer and more pressure was put on Robbins to complete specific tasks to inform the reconstruction, the opportunities for doing exploratory trenching either at the ironworks or on adjoining properties became fewer and fewer. Work for the 1953 season seems to have been concentrated upon the search for the rolling/slitting mill and its associated watercourses. The organization of the hydrologic system was revealed during the archeological excavations and can best be seen in the paintings done for an exhibit at the ironworks. However, in terms of the actual pathway of the waterpower system, surveyor John Bradford's map is less stylistic and more realistic. By the time that Robbins left the reconstruction project in July 1953, he had managed to decipher most of the system in much of its complexity, including the dam that created Pranker's Pond, the channel that transported the water over 1600 feet, the holding basin that contained water for use by the industrial buildings, and the channels that flowed out of the holding basin to supply water to the furnace, forge, rolling/slitting mills, and the Jenks complex. The Saugus waterpower system was a credit to the early engineering skill of the colonial industrialists.

9.1 South view illustrating work to the south of the blast furnace, September 2, 1949. (Photograph 103 by Richard Merrill, 1949.)

Miscellaneous Features and Structures

William A. Griswold

In addition to the various industrial structures (see Chapters 5, 6, 7, and 8), Roland Robbins discovered numerous other features that were also part of the ironworking complex. Robbins correctly identified some of these components and the architects incorporated them into the reconstructed ironworks. For others, however, Robbins was only able to describe and document their presence. Fifty years of hindsight and reflection have helped in the identification of some remains, but many remain a mystery. This chapter discusses several of the miscellaneous finds unearthed by Robbins during his excavations including the wharf area, the charcoal house, various foundations, and precontact deposits.

To understand the function of many of these miscellaneous features, it helps to know where the archeological remains were found on the landscape. By considering the physical relationship of one feature to another, insight can be gained as to how the ironworks system would have functioned as a whole. From its inception, Saugus was designed to function as an integrated system, even incorporating elements from other sites. For this chapter, the furnace shall serve as the center point of the map and other discoveries will be discussed according to their cardinal direction from this central ironworks component. For the most part, Robbins discussed his findings in much the same way, although he often excavated in several areas at one time.

Features and Artifacts to the South of Blast Furnace

Following Robbins' initial discovery of the furnace, he began to branch out with his excavations and first turned his attention to the area south of the furnace. He began uncovering additional features when he sunk a test hole in an area approximately 40 feet south of the southwest corner of the furnace foundation. It was here that Robbins found a foundation with two joining perpendicular walls (Foundation #2 in Robbins' notes).[1] He uncovered evidence of the furnace tailrace, as well as a building possibly spanning the tailrace in this area. He calculated that the building was approximately 14 feet wide with a hammer located in the southwest corner. A forge is also described as being located 22 feet east of this area.[2] Little additional information is recorded for this building, but in a later log entry, Robbins notes that Foundation #2 may also have been used to retain soil along the western hill slope (along what was then Central Street).[3] The location of these discoveries was, however, just to the north of the buildings later identified with Joseph Jenks (see Chapter 7) and may relate to the Jenks' complex.

Monday, June 27, [1949]. Continued to work east clearing soil from about new wall found 22' east of junction of 2 walls 40' southwesterly of furnace's southwest corner. Also continued to work east of here, bringing the soil down to the level of the era in which the Iron Works operated. I continued to excavate the area 55'–60' southwesterly of furnace. It appears that the tailrace continued a straight course it followed through this building [and] has been filled with a reddish gravelly soil. This soil had slag and metal evidence in it. Possibly when this building was dismantled the tailrace timbers were also taken off. The depression left by removing the tailrace was later filled with soil I have mentioned. It would not surprise me if I find the tailrace went through a building about 14' in width in which (at its southwestern corner) was located a hammer. The foundation being excavated 22' east of this area may prove to be the site of a forge. If such is the case then we may find that 1 wheel *(a turbine) furnished power to operate both a hammer as well as a bellows for a forge.*

Roland Robbins, "Saugus Ironworks Daily Log - 1949," June 27, 1949.

The wharf for Saugus was found fairly late in the project, although Robbins speculated in July and August 1949 that he had uncovered remains of the wharf along the Saugus River.[4] Some of the early maps made by Bradford illustrate an area adjacent to the Saugus River and identify it as a wharf area, but the use of this terminology was rather quickly abandoned. The real wharf and dock area began to be uncovered during the 1952 and 1953 fieldwork.

When the entire length of the base sill for the wharf was unearthed, Robbins found it to measure just shy of 181 feet in length, running from east to west.[5] It was located well to the south of the forge and slitting mill. Robbins uncovered numerous oak timbers laid end to end along the 181-foot stretch. These base sills had mortises, or slots, cut into them about every two feet to receive the tenons from the uprights. Robbins also uncovered several dead men, or braces, crossing the base sill at perpendicular angles and extending well to the north, in an area that would have been covered by fill to elevate the ground behind the wharf to a level well above high tide. Robbins comments on the construction:

> A trench had been dug into the natural peat in which the dead man was buried. The gravel fill had not taken place at that time—or at least it had not advanced south to this point—for the trench had been backfilled with peat, not gravel, nor a mixture of peat and gravel. The northerly end of the dead man was buried in 2 ¼' + of peat. (See Kodachromes for Thurs. am, 3/26/53.) The gravel fill took place *after* the dead man had been buried in peat. Later the slag heaps extended over the gravel fill.[6]

The peat probably acted as a preservation agent by maintaining a constantly moist environment around the structural members. The peat would have mitigated moisture loss due to tidal fluctuations and preserved the wood much longer than if it had been allowed to dry out with the ebb and flow of the tide. Robbins goes on to comment:

> Another interesting observation concerns the oak piece used for the dead man. It had been a log which boards had been cut from. The saw marks are clearly visible. When it became too thin to produce more boarding, it was utilized as a dead man. The dead men which retained the yard base sills were whole logs which had notches cut in both ends, one end to fit over the base sill, the other to fit into a notched beam buried in the fill soils. This piece did not have the girth to permit notching. So they cut a rectangular hole thru it near its northerly end and drove a wooden stake thru the hole. The stake in turn was reinforced with a wooden piece to its south side which was running at a right angle to the dead man. This piece in turn had medium size stones to its south side which helped to anchor it more firmly.

The westerly end of the sill with its uprights and sheathing was set in a trench dug into *the peat. No* dead men*, or* heavy stakes *were driven to the south side of the sill to stabilize it at this point. Being embedded in natural peat proved sufficient anchorage here. The south side of this trench terminated about 5' east of east surface of most westerly upright.*

Roland Robbins, "Supplementary Yard and Dock Sill - 1953 [file]," April 3, 1953.

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9.2 Photograph of the bulkhead sheathing and uprights for the wharf east of the slag pile, October 8,1951. (Photograph 839 from the Roland W. Robbins slide collection, 1951, Saugus Iron Works. Courtesy The Thoreau Society® Collections at the Thoreau Institute at Walden Woods.)

> It is interesting to note that the wooden piece used to reinforce the stakes had a tenon on either end with dowel holes thru the tenons. This piece had been cut for some other purpose. Having not been used as originally intended, it was utilized here. This supplements similar wooden evidence found about and under the dead men in the yard area. In some instances the dead men had been propped with oddly cut wooden pieces. Similar pieces were also found in the fill soils there.[7]

Behind the uprights were oak planks stacked on top of each other to form a sheathing for the wharf to contain the fill. Robbins describes some of these uprights as being preserved to a height of approximately seven feet above the base sill.[8] Steve Whittlesey, Robbins' assistant who succeeded him after his resignation, notes on a September 10, 1953, sketch that at least a couple of the tenons from the uprights that had been sheared off in the base sill mortises still had one and a quarter inch dowels securing the tenons to the base sill.[9] While remnants of a top sill capping the uprights were not found by Robbins, they would have been part of the original wharf construction. Robbins believed that the uprights and sheathing maintained a height of approximately seven feet until they reached the western side of the forge's western tailrace.[10]

Whittlesey also notes that the wharf had stonework in front of it on the water side. Only along the western portion, however, was Whittlesey willing to call this stonework a wall. "Here, the thickness at the bottom (top of sill) is about two feet, tapering somewhat toward the top, with the stone layers bearing the weight of those above them in the accepted manner of stone walls."[11] As it progressed from west to east, the wall began to look more like rip-rap. Robbins notes that the stones comprising the wall were primarily composed of "Rock Mine Ore," a term used to indicate a stone or ore used in the iron manufacturing process. [12] It is interesting to note that even with a dynamic environment like the one exhibited in the Saugus tidal basin remains from the original wharf survived for 300 years. Large portions of the wharf were preserved in place despite tidal fluctuations and frequent flooding. This is a credit to the original construction techniques.

Possibly the 10% or so of stone evidence found here came from the top of the stone wall which was built above the yard sill, just east of where the forge westerly waterway passes. A study of the gravel fill above the natural peat at westerly end of the yard-dock sill, and the el[evation] of its surface, will show to what height (minimum) the sheathing extended there. (Possibly the stone wall was constructed of much "Rock Mine.")

Roland Robbins, "Supplementary Yard and Dock Sill - 1953 [file]," March 24, 1953.

During the Saugus excavations, Robbins also uncovered evidence of the dock and boat basin between the wharf and the slag pile. The boat basin and the excavations for it are mentioned in Robbins' notes for 1951. This basin and adjacent dock would originally have been large enough to accommodate a boat either bringing raw materials in or shipping finished products out. The basin would also have had to be deep enough to float a vessel, fully loaded, at low tide. Robbins comments in a March 1953 log entry:

> In examining the stones which were removed from the fill at the dock basin (this work done late in 1952), I find that about 90% of them are Rock Mine Ore. This would suggest the possibility of this ore having been brought in by barge. It was hard to define

9.3 Robbins at the wharf. Notice the sheathing and deadmen still intact. (Photograph 531 by Richard Merrill, 1951.)

> the nature of these stones when found because of the black stain upon them. During the past several months, their exposure to the weather elements removed the black stain, revealing their identity.[13]

Excavations in the larger tidal basin area provided substantive information about how river travel would have worked. Saugus was located along a river, but close enough to the coast to be affected by tidal fluctuations. Ultimately this meant that at certain times of the day, more water was present in the tidal basin than at other times of the day. Seasonal fluctuations also occurred, making the basin a dynamic environment that could be shaped by the early settlers, but in no way controlled. Flooding either from seasonal rains, winter snow melts, or dam failures were especially destructive to industrial operations like the ironworks. Robbins notes in a November 25, 1952, entry that he used a clam-shell dredger to open a test trench to the south of the coffer dam constructed during the restoration work in the dock area. The clam-shell trench was dug to determine if a channel had ever been dredged by the original ironworks operation to allow access from the river to the dock.[14] No channel was ever identified, but stratigraphic evidence led Robbins to believe that the larger tidal basin had undergone modification when the ironworks was constructed.

In order to reconcile the elevation of the wharf area and that of the waterwheels found in the Jenks area, Robbins and Dr. Elso Barghoorn from Harvard University's Biological Laboratories speculated that the conditions in the 1950s were not the same as in the middle of the seventeenth century.[15] They questioned whether the land had subsided or the sea level had risen, or whether both had occurred.[16] It was believed that the water level at the time of the ironworks was approximately three feet lower than at present. The water level became a major point of contention late in the project when the First Iron Works Association (FIWA) was recreating the entire basin area. Robbins discussed the problem with architect Conover Fitch in June 1953 and detailed the conundrum in his daily logs.[17] The FIWA had two choices. Either it could reconstruct the basin three feet lower than the river bed, which would portray an image of a basin that was always filled with water, or it could raise the level of the wharf and dock to portray a basin that was wet at high tide and dry at low tide. Ultimately, a compromise between the two alternatives was chosen by constructing a small dam downstream.[18] This small dam mitigated the effects of tidal fluctuations and allowed the water to drain more slowly from the recreated basin.

Features to the North of Blast Furnace

During the course of excavations to the north of the furnace, Robbins found the remains of two buildings, several waterways, and a small holding pond. Because of its contents, one of the buildings was easily identifiable as the charcoal house. This structure was identified by Robbins in the backyard of Al Yanofsky's house (the old Scott House) in October 1950.[19] The charcoal house was located just under two

Thursday, June 25 [1953] . . . . Fitch and I spent the morning going over details relative to the yard-dock area. We agreed that there is not need to build a road from the dam to the yard area at the time being. This can be done six or so weeks from now. We are seriously considering the elevating of the yard-dock sills to the level of the present river bed. To do this would mean that there would be less contrast between certain restored areas. If we restore the river bed of three centuries ago, where it abuts yard-dock areas, etc., it means this area will be about three feet lower than the present river bed. It will always be under water, even when the tide is out AND THE PRESENT RIVER BED IS DRY. This will convey the impression that a body of water (similar to the basin) existed over a large area. To elevate the base sills of the yard-dock area, as well as the westerly waterway from forge, etc., to the elevation of the present river bed, which is about at el[evation] 8., would mean the entire river bed would be visible when the tide was out. The river bed would abut the yard-dock area, etc., and the restored basin would be clearly defined by its pool of water. While this seems to be a meritous idea, we shall have to consider it from all angle[s] so that it will not present an unforeseen complication during later developments.

Roland Robbins, "Saugus Ironworks Daily Log - 1953," June 25, 1953.

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9.4 Looking out over the tidal basin and down the Saugus River in September 1951. (Photograph 782 from the Roland W. Robbins slide collection, 1951, Saugus Iron Works. Courtesy The Thoreau Society® Collections at the Thoreau Institute at Walden Woods.)

hundred feet from the blast furnace, close enough to provide a ready supply of charcoal but far enough away to avoid sparks from the furnace. It was not until the very end of the month, on October 31, 1950, that Robbins made extensive notes on this discovery. In the log entry, Robbins notes that portions of the east, north, and south walls were destroyed by later construction, but that parts of the north, west, and south walls were found intact and in good condition.[20]

At one place on the north wall, Robbins describes the foundation as covered by 23 inches of soil. Here the wall measured 29 inches deep and was well constructed, with approximately fifty percent of the stones containing cut surfaces; the remaining charcoal bed inside the structure near the north wall was 45 inches deep. The northwest corner of the building had been impacted by a later feature and was not as well preserved as the spot on the north wall just described. The wall was only preserved to approximately 18 inches in the southwest corner of the building. Here, Robbins reports finding approximately two feet of charcoal deposited on top of gravelly, sandy soil. The south wall of the house could not be carefully studied because of tree roots but Robbins was sure that he was able to identify the corner of the building. Along the south side of the building, he thought that he could identify a sloping surface beneath the charcoal and speculated that this was the opening to the building.[21]

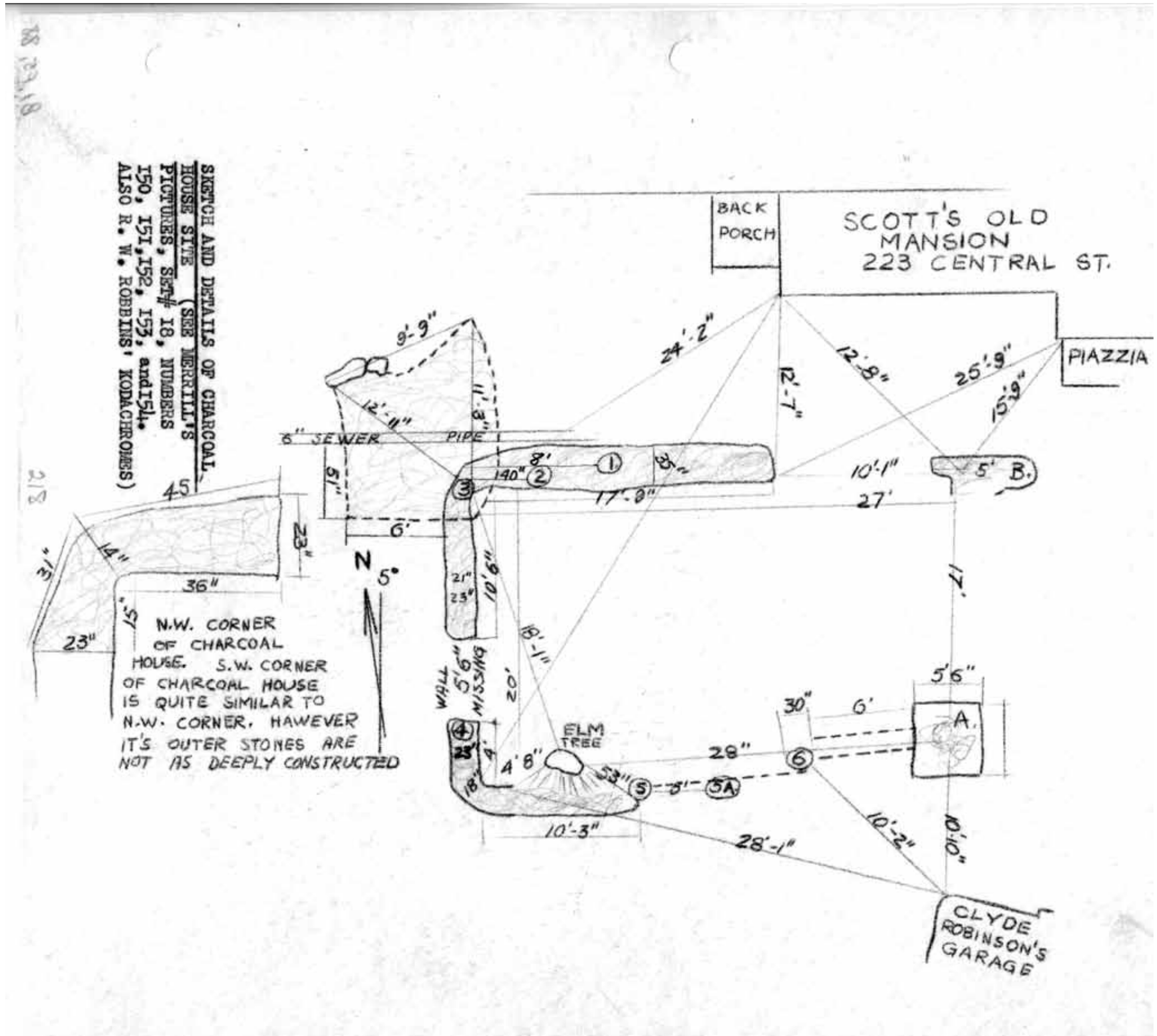
In addition to the excavations Robbins used to identify the walls of the house, several test holes were dug. The first one reported was Hole A, excavated at the juncture of the east and south walls. Disturbance here is noted to be seven feet, eight inches deep. No pattern was apparent among the stones found in this hole. Robbins then reports that he began tunneling to the west, eventually breaking through to Trench 6, located about six feet to the west. In this tunnel, the excavators reportedly uncovered brick and cinders from the ironworking facility. In another hole, further to the north and at a spot that approximates the northeast corner of the structure, Robbins found evidence that was difficult to disentangle. He thought that the remains might represent the northeast corner of the structure.[22]

Overall, Robbins estimated the structure to have been 27 feet long. He never mentions a width, but the sketch map that he included with the description shows it to be about 20 feet wide. Below the charcoal in the northern portion of the building, Robbins found a sandstone spike. This spike was similar in appearance to ones found at the furnace. It had a glaze on it indicating the likelihood that it had been used in the furnace. Robbins notes that its position below the charcoal suggests that the furnace had been in operation long enough to produce a burned lining before the remaining charcoal was stored here, or before it was used as a charcoal house.[23]

Another foundation was uncovered by Robbins in the middle of Marion Road in September 1950.[24] These remains were located in front of Clyde Robinson's house. While the majority of the foundation was found in the street, Robbins reports that some of the remains continued into Robinson's front yard.

Undoubtedly the area about the easterly end of the charcoal house, as well as along a section of the easterly end of the charcoal house southerly wall, had been disturbed by a later generation—and to a depth exceeding the elevation of the easterly end of the charcoal house. The coal and cinders and the fact Scott owned this property would suggest that Scott may have created the disturbance. To properly evaluate who disturbed what and when would necessitate more extensive excavations. We would have to carry away much of the excavated soil to permit proper working conditions. This work cannot be done under present arrangement with owners and tenants. All artifacts found in excavations at test holes A will be found under relics for this date.

Roland Robbins, "Saugus Ironworks Daily Log - 1950," October 31, 1950.



9.5 Sketch of the charcoal house foundation by Robbins recorded in his October 31, 1950, daily log.

The discovery put an earlier controversy to rest. Edward Guy, the blacksmith who had lived and worked in the area, had told Robbins early on that when the water pipe had been buried below the street in about 1942, the crew excavating the trench had broken their mechanical shovel trying to get through the stone foundation. Although the contractor that excavated the trench couldn't remember encountering any large stones, the discovery of the remains validated Guys' remembrances.[25]

Evidently the contractor had cut through the west wall of the building and had torn out a considerable amount of the south wall. The stones in the foundation are described as quite large and mortared. Brick, plaster, and nails were found within the foundation; it appeared to Robbins that the bricks and nails and the robust construction of the foundation would make it of a later date, rather than being associated with the ironworks period, unless the original remains had been reworked at a later time.[26]

It is very difficult to evaluate Robbins' conclusions about this foundation from the available evidence. Several photographs, a sketch map or two, and a brief description certainly do not qualify as adequate documentation. The stones used in the foundation do appear quite large in his illustrations. Based on the placement of the east and west fragments of wall, Robbins estimated the building to be about 32 feet long; no width is given.[27] There remain two possible interpretations for the building. First, that Robbins was correct and that the building dates to later than the ironworks period, or second, that the building dates to the ironworks period and was reused at a later time. If the remains were originally part of the ironworks and later reused, it may be one of several missing buildings from a theoretical ironworks landscape, perhaps an office, barn, or storage shed. Unless additional excavations are undertaken, one may never know the date or function of the building.

Also to the north of the furnace, Robbins located what he thought was a basin to contain water before it was used to power the buildings in the industrial sector. This basin, of unknown size, would have served as an intermediary water-containment device, positioned between the canal from Pranker's Pond to the north and the industrial buildings to the south (see Chapter 8). Robbins speculated that the four raceways that he eventually identified as watercourses that provided water power to the buildings originated at this holding pond. He notes in a November 1952 entry that banking for the basin had turned up in one of his test trenches.[28] Because of grading done for the driveway for the Eastern Industrial Oil building, he thought that it would be difficult if not impossible to determine the northern extent of the basin. Robbins theorized that if the basin and banking extended all the way to Clyde Allen's property, it might be found archeologically. No evidence of earlier ironworking activity appeared in the southern portion of the trench, indicating that the basin was constructed before the ironworking activities began at Saugus. However, Robbins notes that he found ironworking materials on the eastern side of the banking, including bricks. No additional excavations were done in this area because he judged these deposits to be later than the ironworks period.[29]

Oct. 24, Tuesday [1950] . . . . The soil westerly of this 37' trench was disturbed, apparently because of a building which was built just beyond at one time. (The southerly wall of this building was found in Marion Rd. Its inside measurement (distance between its westerly and easterly walls) was 32'.) We could not follow its easterly and westerly walls because they run under Clyde Robinson's front lawn. This wall clears up an old controversy. Mr. Guy claims he saw large cut stones here when the original water main was laid about 1942. And the contractor broke his shovel when digging through them. This proves Mr. Guy's statement to be correct. The contractor had cut through the west wall when digging for the water line. Not realizing he was cutting through a building foundation—and was running quite parallel with its southerly wall, he tore out more than one half of the southerly wall when digging the water line trench. The stones in this foundation were nicely cut, and quite large. They were mortared. Within this foundation we found bricks and plaster. Bricks, plaster and mortar from the foundation were saved.

Roland Robbins, "Saugus Ironworks Daily Log - 1950," October 24, 1950.

9.6 Robbins examining the building foundation discovered below Marion Street, September 27, 1950. (Photograph 233 by Richard Merrill, 1950.)

Features to the West of the Blast Furnace

It wasn't until 1950 that Robbins began excavating the area west of the furnace, past the wheel pit and tailrace. He began making interesting discoveries in January 1950, when he located considerable amounts of iron-bearing rock and flux (coral and shell) in an area a few feet south of the ironworks sign on the plateau of the ridge above the furnace.[30] Half a nail barrelful of coral (Robbins often assessed quantities this way) and a few clam shells were uncovered in this location, as were a 37-inch-long sow, stone and iron-ore rubble, and fired clay. Robbins notes in a January 1950 entry that these discoveries might signal the location of a forge, firing activity area, and/or ore shed.[31] After a few days of additional excavation, Robbins became convinced that the remains were that of an open forge, with the open side facing to the south or southeast. He acknowledged, however, that the assemblage of materials recovered from the site might better represent smelting activities rather than forging operations.[32]

Later, in June 1953, Robbins located what he interpreted to be an anvil block on the plateau of the ridge above the furnace.[33] The anvil block was located at the northern end of the western stone wall lining the ridgeline of the plateau. On the afternoon of June 9, 1953, the site was visited by iron specialist Charles Parker, historian Neal Hartley, and a Professor Chippendale (first name not given) from MIT. These individuals thought the remains that Robbins discovered on the eastern side of the wall were probably the remains of roasting ovens, but they had a difficult time reconciling why an anvil block would be found near this area.[34] Robbins notes his skepticism about this interpretation in his log entry, yet Hartley, Parker, and Chippendale's interpretation seems to be better supported by the available evidence than does Robbins'.[35]

It seems that one must look at a larger area to understand these remains. If they were the remnants of a forge, why did the ingredients for smelting iron show up in such quantities? If this was the site of a forge, where was the power source and why are other features and artifacts associated with a forge not also found? The lack of good answers to these questions casts doubt on Robbins' interpretation. If the remains were not a forge, what were they? To answer this question, the remains uncovered along the plateau ridgeline must be examined, along with the corresponding lack of industrial remains on the top of the plateau.

The production of iron required raw materials, including charcoal, iron ore, and flux, to be gathered and stockpiled (see Chapter 1). Once the furnace was in blast, it required nearly constant feeding to produce iron for months on end. Allowing iron ore and flux to weather removed impurities and made the production of iron easier. In some cases, the iron ore and flux were allowed to age for a considerable time before they were put into the furnace. Charcoal, on the other hand, needed to be covered and shielded from sparks from the blast furnace.

Friday, Jan 27 [1950] . . . . Found a considerable amount of iron rock evidence. There appeared to be a number of different types of iron rock. It will be interesting to learn if this is the case—and just where these ores were available. I found one-half a nail barrel load of coral, some pieces of good size. A few pieces of clam shells were also found. A large section of sow 37" long was found amid the stone and ore rubble. In the same rubble was found clay and charcoal evidence. The clay evidence had turned red by heat, apparently, must have been within forge or similar firing activity. I don't believe it was from furnace activity, no burned sandstone etc. or red clay packing pieces. Fact is the clay evidence found today was granulated. The diggings today were but several feet southerly of I.W. sign.

Roland Robbins, "Saugus Ironworks Daily Log - 1950," January 27, 1950.

9.7 The location of the controversial forge/furnace findings adjacent to the tercentenary sign, late January 1950. (Photograph 328 by Richard Merrill, 1950.)

Looking at the layout of the site from a strictly economic perspective, a basic plan or organization for the Saugus ironworks becomes apparent. While an economic explanation does not necessarily work for all sites, especially those that predate capitalist economies and industrialization, it does seem to work here. To maximize the output of the blast furnace operation, ironworks managers Leader and later Gifford would have organized the production in the most efficient manner possible. Since the location of the charcoal house less than two hundred feet from the northwest of the furnace was confirmed by Robbins, it is very likely that piles of iron ore and flux were also kept in the vicinity despite the lack of archeological evidence. From a pragmatic perspective, very large piles of raw materials would have been needed very close to the blast furnace, probably somewhere on the plateau. The laborers connected with the ironworks would have constantly drawn on these raw material piles to feed the furnace 24 hours a day and seven days a week so that the lining of the furnace would not need to be rebuilt. It was expensive and time consuming to rebuild a furnace, so the owners and managers of ironworking sites endeavored to keep the furnace in blast for as long as possible. This would have meant creating huge stockpiles of raw materials.

In all likelihood, the raw materials (iron ore and flux) would need to be broken down into smaller pieces for aging, roasting, and ultimately delivery to the furnace. Some processing of the raw materials would likely have occurred on site. An anvil and a hammer of one form or another were likely used for this purpose, making it logical that Robbins found an anvil base in conjunction with what Hartley, Parker, and Chippendale interpreted as roasting ovens. The anvil base may have simply been used to refine raw materials for roasting, aging, or processing. The discovery of a sow in this area does not cause concern because remelting was common if the original cast was considered subpar. Even the sow would have needed to be broken up into pieces for more efficient processing.

These piles of iron ore and flux would likely have been large enough to continue operations during short-term, intermittent supply disruptions. If the materials were being aged to reduce the amount of impurities present, then the piles would have needed to be much larger than if they were used shortly after being mined. These stockpiles, in either case, would likely have been quite large and would have occupied a prominent feature on the landscape. Given the need to load the furnace from the plateau, this would have been the ideal location for the stockpiles.

It seems highly likely that iron ore was available at or very near the site. If Leader had done his job effectively when he scouted out the site for the construction of the ironworks, he would have searched for a location that provided an ample water supply, a drop in terrain that would accommodate a furnace and other ironworking buildings, hundreds if not thousands of acres of forested land, and a nearby source of raw materials. Since the Massachusetts Bay Colony had granted the Undertakers a monopoly on iron production and because iron was such an important commodity for the developing colonial economy,

In the general vicinity were low-lying meadows and swamps containing bog iron ore of good quality. Hard by the bridge which carried the main road between Boston and Salem over Saugus River was a kind of natural amphitheatre, so situated that on fairly level land washed by the stream a furnace could be erected with adequate water power and easy charging from a natural elevation rising above the riparian plain. At high tide Saugus River was navigable right up to the site in question. Handy as the place was to the growing towns of Salem and Lynn, Charlestown and Boston, it was not far from the common lands of Lynn, much of them covered with stands of virgin timber promising an almost inexaustible store of wood for charcoal and construction work. One can easily conjure up a picture of Richard Leader standing at the top of the amphitheatre and announcing, "This is it!"

E. Neal Hartley, *Ironworks on the Saugus,* pp. 123-24.

9.8 November 1942 photograph of the stockpiles of coal and iron ore for the Hanna furnaces of the Great Lakes Steel Corporation. (Photograph by Arthur Siegal. Library of Congress, Prints and Photographs Division, LC USW3-011208-C [P & P.])

the government would likely have supported the industry in any way it could. Leader therefore had both the backing and the incentive to wait until he found the absolute best location for an ironworks. He could have afforded to be very choosy about the final site. It seems highly doubtful that he would have picked a site where the primary component of iron making would have needed importation.

The possibility that the cranberry bog was a source of iron ore for the plant makes the selection of the ironworks site even more logical. Robbins argues this point in his July 17, 1951, log entry.[36] In addition, local legend held that the cranberry bog was the remnant of iron-ore mining activity. If iron ore came from the cranberry bog, it would have been fairly easy for Saugus to build up a substantial stockpile of ore and to circumvent any disruption of supply, at least until the source in the bog was exhausted. The mined ore could have then been aged on site until needed for the furnace. The bog is large enough to have supplied iron ore for years. Ethnographic accounts given to Robbins by men who had discovered bog iron ore at the site provide additional support for this interpretation.[37]

Other raw materials like flux and charcoal would not have been as important in determining site selection. After the immediate woods around a site were exhausted, charcoal would have been brought in from the nearby countryside. The monopolistic grant awarded to the Undertakers also contained provisions for surrounding woodland to support the ironworks. Fluxes could be derived from many different sources and were required in smaller proportions than ore or charcoal. In terms of a purely economic labor model, it would have been most important to locate the facilities near an iron ore source and close to an adequate charcoal supply. Fluxes were the least important commodity and could be imported if necessary. Saugus met all of these needs and provided a terminus for importing flux by water, a cheaper and more effective method of transportation than overland routes.

Although not essential for smelting iron, clay was another essential raw material for the casting of various ironwares. Clay was used in a variety of contexts at the site, but most notably in molds for making cast-iron products, mainly hollowwares. The closer that a good source of clay could be found, the greater the profits from the undertaking, because importing the raw materials cost money. It is interesting to note that in Robbins' April 30, 1950, log entry he records the presence of a clay deposit on Bridge Street.[38] Earle Smith, one of the consultants hired for the restoration project, told Robbins that Saugus would likely have had three years of clay supplies on hand. Clay also needed to weather to develop more plasticity; Smith told Robbins that in England some clay was weathered for as much as five years. Smith thought that the clay discovered on Bridge Street would have made good molding clay. Hartley noted that a local clay source such as this one may account for the lack of any entries for carting clay in the historical documents.[39]

Oct. 20, Friday [1950]. . . . This muck smelled sour, similar to soil found on mud flats when the tide is out. Dr. LaForge and Neal Hartley both examined this soil and agreed it was indicative of a pond bed. No evidence of bog ore was found in this muck. *This observation contradicts some contemporary (hear-say) historians belief that this was a bog ore pit. This hole was more than 10-1/2' deep.*

Roland Robbins, "Saugus Ironworks Daily Log - 1950," October 20, 1950.

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9.9 The cranberry bog, February 1950. (Photograph 344 from the Roland W. Robbins slide collection, 1950, Saugus Iron Works. Courtesy The Thoreau Society® Collections at the Thoreau Institute at Walden Woods.)

Features to the East of the Blast Furnace

The two most important finds made to the east of the blast furnace were the forge and the slitting mill (see Chapter 6). These two structures and their component parts completed the industrial triad of iron-working facilities. Substantially more archeological evidence was found to document the presence of the forge than the slitting mill. Other features including a possible warehouse and a corduroy road were recovered to the east of the blast furnace.

Robbins notes discovering the foundations to what he termed a warehouse between the blast furnace and the Saugus River, in 1949. He numbers this discovery Foundation #6 and argues that the walls were at least contemporary with the slag and thus the ironworks.[40] In a November 9, 1949, entry Robbins speculates that the wooden tank found within Foundation #6 may have been used for tanning. [41] Leather for the bellows and other animal products like cattle hair for waterwheel caulking were necessary for the ironworks operation. Robbins seems to have abandoned his investigation of this building until August and September 1952, when he began excavating in and around the foundations. He then discovered numerous large stones and some fragmentary wood remains associated with the building.[42] Robbins' artifact cards indicate that a tin pot and leather remains were also found in or around the building, although the stratigraphic integrity associated with these artifacts is somewhat uncertain.[43]

Friday, July 29, [1949] . . . . Continued to excavate for wharf site. One or two observations concerning foundation #6. Slag fill at river backs to outer side of foundation #6 southern wall where its depth is about 2'. Inside the foundation #6 area no slag is found. The fact this slag abuts the wall is indication that the wall ant[e]-dates, or is contemporary, with slag fill, possibly both having been undertaken at about the same time . . . .

Roland Robbins, "Saugus Ironworks Daily Log - 1949," July 29, 1949.

Several maps in the Saugus archive illustrate the location of Foundation #6. The remains were located in front of the forge, just to the west of the well. The log entries from late 1952 seem to indicate that the building may have spanned the tailrace on the eastern side of the forge.[44] The warehouse that was reconstructed at Saugus was not located on the remains of this building. Instead, a much diminished warehouse was constructed south of the building remains.

Another miscellaneous feature that Robbins discovered east of the blast furnace was the so-called corduroy road. This log feature, located just to the south and in front of the slitting mill, is briefly mentioned in the May 19, 1952, log entry. It may have been used to stabilize a roadway adjacent to a spring located just to the north of the road.

> Paul found base sills just S.E. of old well which is easterly of foundation #6. The sapling pieces, laid out like [a] corduroy road at S.E. side of one of sills. To northeast of most S.E. sills more wood is noted running N.W.–S.E. It has stone over it. As such the stone work is being removed along course of wood to determine its length and significance if any. The stones have Iron Works activity beneath them.[45]

Due to copyright restrictions, this image is not available in the on-line version of this publication.

9.10 The wooden tub associated with Foundation 6, November 1949. (Photograph 261 from the Roland W. Robbins slide collection, 1949, Saugus Iron Works. Courtesy The Thoreau Society® Collections at the Thoreau Institute at Walden Woods.)

While the road is a prominent reconstructed feature at the Saugus Iron Works, it is barely mentioned by Robbins in his log. Even though he indicates that the corduroy road had stones over it, the reconstructed road lacks the stonework.

The east bank of the Saugus River, across from the ironworking facilities, is a kind of tabula rasa. Robbins never conducted substantial excavations in this area as he did to the west. Photographs taken late in project show a large amount of fill being brought in to raise the grade of the east bank behind the stone wall at the river's edge. While little is known archeologically of this area, this location may have contained some of the missing structures thought to be associated with the ironworks or for housing its employees. However, since all of the buildings seminal to the story of iron production at Saugus turned up on the west bank of the river, neither the FIWA nor the Reconstruction Committee saw a reason to focus research on this parcel of land. Archeological excavations done since Robbins' time have provided little new information.[46]

The portion of the Iron Works property on the east bank of the Saugus River is archeologically virtually unknown. Although it has been subject to disturbance, the possibility of intact archeological deposits remains. These deposits may include the remains of important, but presently poorly known, groups such as Native Americans and ironworkers and their families.

Eric Johnson, *Archeological Overview and Assessment of the Saugus Iron Works National Historic Site, Saugus, Massachusetts*, p. 68.

Burials, Miscellaneous Finds, and Ethnohistorical Accounts

A great deal of folklore and many anecdotes and ethnohistorical accounts made their way into Robbins' log entries. Because the accounts often lack details, it is difficult to judge their value for understanding the Saugus Iron Works site. Neighbors and interested locals often informed Robbins of discoveries in the neighborhood. For example, on August 11, 1949, Mr. Russell of 223 Central Street told Robbins about a pipe near the river where he used to fill jugs. He also told Robbins about a stone-lined well in Mr. Yanofsky's cellar (the site of the Old Scott House) that Russell had filled in. Mr. Russell also told Robbins about falling through what appeared to be an old ice-or cool house, the remains of which were now under Mr. Robinson's house.

Burials at the site had been reported for years and anecdotal accounts of them also made their way into Robbins' notes. One of the most frequently mentioned accounts concerned a purported burial next to Lovell's garage. In the August 11, 1949, entry in his log, Robbins relates a conversation he had with Mrs. Lovell. Evidently, James Staziniski, the builder of the Lovell house, had called Mrs. Lovell and told her that during construction of the house he had found a building foundation, a number of coins (two-cent and three-cent silver pieces), and a grave on the side of Lovell's garage facing Marion Street. Subsequent investigations by Robbins failed to locate this burial. However, National Park Service staff has reported other anecdotal accounts of burials at the site, one purportedly up next to the museum. According to staff, a burial was supposedly found there with a large cache of arrowheads, although no written account of this exists.

9.11 The excavation of the corduroy road timbers and associated bridge, November 11, 1952. (Photograph 746 by Richard Merrill, 1952.)

Robbins makes several references in his log entries to prehistoric deposits near the river in the industrial area of the site. He mentions shell found in conjunction with lithics. Professional archeologists today would consider this a key determinant and probably refer to it as a shell midden. In a June 10, 1953, entry, Robbins likewise refers to Indian ash pits found below the working surface to the south of the slitting mill.[47] A brief perusal through the prehistoric collections made by Robbins and curated at the Saugus Iron Works indicates the great variety of tool types and lithic sources used in prehistoric tool production at the site. Robbins even called the Massachusetts Archaeological Society in to excavate prehistoric features, to no avail.[48] The variety of stone types in the collection is truly remarkable.

While the wharf, dock, and tidal basin were eventually reconstructed by the FIWA, other features like the charcoal house, raw material stockpiles, water-holding basin, and bog-ore mining areas, and the Jenks area never were. Part of the problem lay in the fact that many of these features were located on land not owned by the FIWA. It is somewhat unfortunate that many of the miscellaneous features that could be identified were not reconstructed at the same time as the furnace, forge, and slitting mill. It makes for a rather incomplete picture of the facility. Visitors take away a very biased representation of how the site looked in the mid-seventeenth century based only on the three reconstructed industrial buildings (five counting the warehouse and later blacksmith's shop). Places like Hopewell Furnace National Historic Site present a much more accurate picture of what an ironworking site may have looked like, although Hopewell dates from a later period and was not in a ruinous condition like Saugus when it became a park. The presence of a collier's hut, charcoal pit, charcoal house, tenant houses, barn, springhouse, etc., provide a more complete representation of the other buildings that would have supported the iron production.

10.1 View of the materials collected by Robbins, January 7, 1950. Note the nail barrels for storage. The inset at the upper right is an example of the catalog cards that Robbins used to keep track of artifacts in the collection. (Photograph 141 by Richard Merrill, 1950.)

The Artifacts

Janet Regan and Curtis White

Roland Robbins uncovered thousands of artifacts during his five years of excavation at Saugus Iron Works. This chapter presents a general survey of the artifacts contained in the collection, by Janet Regan, and a thorough examination of the seventeenth-century casting process based upon the artifacts, by Curtis White. This collection has enormous research value for addressing a multitude of issues connected with early colonial ironworking and precontact lifeways. Hopefully, this overview of the collection will inspire those interested in material culture to undertake additional research based on this rich resource.

Thursday, November 20th. Continued excavations at dock site . . . . Among the interesting artifacts being found at dock site excavations, was a heavy lead weight. This weight had an iron pin running through it from top to bottom. The top of the pin had an iron ring through it. The most unusual thing about the weight was interesting Hallmark, or Guild mark found stamped on its top. It should be interesting trying to run down its identity.

Roland Robbins, "Saugus Ironworks Daily Log - 1952," November 20, 1952.

The Roland W. Robbins Collection at Saugus Iron Works

The Roland Wells Robbins Collection (1948–1953) contains more than 4,000 artifacts recovered from the site of the 1646 ironworks known as Hammersmith. In addition to the seventeenth-century artifacts, the collection also contains a significant number of precontact and contact-period artifacts representing more than 7,000 years of Native American activity in the area. The sheer volume of artifacts from these periods makes this collection truly unique and contributes to the site's potential to expand our understanding of these eras.

The extensive historic artifact collection is made all the more valuable by the archival records of the First Iron Works Association (FIWA), which chronicle the site's archeological excavation and reconstruction from 1948–1954. These records include Robbins' daily archeological logs and field note cards, as well as materials compiled by the American Iron and Steel Institute, including correspondence, meeting minutes, maps, architectural drawings, oral histories, 16 millimeter films, and more than 5,000 photographic images. The archive provides invaluable information on the site's complex archeological story and lends special insight into the motives and methods of those involved in reconstructing the ironworks.[1]

Native People Collection

Roland Robbins' mission, as assigned by the Reconstruction Committee, was to locate key features and recover materials associated with the 1646 English colonial ironworks. As a result, he gave only secondary consideration to precontact evidence. In fact, Robbins gave more than 1,000 precontact objects to a neighborhood school boy. Fortunately, the collection was returned to the Saugus Iron Works National Historic Site in 1978; however, Robbins' field notes associated with the collection were lost when water flooded the donor's basement. Despite this loss and research limitations due to provenience problems, the surviving objects themselves hold great value in depicting activities that occurred at this site over thousands of years.

Because the ironworks site was situated immediately below a fall line at the head of the Saugus River estuary, the area was an important fishing ground for Native Americans. The precontact-period collections feature an assortment of lithic tools that date from the Middle Archaic (8,000–5,000 B.P.) to the Contact Period (1500–1620), including grindstones, grooved axes, drills, gouges, pestles, plummets, awls, scrapers, knives, hoes and a variety of projectile point types. Many prehistoric objects in the collection are made from "Saugus Jasper," an easily worked stone that was widely traded as a tool-making material. Ceramic and soapstone sherds and bone objects are also present in the collection.

The Saugus collection is especially valuable for telling the story of Native people during the Contact Period. The people of the Saugus area were called the Pawtuckets (also known as the Penacooks). An Algonkian speaking people, they lived in semi-sedentary communities that moved with the changing seasons from winter longhouse settlements, to spring fishing sites, to summer villages, to fall hunting camps.[2] Contact with Europeans brought epidemics in 1616 and 1633 that devastated Pawtucket communities and depopulated large tracts of their lands.[3] As pressures from English settlement increased, dispossession of Indian land intensified. Some surviving Pawtuckets made alliances with settlers and some even became Christian converts.[4] According to the ironworks' accounting papers, two Native people were employed to cut trees for charcoal production at the ironworks in 1651.[5]

Native Americans were the sole human occupants of the Saugus area for over 10,000 years. The Iron Works Site was an important area during most, if not all of this span.

Eric Johnson, *Archeological Overview and Assessment of the Saugus Iron Works National Historic Site, Saugus, Massachusetts*, p. 25.

The Saugus Iron Works museum collections hold examples of merchandise typically traded to Native Americans, including axes, pots, and "Jew's harps" that were produced by the ironworks. Industrially manufactured trade goods replaced stone, wood, bone, and ceramic items, helping to erode the self-sufficiency of indigenous economic structures and Native Americans' traditional lifeways. With the defeat of Native peoples allied during King Philip's War in 1676, most surviving Pawtucket families moved further inland, joining western tribes such as the Mohegans.[6]

Hammersmith Collections

The majority of the Robbins collection documents the seventeenth-century ironworks and its surrounding community. The collection provides a remarkable record of early iron-making processes, products, and mechanical techniques, as well as a portrait of early colonial settlement life in and around the industrial compound. Exceptional in its scale, degree of preservation, and rarity, this collection is a compel-

10.2 An assortment of net sinkers or plummets (SAIR 4298, 4491, 2507, 4188) provides evidence of fishing at this site. (Photograph by William Griswold.)

ling resource for those interested in seventeenth-century settlement history, industrial archeology, or iron-making tools and machines.

Blast Furnace Site Collection

The remains of the blast furnace overshot waterwheel and its nearly intact 27-foot-long by six-foot-tall hutch enclosure are a centerpiece of this collection. The hutch is comprised of sills, posts, plank sheathing, and decking and several pieces are incised with Roman numerals that colonial millwrights used to guide its assembly. About forty percent of the waterwheel has survived. Its components include soles, bucket boards, rungs, spokes, and shrouds that also bear incised millwright's markings. The blast furnace waterwheel and hutch assemblage and its 31-foot wooden raceway section, complete with staple-shaped iron supports and cow-hair caulking, are outstanding sources of information on colonial water-power technology and millwright construction techniques and designs.

Architectural remains of the furnace include furnace stones, bricks, clay packing, beam pieces, sow bar lintels, and sandstone lining, and the oak sills and wrought-iron tuyere (air nozzle) of its water-driven bellows, along with cams and a cam shoe that closed the furnace bellows. Surviving workers' tools held in the site's collection include crucibles and ladles, which were used to pour molten metal into forms buried in casting sand, and ringer fragments, pointed iron poles that were used to scrape liquid iron from the furnace hearth.

The collection also contains a variety of products manufactured at the colonial furnace including several sow and pig iron bars, ranging in weight from 14 pounds to 290 pounds. Many hollowware fragments that are evidently failed castings (called wasters) are also held in the collection. These fragments illustrate a range of vessel types, including pots, kettles, Dutch ovens, and large cauldrons. Although Robbins' excavations did not unearth a whole cast-iron vessel, the Lynn Public Library holds a complete pot with a lid and bale, known as "the Saugus Pot." The pot's metallurgy matches the pot fragments preserved in the site's collection.[7] Additionally, Robbins recovered cast-iron and lead weights from various areas within the furnace site, some with rings and some without, and some impressed with a stamped design. These may have been sold as "standard weights" to local merchants and/or were used by iron-workers to weigh products or materials at the furnace's steelyard or balance.

Colonial furnace workers also cast replacement equipment for the ironworks itself, such as hammer-heads, cams, cam shoes, etc. The collection holds what seem to be the remains of a shattered trip hammerhead. The site's history object collection also includes a fireback, embellished with the date 1655, the initials "E H," and a handsome pattern of decorative fretwork, that is a metallurgical match to Saugus

[Cast and wrought iron products] helped fuel what has been called [a] "consumer revolution" . . . that had its impact on the material culture of Massachusetts Bay from the very beginning. The English increasingly became leaders in manufacturing cheap but serviceable iron-wares: kettles, skillets, pots, nails, pins, trivets, andirons, wool combs and cards, axle-trees, bits, stirrup irons, spurs, grates, locks, and keys. These [wares]. . . helped raise the standard of living for the families of gentlemen, yeomen, and even craftsmen. These were all amenities that the migrants to Massachusetts Bay expected to continue to enjoy in their new homes.

