Pillsbury A Mill Tunnel Historic and Engineering Condition Study

Report prepared for

City of Minneapolis

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1. Introduction

A. Project background

Dominium, the owner of the Pillsbury A Mill property and tunnel system, is in the process of redeveloping the Pillsbury A Mill as residential housing units for artists, and plans to retrofit the waterpower tunnel system at a future date for use as a renewable energy center, including hydroelectric power and hydrothermal heating and cooling. Dominium, the Minnesota Historical Society, and the St. Anthony Falls Heritage Board are also exploring a potential interpretive center at the Pillsbury A Mill. The Pillsbury A Mill and its tunnel system are located at approximately 100 Third Avenue Southeast in Minneapolis, along the east bank of the Mississippi River. Completed in 1881 and 1882, the Pillsbury A Mill is a National Historic Landmark and is located within the St. Anthony Falls National Register of Historic Places (National Register) Historic District and Mississippi National River and Recreation Area. The tunnel system was constructed in 1881 and has not been used for power generation since the mid-1950s. It is part of the historic complex and served as the conduit for the direct drive water power, which employed water from the Mississippi River at St. Anthony, used in the historic flour-milling operations at the site. A description of the direct drive water power system is presented in Section 1.C below, and a more detailed description of the tunnel system is presented in Section 4.

To assist with planning for the future retrofits to accommodate the renewable energy and interpretive centers, the City of Minneapolis partnered with Dominium, using funding from the Arts and Cultural Heritage Fund and the St. Anthony Falls Heritage Board, to complete this Pillsbury A Mill Tunnel Historic and Engineering Condition Study (Study) of the historic water power tunnel system associated with the Pillsbury A Mill. Working under contract to the City of Minneapolis, the Study team includes the following:

- Mead & Hunt, Inc. – Project Management and Historic Condition Assessment
- CNA Consulting Engineers – Structural Condition Assessment
- Rani Engineering – Structural Condition Assessment
- 10,000 Lakes Archaeology, Inc. – Archaeological Fieldwork Plan
- Arch^3, LLC – Photographic Documentation
- Rescue Resources of MN, LLC – Safety oversight for site visit

The Study addresses the structural condition, geotechnical condition, historic condition, and historical significance of the tunnel system. It also includes an archeological fieldwork plan to address areas within the tunnel system that appear to have archeological research potential or are otherwise unique. In conjunction with the Study, photographic documentation of selected areas of the tunnel system was completed.

B. Collaborative approach to Study

Working collaboratively, the historians, archaeologists, engineers, and photographer undertook the historic and structural condition assessments of major components of the tunnel system: headrace, forebay, and upriver turbine service room. The Study team also undertook a preliminary structural condition assessment of the downriver tailrace.

The collaborative nature and design of the Study was important because of the historical significance of the Pillsbury A Mill, which is a National Historic Landmark located within the St. Anthony Falls Historic District and the Mississippi National River and Recreation Area. The proposed energy center will include technologically advanced systems of hydrothermal exchangers and hydroelectric generators to be installed within and around the water power tunnel. While the interpretive center plans are still in the very early stages, the feasibility of providing tours of the tunnel system is being explored. This Study provides a planning tool for the energy and interpretive center developers so they understand the historic and structural condition of the tunnel system.

In late January 2014 the Study team entered, investigated, and photographed accessible sections of the major tunnel system components. Team members observed and recorded tunnel features and conditions, which provide the foundation of the Study's results and recommendations presented in this report. The Study team's engineers and photographer completed a follow-up site visit in early April 2014 to prepare a preliminary assessment of the downriver tailrace. Historical and archival research on the development and construction of the tunnel system and Pillsbury A Mill, as well as St. Anthony Falls water power development, were also conducted for the Study.

C. Direct driver waterpower system

To facilitate readers' understanding of the Pillsbury A Mill tunnel system, an overview of how a direct drive water power system functions is provided in this section. The direct drive water power system has a number of components that, as a system, take advantage of the energy that resulted from water dropping. Such a system has a headrace that carries water horizontally from an intake gate, where water enters from the source at a point that is upriver from where that water source changes elevation. The water is conveyed through the headrace to a vertical drop shaft and through a turbine that operates an intricate system of machinery. After turning the turbine, the water exits the bottom of the drop shaft, flows through the tailrace and re-enters the water source at an elevation below the waterfall.

In the case of the Pillsbury A Mill tunnel system, when it was in operation, the water source was the Mississippi River, and the water entered the headrace at the intake gate located at the East Bank Mill Pond, upriver from St. Anthony Falls. From the intake, water was conveyed through the headrace, located under Main Street Southeast, to the Pillsbury A Mill at the forebay. The headrace also brought water to smaller headraces that served specific mills or auxiliary buildings (e.g. Phoenix Mill and the Pillsbury A Mill Machine Shop). Each mill-specific headrace entered the basement level of a mill where it connected to a vertical drop shaft through a gate, which could be raised or lowered to control the amount of water entering the shaft. The turbine, located in the turbine pit at the bottom of the drop shaft, connected to a drive shaft that extended up through the drop shaft and connected to an intricate system of gears and belts within the mill that transferred the kinetic energy created by the turbine directly to the milling and other equipment. After turning the turbine and exiting the bottom of the drop shaft, the water then flowed out through the tailrace tunnel and emptied into the Mississippi River at an elevation below St. Anthony Falls.[1]

The locations of these various waterpower components associated with the direct drive water power system reflect Minneapolis' particular geology. The headrace is basically located above the layer of limestone bedrock, in the area between the ground surface and limestone bedrock that could be excavated from the surface. The tailraces are below the limestone bedrock, in the layer of relatively soft sandstone that could be excavated by digging horizontally in from the river bluff. The drop shafts extend down through the hard (and difficult to excavate) bedrock layer. See Figure 1 for an illustration of the direct drive water power system.

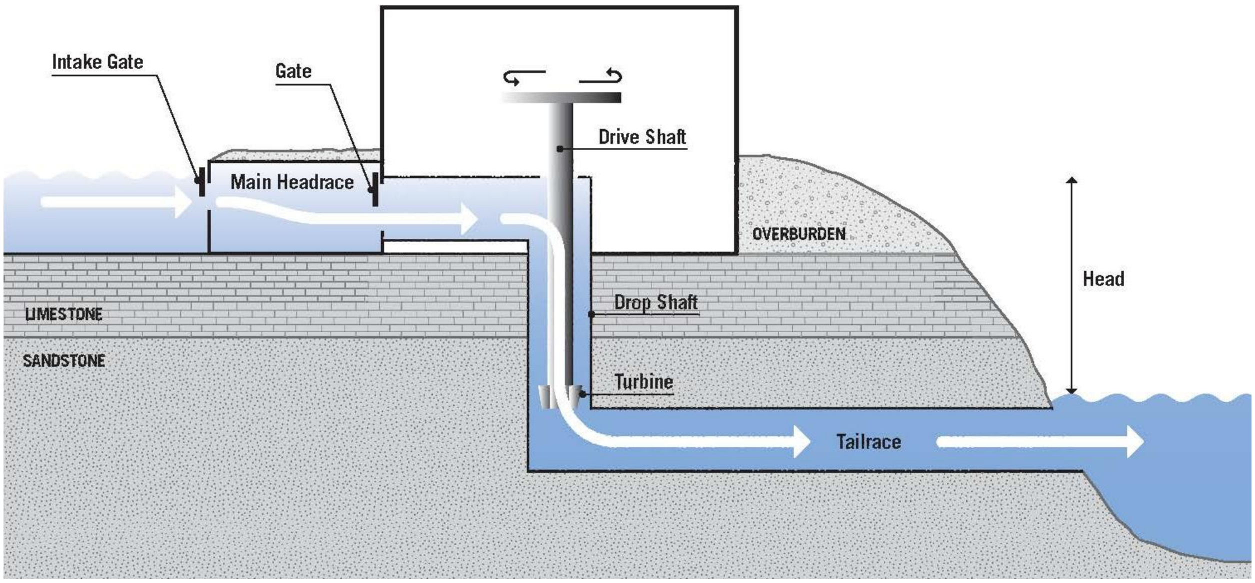

Figure 1. Illustration of the Pillsbury A Mill direct drive water power system. Prepared for the purposes of this Study.

