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

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 iron-works (bottom right), Pranker's Pond (top center), and the cran-berry bog (left center). Notice how developed the area was in 1949. (Photograph 1719 by Lau-rence 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.

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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.)

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]

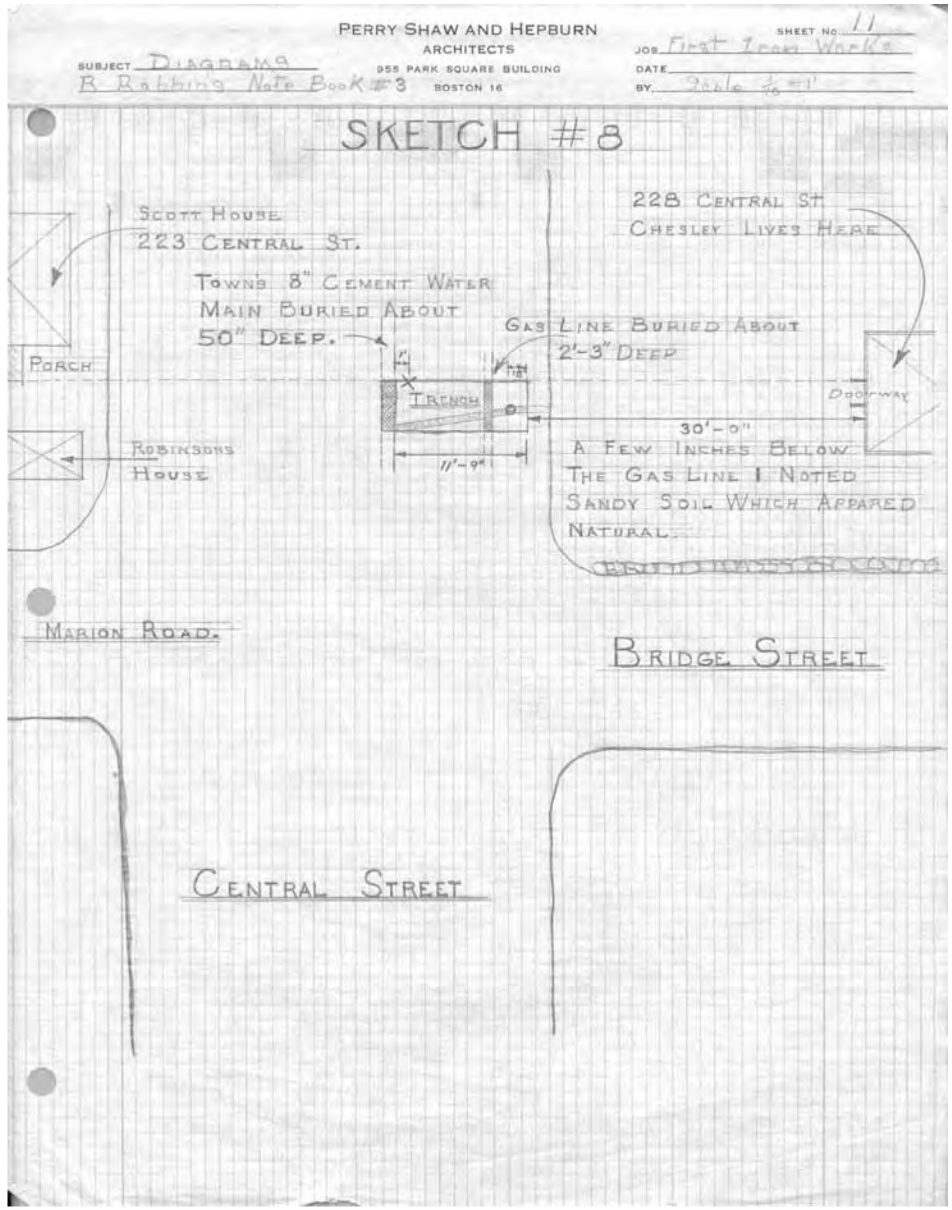
By December 1952, Robbins was speculating that the holding basin for the site may have extended all the way to Chesley's house, just north of the furnace, forge, and rolling/slitting mill. Benjamin F. Newhall, who wrote an article about the ironworks for the March 19, 1859, edition of the ***Lynn Weekly 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.