Stephen Innes, *Creating the Commonwealth, the Economic Culture of Puritan New England*, p. 278.

10.3 Analysis being conducted on the "Saugus Pot." (Photograph 279 by Richard Merrill, 1951.)

castings. This piece was discovered in Maine and is one of five surviving firebacks attributed to the Saugus furnace.[8]

Robbins also collected raw materials associated with the ironworks, including samples of gabbro (a local igneous rock used as a flux), bog ore, West Indies coral, and charcoal. Large amounts of slag (a by-product of iron production) were also collected by Robbins and are represented in the collection and on the site; the slag pile, adjacent to the furnace, is one of the last surviving in situ remnants of the original ironworks.

Forge Site Collection

Robbins' investigations uncovered dramatic finds at the forge site. A 500-pound trip hammer and two anvil bases with their supporting crossbeams are impressive objects that speak to the powerful mechanics entailed in the colonial refining process. Stone foundation remains, wooden uprights, pig bars and pig bar ends, casting pieces, wedges, spikes, and heavy slabs of iron are some of the objects found here that may be related to the refining process. The pig ends and possibly the casting pieces would have been melted in the finery hearths to start the refining process; wedges and spikes would have been used to brace equipment or to split lumps of material; and iron slabs may be the "plates"on which the "finers" beat and dragged "loops" (masses of iron that have been "cooked" in the finery hearth). [9] A large clump of fused iron and slag with a wedge stuck in its middle—remaining just as a workman left it more than three centuries ago—may, in fact, be an example of a loop. Regrettably, provenience data is missing for this interesting object.

Hammersmith was a school for ironworkers. Its alumni went forward to build and work many later plants ranging from Massachusetts to New Jersey.

Neal Hartley, "Iron, Steel, and American History," speech, American Iron and Steel Institute regional meeting, Chicago, Illinois, 1953.

Absent from this collection is an example of a "merchant bar," the forge's main commercial product. This valuable sales item would have been sold as a semi-finished commodity to local merchants or as stock to blacksmiths, who would fashion the iron bars into all manner of finished tools and utensils. Colonial workmen may have also forged anchors at this site–an anchor shank was recovered from the Saugus River and 36 anchors are listed in the 1653 ironworks inventory.[10] The collection also holds a jaw piece from a set of large-scale tongs that are without site provenience, but are very likely the remains of a tool used by workmen at the forge.

Slitting Mill Site Collection

About 12 percent of merchant bars traveled to the rolling and slitting mill to be made into flat bars, which were useful as blacksmith stock for hinges, lock plates, and other pieces or as iron bands for wagon wheels. Some of the flat bars were slit into nail rod and sold to blacksmiths for nail production. Objects in the collection associated with the slitting mill include several flat bars, a partially slit flat bar,

10.4 Latch handle, hinges, and door bolt (SAIR 3312, 2084, 2456, 2427.) (Photograph by William Griswold.)

several nail rod pieces, a machine spacer, and a cross-rung from the lantern wheel.[11] Robbins' field notes also mention that fused lime materials, a fire bed, sand, clinker material, and a long notched bar were found in the slitting mill area.

Jenks Site Collection

Robbins' excavation of the Jenks' blacksmithing forge uncovered evidence of water-powered mechanization at this site, including waterwheel remains, a tuyère, an anvil base, and a gear hub. The Jenks blacksmith shop specialized in edge tools and the collection from this area includes knives, a scythe blade, axes, adzes, chisels, a drawshave, a hacksaw, and a pole saw. An extraordinary example of an early sawmill blade was also uncovered here. This blade may have been intended for Richard Leader's water-powered mill in what is now North Berwick, Maine, which operated with "nere 20 saws at once."[12] The Jenks shop also ran a wire-drawing operation, which produced hundreds of brass straight pins and two brass brooches that were recovered during the excavation. Several latten spoons were also found along with sheets of brass. Spades, hoes, a pitchfork fragment, a cow bell, a stirrup, a brass spur, ox shoes, and horseshoes discovered at this site give us a depiction of agriculture and animal husbandry in the Massachusetts Bay Colony. Blacksmithing and other tools found here include tongs, hammers, a die, a rasp, ringer tips, a wrench, and a tool rest.

Dr. Barghoorn, Miss LaCroix and Gerry here at 6:45 (Gerry here at 5:45). We had dinner, then came back to my office and went over details for a new building for storing and cataloguing relics. Also discussed a system for cataloguing our relics. Left here at 11:15 p.m.

Roland Robbins, "Saugus Ironworks Daily Log - 1952," July 1, 1952.

General Tool and Hardware Collection

Robbins recovered an assortment of hardware, including latches, locks, keys, pintles, a variety of hinge styles, and many types of fasteners such as nails, spikes, staples, threaded screws, bolts, rivets, and thatch pins. Among the collection's many woodworking tools are axes, froes, chisels, claw hammers, gouges, pliers, a mallet, and a scribe. One surprising artifact in this category is a beautifully decorated carpenter's claw hammerhead. This utilitarian object, ornamented in the Mannerist style, was discovered in the mud at the waterfront's boat basin, where its owner might have accidentally dropped it into the river. The ironworks existed during the Mannerist period, when designs and flourishes embellished all manner of things, including everyday objects like tools. Historian Jonathan Fairbanks writes in ***New England Begins*** that "… the people of the 17th-century … could not separate notions of beauty or form of an object from its use. Beauty, significance, utility, and form were all inseparable parts of the whole."[13]

Various trades and industries are represented by objects in the collection, including large rings that were likely used in the production of cast-iron salt pans, an essential piece of equipment for salt makers. Salt making was fundamental to the fishing industry, which shipped huge quantities of salted cod to the Catholic countries of Europe. Other fishing-related items in the collection are fishhooks and a harpoon fragment. Maritime items include a ship's deadeye, an anchor, and a thimble for rigging. These materials

10.5 Claw hammerhead decorated with incised lines that reflect Mannerist aesthetics of seventeenth-century England and New England (SAIR 2533). (Photograph 1029 by Richard Merrill, 1953.)

may have been associated with the company's sailboats. The collection also contains a number of axes that would have supplied shipwrights, housewrights, and colliers. Coopers would have used iron bands for their barrels and soap-makers would have used the ironworks' cauldrons for " boyleing sope in ye River."[14]

Domestic life in and around the ironworks is represented through a variety of material types. Ceramic and glassware fragments are prevalent in the collection and have been useful to researchers interested in charting overseas trade relationships.[15] The ironworks regularly supplied its workers with tobacco and a large number of clay pipe pieces were recovered, including several terra cotta pipes of New England manufacture.[16] Other domestic items include a pair of scissors, several latten spoons, andirons, a variety of kitchen wares, a finger ring, brooches, and a nursing nipple.

The Robbins collection also holds a number of shoe parts that are evidence of a cobbling operation. These objects date to the late or post-ironworks period and include a cobbler's hammer and knife and a pair of cobbler's pliers. An assortment of worn leather shoe pieces, a few unused shoe pieces, cutting scraps, a large leather apron piece, and several stacked heals with wooden pegs are also present.[17] Shoe parts were found in the furnace area, the Jenks site, the slag pile, and the dock site.

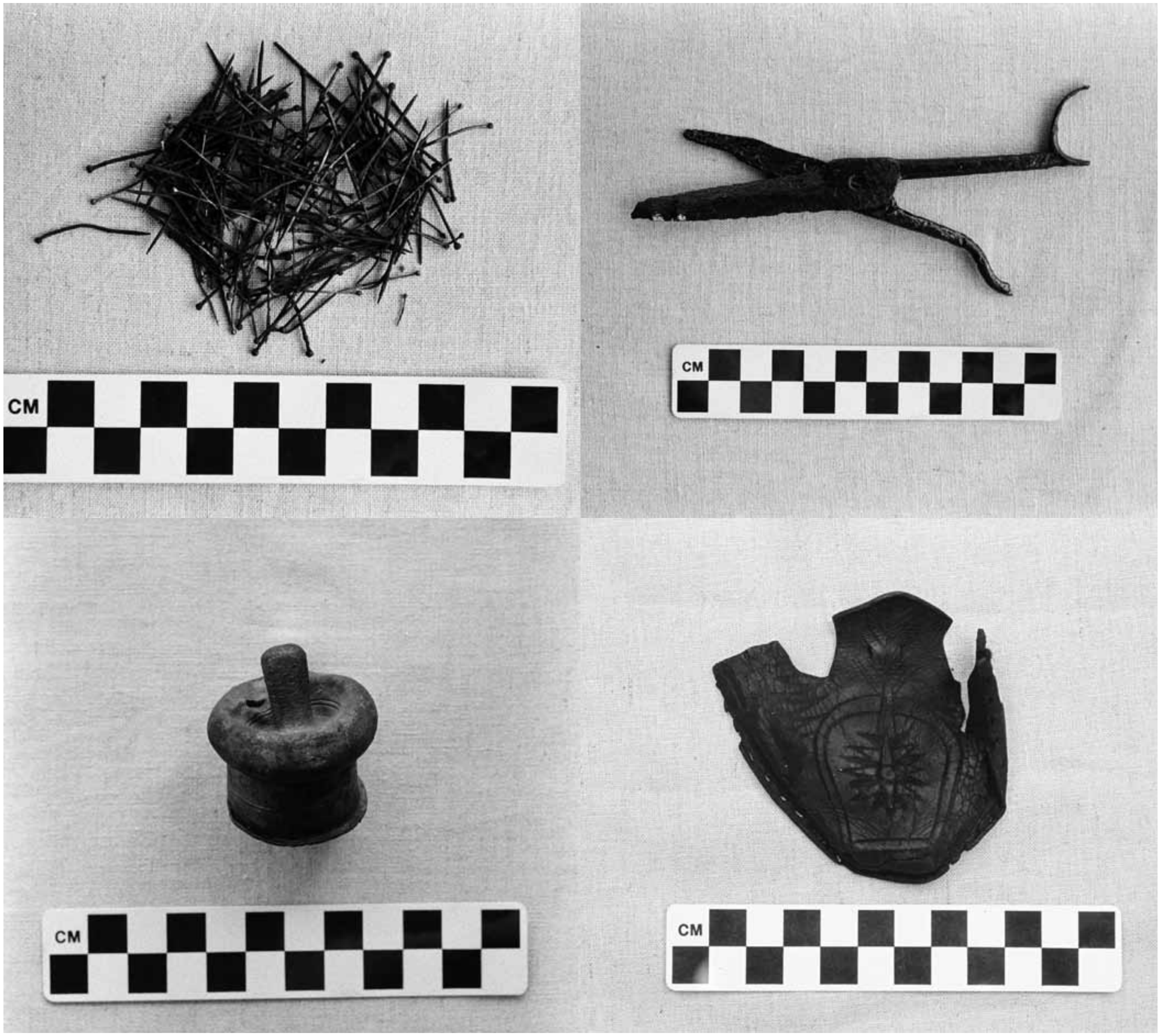
The site's weaponry collection consists of pikes, a musket barrel, a breach plug, shot, cannon balls, bullet molds, a bullet, and a grenade. Although militia service was a requirement for most settlers, ironworkers were exempt from military duty, perhaps because of the importance of their work and its round-the-clock nature once a blast began.

Collection Provenience

Provenience is a significant problem for the Robbins collection. This is a consequence of Robbins' labeling system in combination with circumstances that occurred after he left the project. Robbins, and occasionally his crew members, recorded provenience information for excavated objects on three-by-five-inch index cards, but they also used slips of paper, tags, envelopes, and fragments of cardboard to note in situ object location. Some of Robbins' field note cards plotted the specific location of an artifact by triangulation from two known points and many included diagrams depicting object location. Because Robbins assumed that a physical association between the field note cards and the objects would be maintained, his field note cards often use generic descriptors such as "these artifacts were found . . . ," without identifying specific objects. Unfortunately, collection pieces and field note cards were separated and/or cards were lost or damaged, resulting in the loss of provenience information for the majority of the collection.

Friday, April 24th . . . . Yesterday Fitch showed me a letter from Attwill stating that when we install the clock system for the watchman, there probably will be no need of the A.D.T. System for the old museum building. To my mind, this is ridiculous. If the watchman checks the different buildings once an hour or twice an hour the time between these checks would permit the old buildings to become a raging inferno before the watchman's next check. To my mind, if fire should brake [sic] *out in the old museum building, within five minutes the interior could well be beyond control. In any event, I have made my point, this being the need of utmost precautionary measures where we are exhibiting our original waterwheel, anvil block, other wooden artifacts and hundreds of invaluable relics.*

Roland Robbins, "Saugus Ironworks Daily Log - 1953," April 24, 1953.



10.6 Clockwise from top left: straight pins from the Jenks area (SAIR 9714), wrought iron scissors (SAIR 3310), shoe vamp with decorative toe medallion (SAIR 2699), and a pewter nursing nipple (SAIR 2819). (All photographs by William Griswold.)

Robbins did use a few other systems to identify object provenience. He incorporated data from his field note cards into his notebooks and produced careful sketches illustrating context for some of his finds. His Kodachrome slides and Richard Merrill's black and white photos supplement provenience information. Robbins also applied "relic numbers" (a three- or four-digit number separated by hyphens and often followed by an asterisk) in ink or paint directly onto roughly 140 objects collected from the blast furnace area and annotated the corresponding field note cards with the numbers. Several of these numbered object lots are mentioned in Robbins' report, "Excavations and Artifacts, Record of 1948." He also applied numbered fiberboard tags to wooden pieces from the Jenks shop that are noted on measured drawings drafted by Herb Bogan of the architectural firm Perry, Shaw, and Hepburn, Kehoe and Dean. He inserted numbered window-hanger's buttons to some of the furnace waterwheel hutch pieces, presumably to aid in its reassembly, and attached aluminum tags to other wooden architectural elements. Neither the window-button numbers nor the metal tag identifiers were noted on the field note cards or in any other document that remains with the collection.

In Robbins' museum, his field note cards served as labels for artifacts stored in museum cases. Robbins kept a card file for objects that were displayed without cases. Additionally, he stored a significant quantity of excavated artifacts and materials with their associated field note cards in a variety of containers that he kept beneath exhibit display tables and in the museum attic.

Tuesday, June 16th. Continued work in museum buildings. Had Bill the carpenter build a panel on which to exhibit the largest waterwheel found in the Jenks area. Relocated the exhibit case in the old museum building and arranged a new layout of artifacts in it.

Roland Robbins, Saugus Ironworks Daily Log- 1953," June 16, 1953.

At some point after 1953, portions of the Robbins collection that had been stored in containers were moved to a large, open crawl space beneath an outbuilding on the east side of the Saugus River. There the collection remained until 1972, when the National Park Service undertook a project to inventory this object group. The artifacts were shipped to the Harpers Ferry Center, Harpers Ferry, West Virginia, by truck and the cards and objects shifted during transit.[18] According to NPS Supervising Archeologist John Cotter, the collection arrived in

> ... an assortment of containers, including over 100 wooden nail kegs, gunny sacks, tubs, oil cans, buckets, cardboard boxes, and other miscellaneous receptacles .... Provenience cards, usually 3x5", were scattered in the lots, sometimes more than one to a lot. Some lots lacked data cards or any type of identification.[19]

The overall condition of the note cards for this artifact group is poor to very poor, with cards damaged by tears, dirt, sun bleaching, mold, and water stains; many are simply illegible. Harpers Ferry staff assigned lot numbers to each of Robbins' artifact groupings and attempted to reassociate their field note

10.7 The artifact display cases in the museum. (Photograph 794 by Richard Merrill, 1953.)

cards with limited success. The Harpers Ferry project culled the collection so that "about half of the weight and bulk of the collection" was discarded.

In 1973, the NPS hired contractors Denis Piechota and Russell Barber to conserve and catalog the artifacts and materials that were returned by Harpers Ferry and those that remained at the Saugus on-site museum. Project cataloger Russell Barber found this collection to be in disarray:

> . . . a portion of the materials indicates that the index cards used for recording proveniences of lots sometimes were out of place, only partially descriptive, or missing altogether. Discrepancies between the 1972 cards and the materials found in the summer of 1973 suggest further jumbling. As a consequence, a great portion of the collection is without site context; the majority of it is without positive provenience.[20]

Piechota and Barber undertook a second culling of the collection with a qualitative sampling of "the most common artifacts, e.g. nails, utility potsherds, bricks . . . [that] resulted in the discard of approximately one-half, by weight, of the collection."[21]

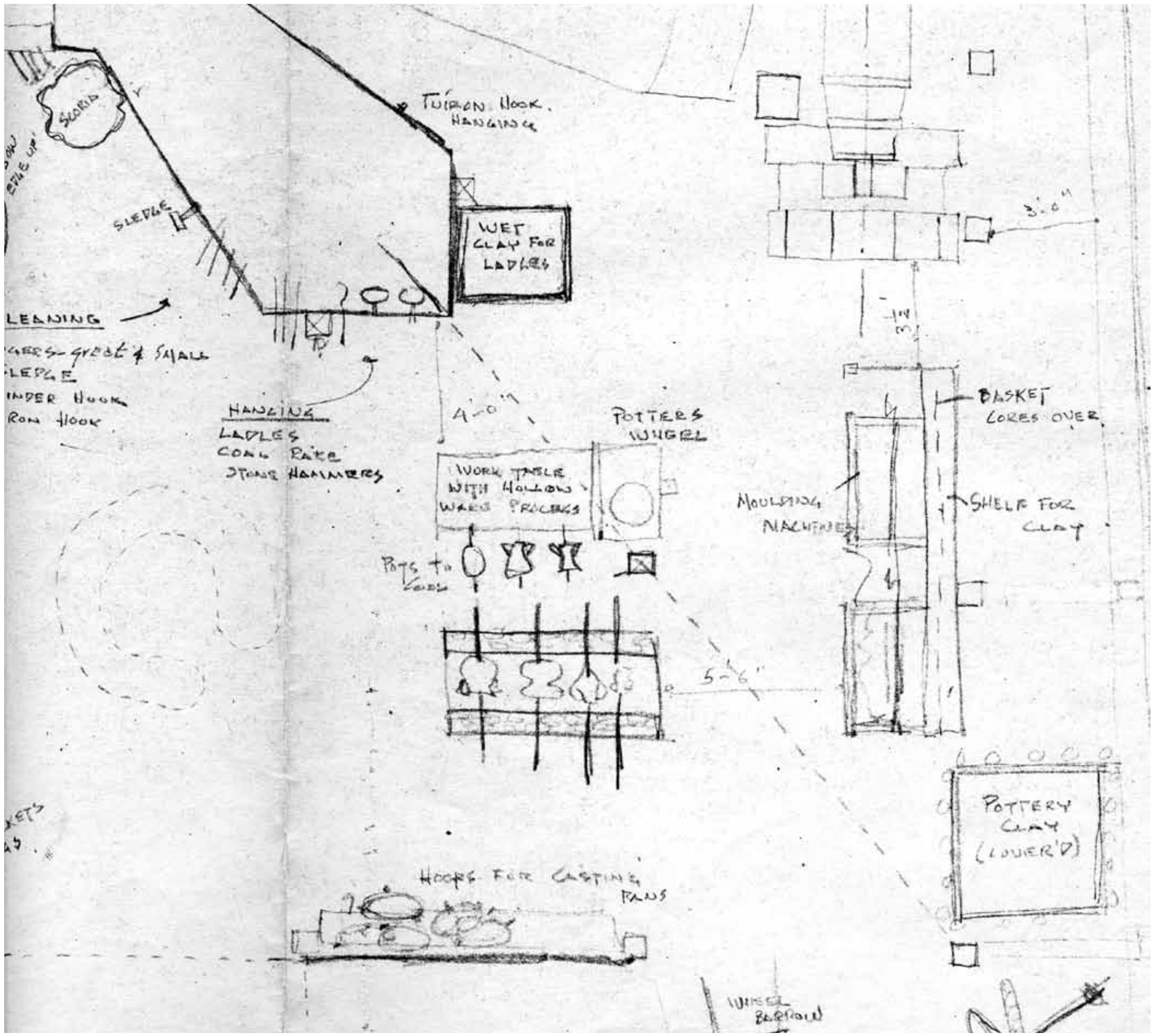
For the past several years, NPS staff and a cadre of dedicated volunteers have invested much effort in organizing, scanning, and transcribing Robbins' field note cards, notebooks, reports, committee meeting minutes, and other documents. Eventually, staff can begin to layer excavation discovery information to help fill in the gaps and hopefully to reestablish provenience for some of the collection. In addition to the thousands of artifacts recovered during the excavations, accounting records, court records, inventories, and some correspondence from the original ironworks have survived and are preserved at several local repositories, including the Baker Library at Harvard Business School, the Massachusetts State Archives, the Lynn Library, the Old Colony Historical Society, and the Peabody Essex (Philips) Library. With these primary sources, it is possible to provide historical context for many museum pieces.

A Reevaluation of Three Groups of Artifacts Associated with the Blast Furnace

Artifacts discovered during Robbins' excavations inspired a passionate commitment toward an accurate reconstruction, while at the same time creating controversy among the original planners of the Saugus Iron Works restoration. Problems associated with the interpretation of various features and artifacts, such as the existence of a second power hammer in the original Saugus forge, have continued to generate discussion among scholars. The following section offers a reevaluation of three groups of mystifying artifacts produced at the ironworks and excavated at or near the blast furnace site: a collection of 78 notched bars and notched bar fragments made of cast-iron, a collection of cast-iron pot fragments, and two large iron rings and three iron ring fragments. All three groups of objects provide important infor-

I wonder if it is possible that a trough ran from the hearth through the sow casting bed down into this area where moulds had been placed in this sand? That would have made possible the casting of sows, kettles, etc., all in one operation! Also would help to account for the use of a slope for early operations. Future work here shall reveal more information, I'm sure.

Roland Robbins, "Saugus Ironworks Daily Log - 1949," November 9, 1949.



10.8 This drawing proposes how molding operations would be represented in the northeast corner of the casting shed. It includes molding machines, a drying furnace, a bin for mixing loam, and hoops for casting pans (bottom). The circle of dashed lines on the left represents the archeological remains of the casting pit. (Perry, Shaw and Hepburn, Kehoe, and Dean, undated drawing.)

mation about seventeenth-century furnace processes and shed light on decision making by the planners and architects of the twentieth-century furnace reconstruction.

"Notched bars" and the Iron Works Operations in Braintree and Saugus: Implications for a "Second Hammer" in the Saugus Forge

Perhaps the artifacts that best illuminate the technical skills of seventeenth-century metallurgists at colonial ironworks are the 78 cast-iron objects that Roland Robbins called "notched bars." Only one notched bar (SAIR 1665) remains unbroken. This intact iron bar measures 29 inches long and gradually tapers to a point at both ends. It has V-shaped notches cast crosswise and uniformly spaced along its underside for its full length. To produce it, the molder at the blast furnace carefully pressed a wooden pattern carved with notches into the sand floor of the casting shed, leaving a negative form of the pattern in the special casting sand. As the molder gently poured molten iron into the void made by the wooden pattern, the glowing liquid iron began to darken and "freeze" into the solid form of the notched bar.

Before casting began, workers would break the notched bar and examine the fractured iron surfaces in cross section to determine whether they had the right type of iron for the desired finished product. Knowledge of the nature and composition of the iron was critical to maximize profits and reduce damage from high furnace temperatures that would "tear the furnace" and increase maintenance costs. Robbins found many sections from these cast-iron bars just a few feet southwest of the stone base of the blast furnace, the location where they would have been used as diagnostic tools for the production of cast iron. Workmen could either direct the iron into sand molds for sows that would be forged into wrought iron or directly cast it in a loam mold that was specially prepared and dried.[22]

While one might argue that most archeologically recovered material is fragmentary, fragmentation of the notched bars at Saugus actually proved diagnostic. The purpose of the notched bar is suggested by the fact that all but one of the bars unearthed by Robbins had been broken. Governor Winthrop described this process to the younger John Winthrop in 1648, noting that "They tried another mine [iron ore], and after 24 hours they had a some [sum?] of about 500: which when they brake [break] they conceived to be a 5th par[t] silver [white iron]."[23] Iron manufactured in the early twenty-first century is still tested and graded by this analytic process called fracture. Metal workers, perhaps for thousands of years, have known that when a V-notch is cut, chiseled, or cast into the metal, this notch can be used to initiate a fissure that promotes complete fracture. Because cast iron is brittle, there is virtually no plastic deformation when it is fractured. Despite their intrinsic brittleness, these cast-iron bars require significant and deliberate force to break at the notch. The resulting newly exposed surface allows examination of the variable crystalline structures within the iron fragment being tested. These visual surface attributes can be compared in much the same way as minerals produced in nature, using terms such as color and luster

Classified relics. Hartley in for two hours in a.m. Neal said that a small book "Pioneer America", by Carl Dreppard has lots of information on 17th century furniture and utensils. Said that it has a picture of a metal bar, similar to the bars we find notched on one side, and it is called 'Cob Iron'. It is used in the fireplace, stretched across a small standard at either end, and wood is set upon end resting against the notched bar which holds it in place.

Roland Robbins, "Saugus Ironworks Daily Log - 1950," June 6, 1950.

10.9 Four examples of broken "notched bars." First rust and then artifact conservation have rendered the original fracture surfaces indecipherable. (Photograph by Curtis White.)

to observe the refraction of light. About 1643, while John Winthrop, Jr., was collecting information on smelting ore into iron, he came across and recorded comments from English ironmaker Thomas Cootes about the various types of iron: "... [the ore] yielded great store of Iron and wrought very well and gently, in the furnasse, and would make both gray motly or white sowe Iron."[24] The terms gray, motley, and white are actually standard classifications given to cast iron based upon visible examination of the fracture. Clearly, both Winthrop and his father, Governor Winthrop, were familiar with fracture testing even before the establishment of the Saugus ironworks.

Many commentators have noted that the final cast-iron product can be changed accidentally or, more importantly, deliberately by varying any one or a number of factors. In 1964, G. Reginald Bashforth explained that "the type of iron produced is dependent on three factors: (1) the raw materials charged; (2) the temperature at which the furnace is operated;" and "(3) the type of slag formed."[25] Writing some 200 years earlier in 1775, Pierre Grignon described the effects of factors such as cooling rate and material thickness:

> ... when cast iron that is by nature gray is received in a cold, humid, compact body, it congeals precipitately and becomes white, hard, and brittle, so that if a piece is molded in such a manner as to make it unequal in its thickness, even though it is cast from the same drop of gray cast iron, the thinnest part is white, that which is a little thicker is mottled, and that which has the greatest volume is gray ... .[26]

The notched bar's purposeful form provides the key to its function; it serves well as an analytical device precisely because it gradually tapers from the middle to a point at either end. As Grignon states, the iron at the ends freezes quickly into a white iron. As the thickness of iron increases toward the center of the bar, the iron transitions from a mottled gray and white to a gray iron. Depending on the amounts of carbon, iron, and silica, the cooling rate, and the bar thickness, the transition from white to mottled iron would vary both from furnace tapping to furnace tapping and from notched bar to notched bar. To use the notched bar to inform production, the bar would be broken at a thickness similar to the thickness of the planned casting. Workers would then adjust the volume of air blown into the furnace, the iron composition, or the cooling rate in order to obtain the attributes desired for the finished casting. Additional fracture tests could then be made to reanalyze material changes just prior to making the final casting.

Gray, white, and mottled irons all had practical uses in the seventeenth century. All three were cast directly from the furnace into the mold; both this process and its product are now referred to as "direct metal."[27] Gray iron gets its color from carbon, visible in the form of graphite flakes. Graphite is a lubricant that makes it easy to file or saw off flash (the molten metal that has squeezed its way between parting lines of a mold and hardened) and sprues. Sprue refers to metal that remains in a mold's gates,

Among the more striking features of pots made at the ironworks are the feet and the numerous bands or ribs that decorate the body of the pot. The feet are fashioned with five facets, the innermost of which is wider than the other four, and a pronounced toe.

Jonathan Fairbanks, New England Begins, The Seventeenth Century, Vol. 2, p. 354.

10.10 Typically, cast-iron pots were made from gray cast iron cast in a loam mold. (Photograph by Curtis White.)

which control the rate at which a mold cavity is filled.[28] Gray iron at Saugus was used to cast pots, skillets, firebacks, and round and square salt pans used to evaporate sea water for the purpose of extracting salt.[29] The ironworks may have also produced a small number of try pots for rendering whale blubber into oil at shore-based whaling operations, although there are no written references to it. Similarly, iron may have been cast as boiling or reducing vessels, since the 1650 inventory lists a furnace at the river for boiling soap.[30] Presumably the quantity of wood ash generated at ironworking locations facilitated the manufacture of lye, a vital ingredient of soap.[31]

Mottled iron results when part of the carbon occurs as graphite while the rest melds with the iron. An eighteenth-century reference describes its appearance as "the spots on a dogfish or trout."[32] White cast iron results from smaller amounts of carbon and silicates. It is harder than gray iron and therefore more difficult to work with hand tools. Its brittle hardness and resistance to wear make it suitable for machine parts subjected to compression stresses, such as the casting cams and large hammerheads and could be used at the ironworks.[33]

Gray, white, and mottled wrought iron can also be processed from pig iron. Each type of iron requires special treatment in the forge, achieved by manipulating iron plates and the direction of the air blast in the hearth.[34] Knowing whether iron is gray, white, or mottled, therefore, is crucial, making the use of the notched bar for testing a critical step in ironworking.

The notched bar has direct relevance to the discussion of comanagement of the dual English colonial ironmaking operations established by the Company of Undertakers: the 1643 ironworks in Braintree (now in Quincy) and the 1646 ironworks at Lynn (now in Saugus). In an April 1652 letter to the ironworks agent, John Gifford, John Becx and other investors told Gifford how to better manage the company's assets at both Braintree and Lynn: "As concerning the furnace at Braintree, we would have nothing cast in that but pots or other cast ware or salt pans or shot (in the furnace at Lynn nothing but pigs should be cast which will make your pigs better and tear the furnace less)."[35] The investors obviously distinguished the difference between gray and mottled iron and understood the effects of the corresponding manufacturing processes on furnace linings. They strongly suggested to Gifford that he make only mottled iron at Lynn thus extending the life of the furnace lining while improving the quality of pig iron made there. Extending the life of a furnace lining would increase the annual production of pig iron and, by extension, the production of wrought iron.

Clearly, the Company of Undertakers was aware of fracture testing as a vital tool to manage iron production. With the anticipated increase of pig iron at Lynn, Becx proposed the addition of another finery to lower the iron's carbon content. He also suggested building another water-powered hammer to forge

Our desire is that another hammer be set up in Lynn forge and another finery, there being a hutch [wheel pit] for it already and will be done with little cost . . . .

Lynn Iron Works Collection. Baker Library Historical Collections, Harvard Business School, p. 35.

10.11 Fragment (SAIR 2166) showing the misalignment of the two halves of the loam mold. The right side is thicker than the left. The inside of this fragment has no such ridge as the loam core was a single piece with no parting line. (Photograph by Curtis White.)

wrought-iron bars since there was already a tailrace to carry away the water after it had powered the waterwheel and hammer.

Cast-Iron Pots

While the Undertakers apparently pushed John Gifford to manufacture gray iron castings exclusively at Braintree, the archeological collection at Saugus includes the remains of dozens of castings of iron pots. These fragments may have been produced before John Becx's 1652 letter or after the ironwork's bankruptcy in 1653. Of course, all of the pots are broken or have some defect that prevented their sale. Pot legs, ranging in size from a few ounces to a few pounds, illustrate the various sizes of castings produced at Saugus. Pot defects include pock marked castings caused by excess moisture in the mold, a sprue and rim resulting from the use of low-temperature iron or an insufficient quantity of iron, and, in the case of one particular piece, misaligned mold halves. These imperfect castings typically would have been dumped into the furnace and the iron used once again.

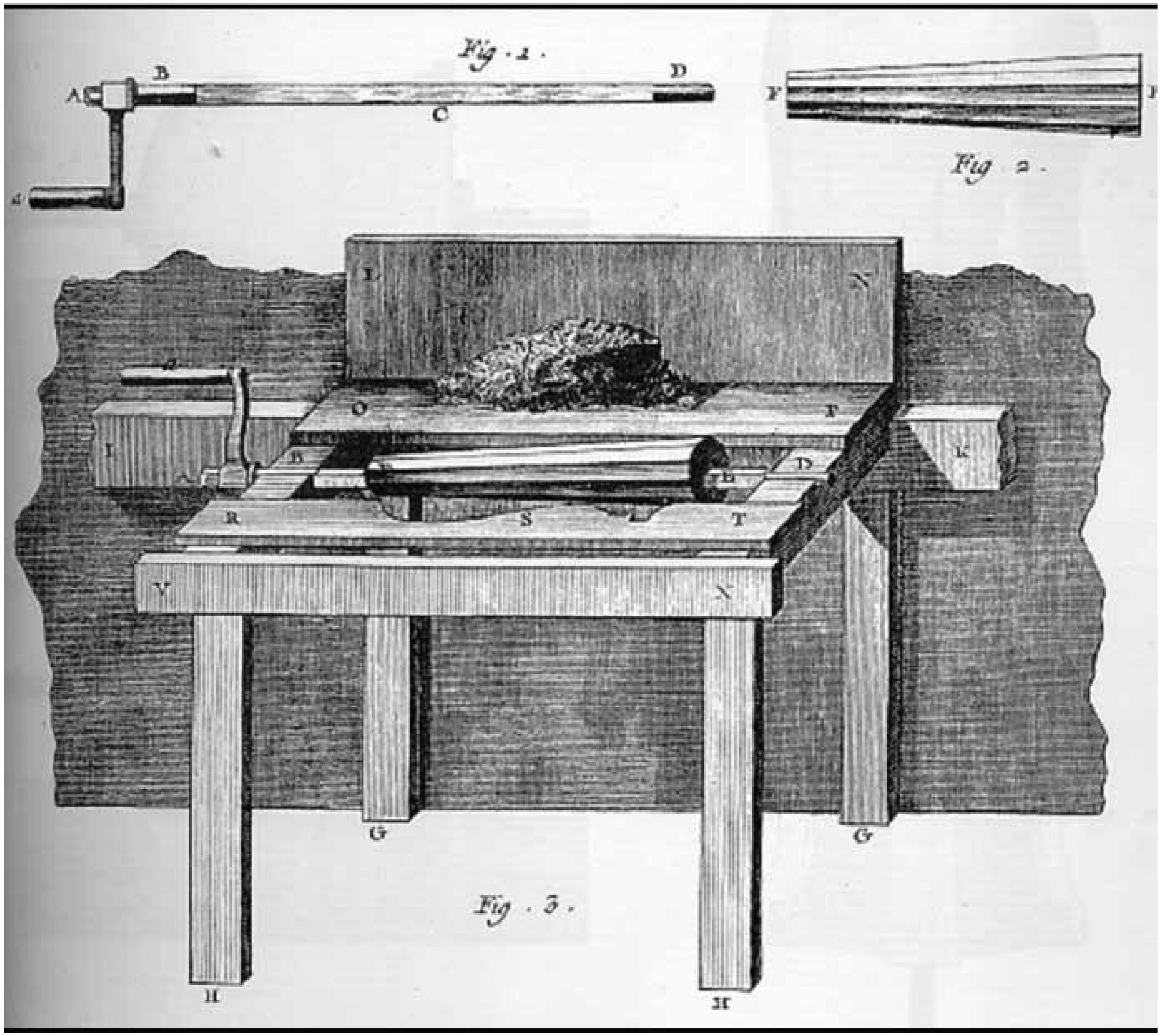
At first glance, a cast-iron pot is a simple form: a single casting that includes a bulbous body, triangular ears, called lugs, to hold the wrought iron bale or handle, and legs with feet that level the pot. Closer examination raises many questions about the production process, including how the legs and lugs were attached and how the molds themselves were made. A careful reading of the surviving pot fragments, such as body fragments, legs, and triangular lugs, and of contemporary literature on iron making may furnish many answers.

Diderot's mid-eighteenth-century *L'Éncyclopédi*é illustrates two methods of making cast-iron pots: a green, not fired sand method whereby damp sand mixed with a little clay is packed around a wooden pattern to form the shape of the mold and a loam-molding method whereby loam is formed with a series of sweeps or mold boards around a central axis.[36] Analysis of pot fragments recovered by Robbins during the excavations reveals that the ironworks used the loam-molding process. This molding method could employ two approaches, both of which were used at Saugus. The first approach utilized a horizontal bench similar to a lathe around which the mold is built up and revolves; this method was used for making small cast-iron pots. The other method involves digging a pit in the casting house floor; this process was used for making larger castings. Both methods were complicated and time consuming, requiring highly skilled mold makers who understood how the molds interacted with the molten metal that came from the furnace.

The loam-molding process used a mixture of clay, sand, and some sort of binder such as wool fibers, chopped straw, or dung from a horse or cow.[37] Loam was mixed in a trough on the floor of the molding room using tools similar to those for mixing cement, such as a hoe or fodder chopper. Gobs of this

Everyone here agreed that we are faced with the fact that there had been two power hammers at the forge area at Saugus. What was not so clear was whether or not they were ever in use at one and the same time.

Andrew H. Hepburn to H.R. Schubert, September 23, 1952.



10.12 A loam molding bench with a core-bar, loam, and loam board set in place. Using three such loam boards, the molder and his machine scribed loam into the form of a pot mold. (Plate from Recueil de Planches sur les Sciences, les Arts Liberaux, et les Arts Mechaniques, avec Leur Explication, Troisieme Livraison, Paris, 1765, Forges, 3e Section, Forneau en Merchandise, Moulage en Terre, plate III. Saugus Iron Works NHS.)

loam were then placed on the narrow shelf set along the back edge of a molding bench, a heavy wooden framework probably attached to a wall for stability. As seen in Figure 10.12, a half-round wooden channel provided the bearing surface for a square iron bar with cylindrical ends. The iron bar was partially covered with a faceted, conical wooden shaft to form the core bar. The entire assembly was rotated by a hand crank and became the foundation on which the body of a pot mold was built.

Each size of pot required three precision-made mold boards to make the mold for the pot body.[38] Mold boards controlled the application of loam and were a set of masters that produced molds of consistent sizes. The first mold board was used to form the shape of the mold's core or the inside shape of the pot. The second mold board was used to form the outside shape of the pot and the third board left a thick layer of loam that made up the outer shell of the mold.

To make a mold, the first mold board was locked onto its registration pins on the molding bench. Rope was tightly wound around the core bar forming a solid foundation onto which loam was applied. The rope was later removed so that the mold could be dried and poured. The first layer of loam was then applied to the rope foundation; when the hand crank was turned, the profile of the first loam board formed a smooth and almost spherical shell around the rope. This produced the mold's core.

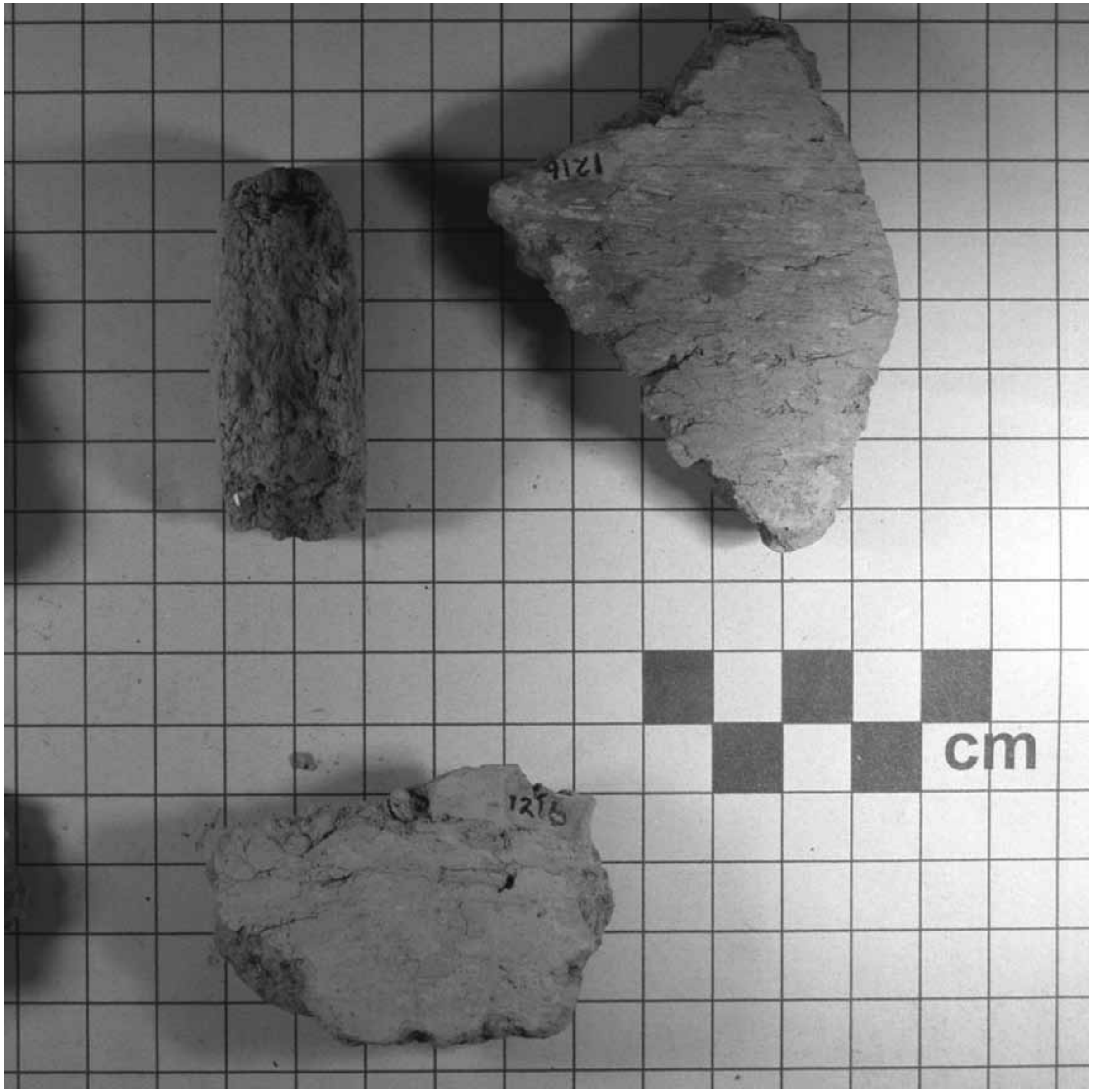
After the first mold board was removed, a thin layer of parting compound was applied to the core. The second mold board was attached to the registration pins and a thin second shell was applied over the first. This second loam board applied a very precise layer of loam that formed the outside shape of the pot. The second layer was physically removed before the pot was cast, but in the interim the outer portion of the mold took on the impressions of the rings that went around the pot's exterior. These rings helped to place the ear molds and leg molds. An additional layer of parting compound was applied over the second shell of loam.

Finally, with the third board attached, a third, thicker shell of loam was applied to form the outer shell of the mold. The three layers of loam, still on the core bar, were dried over a low fire. Each of these molding processes left a visible mark on body fragments of cast pots from Saugus. For example, the inner wall of SAIR 2609, a pot body fragment, has score marks left by the mold sand as the core was turned against the mold boards.

After drying, the mold was slid off the end of the core bar and the rope was pulled from the inside of the core. The molder set the pot mold with the flat side down on the molding bench and carefully cut the third shell in half. He then separated those two hemispheres from the two inner shells and put them aside.[39] The second layer of loam was broken away from the first layer and discarded. The loam core

[A]ll manner of earth, stoanes, turfe, clay, & other materials for buildings & reparations of any of their works, forges, mills, or houses, built or to be built, or for the making or moulding any manner of guns, potts, & all other cast iron ware.

Massachusetts Records, Vol. II, p. 126.



10.13 Pot mold fragments (SAIR 1216) were analyzed by the National Park Service and found to be composed of five parts sand to four parts clay. Drying heat has made the gray clay's outer surfaces a light salmon color. (Photograph by Curtis White.)

contained a hole where the core bar had passed through. This hole was patched with loam and the core set aside to await later reassembly.

Next, molds were made for the two lugs that held the bale and for the three legs which would be attached to the main body of the pot. Four wooden patterns were used to make these mold parts: two for the lugs and two for the legs.[40] Once the lug mold was finished, the molder drilled two holes through one hemisphere of the third layer of loam and affixed the two ends of the lug mold, then did the same on the other hemisphere. The process for creating the leg molds was similar to the lugs.[41] Many pot legs retrieved from the Saugus excavations (SAIR 9477, 1950, 9729) are five sided, reflecting the pattern used to form the mold. The leg molds were installed with two legs on one hemisphere and one leg on the other, all located about 120 degrees apart.

With the lug and leg molds complete, the hole where the core bar originally passed through the two outer hemispheres was patched and holes were drilled through the bottom of the outer shell to form gates for filling the mold. Conical risers were made using loam that was wrapped around a wood pattern in much the same way as the leg molds were crafted. The risers were attached to the mold, the two hemispheres were reassembled around the core, and all cracks were sealed with loam.[42]

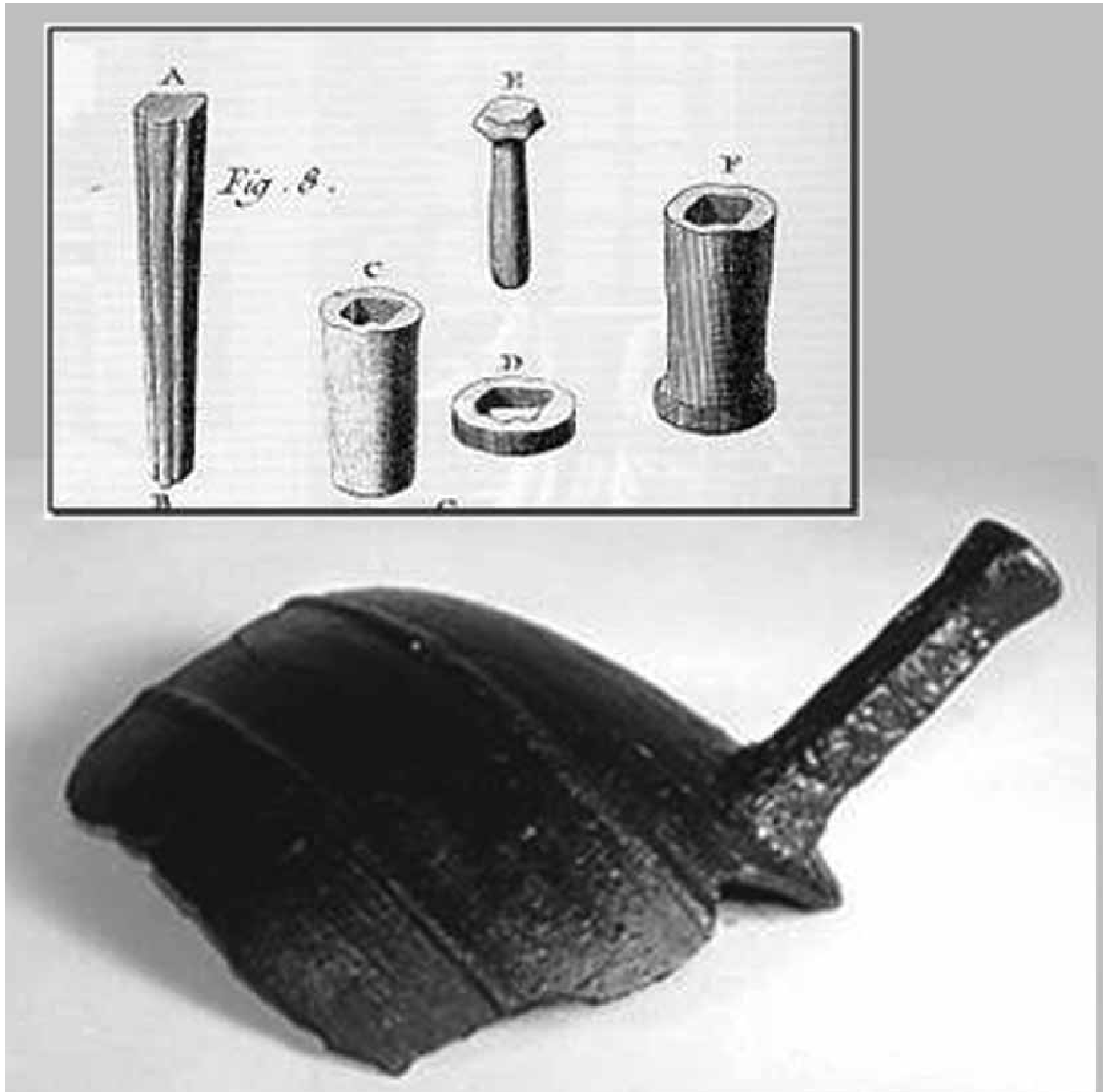
The assembled mold was then dried and buried upside down in the sand with the risers and legs sticking up out of the ground. The pot mold was then filled through the risers with molten iron. Excess iron flowed out of the riser onto the sand floor of the casting shed and sometimes formed a roughly cast iron ring (SAIR 1880).[43] Once cooled, the sprue of cast iron was broken off (SAIR 2892), the mold was opened, and the finished casting was inspected.