[1] In Minneapolis' west bank milling district, there was a similar, but more extensive, water power system. There was a main headrace canal with a large gatehouse that controlled the water flow (both of which are still in existence, but buried), from which branched a larger number of mill-specific smaller headraces. There also was a main tailrace that served multiple mills.

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2. Developmental History

A. Historical background and context

In 1881-1882 the St. Anthony Falls Water Power Company constructed the Pillsbury A Mill tunnel system along the east bank of St. Anthony Falls in Minneapolis. The company built the tunnel system to convey water to power the Pillsbury A Mill, the largest and highest producing flour mill of its time. The Pillsbury A Mill, built by C.A. Pillsbury & Company, was the company's flagship mill to substantially increase the company's capacity provided by other mills, including the Pillsbury B Mill on the west bank of the Mississippi River.[2] The Pillsbury A Mill's productivity was due in part to the excellent water power conditions created by St. Anthony Falls. The Mississippi River falls 70 feet at St. Anthony Falls, and the tunnel system took advantage of this energy source by carrying water from the intake at the east bank mill pond approximately 550 feet downriver to the Pillsbury A Mill to power the mill's machinery. The water ran through the tunnel system, down drop shafts, and into turbine pits, where it powered the turbines. The energy created by the turbines was directly transferred to mill equipment, instead of storing the power as electricity.[3] Figure 2 shows a present-day map that identifies the approximate location of the Pillsbury A Mill and its tunnel system, as well as nearby popular landmarks, to facilitate the readers' understanding of the St. Anthony Falls and Pillsbury A Mill area.

[2] Letters were assigned to mills based on the hierarchy in the milling operations; they were not necessarily assigned in a chronological order. The letter "A" was reserved for a company's flagship mill.

[3] Louis C. Hunter, *Waterpower, A History of Industrial Power in the United States, 1780-1930 vol. I*, (Charlottesville, Va.: University Press of Virginia, 1979), 274.

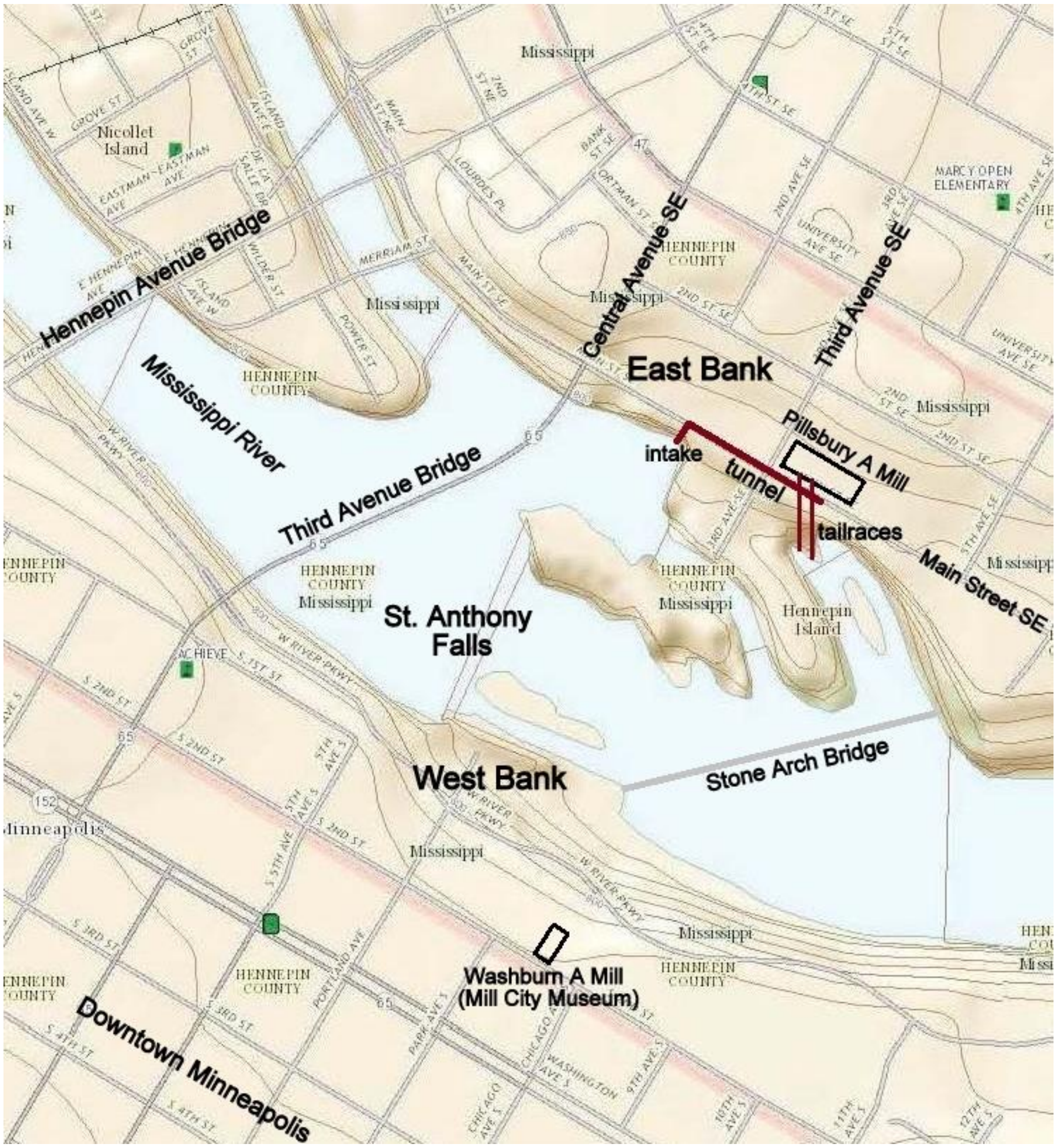

Figure 2. Present-day map showing the St. Anthony Falls riverfront along the Mississippi River. The approximate location of the Pillsbury A Mill tunnel system is outlined along the east bank of St. Anthony Falls. Adapted by Mead & Hunt, Inc. from the USGS National Map website http://viewer.nationalmap.gov/viewer/ (accessed 27 May 2014).

Due in large part to the importance of the Pillsbury A Mill, C.A. Pillsbury & Company and its successor companies, which were headquartered in Minneapolis, became one of the leading flour milling and food products companies in the United States. In 1975 the Pillsbury A Mill, including the associated tunnel system, was designated as a National Historic Landmark. It is also a contributing feature of the St. Anthony Falls Historic District, which was listed in the National Register of Historic Places (National Register) in 1971.

(1) Early settlement along St. Anthony Falls

St. Anthony Falls is the only natural waterfall along the Mississippi River. The steep river drop created an ideal site for waterpower development, and as early as the 1820s settlers took advantage of the falls to power mill sites.[4] The first settlement near the falls area was Fort Snelling, a government outpost constructed between 1820 and 1823 under the direction of Colonel Josiah Snelling. Fort Snelling is located at the junction of the Minnesota and Mississippi Rivers about 9 miles downriver from St. Anthony Falls. The fort had jurisdiction over the falls and constructed the first saw and grist mills on the west bank by 1823.[5]

In 1837 the U.S. government opened the east bank of the Mississippi for settlement, while the west bank remained under control of Fort Snelling. Franklin Steele purchased land and the adjoining water rights along the falls, and constructed a timber dam, saw mill, and flour mill over the next 20 years. He also platted the town of St. Anthony along the east bank in 1849.[6] Meanwhile, Robert Smith leased the Fort Snelling mills along the west bank of the river in 1848 and purchased the land and water rights when the west bank opened to settlement claims in 1852. In 1854 the town of Minneapolis was founded along the west bank.[7] In subsequent decades, milling districts developed in both St. Anthony and Minneapolis; however, the east and west banks developed along different timelines and utilized different water power distribution approaches.

(2) The development of the Minneapolis Mill Company and St. Anthony Falls Water Power Company

In 1856 Franklin Steele founded the St. Anthony Falls Water Power Company (SAFWPC) on the east bank and Robert Smith founded the Minneapolis Mill Company on the west bank. Each company constructed a mill pond to receive water and supply its own water power system. The two companies cooperated to construct the St. Anthony Dam, which directed part of the river flow into the mill ponds on either side of the river.[8] After the dam was constructed, the Minneapolis Mill Company successfully established the Lowell model of water power distribution, which involved construction of a single power canal fed by the mill pond. This allowed for construction of mills on either side of the canal. The company then leased water power usage to mill companies. Each mill company constructed their own headrace and tailrace along the canal.[9] The Minneapolis Mill Company constructed the west side power canal in 1857 and began selling land along the canal to mill companies. By 1869 the waterfront along the canal was crowded with mills.[10]

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[4] Lucile M. Kane, *The Falls of St. Anthony* (St. Paul: Minnesota Historical Society, 1987), 1-7; Louis C. Hunter, *Waterpower, A History of Industrial Power in the United States, 1780-1930* vol. I (Charlottesville, Va.: University Press of Virginia, 1979), 233.

[5] Minnesota Historical Society, "Timeline," *Mill City Museum*, www.millcitymuseum.org/timeline (accessed 6 February 2014).

[6] Don Coddington, *St. Anthony Falls Historic District* (Washington, D.C.: National Register of Historic Places, National Park Service, 11 March 1971), 8-1; the town of St. Anthony was absorbed into Minneapolis in 1872.

[7] Coddington, 8-1.

[8] Kane, 42-44.

[9] The Lowell model is described in Hunter, 204-227; Kane, 53-54.

[10] Kane, 53-54, 59.

The east bank developed more slowly. Plagued by internal struggles and financial difficulties, the SAFWPC failed to complete construction of a power canal for several decades. Though the SAFWPC attempted to construct a canal in 1866, work halted after it encountered a cave. This canal was named "Chute's tunnel" after the company manager Richard Chute. It extended from the bluff near Fifth Avenue Southeast to Main Street Southeast, where it ran under Main Street until it ended at the cave. Construction ceased, and for a time the SAFWPC allowed a private party to operate Chute's Cave for tourism. Without a power canal, the SAFWPC had to transfer power to mills through a system of ropes and shafts running from turbine installations on the dam. Years later, in 1874, canal construction began again, but instead of completing the power canal, a segment of Chute's tunnel became part of the tailrace for the newly constructed Phoenix Flour Mill.[11]

After several decades of hardship, including lawsuits, debt, and fires, the original SAFWPC owners sold out to Minnesota railroad entrepreneur James J. Hill in 1880.[12] After Hill purchased the SAFWPC, he sought to harness and distribute water power more efficiently and revitalized plans to construct a power canal along the eastern waterfront. However, due to an existing commitment to provide power to the proposed Pillsbury A Mill, the company constructed a shorter tunnel, rather than open canal, directly to the mill in 1881.[13] This arched limestone tunnel system running beneath Main Street Southeast became known as the Pillsbury A Mill tunnel.[14]

Lacking an accessible canal, the east bank looked very different from the west (see Figure 3). The west bank had a densely developed mill row along the Minneapolis Mill Company power canal, while east bank development remained limited. By 1893 only two flour mills were located on the east bank: the Pillsbury A Mill and the smaller Phoenix Flour Mill. The four-story, limestone Phoenix Flour Mill was built in 1875 by Stamwitz and Schober. Though it pre-dates the Pillsbury A Mill, it was eventually incorporated into the Pillsbury Company and converted to a rye mill.[15] With the exception of these two flourmills, the east bank remained relatively undeveloped. The west bank, by contrast, was crowded with flour mills. The Minneapolis Flouring Mill, Pillsbury B Mill, Excelsior Mill, Northwestern Roller Mill, Pettit Mill, Zenith Mill, and Galaxy Mill were built side by side along the Minneapolis Mill Company canal. Farther inland the

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[11] Coddington, 7-56, 57.

[12] Kane, 7-56.

[13] "Local and Personal," *Northwestern Miller,* 11 March 1881. Charles Pillsbury, the founder of the Pillsbury Company, had been involved in Minneapolis milling for 10 years prior to the construction of the Pillsbury A Mill. After investing in several mills independently, Charles formed C.A. Pillsbury & Company in 1871. The company continued to lease and remodel mills over the next decade. Notable Pillsbury mill renovations from the 1870s included the Empire Mill and the Pillsbury B Mill, formerly known as the Alaska Mill. After researching milling techniques and gaining years of experience, Pillsbury constructed the Pillsbury A Mill in 1881. *A History of Pillsbury's "A" Mill,* Minnesota: n.p., n.d.

[14] Kane, 123; most historic resources refer to the Pillsbury A Mill tunnel as a canal, though it is a completely enclosed underground space. The term "canal" was generally used for both east and west water supply systems in historical documents.

[15] Coddington, 7-57.

Washburn C Roller Mill, Washburn A Mill, and Crown Roller Mill were only a few of the many other milling operations, which included saw mills, a paper mill, and a woolen mill.