Besides a parcel of molds for pots left, that were ready to cast, the furnace newly repaired, etc., new beam and wheel, furnace filled with Coals ready to blow which molds would have been worth about 700 pounds, proper for me to have.

Lynn Iron Works Collection. Baker Library Historical Collections, Harvard Business School, p. 252.

Salt Pan Rings

Although the Saugus collection contains two complete and three broken iron rings, on September 6, 1951, Robbins found the first of three large rings lying east of the slag pile and downhill of the furnace casting beds and refinery forge. The ring, SAIR 2930, was 42 inches in diameter, three and one-quarter inches wide, and about three-quarters to one inch thick. On October 5, he discovered a 34-inch section of a broken ring of similar construction, standing on its edge at the Jenks site along the furnace tailrace. Several days later, he found a second complete ring lying in slag fill just south of the dock (SAIR 2929).[44] The rings appeared to have been made by welding together a number of short, flat wrought-iron bars to form a large circle. One of two complete rings fits inside the other. On November 26, Robbins had a few holes drilled in one of the broken rings. The shavings were collected and sent out for testing, but the results of that test are unknown.



10.14 Leg mold (SAIR 2493) made of two pieces, the leg and the foot. The swell where the leg meets the body of the pot is where the body mold was pierced to attach the leg mold. Patterns (A-leg and E-foot) are used to form each leg mold assembly (F). (Plate from Recueil de Planches sur les Sciences, les Arts Liberaux, et les Arts Mechaniques, avec Leur Explication, Troisieme Livraison, Paris, 1765, Forges, 3e Section, Forneau en Merchandise, Moulage en Terre, plate IV. Saugus Iron Works NHS.)

Undoubtedly, the large rings that Robbins found were two of eight cast rings listed on the 1653 inventory as "8 hoops for casting pans." There may have been a single set of eight rings, each fitting inside another so that the molder could make a wide range of pan sizes or a number of pairs so that multiple rings could be cast at the same time.

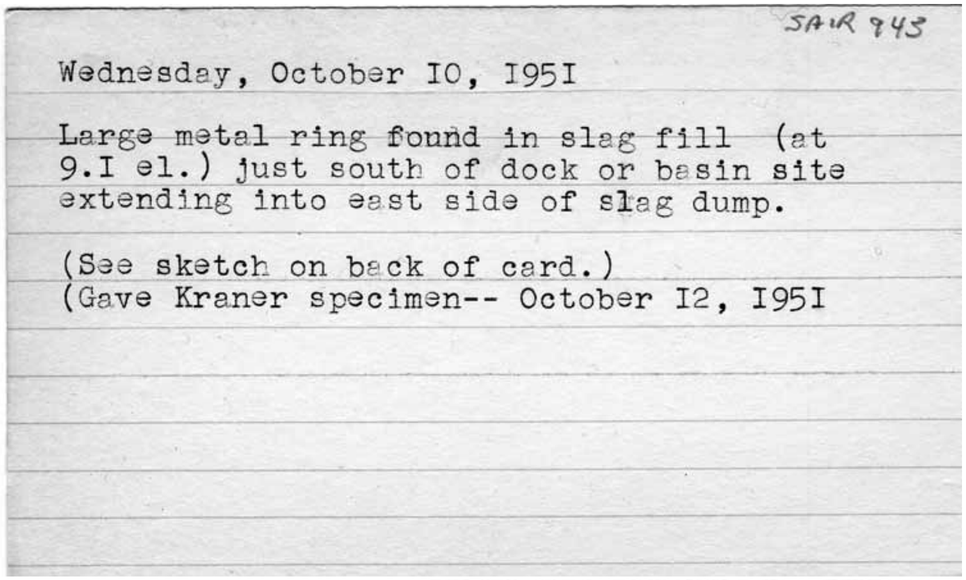
The clean and sharp edges of the fractured iron ring show no bending or deformation, confirming that it is composed of cast iron rather than wrought iron. On close inspection, one can tell that the rings were cast in open sand molds. To set up the casting, the molder might have first marked a center point in the casting sand and then used a string and scribe to delineate a circle. By pressing a short wooden board into the casting sand while following the marked circle, he could neatly displace the sand to make the roughly round circular void that would serve as the mold for the iron ring. This mold was then carefully filled with molten cast iron. When the iron hardened and was removed from the sand, its bottom edge bore in fine detail the irregular impressions of the board that had been pressed into the sand. The top surface of the completed iron casting would have been consistently flat with just a few visible gas bubbles, the result of the molten iron freezing in a sand mold that had a wide surface exposed to the open air.

Unlike most of the tools listed in the 1653 inventory, the rings have a fairly complete description: "8 hoops for casting pans." Properly defined, a pan is a shallow, wide, open container. Since salt pans were used to evaporate water from sea water to leave the salt behind, a wide pan shape provided a great deal of surface area where water could evaporate quickly. From the bottom of the pan the sides flared out toward the rim. Molds for large castings were cast in the hole at the forehearth in the casting shed, below the seventeenth-century ground surface. Large molds were made in much the way that smaller pot molds were made but rather than working horizontally and turning the mold, the molder had a vertical shaft, and a series of three sweep boards. The sweep boards were attached to the center shaft and walked around the stationary loam mold.

Molders used concentric rings or "hoops" rather than a single, solid mold with a base in order to form the flared, concave shape of a pan. A pair of nested rings sat upon bricks at the bottom of the pit. Instead of building up a core around a core bar and coil of rope, the mold was constructed of loam applied with a sweep board around a foundation of brick atop the inner cast-iron ring. Just as it does in the smaller pot, the core defined the inner shape of the pan. A second sweep board replaced the first and, just like with the smaller cast-iron pot, the sweep board formed the loam into a pattern that simulated the thickness of the casting. The outer shell of the large mold was built over the second layer but was supported by the outer cast-iron ring. Because the mold was made upside-down, the concave shape of the third shell allowed it to be lifted in one piece from the core using a crane or winch mechanism rigged with hooks that fastened under the outer ring.[45] When the outer shell was lifted from the core, the second thickness of loam that was sandwiched between the core and the outer shell could be removed, thus cre-

On these pages are shown some of the interesting activities of the Committee. Above they are shown admiring the latest discovery unearthed by Archeologist Roland Robbins. It is an iron ring, 3 feet 8 inches in diameter. Preliminary conjecture i[s] that it may have been a ring at the top of the furnace, around the charging hole.

"First Iron Works Gazette," October 1951.

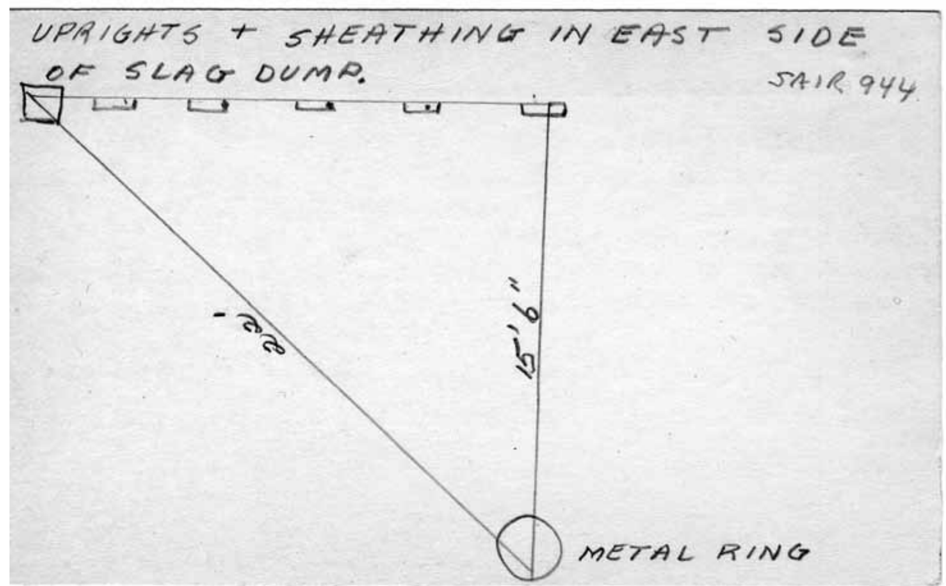


SAIR 943

Wednesday, October 10, 1951

Large metal ring found in slag fill (at 9.1 el.) just south of dock or basin site extending into east side of slag dump.

(See sketch on back of card.)
(Gave Kraner specimen-- October 12, 1951



10.15 The front and back of Robbins' notecard indicating the location where the smaller cast iron ring (SAIR 2929) was found. (Robbins notecard scans numbered 943 and 944.)

ating the cavity into which the iron was poured. If the large casting was to be a large form of a cast-iron pot (with a bulbous shape) the third shell would need to be split as it was in the smaller cast-iron pot mold, as the outer shell could not be lifted from the core.

In the October 1951 issue of the *First Iron Works Gazette,* one writer speculates that these rings had been used to encircle the charging hole of the blast furnace.[46] As interesting and practical as this idea sounds, iron rings of this type were not integrated into the design of the reconstructed blast furnace. Instead, the charging hole was surrounded by eight separate cast-iron plates, each about two inches thick. Apparently the Reconstruction Committee or the architects did not agree that the iron rings had been used around the charging hole. In the late 1970s, the National Park Service added two cast-iron rings to the forge exhibit and one broken cast-iron ring to the blast furnace exhibit as examples of the use of wrought iron.

As time drew closer to the grand opening date of September 17, 1954, a concerted effort was made to outfit the reconstructed ironworks with iron-making tools of the trade. In June 1954, historian Neal Hartley and architect Conover Fitch assembled "a list of tools and implements" used at the blast furnace, forge, and slitting mill based on the 1650 and 1653 Iron Works inventories. They referred to works by Agricola, Diderot, and Hilestrom to understand the size, shape, and function of each tool and approved or disapproved its reproduction[47] The blast furnace exhibit featured tools to move slag, make molds for iron pots and pans, and tap the furnace. Pig-iron bars, molding benches, rakes, ringers, wheelbarrows, ladles, patterns, sieves, baskets, hammers, a box of molding clay, a box for drying molds by the fire, and "8 hoops for casting pans" were all included in a hand-drawn sketch showing the placement of each item.[48] Hartley and Fitch decided to omit the reproduction of the salt pan rings due to "insufficient information on these hoops to determine size and function at present."[49]

The physically and emotionally engaging ironworks complex, reconstructed as the Saugus Iron Works Restoration by 1954, can overshadow the thousands of original artifacts in the site's museum collections. Artifacts are primary cultural resources that, when combined with documentary evidence, tell an important story about the founding of North America's iron and steel industry and its importance to the history of the United States. The archeologically recovered artifacts in park collections provide tangible evidence of the Company of Undertakers' venture in iron making in the Massachusetts Bay Colony. Some artifacts have excellent provenance, which provides the best cultural context, while others unfortunately do not. Even the latter, however, contribute to the interpretation of our shared American heritage.

11.1 Robbins and others at the blast furnace, February 21, 1951. (Photograph 296 by Richard Merrill, 1951.)

Conservation Methods

Brigid Sullivan

On August 24, 1948, J. Sanger Atwill, President of the First Ironworks Association, wrote to me asking if I "would like to go on an antique treasure hunt." This treasure hunt, Mr. Atwill stated, was to locate and excavate, if possible, the foundations of "the Blast Furnace and Mill with undershot wheel.

Roland Robbins, Report of Archaeological Progress at the Old Iron Works Site, Saugus, Massachusetts, from September 10, 1948 to June 25, 1949.

Before historical archeology was recognized as a distinct specialization governed by professional ethics and standards of practice within the formal field of archeology, excavation of historic sites was frequently driven by recovery of historic "relics." These material remains, including objects and structures, were used in the interpretation of daily life, becoming stage props for enriching the reconstructed historic scene. This was especially true in New England, where antiquarians like Wallace Nutting forged an indelible, if not always accurate, image of daily life in colonial America. Drawn from the archeological and archival record, these images became the visual foundation of the Colonial Revival movement in America.

In this spirit, in 1948, J. Sanger Atwill, president of the newly formed First Iron Works Association (FIWA), offered the local amateur historian/archeologist Roland Robbins the opportunity to excavate the remains of a seventeenth-century ironworks site in Saugus. Robbins would embark, as Mr. Atwill put it, "on an antique treasure hunt."[1]

Under the direction of Robbins, the focused effort to preserve materials recovered in the early 1950s excavation was extraordinary for historical archeology of this time. Robbins' interest in preservation of the excavated Saugus ironworks material went beyond the traditional lexicon of preservation techniques and formulas to embrace contemporary scientific methods and materials based on technical research in Europe and the United States.

Professional Conservation in the Early- to Mid-Twentieth Century

Interestingly, the time span of the FIWA excavations coincided with the growth of scientific conservation theory and practice, the center of which was arguably Harvard's Fogg Museum in nearby Cambridge, Massachusetts. Following the lead of the British Museum, which established a conservation research laboratory in 1920, Edward W. Forbes, director of the Fogg, set up the first technical department in an American museum in 1928. George L. Stout served as head conservator and Rutherford J. Gettens as the conservation scientist. Fine arts conservator Richard D. Buck joined the department in 1937, bringing a specialization of wood to the team. The Fogg Museum published the first technical journal focused on scientific conservation, *Technical Studies in the Field of the Fine Arts*, from 1932 to 1942.

The Museum of Fine Arts in Boston and the Metropolitan Museum in New York established conservation laboratories in 1930 and 1931, respectively, and the influential Worcester Art Museum in Massachusetts developed a professional conservation lab in 1939. Harvard's Peabody Museum of Archaeology and Ethnology developed a conservation lab for their collections in the 1940s.

In the early days of professional conservation, the founding conservators of the new scientific movement and their museums were strongly interconnected. A 1949 *New York Times* article demonstrates this close collaboration, noting that

> Richard D. Buck, a member of the staff since 1937, today was appointed conservator of the Fogg Art Museum at Harvard University. A native of Middletown, N.Y., Mr. Buck was graduated from Harvard College in 1937, and received his Master of Arts degree from the university in 1938. He gained his conservation training with George L. Stout, director of the Worcester (Mass.) Art Museum, and former head of the conservation department of the Fogg.[2]

A few of these early conservationists, Rutherford Gettens, George L. Stout, and Richard Buck, would visit Saugus at the invitation of Roland Robbins.

As a major museum entity in its own right, the National Park Service (NPS), along with other cultural and scientific organizations, benefited from the profusion of scientifically-based technical publications that rapidly became available during these years. These include *The Preservation of Antiquities* by Harold J. Plenderleith (London: The Museums Association, 1934) and Douglas Leechman's "Technical Methods in the Preservation of Anthropological Museum Specimens" (published in the *National Museum of Canada Bulletin* No. 67, 1931), which the NPS museum program recommended to its parks in all regions for guidance in preserving museum collections.

In 1936, J.C. (Pinky) Herrington took over management of historical archeology projects at Colonial National Historic Park in Jamestown, Virginia, and set up a conservation laboratory. The work of stabilizing and cleaning the material excavated at Jamestown was based largely on the published guidance of Plenderleith and Leechman.[3] *A Field Manual for Museums,* written by Chief NPS Exhibits Preparator Ned J. Burns in 1941, which included and expanded on Plenderleith's and Leechman's work was widely distributed to all NPS parks for decades. Not surprisingly, early professionally trained conservators hired by the newly formed NPS Branch of Museum Services were trained at the Fogg Museum, bringing with them a new sense of professionalism to what was previously a restoration craft.

Sanger came at noon . . . . I told him I was anxious to have the wooden relics treated for preservation. He didn't seem too concerned about their being treated. Said I would see Mr. Orchard, Curator of Peabody Museum about making arrangements for them to do the work. He made no comment.

Roland Robbins, "Saugus Ironworks Daily Log – 1949," May 23, 1949.

11.2 Close-up view of the blast furnace tailrace with iron staples. (Photograph 411 by Richard Merrill, 1951.)

As the professional conservation community continued to grow in America and Europe, the first international Conference for the Study of Scientific Methods for the Examination and Preservation of Works of Art was held in Rome in 1930. The first International Institute for Conservation of Historic and Artistic Works (formerly known as The International Institute for the Conservation of Museum Objects) was incorporated in 1950. These international ventures created accessible forums in which to share research and discuss strategies for resolving complex preservation problems. For example, the 1939 discovery of the Sutton Hoo burial mounds in Suffolk, England, proved hugely important internationally. The decades-long conservation effort it entailed resulted in a major advancement in the knowledge of the conservation of waterlogged wood, corrosion chemistry, and the alteration of leather in wet archeological sites.

Preservation Activities at the Saugus Iron Works

It is clear from Robbins' meticulous field notes spanning the years 1948 to 1953 that he was aware of artifact preservation as a complex science rather than a recipe book. As a result, he sought a professionally acceptable program of treatments for the Saugus archeological finds. As early as May 1949, Robbins raised the issue of treating wooden artifacts with FIWA president J. Sanger Attwill, who reportedly "didn't seem too concerned" about preserving these objects.[4]

This exchange foreshadowed the frustration that Robbins would encounter in his dealings with the FIWA management team throughout the excavation, problems that eventually led to his resignation in 1953. Undeterred by Attwill's laissez faire attitude, he contacted his friend Frederick Johnson, curator of the Robert S. Peabody Museum of Archaeology at Phillips Academy in Andover, Massachusetts, who had experience in the recovery of waterlogged wood from his work on the Late Archaic-period Boylston Street Fish Weir site, located under the streets of the Back Bay area of Boston. This site, excavated in 1913 and then again in the 1940s by Johnson, "became a benchmark for the multidisciplinary application of scientific methods in archaeology."[5]

Robbins then contacted Frederick Orchard, Curator of archaeology and ethnology at Harvard's Peabody Museum, to discuss the possibility of the museum undertaking preservation of the excavated timbers of the tailrace and bellows base. Robbins reported that Orchard "told me that the museum is not set up to do the work I mentioned concerning dehydration of the tailrace beams and planking, bellows base, etc. He knew of no place where this work could be done (not only in the N.E. but no place in the country). He knew of no group or archeologist who could dismantle the number of tailrace remains for dehydration and preservation treatment and then reassemble same."[6]

With an enduring period of preservation in mind, careful thought as to the proper method of preserving our artifacts must be taken.

Roland Robbins to Quincy Bent, March 16, 1950.

11.3 Workmen applying preservative oil to timbers from the raceway. (Photograph 795a by Richard Merrill, 1953.)

The concern for the long-term preservation of the timbers continued, but in 1949–1950, the primary challenge shifted to preserving the enormous number of metal objects being excavated. During this period, metal preservation treatments were primarily those developed during the war to keep metal armaments stable and rust-free. They consisted of superficial rust reduction (mainly mechanical), possible surface passivation, and applying a protective coating to the core metal.[7] However, in terms of material characteristics, modern metal has little in common with archeological metal that has been buried in a damp site for three hundred years. The metal excavated by Robbins had only negligible core metal remaining and its shape definition existed primarily in the corrosion crust. On May 10, 1949, Robbins sent a collection of 19 metal specimens to Mr. C. H. Herty, Jr., of Bethlehem Steel, Bethlehem, Pennsylvania, for metallographic examination and on August 25, 1949, received the analytical report recommending future treatment.

We have here the problem of restoring and preserving hundreds of such items. Some of our artifacts exceed one hundred pounds in weight. I do not have time to attend to this work and I am attempting to have the Steel Institute to provide me with an assistant whose entire time would be given to the attention of our relics. If these plans materialize, I shall want to visit with you and get more detailed information.

Roland Robbins to Maurice Robbins, May 4, 1950.

In early 1950, Henry Hornblower, history buff and founder of the Plimoth Plantation Living History Museum, recommended to his friend and colleague Quincy Bent, chair of the FIWA Reconstruction Committee, that he contact James R. Bateman, an "iron restorative man" working with the archeological and museum laboratories at Williamsburg, Virginia.[8] Bent relayed this information to Robbins, who sent Bateman "a cross section of artifacts to be restored so as to determine whether it may be wise to consider his method when we are ready to prepare our museum exhibit."[9]

The archeological and museum laboratories at Colonial Williamsburg were well known and generally respected in the field of historic preservation. Supported by philanthropist John D. Rockefeller, the ambitious reconstruction had such a large endowment that few if any expenses were spared in the recovery, preservation, and interpretation of the various sites and their artifacts. In 1931, Rutherford Goodwin of the Colonial Williamsburg Foundation established a conservation laboratory to process and preserve of the huge amount of archeological material being excavated. In doing so, Goodwin relied heavily on the recently published *Antiques, Their Restoration and Preservation* by Alfred Lucas, a British Egyptologist and scientist who, along with Howard Carter, developed preservation treatments for the Tutankhamen tomb artifacts.[10]

As early as 1935, the Williamsburg conservation lab prepared a three-page document to serve as a protocol for treating excavated iron objects, ***Treatment for Cleaning and Preserving Excavated Iron Objects Found in the Course of Archaeological Excavation in Connection with The Williamsburg Restoration at Williamsburg, Virginia.*** Colonial Williamsburg made the document available to any interested museums or organizations between about 1935 and 1950; few changes were made to the original document during this time.[11] The standard treatments in the document included mechanical cleaning of corrosion crusts, electrochemical reduction using caustic soda (sodium hydroxide), zinc, and nitric acid, and applying a mixture of paraffin and microcrystalline wax as a protective coating. The document was slightly refined

11.4 Some of the iron artifacts before conservation. (Photograph 138 by Richard Merrill, 1950.)

in 1953 to include more specific information after conservators observed that the treatment effectiveness decreased when they reused an electrolyte solution to treat multiple batches of iron material.

Although Robbins sent the artifacts to Williamsburg in January 1950, he was not pleased with the prices Bateman quoted him. Moreover, Robbins felt uneasy about the long-term effect of a paraffin protective coating on the metal objects. The objects were returned in February and Robbins was disappointed in the results, noting that "possibly I had expected too much, especially after the good reports that Hornblower made, but the restored objects were not as good as I expected."[12]

Unwilling to use the Williamsburg lab, Robbins once again turned to Harvard. He contacted Dr. J. O. Brew, director of the Peabody Museum of Archaeology and Ethnology, for a referral to someone "who could go over our relics and properly treat and preserve them for museum purposes."[13] Brew recommended Karl Fernstrom, who held an A.B. in Anthropology and had a strong interest in colonial New England archeology, to examine and treat the collection on the premises, a huge plus over transporting it out of state. However, Brew stated that Fernstrom, although knowledgeable about ceramics, was not familiar with conservation treatment of wood and iron. Robbins felt an urgent need to get started on preserving the growing backlog of artifacts. Fernstrom could "apply himself to the method determined to be the most beneficial to our purposes," Robbins decided, and recommended that the Reconstruction Committee hire him.[14] Although Robbins corresponded with Fernstrom over a five-month period in 1950, it is unclear whether Fernstrom was actually hired as a salaried employee.[15]

Our museum is bulging with tons of various artifacts uncovered during past excavations. These visible legacies of the past are being classified and must be preserved for the future generations to revere and ponder.

Roland Robbins, "Report of 1949 Archaeological Progress at the Iron Works, June 1950."

In early April, Robbins attended the Massachusetts Archaeological Society Meeting in Attleboro. There he consulted with his friend Maurice Robbins, a founding member and first president of the Massachusetts Archeological Society, Massachusetts State Archeologist, and the author of ***The Amateur Archeology Handbook,*** which helped train several generations of archeologists across the country.[16] At the meeting, the men discussed the use of a paraffin coating on metal.[17] Maurice Robbins commented that he did not recommend the Bateman paraffin treatment, based on his experience and research. He also explained that he was now using a new lacquer marketed as a pressurized spray under the proprietary name of Krylon™. Robbins gave him an iron spike similar to the one restored by Bateman, planning to compare the results of both treatment techniques. The treated iron spike was returned on May 4 and Robbins was very pleased with the results. Later in May, Robbins wrote to Maurice Robbins that "I am getting ready to set up a system whereby we can prepare and preserve our metal artifacts . . . . I would like very much to visit with you and discuss several angles.[18]

By early June, Robbins began initial treatments trying to replicate the even black appearance of the spike treated by Maurice Robbins. Major elements of the first treatment protocol included testing for chlo-

11.5 Iron objects found at Saugus during excavations. (Photograph 1087b by Richard Merrill, 1953.)

rides with silver nitrate, electrochemical reduction by boiling in a caustic soda solution and zinc mossy for hours, mechanical cleaning, and final spraying with Krylon™.[19]

In 1951, Robbins invited Professor Herbert Uhlig, director of the MIT Corrosion Laboratory and author of the recently published and enormously influential *Corrosion Handbook* to visit the excavation site at Saugus.[20] Uhlig was surprised to see how much metal had survived centuries of burial and reviewed the 1949 metallographic analysis of twenty iron specimens selected by Robbins.[21] Uhlig also asked for a sample of the burial soil, as his current research centered on determining the scale or rate of growth of corrosion crusts. He approved of Robbins' use of caustic soda and zinc mossy for electrochemical reduction, but recommended electrolytic reduction instead. Although slower, this new method would be a more effective treatment. Uhlig offered to help set up the mechanical apparatus in Robbins' museum building. Always looking for a trained assistant to organize and preserve the huge amount of excavated material, Robbins asked Uhlig if Saugus could hire an MIT student over the summer to treat the artifacts with this new method. Uhlig thought it would be a great opportunity for a student.[22]

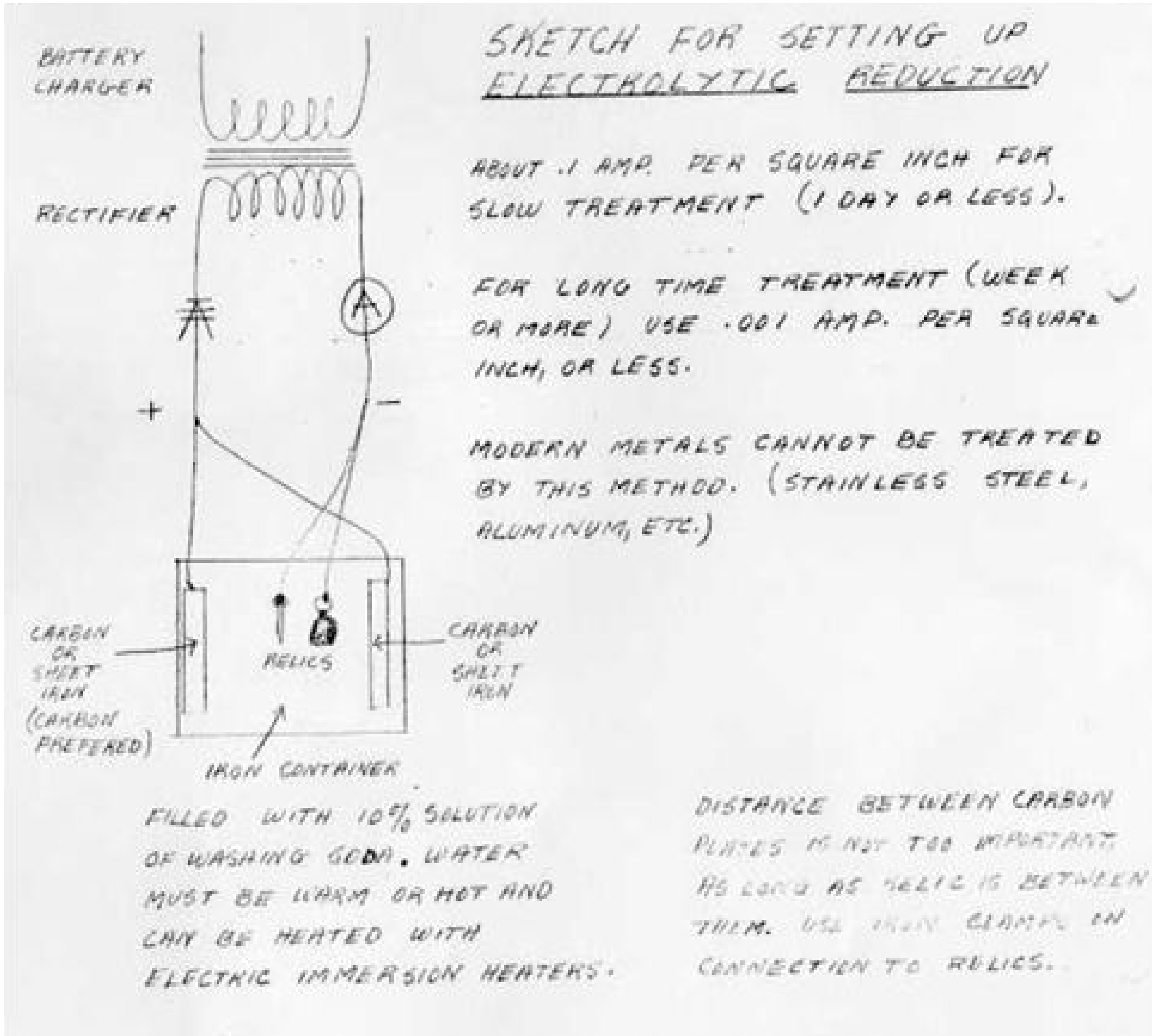
[Professor Uhlig] said that a more thorough treatment for our artifacts is by "Electrolytic Reduction" [and] said we could set up the mechanism necessary for this treatment here in my museum . . . . Below is a sketch of the device I could set up here to perform Electrolytic Reduction on my relics.

Roland Robbins, "Saugus Ironworks Daily Log – 1951," February 17, 1951.

Just a week after meeting with Uhlig, however, Robbins unexpectedly uncovered forty percent of the original Saugus waterwheel and three wheel spokes. Robbins wrote "Jackpot!" in his February 23, 1951, log.[23] With this dramatic discovery, the preservation focus shifted to the treatment of wet wooden objects. Robbins again asked the Peabody's Johnson for advice on immediate post-excavation preservation of wheel timbers. Johnson said that some of the wooden stakes from the Boylston Street Fish Weir site were preserved in an alcohol solution and essentially hermetically sealed. Johnson telephoned colleague Dr. Elso Barghoorn at Harvard's Biological Laboratories to discuss the problem. Barghoorn said that he would like some waterlogged wood samples for analysis and material testing, which Robbins later provided.

Johnson also recommended that Robbins consult with Professor F. O'Neill Hencken of the Peabody about preservation of the wheel. Hencken was a member of the Sutton Hoo recovery team in Suffolk, England, and was involved in experimental treatments of the Anglo-Saxon wood excavated in 1939. "This sounds very much like what we have at Saugus. It will be interesting to learn what Mr. Hencken has to say about the manner in which these relics were removed and preserved!" wrote Robbins in his daily log.[24]

Robbins met with Richard Buck, conservator at the Fogg Museum in April to discuss preservation of the waterwheel and associated timbers. Although Buck had experience in the analysis and treatment of very old wood, such as medieval and renaissance panel paintings and sculpture, and an interest in structural problems of wood excavated from wet sites, he had no practical experience. Robbins then visited Dr. F. O'Neill Hencken at the Peabody to discuss the method of treatment used for the waterlogged wood



11.6 Sketch of electrolytic reduction by Robbins in his daily log, February 17, 1951.

from the Sutton Hoo excavation. He discovered that the procedure involved gradual water displacement by soaking the wood in tanks of alcohol/hydrocarbon solvent, followed by immersion in a tank of melted wax. However, Hencken explained that the method was not entirely successful and that the National Museum of Norway in Oslo had improved upon it.[25]

Immediately after his visit with Hencken, Robbins telephoned Barghoorn to discuss the results of the water-content analysis of the wood fragments from Saugus and to explore the possibility of storing them at Harvard until they could be preserved. Barghoorn continued to experiment with a variety of known treatments and possible variations and also explored new directions in wet wood preservation. In early May, Robbins visited Barghoorn at his lab to view the progress of the treatment tests. Barghoorn demonstrated the basic treatment involving the immersion of the wet wood in hot paraffin wax until the water had been driven out of the wood.

Later that month, Barghoorn recommended a treatment for the waterwheel in a formal letter to Robbins. Barghoorn explained that

> based on preliminary experiments with samples of wood taken from the old water wheel at Saugus, I am glad to say that a very satisfactory, feasible, and economical method to preserve them has been worked out in my laboratory. The wood specimens from the wheel are typical of anaerobically decayed timber, but fortunately these retain a sufficient amount of their original wood cellulose to make impregnation techniques applicable in preserving them in a relatively unmodified form. The method developed is one of hydrocarbon paraffin wax impregnation by immersion temperatures above the boiling point of water. Under suitably controlled conditions the moisture is replaced by liquid paraffin, which after penetration and cooling to room temperature, solidifies throughout to give support and body to the wood. In addition, a very satisfactory surface texture of the treated wood results.[26]

In June, Barghoorn and his assistant, Teresa J. La Croix, began treating the waterwheel components. Robbins reported to the FIWA Reconstruction Committee that

> The waterwheel has been carefully dismantled and its many pieces have been taken to Harvard College where Dr. Elso Barghoorn and Miss Teresa La Croix, his assistant, are treating and preserving this fabulous relic . . . . I also plan to carefully dismantle the pit in which the waterwheel operated and have it preserved. At a time when our new museum has been built, we shall assemble one side and both ends of the waterwheel pit and have the remains of the old wheel suspended in its original position. I believe

I shall attempt to get Mr. Barghoorn down to Saugus so that he may receive a first hand account of our problem. Mr. Johnson also suggested that I contact Hugh Hencken about my problem. Hencken is at Peabody Museum, Cambridge. Said that Hencken had excavated several medieval boats in Ireland, they being buried in mud, or at the bottom of a pond or swamp. This sounds very much like the problem we have at Saugus. It will be interesting to learn what Mr. Hencken has to say about the manner in which these relics were removed and preserved!

Roland Robbins, "Saugus Ironworks Daily Log - 1951," March 14, 1951.

11.7 Robbins and Elso Barghoorn at blast furnace waterwheel, June 1, 1951. (Photograph 345 by Richard Merrill, 1951.)

> that this will prove to be one of America's outstanding Colonial relics .... I should point out that Dr. Barghoorn's method has provided the archaeological field with a new medium for preserving ancient wood. Such a process has long been sought by archaeologists and antiquarians. We are indeed fortunate in obtaining Dr. Barghoorn's scientific knowledge.[27]

With Barghoorn's blessing, Alvar™, a polyvinyl acetal resin used since the early 1950s to consolidate archeological woods, was applied to selected artifacts. This approach had been suggested by Fred Johnson, the Curator at the Peabody Museum in Andover, Massachusetts.[28] According to Robbins' daily logs, timbers were also treated with "floor oil" cut with thinner (presumably turpentine), which seems to be a generic term for a number of oils traditionally used to treat unfinished wood floors and other boards. The term "floor oil" could mean either linseed oil or boiled linseed oil, with the addition of other oils. Some of these, such as "range oil" (a petroleum based oil similar to kerosene), are quite flammable. Typically, more than four coats of floor oil were applied until the wood failed to absorb more.[29] Robbins and Barghoorn discussed the possibility of spontaneous combustion and carried out a controlled lit-match test to see at what distance from the flame the treated wood would combust. It proved to be less than one inch, which they thought safe, although Barghoorn recommended that a fan be used to keep air circulating within the museum.[30]

Searching for a method to remove corrosion incrustations, Robbins gave an excavated nail and casting piece to William Porter of Enthone, Inc., who had visited the site on January 8, 1952, to discuss possible treatments for metal artifacts. Porter returned with the treated specimens several weeks later and Robbins thought "they turned out real well."[31] Porter used a method based on principles of electrolytic reduction; Robbins inquired about setting up the process on site.

The entry "Had men clean relics" occurs quite frequently in Robbins' daily logs, especially during periods of inclement weather. The men were employees of Bogart Co., a local construction contracting company hired by the FIWA to undertake work related to the excavation and construction of museum structures. The in-house preservation of organic and inorganic artifacts by Bogart's men continued throughout 1952. For example, they treated leather shoe soles with a ten percent solution of sulphate Neatsfoot oil, a procedure traditionally used for treating leather tack and utilitarian leather equipment.[32] They cleaned metal objects mechanically with wire brushes and picks; when the objects had dried thoroughly, they buffed them with Butcher's Paste Wax (carnauba and other waxes in turpentine and mineral spirits).[33]

Within about twenty years, most metal objects treated during and immediately after the excavation needed retreatment. These were conserved in 1973 by conservation contractor Dennis Piechota; por-

He [Barghoorn] took a small piece of wet wood (which I had given him) and placed it in quite hot paraffin .... Immediately the hot paraffin began simmering the water from the wood, actually the action was similar in appearance to the effervescence created when a glass of ginger ale is poured. When the wood had been dehydrated the effervescence ceased, completing the treatment of the wood now being impregnated with paraffin.

Roland Robbins, "Saugus Ironworks Daily Log – 1950," May 7, 1950.

11.8 Harvard University paleobotanist, Professor Elso Barghoorn, consolidates an archeological timber using a water displacement/wax infusion technique, June 6, 1951. (Photograph 349 by Richard Merrill, 1951.)

tions of the collection were treated again in the 1980s by NPS conservator Ed McManus. Little happened to the collection until 2005, when the exhibits were dismantled and stored due to the structural rehabilitation of the museum and the artifacts were examined by NPS objects and wood conservators. The wheel fragments treated by immersion in melted paraffin by Elso Barghoorn were in good condition structurally, but the raceway timbers treated with "floor oil" were in poor condition, with friable surfaces and cross-grain checking indicative of fungal decay. Under the direction of NPS wooden objects conservator Al Levitan, the fragile oil-treated timbers were consolidated with polyvinyl butyral in alcohol (Butvar B98™), a treatment compatible with the earlier use of oil and of Alvar™. The waterwheel and raceway are now reinstalled in the museum with very little loss of historic material.

Every aspect of artifact preservation at Saugus was overseen by Robbins, who engaged the pioneer scientific conservation community in Cambridge, Boston, Andover, and elsewhere for guidance in treatment methodologies and materials. Robbins also oversaw the museum building and exhibition of the "relics." The work that Robbins did at Saugus was far from the "antique treasure hunt" proposed by J. Sanger Atwill in 1948.

Although no longer associated with the project after 1953, Robbins' interest in the site and engagement with the scientific community continued. In 1958, he recorded that "Professor Uhlig and I went to Saugus and dug up modern metals that we buried near the S.E. corner of the furnace on Wed. May 6, 1953."[34] The archeologist and the MIT scientist shared the intellectual excitement of evaluating the condition of these test artifacts. This same sense of inquiry and commitment drove Robbins to seek out the best artifact treatments available from the emerging field of scientific museum conservation and apply them to the emerging field of historical archeology in the early 1950s.

12.1 Robbins addresses tour group at the forge building excavation. (Photgraph 750 by Richard Merrill, November 15, 1952.)

Robbins' Public Outreach and Outside Research

Donald W. Linebaugh

Beyond the project's obvious contribution to early industrial archeology, two aspects of Robbins' work at Saugus stand out in the history of historical archeology: his public outreach and his own research and use of specialists in wide-ranging areas from ironworking to faunal analysis to artifact analysis and conservation. While Robbins did not always welcome the intrusions of visitors to the site, he was keenly aware of the need to include the public in the work in order to garner its financial and political support. He also had a more selfish interest in promoting himself as an archeologist and in taking "ownership" of the discoveries. Likewise, his use of specialists was driven by a number of issues, including the input and direction of the Reconstruction Committee, the huge and varied volume of artifacts that required new approaches to analysis and conservation, and his own uncertainty and inexperience in the nascent field of historical archeology. Susan Colby, an assistant at his subsequent Philipsburg Manor Upper Mills project in New York, remarked that "Robbins wanted people to accept his ideas but understood his limitations, particularly his lack of formal education."[1] For Robbins, the outside experts he engaged served to advance his archeological education, bolster his confidence, and legitimize his findings and interpretations. This chapter considers the ways in which Robbins sought to educate the public about his work at Saugus, even as he himself was learning on the job, and explores his collaborations with specialists in many affiliated disciplines.

He saw it almost as a mission to get people involved in these sites so that they could participate in their own heritage. [Robbins' contributions were] to get people interested in archaeology and bring attention to historic-sites archaeology, in that order.[1]

Paul Heberling, personal communication, 1992.

While Robbins was always concerned about receiving the credit due him for his archeological "discoveries," he was also extremely generous toward those who acknowledged and respected his work. He shared his knowledge with interested members of the public from the very start of his career at Walden Pond, although he sought to keep the exact location of the excavation secret in order to both control news of the discovery and protect the site. Robbins' interest in public archeology began in the fall of 1945, when, armed with "a pocket compass, a ninety-eight cent G.I. trench shovel . . . [and] a couple . . . of probing rods," he began looking for the Walden Pond house site of Henry David Thoreau.[2] From 1945 to 1947, Robbins identified, excavated, and carefully documented the building's stone chimney foundation, stone corner piers, and root cellar.[3]

As noted above, Robbins initially guarded his claim to the discovery of the cabin site, carefully controlling who saw his discovery at Walden.[4] English professor and colleague Walter Harding remembered that Robbins was reluctant to allow him to see the site because he "was always very suspicious of any college teachers—he had one particularly unfortunate experience."[5] Robbins made no excuse for his careful handling of news about the discovery, stating that "many are they who want to know the secret and have gone out to Walden Pond to seek it."[6] It seems clear that Robbins' experiences at Walden colored the remainder of his career; he developed a wariness of those who might attempt to exercise control over or misrepresent his work.

While Robbins was clearly concerned about being scooped on the news of his discovery, he also sought to interest the public in the process of research and the excitement of discovery through the publication of *Discovery at Walden*. The animated style of this book was well suited to captivate readers and bring the story of his work to the attention of the public. In the introduction to *Discovery at Walden*, Thoreau Society secretary Walter Harding writes that a brief visit to the site gave him a "shiver of excitement" and a review of the evidence convinced him of the accuracy of Robbins' work.[7]

As will become clear, Robbins quickly developed a philosophical commitment "to make history come alive by digging it up, getting others involved . . . ."[8] This philosophy manifested itself in a lifelong dedication to public and civic engagement in terms of archeology. Initially based on a very personal desire for success, he came to see the larger benefit of teaching history and archeology to the public. His work at Saugus deepened his appreciation of the important benefits of public participation. After Saugus, he went on to develop a vital public archeology program during his excavations at the Philipsburg Manor Upper Mills (PMUM) site in North Tarrytown, New York, from 1956 to 1962.[9] By the mid-1960s, Robbins had also established successful school-based archeology programs in New York and New Jersey.[10]

Although Robbins did not have a formalized program for public participation in the archeology at Saugus, he opened the site to visitors, developed a museum exhibit of artifacts that included portions of the conserved waterwheel and wheelpit, helped with media coverage of the project, regularly lead tours through the excavations for general visitors and local school and civic groups, and gave public lectures on his Saugus work throughout New England. The small size of the First Iron Works Association (FIWA) and lack of experience of its local organizers dictated that someone like Robbins would end up managing and carrying out many parts of the project. Asked to wear many hats at Saugus, Robbins discovered the opportunities and problems inherent in operating a large excavation open to the public, including the difficulty of staffing and running a public program, the political benefits of public participation, and the excitement and power of public interest. While these demands provided Robbins with real opportunities for professionalization, they also stressed him and distracted him from the archeological work at hand.

As complex as my archaeological work was it presented no problem which would wear me out, both physically and mentally. But to mix this work with sundry duties ranging from overseer of all problems to caretaker of washrooms, interspersed with two museums to study and carefully prepare appropriate exhibits for, as well as public relations and goodwill, research which developed mediums for restoring our priceless artifacts, both metals and wood, annual meetings which necessitated careful planning and many late evenings, as well as numerous other time absorbing details, was more than my strength could contend with after dieting on it for five years.

Roland W. Robbins to Quincy Bent, November 16, 1953.

12.2 Robbins probing in trench with school children looking on, September 27, 1950. (Photograph 235 by Richard Merrill, 1950.)

Robbins' education of the public also had distinct political and economic ramifications; for example, he engaged in community politics during the campaign to relocate Central Street for the Saugus excavations.[11] Negotiations between the FIWA staff and town officials to close and reorient the street to provide access for excavating the buried furnace waterwheel were contentious and dragged on for several months. Town meetings generated heated debate among all parties and opposition from homeowners in the ironworks neighborhood. Town representatives and neighbors regularly visited the site throughout the summer of 1950. During these visits, Robbins gave them special tours of the excavations, museum and laboratory, and artifact collection, and vigorously lobbied for the importance of completing the waterwheel excavation.[12] With the help of this personal lobbying effort by Robbins, the road rerouting was approved during a special town meeting.

Mr. Tower, Bent, Hartley, Attwill and I met at the Town Line for lunch. In morning Mr. Young, Saugus' new Town Manager, DeFronzo and Chapman were with me an hour at 3:00 p.m. All persons mentioned above went over the rerouting of Central St. and were in accord of the situation. This being the taking of a bit of Robinson's lawn at the corner of Marion Rd. and Central St. so as to round this turn more. At the Union St. extension end it was agreed that the road should run between the store at the corner of Pleasant and Central Sts. and the white house just beyond and on Central St. This way no building would be disturbed. At 8:00 p.m. the above people, the five Saugus selectmen, 4 members of the Planning Board, Nelson Pratt, Mr. Hills, Mr. Nardo and several other interested persons went over the proposed route and were in accord with the proposed route. After the tour of the proposed re-route of Central St. the above people gathered at my museum where the meeting and discussion was [sic] *held.*

Roland W. Robbins, "Saugus Ironworks Daily Log – 1950," July 6, 1950.

Another educational aspect of the Saugus project was the museum created by Robbins to house the thousands of artifacts uncovered during the excavations. Begun in the first full year of the project, the museum was initially housed in Edward Guy's former blacksmith shop, adjacent to the Iron Works House. In June 1949, just eight months into the project, Robbins had "moved [the] D.A.R. and Mr. Guy's effects from my museum, cleaned it up and rearranged [the] artifacts."[13] By month's end, Robbins reported that he and several staff members had "finished cleaning and arranging my museum."[14] It became clear to Robbins early in the project that the volume of artifacts was going to be huge and would require space for both processing and exhibition to the public.

Always cognizant of the publicity angle of his projects, Robbins also saw the museum as a direct reflection of his work; it was, he emphasized, "my museum."[15] This sense of possessiveness and responsibility was not unusual among the early archeological pioneers. It exists to some extent even today, as the artifacts are a tangible and essential type of evidence for interpretation and to control them is to control the site. It also seems clear that the museum was seen by the officers of the FIWA as a crucial part of the overall project and important for drawing visitors. The organization's president, J. Sanger Attwill, had been the president of the Lynn Historical Society before joining the Saugus organization and seems to have regarded the exhibition aspect of the site as a central component. Clearly, however, most of the attention was on the house and industrial buildings themselves. It was only when the excavations began to yield such amazing finds as the furnace waterwheel that Robbins' associates began to take the museum more seriously. In fact, Robbins and Attwill regularly argued about the building's heating, fire protection, and security.[16] For example, on November 14, 1949, Robbins recorded that

> over the weekend someone was in museum and handled relics. In so doing, they handled tuyere and chipped 2 pieces from the larger end, one piece being the size of 2 half dollars. Attwill was here and Miss Hawkes informs me he showed members of the

12.3 Robbins showing gear and other artifacts in museum building. (Photograph 137 by Richard Merrill, 1950.)

> Field and Forest Club the relics. Phoned Sanger in a.m. about gas heat [and security] being installed in the museum. He believed the initial expense would be too great.[17]

Robbins and Attwill went back and forth on these issues over the next year or more with Attwill contending that these modifications were not appropriate expenditures as the structure was a "temporary" museum building.[18]

While "temporary," the museum building quickly became the central location for artifact storage, processing, conservation, and display. At first, the space housed piles of artifacts identified by general type and material, particularly iron and slag pieces. Eventually, it evolved into a rather amazing facility for the time. The museum became a place for the crew of laborers to work indoors on "relic classification" and exhibit preparation when the weather was not suitable for field work. In July 1949, Robbins reported that he "told Mr. Bent that I would be busy with excavations until winter set in. Then I would turn to my museum work and relic classification."[19] In September 1950, Robbins noted that he moved the "newly located hammer head, found in excavations along northerly side of Bridge St., into my museum," where it would undergo cleaning and conservation.[20]

The museum was also very much the principal public face of the project. It was a work in progress during the entire excavation period, providing an excellent and generally up-to-the-minute summary of the work underway and the discoveries made to date. It typically didn't take Robbins too long to get major artifacts cleaned, and in some cases conserved, and on display in the museum. This enabled visitors to follow the excavation quite closely in terms of the many spectacular artifacts and features discovered. For example, Robbins moved the bellows beams into the museum for exhibit in January 1950.[21] In August 1951, he recorded that he "built [a] platform and placed [the] 500 lb. hammer head upon it" and noted that he and his staff had begun work on the waterwheel exhibit.[22] Likewise, in June 1952, he wrote that the "men brought Jenk's anvil base up to museum. We found we could not lift it out with 80' crane without damaging it. Jones' men made a new stand for it. Tomorrow we shall place it in museum upon new stand."[23] While these were often temporary exhibits that were later reworked, they provided a great sense of the amazing preservation of the site and its artifacts and offered visitors a real and tangible view into what the ironworks might have been like.