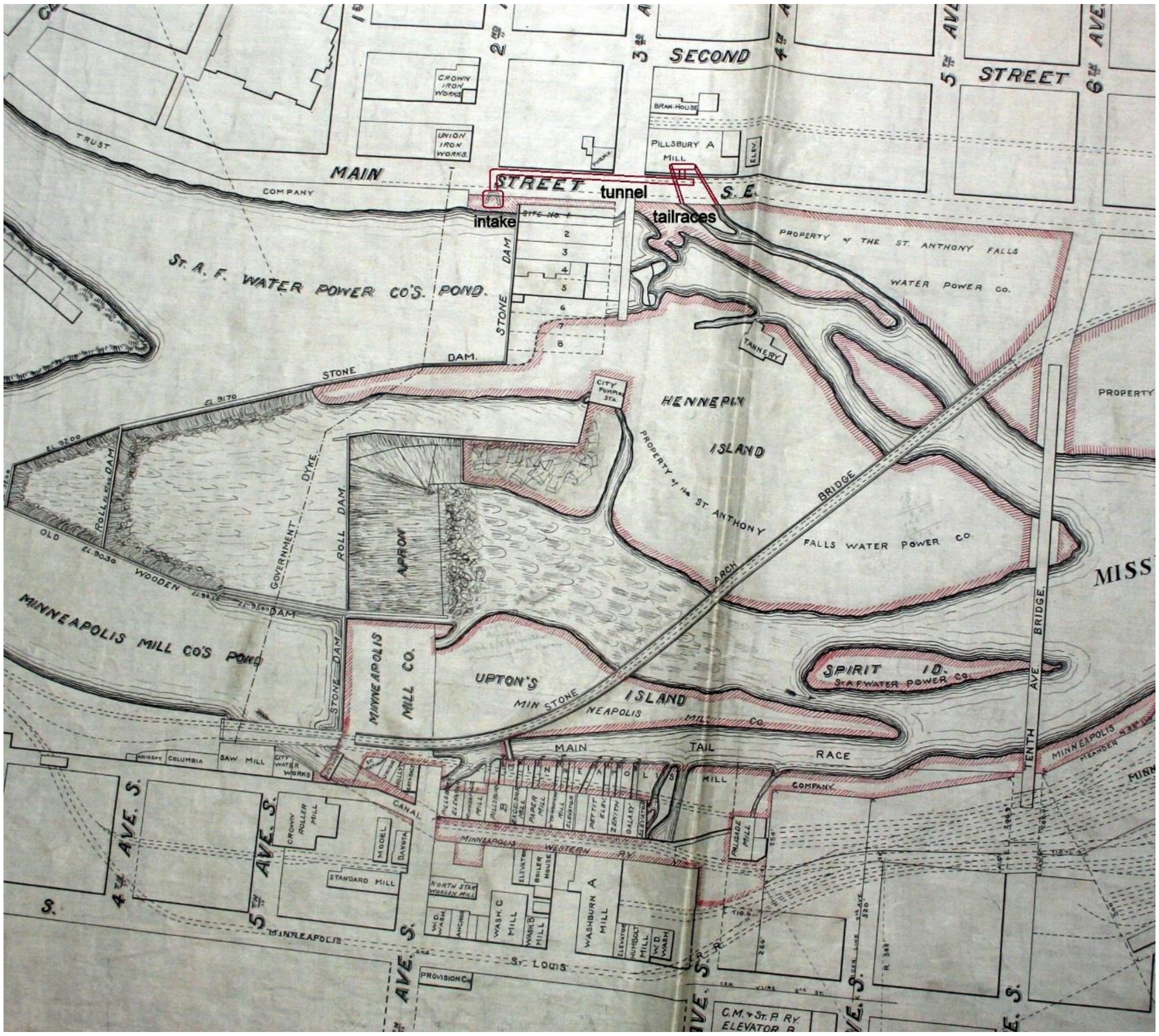

Figure 3. Adapted 1893 map of St. Anthony Falls, showing the development along the east and west banks of the river. An outline of the Pillsbury A Mill Tunnel has been added to the map. "Map Showing Location of Property of the St. Anthony Falls Water Power Co. and the Minneapolis Mill Co." 1893. Available at the U.S. Army Corps of Engineers library, St. Paul, Minn.

The contrast between the east and west banks of St. Anthony Falls reflects the different approaches each company had to water power distribution. The easily accessible west bank power canal constructed by the Minneapolis Mill Company allowed for many mills to operate along the river bank. Across the river, the SAFWPC constructed a tunnel with restricted accessibility dedicated largely to the operation of a single mill. There was little opportunity for other mills to access the power tunnel, resulting in limited industrial growth along the east bank.

(3) The Pillsbury A Mill and Minneapolis milling

The St. Anthony Falls milling industry was originally dominated by saw mills, with a variety of other small industrial facilities present. However, throughout the 1870s and 1880s the saw milling industry slowly moved to north Minneapolis and flour mills came to dominate St. Anthony Falls.[16]

Charles A. Pillsbury was one of the most prominent flour mill entrepreneurs in Minneapolis. He began acquiring mills along the Minneapolis waterfront in 1869 and, with others, promoted new technological innovations that allowed for successful spring wheat milling. Charles formed the C.A. Pillsbury & Company in 1871, and several family members joined his company, including his brother Fredrick and uncle John. The company continued to invest in the industry over the next decade, and in 1880 Charles, Fredrick, and John purchased several east bank parcels along Main Street Southeast and began construction of the mammoth Pillsbury A Mill. The Pillsbury A Mill was intended to be the company's flagship mill. Designed by Minneapolis architect LeRoy S. Buffington, the mill was 175 feet wide and 115 feet deep, with a total height of 187 feet. The construction was completed in 1881 at a cost of $500,000. At this time it was the largest mill in the world, producing 4,000 barrels of flour a day.[17]

As the Minneapolis flour milling industry flourished in the late nineteenth century, it also experienced a period of consolidation. In 1876 there were 17 firms operating 20 mills. By the early twentieth century, only three major corporations owned most of the flour milling operations in Minneapolis: Washburn-Crosby (later General Mills), Pillsbury-Washburn (later the Pillsbury Company), and Northwestern Consolidated Milling. Minneapolis became the center for flour milling in the U.S., and led the industry from 1880 until 1930.[18]

Over these decades, the Pillsbury A Mill remained the largest mill in the world. Production rose to 5,000 barrels a day in the fall of 1882 and 7,000 barrels a day by 1886. By the mid-1890s capacity had reached 9,000 barrels a day, and production increased to 16,113 barrels a day by 1905. The Pillsbury Company achieved this increase in production numbers through updated technology and additions to the mill. As time passed many technological changes increased the productivity of mill machinery. Other improvements included turbine replacement in 1901, and the gradual addition of steam power over the next few decades.[19]

By 1930, however, the era of Minneapolis milling dominance had ended and companies moved their operations to new milling centers in Kansas City, Chicago, and Buffalo, New York. Factors such as

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[16] Kane, 115.

[17] A History of Pillsbury's "A" Mill.

[18] Coddington, 8-6. Minnesota Historical Society, "Timeline."

[19] "Improvements to Pillsbury A Mill," *Minneapolis Journal*, 2 December 1901; 8 December 1913; C.A.P. Turner, "Alterations to Pillsbury A Mill," Plans Prepared for the Pillsbury A Mill, 13 February 1912. In 1912 the Pillsbury A Mill required the addition of eight large concrete buttresses, designed by noted engineer C.A.P. Turner, to reinforce the mill's east wall; the structure was shifting due to unexpectedly severe vibrations from turbine activity. During these alterations, a steel skeleton was also built into the plant to minimize vibration effects, replacing the previous timber beam construction.

changes in regional wheat quality, increased freight rates, and unfavorable tariff policies led to the downturn in the milling industry.[20] Mills gradually closed as the hydroelectric industry expanded along the river. Soon hydroelectric power generation replaced milling as the dominant industry at the falls. As the milling industry moved to other cities, the Pillsbury A Mill remained one of the few mills at the falls. After the Washburn Mill closed in 1975, it was the last operating mill until it closed in 2003.[21]

[20] Coddington, 8-7.

[21] Jim Buchta, "Pillsbury A Mill Renovation Project is Back, on a New Track," *Star Tribune*, 30 October 2013.

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3. Chronology of Development and Use

A. Pillsbury A Mill tunnel system construction

Concurrently with construction of the Pillsbury A Mill, the SAFWPC began construction of the tunnel system to bring water to the mill. Because the east bank did not have a power canal, the SAFWPC agreed to construct an underground power tunnel directly to the Pillsbury A Mill. The large mill was designed to be run by twin water turbines, each powering half of the mill's machinery.[22] The Pillsbury A Mill tunnel system carried water from the east bank mill pond to the turbine drop shafts and turbine pits, located below the mill's basement, before channeling it back through two tailraces southwest of the mill. Due to the large scale of the project, the construction of the tunnel system was of great interest to the community, and was well documented by local papers such as the *Minneapolis Tribune* and *Northwestern Miller.*

As construction of the Pillsbury A Mill rapidly progressed, the SAFWPC scrambled to start building the tunnel system in January 1881. Early in January, workmen were already deepening the older tunnel, even before the city council gave official permission to begin construction. The excavation was already 4 feet deep in less than a month, and 10 feet deep a few more weeks later. Construction of the headrace, coffer dam at the tunnel entrance, and tailraces was well under way by mid-February, and the excavation reached 20 feet by mid-March. At that point construction crews reached a bed of limestone, which had to be quarried out to reach the desired depth. [23]

Though the tunnel system construction employed at least 500 men, it caused nearby businesses difficulties. Early in construction, the already operating Phoenix Flour Mill had trouble receiving wheat deliveries because of the torn up streets, causing it to shut down intermittently. As the tunnel system construction progressed, the Phoenix Flour Mill and nearby North Star Grist Mill completely shut down for six to eight weeks due to limited accessibility.

At the end of March, the SAFWPC modified the original plans and widened the tunnel. Plans submitted in February 1881 to the U.S. Engineer Office indicated tunnel measurements would have been 14 feet wide and 24 feet deep. These plans show the masonry arch form of the tunnel and the geologic formations surrounding the tunnel. [24] Although the *Northwestern Miller* reported the tunnel would be widened to 16 feet, 2014 measurements document a final width of 15 feet, 2 inches. The newspaper also reported the

[22] *A History of Pillsbury's "A" Mill*; the twin turbines were 1,200-horsepower, 55-inch Victor water turbines.

[23] "Local and Personal," *Northwestern Miller,* 7 January 1881, 21 January 1881, 4 February 1881, 18 February 1881, AND 11 March 1881.

[24] The full report, written by W.S. Morton, was not located during research at the U.S. Army Corps of Engineers Office Library. W.S. Morton worked for the Corps under Col. Farquahar and Major Allen as an assistant engineer in St. Paul until April 1881, when he formed his own civil engineering firm with V.D. Simar; "Personal," *Engineering News,* 23 April 1881.

tunnel would be about 32 feet deep, though 2014 measurements indicate the tunnel is 24 feet deep, following earlier plans.[25]

As March drew to a close, workers started laying the stone walls of the tunnel, beginning at the end closest to the Pillsbury A Mill. The *Northwestern Miller* reported on the chaos of the construction site: “a great number of teams hauling earth and brick and stone to and from the canal must be added to the hundreds of wood carts and heavily loaded lumber wagons hauling off the freshly cut lumber.”[26] In early May, despite setbacks after the river washed away a portion of the coffer dam, the walls and tunnel intake were almost complete and construction of the structure’s arch roof began.[27]

In late June arch construction was complete, and the SAFWPC tested the structure by letting a small amount of water through the tunnel. By July 1 the main tunnel and upriver tailrace were finished and the Pillsbury A Mill leased 10 millpowers of water from the SAFWPC. Flour production began a few weeks later.[28] The Phoenix Flour Mill also began using the tunnel. It had previously used a short headrace from the east side mill pond, but after the Pillsbury A Mill tunnel system was complete, it utilized the Pillsbury A Mill tunnel and upriver tailrace.[29]

While tunnel construction was ongoing, the Pillsbury A Mill was constructed in two phases. The mill was designed to run with two independent units of machinery, and each unit was installed during a different phase of construction. During the first phase, the Pillsbury Company constructed the mill building and installed the upriver machinery unit. The SAFWPC finished the main tunnel and upriver tailrace in time for the Pillsbury A Mill to begin production with its upriver unit of the mill machinery.[30]

Though the main tunnel and upriver tailrace were finished in July, construction continued on the second phase, which included the downriver tailrace and installation of the second unit of the mill machinery. Construction had gone without major setbacks up to this point, but in August troubles began stalling the project. The *Northwestern Miller* reported a hole sprung in the finished, upriver tailrace, which shut down

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[25] *Northwestern Miller,* 1 April 1881; 8 April 1881; *Cross Section of Canal in Process of Construction by the St. Antony Falls Water Power Company*, 19 February 1881, http://reflections.mndigital.org/cdm/singleitem/collection/mpls/id/10691 (accessed 14 February 2014).

[26] “A Busy Scene,” *Minneapolis Tribune,* 6 May 1881.

[27] “Local and Personal,” *Northwestern Miller,* 22 February 1881, 1 April 1881, 29 April 1881, 6 May 1881, and 20 May 1881.

[28] Kane defines a millpower as “the amount of power that could be derived from 30 cubic feet of water per second used on a twenty-two food head. Theoretically, this volume and head would create seventy-five horsepower,” Kane, 55; “Local and Personal,” *Northwestern Miller*, 1 July 1881 and 15 July 1881; J.T. Banker, “Location of Center Line of Main St. at Second Ave SE,” 8 May 1891, Northern State Power Company Records of Predecessor Companies; Minnesota Title Insurance and Trust Co., “Abstract of Title to Lots 13, 14, 15, and 5 Feet Lot 16 Near Lot 15 of Block 5 St. Anthony Falls.”

[29] “Local and Personal,” *Northwestern Miller,* 8 April 1881; Kane, 122; Coddington, 7-57.

[30] “Local and Personal,” *Northwestern Miller,* 8 April 1881; Kane, 122; Coddington, 7-57.

the Pillsbury A Mill for several weeks.[31] An assessment of the tunnel's condition revealed the floor of both the turbine pits and the tunnel were too weak. Over the next few months, production at the Pillsbury A Mill and the Phoenix Flour Mill ceased as the SAFWPC fixed the problem by rebuilding the tunnel floor and replacing the original 12-inch plank with heavier plank.[32] The turbine pit floor was reconstructed using concrete, timbers, and boiler iron to ensure protection from leakage.[33]

In the fall of 1881, after the tunnel floor was rebuilt, the finished half of the Pillsbury A Mill resumed production, while construction continued on the second unit of the mill machinery and the downriver tailrace. At times throughout 1881 and 1882 construction required the productive half of the Pillsbury A Mill and the Phoenix Flour Mill to shut down.