While Robbins was clearly advancing in his knowledge of archeology day by day, he also was steadily picking up on the museum aspects of his job. In June 1950, he reported that he joined the American Association of Museums, no doubt to increase his connection to the museum world and to benefit from its resources in terms of exhibit preparation and presentation.[24]

This morning we moved the newly located hammer head, found in excavations along northerly side of Bridge St., into my museum. First we took it to Eastern Industrial Oil Products Co. and weighed it. It weighed 505 lbs. Originally it probably was cast as a 500 lb. Head. The extra 5 lbs. can be accounted to oxidation, and what. . . soil became adhered to the hammer head by oxidation. What appeared to be a concave area along one side of the head of the hammer, which was first noted when the hammer was uncovered, and believed to have been constructed that way, now appears to have been treated by breakage, or chipping. I phoned Hartley twice this a.m. First to tell him the head would probably weigh at least 400 lbs. And then to inform him as to its exact weight of 505 lbs. He was surprised. Said he couldn't recall reading of hammers of that weight. Thought it was very impressive.

Roland W. Robbins, "Saugus Ironworks Daily Log - 1950," September 2, 1950.

12.4 Exhibits in museum building with forge hammerhead display in foreground. (Photograph 471 by Richard Merrill, 1951.)

Robbins and his staff constantly rearranged and improved the museum as the project progressed. For example, in June 1951, he and his staff "moved the relics in my museum back to make room for the west sill of the hutch which we removed today."[25] Robbins realized that he needed full-time help with the museum and artifacts in the second year of the project, as the volume of artifacts grew exponentially; he was not allowed to hire an assistant until June 1952. His assistant, Barbara Franklin, started on June 16, 1952, and it is clear that she was quickly put to work on artifact classification and exhibit planning and organization.[26] In June 1951, Robbins had arranged with artist Charles Overly to prepare murals of the ironworks site for the museum building. Robbins reported that "Howard Stevenson sent me prints of sketches to be used in [the] new booklet. I will have my artist be guided by their detail when laying out [the] mural in my museum."[27]

In 1952, a new museum building was constructed to provide a larger exhibit space. The old building was to be used for storing and processing the ever-increasing collection of artifacts. Over the next two years, Robbins developed, expanded, and enhanced his new facility. In August, he reported that he had "Jones put up four panels in [the] new museum building. Will use these for exhibit purposes."[28] In September, carpenters built a frame for the "base sills of the anvil and 1st anvil base. This is being set up in the old museum building, at the westerly end, just beyond the platform which exhibits the three waterwheels."[29] Several days later Robbins had his men "clean and wash the J.J. [Joseph Jenks] drawers in the new exhibit case. Also had some of relics buffed. Clyde Hiltz here this P.M. with sign for forge anvil base exhibit—laid out more sign work for new museum with him. In P.M. I worked in new museum arranging relics on the three panels."[30]

In December 1953, Robbins began the process of disassembling the original furnace waterwheel pit so that it could be reassembled in the museum building. He and architect Conover Fitch agreed to "have the chimney in the old museum building removed. This will make possible the assembly of the original furnace wheel pit . . . ."[31] Several weeks later, Robbins spent time with his new assistant, Steve Whittelsey, "going over my thoughts regarding new arrangements of artifacts in the museum buildings."[32]

In March 1954, Robbins again met with Fitch to discuss museum exhibits, particularly the installation of the furnace wheel pit. He recorded that

> In speaking of the assembling of the furnace wheel pit timbers, its funnel and tailrace, we decided it would be detrimental to the exhibits to extend the length of the building to accommodate a full section of the tailrace. We decided that the tailrace section could be carefully cut so that it would fit in the present building.[33]

This will make possible the assembly of the original furnace wheel pit along the north wall of the building. As I think of it, if we were to remove the bench along the north side of the old museum building, it might make possible the assembly of the furnace wheel pit, the funnel connecting it to the race and a section of the race. This is worthy of consideration.

Roland W. Robbins, "Saugus Ironworks Daily Log - 1952," December 4, 1952.

12.5 Robbins talking to tour group in museum building with furnace waterwheel section display at left, June 30, 1951. (Photograph 376 by Richard Merrill,1951.)

Work on the furnace tailrace exhibit in the new museum building was finished in early April when Robbins noted that "this is making quite an impressive exhibit."[34] He then had his workers move "Jenks' two waterwheels, gudgeon bearing block, and hub from old museum building to new . . . . Dismantled the bench which exhibited the three waterwheels in the old museum building."[35]

Although Robbins had contacted artist Charles Overly about developing a mural for the museum building in 1951, it appears that Overly did not begin this work until at least 1952, when the old museum was being reworked and the new museum finished. Robbins' logs record that Overly worked on painting the mural in the old museum in June 1953.[36] In the meantime, Robbins and his staff assembled the "section of the furnace wheel and spoke in the original furnace wheel pit."[37] This artifact had been displayed in the old museum since 1951 and was moved when the wheel pit was installed in the new museum.[38] As in other areas of the Saugus project, Robbins had to do it all in terms of working on the museum, including ordering "paper cup dispensers for the toilets" and supervising his men to "oil the floor of the old museum building."[39]

During the project, Robbins also became a consummate tour guide, leading literally thousands of visitors around the site. While at some level he saw these activities as linked to "publicity" for the site, he came to realize their educational value and to appreciate the intense interest of the public in his excavations. Thus, as work on the site progressed, he lead more and more tours, both formal and informal, for school groups, local business leaders, visiting dignitaries, and colleagues. During a typical tour, Robbins showed visitors the excavation area, ongoing restoration work, and the museum and artifact collections. He and his staff later developed signage for a marked path that took visitors on a self-guided tour of the site. Signs were placed at a series of platforms where visitors could safely stand and watch the excavation work in progress.[40]

As early as September 1949, Robbins reported that he showed a couple "about the excavations and the museum."[41] In the summer of 1950, he showed many Saugus residents around the site to sell them on the idea of closing Central Street so that Robbins could search for and excavate the furnace waterwheel. For example, in June he noted that the George Layhe family "came in to see me. They are part of a committee formed to consider the present situation of the I.W. etc. I showed them about my museum, the excavation, etc. Attwill had spoken to their group last night. They seemed quite impressed by their visit here. Said they believed everything would go through o.k."[42] In August 1950, Robbins met a Professor Gronewold and a group of 33–35 school teachers from western New York and gave them a tour of the site and museum.[43]

Robbins often found himself on call to lead tours for special groups and important visitors. In August 1950 he recorded that Mrs. Crowninshield and her Marblehead Garden Club were to tour the museum

If the new museum building could be built to accommodate the entire tailrace assembly, the pieces could be fitted and matched and be quite unnoticeable. To cut these pieces at an angle, such as ship lapping, might make the joining less noticeable. The flooring near the northeast corner of the old museum building has settled badly. It would not be an easy job to raise this flooring. We decided to leave it as it is and to build up this area along the area that the tailrace will occupy.

Roland Robbins, "Saugus Ironworks Daily Log - 1953," March 17, 1953.

12.6 Museum assistant Barbara Franklin (?) talking about exhibit panels in museum building, June 30, 1951. (Photograph 382 by Richard Merrill,1951.)

after a presentation by project historian Neal Hartley.[44] Robbins lamented that "my entire day was given to preparing [for] and welcoming the 17 members of the Marblehead Garden Club. Only several came into my museum—and then for ***only 4 minutes.***"[45] This type of situation was clearly annoying to Robbins, but it seems that it was the exception not the rule. Robbins would lead lengthy tours for both small and large groups. These smaller groups might spend one or two hours with Robbins, as he accompanied them around the site.[46] He eventually had to hire a tour guide during the busier summer months as the demands on his time increased.[47] The range of groups visiting the site was truly extraordinary. Robbins and his new guide, Fred England, Jr., led regular group tours for Salem Teachers College, Lynn Classical High School, the Harvard Botany Club, the Nahant and Saugus schools, the Braintree Women's Club, and the National Federation of Business and Professional Women's Clubs, among others; the last group, numbering over two hundred, was in town for its annual convention.[48]

Visitors consistently found the excavations to be fascinating. In November 1952, the Appalachian Club visited the site. Although the organizers had estimated a turnout of 15 members, over 40 arrived for the tour and "showed considerable enthusiasm for the entire project."[49] Visitation to the site was particularly high on weekends. In March 1953, Robbins recorded that on "Saturday 36 or more people registered in the new museum building. Sunday, 141 or more registered in the new museum building. We have no way of telling how many visited the museum, certainly all did not register."[50]

At 2:00 P.M. [members of the Appalachain Club] gathered in the new museum. I spoke to the group, and showed pictures of our work. Attwill operated the projector. At 3:00 P.M. I took them into the field and showed them about the excavations, new furnace and forge site. The group was an excellent one to talk to and showed considerable enthusiasm for the entire project. The last members lingered until nearly 5:00 P.M.

Roland Robbins, "Saugus Ironworks Daily Log - 1952," Nov. 15, 1952.

Robbins engaged in many other types of public outreach as part of the publicity and marketing plan for the site. For much of the excavation and reconstruction periods, the overall publicity for the project was handled by the New York public relations firm of Hill and Knowlton. Robbins participated in publicity as early as 1949, when he did a half-hour radio interview on WLYN with several other members of the FIWA staff.[51] He was also asked to work with writers and photographers who were preparing stories about the excavations for magazines like ***Popular Mechanics*** and ***Business Week*** and newspapers such as the ***Boston Globe***.[52] He reported that Hill and Knowlton "sent one dozen copies of 'Restoration of First Iron Works, Saugus, Massachusetts.' These I shall pass out to newspaper or magazine writers, or sources whereby this material will be beneficial for our public relations."[53]

Robbins and his staff also regularly assisted with and participated in publicity photos with school children, scouting groups, and civic organizations.[54] For example, in September 1950, he remarked on the school kids "who posed with me yesterday at the hammer head site . . . . These pictures were taken yesterday for publicity purposes."[55]

Interestingly, Hill and Knowlton made Saugus one of the earliest sites publicized through the new medium of television. In 1950, Robbins noted that a Professor Wesley Pratzner of Boston University was "coming out tomorrow p.m. with Phil Coolidge, a television man, to size up the situation for television

12.7 Robbins and school students pose for "publicity shot" with forge hammerhead, November 19, 1950. (Photograph 269 by Richard Merrill, 1950.)

possibilities."[56] Several months later, in January 1951, Robbins was "Ruth Lev's guest at 11:15 a.m. on her television show 'All About People,' broadcast on WBZ Boston." He went on to note that it was "an audition for her, N.B.C. officials being present."[57]

Television work led Robbins to photographer Henry Gibson, who suggested the preparation of a color movie about the excavations. Gibson reviewed many of Robbins' color photographs, planning to use some of them in the film. Much of Robbins' photography was eventually used in the 1955 documentary film, "The Saugus Iron Works Restoration: A Shrine to Pioneers of American Industry," which won the Golden Reel Award in the History and Biography Category at the 1955 Golden Reel Festival.[58] The FIWA also produced two filmstrips on the excavation work, titled "Discovery at Saugus" and "The Cradle of an American Industry," for use in schools. Robbins served as a consultant on the project, providing scriptwriter Henry Gibson with images of the excavation and artifacts and offering comments and suggestions as the project proceeded.[59]

In addition to his day-to-day work with Hill and Knowlton, Robbins lectured to community and professional organizations across the region. During his tenure at Saugus, he made over fifty public appearances, lecturing to more than 3,500 people on his archeological work at Walden Pond and Saugus and reading his Vermont stories and poetry. Almost two thirds of his lectures focused specifically on the Saugus excavations, reaching over 2,000 people in the community and region. Following his employment at Saugus, Robbins continued to lecture on the excavations, addressing approximately 4,000 people during 35 separate lectures between 1954 and 1957. Beginning in 1955, he developed a lecture program that drew on his various excavations, including Saugus, Walden, Shadwell, the Thomas Jefferson birthplace, and the Quincy Iron Works. Between 1955 and 1957, he delivered this new talk, "Treasure Hunting in Americana," almost fifty times to audiences totaling over 8,000.[60]

Robbins' audiences included historical societies, clubs, civic and community groups, patriotic organizations like the DAR, schools, libraries, and churches. He also spoke on his excavations and discoveries at Saugus to members of the Massachusetts Archaeological Society, at a conference sponsored by the Antique Club of New Jersey, and as part of an exhibit opening at the New Jersey State Museum. Of this last lecture, Kathryn Greywacz, director of the museum, wrote to Robbins that "before any more days pass, I must write and thank you for the wonderful talk you gave at the Museum on the 'Restoration of the Saugus Iron Works.' There was so much interest taken in your talk and we have received so many requests to have you back again some evening, I would be glad to have you let me know should you be planning to be in the area later on . . . ."[61]

Robbins's regular lecturing on the Saugus project proved to be a major avenue for interesting and exciting the public. This lecturing benefited Robbins and the project in several direct ways, particularly in

Gibson left for my use a moving picture camera and several rolls of color film. He instructed me on handling the camera, etc. I shall take a roll of color shots tomorrow, weather permitting, and send them on so he can see how I am doing. The pictures I take will be used for a color film to be prepared.

Roland W. Robbins, "Saugus Ironworks Daily Log - 1951," January 17, 1951.

12.8 Robbins shooting movies of excavation work. Note the refinery (forge) sign and Bridge Street in background, October 1951. (Photograph 1805 from the Roland W. Robbins slide collection, 1951, Saugus Iron Works. Courtesy The Thoreau Society® Collections at the Thoreau Institute at Walden Woods.)

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garnering community interest and support for the project. While lecturing generated income for Robbins during much of his later career, he generally did not charge for his Saugus talks during the project as he considered publicity part of his job. Hill and Knowlton supported Robbins' lecturing and regularly arranged appearances.[62] He consciously cut back on his other "professional engagements" during his time on the job at Saugus. In 1950, Quincy Bent questioned Robbins about doing lectures during the work day: "Being busy, as you are, with your archaeological work I wouldn't want you giving lectures through the day time."[63] Robbins was incensed, and wrote in his daily log that

> I told him that he should know better than to as much as imply I should do such a thing. I said that in the past I had talked to local Rotary and Lions Clubs at their luncheons—but had not taken professional engagements. How caustic—how ironic! To think of all the free evening lectures I gave last winter and spring simply to create interest and spread goodwill![64]

This experience further confirmed his already negative view of Bent and had a lasting impact on his relationship to other organizations for which he worked. In regard to Saugus, he wrote in 1950 that "after Mr. Bent's acid remark, I have no designs on continuing this goodwill work in the future." He kept his promise, as his records indicate that while he gave 12 lectures in 1949 and seven in 1950, he offered only five or six in 1951 and only eight over the next two years.[65] Restricting his lecturing principally to evening and weekend hours, he now charged for these "professional engagements," unwilling to donate any more after-hours time to the project.

Robbins had similar disagreements at subsequent projects regarding lecturing and time commitments. He came to see his archeological discoveries as his intellectual property to use as he liked, balking at any suggestion that the story and the information belonged exclusively to the site and the organization sponsoring the work. Nevertheless, he remained committed to providing lectures for publicizing his various projects, often at no charge to his employer; lecturing was, he found, an excellent way of "getting others involved . . . ."[66] During his career, Robbins delivered almost 700 public lectures to an estimated 70,000 people, who apparently found him an engaging speaker and his subject one of great interest.[67] The vast majority of his lectures came during periods between major excavations. From 1954–1957, between the end of the Saugus project and the beginning of the Philipsburg Manor work, Robbins presented 120 lectures to over 17,000 people. Even when doing his lectures pro bono, Robbins found that they were a very useful publicity vehicle for networking with groups and organizations in search of an archeologist; they literally became marketing opportunities for himself as an archeologist. As J. C. Harrington noted in 1965, at the time it was "harder to find an available [historical] archaeologist than a Chaucerian scholar."[68]

"Uncovering the Ruins of America's First Iron Works"

A New, Exciting, Illustrated Lecture

By Colonial Archaeologist Roland Robbins

See—the uncovering of hand-hewn timbers buried three centuries—excavating the foundations of many Colonial buildings—locating tons of ancient relics . . . AND—to make possible this new national shrine, the moving of buildings and the relocating of existing streets.

Hear—the first-hand account by Roland Robbins. Follow his progress with clear, vivid Kodachromes.

Colonial Archaeology is Thrilling—Humorous—Educational—TOPS in ENTERTAINMENT!

Lecture flyer, n.d., The Roland Wells Robbins Collection in the Thoreau Society Collections at the Thoreau Institute at Walden Woods.

12.9 Robbins lecturing on the ironworks excavations, November 15, 1951. (Photgraph 508 by Richard Merrill,1951.)

The benefits of Robbins' lecturing were, however, far from his alone. Thousands of men, women, and children learned and laughed with Robbins, often getting their first introduction to historical archeology from him. During the Saugus project in particular, Robbins came to realize and capitalize on the excitement generated by the tangible remains of the past and the thrill of discovery; he understood the emotional appeal of archeology and stood ready to weave a compelling story around his discoveries. Archeologist James Deetz underscored the importance of this emotional appeal of the past and its connection to intellectual pursuits in his book *Flowerdew Hundred*, specifically pointing to the work of Robbins at Saugus in this regard.[69]

Clearly ahead of his time in taking archeology to the streets and schools, Robbins ultimately paid a heavy price for his public-oriented approach. His populist appeal, which earned him the title "the People's Archaeologist," created a tension between himself and university professionals that would ultimately shatter his reputation and career. As the academy drew the discipline of historical archeology under its wing, it began the slow process of professionalization that enabled academics to control and standardize archeological knowledge. As a result, the field's "secrets" were restricted to those with a certain level of professional proficiency, limiting membership in the new "community of the competent."[70] Robbins believed that the ownership of the past belonged in the hands of the individual, making "everyman his own historian," to use Carl Becker's phrase.[71] Robbins's unrestricted approach, which shared archeology with the masses and suggested that they could themselves be archeologists of sorts, ran counter to all that was held sacred in the professional culture. Ironically, Robbins' successes and failures at pioneering public archeology inform current attempts at public education and interpretation, even among academics.[72]

But the emotional impact of these objects [Saugus artifacts] is palpable, reminding us in ways that no written account could of what it must have been like in the rough New England frontier, trying to develop a technology in the face of considerable odds.

James Deetz, "Flowerdew Hundred: The Archaeology of a Virginia Plantation, 1619-1864," pp. 169-174.

Robbins also served as a pioneer in historical archeology by involving a host of specialist researchers and consultants in the Saugus project and by carrying out his own outside research on a host of topics and subjects, including historical and oral history research, the study of other contemporary iron-making sites, artifact identification, conservation, materials testing, and geoarcheology. In most of these areas, Robbins and his colleagues literally broke new ground in the fields of industrial and historical archeology.

Throughout the project, Robbins traveled to area libraries and research centers to consult documentary records, including early illustrations of ironworks by Diderot, plats and maps, and contemporary accounts.[73] His historical research began early in the project, before full-time historian E. Neal Hartley was hired. While limited in scope it "helped him in interpreting his archaeological finds."[74] He recalled that most of his reading was directed at obtaining a "little better idea of what I should look for . . . . I had to learn to identify the iron works buildings, what we should expect to find, what a blast furnace consisted of . . . . I thought that would be the best information to have if I was going to dig."[75] In September 1949,

12.10 Robbins discussing artifacts with tour group in the museum building, October 18, 1952. (Photograph 739 by Richard Merrill,1952.)

for example Robbins traveled to Salem, Massachusetts, where he examined several diaries in the collection of the Essex Institute.[76] Archeologist Mary C. Beaudry, who subsequently analyzed the use of documentary sources for the project, writes that Robbins "did not have the advantage of a full-scale [historical] research report to guide his investigations" or even a complete chain of title for the property.[77] He was, she concluded, "able to make fairly accurate statements about the remains he uncovered, based on the small-scale research which he personally conducted."[78]

Robbins and his colleagues at Saugus had a great deal to learn about early iron making and availed themselves of any opportunity to study other furnaces and ironworks layouts. Robbins supplemented his documentary research with visits to other iron-making sites in the area and throughout New England.[79] For example, in 1949, he visited the modern Lynn Iron Foundry, where he observed the "plant operations" and the casting process; he noted that he learned the "names of the different channels which carry melted metal through the sand mould."[80] Robbins seems to have literally taken every opportunity to examine other furnace operations. While on vacation in Vermont in the fall of 1949, he visited the Forest Dale Furnace and then spent several days studying the Pittsford Furnace.[81] In 1950, while working on the furnace waterwheel at Saugus, Robbins visited Sturbridge Village with Hartley to study the "22 foot waterwheel in operation at the gristmill."[82] Robbins and the Saugus team also visited several eighteenth- and nineteenth-century ironworks sites in the Ringwood Manor State Park in New Jersey in early 1952, one of several trips set up by the American Iron and Steel Institute.[83]

Robbins also met with several iron-industry experts during the course of the project. For example, in 1950, ironworks expert Earle Smith visited the site to discuss the Saugus evidence; Smith likened the Saugus setup to the Sandvik, Sweden, furnace.[84] Robbins questioned him about the construction of furnace foundations, the arrangement and use of casting beds, and the layout of the forge hammer. Smith explained that the hammer area "should produce a wooden block in its center on which the anvil rested." Robbins asked Smith to look at several artifacts, including a series of "cupped metal pieces" that Smith identified as ladles. Robbins and Hartley arranged to send Smith samples of slag, metal, ore, and limestone from both the Saugus excavation and testing at the Hammersmith furnace in West Quincy.[85]

Robbins' meeting with English ironworks expert Dr. H. R. Schubert was less successful than his visit with Smith. He and Schubert strongly disagreed on the interpretation of several pieces of evidence related to the ironworks layout. In June 1952, Robbins recorded that "I was talking to Dr. Schubert and Hartley and remarked that the forge hammer base was seated upon a large horizontal beam. He [Schubert] remarked, 'It couldn't be, they always placed a metal plate, or sow bars, at the bottom of the anvil base.'" Robbins noted that he "had to take him down to the site to prove my point."[86] In another exchange, Robbins recalled telling Dr. Schubert

Mr. [Earle] Smith went over the casting beds, their slope, the stone ramp at S.E. corner of furnace and agreed that they are all very logical. He said the size of the casting area and its slope were in keeping with casting beds he has seen in Sweden . . . . He said it was not unusual to cross a casting bed to get to the slag dump. He agreed 100% with my archeological theory of this layout. Also he offered a likely solution for the disturbed low area to the front of furnace breast. He said that cart service across that area would sink into the mud hub deep or more. It is possible that the area was cleared of its mud and filled with slag, metal waste, etc. for a more solid base. Also cart and breast service across this area would churn up the loam and mix surface evidence into it.

Roland W. Robbins, "Saugus Ironworks Daily Log – 1950," April 29, 1950.

12.11 Diderot sketch of ore harvesting boat. (Gillispie, *A Diderot Pictorial Encyclopedia*, Vol. 1, plate 83, 1959. Courtesy of Dover Publications, Inc.)

> how I found the casting beds clinging to the south side of furnace breast. He insisted that that could not be the case, "they ran out from the center of the casting arch." I told him I had the sands from these beds. He said that that wasn't possible, "they wouldn't last that long." He didn't seem interested in this evidence, he felt certain that this was never the case with the English furnaces . . . . All this, mind you, without any knowledge of the evidence uncovered by my work. He seems entirely convinced that Saugus was a prototype of English Iron Works.[87]

Robbins sarcastically noted that "Dr. Schubert should have been brought over 3½ years ago. With his knowledge of English Iron Works there would have been no need of engaging an archaeologist to determine the basic pattern of the Saugus Iron Works."[88]

Robbins also studied sites and features with historical links to Saugus, such as the furnace at Braintree Quincy, Massachusetts. As noted above, he took ore, slag, and coal samples for laboratory analysis and eventual comparison with the Saugus specimens.[89] Robbins developed a dialogue with other archeologists and historians working on historic sites around the country, including those excavating iron-making sites such as the National Park Service's project at Hopewell Village in Pennsylvania.[90]

In 1950, Robbins traveled to Quincy, Massachusetts, to locate and investigate the Braintree furnace, related to the Saugus Hammersmith operation and the later Hubbard Furnace on the Monatiquot River.[91] Robbins noted that he sought out a site on the property of a Ford automobile dealer; he investigated along the river, recording "much evidence of building foundations along the water way. Also sites of two or three dams."[92] While he thought this indicated "many generations had made use of this area and its water power for different manufacturing and business purposes," he felt that the topographic relief in this area argued against its being the location for the furnace.[93] He also noted that the river at this point was clearly not navigable. Moving farther downriver, Robbins stopped by a site that Hartley believed to be the Hubbard Furnace, which operated after the Braintree Furnace ceased operation. Although he could not examine the site closely, Robbins noted that it did have sufficient topographic relief for a furnace and furnace bridge.[94]

Robbins and his colleagues next visited a site at the Hall Cemetery, which he reported as having started in 1643.[95] He located a mounded area that was close to a channeled waterway known as Furnace Brook. After obtaining permission for some limited testing from the cemetery superintendent, Robbins excavated two small test pits in the approximately 21-by-24 -foot raised earthen feature. In test pit #1, Robbins dug to a depth of 37 inches, recovering "stone, glass and other rubbish" from the first 18 to 20 inches.[96] He notes that the soil below about 20 inches "began to take on the reddish color found in soil that filled Saugus crucible pit and its surrounding area"; this soil continued to the bottom of the test. He

The chemical analysis indicated below, compared with the Saugus slag analysis covered in my letter of November 18, 1949, shows that they bear very close resemblance to each other and therefore are probably of the same general type. It would seem with this magnesia content that the gabbro from Nahant must have been used in these slags as well as those from Saugus.

H. M. Kraner (Bethlehem Steel Company) to Roland W. Robbins, September 11, 1956. Robbins, "Report of the 1956 Archaeological Exploration at the Site of the 1644 John Winthrop, Jr. Blast Furnace," p. 273.

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12.12 Iron expert Earle Smith examining artifacts during visit to Saugus, April 30,1950. (Photograph 373 from the Roland W. Robbins slide collection, 1950, Saugus Iron Works. Courtesy The Thoreau Society® Collections at the Thoreau Institute at Walden Woods.)

also records that a metal probe rod hit what he suspected was a stone foundation at about 55 inches and that the bottom of the test pit contained "burned sandstone furnace lining similar to that found at Saugus."[97] The unit also contained slag waste pieces and what he thought might be a piece of metal waste. Robbins' other test pit was dug some fifty feet north of the earthen feature and contained a layer of slag that further probing suggested was at least two or three feet thick. Robbins ends his notations by stating "today's tests and observations here were gratifying. Time may prove this site to be the Braintree branch of the Saugus Iron Works." [98] Visits like this were critical in Robbins' ongoing education on ironworks, helping him to improve his understanding of furnace layouts and to read the landscapes of these industrial sites.

Another important early furnace was the Falling Creek Ironworks site in Virginia, thought by some to be the first ironworks in America. Robbins visited the site in 1951 at the request of the Restoration Committee of the FIWA and members of the American Iron and Steel Institute.[99] Both groups were aware of the Falling Creek site and became concerned about the legitimacy of their claim that the Saugus facility was actually the "first" ironworks site in colonial America. Robbins was asked to investigate the site and determine whether evidence existed that would confirm that the Falling Creek site actually operated before its destruction during the 1622 massacre.[100]

Robbins records his Falling Creek visit in his Saugus daily log for March 31, 1951, providing an important sketch map of the site.[101] He reports that he located evidence of an old dam and deserted canal that ran along the north side of the river from the dam to a gristmill ruin. Working south from U.S. Route 1, he notes that the stream banks from Route 1 to the dam were steeply sloped and that the area "permits no working area for casting, etc."[102] He continues his observations by recording that "the general area where the ruins of the grist mill stand [are] most desirable for blast furnace operations. Here, either side of Falling Creek provides ideal elevations for a furnace bridge, as well as a working area . . . ." He further favored this area because it provided navigable waters that terminated at the falls and calculated that a dam at this "cascades" would provide a good head of water to power the furnace. While Robbins states that he looked carefully at the conjectured furnace site area, he notes that he found no slag or other evidence to suggest furnace activity. He did find, he continues, metal waste, metal, brick, and refractory brick 20–25 feet west of the gristmill ruins and notes that "this evidence indicates that forge activity took place in this area some time ago."[103] Subsequent research suggests that this evidence reflects the location of Archibald Cary's eighteenth-century forge on the site. Robbins reports that the materials suggested forge activity prior to the building of the gristmill and that he "took a refractory brick, metal waste materials, and a large piece of metal . . . back to my hotel."[104] He took these samples back to Saugus for further examination and testing and ends his notes by stating that "if I have the opportunity to continue the Falling Creek investigation I shall first concentrate on the area to either side of Falling Creek at the cascades."[105] The trip thus ended without a confirmation of the whether the site actually produced iron

Bricks I found at forge site at Falling Creek yesterday compare favorably in size and appearance with a brick in the Archaeological Museum which has 1717 carved in it. Bricks were often burned (made) on site where the building they were to be used in was being erected. Small (thin) size brick found only occasionally and in small quantities in Williamsburg. Probably Williamsburg "English" bricks are similar to the thin bricks we have found during the Saugus excavations. The thin bricks found at Saugus are contemporary with the Iron Works, having been found in two places in the furnace construction. (In circular structure at N.E. corner of crucible pit, and in drainage system leading into north wall of crucible pit from bellows base timbers. Also the furnace lining probably used brick to some extent, possible at the tunnel head.) At 2 P.M. I met Mr. Minor Wine Thomas, the Williamsburg Archaeologist.

Roland W. Robbins, "Saugus Ironworks Daily Log – 1951," March 31, 1951.

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12.13 Historian E. Neal Hartley standing on retaining wall along Furnace Brook, looking toward the site of Braintree works. (Photograph 1963 from the Roland W. Robbins slide collection, 1950, Saugus Iron Works. Courtesy The Thoreau Society® Collections at the Thoreau Institute at Walden Woods.)

and thus could be considered the first ironworks in the colonies. Subsequent work by Robbins, Howard McCord, the staff of the William and Mary Center for Archaeological Research, and, most recently, Lyle Browning of the Falling Creek Ironworks Foundation, suggests that Robbins' educated guess was correct and that the furnace stood on the west bank of Falling Creek in the immediate vicinity of the "cascades" or falls.[106]

In addition to his consultations with iron-industry experts and visits to various sites, Robbins also sought assistance with the analysis and interpretation of the artifacts recovered from Saugus. In January 1950, while visiting Fred Orchard at Harvard's Peabody Museum to learn more about artifact conservation techniques (see also Chapter 11), Robbins asked about help with identifying early American pottery. He notes that he told Orchard about an idea from Plimouth Plantation's Henry Hornblower to check "antique shops along Charles St. . . . I asked why this would be advantageous and he said that some of the pieces found in these shops may be dated. Believed I quite possibly could find valuable information and similar specimens to those uncovered during my excavations at the Society of the Preservation of N.E. Antiquities *[sic]*."[107] Likewise, while in Virginia to investigate the Falling Creek Ironworks site, Robbins notes that he spent "time in the Archaeological Museum and with Williamsburg's archaeologist, Minor Wine Thomas. This trip was very successful and informative. Wish I had some time [to] spend there. He wants me to return and to visit his lab."[108]

Robbins clearly took every opportunity to learn about the artifacts he was recovering. Because historical archeology was such a new field, he had to approach this work from many directions to get even basic information. Over the course of his five years at Saugus, Robbins spent considerable time getting to know pottery types, clay tobacco pipes, animal bone, and the many kinds of metal artifacts used in and produced by the ironworks. In January 1949, Robbins began his artifact research at the Concord Public Library, looking for information on the clay tobacco pipes he was recovering. He was excited to find a *Scientific American Supplement* from 1908 that told "considerable about the early clay pipes."[109] A visit to the tenth annual meeting of the Massachusetts Archaeological Society provided another opportunity for asking questions about pipes, but Robbins notes that archeologists William Fowler, Jesse Brewer, and Charles Sherman were only able to tell him that the clay pipe bowl he brought along was "not of Indian origin."[110] Robbins, like J.C. Harrington at Jamestown in the 1930s, struggled with the general lack of information on historic artifacts. As Harrington later wrote, "I came to Jamestown with the ability to recognize the difference between a corrugated and a simple stamped Indian potsherd, but such terms as 'delftware' and 'stoneware' were completely foreign to me; they were all just 'china.'"[111] In an attempt to discover more about pipes, Robbins wrote to H. Geiger Omwake, superintendent of the Lewes School District, Lewes, Delaware, who he records "is a top authority on Colonial clay pipes," and sent him several sketches of pipe bowls recovered at Saugus. [112] While waiting for a reply from Omwake, Robbins visited the Art Department of the Boston Public Library, where librarians found several articles from

During the four years of excavations here at Saugus, we have located considerable evidence regarding clay pipes and the periods when they were used. Many of them have been found at working levels associated with the Iron Works activity which took place here three centuries ago. While all of these specimens have been carefully carded, plotting their association with the different sites, time has not permitted a careful study of their significance and relation to different periods. This will be attended to in due course. However, I think it is well to point out that the earliest pipes did not always contain a small bowl. Also, here at Saugus, we have uncovered considerable evidence of red clay pipes.

Roland W. Robbins to Maurice Robbins, January 26, 1953.

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12.14 Sketches of tobacco pipes found at Saugus, drawn by Nan Herwitz, January 1953. (Courtesy The Thoreau Society® Collections at the Thoreau Institute at Walden Woods.)

the journal *Antiques* on "TD" pipes and "colonial pipes found in and about Yorktown" and suggested a couple of pottery and porcelain books that reference clay tobacco pipes (i.e., works by Edwin Altee Barber and William Chaffers).[113] Robbins also contacted archeologist Arthur Woodward of the Los Angeles Museum for more information on the identification and dating of pipes.[114] By the end of the project, Robbins was passing his information on tobacco pipe identification on to fellow archeologist Maurice Robbins, providing a sketch of the marked pipes at Saugus (drawn by Nan Herwitz) and explaining what he had learned about each pipe and its maker.[115]

Although not a primary focus of his work at Saugus, Robbins also sought help with Native American artifact identification from colleagues at the Peabody Museum and the Massachusetts Archaeology Society. For example, in late 1951, Robbins took an unusually large stone axe found in the fill of the refinery waterway first to Ben Smith, the president of the Massachusetts Archaeology Society, and then to Frederick Orchard at the Peabody.[116]

As discussed above, Robbins sought out help in identifying ceramics early in the project. After being directed to the collection of the Society for the Preservation of New England Antiquities for comparative examples, he also visited the Concord Library for sources "on pottery and china marks to determine age of chinaware uncovered in fill to north side of Bridge St's. retaining wall."[117] Robbins also met with local experts like Henry Hornblower. Hornblower examined the

> pottery and glass bottle piece[s] found amid stones of foundations #9 and 10. After examining these specimens he doubted either was earlier than 1720. Said it was unlikely that the glass bottle bottom was much earlier than this. Said the pottery piece could be earlier. I asked if it could be earlier than 1680. Again he said he didn't think so. He said no careful study of earlier pottery has been made which could set a definite period on any amount of it. Also said that John Marshall Phillips at Yale University could be helpful, he being one of the top authorities in his field.[118]

Similarly, while in Williamsburg, Virginia, in 1951, Robbins met with "Williamsburg's archaeologist, Minor Wine Thomas" to get help with identifying Saugus artifacts. On this trip, he spent time in the Archaeological Museum, where he took copious notes in his daily log on various types of ceramics recovered at Colonial Williamsburg.[119] On several occasions Robbins met with Lura Woodside Watkins and her son C. Malcolm Watkins, both ceramics experts, who helped with the identification of Saugus artifacts.[120] For example, in December 1952, Robbins recorded that the Watkinses

With Mrs. Crowninshield was a man (a Boswell or Buswell) who apparently was well versed in pottery. He inspected the pottery piece found amid stones of foundation #7 (Sept. 8 relics), and stated it could well be 3 centuries old. He said it had the lines of 17th century pottery. The bottle bottom with (Aug. 25 relics) was not as old in this man's opinion. Possibly about 1776 he suggested. He thought that the Brooklyn (N.Y.) Museum would know. Mrs. Crowninshield said she would send me the address of the person to write to at the Brooklyn Museum.

Roland W. Robbins, "Saugus Ironworks Daily Log – 1949," September 21, 1949.

12.15 Seventeenth-century "latten" spoons excavated at Saugus, April 1953. (Photograph 868 by Richard Merrill, April 27, 1953.)

> looked at some of the pottery fragments I have uncovered at Saugus. I showed pottery pieces from below the base sills of Jenks 1st wheel pit. She said they were 17th century. Also the pottery pieces from the dock excavations were identified as of 17th century, one piece from the dock site was delft. The complete bottom of a red clay pottery piece, filed with the Sept. 18-23, 1950 relics also is of the 17th century. The clay plugs I have found (they may not be contemporary with Iron Works period) she suggested that they may have been used by potters when stacking jugs in the kiln. They would use such a plug to set jugs upon one another. I also showed her the bottom of a china dish which I removed this week from between two of the stones in the easterly side of the middle stone well which is south-east of the forge. She said it might be 1900, certainly not earlier than 1850. This china piece, plus the wire nails found in the sieve, at end of lead pipe leading from the easterly side of this well; as well as Iron Works impurities found more than 6" below lead pipe, and about the base stones of this well; as well as the cut through the natural loam line, with sand or clay fill upon it, with Iron Works impurities upon the clay or sand fill, which was made when the area was dug out for well purposes, strongly suggest that this well is *not* contemporary with the Iron Works era. I shall do more work here before completely eliminating this well as being associated with the Iron Works period.[121]

With continuous input from experts like the Watkinses, Robbins became more comfortable with artifact dating and, as demonstrated above, was clearly using artifacts to establish relative stratigraphic and chronological relationships.

Robbins also drew on experts in the field of forestry to provide help with the identification and dating of the many wooden artifacts recovered from Saugus. He had experimented with dendrochronology at the Walden Pond project to date a tree stump near the cairn marking the Thoreau cabin site. At Saugus, he called on the same expert, forester Jack Lambert of the Massachusetts Department of Conservation, Division of Forestry, to study wood samples. In early 1949, for instance, he contacted Lambert to help with identifying the types of wood being found in the furnace sluiceway. Robbins reports that Lambert "felt quite certain that the beam which lies across the sluiceway near the converged end is oak. As for samples of the easterly sluiceway beam and the large beam which crosses at sluiceway's rear, he was more doubtful but believes they are chestnut. Chestnut is one of best woods for use in contact with ground."[122] In April 1953, Robbins invited Lambert and associate Harold O. Cook to study "the growth rings on the anvil block." They determined that there were "270 discernible rings, (about 8 more rings were difficult to discern.) Jack estimated that 25 more rings could be added between the last discernible ring and the pith of the tree, giving it an overall age of about 295 years."[123] Lambert and Cook also provided help in locating trees of sufficient diameter to be used as anvil bases in the reconstructed forge building.[124]

The Watkins also looked at pottery pieces removed from *the charcoal bed just east of south-east corner of forge. Said it is 17th century. I showed them a piece of blue chinaware from this area (exact site unknown.). They identified it as Blue Staffordshire china 1815-1835. Her son, C. Malcolm, went over my evidence, also. He agreed with his mother's views concerning my artifacts. He is associate curator, Division of Ethnology at the Smithsonian Institute.*

Roland Robbins, Saugus Ironworks Daily Log - 1952, December 26, 1952.

Due to copyright restrictions, this image is not available in the on-line version of this publication.

12.16 Robbins with ceramics expert Mrs. Lura Watkins, March 17, 1952. (Photograph 1264 from the Roland W. Robbins slide collection, 1952, Saugus Iron Works. Courtesy The Thoreau Society® Collections at the Thoreau Institute at Walden Woods.)

At a time when faunal bone was not even being collected at most historic sites, Robbins sought help from Barbara Lawrence and staff at the Harvard Zoological Laboratory to analyze selected faunal remains from the site.[125] The specimens were typically objects of special interest or from important contexts which Robbins hoped to identify and even date. Although Lawrence indicated that dating wasn't possible, she and collegue Dr. Irwin Romer provided general identification for most of the samples. A 1950 letter report indicates that the list of identified bones included cow, pig, sheep, cat, and chicken. The authors note that "from the sharply cut surfaces of some of the long bones and pelvis, it shows clearly that most of the collections were the debris of foodstuffs of the early pioneers, except the cat which was presumably a pet."[126] Robbins also sought help in identifying the animal-hair packing used to caulk the buckets of the furnace waterwheel; the results suggested cattle hair.[127]

The Saugus site produced thousands of artifacts, with excellent preservation of metal, wood, and leather. These materials presented enormous conservation problems for Robbins (see Chapter 11).[128] From the very beginning of the excavations, he conducted research on approaches to dealing with these materials and consulted with several conservation specialists. For example, he worked with Professor Uhlig of MIT to conduct a series of experiments on iron preservation and the corrosion process.[129] In 1952, Robbins hired a worker to begin a series of metal-cleaning experiments with brushes, grinding wheels, and electrolytic reduction.[130] Even more problematic than metals were wooden artifacts. Robbins voiced his concerns with wood preservation problems in early 1949 and quickly began searching for help with this conservation challenge.[131] With the discovery of the large waterwheel sections in 1950, he stepped up his search for suitable wood treatments. In early 1951, Dr. Elso Barghoorn of the Harvard Biological Laboratory conducted a series of experiments to test possible treatments on samples of ironworks wood and finally settled on a paraffin wax impregnation technique.[132] Many sections of the waterwheel pit and flume and waterwheel itself were successfully preserved in this way and remain on display to this day.

Robbins and the Reconstruction Committee also engaged researchers from the iron industry to provide sampling and testing of slags, iron products, iron ores, and casting sands from Saugus. Beginning early in the project, Robbins regularly sent groups of samples to various iron company laboratories, such as Bethlehem Steel, Inland Steel, and Republic Steel. For example, in April 1949, he sent a package of samples including "castings, metals, nails, tuyere, sows and a circular metal piece," as well as samples from the slag heap, to a Mr. Herty at Bethlehem Steel in Pennsylvania.[133] Robbins would typically prepare a list of the samples, providing a brief description and provenience if available.[134] In July 1953, for instance, he sent a group of eight specimens of "impurities" from near the slitting mill site to H.M. Kraner of Bethlehem Steel for analysis.[135] His notes indicated that Specimen #2 consisted of "pieces of two fair sized clinker specimens found in the 13½" deep bed of impurities which were above the lens of lime

I went to Robert Peabody Museum at Andover and looked up Fred Johnson. I want[ed] to get his suggestions for preserving the waterwheel, its buckets, etc. Also to get his suggestions for dismantling the wheel when we remove it.

He telephoned E. Barghoorn at Harvard's Biological Laboratories . . . and told him our problem. Mr. Barghoorn was interested and asked if I would bring him samples of the wood we are finding. He would like to make test with them. I shall do this soon. I shall attempt to get Mr. Barghoorn down to Saugus so that he may receive a first hand account of our problem.

Roland W. Robbins, "Saugus Ironworks Daily Log – 1951," March 13–14, 1951.

Due to copyright restrictions, this image is not available in the on-line version of this publication.

12.17 Crucible after cleaning and treatment in museum building. (Photograph 1568 from the Roland W. Robbins slide collection,1952, Saugus Iron Works. Courtesy The Thoreau Society® Collections at the Thoreau Institute at Walden Woods.)

materials." Robbins recorded that it was possible that "these specimens could identify the nature of the activity taking place there."[136]

In May and June 1949, Robbins sent 20 samples of cast and wrought iron from the furnace area for analysis. A report by analysts S. Epstein, K. Haupt, and A. G. Ferdinand details the chemical and metallographic examination of these specimens, separating them into two groups of cast-iron (five) and wrought-iron (twelve) samples.[137] The authors note that while both the wrought- and cast-iron specimens showed considerable variation in phosphorus and sulphur content, in general the wrought-iron specimens were lower in phosphorus and sulphur than the cast iron. The analysts also note that "all of the wrought iron specimens were relatively low in carbon content."[138] They found that it was unlikely that any of the wrought-iron specimens was "quenched from above the critical temperature for hardening."[139] Similar analyses were performed on the sandstone-lining evidence, the slags, and molding and casting sands.[140] In the case of the molding and casting sands, Robbins submitted numerous samples of sand and mold fragments from the sow and hollowware casting beds of the furnace.[141] Sample B-1, analyst Frederick Matson reports, was "a mixture of raw very fine textured sandy clay and of clay that has been exposed to heat and has been oxidized to an orange color."[142] Matson also notes that the "quartz grains are dominant and control the color, while the actual clay particles act as a bond." [143] These types of studies were extremely important for the confirmation of Robbins' interpretation of various features, providing solid physical evidence of specific types of ironworking activities.

Robbins' collaboration with Dr. Elso Barghoorn on wood conservation resulted in their study of sea level rise along the coast. Robbins' discovery of three-hundred-year-old ironworks features submerged under the Saugus River caused him to wonder about sea level during the 1640s. Dr. Barghoorn began studying the features and the underlying geological formations in 1951, and published "Recent Changes in Sea Level Along the New England Coast: New Archaeological Evidence" in 1953.[144] This article, based on the archeology at Saugus and at the Boylston Street fish weir in Boston, concluds that the Saugus evidence proved a sea level rise of three feet over three hundred years or about one foot per hundred years.

Robbins' reliance on outside research, both his own work and the contributions of specialist researchers and consultants, added greatly to the success of the Saugus Iron Works reconstruction project. With historical archeology still in its formative stages, the general level of knowledge about artifact and feature types was extremely limited. At industrial sites, this knowledge was virtually non-existent in the late 1940s. Robbins and his colleagues on the Reconstruction Committee were forced to pursue a wide variety of approaches and were generally open to input from many sources. While Robbins worked on all aspects of the research, he also had a great deal of assistance from experts in many fields. Much of the analysis and eventual translation of the evidence into the physical reconstruction would not have been

Took samples of teeth from May 25 and June 11 artifacts (tailrace excavation), as well as bone evidence from May 24 (2 pieces) and June 10 (east of tailrace excavations) 2 pieces and one tusk for examination at Harvard Zoology Museum. Sent Herty Jr. specimens of furnace's sandstone lining (1 piece); its clay packing (1 piece); piece from broken casting (#20) piled in corner of two walls located 40' south westerly of furnace's southwest corner; and 2 pieces of bog ore removed from excavations about area near to south wall of furnace.

Roland W. Robbins, "Saugus Ironworks Daily Log - 1949," June 14, 1949.

12.18 Technician using spectrometer to examine chemical composition of "Saugus Pot," January 4, 1951. (Photograph 280 by Richard Merrill,1951.)

possible without the input of so many other researchers, particularly the iron-industry experts and analysts.

13.1 Opening day crowds on the path to the reconstructed industrial buildings. (Photograph 1270 by Richard Merrill, 1954.)