In January of 1882, as construction continued, the North Star Grist Mill took advantage of the tunnel and constructed a tailrace connecting to the Pillsbury A Mill tailrace. Six months later work on the downriver half of the mill and downriver tailrace was complete (see Figure 4). That summer, the Pillsbury A Mill, powered by direct-drive water power through the completed Pillsbury A Mill tunnel system, began full production.[34]

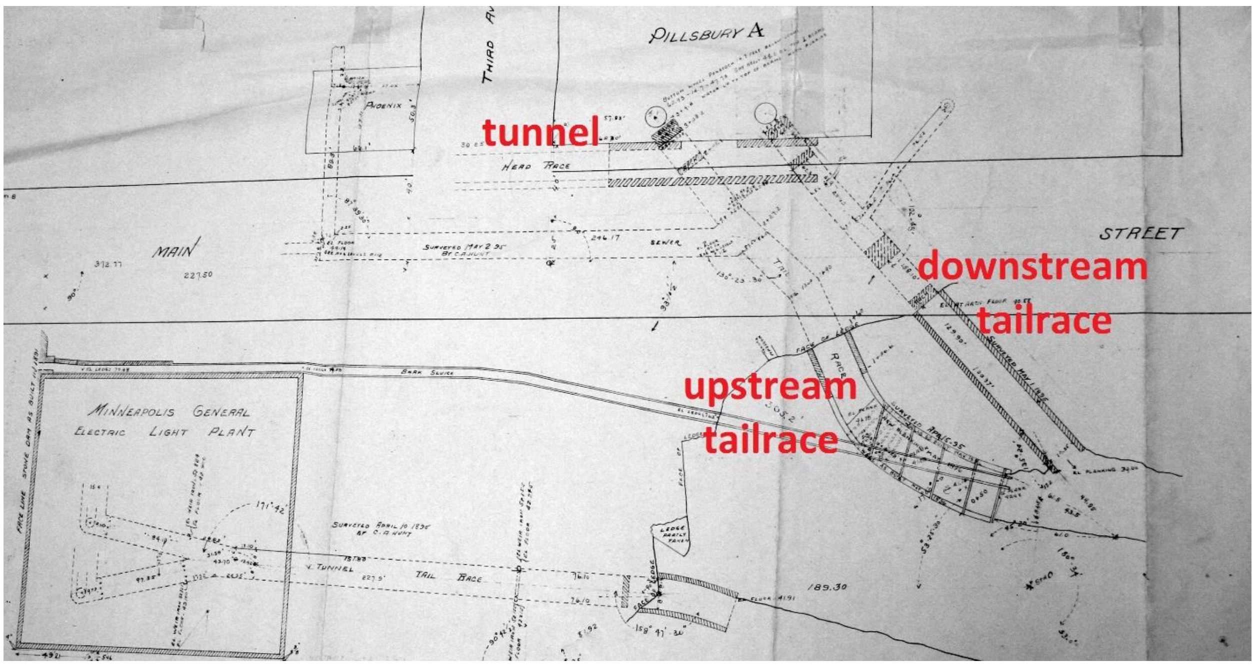

Figure 4. Map showing the location of the Pillsbury A Mill tunnel tailraces. It is the earliest available drawing of the two tailraces. The map is undated, and was inventoried in the U.S. Army Corps of Engineers library in 1938. Adapted by Mead & Hunt, Inc. "Minneapolis GE and Pillsbury A Mill Tail Race Tunnels," n.d. Available at the U.S. Army Corps of Engineers library, St. Paul, Minn.

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[31] "Local and Personal," *Northwester Miller,* 12 August 1881.

[32] "Local and Personal," *Northwestern Miller,* 19 September 1881.

[33] "Local and Personal," *Northwestern Miller,* 26 August 1881.

[34] "Local and Personal," *Northwestern Miller,* 18 November 1881 and 2 January 1882; *A History of Pillsbury's "A" Mill.*

(1) Construction materials

Though little is known about the origins of the stone used to construct the tunnel, stone construction of nearby projects may provide insight. Located just below the falls, the Stone Arch Bridge was designed for James J. Hill by bridge engineer Col. Charles C. Smith and constructed by the Minneapolis Union Railway Company between 1881 and 1883. Smith utilized Kasota limestone and St. Cloud granite to construct the imposing bridge spanning the Mississippi. The granite came from Sauk Rapids, and the limestone was quarried at Mankato, Minnesota, and Stone City, Iowa. Unexposed limestone was quarried on site.[35] These same limestone varieties may have been used in the construction of the Pillsbury A Mill tunnel, which occurred around the same time. A *Northwestern Miller* article detailing construction progress on the tunnel explains, "the excavators are now about 20 feet deep the whole length of the canal, at this depth the limestone is reached and there will be from five to ten feet of this to be quarried out."[36] Since none of the tunnel was meant to be exposed, and did not need to be constructed of a higher quality material, it is possible the limestone quarried out during excavation was used to construct the tunnel system. The off-site quarries from which materials were obtained for the Stone Arch Bridge are another possible source of limestone, as both structures were built for the same owner, James J. Hill, within one year of each other.

(2) The Pillsbury A Mill tunnel during the peak of Minneapolis milling

As mill productivity increased and water power became less reliable due to seasonal low water levels, the Pillsbury A Mill added auxiliary steam power to supplement direct drive water power. Minneapolis was experiencing a water power shortage at the beginning of 1884, prompting the Pillsbury Company to install auxiliary steam engines in the Pillsbury A Mill by the end of February.[37] Although the Pillsbury A Mill had steam power engines to augment the water power, it still relied primarily on the tunnel for direct drive water power.[38]

In 1887 the Minneapolis Mill Company and SAFWPC both came under the ownership of the Pillsbury-Washburn Flour Mills Company, Ltd. The new owner worked to increase power output to mills and began building a major hydroelectric site at the falls.[39] William De la Barre, engineer for the company, began a series of measures that would promote efficient consumption of the limited water power supply. The company dredged out the east side mill pond, repaired dams, maintained water levels in the mill ponds, and enforced water power lease amounts. Barre's efforts preserved water power availability for the mills.[40]

By the early twentieth century the Pillsbury A Mill required greater power to increase productivity. In 1901 the SAFWPC deepened the downriver tailrace in conjunction with the installation of new 2,500-horsepower, 56-inch Sampson water turbines. However, the new turbines alone did not produce enough

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[35] Mead & Hunt, "Stone Arch Bridge," Minnesota Historic Property Record, 2006, http://www.dot.state.mn.us/historicbridges/pdf/27004MHPR.pdf (accessed 31 January 2014).

[36] "Local and Personal," *Northwestern Miller,* 11 May 1881.

[37] "The Minneapolis Mills in 1884," *Northwestern Miller,* holiday edition 1884-1885; Kane, 119.

[38] *Minneapolis, Minnesota, vol. 2* (New York: Sanborn Map and Publishing Co., 1885), http://sanborn.umi.com.ezproxy.hclib.org/mn/4339/dateid-000001.htm?CCSI=8887n (accessed 25 February 2014).

[39] Kane, 146; *Minneapolis Tribune,* 14 May 1895.

[40] Kane, 146-149.

power, and later that year the company added a new steam plant to the mill. Over the next decade, steam engines increased power to the Pillsbury A Mill, and in 1909 the SAFWPC constructed a steam powerhouse for the mill. Ten years later steam lines were added to the tunnel.[41]

(3) The decline of water power and Pillsbury A Mill tunnel use

In 1923 the Northern States Power Company acquired the Minneapolis Mill Company and the SAFWPC from the Pillsbury Flour Mills Company, the successor company of Pillsbury-Washburn Flour Mills Company, Ltd., which also owned the Pillsbury A Mill and tunnel system. The Northern States Power Company became the primary supplier of electricity to the Twin Cities and communities in surrounding states, and St. Anthony Falls was an important part of Northern State Power Company's hydroelectric developments. The new owner utilized the falls for electrical power generation, using less and less water to power turbines at the mills. However, the Pillsbury A Mill tunnel system remained in use, bringing direct drive water power to the mill.