Evaluating the Reconstruction

William A. Griswold

By the end of the reconstruction, The First Iron Works Association (FIWA), backed almost entirely by the American Iron and Steel Institute, had spent about two million dollars on the project. Two million in 1950s dollars would be worth almost fifteen million dollars today (CPI adjustment), a very generous gift intended to commemorate the birth of the iron and steel industry in the United States. This chapter evaluates how well the Institute's money was spent. Does the reconstructed Saugus Iron Works of today closely resemble the historic seventeenth-century ironworks? To answer this central question, two additional questions must be explored: how accurately were the buildings reconstructed and does the limited reconstruction represent the ironworks of the 1640s?

The Accuracy of the Reconstructed Buildings

From the very inception of the project, the FIWA and the smaller Reconstruction Committee knew that archeological investigations could provide key information to aid in the reconstruction. However, even as plentiful and well-preserved as the archeological record was at the site, the members of these organizations realized that archeology would not provide all the information necessary for the reconstruction. Archeology could locate the various features on the landscape (furnace, forge, canals, etc.), but could not provide information on the height of the furnace stack or how the gears of the rolling and slitting mill functioned. To learn about these details, an enormous amount of historical research was done by several members of the project including Neal Hartley, Charles Rufus Harte, Walter Renton Ingalls, H. R. Schubert, and various individuals associated with the architectural firm of Perry, Shaw, and Hepburn, Kehoe and Dean. These individuals worked in conjunction with many members of the American Iron and Steel Institute who had equally impressive credentials for understanding the historical manufacture of iron. To justify the price tag of the undertaking, the FIWA had amassed the most knowledgeable minds in the business; Saugus was to be the industry's legacy.

Even though the best and brightest worked on the project, a great deal of the information needed for a bottom-up reconstruction was either unavailable or proved contradictory or ambiguous. In these cases (and there were many), the architects were charged with providing the necessary details to come up with a workable solution toward physical reconstruction. The architects' solutions were then discussed and evaluated by the Reconstruction Committee members and/or by the specialists associated with the

Any student of colonial history knows that there were dozens of loudly hailed grand designs and projects, most of which came to naught and stand embalmed in the records only as evidence, now quaint and touching, now grandiloquent beyond belief, of the dreams of pioneers. The New England ironworks, however, became realities, and impressive realities, despite the limited duration of their effective production. One of the Company's agents adjudged them "as good as any worke England doth afoarde." The researches of modern scholars do not seriously weaken his claim . . . . At Lynn, there was a complete ironworks, whose design and engineering were as bold as sophisticated. Here was a huge furnace, a forge comprising two fineries, a chafery, and a big hammer, an extensive water-power system, good storage facilities, workmen's accommodations, and a pier for the use of the small boats which plied the Saugus River laden with the ironworks products. Here was a rolling and slitting mill, the first in the New World, and set up when there were only about a dozen of which we have record in the British Isles and on the Continent. To build all this had taken the willingness to risk of capitalists, the vision of men we today call engineers, the sweat of all but unknown workmen achieving performances of high skill in the working up of timber and stone and iron.

E. Neal Hartley, *Ironworks on the Saugus*, pp. 4-5.

project. Sometimes the committee members and specialists liked the architects' solutions, while at other times they lambasted the architects either for providing too complex a solution or for not having done enough historical research on the issue.

As seen time and again at Saugus, strange things can happen in committees. Some naively believe that committees are primarily egalitarian places where ideas are brought up and discussed in a totally intellectual framework devoid of constraints like money, time, charisma, personality, hierarchical structure, politics, or discipline hierarchy. However, those who regularly serve on committees know that these constraints typically dominate the decision-making process. At times, one can anticipate what arguments will be made by certain individuals or particular groups before the topics are even brought up for discussion. In the end, some decisions that are made in committees are good and some are bad. The Reconstruction Committee at Saugus was no different than present-day committees and as such was governed by a multitude of constraints from personality clashes to intellectual disagreements.

In the project correspondence, it is indeed difficult to distinguish the Reconstruction Committee from the FIWA from contractual specialists. Even though each of these groups had a defined membership, a great deal of overlap occurred. Membership also changed through time, so one has to be very careful to identify the year under discussion. When begun in the early 1940s, the FIWA's membership was small, but it ballooned by the early 1960s. Technically, in 1952, it was composed of J. Sanger Attwill (president), Henry Peckham (vice president), Thomas McNichols (treasurer), Miss E. Florence Addison (assistant treasurer), Miss M. Louis Hawkes (clerk), and nineteen directors, including Walter Tower, Quincy Bent, Edward Bartholomew, Jr., Charles Rufus Harte, Walter Renton Ingalls, and Mrs. F. B. Crowninshield. The Reconstruction Committee was the group directly responsible for getting the Saugus Iron Works reconstruction built. From 1948 to 1953, this much smaller, task-oriented group included Atwill, Bent, E. Neal Hartley, Harte, architects Andrew Hepburn, Sr., and Conover Fitch, Jr., Ingalls, Bartholomew, and Carl T. Emery. Individuals like Roland Robbins, H. M. Kraner, Elso Barghoorn, and H. R. Schubert were considered specialists and while their input on the project was highly valued, they were never considered members of either committee. Hartley, while named as a Reconstruction Committee member in photographic captions, never considered himself a member of either group.

A careful reading of the correspondence makes it clear that there were several camps within the committees. Robbins seemed to get along famously with Charles Rufus Harte and rather well for the most part with Hartley. Robbins did not get along well with either H. R. Schubert or the architects, especially Harrison Schock. The disagreements were sometimes the result of intellectual disagreements but more often than not were simply the result of personality clashes. Robbins seemed to have been the real rebel of the

Even within the smaller working group communication has not always been perfect and there have been fumbles. This I take to be the best evidence in the world for the necessity to have the decision making carried by a small body. As one example of a failure to communication take the furnace bridge. I do not believe that I saw the plans for it in advance of its actual construction. I did see the bellows plans and approved them as coming closest to squaring with Robbins' data of the several versions which they worked out with adequate historical precedents. The fumbles are ab*normal. Normally, to my eyes, we work together quite satisfactorily and what we come up with is a* joint *product. Robbins is not always satisfied. Neither am I. Neither are the architects. But we do the best we can . . . .*

E. Neal Hartley to Charles Rufus Harte, August 20, 1952.

13.2 Members of the Reconstruction Committee pose with iron ring on September 11, 1951. (Photograph 438 by Richard Merrill, 1951.)

group, constantly locking horns with the architects. He was not the only person to question the work of the architects, as a July 24, 1951, letter from Charles Rufus Harte to Quincy Bent illustrates:

> When, some weeks ago, Robbins told me that the architects' representative, one Schock, had said they proposed to tear down the walls [of the furnace] and rebuild them, the idea seemed so preposterous, in view of their condition, that I assumed it was due to the man's ignorance or incompetence, and gave it no further thought. Yesterday, however, I found that not only the comparatively small collapsed section, but all traces of the old masonry had been removed, an act which to me seems little short of criminal.[1]

While not mounting a vigorous defense of the architects, Hartley did believe they were doing the best job they could under the circumstances and even had faith in Schock, as is evident in a letter from Hartley to Harte dated August 10, 1951.

> He has a very difficult situation on his hands in that he is working closely with two people of whom I am very fond but who are possessed of potent Yankee personalities and an almost messianic zeal for the job in hand, Miss Hawkes and Robbins. Few could satisfy the former, and Schock's personality is such that he could not fail to clash with the latter. He means to do well, and he has certainly given the literature a terrific going over before coming up with what he considers sound. He has to be shown but he is not closed to further suggestion or editing of what he has produced. In summary I do not share Robbin's doubts as to the competence of Perry, Shaw and Hepburn in general or of our friend Schock in particular. I do insist that they, like all architects in all times and places, need close supervision.[2]

In many instances, decisions regarding the reconstruction were made by Quincy Bent, the chairman of the Reconstruction Committee and key contact for the American Iron and Steel Institute. It was Bent who called the shots for the project and without his seemingly dictatorial style of decision making, it is unlikely that the ironworks reconstruction would have ever been completed.

One Reconstruction Committee member in particular, Charles Rufus Harte, was very dissatisfied with Quincy Bent's leadership. Ultimately, Harte became so disenchanted with how the committee worked that he resigned. Hartley's letter to Harte dated August 20, 1952, is especially informative about the workings of the committee.

. . . . In line with our conclusions reached yesterday:

1. Proceed with the furnace lining as shown on our drawings with the circular and not square lining, in spite of the recommendations of Dr. Schubert, which I think are entirely unreasonable. . . .

Quincy Bent to Conover Fitch, Jr., August 29, 1952.

13.3 Louise Hawkes and E. Neal Hartley looking at a scapbook in the Iron Works House, January 31, 1950. (Photograph 144 by Richard Merrill, 1950.)

I cannot tell you the proper functions of the Restoration Committee. It was established before I became connected with the project. In my judgment neither Robbins nor I hold membership on it. Robbie thinks he does. I think he failed to notice a line on the basic organization chart which separates the Committee from us who are hired hands, so to speak. Certainly, in my understanding, Mr. Bent runs the job and bears full responsibility for all decisions so far as the Iron and Steel Institute is concerned. And since they are paying the fiddler their authorized agent must in all propriety be allowed to call the tunes. The relationship between the Institute and the First Iron Works Association has never been clear to me. As things have worked out, however, I should say that Mr. Bent has called on certain especially interested and qualified members of the Association and of the Reconstruction Committee to ponder, deliberate, advise and recommend rather than to "pass on" construction decisions. I am sure that he will make available to them complete information on all developments. Certainly we all of us want their help. As I see it, however, if all plans and drawings had to be formally approved by the whole Reconstruction Committee or even by a smaller effective nucleus thereof the whole job would be slowed down dangerously. Efficiency and common sense seem to require that the decision making be carried by a small group of men all right on tap here most of the time, all familiar with all the aspects of the whole job in hand, under a Chairman who is simultaneously looking out for the interests of the steel industry, the Association, and the general public, in last analysis the people for whom the work is being done. If members of the Association feel that they are being outvoted or shortchanged in any way I'm afraid I'd be impelled to point out to them that few civic minded groups have been the recipients of such largesse as the Association is getting thanks to the decision of the steel industry to commemorate its effective beginnings by restoring Hammersmith.

And if the industry has been generous in carrying the job in the name and legal title of the local group it has been, I think, unusual in the democracy of decision making. Mr. Bent has not and does not act as a dictator. What happens is roughly as follows. Robbins' and my data are fed to the architects. They come up with a plan which squares as nearly as possible with these data and makes sense in terms of engineering efficiency and the long-range plans of a restoration which will be an outdoor museum, so to speak. The plan in question is discussed, and disagreements reconciled as well as they can be, in a meeting of the working group of architects, historian, archaeologist and Mr. Bent. In the case of a major unit such as the furnace the nucleus of the Restoration Committee joins the working group in another meeting in order that their reactions may be obtained, their criticisms registered, etc. [3]

What comes out of the whole will not satisfy all of us. It will be as close to consensus of all concerned as it is possible to make it. In the case of matters of detail I think that Mr. Bent has been convinced that decisions of the working group which met his own approval could stand on their own. In all of this the decision making has been democratic and as well informed as our talents and energies could make it.

E. Neal Hartley to Charles Rufus Harte, August 20, 1952.

13.4 Charles Rufus Harte (front) examines the remains of the waterwheel, June 30, 1951. (Photograph 370 by Richard Merrill,1951.)

Why go into so much discussion about the various committees and individuals associated with them? When dealing with reconstructions, especially those based on archeological evidence, visitors seem to think that archeological excavation somehow provides an exact blueprint for the reconstruction. Visitors generally assume that even the smallest details of the reconstruction are based on something that was recovered from the archeological excavations, like those of Pompeii. In actuality, information necessary to rebuild comes from a variety of sources including archeology, history, maps, and photographs, as well as the knowledge of learned people who have studied the site or time period. Reconstructions in other words are best guesses at what something like Saugus Iron Works was like rather than a precise blueprint derived from any one particular source. Evaluating the accuracy of a reconstruction must be based on how well it reflects the past given the evidence available when the reconstruction was done. The section below provides a review of the information used to reconstruct the major buildings at the Saugus Iron Works including the furnace, forge, rolling/slitting mill, and associated structures, and evaluates how well they reflect the past.

Buildings Reconstructed

Furnace

The first ironworks building to undergo reconstruction was the furnace. As discussed in Chapters 3 and 5, Robbins identified numerous features connected with the furnace, including the size of the base and the geographic location and details of the furnace stack, drainage system, crucible, waterwheel, wheel pit, bellows, hearth, casting areas, and tailrace. Of all the industrial components at the Saugus Iron Works, the furnace was the best documented and most researched. Yet, even with the large amount of archeological and historical research done on the furnace, many details associated with the reconstruction required some educated guesswork. A lot of this speculative work took place at frequent, but not necessarily regular, Reconstruction Committee meetings. Regular attendees at these meetings usually included Bent, Hartley, Robbins, Attwill, Hepburn, and Fitch.

The Reconstruction Committee used a great deal of backward engineering to determine the features of the furnace. For example, even though the exact height of the furnace stack was not known, Hartley's historical research uncovered a letter that pegged the output of the furnace at one ton per day.[4] From this figure, which he interpreted to be the long ton (2,200 pounds), he believed that castings from the furnace were done twice per day. This amount of cast iron was more or less accepted by the members of the Reconstruction Committee. However, Robbins believed that there was not enough physical space within the casting area to fit the 1,100 pounds of iron that were drawn from the furnace during each tap.[5]

Hartley phoned this P.M. and asked what I thought the average length of the sow bars were. I told him the largest one found was 52 1/2 inches long, weighing 290 pounds. He seemed to think they never exceeded the one ton a day capacity that Governor Winthrop mentioned in a letter to a friend. He believed this would be based on the long ton of 22 hundred pounds. I asked him how many tappings a day took place. He said that he believed that only two *castings a day took place at the furnace. If this was the case then each casting would produce 11 hundred pounds of pig or sow iron. I don't think this was the case. The largest bar that we have found was 52 1/2 inches long, 9 inches wide and 4 inches thick and weighs 290 pounds. If the furnace had but two tappings a day, each of 11 hundred pounds, each casting would produce about four times as much iron as we find in this bar. In the first place the casting bed is not wide enough to permit the casting of four bars side by side at a time. If it had two of these bars side by side at a time it would mean each bar had a length of about eight feet, nine inches. I doubt that the sow casting bed would accommodate a bar of such a length . . . .*

Roland Robbins, "Saugus Ironworks Daily Log - 1953," May 11, 1953.

13.5 Visitors looking at the reconstructed blast furnace, September 29, 1956. (Photograph 1373 by Richard Merrill, 1956.)

Hartley's textual discovery led others to begin to sketch out the size, shape, and amount of materials necessary to keep the furnace in blast. Based on the dimensions of the foundation and the production estimate of one ton per day, Walter Renton Ingalls, Reconstruction Committee member, estimated that the furnace was probably about 18 feet tall from hearth to tunnel head and about four and a half by six feet at the bosh. This size would allow the production of seven to eight tons of iron per week. [6] H. M. Kraner, a ceramicist with the American Iron and Steel Institute, speculated in a September 29, 1950, letter to Charles M. Parker, an Institute metallurgist, that the furnace was probably about 20 feet high and approximately five feet in diameter at the bosh and consumed 371 cubic feet of burden and fuel per day.[7]

Numerous decisions were made in the committee that had bearing on the reconstruction of both the exterior and interior of the furnace. Much to the displeasure of Harte and Robbins, the original exterior walls of the furnace were dismantled and then rebuilt using most of the original stones except for those on the top of the platform.[8] The stone used to finish off the top of the platform came from Rockport, Massachusetts, and was selected because it blended well with the local Saugus stone.[9]

Like the exterior stonework, several challenges faced the Reconstruction Committee over the interior of the furnace. One of the challenges concerned the finish of the lining. Samples of finished stone for the liner were solicited from several different companies. Most of the samples that the Committee received were regarded as far too well finished. A memorandum from the September 5, 1952, meeting of the committee notes that "it was emphasized that [the] original lining stone would have been hand-split at [the] Iron Works and would be quite crude. Therefore all appearance of machine finish and cutting should be avoided. As Prof. Hartley has said we can err drastically in making the lining too "Slick" and well finished. We could hardly err in making it too rough."[10] A rough-cut stone was therefore chosen to approximate the examples uncovered by Robbins.

Another issue of debate amongst Reconstruction Committee members was the shape of the boshes. Schubert had expressed the opinion on several occasions that the boshes for the furnace should be square. Hartley's research, however, could not confirm whether early boshes were square or round. The issue was discussed at a July 17, 1952, meeting held at the offices of Perry, Shaw, and Hepburn, Kehoe and Dean.[11] Ultimately, the furnace was constructed with a circular bosh.

In addition to decisions made about the size, shape, and finish of the furnace stack, many other decisions were needed regarding related features of the furnace. One feature that was consciously left out of the reconstruction was the bridge house. Schubert strongly felt that there would have been a bridge house covering the charging bridge, a belief based on examples at the Cannope and Parke furnaces.[12] The Bridge House would have provided protection to the ironworkers and the furnace supplies during

Mr. Attwill again questioned the use of vertical boarding on the roof of the casting and bellows shed. I told him that our research definitely indicates that "purlin Roofs" with vertical boarding were in common use in the early 17th century as well as "rafter roofs" with horizontal boarding and that the former are apparently considered the earlier type, although the development was not always strictly chronological. In any event "purlin roofs" were common in England in barns and other rough structures.

Minutes of the Reconstruction Committee, September 25, 1952.

13.6 The blast furnace during reconstruction, September 7, 1951. (Photograph 435 by Richard Merrill, 1951.)

inclement weather but would also have increased the likelihood of fire. Ultimately, the Saugus reconstruction was completed without a bridge house.

Numerous other decisions about the furnace made in committee included using a round rather than a corbelled arch;[13] a small casting house without sides, just large enough to cover the casting beds;[14] a double versus a single tuyere;[15] a one-foot, six-inch-high tuyere, a one-foot, six-inch crucible with a five-foot diameter bosh, and a 21-foot overall height for the furnace.[16] These decisions were made with the best information available at that time and by the best minds in the business after much discussion. When looking at the furnace, one must be mindful that much of the reconstruction was a direct result of decisions made in committee rather than the result of archeological or historical discovery.

Forge

The Reconstruction Committee expended an equal amount of effort on the reconstruction of the forge. Just to the east of the furnace, Robbins found the archeological remnants of many elements of the forge, including the headrace and tailrace, two wheel pits, foundations for the finery, chaffery, and hammer (along with the hammerhead), and the enormous foundations for the anvils. The height of the building, type of roof, height of the stacks for the finery and chafferies, and other details were not revealed by archeological or historical sources but nevertheless had to be determined to bring about the reconstruction.

The preliminary design for the forge had been produced by the architects based almost entirely on historical information provided by Schubert and Hartley. As this preliminary design included just one anvil and power hammer, Robbins' 1952 discovery of a second anvil threw the plans into question. Schubert wrote to Hartley in a September 10, 1952, letter that the discovery was to be expected.

> I was pleased about the discovery of the second anvil base because it fits in very well with the plan of the forges we all approved on July 7th, & the plan I received from Mr. Fitch last week confirms it. Just near the fineries—where it should be! It is quite in keeping with many 17th-century inventories in which 2 anvils are referred to. Such a second anvil however most certainly does ***not*** require a second power hammer. I'll send you a more detailed report on the use of the second anvil a few days later . . . .[17]

The architects were not pleased with this reaction to the discovery of the second anvil base and A. H. Hepburn wrote to Schubert on September 23, 1952:

> You suggest in your letter to me, and in a recent letter to Mr. Fitch, that this second anvil base fits in exceedingly well with our first approved plan. You feel it would not

Tuesday, July 29 [, 1952] . . . . Last but not least, another anvil base has been found at the finery. It appears to have a 42" diameter, similar in width with the other finery anvil base. This was found handy to the southwest corner of the hutch of the wheel pit of the second waterway crossing Bridge Street. It was about 9' south of the south side of the stone wall running from the west side of the wheel pit on the second waterway in a westerly direction. This stone work had natural clay to its northerly side with Iron Works working floor abutting its southerly side. This stone evidence and its working floor was found during Dr. Schubert's visit. It was this area that Dr. Schubert would not accept as being contemporary with the Iron Works. It was not accepted by Dr. Schubert because he could not find a place for it in any of his plans of contemporary British Iron Works.

Roland W. Robbins, "Saugus Ironworks Daily Log - 1952," July 29, 1952.

13.7 The forge during reconstruction, February 27, 1953. (Photograph 819 by Richard Merrill, 1953.)

have been provided with a power hammer but would presumably have been used for an anvil serving operations carried on with hand hammers. Unfortunately, the construction of this second anvil base is such that it is not reasonable to believe that it could ever have been installed for anything less than a power hammer. As we wrote you on August 27th, it is a very large block of oak, every bit as heavy as the first. It was sunk into the earth a foot deeper than the other anvil base, had even larger cross timbers under it and was provided with an elaborate arrangement of tenons locking it into the base timbers and had a heavy iron band around the bottom—features of advanced workmanship, suggesting the anticipation of very heavy duty for the block, which were lacking in the base first discovered.

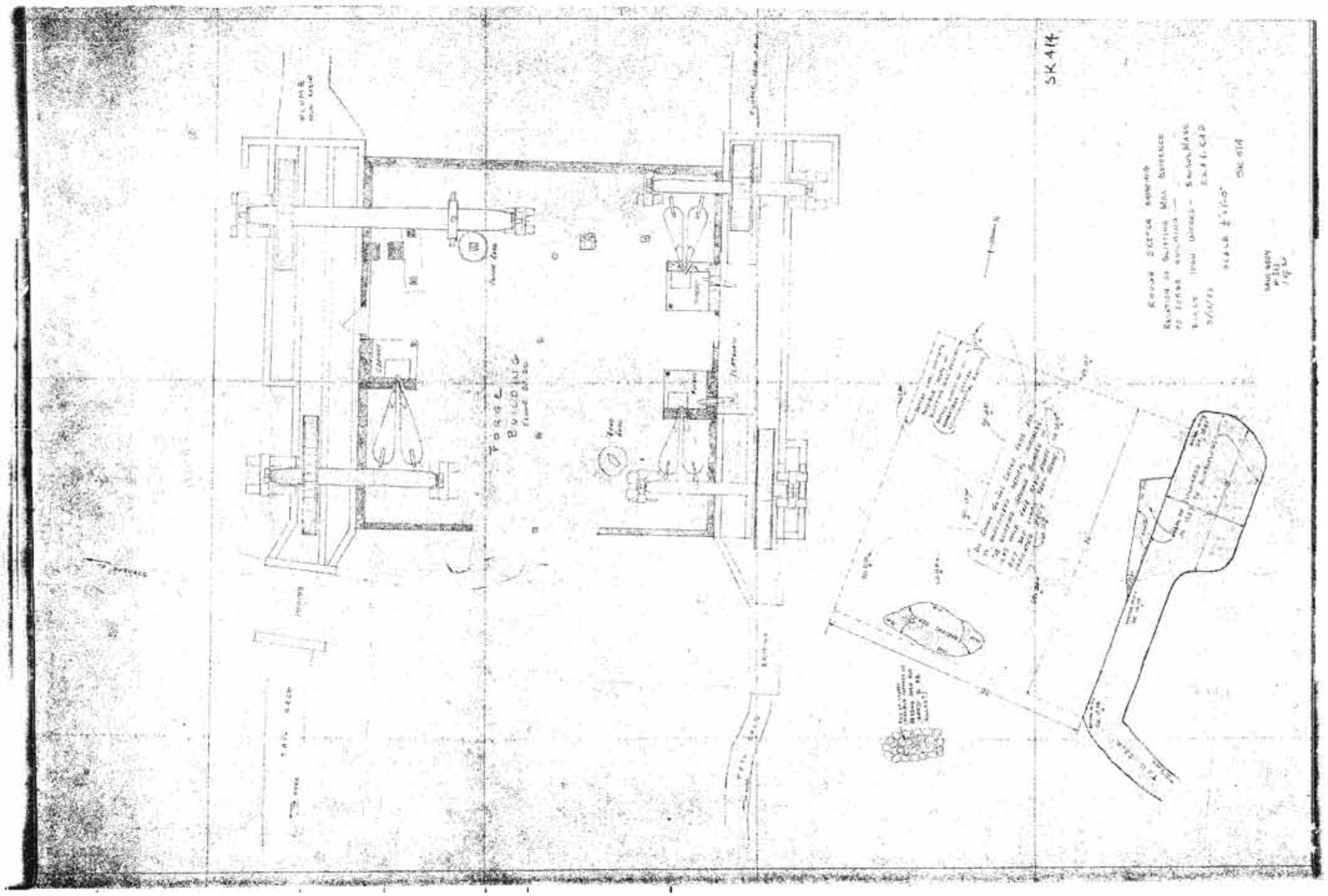
Since our letter to you on August 27th, Robbins has found the imprint of a very large upright post about 14 feet west of the new anvil base. This upright bears the same relation to this base as does a similar upright to the anvil base found earlier, and they both would appear to have been end supports for large overhead "dromes" for power hammers.

Everyone here agreed that we were faced with the fact that there had been two power hammers in the forge area at Saugus. What was not so clear was whether or not they were ever in use at one and the same time. Negative evidence in the documents had always suggested one hammer only during the period of maximum operations, although there are confusing references to new hammer beams, wheels, anvil blocks, etc., and it is possible to infer from the records that a second hammer could have existed. Naturally, we did not want to discard one of the hammers without good reason. The best single reason for deciding that one of them must have been abandoned in favor of the other is the fact that the physical limitations in the size of the forge area and the arrangement of the water courses and wheel pits prevent us from working out any two-hammer layout in which two fineries and a chafery are also included and arranged in a manner satisfactory to us all. We have developed six interim plans in an attempt to evolve a two-hammer forge which made sense. All that we have proved is that the Saugus Forge could not have had two hammers at any one time and have also contained the two fineries and one chafery which are so clearly indicated in the inventories . . . .

There is much that is confusing in the archaeological evidence, but it has become increasingly clear that the anvil base in the southeast corner was the earlier of the two and that the anvil base in the northwest corner was not installed until after forge activity had gone on for some time. This reinforces our present theory that the first power

Mr. Bent directed us to go right ahead full speed on Forge to get as much done this fall as possible. He suggested we should get building closed in before cold weather so that work could go on within Forge during winter months. (N.B.: Work on wheels, etc. will probably best be done in Contractors [sic] *shop building.) Mr. Bent asked that we mail latest sketches of Forge to him at Bethlehem. Maintain first priority on the Forge work. Let nothing else take precedence. Robbins to continue investigation at south end of two forge wheel pits and to east of Forge.*

Minutes of the Reconstruction Committee, September 25, 1952.



13.8 Drawing of final forge layout by Perry, Shaw, and Hepburn, Kehoe and Dean, 1953. Note evidence found for slitting mill and its relationship to the forge.

hammer was abandoned about 1652 and a new one erected in the northwest corner on the site of a finery which was itself removed and later rebuilt at the southeast corner in the place where the first hammer had been. Apparently, the first hammer was removed in very early times by the iron workers themselves, judging from the evidence in the hole where the large "drome" support must have been. But apparently, also, they choose to leave the first heavy anvil base where it was and use it for supporting a hand anvil. This would fit in with your thoughts that they might well have needed such a second anvil not connected with a power hammer . . . .[18]

It was, therefore, decided to build the forge with only one working hammer and anvil. Minutes from an August 28, 1952, meeting of Bent, Hartley, Robbins, Hepburn, and Fitch indicate that pressure was building to complete the project.

Mr. Bent emphasized that we must proceed with construction now even though it may later be proved that we have made mistakes and have not interpreted the evidence properly. He said that if we do find we have made mistakes later that we can then consider making changes. He asked that we make every effort to work out the design of the wheels so that they bear a convincing relation to the features of the watercourses and pits.[19]

Robbins was not happy with the final scheme, but was rather powerless to modify the plans. The architects were very critical of Robbins and his work at the forge during the August 1952 meeting. He notified Charles Rufus Harte of his discontent with the chosen design in an August 29, 1952, letter.

Yesterday's meeting doted on the forge layout. Much maneuvering has been done to erect two forges [fineries], a chafery and a couple of anvil bases in the area we believe to show the bounds of the forge layout. No maneuvering on the part of Hartley and the architects can incorporate two hammers at the forge. As such, it has been decided by Hartley, the architects and Mr. Bent that the forge layout contained, when in operation, but one hammer. The second hammer site found recently they believe to have been an early site of the hammer which was discontinued when a new hammer site was decided upon. I am the lone dissenter on this theory. I will not annoy you at this time with the details concerning my reasons for believing the way I do. [20]

Any evaluation of the forge needs to take this dissent into account. The forge was reconstructed with only one working hammer even though Robbins uncovered two anvil bases. The decision to reconstruct the forge with only one hammer was determined by the best fit of all the evidence including archeologi-

Work is to proceed as rapidly as possible on the single-hammer layout based on Scheme "H", SK 324, scheme to be modified to allow chafery wheel to make better use of the waterway possibly in the manner shown in Scheme "J", SK 318A. Robbins is to clarify all evidence in the Forge area and attempt to find new pertinent evidence. It was agreed that in putting in the concrete retaining and foundation work the south end of the Forge would be left open as long as possible for further exploration. Together we are to work out satisfactory finish grades for the perimeter of the Forge area and for the working floor within the Forge. Of this latter, it was agreed that a slight slope of approximately 1'-0" from north to south be acceptable but not a marked change in grade.

Minutes of the Reconstruction Committee, August 28, 1952.

13.9 Reconstructed hammer and anvil in the forge. (Photograph 926 by Richard Merrill, 1953.)

cal, textual, and, physical design constraints. This decision does not mean that two hammers did not exist at the same time, only that a preponderance of the evidence points to only one hammer in operation at a time.

Rolling/Slitting Mill

Whereas substantial archeological information was preserved at both the furnace and the forge, far less evidence was available for the reconstruction of the rolling/slitting mill. Robbins' had located the wheel pits for an unidentified building. He and the members of the Reconstruction Committee chose to reconstruct this building as the rolling/slitting mill because of three key pieces of evidence: historical reference to a rolling/slitting mill in operation at Hammersmith; lack of anvil foundations within the building footprint; and the location of a partially slit piece of metal, colloquially known as the squid, in the immediate vicinity. Together these components provide a compelling case for reconstruction of the rolling/slitting mill on this site, but the case is by no means conclusive. A July 6, 1953, memorandum from a meeting at Quincy Bent's house in Annisquam attended by Bent, Attwill, Hartley, Robbins, and Hepburn suggests the tenuous nature of the evidence:

> It was the consensus of opinion that there was no evidence whatsoever as to the plan of this building: the only evidence as to its location is the excavated area which in size and shape suggests a hutch for two wheels.[21]

Two aspects to the archeological evidence never fit especially well with the reconstructed rolling/slitting mill. First, the orientation of the footprint of the building differed from those of the other two industrial buildings on the site. No one was ever able to satisfactorily explain why the building was sited differently. Second, two saucer-like depressions were found to the south of the wheel-hutch (compartment built to contain the waterwheel), the eastern one filled with lime. Robbins thought that perhaps the lime-filled depression was connected to some type of smelting activity, possibly associated with a bloomery. However, Hartley was emphatic that the presence of lime meant that it could not be part of the rolling/slitting mill. [22] A large charcoal deposit just to the north of these saucer-like features could never be satisfactorily explained, adding to the uncertainty.

The rolling/slitting mill thus was a very speculative reconstruction compared to the other two buildings. This reconstruction was a best guess of how a seventeenth-century rolling/slitting mill would have looked and functioned. While historical research provided examples of other rolling/slitting mills around the world, archeological excavation and the artifacts uncovered nearby (e.g., the squid) revealed little other than the basic footprint of the building.

I noticed the slitting mill proposed has 2 chimneys & therefore apparently 2 furnaces, thus resembling a slitting mill as it was in Sweden around 1780, but not like an English mill of the 17th century which had one furnace only, see Plot (1686), p. 163. I am very doubtful whether there was space for 2 water wheels as such a wheel was pretty wide (comp. Smeaton's design for Kilnhurst Forge: 4'4" wide). Of course it depends on further archeological findings, & I think neither of us can do or suggest much before Mr. Robbin's [sic] *excavations will be more advanced.*

H. R. Schubert to Conover Fitch, July 30, 1953.

13.10 The slitting mill under construction, December 21, 1953. (Photograph 1081 by Richard Merrill, 1953.)

Other Reconstructed Features

Several of the other features reconstructed at the Saugus Iron Works, like the head and tail races for the various waterwheels, were almost entirely based on archeological discoveries. Because the reconstruction so closely followed these discoveries, there is not much discussion of it in the records of the FIWA or the Reconstruction Committee. The extraordinary photographs taken at the time of discovery and Robbins' descriptions of the finds indicate that the reconstructions of these features very closely resemble what he found in the field in terms of both their location and their reconstructed appearance. Many of these reconstructed features, however, have concrete bases covered by a wooded veneer, but the reconstruction accurately communicates the look of the original to the visitor.

Other features require a little more scrutiny to assess their accuracy, such as the turning basin, the bulkhead, and the dock. Robbins excavated this area intermittently between 1951 and 1953. His terminology for the discoveries is somewhat confusing in that he refers to the bulkhead as the yard sills. This long and heavily built east-to-west-oriented structure lined the southern extent of the site and separated the land from the water. The text and the photographs from Robbins' excavations illustrate its characteristic features, its construction, and its location. Robbins' notes also indicate that a small boat basin was found between the slag pile and the western end of the wharf.[23]

While Robbins and Whittlesey identified a stone feature at the western extent of the bulkhead, its identification as the dock or wharf seems to have been somewhat speculative. Robbins reasoned that

> the answer to why that end of the yard-dock area had been developed may be found under the slag dump, just south of the westerly end of the yard-dock sill, and west of the dock basin. It is possible that during the early development, the boats were unloaded from the westerly side of the dock basin. Later on, when a decision was made relative to the course of the slag dump, which was to include the possible early site of the dock, then the stone wall was built above the yard-dock sill to the easterly side of the basin, creating a new wharf on the easterly side of the basin.[24]

Logistically speaking, an ironworking operation like Saugus would have needed a dock or wharf to accommodate boats. While the evidence is not conclusive for the location of the dock or wharf, Robbins makes a good argument for it being just to the east of the boat basin, so that the reconstruction of the dock appears reasonable.

Some discussion did take place at the time about the level of the sill of the bulkhead and dock. The reconstructed level would ultimately affect the appearance of the entire turning basin. Robbins captured the dilemma when he wrote that

. . . Continued following large beam running north from near west end of yard-dock sill and sheathing. This appears to run for some distance. About 12' north of its southerly end, we encountered across member headed east-west. To the northerly side of it is an upright. This has not been complete excavated. However, the upright may be driven through a hole in the large beam acting as a pin to hold the large beam in place. It may prove to be some form of dead-man . . . .

Roland Robbins, "Saugus Ironworks Daily Log - 1953," March 27, 1953.

13.11 Basin bulkhead under construction, November 9, 1953. (Photograph 1051 by Richard Merrill, 1953.)

> we are seriously considering the elevating of the yard-dock sills to the level of the present river bed. To do this would mean that there would be less contrast between certain restored areas. If we restore the river bed of three centuries ago, where it abuts yard-dock areas, etc., it means this area will be about three feet lower than the present river bed. It will always be under water, even when the tide is out AND THE PRESENT RIVER BED IS DRY. This will convey the impression that a body of water (similar to the basin) existed over a large area. To elevate the base sills of the yard-dock area, as well as the westerly waterway from forge, etc., to the elevation of the present river bed, which is about at el. 8., would mean the entire river bed would be visible when the tide was out. The river bed would abut the yard-dock area, etc., and the restored basin would be clearly defined by its pool of water.[25]

Ultimately, the Reconstruction Committee decided to elevate the bulkhead and dock.[26]

While Robbins mentions excavating a warehouse feature several times in his daily log, the reconstructed warehouse appears in a different area on the site than where Robbins reported finding the foundations. These inconsistencies can be seen by comparing the earlier maps done by surveyor John Bradford and the later maps illustrated by Whittlesey. Robbins' excavations for the warehouse seem to have taken place on a larger structure northeast of the reconstructed warehouse. The warehouse, perhaps never viewed by the Reconstruction Committee as crucial to the reconstructed ironworks, may have been located adjacent to the dock and wharf area more out of convenience than historical accuracy.

Proceeding easterly from the west end, the wall becomes less self-supporting, leaning back on the fill behind it with an increasing batter resembling a steeply and closely fitting rip-rap. For the most part there was only one layer of stone. The stones becoming progressively smaller toward the upper part. The wall has been removed and the stones set aside in a separate pile.

Stephen Whittlesey, notes, September 10, 1953.

The Reconstruction as Representative of Early Ironworks

While there were several controversies over the reconstructed buildings, in the final analysis the Reconstruction Committee did an admiral job with the reconstructions. It invited input from a variety of different disciplines and used all accurate information provided to aid in the reconstruction. Numerous elements affected the reconstruction. When archeology and history were silent, the architects and iron and steel industry representatives had to take their best guess at what a feature or building looked like and how it functioned. Overall, the reconstructions were good to very good.

One major critique of the project lies not with the reconstructed buildings and features, but with the failure to reconstruct buildings and features that were identified. This comes to the very core of answering the question of how well the site as a whole simulates a seventeenth-century ironworks. Very significant buildings, including all of those buildings associated with ironworker Joseph Jenks, the charcoal house, and the holding pond, were never reconstructed. In addition, numerous other buildings mentioned in the various inventories were never identified archeologically (primarily worker housing). This no doubt

13.12 The dock under construction, January 29, 1954. (Photograph 1107 by Richard Merrill, 1954.)

stemmed from a lack of money devoted to additional reconstructions. A January 9, 1951, letter from Quincy Bent to Conover Finch indicates that Bent had a notion to reconstruct the charcoal house on the Lovell lot and was leaving a space open for the Scotch-Boardman House, a seventeenth-century house also located in Saugus, in case a deal for the house could be made.[27] Without these features, however, visitors have a distorted sense of the original landscape of the ironworks.

Another critique of the project concerns the current configuration of the top of the plateau behind the Iron Works House. If Hartley's estimates were correct, the blast furnace required approximately 371 cubic feet of burden and fuel for each day of operation. Since it was very costly to rebuild and restart the furnace, it would have been important to keep a surplus of both fuel and burden at the site to offset any kind of material disruptions. The estimated 371 cubic feet of material required an area approximately thirteen and a half feet by thirteen and a half feet piled two feet high. Thus, a month's supply of burden and fuel would have taken up most of the open area of the plateau. These supplies would probably have been placed in piles rather than spread out so that the plateau was completely covered with raw materials for the furnace, forge, and slitting mill. The present park-like environment is completely deceptive. In reality, this area would likely have been a grimy, industrial area reminiscent of the stock pile areas in modern ironworking facilities.

Overall Evaluation

To evaluate the overall project, one needs to return to the questions laid out at the very beginning of the chapter. Does the reconstructed Saugus Iron Works closely resemble the historic seventeenth-century ironworks? How accurately were the buildings reconstructed? The above discussion has, hopefully, shed some light on the way that major reconstructions succeed and fail.

Overall, the FIWA and the Reconstruction Committee did a very good job reconstructing the elements of the site that they chose to reconstruct. However, many of the buildings and features that were once an integral part of the ironworks have not been reconstructed or are being used in a way that does not reflect their historical usage. Reconstructing and incorporating these elements would provide visitors with a much more accurate view of the historic ironworks. The National Park Service, as owner and administrator of the site, should attempt to compensate for the missing buildings and features through interpretive programs or by undertaking additional reconstructions. Ideally, NPS would reconstruct the missing buildings and features although neither regulations nor budgeting would permit such an undertaking. Reconstructing the additional features would cost far more than the original expenditures to reconstruct the existing buildings. The current interpretive program has already been adapted to inform visitors on these issues.

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14.1 A dapper Roland Robbins in his Saugus office mid-1953, just prior to his resignation. (Photograph 2160 from the Roland W. Robbins slide collection, 1953, Saugus Iron Works. Courtesy The Thoreau Society® Collections at the Thoreau Institute at Walden Woods.)

Saugus Iron Works Post-1954

William A. Griswold and Donald W. Linebaugh

For over 50 years, the Saugus Iron Works site has provided an unparalleled educational setting for learning about early colonial ironworking in America. Management and interpretation of the site were the responsibility of the First Iron Works Association (FIWA) from 1954 until the site was officially transferred to the National Park Service in 1969. This chapter presents the history of the site following the completion of the initial archeological excavation and reconstruction program in 1954. The management of the site and its archeological resources and later archeological investigations of previously unexplored areas and work done in advance of specific ground disturbing projects receive particular emphasis. While Roland Robbins resigned from the project in 1953, he periodically corresponded with staff and managers of the site in an attempt to help with interpretation of his excavation work.

It was decided by Restoration officials after much research and consideration, that Saugus marked the first really effective working of American iron ores into useful metal. Here, at Saugus, was the first documented successful and sustained production of cast and wrought iron in the New World. As such, it is the true cradle of our steel industry.

Edward L. Ryerson, Chairman of the Executive Committee, Inland Steel Company, "Restoration Dedicated at Impressive Ceremony," reprinted in ***First Iron Works Gazette***, Fall 1954.

FIWA History

The initial period of archeological investigations at the ironworks officially ended in 1954 with the opening of the reconstruction and the resignation of archeology supervisor Steve Whittlesey. The resignation of Roland Robbins in July 1953, however, effectively brought the major fieldwork to a close. With the principal excavations completed and the reconstruction of all the buildings, except for the slitting mill, largely finished, Whittlesey and his crew focused on finishing up loose ends, particularly in the dock and slitting mill areas. In the process, they provided what help they could to the architects, who were struggling with the design of the slitting mill (see Chapter 6).

Robbins's resignation in 1953 stemmed from his growing frustration with the project and the site's overwhelming intricacies.[1] Archeologist Marley Brown writes that "it would appear that Robbins's resignation was triggered in part by an argument with Quincy Bent." Historian Stephen Carlson has likewise reported that "increasingly, Robbins came into conflict with Quincy Bent over the extent of the remaining archaeological effort."[2] Robbins's decision to resign grew out of a variety of obstacles, including his continuing frustration with the decisions of the FIWA, the Reconstruction Committee, and the architects, an extremely complex archeological site, overwork caused by responsibility for many non-archeological issues, and the cumulative effects of these stresses on his physical and mental health.[3]

Robbins, the Reconstruction Committee members, particularly Quincy Bent, and the architects had regular conflicts about priorities for the excavation. Robbins and his field crew were frequently instructed to move from one area to another for the benefit of the architects as they sought to answer specific questions related to designing the reconstructed buildings. For example, while focused on the forge excavations in 1951 and 1952, Robbins was repeatedly asked to reexcavate areas around the blast furnace as the architects sought to finalize plans for that structure. In addition, some of Robbins' discoveries did not fit into the overall plan for the reconstruction, as understood by senior members of the Reconstruction Committee, and thus were seen as taking time and effort away from the task of reconstructing the principal ironworks structures.

Robbins' work on the Jenks site proved particularly problematic. While working in the dock area, he discovered the foundations of a forge operation along the furnace tailrace that he believed belonged to colonial ironworker Joseph Jenks. He became very interested in this site and eventually identified three separate waterwheels that had powered various components of the operation, as well as Jenks's forge hearth. While this area was exceptionally rich in features and artifacts, Robbins was forced to abandon it to return to work on the forge and slitting mill areas. Robbins notes in his daily log that he received "a copy of Bent's letter to Attwill where he shows concern for 'forge-finery, slitting mill and wharf' restoration, not Jenk's area."[4] Not surprisingly, Bent was focused on getting the buildings the FIWA had committed to reconstruct finished and opened to the public, while Robbins was intent on uncovering what he saw as the entire archeological story of the ironworks.

The fill over the wharf sill and in back and under the wall had some small boulders in it, but was for the most part made up of vitreous slag and sandy gravel consolidated in some places into a compact mass. This consolidation is especially evident at the bottom of the wall where iron works fill surrounds the boulders and appears to be the wall's foundation.

Stephen M. Whittlesey, "Observations on Wall Over Wharf Sill," September 10, 1953.

In addition to working on the rolling and slitting mill site in early 1953, Robbins also sought to restore the area along Central Street to its mid-seventeenth-century topographic configuration.[5] He notes that he returned to excavate in the Central Street area in June 1953, running test trenches to "determine the extent of fill" and "pick up contours that existed there 3 centuries ago." This process continued until July, when Quincy Bent ordered him to stop all work. Several days later, Robbins resigned. While his resignation appears to be rather abrupt, in actuality he had been increasingly unhappy with the management style of Bent and others and their plans for the reconstruction. Robbins felt that more work was necessary to fully understand and interpret the complex, particularly the slitting mill site, while the FIWA was anxious to complete the restoration and open it to the public.

With Robbins' resignation in July 1953, the FIWA and the American Iron and Steel Institute turned to his assistant Stephen Whittlesey to complete the remaining archeological work at the site. Robbins had hired Whittlesey as his "civil engineer" in April 1952, so they had worked together on the later excavation areas, including the forge, dock, and slitting mill sites. Whittlesey had no previous archeological experience and was hired to map and document the excavation.[6] However, he became very familiar with the overall process and frequently served as the site supervisor in Robbins' absence. Robbins later re-

14.2 Workers grooming slope by the Jenks site with reconstructed blast furnace, forge, and slitting mill buildings in background. (Photograph 1184 by Richard Merrill, 1953.)

flected that "inasmuch as Steven Whittlesey had been my civil engineer for the past 15 months and had been with me in the field work, he was my most logical successor."[7]

While Robbins kept voluminous, detailed daily logs of his activities during his five years at Saugus, Whittlesey provided few documentary records beyond some field drawings and notes of his final field work at the slitting mill site and dock area. As an engineer, Whittlesey produced drawings that provide good detail of the features identified, such as the wharf cribbing and sills. His limited notes also offer clear observations on the final months of work at the site. For example, on September 10, 1953, he records work on a wall foundation over the wharf sill, commenting that they had gotten "a fairly good idea of how the wall was built . . . . "[8] In terms of the overall archeology, however, little is known about the period between Robbins' resignation in July 1953 and Whittlesey's resignation in September 1954.

The initial archeological work officially came to an end with the opening of the site to the public on September 17, 1954. Having spent almost $2 million on the reconstruction, the American Iron and Steel Institute engaged in a major publicity campaign to highlight its participation in the project and organized a gala ceremony on opening day.[9] The ceremonies began at 2 p.m. on September 17 and included remarks by Benjamin F. Fairless, Chairman of the Board of U.S. Steel Corporation, Edward L. Ryerson, Chairman of the Executive Committee of Inland Steel Company, the Honorable Christian A. Herter, Governor of Massachusetts, and a host of other state and local officials. The *First Iron Works Gazette* reported that "despite a cold rain, more than 1,200 First Iron Works Association members, steel industry official, historians and civic officials were on hand when the ceremonies began."[10] The speakers addressed the audience from a platform "decorated in red, white and blue bunting" and framed by the restored buildings.[11]

Those in attendance listened to speeches that touted the site's far-reaching significance as "the true cradle of our steel industry."[12] Steel industry executive Ryerson, in a speech that drew on typical Cold War rhetoric, noted that the site's importance reached well beyond the steel industry.[13] "Its real significance," he explained, "arises out of the fact that this extraordinary exhibit is a perfect living illustration of what individual initiative and American freedom can do."[14] Striking a very similar chord, Governor Herter noted that "perhaps one of the most significant things about this restoration is the fact that it is the very first industrial restoration in the United States." He continued that "all of us are tremendously conscious of the meaning of industry in the colossal growth of this nation. In fact, it alone has allowed us to remain a free nation, and is our greatest bulwark toward remaining a free nation in the future."[15] The governor ended by proclaiming that he hoped the site was "only the beginning of a recognition of industry—not as many of us think of it, an inhuman materialistic part of our life, but as an integral part of our existence."[16] Like the governor, steel executive Fairless touted the history of industrial growth represented by the site and its important linkage to individual freedoms and expressed hope that "it will serve as a living example of how from this humble beginning, there developed the great steel industry of today by

We hope the Saugus Ironworks Restoration will become more than just a tourist attraction. We hope that it will provide an inspiration for our youth as they see again what men with vision, with courage, and with ingenuity built in what was then a wilderness.

Benjamin F. Fairless, Chairman of the Board, United States Steel Corporation. "Restoration Dedicated at Impressive Ceremony," reprinted in *First Iron Works Gazette*, Fall 1954.

14.3 September 17, 1954, grand opening with U.S. Senator Leverett Saltonstall giving his address. Massachusetts Governor Herter is seated to Saltonstall's right and Inland Steel Chairman Benjamin Fairless is seated to Herter's right. (Photograph 1247 by Richard Merrill, 1954.)

virtue of the freedom of individual initiative equaled nowhere else in the world."[17] Following the lengthy speechifying, the audience was invited to tour the reconstructed buildings, Iron Work's House, and the museum.

Robbins and his wife Geraldine were among those in the audience that September day. Robbins' last entry in his daily log for Saugus briefly records the ceremony, noting that "today was the official dedication of the Saugus Ironworks. Though the weather was bad, it being overcast and rainy, the ceremonies were excellent. Everything went wonderfully well. Gerry and I were there for the preview and the buffet lunch."[18] Robbins' log closes by noting the resignation of Whittlesey and the end of the archeological excavation that had run almost continuously since the fall of 1948.[19]

More than five thousand people visited the site in the months following the opening ceremony, suggesting that it got off to a great start.[20] While attendance grew for the first couple of years, visitation eventually began to decline, causing a series of management issues that would eventually result in the National Park Service's acquisition of the site.

In September 1954, the FIWA hired Frederick Bonsal as the site custodian and curator. Bonsal worked under the direction of a board of management appointed by the directors of the FIWA.[21] Bonsal and the Board of Management set out to run the site in a business-like manner, with an eye toward both fiscal responsibility and increased public attendance. The FIWA had a bank balance of approximately $16,000.00 and showed annual expenses of approximately $2,000.00 in May 1955.[22] By the annual meeting in 1957, however, the organization had an annual operating deficit of almost $6,000. It was noted in the minutes that many of the early members of the FIWA had died or reached retirement age and were no longer able to support the organization financially.[23] Although the financial side of the operation was showing strain, visitor numbers were growing; Bonsal reported to the meeting that between April and June 1957, approximately 8,000 people visited the ironworks, an increase of more than 3,000 over the same period the previous year.[24]

Bonsal and Robbins began what would become a lifelong friendship and correspondence shortly after the opening of the site, when Bonsal was asked to check with Robbins about "a loan of artifacts to a Concord school."[25] Robbins responded that if given a bit more information, he would try to "recall its disposition," as he recalled "arranging for no such exhibit in Concord."[26] While he expressed his sympathy regarding the missing artifacts, he pointedly noted his additional concern

> for the thousands of fascinating artifacts that have been denied the classification which they so rightfully deserve. If they are not properly recorded for posterity, they will be meaningless. As it is they have been carelessly handled during the past year,

It is a proud past, and the re-creation of it stands today in Saugus—the great furnace laid up in stone (with cement, alas!) stands where the old did; the water wheels turn (with town water so far); the bellows rise and fall; the hammer drops and the whole integrated ironwork, restored by careful historical research, is there to see. And even the ironmaster might be looking out of the window of the house, in spirit, to see the flame leap out of the furnace top and the oxen draw the finished iron to the wharf.

It is a shrine worth visiting.

"Our Industrial Shrine," *The Boston Herald*, September 24, 1954, p. 26.

14.4 Crowd watching forge hammer demonstration on opening day, September 17, 1954. (Photograph 1266 by Richard Merrill, 1954.)

> adding to the difficulty of the work to be done. This is inexcusable, for I have volunteered to assist with this work, and at no expense to anyone.[27]

Robbins went on to note that the attention to a few missing artifacts, with an "absence of concern for the vast collection of unclassified artifacts, which represent the greatest array of relics of the seventeenth century yet uncovered in America, can be likened to an awful lot of 'fiddling being done, while Rome burns.'"[28]

Bonsal reported to Robbins in 1958 that "everything here is, with the exception of important proposed maintenance repairs or improvements in the Restoration area, 'tip top.'"[29] He added that there was "lots of snow, cold weather, and the usual day-to-day problems."[30] Among these day-to-day problems he included "our mutual friend, JSA."[31] A strong and mutual distrust and dislike of FIWA President J. Sanger Attwill was shared by Bonsal and Robbins and emerges in their correspondence of over 30 years; both men clearly credited much of the stress they felt at Saugus to Attwill.

While the general fund of the FIWA was back in the black by 1959, the treasurer's report noted that the "entire maintenance fund is supported by donations from the Iron and Steel Institute . . . . Without the continued support of the Iron and Steel Institute, the available funds of the First Iron Works Association would be insufficient to maintain this property for one year."[32] As will be seen, the reliance on the Institute for annual operating funds became increasingly problematic as the early supporters and leaders of the project, such as Quincy Bent and Louise DuPont Crowninshield, passed away; these individuals had exerted considerable influence on the Institute for continued support of the Saugus site.

In a 1959 director's report, Bonsal notes that the site continued to garner good public relations, with articles in local newspapers and appearances by staff on Boston TV stations. He also explains that some 15,000 brochures had been distributed to a wide range of libraries, museums, and travel agencies in an effort to further increase attendance.[33] Bonsal reports that the FIWA expected "to get considerable national attention when a book, *Hidden America*, written by our famous archaeologist, Roland Robbins, is published this year." He explains that "Robbie tells me the longest chapter is devoted to the Restoration."[34] Bonsal also discusses a visitor survey that was done to "determine what kinds of people visit the restoration, why they visit it, and what they think of it."[35] The survey indicated that most visitors found the site hard to find and that they had heard of the site via word of mouth rather than any publicity efforts; it appears that school groups formed a very significant percentage of visitors during the school year.

The biggest single expenditure for the FIWA, other than personnel costs, was the upkeep and maintenance of the physical plant. Although newly constructed, the buildings and their systems, such as the

You will be glad to know that the great shear in the slitting mill works as it should. Yesterday I cut a nail rod with it as easily as cutting cottage cheese and it cut one of A. M. Byers' best wrought iron flats, ½" x 3 ½" cold, as easily as one would cut a mild cheddar. Neal Harley now wants to cut the long flats in the forge in half since they are too long and he and I will do this on our next visit.

Conover Fitch, Jr., to Charles M. Parker, April 26, 1955.

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14.5 Robbins and curator Fred Bonsal standing in front of restored ironworks structures in June 1959. (Photograph 2382 from the Roland W. Robbins slide collection, 1959, Saugus Iron Works. Courtesy The Thoreau Society® Collections at the Thoreau Institute at Walden Woods.)

working waterwheels, furnace bellows, trip hammers, and slitting mill, all required extensive upkeep, particularly those that were exposed to the water of the waterpower system. While many minor adjustments to the various operating machines and buildings were required in the years immediately after the site opened to the public, within just five years more major repairs were needed. For example, a March 1959 letter from construction contractor W. M. Bogart to Perry, Shaw, Hepburn and Dean noted that

> the four uprights holding the counter weight for the bellows on each side of the big doors on the outside of the Refinery Building, were rotted off at the bottom, in a way similar to those at the Casting Shed, and to be repaired in about the same manner.[36]

In addition to wear and tear and deterioration from weather, many of these systems were designed by architects who had never worked with this type of industrial plant, and thus were experimental. As the various operations, such as the bellows and trip hammer, were put into regular service, it was also necessary to tinker with the original design when it became clear that a component or element was not working as planned. In a 1956 letter, H. M. Kraner writes to Conover Fitch that

> I am sending you herewith some sketches showing changes in the Saugus Furnace Hearths and Hearth plates to take care of the expansion of these plates against the masonry walls. I have investigated packing material which would be suitable to use between masonry and iron plates and find that the material called "Fibrefrax" . . . is what would be necessary to use.[37]

The final arrangement of plates in the hearths agrees very closely with the number of plates and the total weight of plates carried in the Saugus inventories. It does not seem strange to us that after a full season, during which fires were kept going in the hearths, the plates need a certain amount of re-packing or re-setting.

Conover Fitch, Jr., to H. M. Kraner, April 26, 1956.

With funding from the American Iron and Steel Institute, the FIWA could continue to maintain its annual operations of the site and keep current with its heavy maintenance demands, particularly in terms of the wooden buildings. However, in 1961, FIWA directors Fred England and E. Neal Hartley were called to a special meeting at the Institute in New York and informed that due to a decline in the steel business, it could no longer finance the ironworks.[38] The FIWA asked the Institute to reconsider or to at least consider providing a reduced annual operating budget. In the meantime, talk turned to cost-cutting measures and other sources of funding, such as the Carnegie Foundation; it was noted that a last resort was "turning the Iron Works over to the National Park Service."[39]

At another special meeting of the FIWA board in November 1961, the talk of budget reduction and fund raising continued. Ideas ranged from asking the town of Saugus to reduce the price of water used by the operation to the addition of a snack bar to increase income. Two principal ideas, a fundraising drive for an endowment and help from the National Park Service (NPS), were the focus of discussion. Although the group held out hope that it could regain the support of the American Iron and Steel Institute with

14.6 Fabrication of paddle wheel for forge, November 2, 1953 (Photograph 1041 by Richard Merrill, 1953.)

some lobbying from its members and friends, the board voted to immediately sell some of the properties owned by the FIWA around the periphery of the site.[40] Bonsal wrote to Robbins in December 1961 that

> there is MUCH that I might write you as to the general situation here, especially with respect to the financial status of the Maintenance Fund. Actually, we have enough funds, now, to see us through January so, unless something constructive happens VERY SHORTLY, the Fred Bonsals may be selling apples on the streets of Boston and/or Lynn. And I am not fooling![41]

In early 1962, the board received a reply from the Institute to their plea for future financial assistance. The Institute, wrote President Max Howell, would provide a final $25,000 in support, provided that the board agreed to devote some of its own funds to the operation and maintenance, immediately seek other more permanent sources of support (including the NPS, the Commonwealth of Massachusetts, and local funding sources and/or governments), and acknowledge that this was to be the Institute's final contribution to the FIWA. The board quickly voted to accept the offer and began exploring the question of fundraising; a professional consultant reported to the board that it would need some $2 million to adequately endow the site.[42]

At a board meeting in March 1962, Bonsal resigned and the board discussed hiring a part-time replacement in order to save money.[43] It was also announced that an inquiry had been made to the National Park Service regarding its acquisition of the site. The board of directors learned that a study to consider the site as a unit of the NPS was scheduled for late 1962 or early 1963. While the FIWA tried valiantly to raise funds, it never really succeeded. At a strategy session with representatives of the FIWA and the American Iron and Steel Institute, it was decided to meet with U. S. senators in Washington to discuss the possible acquisition of the site by the NPS.[44]

Attendees at the annual FIWA meeting in June 1963 learned that the Association had an annual deficit of about $12,000, and that it would only be able to cover this from the organization's treasury for at most another two years.[45] This meeting resulted in a renewed call for help in contacting members of the NPS Advisory Board and members of Congress to lobby for the support of an NPS takeover of the site; in particular, it was recommended that Senator Edward Kennedy be approached for his support.[46]

A National Park Service Site

As discussed above, a takeover of the site by the National Park Service was not universally accepted by the FIWA membership. In fact, there was open opposition to the idea and several members of the association considered a government takeover of the site an option of last resort.[47] However, the opposition

The opening you are dedicating here today goes far beyond the borders of Massachusetts. It is, in effect a recognition of the kind of initiative, the kind of leadership, the kind of skilled workmen that Massachusetts, in its great history has produced not only for the state itself, but for the whole of the United States.

Christian A. Herter, Governor of Massachusetts,"Restoration Dedicated at Impressive Ceremony," reprinted in the *First Iron Works Gazette*, Fall 1954.

14.7 Visitors watching demonstration of slitting mill waterwheel. (Photograph 1194 by Richard Merrill, 1954.)

to government control does not seem to have evolved as a result of the inherent distrust of government. Rather, it appears to have been a result of anger directed toward the American Iron and Steel Institute, whose withdrawal of financial support seemed a shirking of responsibility; many FIWA members felt betrayed and abandoned by the industry. E. Neal Hartley keenly summarizes this view in a March 1, 1962, letter to George Rose, vice president and secretary of the Institute:

> That this has been the Institute's preferred course of action has seemed clear from that summer day when Sanger and I were called to New York to receive the sad news that the steel industry was withdrawing its support of a project which it had chosen to undertake and into which it had poured vast sums of money. I think I see why this has been so. The steel industry could slough off a responsibility and pass it along to "government." Its publicists might even manage to make such an action sound like a public service gesture . . . . Nevertheless, where I came from one turned to government only when one was in dire extremity. One went on relief only after exhausting all possible alternatives . . . . I am not anti-government. I have the highest regard for the job the National Park Service does. I am, however, bound to favor private enterprise in all instances save only those in which it clearly breaks down.[48]

The FIWA made a valiant attempt to make things work without government intervention. As discussed above, meeting minutes note several steps that were taken to try to reduce costs and increase income.[49] The various attempts to keep the ironworks in private hands, however, ultimately failed. The FIWA began to actively court the National Park Service, fulfilling a prophesy foretold by Sumner Appleton as early as 1941.[50] It was announced at a March 24, 1962, meeting that the FIWA had contacted the NPS, which had scheduled a study of the site for appropriateness at the end of 1962 or early in 1963.[51] The board voted on May 6, 1963, that its endorsement of the NPS taking over the ironworks would be held in abeyance until after the study was completed. [52] Evidently, the board did not want to tip its hand. The NPS completed the study in the fall of 1963 and FIWA President J. Sanger Attwill reported during the December 9, 1963, meeting that the NPS had found the site eligible.[53]

Stewart Udall, Secretary of the Interior, sent a letter to Attwill announcing the designation of Saugus Iron Works as a National Historic Site on May 20, 1965.

> I am pleased to inform you that the Advisory Board on National Parks, Historic Sites, Buildings and Monuments at its 52nd meeting, April 12-15, 1965, recommended that the Saugus Iron Works be established as a national historic site. I concur in the recommendations of the Board and have so informed Senator Saltonstall, Senator Kennedy and Representative Macdonald.

Wednesday, 11.40 to 2.45, April 10, 1968

We [Edwin W. Small, Project Coordinator, NPS, and Roland Robbins] talked for more than 3 hours, not only about the Saugus Ironworks, but about other restorations, etc., in general. I told him I was happy to see the Ironworks end up in the National Park System.

Roland Robbins, notes, The Roland Wells Robbins Collection in the Thoreau Society Collections at the Thoreau Institute at Walden Woods.

14.8 FIWA President J. Sanger Attwill receives award, June 11, 1955. (Photograph by Richard Merrill, 1955.)

> Your letter of March 16 to Director George B. Hartzog, Jr. of the National Park Service, offering to donate the properties constituting the restored Saugus Iron Works to the Federal Government for inclusion in the proposed national historic site has been brought to my attention. I wish to add my thanks to those expressed by the National Park Service for this generous offer. We shall look forward to working with you in the future on this proposal.[54]

The transfer of Saugus Iron Works National Historic Site to the National Park Service began to be debated in Congress following the recommendation of the Advisory Board. During the debate, the bill, known as S. 2309 in the Senate and H.R. 1308 in the House, first went to the House of Representatives where it was passed. When it reached the Senate, Edward Kennedy testified in support of the bill and gave out copies of the pamphlet prepared to document the history of the restoration. President Lyndon Johnson signed the bill into law on April 5, 1968 (Public Law 90-282). The bill appropriated $400,000 to carry out the purposes of the act. The minutes of the April 29, 1968, FIWA meeting record the passage of the law.[55] It was now official: the Saugus Iron Works National Historic Site was part of the National Park Service.

The period between 1965 and the official transfer of the site in 1969 was one of relief for members of the FIWA Board and an opportunity for reflection on and negotiation with the National Park Service for the continued operation of the site. The FIWA actually remained a chartered organization until 1978, when it was officially disbanded, finalizing various arrangements with the NPS, selling several properties that didn't convey to the Federal government, and disposing of miscellaneous materials and the remaining funds in the treasury.[56] On October 14, 1978, three days after the 35th anniversary of the founding of the FIWA, the board of directors voted to surrender the charter and disband the organization.[57]

The service thus established shall promote and regulate the use of the Federal areas known as national parks, monuments, and reservations hereinafter specified by such means and measures as conform to the fundamental purpose of the said parks, monuments, and reservations, which purpose is to conserve the scenery and the natural and historic objects and the wild life therein and to provide for the enjoyment of the same in such manner and by such means as will leave them unimpaired for the enjoyment of future generations.

National Park Service Organic Act of 1916 (16 U.S.C., Section 1, 39 Stat. 535).

Roland Robbins Reemerges at Saugus Iron Works

After he left the project in 1953, Robbins made only sporadic visits to the site, but kept up with events through friends, acquaintances, and media reports. Robbins had devoted several years of his life and career to the development of the site and had become invested in the outcome of the project. He knew that the ironworks was part of his legacy.

Soon after Saugus became a unit of the National Park Service, Robbins contacted NPS representatives. For some unknown reason, NPS officials ignored Robbins and spurned his offers of educational assistance during the final years of the 1960s. In his notes, Robbins records that he contacted Edwin Small, Project Coordinator for the NPS on Wednesday, April 10, 1968, and offered to help with the site. [58] Almost a year later, Robbins contacted Benjamin Zerby, Superintendent at Minute Man National Histori-

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14.9 Robbins' invitation to the Saugus Iron Works dedication. (Roland Wells Robbins Collection in the Thoreau Societys Collections at The Thoreau Institute, at Walden Woods. Courtesy The Thoreau Society® Collections at the Thoreau Institute at Walden Woods.)

cal Park and the person now in charge of Saugus Iron Works, and offered to conduct a slide show for him and members of the staff illustrating discoveries made during the five years of excavation.[59] On August 10, 1969, Robbins notes that he met with NPS Ranger J. Paul Okey at the ironworks. Robbins again volunteered his services and offered to educate staff on the archeological discoveries and told Okey that he made the same offer to Zerby some time ago. The staff of the ironworks was uninformed, in Robbins' assessment. The staff lacked a copy of his daily notes, which Robbins offered to loan them.[60] Reading Robbins' daily log, one can feel his frustration with the lack of response by the NPS. Finally, on November 5, 1969, Robbins phoned Okey, but instead talked to Glen Gray, the first superintendent of Saugus Iron Works NHS. Robbins, Grey, and Zerby agreed to meet in December. When the meeting finally took place in January 1970 at Robbins' house, the attendees also included Cynthia Pollack, the business manager for the park. Robbins complained in his daily log that "there was so much stuff they didn't know about."[61] He and Grey continued to have meetings and discussions during February and March 1970. Robbins seems to have become friends with Gray, and was genuinely disappointed when he accepted a superintendency at Saratoga National Historical Park.

The written interaction between Robbins and the NPS then stopped until 1975, at least according to the records contained at the Saugus Iron Works and Thoreau Society collections. Early in March 1975, James Deetz, professor of archeology at Brown University and Assistant Director of Plimoth Plantation, notified Robbins that two of his graduate students were going to conduct a survey of past archeological work at Saugus Iron Works. Deetz asked Robbins to consult on the project.[62] Robbins readily accepted and set up a date with Deetz to meet with Marley Brown III and Mary Beaudry. Robbins was not satisfied with the $50/day fee that Deetz offered for the meeting, but notes that more substantial consulting fees would be available later. When the meeting took place on May 17, 1975, Geoffrey Moran also attended. This interaction is very interesting considering what had transpired between Deetz, Robbins, and the NPS during the first half of the decade.

As noted earlier Robbins was not an academically trained archeologist. He developed his expertise in historic and industrial archeology from his project experience. However, during the 1950s and 1960s historical archeology was beginning to carve out a niche among academically trained archeologists. While acceptance of historical archeology was slow to take hold among academics, it seems to have made progress every year toward its ultimate acceptance as a viable subfield of anthropological archeology. In 1966, the National Historic Preservation Act was passed, which began to set standards for archeological excavation. Those who were not academically trained were increasingly seen as rogue practitioners of an academic discipline. "Robbins' approaches to archaeological research and excavation did not improve with respect to the increasingly rigorous standards of the professional community; in fact, they may have deteriorated with his increasing alienation by the academic community, and his growing desire to separate himself and his work from that of the academy."[63]

Monday, 9.40 a.m. to 2.50 p.m., January 26, 1970:

Benjamin Zerby, Supt. of the Minute Man National Park, Cynthia Pollack and Glen Gray were at my house. I served coffee and cookies when they got here, then some clam chowder at noon. I showed pictures of the S.I.R., covering details that I normally wouldn't in a lecture. They were very much interested and impressed . . . . There was so much stuff they didn't know about. It was left that I would go thru my papers and see what I have in the nature of artifact information, etc., and let them know and we would plan to get together again soon.

Roland Robbins, notes, The Roland Wells Robbins Collection in the Thoreau Society Collections at the Thoreau Institute at Walden Woods.

14.10 Glen Gray, first superintendent of Saugus Iron Works NHS. Gray is pictured here from a later assignment at Saratoga NHP. (Courtesy Saratoga National Historical Park.)

One incident brought about by the increasing professionalization of the discipline is key for understanding later interaction between Robbins, the academic archeologists, and the NPS. Following a lecture in Connecticut, Robbins was approached by William J. Morris, Director of the Connecticut Historical Commission, about doing some work for the state. However, because the work was a federally-funded project, Morris had to submit Robbins' name and résumé to the Keeper of the National Register for approval. The Keeper referred the matter to the NPS, which rejected Robbins' qualifications as an archeologist.[64]

Robbins wrote to Massachusetts Senator Edward W. Brooke for help. Senator Brooke asked the NPS for a "complete report" on the situation, but was clearly disturbed by the lack of a direct answer from the NPS to Robbins' questions. Following an additional inquiry, NPS relented and agreed that they could not prohibit any organization from employing Robbins. "Although Robbins participated in several cultural resource management projects during the period and was able to capitalize on the interest in historic sites generated by the nation's bicentennial, he found himself increasingly marginalized by professional academic archeologists who considered his lack of education and excavation standards unacceptable and his populist views alarming."[65] Despite this dismissive attitude, Robbins continued to interact with the NPS, Deetz, and other academics throughout the 1970s.

The work done at Saugus Iron Works by Deetz's students, Marley R. Brown III and Mary Beaudry, focused on assessing Robbins' work with an eye toward future excavations at the site. It included a summary of Robbins' daily notes and maps indicating where excavations had taken place and where archeological potential remained. For the most part, Brown and Beaudry refrained from writing a critical evaluation of Robbins' work at the site and instead summarized the information left behind by Robbins. This laid the groundwork for the later work of Geoffrey Moran, who in 1976 conducted an excavation program on the area to the north of the Iron Works House.

Correspondence contained in the Thoreau Society collection identifies the differences in approach to the site between Robbins and academic archeologists and NPS officials. On one hand, Deetz wanted to bring in many of his students to conduct scientific excavations, much as he himself had done at Plimouth Plantation. [66] Robbins, on the other hand, wanted to restore more of the site's original setting, reconstructing the Jenks area and removing more of the retaining wall along Central Street to recreate the canal that ran from the cranberry bog. In an August 1975 letter to Marley Brown, Robbins wondered if the archeological work would happen at all. [67]

In 1976, several people made contact with Robbins about the Saugus Iron Works project. Richard Cote, an intern at the Society for the Preservation of New England Antiquities, borrowed slides from Robbins and tried to get the NPS to copy all of his slides.[68] Geoffrey Moran visited Robbins a couple of times and

Monday, 9 A.M. to 4.45 P.M., May 19, 1975:

I spent the day at the site going over stuff for their master plan. [Robbins, Brown, Beaudry, and Moran] The Jenks' area will receive priority, etc. THEY SAID THAT THE NEW NATIONAL PARK POLICY IS THAT ALL AREAS MUST BE TAKEN DOWN SO THAT ALL ARTIFACTS FOUND AT EVERY ½" LEVEL MUST BE RECORDED!!!!!! I SAID THIS WAS IMPOSSIBLE AND STUPID WHERE ONE GOES DOWN GREAT DISTANCES IN DEPTH IN HISTORIC SOILS . . . I SAID THAT ONE WOULD NEVER REACH 17TH AND 18TH CENTURY LEVELS AT THIS RATE . . . THEY WOULD SPEND THEIR BUDGETS AND BE COMPLETELY CONFUSED WITH NO ACCOMPLISHMENT!!! THEY AGREED.

Roland Robbins, notes, The Roland Wells Robbins Collection in the Thoreau Society Collections at the Thoreau Institute at Walden Woods.

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14.11 Letter from James Deetz to Roland Robbins about Saugus project. (Roland Wells Robbins Collection in the Thoreau Society Collections at The Thoreau Institute, at Walden Woods. Courtesy The Thoreau Society® Collections at the Thoreau Institute at Walden Woods.)

Robbins showed him slides highlighting the project. Robbins offered to plot features that he had identified in the field to assist Moran with the excavations, but it appears that Moran never took Robbins up on the offer. Moran conducted excavations in May 1976. While he wrote a summary of the work, a more in-depth report was completed by Alex Townsend of John Milner Associates.

Robbins' interaction with the NPS continued to deteriorate during 1977. Cynthia Pollack, park superintendent Jim Gott, and park historian Steve Carlson met in August 1977 for one of Robbins' slide shows. Correspondence in the Thoreau Society's collection indicates that Robbins began to become quite irritated with the NPS after this point. In one letter, he wrote, "More than ever, it becomes quite evident, that unless there is something that suddenly gets the attention of the bureaucratic system, there is little one can do about conducting legitimate business with it."[69] He later comments, "Come to think of it, it was 5 weeks ago I entertained the National Park people here for 2 days. I have yet to hear a word, written or oral, of thanks, nor of their interest in the Gleason-Robbins photographs . . . if, indeed, such exists!"[70]

The Gleason-Robbins photographs that Robbins referred to are an interesting example of Robbins' business acumen. Herbert Gleason, an early professional photographer, visited and photographed numerous National Parks beginning in 1899. [71] Over six thousand of the negatives from his collection were purchased by Robbins from a Boston studio in 1947. Robbins attempted to make money from his investment by selling publication rights to many of these images. Evidently, he attempted to sell many of these negatives to the NPS.

On September 20, 1977, Robbins wrote a letter to Cynthia Pollack stating his displeasure with the way the Park Service handled his involvement at Saugus. He indicated that any further interest in the Gleason Collection or his involvement would have to be made in written form.[72] Evidently, Jim Gott phoned and apologized for the way the NPS responded to his offer of the collection. Gott asked if Robbins wanted to write the Jenks report instead of Carlson, but Robbins indicated he preferred to be a consultant and would help Carlson when he needed it; evidently Gott had asked Carlson to write a report on the Jenks area.[73] On Monday September 26, 1977, Pollack called Robbins.

> I told her that I was getting ready to phone her and apologize for writing the letter I had, I didn't have anything against her in mind, it was the National Park Systems inefficient way of doing everything that I was complaining about. She said she didn't feel upset about the letter, was glad I wrote it! Thought they had handled the Gleason and Robbins' collections poorly.[74]

Monday, 1.30 to 4.45, March 29, 1976:

I discussed the master grid system I use, especially for pretesting sites. I explained [to Moran] how work sheets can record much pertinent info., including artifacts, soil grades and natural subsurface soils, stone, peat, etc. And they can cover many miles of terrain. He seemed interested in learning more about this.

Roland Robbins, notes, The Roland Wells Robbins Collection in the Thoreau Society Collections at the Thoreau Institute at Walden Woods.

14.12 Robbins greets Mr. Guy, son of the former blacksmith, at a May 1980 museum addition dedication ceremony. (Courtesy Mel Pollack Photo Services.)

In November 1977 another event occurred that infuriated Robbins. Evidently Gott had asked Robbins to do some archeological testing for the Jenks Road area. Robbins' November 7, 1977, log entry captures the situation:

> Jim Gott telephoned me. Asked if I could postpone the tests for the roadway to the Jenks' site until later, "besides it is due to rain Tuesday." I said that normally rain doesn't stop me from my work. He said he had been at a NPS meeting in N.J. last week (I believe), and he met "their archaeologists." His guy said he had heard of me and wanted to meet me. Jim also said he didn't know until then that the NPS now have certain rules regulating work of this nature, etc., etc. And Jim said the guy wants to be there when I do the testing. By now I was warming up considerably, but didn't boil over! I said that it probably would be just as well if I forgot about doing the tests; after all, the interest in this area came about when he and other N.P.S. people were here and I was reviewing all my work at the Jenks' site and I mentioned I thought I know where the Jenks road may be, and volunteered to do this testing. He agreed that I could do this. I said that it probably would be best to forget about the testings. He didn't want that to happen. He said that he would have the guy phone me and we could make mutual arrangements.
>
> After our conversation, my slow burn erupted into volcanic proportions!!!!! I DON'T INTEND TO HAVE ANYONE STANDING OVER MY SHOULDER WHILE I WORK READING RULES AND REGULATIONS TO ME !!!![75]

There was no easy resolution to this situation, as Robbins' November 12, 1977, entry shows:

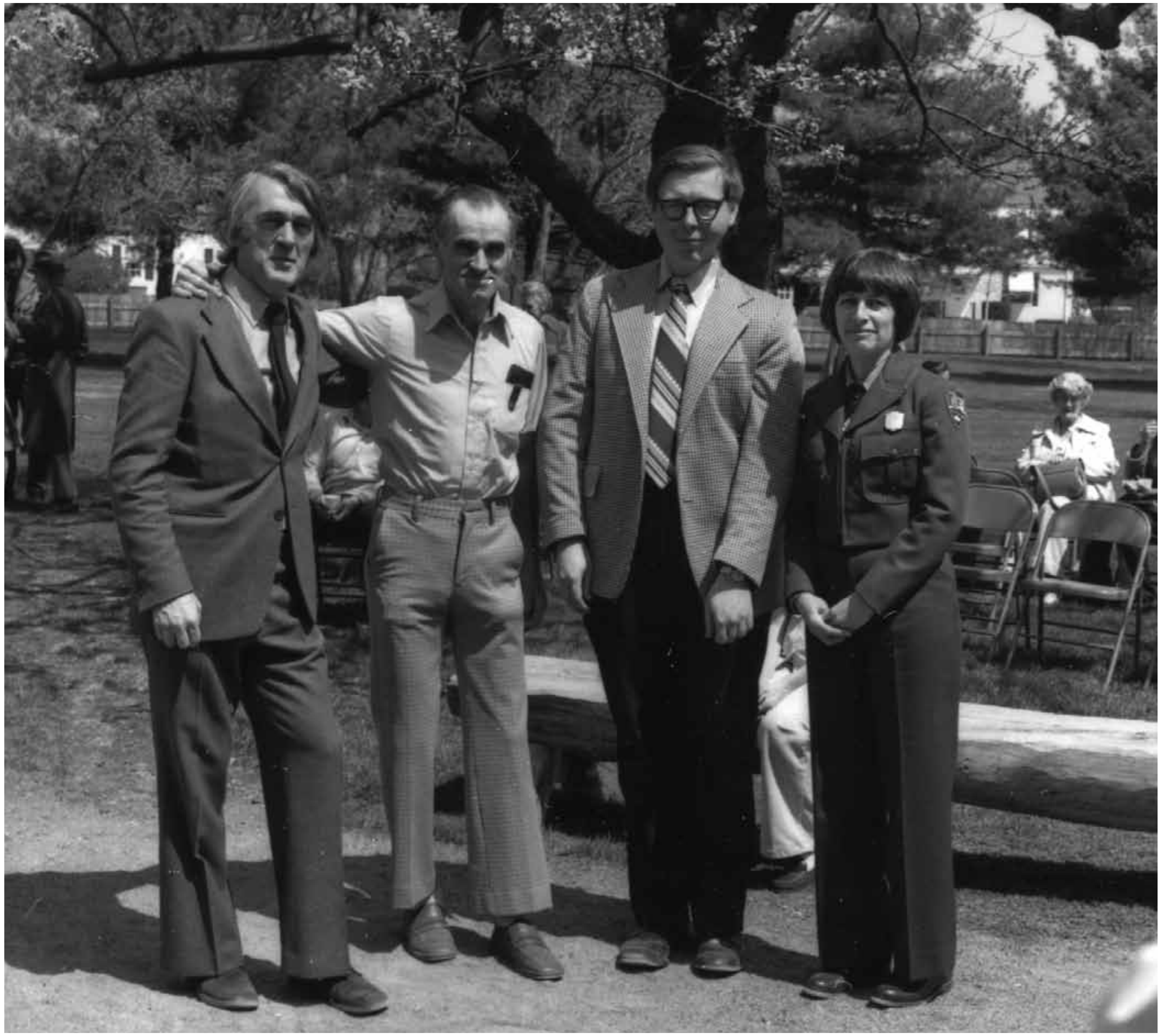
> . . .She [Pollack] didn't know about the "new archaeologist," but he would be a regional archaeologist just out of school.
>
> I told her that this was humiliating, to say the least, especially the new archaeologist's request to be there when I did the testing. I said Nobody has ever looked over my shoulder when I worked, and I am not about to let it start now. She said she couldn't understand that . . . there is no way that anyone can stand over her shoulder when she is working! I said that Steve Carlson was going to be here next Monday and go through more of my personal files on the Saugus Project, which I have been cooperating with. But I shall phone him and say that under the circumstances, I want to cancel this and future cooperation of this nature.
>
> She said she didn't blame me in the least.[76]

Tuesday, 9.30 A.M., September 20, 1977:

Then he [Steve Carlson] said that Mrs. Pollack asked him to tell me that N.P.S. may be in touch with me next spring relative to the Gleason photographs of the National Parks.

FROM WHAT I CAN MAKE OF THIS, MRS. POLLACK HAD STEVE DO HER DIRTY WORK . . . TELL ME ABOUT A POSSIBLE CONTACT FROM THE N.P.S. NEXT SPRING . . . SHE IS THE ONE THAT HAD HANDLED ALL OF THIS, NOW PASSES THE BUCK TO STEVE WHEN THINGS BOG DOWN!!!!!

Roland Robbins, notes, The Roland Wells Robbins Collection in the Thoreau Society Collections at the Thoreau Institute at Walden Woods.



14.13 Photograph of Steve Carlson (second from right) and Cynthia Pollack (far right) at a 1980 museum addition dedication ceremony. (Courtesy Mel Pollack Photo Services.)

While this event seems critical and final, a reconciliation of sorts took place in August 1978.

> Steve Carlson phoned. Wanted to know if he could continue looking at my notes and correspondence that I cut him off from last November. Also wanted to interview me about the construction work at S.I.W. and do some tape recording. I said yes to both. Said he had Conover Fitch there last week for a similar interview . . . . Jim Gott then talked to me. Said he wanted to talk with me sometime about my color photographs of my S.I.W. project work—also there others that wanted to see them, I believe. He apologized about the cancellation of the tests for the road to Jenks' site last November. Said he should have just had it done and not said anything to the others, etc.[77]

Surviving correspondence between Robbins and others grows sporadic at this point. In a February 12, 1979, letter from Robbins to NPS Regional Archeologist Francis P. McManamon, Robbins encloses his résumé, presumably for work on an NPS site.[78] Interestingly, Robbins wrote the letter on regular paper rather than the personal stationery that documented his excavation accomplishments along the left margin and signed it "Roland Wells Robbins, Consultant, American Heritage Landmarks." By this point, Robbins realized that he could no longer fight the establishment.

Whether Robbins ever believed it or not, he left quite a legacy, as a pioneer in several fields. Linebaugh comments, "Robbins believed strongly that he had not been given proper credit by academic professionals for his many pioneering efforts in contract archaeology, public archaeology, and at industrial and domestic sites throughout the Northeast."[79] Linebaugh goes on to note:

> [Marley] Brown conjectured that Robbins's consulting work created ill will among professionals; "we were doing this work for free as Deetz's students and Robbins was working right down the road and getting paid for it." It is not just ironic, but significant, that although Deetz worked from the security of the university, many of his graduate students—those who scorned Robbins's hucksterism, that is, his self-promotion of archaeology as a business—were later employed in contract archaeology or cultural resource management. They were compelled to practice contract archaeology because of underlying economic and political circumstances. As these university-trained archaeologists slowly began to embrace cultural resource management as a legitimate pursuit, they faced many of the same conditions that Robbins had encountered during his 30-year career, including institutional constraints, monetary pressures, and lack of standing within the discipline.[80]

Tuesday, July 29, 1980, 1.55 to 4.00 P.M.:

I took the reel of 16mm film that Henry Gibson gave me after he completed making the Saugus Iron Works Sound Film to the museum. Cynthia Pollack, Louise Gillis, Jim Gott and other personnel were there to see it played through. Cynthia was going to show it again this afternoon to other personnel. She asked if they could borrow it so she could see if they can have a copy of it made for their files. I loaned it to her.

Roland Robbins, notes, The Roland Wells Robbins Collection in the Thoreau Society Collections at the Thoreau Institute at Walden Woods.

14.14 An example of Robbins' early stationery. Note the list of projects along the left margin. (Roland Wells Robbins Collection in the Thoreau Society Collections at The Thoreau Institute, at Walden Woods. Courtesy The Thoreau Society® Collections at the Thoreau Institute at Walden Woods.)

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It is often difficult to see the progress one has made when still embroiled in a struggle. Robbins struggled with the academic field of historical archeology throughout his lifetime. Sometimes, however, recognition and acceptance come later. Now that historical archeology has matured into an accepted academic discipline, we begin to see the enormous impact of early practitioners like Robbins on the development of the field.

Conclusion

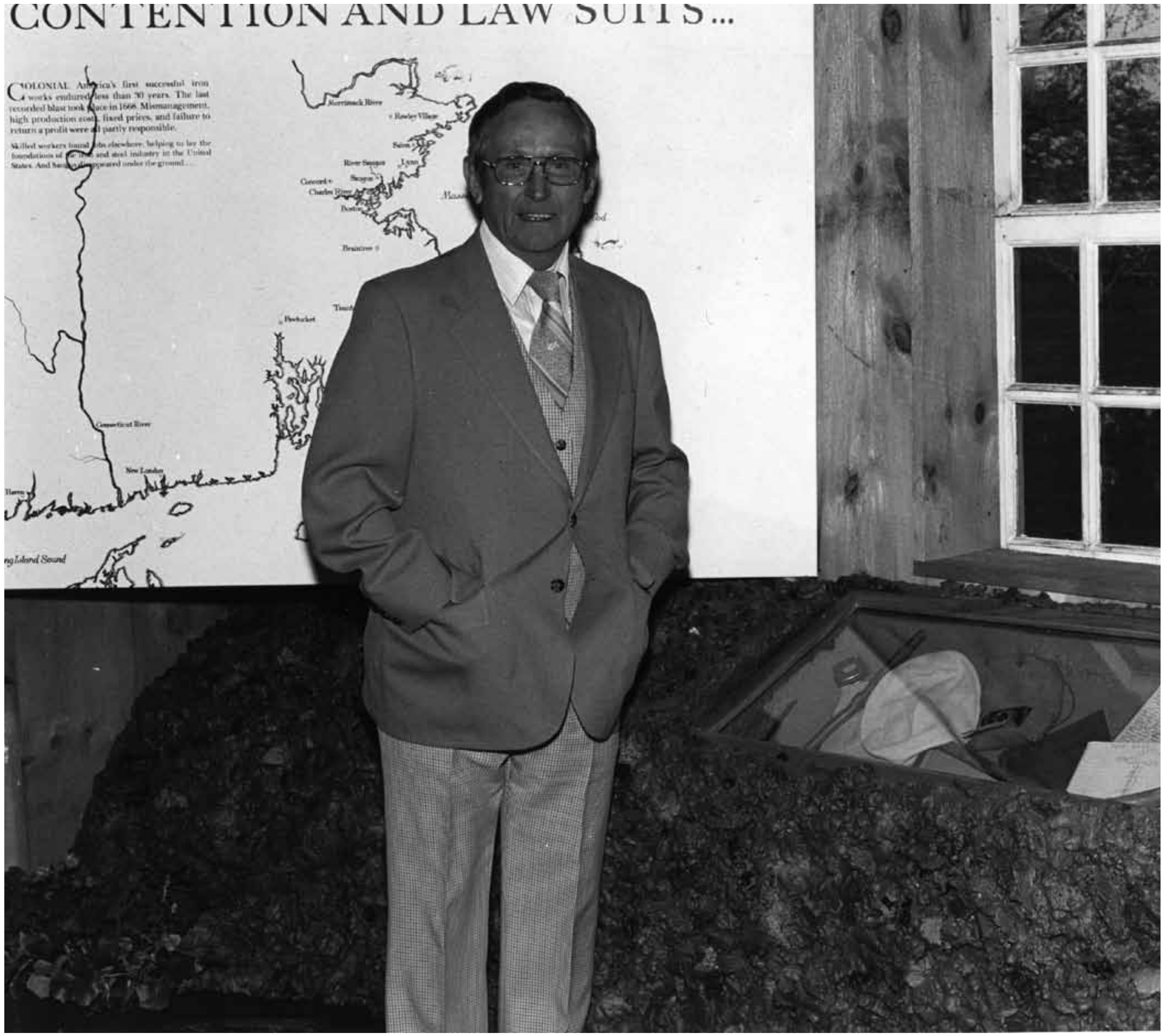
The period from the opening of the Saugus Iron Works in 1954 to the present consists of two very distinctive periods in the history of the site. From 1954 until 1969, Saugus was managed by the First Iron Works Association, the organization that spearheaded the excavation and reconstruction project. While the FIWA was responsible for the day-to-day operation of the site, the American Iron and Steel Institute, which funded the excavation and reconstruction, provided critical financial support for its maintenance and operation. In fact, the Institute's withdrawal of this funding precipitated the transfer of the property to the National Park Service. Archeological work ceased with the opening of the site in 1954, and was not resumed until the Park Service's tenure. During the FIWA's control, very little was done with the archeological collection beyond displaying materials in the museum. Most of this display was created by Robbins and his staff prior to his departure. As noted above in several chapters, Robbins displayed concern for artifact processing and treatment throughout the project. After his departure, he also expressed great concern about the lack of progress in processing and analyzing the collection. In effect, the majority of the materials recovered during the five-year excavation were ignored in the haste to open and operate a functioning museum site.

With the transfer of the site to the National Park Service in 1969, archeological projects focused on fully processing and inventorying the languishing artifact collection. The artifacts were moved from their less than ideal storage areas, rehoused and properly curated. Because Robbins left without completing a final report, the other major undertaking was an assessment of his work to provide a framework for better understanding the artifact collection and to aid future investigations. While several archeological projects have been completed under NPS management, all but two were compliance driven and generally limited in scope. Nothing even approached the scope of Robbins' work.

Roland Robbins' excavations at Saugus left an indelible impression, not only on the reconstructed ironworks at Saugus, but upon historical archeology in general. While most of the archeological investigations done prior to the passage of the National Historical Preservation Act (NHPA) in 1966 were conducted by academically-trained archeologists working for universities, Robbins changed that and brought business to archeology. Without university backing, he had to rely on his entrepreneurial skills

During my four decades of professional study of American history I have been regarded as an archaeologist, which in a sense is true. In the summer of 1955 Collier's Magazine *ran a feature story on me and my work which was entitled "The Pick and Shovel Historian." This has always been my favorite identification. After all, I am a historian who digs when the success of the subject necessitates my doing so. I suppose one could say that I [was] qualified to tackle the Saugus Iron Works challenge because I showed up at the right places in my life at the right times in my life.*

Roland Robbins, incomplete biography, p. xiv. The Roland Wells Robbins Collection in the Thoreau Society Collections at the Thoreau Institute at Walden Woods.



14.15 Robbins posing in front of display of excavation tools at Saugus during May 1980 museum addition dedication. (Courtesy Mel Pollack Photo Services.)

to bring in business. Robbins especially relied on the publicity from his discoveries and the excitement generated from his public lectures to bring in business. He was very successful throughout his life with his entrepreneurial system and was able to work on archeological projects for over forty years. A similar business model was adopted by numerous cultural resource management firms following the passage of the NHPA in 1966, which required archeological investigations before major federally funded undertakings.

What started out to be an antique treasure hunt turned out to be one of the most intensive excavation campaigns on one of the most significant archeological sites in the northeast. The discovery of the archeological remains of the buildings, canals, raceways, and supporting structures at Saugus guided much of the reconstruction. Robbins' success at locating archeological features and the financial support of the American Iron and Steel Institute, which sought to immortalize the birth of its industry, combined in a powerful fashion. All of the stars seemed to align on the Saugus project. Although Robbins was never academically trained, this pick and shovel historian was able to excavate the site, locate the major industrial features, and leave an incredibly well-documented archive of information on his excavations. Robbins and the FIWA truly left a rich legacy at Saugus.

NOTES

PREFACE

[1] Marley R. Brown III, ed., "Saugus Iron Works National Historic Site: An Evaluation of Roland Wells Robbins Archaeology," report on file at Saugus Iron Works National Historic Site, 1975; Mary C. Beaudry, "Appendix: Saugus Iron Works National Historic Site, Archaeology and the Documentary Record" in "Saugus Iron Works National Historic Site"; Eric S. Johnson, "Archeological Overview and Assessment of the Saugus Iron Works National Historic Site, Saugus, Massachusetts," report on file at the Saugus Iron Works National Historic Site, 1997).
[2] Donald W. Linebaugh, "'The Road to Ruins and Restoration': Roland W. Robbins and the Professionalization of Historical Archaeology" (PhD diss., The College of William and Mary, 1996); Linebaugh, "Forging a Career: Roland W. Robbins and Iron Industry Sites in the Northeastern U.S.," *Industrial Archeology* 26 (2000): 5-36.
[3] Roland W. Robbins, *Discovery at Walden* (Stoneham, MA: George R. Barnstead & Son, 1947).
[4] Linebaugh, "Forging a Career."
[5] E. Neal Hartley, *Ironworks on the Saugus* (Norman: Univ. of Oklahoma Press, [1957]; Fort Washington, PA: Eastern National, 2001).

CHAPTER 1 Notes

[1] Jane Waldbaum, *From Bronze to Iron, The Transition from the Bronze Age to the Iron Age in the Eastern Mediterranean* (Götteborg: Paul Aströms Förlag, 1978).
[2] Robert Gordon, *American Iron, 1607-1900* (Baltimore and London: The Johns Hopkins University Press, 1996), 308.
[3] Gordon, *American Iron*, 14.
[4] Gordon, *American Iron*, 14.
[5] Susannah W. Brody, *The History of Dowlin Forge* (Chester County, PA: Uwchlan Township Historical Commission County, 1995), 5; Gordon, *American Iron,* 222-223.
[6] Terry S. Reynolds, *Stronger Than a Hundred Men* (Baltimore and London: The Johns Hopkins University Press, 1983), 11.
[7] Reynolds, *Stronger Than a Hundred Men*, 10-11.
[8] Hartley, *Ironworks on the Saugus*, 109.
[9] Charles C. Gillispie, *A Diderot Pictorial Encyclopedia of Trades and Industry: 485 Plates*

Selected from 'L'Éncyclopédie' of Denis Diderot (Mineola, New York: Dover Publications, Inc., 1987), vol. I, plates 82-85.

[10] Gillispie, *A Diderot Pictorial Encyclopedia,* plates 84–85.

[11] Hartley, *Ironworks on the Saugus*, 167.

[12] Brody, *History of Dowlin Forge*, 66.

[13] David W. Crossley, "A Sixteenth-Century Wealden Blast Furnace: A Report on Excavations at Panningridge, Sussex, 1964-1970," *Post-Medieval Archaeology* 6 (1972): 61.

[14] H. R. Schubert, *History of the British Iron and Steel Industry from c. 450 B.C. to A.D. 1775* (London: Routledge & Kegan Paul, 1957), 222.

[15] Brody, *History of Dowlin Forge*, 69.

[16] Brody, *History of Dowlin Forge,* 70-1.

[17] Brody, *History of Dowlin Forge,* 69; Stevenson W. Fletcher, *Pennsylvania Agricultural and Country Life: 1640-1840* (Harrisburg: Pennsylvania Historical and Museum Commission, 1950), 329.

[18] Radomír Pleiner, *Iron in Archaeology: The European Bloomery Smelters* (Archeologický ústav AV ÈR Praha, 2000), 115.

[19]E. Straker, *Wealden Iron* (London, G. Bell and Sons, Ltd., 1931), 111.

[20] Henry Cleere and David Crossley, *The Iron Industry of the Weald* (Whitchurch: Merton Priory Press, 1995), 133.

[21] Cleere and Crossley, *The Iron Industry of the Weald*, 133.