Over the next few decades, milling along the falls declined as distribution and consumption patterns, freight rates, and the availability of spring wheat drove millers to construct new mills elsewhere. By 1930 Buffalo, New York, was the flour milling center of the country. However, some large mills continued to operate in Minneapolis, including the Washburn A and Pillsbury A Mills.

The Pillsbury A Mill tunnel underwent a few alterations during the mid-twentieth century. In 1949 plans for a Great Northern Railway rail spur on the southwest side of the Pillsbury A Mill were approved. The railroad spur crossed over the Pillsbury A Mill tunnel, and a portion of the tunnel roof was reinforced with a series of closely spaced metal I-beams to carry the weight. Basic tunnel maintenance continued, and in 1951 a concrete pier was built to reinforce the ledge above the downriver tailrace.[42]

After using direct drive water power for more than 70 years, the Pillsbury A Mill switched completely to electrical grid power in 1955. As the company installed large motors, the tunnel was no longer needed to transport water to the turbines. As a result, the tunnel was blocked off at the river intake, and the upriver tailrace was converted to a storm sewer for the city of Minneapolis. Two years later the SAFWPC officially dissolved, and the separate water power firms on the east and west banks of the river combined to form the St. Anthony Hydro Division of the Northern States Power Company.[43] By the mid-twentieth century few mills remained in operation along the falls. After the Washburn A Mill closed in 1965, the Pillsbury A Mill was the last operating flour mill in the area.

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[41] "Local and Personal," *Northwestern Miller,* 18 March 1889; "More Power for Pillsbury A," *Minneapolis Journal,* 22 February 1901;"Improvements Pillsbury A Mill," *Minneapolis Journal,* 2 December 1901; "Electric Mill Power May Supersede Steam," *Minneapolis Tribune,* 6 December 1910; St. Anthony Falls Water Power Company, "Steam Power House for Pillsbury Flour Mills Company," 27 October 1909; "History of Pillsbury Property Expansion Land and Buildings," available at General Mills Archives, Minneapolis.

[42] Kane, 171; Great Northern Railway, "Bridge Over Intake Canal at Pillsbury Flour Mill General Plan," August 1949; Office of the Inspector of Buildings, "Permit to Build Outside of Fire Limits No. B324320," 24 October 1951; "A Mill – Minneapolis," timeline available at General Mills Archives, Minneapolis.

[43] Kane, 174; "Archaeology of the Central Minneapolis Riverfront," *The Minnesota Archaeologist* 48 (1989): 109.

Since the tunnel was no longer in use, only general maintenance activities affected the tunnel during the mid- and late twentieth century. The turbines were not removed until 1992 in preparation for the sale of the Pillsbury A Mill. No further activity or maintenance is recorded until debris removal began in 2013.[44] Presently, the owner of the Pillsbury A Mill complex, which includes the tunnel system, is actively redeveloping the Pillsbury A Mill complex into residential housing units for artists.

(4) Pillsbury A Mill Tunnel construction summary, 1856-2014[45]

1856 Franklin Steele forms the SAFWPC.

1880 James J. Hill acquires the SAFWPC.

1881 The SAFWPC constructs the Pillsbury A Mill tunnel.

1885 First reference to auxiliary steam power usage at Pillsbury A Mill.

1901 The SAFWPC widens the downriver tailrace and installs new 2,500-horsepower, 56-inch Sampson water turbines to replace the original 1,200-horsepower, 55-inch Victor water turbines.

1919 Steam lines and electrical cables are added to the Pillsbury A Mill tunnel.

1951 A concrete pier is constructed to reinforce the ledge over the downriver tailrace.

1955 Water power use is discontinued at the Pillsbury A Mill and a bulkhead is installed at the tunnel intake to block off the tunnel. The upriver tailrace is used as a storm sewer. The Mill is now powered entirely by electricity.

1962 Alterations are made to the tunnel (alterations not specified).

1992 The turbines are removed. Pillsbury A Mill is sold to Archer Daniels Midland.

2003 All production at the Pillsbury A Mill is shut down.

2013 The Pillsbury A Mill is acquired by Dominium after ownership is transferred several times since 1992.

2013-2014 The tunnel is cleaned out in preparation for inspection and evaluation.

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[44] Buchta, "Pillsbury A Mill Renovation Project is Back, on a New Track."

[45] Sources consulted to compile the construction history of the Pillsbury A Mill Tunnel include articles from the *Northwestern Miller*, *Minneapolis Journal*, and *Minneapolis Tribune*, Lucile Kane's history, *The Falls of St. Anthony*, City building permits for the tunnel, *Minneapolis, Minnesota, vol. 1,* New York: Sanborn Map and Publishing Co., 1885, the *Minnesota Archeologist* Journal, the St. Anthony Falls Historic District National Register Nomination, the Historic Preservation Certification Application for the East Bank, and various maps.

4. Physical Description

A. Overview of tunnel system plan and alignment

The Pillsbury A Mill tunnel system was designed and constructed to convey a large, continuous flow of water from the Mississippi River to twin hydraulic turbines located beneath the center of the mill's southwest (front) wall. Water was received at the Mississippi River intake at the tunnel's upriver (northwest) end and conveyed downriver (southeast) through the tunnel headrace to the forebay near the location of the turbines. After passing through the forebay, the flow divided between the two drop shafts, one upriver and one downriver. After passing through the turbines at the bottom of the drop shafts, the water exited directly into two tailraces and returned to the river (see Figure 5 for a site plan).