[22] Crossley, "A Sixteenth-Century Wealden Blast Furnace," 60-61; Cleere and Crossley, *The Iron Industry of the Weald*, 133.

[23] G. F. Hammersley, "The Charcoal Iron Industry and the Fuel, 1540-1750," *Economic History Review,* 2nd ser., 26 (1973): 606.

[24] Hammersley, "The Charcoal Iron Industry," 606.

[25] Gillispie, *A Diderot Pictorial Encyclopedia*, plate 87.

[26] The bars produced from the liquid iron were called sows and/or pigs based on the resemblance in the sand molds to a sow suckling piglets.

[27] Gillispie, *A Diderot Pictorial Encyclopedia*, plate 87.

[28] Cleere and Crossley, *The Iron Industry of the Weald,* 221-22.

[29] Gillispie, *A Diderot Pictorial Encyclopedia*, plate 89.

[30] Gillispie, *A Diderot Pictorial Encyclopedia*, plate 89.

[31] Schubert, *History of the British Iron and Steel Industry,* 241.

[32] Schubert, *History of the British Iron and Steel Industry*, 244. This was true for areas in Britain other than the Weald.

[33] Cleere and Crossley, *The Iron Industry of the Weald*, 111-114.

[34] Hartley, *Ironworks on the Saugus*, 11.

[35] David W. Crossley and Denis Ashurst, "Excavations at Rockley Smithies, a Water-Powered Bloomery of the Sixteenth and Seventeenth Centuries," *Post-Medieval Archaeology* 2 (1968): 34.
[36] Crossley and Ashurst, "Excavations at Rockley Smithies," 34.
[37] Crossley and Ashurst, "Excavations at Rockley Smithies," 35.
[38] Crossley and Ashurst, "Excavations at Rockley Smithies," 34.
[39] Crossley and Ashurst, "Excavations at Rockley Smithies," 34.
[40] Cleere and Crossley, *The Iron Industry of the Weald*, 173.
[41] Schubert, *History of the British Iron and Steel Industry,* 219.
[42] Straker, *Wealden Iron,* 118.
[43] Straker, *Wealden Iron*, 118.
[44] Schubert, *History of the British Iron and Steel Industry,* 219.
[45] Hammersley, "The Charcoal Iron Industry," 593-613; James Dinn, "Dyfi Furnace Excavations 1982-87," *Post-Medieval Archaeology* 22 (1988): 117-18.
[46] Owen Bedwin, "The Excavation of Ardingly Fulling Mill and Forge, 1975–76," *Post-Medieval Archaeology* 10 (1976): 34-64; Owen Bedwin, "The Excavation of a Late 16th-Century Blast Furnace at Batsford, Herstmonceux, East Sussex, 1978," *Post-Medieval Archaeology* 14 (1980): 89-112; Crossley, "A Sixteenth-Century Wealden Blast Furnace," 42-68; David W. Crossley, "Cannon-Manufacture at Pippingford, Sussex: The Excavation of Two Iron Furnaces of c. 1717," *Post-Medieval Archaeology* 9 (1975): 1-37; Crossley and Ashurst, "Excavations at Rockley Smithies," 10-54; Dinn, "Dyfi Furnace Excavations 1982-87," 111-142; David W. Crossley, "A Gun-Casting Furnace at Scarlets, Cowden, Kent," *Post-Medieval Archaeology* 13 (1979): 239-49; David W. Crossley, *The Bewl Valley Ironworks* (Royal Archaeological Institute Monograph, 1975). Dates are approximate.
[47] Dinn, "Dyfi Furnace Excavations, 1982-87," 141.

CHAPTER 2 Notes

[1] [Edward] Johnson, *Wonder-Working Providence of Sion's Saviour in New-England, 1628-1651* (London, Nathanael Brooke at the Angel in Corn-hill, 1654 [facsimile], A2.
[2] E. Neal Hartley, *Ironworks on the Saugus*, 3.
[3] *Records and Files of the Quarterly Courts of Essex County, Massachusetts;* Volumes I-IX, 1636-1686, (Salem, Massachusetts, The Essex Institute, 1975), I:143 cited hereafter as Records of Essex Courts.
[4] A Collection of Papers Relating to The Iron Works at Lynn and More Particularly to The Suit Between Mr. John Giffard The Agent for The Undertakers of The Iron Works and The Inhabitants of The Massachusetts Bay Colony, Dated 1650 et seq., transcribed by Richard

Wormser, (Boston, Baker Library Historical Collections, Harvard University Business School, 1948), 198 (hereafter cited as Lynn Iron Works Collection.)
[5] Hartley, *Ironworks on the Saugus,* 1957, iv.
[6] "A Modell of Christian Charity, Written On Boarde the Arrabella, On the Attlantick Ocean, By the Honorable John Winthrop Esquire, 1630," *Winthrop Papers*, vols. 1-6 (Norwood: The Plimpton Press, 1931), II:295.
[7] John Winthrop to Sir Nathaniel Rich, *Winthrop Papers*, vols. 1-6 (Boston: The Merrymount Press, 1943), III:167.
[8] Stephen Innes, *Creating the Commonwealth, The Economic Culture of Puritan New England* (New York, London: W.W. Norton & Company, 1995), 16; The Rev. Francis Higginson to his friends at Leicester, July 1629 in Everett Emerson, ed., *Letters from New England* (Amherst, Massachusetts, University of Massachusetts Press, 1976) 27.
[9] Bernard Baylin, *The New England Merchants in the Seventeenth Century* (Cambridge: Harvard University Press, 1979), 61.
[10] Records of the Governor and Company of the Massachusetts Bay Colony in New England (1628-86), vols. 1-5. Nathaniel B. Shurtleff, ed. (Boston: The Press of William White, Printer to the Commonwealth, 1853-54), 3:92 (hereafter cited as *Mass. Records*.)
[11] Hartley, *Ironworks on the Saugus*, 53; *Mass. Records,* 1:327.
[12] "Petition of John Winthrop, Jr. to the Massachusetts General Court," *Winthrop Papers*, IV:423; Johnson, *Wonder-Working Providence*, p. 207.
[14] *Mass. Records,* 2:127.
[15] *Winthrop Papers*, V:21.
[16] *Winthrop Papers*, V:6-7.
[17] *Records of Essex Courts,* II:87-88.
[18] *Records of Essex Courts,* II:87, 96.
[19] Lynn Iron Works Collection, 197.
[20] Hartley, *Ironworks on the Saugus*, 187.;
[21] Ironworks Monopoly Agreement: "Whereas they desire ye Corte would not restraine ym from selling iron, or iron worke, eithr to Indians or enemies, any furthr then we restraine orselves by law, wch the Corte granteth," *Mass. Records,* 2:186. The Burr's Hill site yielded many objects strikingly similar to Saugus Iron Works' iron and brass collections. Susan G. Gibson, ed., *Burr's Hill, A 17th-Century Wampanoag Burial Ground in Warren, Rhode Island* (Providence: Eastern Press, Inc., 1980), 79-117.
[22] *Records of Essex Courts*, I:130, 173, 138, 136.
[23] *Winthrop Papers,* V:209.
[24] *Mass. Records,* 3:243.
[25] *Winthrop Papers,* V:248.

[26] Hartley, *Ironworks on the Saugus,* 135; *Mass. Records,* 3:227, 257.
[27] Hartley, *Ironworks on the Saugus,* 141.
[28] Stephen Carlson, "The Scots at Hammersmith" (Fort Washington, PA: Eastern National Park & Monument Association, 1976), 3-6.
[29] *Records of Essex Courts*, II:96-97.
[30] *Records of Essex Courts*, II:96.
[31] *Records of Essex Courts*, II:97.
[32] *Records of Essex Courts*, I:136.
[33] Lynn Iron Works Collection, 34.
[34] Hartley, *Ironworks on the Saugus*, 174.
[35] Sermon of Minister Samuel Treat, 1648-1717, in Henry David Thoreau, *Thoreau Reader, Cape Cod,* www.eserver.org/capecdaa.html (accessed February 8, 2005).
[36] *First Iron Works Gazette,* Vol. 3, No. 3 (July 1953), 8, First Iron Works Association Papers.
[37] General iron types include white iron, which is hard and brittle; grey iron, which is softer and less brittle than white iron; and mottled iron, which is an intermediate state showing both white and grey characteristics. See Schubert, *History of the British Iron and Steel Industry*, 238.
[38] Hartley, *Ironworks on the Saugus*, 175; *Winthrop Papers*, V:246.
[39] Lynn Iron Works Collection, 117.
[40] Hartley, *Ironworks on the Saugus*, 188
[41] Lynn Iron Works Collection, 8, 35, 65, 74, 159, 184, 186, 194, 195, 211, 213, 250; *Records of Essex Courts,* II:94; *Mass. Records,* 3:59
[42] Lynn Iron Works Collection, 35, 184.
[43] Lynn Iron Works Collection, 35, 40, 41, 52, 60, 69, 70, 72, 74, 75, 92, 130, 184.
[44] Lynn Iron Works Collection, 210.
[45] Lynn Iron Works Collection, 210.
[46] Hartley, *Ironworks on the Saugus*, 163.
[47] Hartley, *Ironworks on the Saugus*, 75-76, 197.
[48] Adam Hawkes, a neighbor, repeatedly sued the ironworks for flooding his land. *Records of Essex Courts,* II:210, 211.
[49] *Records of Essex Courts,* II:211.
[50] Lynn Iron Works Collection, 151.
[51] Lynn Iron Works Collection, 116.
[52] The Humble Petition of Joseph Jenkes, May 10, 1646, Massachusetts Archives, microfilm, manuscript, vol. 59, Manufactures 1639-1773, vol. 59, 26. This petition was meant to protect Jenks' "knowledge in Making and erecting of Engines of Mills to goe by water for speedy dispatch of much work with few mens labour in little time."

[53] "Statement of Henry Hoppie and Peter English, undated but ascribed to 1671," in F.H. Blackburne Daniel, ed., *Calendar of State Papers, Domestic Series, December 1671 to May 17th 1672* (London: Public Records Office, 1897), 54-55.

[54] "Petition of Joseph Jinks Sword blade maker for a plot of Ground./ Granted." Ms. R.I.1(e), Archives of the Duke of Northumberland, Alnick Castle, Alnwick, Northumberland, England.

[55] Lynn Iron Works Collection, 90, 91, 140.

[56] *Records of Essex Courts*, III:336.

[57] *Essex County Registry of Deeds* (Salem, MA, Salem Court House), Book 1: 32, 33; *Records of Essex Courts,* I:293.

[58] Hartley, *Ironworks on the Saugus*, 209, 303.

[59] Lynn Iron Works Collection, 158.

[60] *Records of Essex Courts*, V:224.

[61] Lynn Iron Works Collection, 119.

[62] Lynn Iron Works Collection, 122.

[63] Hartley, *Ironworks on the Saugus*, 163.

[64] Lynn Iron Works Collection, 5, 6, 22-24, 38, 48-50, 61, 159, 270, 271.

[65] Lynn Iron Works Collection, 94, 191, 197, 204, 213.

[66] Hartley, *Ironworks on the Saugus*, 216.

[67] Lynn Iron Works Collection, 176.

[68] Lynn Iron Works Collection, 177.

[69] Lynn Iron Works Collection, 253.

[70] Lynn Iron Works Collection, 179.

[71] Stephen P. Carlson, ed., *Records of the Company of Undertakers of the Iron Works in New England* (Saugus: Saugus Iron Works NHS Archive, 1973), 304; "Petition of John Gifford to General Court," Massachusetts Archives, 59:M-Ar.

[72] *Records of Essex Courts*, II:79.

[73] Hartley, *Ironworks on the Saugus*, 242, 243.

[74] Hartley, *Ironworks on the Saugus*, 257.

[75] *Winthrop Papers*, IV:423.

[76] Innes, *Creating the Commonwealth,* 269, 270.

[77] Innes, *Creating the Commonwealth,* 269.

[78] Hartley, *Ironworks on the Saugus*, 61.

CHAPTER 3 Notes

[1] During later excavations along Central Street, Robbins located a "First Iron Works" historical marker placed by the Lynn Historical Society in 1898. Roland W. Robbins, Saugus Ironworks Daily Log - 1951, June 6, 1951, Roland Wells Robbins Collection, The Thoreau Society, The Thoreau Institute at Walden Woods, Lincoln, MA.
[2] Edwin Whitfield, *Homes of Our Forefathers: Being a Collection of the Oldest and Most Interesting Buildings in Massachusetts* (Boston: A. Williams, 1879).
[3] Stephen P. Carlson, "The Saugus Iron Works Restoration: A Tentative History" (Saugus: Saugus Iron Works NHS, 1978), 1.
[4] Carlson, "The Saugus Iron Works Restoration," 1-2. Thomas A. Denenberg's *Wallace* Nutting and the Invention of Old America (New Haven, Yale University Press, 2003) provides a compelling and nuanced treatment of Nutting and his larger project.
[5] Denenberg, Wallace Nutting and the Invention of Old America, 95.
[6] Edie Clark, "The Man Who Looked Back and Saw the Future," *Yankee* 50, no. 9 (1986): 174-75.
[7] Denenberg, *Wallace Nutting and the Invention of Old America*, 97-98.
[8] Carlson, "The Saugus Iron Works Restoration," 3.
[9] Carlson, "The Saugus Iron Works Restoration," 3.
[10] Carlson, "The Saugus Iron Works Restoration," 3.
[11] Carlson, "The Saugus Iron Works Restoration," 3-4.
[12] Fundraising letter, ca. 1942-1943, First Iron Works Association, Roland Wells Robbins Collection.
[13] Carlson, "The Saugus Iron Works Restoration," 5-6. Fundraising letter, ca. 1942-1943, First Iron Works Association.
[14] Louise du Pont Crowninshield, the daughter of Henry F. du Pont, was raised at Winterthur. As an adult she lived at Eleutherian Mills, the original du Pont family home, a site that Robbins investigated briefly in the 1950s. Mrs. Crowninshield is considered one of the nation's leading historic preservation activists in the first half of the twentieth century. See Kim Burdick, "Louise's Legacy: How a du Pont Invented Historic Preservation," *Delaware Today* June 2000, 28, and "Louise's Legacy: The Story of Louise du Pont Crowninshield," lecture presented at the "Pioneers in Public History" conference, Saugus Iron Works National Historic Site, Saugus, MA, October 2004.
[15] Carlson, "The Saugus Iron Works Restoration," 6.
[16] Quincy Bent was a vice president with Bethlehem Steel; Charles R. Harte was a professional engineer who documented many industrial and iron-making sites, primarily in Connecticut, during the first half of the twentieth century; Edward L. Bartholomew, Jr., was an assistant

professor of metallurgy at MIT; Walter Renton Ingalls was an engineer; and John Woodman Higgins was the founder of the Higgins Armory Museum in Worcester, MA. Curtis McKay White, personal communication, 2000.
[17] Carlson, "The Saugus Iron Works Restoration," 9. The complete story of Robbins' work at Thoreau's cabin site is told in Donald W. Linebaugh's ***The Man Who Found Thoreau: Roland W. Robbins and the Rise of Historical Archaeology in America*** (Hanover: University Press of New England, 2005).
[18] Vincent P. Foley, "On the Meaning of Industrial Archaeology," ***Historical Archaeology*** 2(1968): 66-68.
[19] David G. Orr, "Philadelphia as Industrial Archaeological Artifact: A Case Study," ***Historical Archaeology*** 11(1977): 3-14.
[20] David G. Orr, "Philadelphia as Industrial Archaeological Artifact," 3-14.
[21] Vincent Foley, "Reply to Vogel," ***Historical Archaeology*** 3 (1969): 94.
[22] Thomas Blanding, personal communication, 1993.
[23] Paul Heberling, personal communication, 1992.
[24] Evan Jones, personal communication, 1992.
[25] Roland W. Robbins, Report on Research and Excavations: Executed from September 10, 1948 to October 16, 1948, Roland Wells Robbins Collection.
[26] Roland W. Robbins, Report of Archaeological Progress at the Old Iron Works Site, Saugus, Massachusetts, from September 10, 1948 to June 25, 1949, Roland Wells Robbins Collection.
[27] Robbins, Report on Research, 2.
[28] Carlson, "The Saugus Iron Works Restoration," 9.
[29] Robbins, Report of Archaeological Progress, 1.
[30] Robbins, Report on Research, 4.
[31] Robbins, Saugus Ironworks Daily Log - 1948, December 5, 1948.
[32] Robbins, Saugus Ironworks Daily Log - 1948, December 5, 1948.
[33] Robbins, Report on Research, 5.
[34] Charles Rufus Harte, Condition of the Excavation at the Saugus Iron Works Furnace, Saugus, Massachusetts, as of October 18, 1948, Roland Wells Robbins Collection.
[35] Carlson, "The Saugus Iron Works Restoration," 9.
[36] Roland W. Robbins, Saugus Ironworks Daily Log - 1949, May 15, 1949.
[37] Robbins, Saugus Ironworks Daily Log - 1949, May 26, 1949.
[38] Robbins, Saugus Ironworks Daily Log - 1949, May 17, 1949.
[39] Robbins, Saugus Ironworks Daily Log - 1949, May 24, 1949.
[40] Robbins, Saugus Ironworks Daily Log - 1949, June 15, 1949.
[41] Robbins, Saugus Ironworks Daily Log - 1949, June 15, 1949.
[42] Robbins, Saugus Ironworks Daily Log - 1949, July 6, 1949.

[43] Robbins, Saugus Ironworks Daily Log - 1949, July 8, 1949.
[44] Brown, "An Evaluation of Roland Wells Robbins Archaeology," 17.
[45] Robbins, Saugus Ironworks Daily Log - 1950, January 9, 1950.
[46] Robbins, Saugus Ironworks Daily Log - 1950, October 26, 1950.
[47] Robbins, Saugus Ironworks Daily Log - 1950, September 20, 1950.
[48] Robbins, Saugus Ironworks Daily Log - 1950, August 15, 1950.
[49] Robbins, Saugus Ironworks Daily Log - 1950, December 13, 1950.
[50] Mary C. Beaudry, "Archaeology and the Documentary Record," n.p.
[51] Robbins, Report of 1949 Archaeological Progress, 1.
[52] Robbins, Report of 1949 Archaeological Progress, 1.
[53] Robbins, Report of 1949 Archaeological Progress, 2-3.
[54] Robbins, Report of 1949 Archaeological Progress, 3.
[55] Robbins, Report of 1949 Archaeological Progress, 3.
[56] Robbins, Saugus Ironworks Daily Log - 1950, January 11, 1950.
[57] Robbins, Saugus Ironworks Daily Log - 1950, January 6, 1950.
[58] Robbins, Saugus Ironworks Daily Log - 1950, January 23-24, 1950.
[59] Robbins, Saugus Ironworks Daily Log - 1950, January 27, 1950. A sow is an ingot or mass of iron solidified in a sand mold.
[60] Robbins, Saugus Ironworks Daily Log - 1950, February 8, 1950.
[61] Robbins, Saugus Ironworks Daily Log - 1950, January 3, 1950.
[62] Robbins, Saugus Ironworks Daily Log - 1950, January 18, 1950.
[63] Robbins, Saugus Ironworks Daily Log - 1950, January 20 and February 23-24, 1950.
[64] Robbins, Saugus Ironworks Daily Log - 1950, February 3 and 6, 1950.
[65] Robbins, Saugus Ironworks Daily Log - 1950, April 7, 1950. For additional information on Robbins' later excavations at West Quincy, see Donald W. Linebaugh, "Forging a Career."
[66] Robbins, Saugus Ironworks Daily Log - 1950, April 7, 1950.
[67] Robbins, Saugus Ironworks Daily Log - 1950, April 27-28, 1950. Robbins had previously determined that the furnace waterwheel was buried beneath the street.
[68] Robbins, Saugus Ironworks Daily Log - 1950, June 27, 1950.
[69] Robbins, Saugus Ironworks Daily Log - 1950, July 28, 1950.
[70] Robbins, Saugus Ironworks Daily Log - 1950, July 28, 1950.
[71] Robbins, Saugus Ironworks Daily Log - 1950, August 2, 1950.
[72] Robbins, Saugus Ironworks Daily Log - 1950, August 2, 1950.
[73] Robbins, Saugus Ironworks Daily Log - 1950, August 2, 1950.
[74] Robbins, Saugus Ironworks Daily Log - 1950, August 9, 1950.
[75] Robbins, Saugus Ironworks Daily Log - 1950, August 11, 1950.
[76] Robbins, Saugus Ironworks Daily Log - 1950, August 11, 1950.

[77] Robbins, Saugus Ironworks Daily Log - 1950, August 21, 1950.
[78] Robbins, Saugus Ironworks Daily Log - 1950, August 21, 1950. Robbins would often move the heavy equipment into a new area to remove the fill, while his laborers worked on completing the hand excavation in another area. With several pieces of equipment and a good-sized crew, Robbins maintained excavations in several different areas at any moment.
[79] Robbins, Saugus Ironworks Daily Log - 1950, August 25, 1950.
[80] Robbins, Saugus Ironworks Daily Log - 1950, August 25, 1950.
[81] Robbins, Saugus Ironworks Daily Log - 1950, September 2, 1950.
[82] Robbins, Saugus Ironworks Daily Log - 1950, September 5, 1950.
[83] Robbins, Saugus Ironworks Daily Log - 1950, September 9 and 11, 1950.
[84] Robbins, Saugus Ironworks Daily Log - 1950, September 20, 1950.
[85] Robbins, Saugus Ironworks Daily Log - 1950, September 25, 1950.
[86] Robbins, Saugus Ironworks Daily Log - 1950, October 4, 1950.
[87] Robbins, Saugus Ironworks Daily Log - 1950, October 6, 1950.
[88] Robbins, Saugus Ironworks Daily Log - 1950, October 12, 1950.
[89] Robbins, Saugus Ironworks Daily Log - 1950, October 12, 1950.
[90] Robbins, Saugus Ironworks Daily Log - 1950, October 12, 1950.
[91] Robbins, Saugus Ironworks Daily Log - 1950, October 19 and 24, 1950.
[92] Robbins, Saugus Ironworks Daily Log - 1950, October 31, 1950.
[93] Robbins, Saugus Ironworks Daily Log - 1950, November 3 and 6, 1950.
[94] Robbins, Saugus Ironworks Daily Log - 1950, December 1, 1950.
[95] Robbins, Saugus Ironworks Daily Log - 1950, December 1-11, 1950.
[96] Robbins, Saugus Ironworks Daily Log - 1950, December 14-15, 1950.
[97] Robbins, Saugus Ironworks Daily Log - 1951, January 10 and 13, 1951.
[98] Robbins, Saugus Ironworks Daily Log - 1951, February 19, 1951.
[99] Robbins, Saugus Ironworks Daily Log - 1951, February 23, 1951.
[100] Roland W. Robbins, Annual Archaeological Report - 1951, Roland Wells Robbins Collection.
[101] Robbins, Saugus Ironworks Daily Log - 1951, March 14, 1951.
[102] Robbins, Saugus Ironworks Daily Log - 1951, March 22, 1951.
[103] Robbins, Saugus Ironworks Daily Log - 1951, April 20, 1951.
[104] Robbins, Saugus Ironworks Daily Log - 1951, April 24 and May 7, 1951.
[105] Robbins, Saugus Ironworks Daily Log - 1951, May 1, 1951.
[106] Robbins, Saugus Ironworks Daily Log – 1951, May 4, 18, and 24, 1951.
[107] Robbins, Saugus Ironworks Daily Log - 1951, May 24, 1951.
[108] Robbins, Saugus Ironworks Daily Log - 1951, May 29, 1951.
[109] Robbins, Saugus Ironworks Daily Log - 1951, June 19-20, 1951.

[110] Robbins, Saugus Ironworks Daily Log - 1951, July 13-17, 1951.
[111] Robbins, Saugus Ironworks Daily Log - 1951, July 13 – August 17, 1951.
[112] Robbins, Saugus Ironworks Daily Log - 1951, August 15, 1951.
[113] Robbins, Saugus Ironworks Daily Log - 1951, August 25, 1951.
[114] Robbins, Saugus Ironworks Daily Log - 1951, October 6, 1951.
[115] Robbins, Saugus Ironworks Daily Log - 1951, December 6, 1951.
[116] Robbins, Saugus Ironworks Daily Log - 1951, December 10-12, 1951.
[117] Robbins, Saugus Ironworks Daily Log - 1951, December 20, 1951.
[118] Robbins, Saugus Ironworks Daily Log - 1952, January 24, 1951.
[119] Robbins, Saugus Ironworks Daily Log - 1952, January 24, 1952.
[120] Robbins, Saugus Ironworks Daily Log - 1952, February 12, 1951.
[121] Robbins, Saugus Ironworks Daily Log - 1952, February 14, 1951.
[122] Robbins, Saugus Ironworks Daily Log - 1952, February 20, 29, and March 1, 1952.
[123] Robbins, Saugus Ironworks Daily Log - 1952, March 14, 1952.
[124] Robbins, Saugus Ironworks Daily Log - 1952, March 20, 1952.
[125] Robbins, Saugus Ironworks Daily Log - 1952, March 28, 1952.
[126] Robbins, Saugus Ironworks Daily Log - 1952, May 1, 1952.
[127] Robbins, Saugus Ironworks Daily Log - 1952, May 1, 1952.
[128] Robbins, Saugus Ironworks Daily Log - 1952, June 2-3, 1952.
[129] Robbins, Saugus Ironworks Daily Log - 1952, June 24-30, 1952.
[130] Robbins, Saugus Ironworks Daily Log - 1952, June 30, 1952.
[131] Robbins, Saugus Ironworks Daily Log - 1952, August 14, 1952.
[132] Robbins, Saugus Ironworks Daily Log - 1952, August 28, 1952.
[133] Robbins, Saugus Ironworks Daily Log - 1952, August 28, 1952.
[134] Robbins, Saugus Ironworks Daily Log - 1952, September 4 and 10, 1952.
[135] Robbins, Saugus Ironworks Daily Log - 1952, October 24, 1952.
[136] Robbins, Saugus Ironworks Daily Log - 1952, November 5, 1952.
[137] Roland W. Robbins, Archaeological Discoveries for 1952, Roland Wells Robbins Collection.
[138] Robbins, Saugus Ironworks Daily Log - 1952, November 20, 1952.
[139] Robbins, Saugus Ironworks Daily Log - 1952, November 20 - December 29, 1952.
[140] Robbins, Saugus Ironworks Daily Log – 1953, March 16, 1953.
[141] Robbins, Saugus Ironworks Daily Log - 1953, March 24, 1953.
[142] Robbins, Saugus Ironworks Daily Log - 1953, April 9, 1953.
[143] Robbins, Saugus Ironworks Daily Log - 1953, May 4, 1953.
[144] Robbins, Saugus Ironworks Daily Log - 1953, April 9 – June 2, 1953.
[145] Robbins, Saugus Ironworks Daily Log - 1953, May 21 – June 10, 1953.
[146] Robbins, Saugus Ironworks Daily Log - 1953, May 29, 1953.

[147] Robbins, Saugus Ironworks Daily Log - 1953, July 2, 1953.
[148] Robbins, Saugus Ironworks Daily Log - 1953, July 24 – 31, 1953.
[149] Robbins, Saugus Ironworks Daily Log - 1953, July 31, 1953.
[150] Robbins, Saugus Ironworks Daily Log - 1953, September 17, 1954.
[151] Brown, "An Evaluation of Roland Wells Robbins Archaeology," 13; Carlson, "The Saugus Iron Works Restoration," 10.
[152] Robbins, Saugus Ironworks Daily Log - 1953, July 31, 1953.
[153] Robbins, Saugus Ironworks Daily Log - 1950, August 18, 1950. On many occasions, Robbins made short-term loans to crew members to cover what he perceived to be Attwill's negligence.
[154] Robbins, Saugus Ironworks Daily Log - 1953, April 24, 1953.
[155] Robbins, Saugus Ironworks Daily Log - 1951, August 9, 1951.
[156] Robbins, Saugus Ironworks Daily Log - 1951, November 5, 1951.
[157] Robbins, Saugus Ironworks Daily Log - 1951, November 5, 1951.
[158] Roland Wells Robbins to Charles R. Harte, ca. 1952, Roland Wells Robbins Collection.
[159] Quincy Bent quoted in Charles R. Harte to Roland W. Robbins, August 7, 1951, Roland Wells Robbins Collection.
[160] Robbins, Saugus Ironworks Daily Log - 1952, February 18, 1952. Conover Fitch was the project architect for Perry, Shaw, and Hepburn, Kehoe and Dean, and architect Harrison Schock worked for Fitch.
[161] Robbins, Saugus Ironworks Daily Log - 1952, February 26, 1952.
[162] Robbins, Saugus Ironworks Daily Log - 1953, July 22, 1953.
[163] Carlson, "The Saugus Iron Works Restoration," 11.
[164] J. C. Harrington, 1952, quoted in Linebaugh, *The Man Who Found Thoreau*, 86.
[165] Roland W. Robbins to Quincy Bent, August 19, 1951, Roland Wells Robbins Collection. It is unlikely that the academic Hartley would have allowed any such restriction on his academic freedom.
[166] Quincy Bent to Roland W. Robbins, August 20, 1951, Roland Wells Robbins Collection.
[167] Robbins, Saugus Ironworks Daily Log - 1950, August 2, 1950.
[168] Robbins, Saugus Ironworks Daily Log - 1950, August 2, 1950.
[169] Robbins, Saugus Ironworks Daily Log - 1950, August 3, 1950.
[170] Robbins, Saugus Ironworks Daily Log - 1950, August 4, 1950.
[171] Robbins, Saugus Ironworks Daily Log - 1950, September 13-14, 1950; Roland W. Robbins to Walter S. Tower, August 9, 1950; Walter S. Tower to Roland W. Robbins, September 1, 1950, Roland Wells Robbins Collection.
[172] Robbins, Saugus Ironworks Daily Log - 1950, September 14, 1950.
[173] Roland W. Robbins to Quincy Bent, October 22, 1953, Roland Wells Robbins Collection.

[174] Walter S. Tower to Roland W. Robbins, July 3, 1951, Roland Wells Robbins Collection.
[175] Robbins, Saugus Ironworks Daily Log - 1951, July 5, 1951; Tower to Robbins, July 3, 1951.
[176] Geraldine Robbins to Quincy Bent, October 29, 1953, Roland Wells Robbins Collection.
[177] Geraldine Robbins to Quincy Bent, October 29, 1953, 1.
[178] Roland W. Robbins to Quincy Bent, November 16, 1953, Roland Wells Robbins Collection.
[179] Robbins to Bent, November 16, 1953, 1.
[180] Roland W. Robbins to Reverend Charles Jarvis Harriman, November 20, 1952, Roland Wells Robbins Collection.
[181] Robbins, Saugus Ironworks Daily Log - 1952, November 21, 1952.
[182] Robbins, Saugus Ironworks Daily Log - 1952, December 29, 1952.
[183] Robbins, Saugus Ironworks Daily Log - 1953, January 2 and March 2, 1953.
[184] Robbins, Saugus Ironworks Daily Log - 1953, July 24-31, 1953.
[185] Roland W. Robbins to Teresa and Elso Barghoorn, October 27, 1953, Roland Wells Robbins Collection.
[186] Linebaugh, *The Man Who Found Thoreau*, 85-97.
[187] Brown, "An Evaluation of Roland Wells Robbins Archaeology."
[188] Beaudry, "Archaeology and the Documentary Record," n.p.
[189] Robbins, Saugus Ironworks Daily Log - 1950, August 11, 1950. Although not within Robbins' area of interest, he identified prehistoric features on several occasions and contacted members of the Massachusetts Archaeological Society about excavating several features that would be destroyed by the ironworks excavation (Robbins, Saugus Ironworks Daily Log - 1953, June 10, 1953).
[190] See Linebaugh, *The Man Who Found Thoreau*, 40, for an extended discussion of the probe rod testing.
[191] Brown, "An Evaluation of Roland Wells Robbins Archaeology," 3.
[192] Although this approach has now been embedded in a scientific or systematic framework, Robbins' methodology to identify features differs little from present practice.
[193] Robbins, Saugus Ironworks Daily Log - 1949, July 14, 1949; Saugus Ironworks Daily Log - 1950, March 6, 1950; Saugus Ironworks Daily Log - 1953, May 4, 1953.
[194] Beaudry, "Archaeology and the Documentary Record," n.p.
[195] Robbins, Saugus Ironworks Daily Log - 1950, May 16, 1950.
[196] Robbins, Saugus Ironworks Daily Log - 1951, February 17, 1951; Saugus Ironworks Daily Log - 1952, May 24, 1952; Saugus Ironworks Daily Log - 1953, May 6, 1953.
[197] Arthur C. Laura, "Research Notes on Metal Artifacts and Their Restoration," Roland Wells Robbins Collection.
[198] Robbins, Saugus Ironworks Daily Log - 1949, May 23, 1949.
[199] Robbins, Saugus Ironworks Daily Log - 1950, June 23, 1950.

[200] Brown, "An Evaluation of Roland Wells Robbins Archaeology," 15.
[201]Donald W. Linebaugh, "Exploring Interpretive Agendas: The Saugus Iron Works and the Cold War"; "Interpretive Agendas: From the Cold War to the Counterculture." Paper presented at an invited session of the American Association of Museums Annual Meeting, Indianapolis, Indiana, May 2005.

CHAPTER 4 Notes

[1] Linebaugh, "Forging a Career," 8-9.
[2] Linebaugh, "Forging a Career," 10.
[3] Linebaugh, "Forging a Career," 7.
[4] Roland W. Robbins and Evan Jones, *Hidden America* (New York, Alfred A Knopf, 1959), 42.
[5] Robbins, Saugus Ironworks Daily Log - 1948, September 14, 1948.
[6] Robbins, Saugus Ironworks Daily Log - 1949, August 26, 1949.
[7] Named for Sir Mortimer Wheeler and Dame Kathleen Kenyon, two prominent methodological archeologists of the twentieth century.
[8] Ivor Noel Hume, *Historical Archaeology* (New York, Norton, 1969, repr. 1976), 37-39.
[9] Robbins, Saugus Ironworks Daily Log - 1951, October 12, 1951.
[10] Robbins, Saugus Ironworks Daily Log - 1948, September 15, 1948.
[11] Linebaugh, "Forging a Career," 6.
[12] Robbins, "Report of the 1956 Archaeological Exploration at the Site of the 1644 John Winthrop, Jr., Blast Furnace Situated in Hall Cemetery, Crescent Street, West Quincy, Massachusetts." Reprinted in William Churchill Edwards, ed., *Historic Quincy* (Quincy, MA: City of Quincy, 1957), 256-274.
[13] Robbins, Saugus Ironworks Daily Log - 1949, May 31, 1949.
[14] Robbins actually kept a separate set of records that recorded where he lectured and how many people attended the lectures. See Chapter 11 for more information about Robbins' public outreach.
[15] Robbins, Saugus Ironworks Daily Log - 1952, April 29, 1952.
[16] Robbins actually did this at the later Quincy furnace excavations.
[17] Robbins, Saugus Ironworks Daily Log - 1951, August 3, 1951.

CHAPTER 5 Notes

[1] Robbins, Saugus Ironworks Daily Log - 1948, September 14, 1948.
[2] Cleere and Crossley, *The Iron Industry of the Weald,* 244.
[3] Robbins, Saugus Ironworks Daily Log - 1950, April 30, 1950.

[4] Hartley, *Ironworks on the Saugus* (2001 repr.), 51.
[5] Hartley, *Ironworks on the Saugus* (2001 repr.), 172, quoting Robert Plot, *The Natural History of Stafford shire* (Oxford, 1686), 162-63.
[6] Robbins, Saugus Ironworks Daily Log - 1949, April 10, 1949. Robbins also notes finding a subterranean drainage system below the Quincy furnace site, the earlier sister furnace to Saugus. See Robbins, Report of the 1956 Archaeological Exploration, 8-10.
[7] Robbins, Saugus Ironworks Daily Log - 1948, December 5, 1948.
[8] Cleere and Crossley, *The Iron Industry of the Weald*, 249.
[9] Robbins, Saugus Ironworks Daily Log - 1949, June 3, 1949.
[10] Hobart M. Kraner, "Ceramics in the Saugus Blast Furnace – 1650." Paper delivered at the American Ceramic Society Meeting, Chicago, Illinois, May 18, 1959. This paper was later published in the *American Ceramic Society Bulletin* 39, No. 7 (1960): 354-58.
[11] Sand, as well as clay, was another common filling medium found in other furnace sites. Peter Brown, "The Early Industrial Complex at Astley, Worcestershire," *Post-Medieval Archaeology* 16 (1982): 9-10.
[12] Robbins, Saugus Ironworks Daily Log - 1951, July 20, 1951.
[13] Cleere and Crossley, *The Iron Industry of the Weald*, 244.
[14] Cleere and Crossley, *The Iron Industry of the Weald*, 244.
[15] Cleere and Crossley, *The Iron Industry of the Weald*, 244.
[16] Cleere and Crossley, *The Iron Industry of the Weald*, 255.
[17] Schubert, *History of the British Iron and Steel Industry,* 198.
[18] Robbins, Saugus Ironworks Daily Log - 1948, October 13, 1948.
[19] Robbins, Saugus Ironworks Daily Log - 1948, December 5, 1948.
[20] Roland Robbins, Excavations & Artifacts – Record of 1948, Roland Wells Robbins Collection.
[21] Robbins, Excavations & Artifacts – Record of 1948.
[22] Charles Rufus Harte to Walter Renton Ingalls, November 24, 1948, Papers of Charles Rufus Harte, Saugus Iron Works NHS Collection.
[23] Robbins, Saugus Ironworks Daily Log - 1948, December 5, 1948.
[24] The funnel shaped tuyere helped to concentrate the air blast to quickly raise the heat inside the furnace. Two tuyeres were, in fact, recovered by Robbins during excavation, although the second one was discovered out of context in the Jenks area. (See Robbins, Saugus Ironworks Daily Log - 1952, April 10, 1952.) While tuyeres were found at Saugus, they were not necessarily universally used furnace components. (See Cleere and Crossley, *Iron Industry of the Weald*, 251.)
[25] Robbins, Saugus Ironworks Daily Log - 1948, October 16, 1948.
[26] Quincy Bent to Charles Rufus Harte, December 8, 1948, Papers of Charles Rufus Harte;

Walter Renton Ingalls to Charles Rufus Harte, November 29, 1948, Papers of Charles Rufus Harte.
[27] Robbins, Saugus Ironworks Daily Log - 1951, February 23, 1951.
[28] Robbins and Jones, *Hidden America*, 55.
[29] Robbins, Saugus Ironworks Daily Log - 1951, February 23, 1951.
[30] Robbins, Saugus Ironworks Daily Log - 1951, March 12, 1951.
[31] Robbins, Saugus Ironworks Daily Log - 1951, June 6, 1951.
[32] Robbins, Saugus Ironworks Daily Log - 1951, February 28, 1951.
[33] Robbins, Saugus Ironworks Daily Log - 1951, February 28, 1951.
[34] Robbins, Saugus Ironworks Daily Log - 1951, March 17, 1951.
[35] Brown, "The Early Industrial Complex at Astley, Worcestershire," p. 14.
[36] Robbins, Saugus Ironworks Daily Log - 1949, April 24, 1949.
[37] Robbins, Saugus Ironworks Daily Log - 1949, May 20, 1949.
[38] Robbins, Saugus Ironworks Daily Log - 1949, May 20, 1949.
[39] Robbins, Saugus Ironworks Daily Log - 1951, January 10, 1951.
[40] Robbins, Saugus Ironworks Daily Log - 1951, July 11, 1951.
[41] Stephen P. Carlson, *First Iron Works: A History of the First Iron Works Association* (Saugus, MA: Saugus Historical Society, Booklet No. 5, 1991), 20.
[42] Carlson, *First Iron Works*, 20.
[43] Robbins, Saugus Ironworks Daily Log - 1948, October 16, 1948.
[44] Robbins, Saugus Ironworks Daily Log - 1949, October 14, 1949. The stone collection off of the southeastern corner was circular in shape, composed of the same stone used in the blast furnace construction (granite), several feet in height, and contained many artifacts and artifact fragments when dismantled. When Robbins excavated it in October of 1949, he noted that stratigraphically it sat on top of a layer of sand that Robbins attributed to be a casting bed, indicating that it must have appeared after the furnace was operating. Robbins also established that the stone feature had been built after the southern wall of the furnace was built, since it peeled away neatly and was not integral to the foundation.
[45] Robbins, Saugus Ironworks Daily Log - 1949, October 25, 1949.
[46] Robbins, Saugus Ironworks Daily Log - 1949, October 14, 1949.
[47] Robbins, Saugus Ironworks Daily Log - 1949, November 9, 1949.
[48] Robbins, Saugus Ironworks Daily Log - 19, May 24, 1950.
[49] Robbins, Saugus Ironworks Daily Log - 1949, November 21, 1949.
[50] Cleere and Crossley, *The Iron Industry of the Weald*, 253.
[51] Robbins describes removing some of the slag pile for a transportation route. (See Robbins, Saugus Ironworks Daily Log - 1952, February 14, 1952).
[52] Robbins, Saugus Ironworks Daily Log - 1951, August 10, 1951.

[53] E. Neal Hartley to Harrison Schock, 10 August 1951, First Iron Works Association Papers, Saugus Iron Works NHS.

CHAPTER 6 Notes

[1] Robbins, Saugus Ironworks Daily Log - 1949, July 19, 1949.
[2] Robbins, Saugus Ironworks Daily Log - 1949, October 26, 1949.
[3] Robbins, Saugus Ironworks Daily Log - 1950, April 30, 1950.
[4] Robbins, Saugus Ironworks Daily Log - 1950, August 3, 1950.
[5] Robbins, Saugus Ironworks Daily Log - 1950, August 11, 1950
[6] Robbins, Saugus Ironworks Daily Log - 1950, August 25, 1950
[7] Robbins, Saugus Ironworks Daily Log - 1950, August 25, 1950
[8] Robbins, Saugus Ironworks Daily Log - 1950, August 31, 1950
[9] Robbins, Saugus Ironworks Daily Log - 1950, September 2, 1950
[10] S. Epstein, K.F. Haupt, and H. D. Kraner, Examination of Small Metal Specimens Chipped From a 500# Hammer Unearthed Near the Saugus Blast Furnace Site, letter report dated December 6, 1950, First Iron Works Association Papers, Saugus Iron Works NHS.
[11] Robbins, Saugus Ironworks Daily Log - 1950, September 2, 1950
[12] Robbins, Saugus Ironworks Daily Log - 1950, December 2-15, 1950
[13] Robbins, Saugus Ironworks Daily Log - 1950, December 11, 1950
[14] Robbins, Saugus Ironworks Daily Log - 1950, December 12, 1950
[15] Robbins, Saugus Ironworks Daily Log - 1950, December 14, 1950
[16] Robbins, Saugus Ironworks Daily Log - 1950, December 18, 1950; Perry, Shaw, and Hepburn, Kehoe and Dean, Plan of Refinery Hammer & Anvil Sites, December 28, 1950. Drawing Number SK 300, First Iron Works Association Papers.
[17] Robbins, Saugus Ironworks Daily Log - 1950, December 18, 1950.
[18] Robbins, Saugus Ironworks Daily Log - 1951, April 30-May 3, 1951.
[19] Robbins, Saugus Ironworks Daily Log - 1951, May 4, 1951.
[20] Robbins, Saugus Ironworks Daily Log - 1951, May 5, 1951.
[21] Robbins, Saugus Ironworks Daily Log - 1951, July 13-19, 1951.
[22] Robbins, Saugus Ironworks Daily Log - 1951, December 8, 1951.
[23] Robbins, Saugus Ironworks Daily Log - 1951, December 14-15, 1951.
[24] Robbins, Saugus Ironworks Daily Log - 1951, December 27-28, 1951.
[25] Robbins, Saugus Ironworks Daily Log - 1952, January 2-4, 1952.
[26] Robbins, Saugus Ironworks Daily Log - 1952, January 10, 1952.
[27] Robbins, Saugus Ironworks Daily Log - 1952, February 12, 1952.
[28] Robbins, Saugus Ironworks Daily Log - 1952, March 1, 1952.

[29] Robbins, Saugus Ironworks Daily Log - 1952, March 28, 1952.
[30] Robbins, Saugus Ironworks Daily Log - 1952, April 21, 1952.
[31] Robbins, Saugus Ironworks Daily Log - 1952, June 4, 1952.
[32] Robbins, Saugus Ironworks Daily Log - 1952, June 6, 1952.
[33] Robbins, Saugus Ironworks Daily Log - 1952, June 11, 1952.
[34] Robbins, Saugus Ironworks Daily Log - 1952, June 20, 1952.
[35] Robbins, Saugus Ironworks Daily Log - 1952, June 21, 1952.
[36] Robbins, Saugus Ironworks Daily Log - 1952, July 3, 1952.
[37] Robbins, Saugus Ironworks Daily Log - 1952, July 7, 1952.
[38] Robbins, Saugus Ironworks Daily Log - 1952, July 29, 1952.
[39] Robbins, Saugus Ironworks Daily Log - 1952, July 29, 1952.
[40] Robbins, Saugus Ironworks Daily Log - 1952, July 30, 1952.
[41] Robbins, Saugus Ironworks Daily Log - 1952, July 30, 1952.
[42] Robbins, Saugus Ironworks Daily Log - 1952, August 6, 1952.
[43] Robbins, Saugus Ironworks Daily Log - 1952, August 4, 1952.
[44] Robbins, Saugus Ironworks Daily Log - 1952, August 4, 1952.
[45] Robbins, Saugus Ironworks Daily Log - 1952, August 9, 1952.
[46] Robbins, Saugus Ironworks Daily Log - 1952, August 14, 1952.
[47] Robbins, Saugus Ironworks Daily Log - 1952, August 28, 1952.
[48] Quincy Bent to Andrew H. Hepburn, August 15, 1952, First Iron Works Association Papers.
[49] [Minutes], Meeting at Saugus, August 28, 1952, 10:30 a.m., First Iron Works Association Papers.
[50] H. R. Schubert to E. Neal Hartley, September 15, 1952, First Iron Works Association Papers.
[51] A. H. Hepburn to H. R. Schubert, September 23, 1952, First Iron Works Association Papers.
[52] A. H. Hepburn to H. R. Schubert, September 23, 1952, First Iron Works Association Papers.
[53] A. H. Hepburn to H. R. Schubert, September 23, 1952, First Iron Works Association Papers.
[54] A. H. Hepburn to H. R. Schubert, September 23, 1952, First Iron Works Association Papers.
[55] H. R. Schubert to E. Neal Hartley, October 1952, First Iron Works Association Papers.
[56] Robbins, Saugus Ironworks Daily Log - 1952, September 5, 1952.
[57] Robbins, Saugus Ironworks Daily Log - 1952, September 11, 1952.
[58] Robbins, Saugus Ironworks Daily Log - 1952, September 16, 1952.
[59] Robbins, Saugus Ironworks Daily Log - 1952, October 24, 1952, November 17, 1952.
[60] Robbins, Saugus Ironworks Daily Log - 1952, December 10, 1952.
[61] Robbins, Saugus Ironworks Daily Log - 1952, December 10, 1952.
[62] Robbins, Saugus Ironworks Daily Log - 1952, December 12, 1952.
[63] Robbins, Saugus Ironworks Daily Log - 1952, December 12, 1952.
[64] Robbins, Saugus Ironworks Daily Log - 1952, December 12, 1952.

[65] Robbins, Saugus Ironworks Daily Log - 1952, December 15, 1952.
[66] Robbins, Saugus Ironworks Daily Log - 1952, December 27, 1952.
[67] Perry, Shaw, and Hepburn, Kehoe and Dean. Existing Forge Evidence, August 13, 1952, Drawing Number SK 322, First Iron Works Association Papers; Steve Whittlesey, Field Notes - Forge, September 23, 1952, First Iron Works Association Papers.
[68] Perry et al., Existing Forge Evidence.
[69] Robbins, Saugus Ironworks Daily Log - 1953, April 8, 1953. Robbins noted that this meant the tree started growing about 1311, and suggested that they have it studied by "some reputable school of forestry," as it "probably would reveal pertinent data relative to local weather conditions during the past six or more centuries."
[70] Robbins, Saugus Ironworks Daily Log - 1953, April 27, 1953; John H. Lambert to Roland W. Robbins, May 11, 1953, Roland Wells Robbins Collection.
[71] Perry, Shaw, and Hepburn, Kehoe and Dean, "Plan of Refinery Hammer & Anvil Sites," December 28, 1950, Drawing Number SK 300, Saugus Iron Works NHS.
[72] Trip hammer post features, traced from S.W. Work Sheet, September 16, 1952, First Iron Works Association Papers.
[73] Perry et al., Existing Forge Evidence.
[74] Perry et al., Existing Forge Evidence.
[75] Robbins, Saugus Ironworks Daily Log - 1952, July 30, 1952.
[76] Robbins, Saugus Ironworks Daily Log - 1952, August 28, 1952.
[77] Perry et al., Existing Forge Evidence.
[78] Perry et al., Existing Forge Evidence.
[79] Robbins, Saugus Ironworks Daily Log - 1952, October 28, 1952.
[80] Robbins, Saugus Ironworks Daily Log - 1952, November 5, 1952.
[81] Robbins, Saugus Ironworks Daily Log - 1952, December 1, 1952.
[82] Robbins, Saugus Ironworks Daily Log - 1952, December 10, 1952. These wells were located south of the area subsequently identified as the slitting mill.
[83] Robbins, Saugus Ironworks Daily Log - 1952, December 15, 1952.
[84] Robbins, Saugus Ironworks Daily Log - 1952, December 22, 1952.
[85] Robbins, Saugus Ironworks Daily Log - 1952, December 27, 1952.
[86] Robbins, Saugus Ironworks Daily Log - 1953, January 10, 1953.
[87] Robbins, Saugus Ironworks Daily Log - 1953, January 10, 1953.
[88] Robbins, Saugus Ironworks Daily Log - 1953, January 10, 1953.
[89] H. R. Schubert to E. Neal Hartley, February 11, 1953, First Iron Works Association Papers.
[90] Robbins, Saugus Ironworks Daily Log - 1953, March 16, 1953.
[91] Robbins, Saugus Ironworks Daily Log - 1953, March 18, 1953.
[92] Robbins, Saugus Ironworks Daily Log - 1953, April 9, 1953.

[93] Robbins, Saugus Ironworks Daily Log - 1953, May 4, 1953.
[94] Robbins, Saugus Ironworks Daily Log - 1953, May 4, 1953.
[95] Robbins, Saugus Ironworks Daily Log - 1953, May 4, 1953.
[96] Robbins, Saugus Ironworks Daily Log - 1953, July 4, 1953.
[97] Robbins, Saugus Ironworks Daily Log - 1953, July 4, 1953.
[98] Robbins, Saugus Ironworks Daily Log - 1953, May 4, 1953.
[99] Robbins, Saugus Ironworks Daily Log - 1953, May 4, 1953; May 11, 1953.
[100] Robbins, Saugus Ironworks Daily Log - 1953, May 26, 1953.
[101] Robbins, Saugus Ironworks Daily Log - 1953, May 26, 1953.
[102] Robbins, Saugus Ironworks Daily Log - 1953, May 26, 1953.
[103] Robbins, Saugus Ironworks Daily Log - 1953, June 10, 1953. These features were to be examined by Douglas Byers and several associates with the Massachusetts Archaeological Society.
[104] Curtis White, personal communication, January 20, 2009.
[105] Perry, Shaw, and Hepburn, Kehoe and Dean, Rough Sketch Showing Relation of the Slitting Mill Evidence to Forge Building, March 10, 1953, Drawing Number SK 414, First Iron Works Association Papers.
[106] Robbins, Saugus Ironworks Daily Log - 1953, July 4, 1953.
[107] Robbins, Saugus Ironworks Daily Log - 1953, July 4, 1953.
[108] Robbins, Saugus Ironworks Daily Log - 1953, May 26, 1953.
[109] Robbins, Saugus Ironworks Daily Log - 1953, May 26, 1953.
[110] Cyril Stanley Smith, "Iron from the Slitting Mill at Saugus," *Publications in the Humanities*, Number 75 (1966): 5.
[111] Smith, "Iron from the Slitting Mill at Saugus," 5 and Fig. 4. However, Smith contradicts this in the text on page 5 where he notes that "it is impossible to say from what location it came . . . ."
[112] Smith, "Iron from the Slitting Mill at Saugus," 10-11.
[113] Smith, "Iron from the Slitting Mill at Saugus," 10-11.
[114] Smith, "Iron from the Slitting Mill at Saugus," 4.
[115] Curtis White, personal communication, January 20, 2009. Curtis identified the spacer, which had previously been identified as an escutcheon plate.

CHAPTER 7 Notes

[1] Robbins' draft to National Park Service, May 11, 1977, Roland Wells Robbins Collection.
[2] Albert E. Jenks to Mr. Ernst, Dec 30, 1952, Joseph Jenks file, York Historical File, York, Maine.

[3] Colket, Merideth B.; *The Jenks Family of England,* (Salem, Massachusetts: Higginson Book Company, reprint 1956), 5.
[4] "Statement of Henry Hoppie and Peter English" in *Calendar of State Papers, Domestic Series, December 1671 to May 17th 1672*. Thanks to Hounslow Librarian Mr. John Tofts White for providing this information, 1990.
[5] Colket, *The Jenks Family of England,* 7, 11.
[6] Colket, *The Jenks Family of England,* 8.
[7] Colket, *The Jenks Family of England*, 4.
[8] Glover, Moses, Istelworth Hundred map, 1635, original painting at Syon House, Brentford, Middlesex, England, repr. by Pitkin Unichrome Ltd., Andover, Hampshire, England.
[9] Isleworth, description and history from 1868 gazetteer, www.dspace.dial.pipex.com/town/walk/goa57/old/hist/ (accessed December 29, 2006).
[10] Petition of Joseph Jinks Sword blade maker for a plot of Ground, Archives of the Duke of Northumberland.
[11] Richard Candee, "Merchant and Millwright, the Water Powered Mills of the Piscataqua," *Old Time New England,* vol. 60, Number 220 (Spring 1970): 138.
[12] Candee, "Merchant and Millwright," 139.
[13] Petition submitted by Joseph Jenks to the General Court of Massachusetts, May 10, 1646.
[14] John Becx to John Gifford, April 26, 1652, Lynn Iron Works Collection.
[15] Essex County Registry of Deeds, http:/www.salemdeeds.com/historic/00001/0064.tif (accessed 4:52 P.M., July 1, 2010.)
[16] Essex County Registry of Deeds, Book 1: 80.
[17] Records & Files of the Quarterly Courts of Essex County, Massachusetts (Salem, MA: Essex Institute, 1911), vol. 1:293.
[18]"Petition submitted by Joseph Jenks to the General Court of Massachusetts."
[19] Emmanuel Downing to John Winthrop, Jr., December 27, 1650/51, *Winthrop Papers*, VI:97.
[20] Lynn Iron Works Collection, 90, 140.
[21] Joseph Moxon, *Mechanick Exercises,* 1703, repr. 97 (New York: Praeger Publishers, 1970), 97.
[22]Emmanuel Downing to John Winthrop, Jr., December 14, 1652/53, *Winthrop Papers*, VI:247.
[23] Essex County Registry of Deeds, Book 1: 33.
[24] Essex County Registry of Deeds, Book 1: 36.
[25] *Essex Probate Court Records* (Salem, MA, Essex Institute, 1960), vol. II:45, 46, 216, 217.
[26] "Petition of Joseph Jenks Senior to the Massachusetts General Court seeking financial assistance to build a room and procure a stock of coals and iron for the purposes of drawing wire, October 15, 1667," Massachusetts Archives, vol. 59:88.
[27] Smith, Gnudi, *The Pirotechnia of Vannoccio Biringuccio* (Venice, 1540, 1943, repr. by Dover Publications, 1990), 378.

[28]"Petition of Joseph Jenks Senior to the Massachusetts General Court seeking financial assistance to build a room and procure a stock of coals and iron for the purposes of drawing wire."
[29] Hartley, *Ironworks on the Saugus*, 262-263.
[30] Testimony of Joseph Jenks, Sr., and John Jenks; dated the 27th of the 4th month, 1678, seventeenth-century copy at Saugus Iron Works NHS.
[31] Hartley, *Ironworks on the Saugus*, 264-265.
[32] *Lynn Vital Records,* vols. 1-2 (Salem, MA: Essex Institute, 1905), 2:513.
[33] Hartley, *Ironworks on the Saugus*, 278, 303.
[34] *Lynn Vital Records,* 2:512
[35] Pollack Gray interview with Edward L. Guy, June 1974, audio tape at Saugus Iron Works NHS.
[36] Robbins, Saugus Ironworks Daily Log - 1948, September 10, 1948.
[37] Albert Ernest Jenks to M. Louise Hawkes, March 11, 1949, Albert Ernest Jenks Correspondence, 1941-1953, First Iron Works Association Papers.
[38] Robbins, Saugus Ironworks Daily Log - 1952, February 10-14, 1952.
[39] Robbins, Saugus Ironworks Daily Log - 1952, February 20, 21, 1952.
[40] Robbins, Saugus Ironworks Daily Log - 1952, February 29, 1952.
[41] Robbins, Saugus Ironworks Daily Log - 1952, March 1, 1952.
[42] Robbins, Saugus Ironworks Daily Log - 1952, March 1, 1952.
[43] Robbins, Saugus Ironworks Daily Log - 1952, March 3-6, 1952.
[44] Robbins, Saugus Ironworks Daily Log - 1952, March 18, 1952.
[45] Goussier; *Recueil de Plances, sur les Sciences, les Arts Libéraux, et les Arts Méchaniques, avec Leur Explication* (Paris: Au Cercle du Livre Preciex, 1964-1966), vol. II, plate III.
[46] Robbins, Saugus Ironworks Daily Log - 1952, March 14, 1952.
[47] Robbins, Saugus Ironworks Daily Log - 1952, April 11, 1952.
[48] Robbins, Saugus Ironworks Daily Log - 1952, April 10, 1952.
[49] Robbins, Saugus Ironworks Daily Log - 1952, April 11, 1952.
[50] Robbins Note Card number 1004/1005, April 12, 1952, First Iron Works Association Papers.
[51] de Caus, Isaak, *New and Rare Inventions of Water-Works* (London, 1659), 111.
[52] Qunicy Bent to J. Sanger Atwill, April 18, 1952, First Iron Works Association Papers.
[53] Robbins, Saugus Ironworks Daily Log - 1952, April 30, 1952.
[54] E. Neal Hartley to Roland W. Robbins, May 14, 1952, The Roland Wells Robbins Collection.
[55] Hartley to Robbins, May 14, 1952.
[56] Hartley to Robbins, May 14, 1952.

CHAPTER 8 Notes

[1] Norman Smith, *A History of Dams* (Secaucus, NJ: The Citadel Press, 1972), 2.
[2] Smith, *A History of Dams*, 164-65.
[3] Smith, *A History of Dams*, 166.
[4] Lebeler defines "hammerpond" to mean a pond of artificial origin, which has served a forge, a furnace, or both . . . ." Fred Lebeler to Roland W. Robbins, April 5, 1949, Papers of Charles Rufus Harte.
[5] Lebeler to Robbins, April 5, 1949.
[6] Otto Franzius, *Waterway Engineering, A Text and Handbook Treating of the Design, Construction, and Maintenance of Navigable Waterways,* trans. by Lorenz G. Straub (Cambridge: Massachusetts Institute of Technology, The Technology Press, 1936), 23.
[7] *Records of Essex Courts*, II:21-211.
[8] Cleere and Crossley, *The Iron Industry of the Weald*, 225.
[9] Cleere and Crossley, *The Iron Industry of the Weald*, 225.
[10] Cleere and Crossley, *The Iron Industry of the Weald*, 229.
[11] Walter Renton Ingalls to Charles Rufus Harte, June 26, 1949, Papers of Charles Rufus Harte.
[12] Lebeler to Robbins, April 5, 1949.
[13] Ingalls to Harte, June 27, 1950, Papers of Charles Rufus Harte.
[14] "A statement of indebtednesses," copied from the Salem Records & Files, 1653:290 and 291, in Papers of Charles Rufus Harte.
[15] Catherine Teresa Tobin, *The Lowly Muscular Digger: Irish Canal Workers in Nineteenth Century America*, Ph.D. diss., Dept. of History, University of Notre Dame, 1987, 108.
[16] Cleere and Crossley, *The Iron Industry of the Weald*, 237.
[17] Robbins, Saugus Ironworks Daily Log – 1949, July 7, 1949.
[18] Robbins, Saugus Ironworks Daily Log – 1949, July 8, 1949.
[19] Robbins, Saugus Ironworks Daily Log – 1949, July 8, 1949.
[20] Robbins, Saugus Ironworks Daily Log – 1949, August 13, 1949.
[21] Robbins, Saugus Ironworks Daily Log – 1949, August 15, 1949.
[22] Robbins, Saugus Ironworks Daily Log – 1949, August 15, 1949.
[23] Robbins, Saugus Ironworks Daily Log – 1949, August 18 and 19, 1949.
[24] Robbins, Saugus Ironworks Daily Log – 1949, August 19, 1949.
[25] Robbins, Saugus Ironworks Daily Log – 1950, July 21, 1950.
[26] Robbins, Saugus Ironworks Daily Log – 1950, October 12, 1950.
[27] Robbins, Saugus Ironworks Daily Log – 1949, December 5, 1949.
[28] Robbins, Saugus Ironworks Daily Log – 1950, October 12, 1950.
[29] Darcie MacMahon, *Archeological Collections Management at the Saugus Iron Works*

National Historic Site, Massachusetts (Boston: Division of Cultural Resources, North Atlantic Regional Office, National Park Service, U.S. Department of the Interior, 1988), 81.
[30] Robbins, Saugus Ironworks Daily Log – 1950, January 27, 1950.
[31] Robbins, Saugus Ironworks Daily Log – 1950, February 7, 1950.
[32] Robbins, Saugus Ironworks Daily Log – 1950, April 5, 1950.
[33] Robbins, Saugus Ironworks Daily Log – 1950, April 5, 1950.
[34] Robbins, Saugus Ironworks Daily Log – 1950, October 20, 1950.
[35] Robbins, Saugus Ironworks Daily Log – 1950, October 20, 1950.
[36] Frederika A. Burrows, *Cannonballs & Cranberries* (Taunton, MA: W. S. Sullwold, c1976).
[37] Robbins, Saugus Ironworks Daily Log – 1951, May 24, 1951.
[38] Robbins, Saugus Ironworks Daily Log – 1951, May 24, 1951.
[39] Robbins, Saugus Ironworks Daily Log – 1951, May 24, 1951.
[40] Robbins, Saugus Ironworks Daily Log – 1951, May 18, 1951.
[41] Robbins, Saugus Ironworks Daily Log – 1951, January 17, 1951.
[42] Robbins, Saugus Ironworks Daily Log – 1952, July 14, 1952.
[43] Robbins, Saugus Ironworks Daily Log – 1952, December 10, 1952.
[44] Cleere and Crossley, *The Iron Industry of the Weald*, 229.
[45] Robbins, Saugus Ironworks Daily Log – 1952, December 10, 1952.
[46] Robbins, Saugus Ironworks Daily Log – 1952, December 10, 1952.
[47] Robbins, Saugus Ironworks Daily Log – 1952, July 14, 1952.
[48] Robbins, Saugus Ironworks Daily Log – 1952, July 14, 1952.
[49] Robbins, Saugus Ironworks Daily Log – 1952, November 7, 1952; Barghoorn, "Recent Changes in Sea Level Along the New England Coast," 597-598.

CHAPTER 9 Notes

[1] Robbins, Saugus Ironworks Daily Log – 1949, June 27, 1949.
[2] Robbins, Saugus Ironworks Daily Log – 1949, June 27, 1949.
[3] Robbins, Saugus Ironworks Daily Log – 1949, July 27, 1949.
[4] Robbins, Saugus Ironworks Daily Log – 1949, July 29, 1949 and August 1, 1949.
[5] Roland Robbins, Supplementary Yard and Dock Sill file – 1953, March 24, 1953, First Iron Works Association Papers.
[6] Robbins, Supplementary Yard and Dock Sill file – 1953, April 3, 1953.
[7] Robbins, Supplementary Yard and Dock Sill file - 1953, April 3, 1953.
[8] Robbins, Supplementary Yard and Dock Sill file – 1953, March 26, 1953.
[9] Stephen Whittlesey, Supplementary Yard and Dock Sill file -1953, September 10, 1953, First Iron Works Association Papers.

[10] Robbins, Supplementary Yard and Dock Sill file – 1953, March 26, 1953.
[11] Whittlesey, Supplementary Yard and Dock Sill file -1953, September 10, 1953.
[12] Robbins, Supplementary Yard and Dock Sill file – 1953, March 26, 1953.
[13] Robbins, Supplementary Yard and Dock Sill file – 1953, March 24, 1953.
[14] Robbins, Saugus Ironworks Daily Log – 1953, November 25, 1953.
[15] Robbins, Saugus Ironworks Daily Log – 1952, November 7, 1952.
[16] Barghoorn, "Recent Changes in Sea Level Along the New England Coast," 597-598.
[17] Robbins, Saugus Ironworks Daily Log – 1953, June 25, 1953.
[18] Conover Fitch to Elso S. Barghoorn, January 31, 1952, The Conover Fitch Papers, First Iron Works Association Papers.
[19] Robbins, Saugus Ironworks Daily Log – 1950, October 19, 1950.
[20] Robbins, Saugus Ironworks Daily Log – 1950, October 31, 1950.
[21] Robbins, Saugus Ironworks Daily Log – 1950, October 31, 1950.
[22] Robbins, Saugus Ironworks Daily Log – 1950, October 31, 1950.
[23] Robbins, Saugus Ironworks Daily Log – 1950, October 31, 1950.
[24] Robbins, Saugus Ironworks Daily Log – 1950, September 26, 1950.
[25] Robbins, Saugus Ironworks Daily Log – 1950, October 24, 1950.
[26] Robbins, Saugus Ironworks Daily Log – 1950, October 24, 1950.
[27] Robbins, Saugus Ironworks Daily Log – 1950, October 24, 1950.
[28] Robbins, Saugus Ironworks Daily Log – 1952, November 20, 1952.
[29] Robbins, Saugus Ironworks Daily Log – 1952, November 20, 1952.
[30] Robbins, Saugus Ironworks Daily Log – 1950, January 27, 1950.
[31] Robbins, Saugus Ironworks Daily Log – 1950, January 27, 1950.
[32] Robbins, Saugus Ironworks Daily Log – 1950, January 30, 1950.
[33] Robbins, Saugus Ironworks Daily Log – 1953, June 9, 1953.
[34] Robbins, Saugus Ironworks Daily Log – 1953, June 9, 1953.
[35] Robbins, Saugus Ironworks Daily Log – 1953, June 9, 1953.
[36] Robbins, Saugus Ironworks Daily Log – 1951, July 17, 1951.
[37] Robbins, Saugus Ironworks Daily Log – 1951, July 17, 1951.
[38] Robbins, Saugus Ironworks Daily Log – 1950, April 30, 1950.
[39] Robbins, Saugus Ironworks Daily Log – 1950, April 30, 1950.
[40] Robbins, Saugus Ironworks Daily Log – 1949, July 29, 1949.
[41] Robbins, Saugus Ironworks Daily Log – 1949, November 9, 1949.
[42] Robbins, Saugus Ironworks Daily Log –1952, August 18, 1952.
[43] Card Archives, SAIR 771 (G20026), SAIR 772 (G20026b), and SAIR 773 (G20026b2), First Iron Works Association Papers.
[44] Robbins, Saugus Ironworks Daily Log – 1952, September 17, 1952.

[45] Robbins, Saugus Ironworks Daily Log – 1952, May 19, 1952.
[46] Brown, "An Evaluation of Roland Wells Robbins' Archaeology," 33-34.
[47] Robbins, Saugus Ironworks Daily Log – 1953, June 10, 1953.
[48] Linebaugh, "'The Road to Ruins and Restoration,'" 167.

CHAPTER 10 Notes

[1] These artifactual and archival collections have provided the principal sources for the present volume.
[2] Johnson, "Archeological Overview and Assessment of the Saugus Iron Works National Historic Site" (Boston: National Park Service, 1996), 14.
[3] Johnson, "Archeological Overview and Assessment," 14.
[4] Johnson, "Archeological Overview and Assessment," 16-17.
[5] Lynn Iron Works Collection, 84.
[6] Johnson, "Archeological Overview and Assessment of the Saugus Iron Works National Historic Site," 16-17.
[7] Carlson, "The Saugus Iron Works Restoration," 9-11.
[8] Jonathan L. Fairbanks and Robert F. Trent, *New England Begins: The Seventeenth Century*, (Boston: Museum of Fine Arts, 1982), 2:359.
[9] Lynn Iron Works Collection, 185.
[10] *Records of Essex Courts*, VIII:201.
[11] Saugus Iron Works NHS Museum Collections Catalog Data, ANCS+, Form 10-254, cataloged by Russell J. Barber, 1973.
[12] Hartley, *Ironworks on the Saugus*, 137.
[13] Fairbanks and Trent, *New England Begins: The Seventeenth Century*, 1:xx.
[14] *Records of Essex Courts*, I:294.
[15] Steven R. Pendery, "Portuguese Tin-glazed Earthenware in Seventeenth-Century New England: A Preliminary Study" *Historical Archeology* (1999) 33, no. 4: 69.
[16] Museum Collections Catalog Data, ANCS+, Form 10-254; Neal Trubowitz, Survey of Tobacco Pipe Collections, 2009, report on file at Saugus Iron Works NHS, Saugus, MA.
[17] Rusell J. Barber, Report on the Saugus Ironworks Collections and their Cataloguing, n.d., report on file at Saugus Iron Works NHS, 9-10.
[18] David Bogdan, personal communication, 2009. Bogdan is a woodcrafter at Saugus Iron Works NHS.
[19] Barber, Report on the Saugus Ironworks Collections and their Cataloguing, 9-10.
[20] Barber, Report on the Saugus Ironworks Collections and their Cataloging, 2-3.
[21] Barber, Report on the Saugus Ironworks Collections and their Cataloging, 2-3.

[22] Robbins, Saugus Ironworks Daily Log - 1949, April 30 and May 1, 1949.
[23] August 14, 1648, *Winthrop Papers*, II:246.
[24] *Winthrop Papers*, IV:363.
[25] G. Reginald Bashforth, *The Manufacture of Iron and Steel* (London, Chapman & Hallplace, 3rd edition, 1964).
[26] A 1775 treatise by Pierre Grignon outlines the cause and effect of mold thickness on cast iron. Reprinted in Cyril Stanley Smith, *Sources for the History of the Science of Steel 1532-1786* (Cambridge, Massachusetts: The Society for the History of Technology and M.I.T Press, 1968), 132-133.
[27] Taylor Lyman, ed., *Metals Handbook*, 1948 ed. (Cleveland, Ohio: The American Society for Metals), 505.
[28] When the gates and risers are full, they provide a place for iron to shrink that is outside the finished casting.
[29] *Records of Essex Courts*, 1:294.
[30] *Records of Essex Courts*, 1:294.
[31] Dorothy Hartley, *Lost Country Life* (New York: Knopf Doubleday Publishing Group, 1979), 328.
[32] René Antoine Ferchault de Réamur, *Memoirs of Steel and Iron*, a translation from the original printed in 1722 (Chicago: University of Chicago Press, 1956), 260.
[33] Lyman, *Metals Handbook*, 506.
[34] Schubert, *History of the British Iron and Steel Industry*, 286.
[35] Letter from John Becx to John Gifford, April 26, 1652, Lynn Iron Works Collection, 36.
[36]Recueil de Planches sur les Sciences, les Arts Liberaux, et les Arts Mechaniques, avec Leur Explication, Paris, 1965, Forges, 3e Section, Fourneau en Merchandise, Moulage en Sable, plates VII and VIII; and Moulage en Terre, plates III and IV.
[37] Clay and sand were obtained from sources in or near seventeenth-century Lynn. On the tailrace of the blast furnace was a corn mill. The purpose of such a mill at the ironworks site may have been to grind grass fibers or grain for the purpose of binding the clay/sand mixture and providing stability of the loam material through drying. In some cases, after the mold was made and molten iron was poured, the organic fibers of dung or grasses would burn out and provide pores for unwanted gasses to escape from the mold.
[38] The pot molds were made from three shells of loam that were strategically layered over one another.
[39] The reason the third layer is cut and the hemispheres separated is that the pot is of a bulbous shape and the layers cannot otherwise be separated.
[40] The two wooden patterns that are used to make the lug mold are slid into each other, loam is pressed tightly around the pattern assembly, and the patterns are then removed to form an

angular tube. The same is done again to make the other lug mold.
[41] Two patterns are used together. One pattern forms the leg and the other forms a foot. Loam is wrapped around this pattern assembly and the patterns are pulled apart to reveal a faceted tube.
[42] When the core was first turned, it included a kind of knee that circumnavigated the rim area of the mold. This knee came in direct contact with the outer shell of the pot mold, kept the hemispheres properly aligned, and formed a seal.
[43] While cooling, the iron would shrink. If the molder had done his job properly, the core would be crushed as the iron shrank; otherwise, the iron pot would crack and the molding and drying would all have been for nothing.
[44] Robbins, Saugus Ironworks Daily Log – 1951, September 17 and October 12, 1951.
[45] Frederick Overman, *Molder's and Founder's Pocket Guide* (Philadelphia: Moss, Brother and Company, 1860), 104-115.
[46] *First Iron Works Gazette*, vol. 1, no. 4 (October 1951): 2.
[47] Perry, Shaw, and Hepburn, Kehoe and Dean, Correspondence, First Iron Works Association Papers; Tools and Implements, "resume" dated July 26, 1954, First Iron Works Association Papers, Saugus Iron Works NHS.
[48] Scheme III, SAIR archives.
[49] Perry, Shaw, and Hepburn, Kehoe and Dean Correspondence, June 10, 1954, First Iron Works Association Papers, Saugus Iron Works NHS; A Partial List of Tools and Equipment Required to Furnish Blast Furnace, Forge, and Slitting Mill, Saugus Iron Works NHS.

CHAPTER 11 Notes

[1] Carlson, *First Iron Works,* 13.
[2] *The New York Times*, January 12, 1949, 24.
[3] Lewis, Ralph, *Museum Curatorship in the National Park Service 1904-1982* (Washington, DC: Department of the Interior, 1993), 338.
[4] Robbins, Saugus Ironworks Daily Log - 1949, May 23, 1949.
[5] Kaplan, Lawrence, Mary B. Smith, and Lesley Sneddon, "Boylston Street Fishweir: Revisited," *Economic Botany Journal* 44, no. 4 (October 1990): 516-538.
[6] Robbins, Saugus Ironworks Daily Log - 1949, June 15, 1949.
[7]This process involves protecting metal from corrosion by making the electrochemically active surface of metal "passive" with a chemical treatment which ties up active electrons necessary for the corrosion process.
[8] Robbins, Saugus Ironworks Daily Log - 1950, January 18, 1950.
[9] Roland W. Robbins to Quincy Bent, March 16, 1950, First Iron Works Association Papers.

[10] Emily Williams, "Sixty-Five Years of History: Archaeological Conservation at Colonial Williamsburg," *North American Archaeologist* 21, no. 2 (2000): 107-113.
[11] Sean Charette, personal communication, May 18, 1999. Charette is a Getty Conservation Institute Project Director.
[12] Robbins, Saugus Ironworks Daily Log – 1950, February 23, 1950.
[13] Robbins, Saugus Ironworks Daily Log – 1950, January 18, 1950.
[14] Roland W. Robbins to Quincy Bent, March 16, 1950, First Iron Works Association Papers.
[15] Carl Salmons-Perez, Carl, personal communication, November 16, 2009. Salmons-Perez is Saugus National Historic Site Curator.
[16] Maurice Robbins was a founding member and president of the Massachusetts Archaeological Society as well as the author of *The Amateur Archeology Handbook*, which helped train generations of archeologists from across the country. He was a good friend of Roland Robbins, but not related.
[17] Roland W. Robbins to Maurice Robbins, May 4, 1950, First Iron Works Association Papers.
[18] Roland W. Robbins to Maurice Robbins, May 26, 1950, First Iron Works Association Papers.
[19] Roland W. Robbins, First treatments and preservation of metal relics, Notebook No. 3, June 9, 1950, First Iron Works Association Papers.
[20] Herbert Uhlig, *Corrosion Handbook* (New York: J. Wiley & Sons, 1948, repr. by Wiley, 2000).
[21] S. Epstein, K. Haupt, A.G. Ferdinand and R.S.A. Dougherty, Metallographic Examination of Cast Iron and Wrought Iron specimens from the Site of the Saugus Furnace: August 25, 1949.
[22] Robbins, Saugus Ironworks Daily Log – 1951, February 17, 1951.
[23] Robbins, Saugus Ironworks Daily Log – 1951, February 23, 1951.
[24] Robbins, Saugus Ironworks Daily Log – 1951, March 14, 1951.
[25] Robbins, Saugus Ironworks Daily Log – 1951, April 17, 1951.
[26] Elso Barghoorn to Roland Robbins, May 22, 1951, First Iron Works Association Papers.
[27] Annual Archaeological Report – June 30, 1951
[28] Robbins, Saugus Ironworks Daily Log – 1952, September 12, 1952.
[29] Robbins, Saugus Ironworks Daily Log – 1952, June 8, 1952.
[30] Robbins, Saugus Ironworks Daily Log – 1952, March 30, 1952.
[31] Robbins, Saugus Ironworks Daily Log – 1952, January 1952.
[32] Robbins, Saugus Ironworks Daily Log – 1952, December 3, 1952.
[33] Robbins, Saugus Ironworks Daily Log – 1952, November 19, 1952.
[34] Handwritten addition, Saturday, June 21, 1958 to Robbins, Saugus Ironworks Daily Log - 1954, September 23, 1954.

CHAPTER 12 Notes

[1] Susan McKanna (nee Colby), personal communication, 1991.
[2] Robbins, *Discovery at Walden*, 19.
[3] Robbins, *Discovery at Walden*, 19.
[4] Robbins' notebooks reveal a level of personal insecurity understandable in someone embarking on a new career.
[5] Walter Harding, personal communication, 1992.
[6] Roland W. Robbins to Walter Harding, January 23, 1946, Roland Wells Robbins Collection, The Thoreau Society and Thoreau Institute, Lincoln, MA.
[7] Walter Harding quoted in Robbins, *Discovery at Walden*, xv-xvi.
[8] James Dodson, "The Man Who Found Thoreau," *Yankee* 49 (1985): 116.
[9] Linebaugh, *The Man Who Found Thoreau,* 123-128.
[10] Linebaugh, *The Man Who Found Thoreau,* 197-198.
[11] Robbins, Saugus Ironworks Daily Log – 1950, April 27, 1950.
[12] Robbins, Saugus Ironworks Daily Log – 1950, June 28, 1950.
[13] Robbins, Saugus Ironworks Daily Log - 1949, June 20, 1949.
[14] Robbins, Saugus Ironworks Daily Log - 1949, June 22, 1949.
[15] Robbins, Saugus Ironworks Daily Log - 1950, June 22, 1950.
[16] Robbins, Saugus Ironworks Daily Log - 1953, April 24, 1953.
[17] Robbins, Saugus Ironworks Daily Log - 1949, November 14, 1949.
[18] Robbins, Saugus Ironworks Daily Log - 1953, April 24, 1953.
[19] Robbins, Saugus Ironworks Daily Log - 1950, October 3, 1950.
[20] Robbins, Saugus Ironworks Daily Log - 1950, September 2, 1950.
[21] Robbins, Saugus Ironworks Daily Log - 1950, January 4, 1950.
[22] Robbins, Saugus Ironworks Daily Log - 1951, August 15, 1951.
[23] Robbins, Saugus Ironworks Daily Log - 1952, June 2, 1952.
[24] Robbins, Saugus Ironworks Daily Log - 1950, June 18, 1950.
[25] Robbins, Saugus Ironworks Daily Log - 1951, June 11, 1951.
[26] Robbins, Saugus Ironworks Daily Log - 1952, June 16, 1952.
[27] Robbins, Saugus Ironworks Daily Log - 1951, June 22, 1951.
[28] Robbins, Saugus Ironworks Daily Log - 1952, August 27, 1952.
[29] Robbins, Saugus Ironworks Daily Log - 1952, September 16, 1952.
[30] Robbins, Saugus Ironworks Daily Log - 1952, September 23, 1952.
[31] Robbins, Saugus Ironworks Daily Log - 1952, December 4, 1952.
[32] Robbins, Saugus Ironworks Daily Log - 1953, January 22, 1953.
[33] Robbins, Saugus Ironworks Daily Log - 1953, March 17, 1953.

[34] Robbins, Saugus Ironworks Daily Log - 1953, April 1, 1953.
[35] Robbins, Saugus Ironworks Daily Log - 1953, April 6, 1953.
[36] Robbins, Saugus Ironworks Daily Log - 1953, June 15 and 17, 1953.
[37] Robbins, Saugus Ironworks Daily Log - 1953, June 15, 1953.
[38] Robbins recorded that he assembled the furnace waterwheel exhibit in June 1951. (See Robbins, Saugus Ironworks Daily Log - 1951, June 29, 1951.)
[39] Robbins, Saugus Ironworks Daily Log - 1953, June 17, 1953.
[40] Robbins, Saugus Ironworks Daily Log - 1951, January 26, 1951. Robbins notes building a "platform for visitors."
[41] Robbins, Saugus Ironworks Daily Log - 1949, September 19, 1949.
[42] Robbins, Saugus Ironworks Daily Log - 1950, June 27, 1950.
[43] Robbins, Saugus Ironworks Daily Log - 1950, August 8, 1950.
[44] Preservationist Louise du Pont Crowninshield was a board member of the First Iron Works Association and a founder of the National Trust for Historic Preservation. She was also a financial contributor and fundraiser for the Saugus project.
[45] Robbins, Saugus Ironworks Daily Log - 1950, August 16, 1950.
[46] Robbins, Saugus Ironworks Daily Log - 1950, September 4, 1950; Saugus Ironworks Daily Log - 1951, January 5, 1951, February 26, 1951.
[47] Robbins, Saugus Daily Log, May 25, 1951.
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[61] Kathryn B. Greywacz, New York State Museum to Roland W. Robbins, May 25, 1954. Roland Wells Robbins Collection.

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[66] Dodson, The Man Who Found Thoreau, 116.
[67] Linebaugh, *The Man Who Found Thoreau*, 163-166.
[68] J. C. Harrington, *Archaeology and the Historical Society* (Nashville, TN: American Association for State and Local History, 1965), 35.
[69] James Deetz, *Flowerdew Hundred: The Archaeology of a Virginia Plantation, 1619-1864*, Charlottesville, University Press of Virginia, 1993, 169-174.
[70] Donald M. Scott, "The Profession That Vanished: Public Lecturing in Mid-Nineteenth-Century America," in *Professions and Professional Ideologies in America*, ed. Gerald L. Geison (Chapel Hill: University of North Carolina Press, 1983), 27-28.
[71] Carl Becker, "Everyman His Own Historian," *American Historical Review* 37, no. 2(1932):221-236.
[72] Linebaugh, *The Man who Found Thoreau*, 7.
[73] Robbins, Saugus Ironworks Daily Log - 1948, September 4, 1948; Saugus Ironworks Daily Log - 1948, June 7, 1948; Saugus Ironworks Daily Log - 1953, April 27, 1953.
[74] Mary C. Beaudry, "Archaeology and the Documentary Record," n.p. Beaudry was the project historian and reviewed the documentary records related to the project.
[75] Roland W. Robbins, *The Reader's Almanac*, Audio tape of November 24, 1959, New York: WNYC, 1959.
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[77] Beaudry, "Archaeology and the Documentary Record," n.p.
[78] Beaudry, "Archaeology and the Documentary Record," n.p.
[79] Robbins, Saugus Ironworks Daily Log - 1950, November 25, 1950.
[80] Robbins, Saugus Ironworks Daily Log - 1949, October 5, 1949.
[81] Robbins, Saugus Ironworks Daily Log - 1949, December 29, 1949. Robbins took several pages of notes on the Pittsford Furnace.
[82] Robbins, Saugus Ironworks Daily Log - 1950, July 24, 1950.
[83] Robbins, Saugus Ironworks Daily Log - 1952, April 3, 1952. Robbins went on to work at several of these Ringwood State Park sites in the mid-1960s; he established a successful school-based program at the Hewitt site. Linebaugh, *The Man Who Found Thoreau*, pp. 187-198.
[84] Robbins, Saugus Ironworks Daily Log - 1950, April 30, 1950.
[85] Robbins, Saugus Ironworks Daily Log - 1950, April 30, 1950.
[86] Robbins, Saugus Ironworks Daily Log - 1952, June 19, 1952.

[87] Robbins, Saugus Ironworks Daily Log - 1952, June 19, 1952.
[88] Robbins, Saugus Ironworks Daily Log - 1952, June 19, 1952.
[89] Robbins, Saugus Ironworks Daily Log - 1950, April 7 to April 12, 1950.

[90] Robbins, Saugus Ironworks Daily Log - 1950, May 9, 1950. A visit by Ronald F. Lee, Chief Historian for the National Park Service, put Robbins in touch with colleagues at the Hopewell Furnace site in Pennsylvania. Several weeks later, Robbins gave a tour to Dennis Kurjack of the Hopewell furnace project, who invited Robbins to the PA site. Beginning in the late 1940s, Robbins also developed a regular correspondence with Harry Hornblower of Plimoth Plantation (Saugus Ironworks Daily Log - 1952, July 22, 1952), J.O. Brew at Harvard, J.C. Harrington and J. Paul Hudson at Jamestown, Dr. Maurice Robbins, and C. Malcolm Watkins at the Smithsonian. Robbins also reported a visit by Mr. and Mrs. Kenneth Kidd of the Royal Ontario Museum.
[91] Robbins, Saugus Ironworks Daily Log - 1950, April 7, 1950.
[92] Robbins, Saugus Ironworks Daily Log - 1950, April 7, 1950.
[93] Robbins, Saugus Ironworks Daily Log - 1950, April 7, 1950.
[94] Robbins, Saugus Ironworks Daily Log - 1950, April 7, 1950.
[95] Robbins, Saugus Ironworks Daily Log - 1950, April 7, 1950.
[96] Robbins, Saugus Ironworks Daily Log - 1950, April 7, 1950.
[97] Robbins, Saugus Ironworks Daily Log - 1950, April 7, 1950.
[98] Robbins, Saugus Ironworks Daily Log - 1950, April 7, 1950. Robbins excavated this site in 1956, a few years after leaving his position at Saugus. This work is discussed in Donald W. Linebaugh, "Forging a Career," and Robbins' Report of the 1956 Archaeological Exploration, 256-274.
[99] Robbins, Saugus Ironworks Daily Log - 1951, April 17, 1951. Robbins began research on the Falling Creek site with an inquiry to the local library in Chesterfield County, VA, in August 1950 (Robbins, Saugus Ironworks Daily Log - 1950, August 7, 1950).
[100] A reevaluation of the site was conducted by the William and Mary Center for Archaeological Research in 1995. Thomas F. Higgins III, Charles M. Downing, Donald W. Linebaugh, Antony F. Opperman, and E. Randolph Turner III, "Archaeological Investigations of Site 44CF7, Falling Creek Ironworks, and Vicinity, Chesterfield County, Virginia," Virginia Department of Historic Resources Survey and Planning Report Series No. 4. Richmond, VA, 1995.
[101] Robbins, Saugus Ironworks Daily Log - 1951, March 29, 1951 (38A).
[102] Robbins, Saugus Ironworks Daily Log - 1951, March 29, 1951 (38B).
[103] Robbins, Saugus Ironworks Daily Log - 1951, March 29, 1951 (38C).
[104] Robbins, Saugus Ironworks Daily Log - 1951, March 29, 1951 (38C).
[105] Robbins, Saugus Ironworks Daily Log - 1951, March 29, 1951 (38C).

[106] See Higgins et al., "Archaeological Investigations of Site 44CF7" and the Falling Creek Ironworks Foundation at www.fallingcreekironworks.org.
[107] Robbins, Saugus Ironworks Daily Log - 1950, January 3, 1950.
[108] Robbins, Saugus Ironworks Daily Log - 1950, January 3, 1950.
[109] Robbins, Saugus Ironworks Daily Log - 1949, January 4, 1949; *Scientific American Supplement*, No. 1693, June 13, 1908, 380.
[110] Robbins, Saugus Ironworks Daily Log - 1949, April 9, 1949.
[111] J. C. Harrington, "From Architraves to Artifacts: A Metamorphosis," in *Pioneers in Historical Archaeology: Breaking New Ground*, ed. Stanley South (New York: Plenum Press, 1994), 7.
[112] Robbins, Saugus Ironworks Daily Log - 1950, July 17, 1950.
[113] Robbins, Saugus Ironworks Daily Log - 1950, November 21, 1950.
[114] Robbins, Saugus Ironworks Daily Log - 1950, December 19-20, 1950.
[115] Roland W. Robbins to Maurice Robbins, January, 26, 1953, Roland Wells Robbins Collection.
[116] Robbins, Saugus Ironworks Daily Log - 1951, November 18 and 26, 1951.
[117] Robbins, Saugus Ironworks Daily Log - 1950, November 30, 1950.
[118] Robbins, Saugus Ironworks Daily Log - 1949, November 28, 1949.
[119] Robbins, Saugus Ironworks Daily Log - 1951, March 30, 1951.
[120] Robbins, Saugus Ironworks Daily Log - 1952, March 14 and December 26, 1952. C. Malcolm Watkins and Lura Woodside Watkins were highly respected ceramics experts, and Robbins continued to consult with them on ceramic identification throughout his career.
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[122] Robbins, Saugus Ironworks Daily Log - 1949, April 25, 1949.
[123] Robbins, Saugus Ironworks Daily Log - 1953, April 27, 1953; John H. Lambert to Roland W. Robbins, May 11, 1953, letter report on file, Saugus Iron Works National Historic Site, Saugus, MA.
[124] Robbins, Saugus Ironworks Daily Log - 1953, April 27, 1953.
[125] Robbins, Saugus Ironworks Daily Log - 1949, November 8, 18, 21, and 23, 1949.
[126] Cze-Ching Cheng to Roland W. Robbins, April 12, 1950, letter on file, Saugus Iron Works National Historic Site, Saugus, MA.
[127] Robbins, Saugus Ironworks Daily Log - 1949, May 20, 27, September 15, October 7, November 28, Dec 8, 1949; Saugus Ironworks Daily Log - 1950, January 23, 1950.
[128] Artifact conservation is discussed more fully in Chapter 11.
[129] Robbins, Saugus Ironworks Daily Log - 1951, February 17, 1951; Saugus Ironworks Daily Log - 1952, May 24, 1952; Saugus Ironworks Daily Log - 1953, May 6, 1953.
[130] Arthur C. Laura, Research Notes on Metal Artifacts and Their Restoration, ca. 1952, The

Roland Wells Robbins Collection. This work is meticulously documented and includes a sketch of the artifact with pretreatment measurements, detailed condition of object, and the treatment program carried out.
[131] Robbins, Saugus Ironworks Daily Log - 1949, May 23, 1949.
[132] Robbins, Saugus Ironworks Daily Log - 1951, March 14, 22, April 24, and May 7, 1951; Elso S. Barghoorn to Roland W. Robbins, May 22, 1951, Roland Wells Robbins Collection.
[133] Robbins, Saugus Ironworks Daily Log - 1949, April 27, 1949.
[134] Robbins, Saugus Ironworks Daily Log - 1949, September 28, 1949.
[135] Roland W. Robbins, Observations on Iron Works Impurities Removed from Area Immediately to the South of the Slitting Mill Site and Sent to H. M. Kraner, Bethleham Steel, for Analysis, letter report dated July 14, 1953, on file, Saugus Iron Works NHS.
[136] Roland W. Robbins, Observations on Iron Works Impurities.
[137] S. Epstein, K. Haupt, A. G. Ferdinand, and R. S. A. Dougherty, "Metallographic Examination of Cast Iron and Wrought Iron Specimens from the site of the Saugus Furnace," August 25, 1949, Roland Wells Robbins Collection.
[138] S. Epstein et al., "Metallographic Examination of Cast Iron and Wrought Iron Specimens."
[139] S. Epstein et al., "Metallographic Examination of Cast Iron and Wrought Iron Specimens."
[140] E. Neal Hartley to Harrison Shock, July 17, 1951. First Iron Works Association Papers; R.A. Limons, H.M. Kraner, "Comparison of English Sandstones and a Saugus Spike, via Petrographic Examination, Chemical Analysis, and Deformation Tests," letter report dated February 13, 1952 on file, Saugus Iron Works NHS; James B. Thompson, Jr., "Report on Rock Spikes from Saugus Furnace," n.d., letter report on file, Saugus Iron Works NHS; Laurence LaForge, "Granite and the "Spikes," letter report dated February 3, 1951, on file, Saugus Iron Works NHS; Laurence LaForge, "The Spikes are not Granite," letter report dated January 9, 1951, on file, Saugus Iron Works NHS; R.A. Limons, H.M. Kraner, "Petrographic Examination of Saugus Samples marked QB-1 through and including QB-8," letter report dated August 21, 1953, on file, Saugus Iron Works NHS.
[141] Matson, Frederick R., "Saugus Sands and Mold Fragments from the Sow and Hollowware Casting Beds," Report No. 4, July 17, 1951, report on file, Saugus Iron Works NHS.
[142] Matson, "Saugus Sands and Mold Fragments from the Sow and Hollowware Casting Beds."
[143] Matson, "Saugus Sands and Mold Fragments from the Sow and Hollowware Casting Beds."
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CHAPTER 13 Notes

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[2] E. Neal Hartley to Charles Rufus Harte, August 10, 1951, Papers of Charles Rufus Harte.
[3] Hartley to Harte, August 20, 1952, Papers of Charles Rufus Harte.
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[5] Robbins, Saugus Ironworks Daily Log – 1953, May 11, 1953.
[6] Walter Renton Ingalls to M. Louise Hawkes, December 11, 1948, Papers of Charles Rufus Harte.
[7] H. M Kraner to Charles M. Parker, September 29, 1950.
[8] Charles Rufus Harte to Quicy Bent, July 24, 1951, Papers of Charles Rufus Harte.
[9] Conover Fitch to Quincy Bent, October 26, 1951, Papers of Charles Rufus Harte.
[10] Memorandum, September 5, 1952, Reconstruction Committee meeting, First Iron Works Association Papers.
[11] Memorandum, July 17, 1952, Reconstruction Committee meeting, First Iron Works Association Papers.
[12] Memorandum, July 17, 1952, Reconstruction Committee meeting, First Iron Works Association Papers.
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[18] A. H. Hepburn to H. R. Schubert, September 23, 1952, First Iron Works Association Papers.
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[22] Robbins, Saugus Ironworks Daily Log - 1953, July 3, 1953.
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[27] Quincy Bent to Conover Fitch, January 9, 1951, First Iron Works Association Papers.

CHAPTER 14 Notes

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[4] Robbins, Saugus Ironworks Daily Log - 1952, April 21, 1952.
[5] Robbins, Saugus Ironworks Daily Log - 1952, pp. 93, 95, 105, 108, 114-129; Saugus Ironworks Daily Log - 1953, March 16, 1953.
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[10] "Restoration Dedicated at Impressive Ceremony," *First Iron Works Gazette* 4, no. 4 (Fall 1954): 1.
[11] "Restoration Dedicated at Impressive Ceremony," 2.
[12] "Restoration Dedicated at Impressive Ceremony," 5.
[13] For more on Saugus and Cold War history, see Linebaugh, "Exploring Interpretive Agendas: The Saugus Iron Works and the Cold War."
[14] "Restoration Dedicated at Impressive Ceremony," 5.
[15] "Restoration Dedicated at Impressive Ceremony," 5.
[16] "Restoration Dedicated at Impressive Ceremony," 5.
[17] "Restoration Dedicated at Impressive Ceremony," 9.
[18] Robbins, Saugus Ironworks Daily Log – 1954, September 10, 1954.
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[31] Roland W. Robbins to Frederick A. Bonsal, January 13, 1958, The Roland Wells Robbins Collection in the Thoreau Society Collections at the Thoreau Institute at Walden Woods.
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[63] Donald W. Linebaugh, "'The Road to Ruins and Restoration,'" 446.
[64] Linebaugh, "'The Road to Ruins and Restoration,'" 496-97.
[65] Linebaugh, "'The Road to Ruins and Restoration,'" 469-70.
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