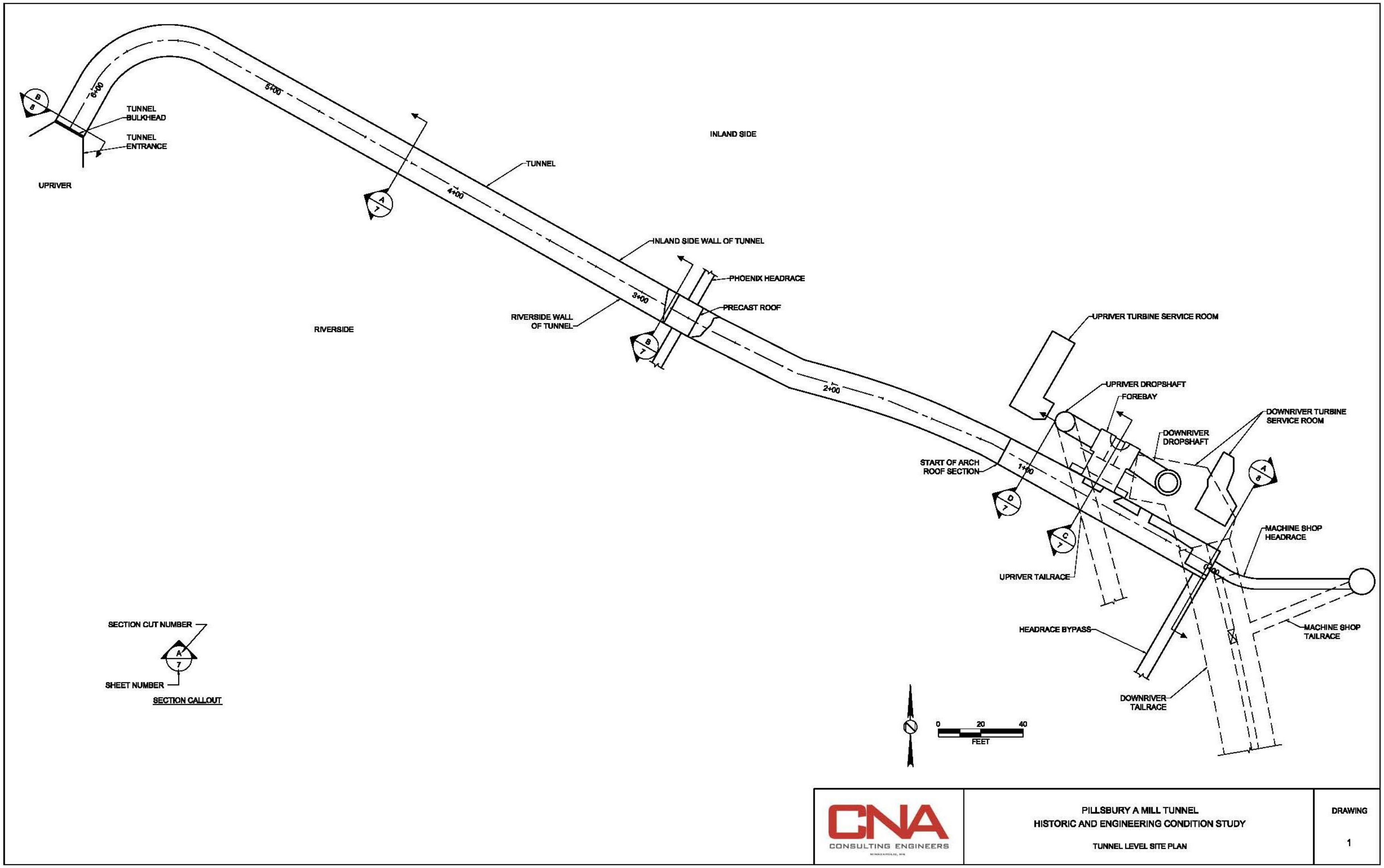

Figure 5. Pillsbury A Mill tunnel drawing, provided by CNA Consulting Engineers, "Tunnel Level Site Plan," 28 May 2014.

B. Tunnel headrace

The primary portion of the tunnel, known as the headrace, is a continuous, approximately 600-foot, underground structure beneath Main Street Southeast, that is aligned primarily northwest-southeast. For most of the tunnel headrace's length the alignment parallels the Mississippi River, which is located southwest of the tunnel. The northwest end, or tunnel intake, opens onto the river at a point beneath the extension of Second Avenue Southeast. The tunnel headrace then extends about 45 feet northeast, where it curves 90 degrees southeast to an alignment beneath Main Street Southeast. It extends for approximately 450 feet directly beneath Main Street Southeast to the intersection of Third Avenue Southeast and Main Street Southeast.

At the intersection of Third Avenue Southeast and Main Street Southeast, the tunnel headrace turns diagonally northeast on a new alignment adjacent to the southwest wall of the Pillsbury A Mill. It continues straight along the southwest wall of the mill for approximately 110 feet, terminating at the machine shop headrace entrance.

The tunnel is partly cut into existing bedrock, which constitutes the tunnel floor, and partly built-up with sidewall buttresses constructed of limestone block masonry. In some sections the tunnel walls are largely original rock, and in other areas, they are largely built-up limestone masonry.

Yellow brick was randomly placed in voids between bedrock and the built-up limestone masonry along the tunnel walls. The roof of the tunnel is continuous limestone round arch, constructed in two long, unbroken sections. The first arch section extends from the tunnel intake, around the 90-degree curve, to the point where the Phoenix Flour Mill headrace intersects with the tunnel. The arch begins again on the southeast edge of the Phoenix Flour Mill intersection and continues to a point near the southwest corner of the Pillsbury A Mill building. A visible line of keystones extends the full length of each tunnel section. The ends of the two tunnel sections have finished masonry detail with arch rings of voussoir stones. The tunnel is 15 feet, 2 inches wide and 24 feet tall.[46]

The features described below are located along the length of the tunnel headrace, from northwest (upriver) to southeast (downriver), and constitute the only notable features in the headrace.

(1) Tunnel intake

The tunnel intake is located at the extreme upriver end of the tunnel where it opens to the Mississippi River at the location of the old SAFWPC mill pond. The exterior, or river side, of the intake is flanked by short diagonal wingwalls. According to the 1881 tunnel plan, a large pier divides the intake, creating two gateways.[47] When the tunnel system was removed from service, there was either one extensive bulkhead or two bulkheads (one that is visible from the exterior and that extends further into the river than the pier at the intake mouth and another one that is visible from the interior of the tunnel) added across

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[46] CNA Consulting Engineers, "Typical Cross-Section Pillsbury A Mill," 19 February 2014.

[47] *"Plan of Canal in process of construction by the St. Anthony Water Power Company," 19 February 1880 (correction: 1881). Available at http://reflections.mndigital.org/cdm/singleitem/collection/mpls/id/10672 (accessed 14 February 2014).*

the entire entrance to the tunnel system. On the interior side of the intake the concrete bulkhead extends from the floor to the top of the arch, and from wall to wall. A 1-foot by 1-foot opening, now partially closed, is centered in the bulkhead, approximately 5 feet above the floor.

(2) Phoenix Flour Mill headrace intersection

As previously discussed, a portion of the Phoenix Flour Mill headrace, which predated the Pillsbury A Mill tunnel, was incorporated into the Pillsbury A Mill tunnel system. It is aligned perpendicular to the tunnel and intersects with the inland (northeast) side of the Pillsbury A Mill tunnel headrace about 100 feet upriver of Third Avenue Southeast. It extended under Main Street Southeast to the nonextant Phoenix Flour Mill on the northeast corner of Main Street Southeast and Third Avenue Southeast. When it was in use, the Phoenix Flour Mill headrace conveyed water through the inland wall of the Pillsbury A Mill tunnel headrace, where it transported water inland to the Phoenix Flour Mill. At the location where the Phoenix Flour Mill headrace was incorporated into the Pillsbury A Mill tunnel, the stone arch of the headrace tunnel terminates on both sides of the Phoenix Flour Mill headrace. The Phoenix Flour Mill headrace has a flat roof covered by a rectangular wood plank panel, and the floor is cut slightly deeper in the bedrock than that of the tunnel headrace. The outline of two circular openings to the former Phoenix Flour Mill headrace remain on the inland and riverside (southwest) walls of the Pillsbury A Mill tunnel headrace. The remainder of the headrace, which ran from the east side mill pond to the river side of the Pillsbury A Mill tunnel, was completely blocked off from the Pillsbury A Mill tunnel headrace. The inland and riverside circular openings are nominally 7 feet in diameter and outlined in brick. The inland opening is covered by a deteriorated, circular metal gate that is bolted in place with modern clamps. Timber remnants of the original gate operating mechanism remain on either side of the opening. The riverside tunnel opening was completely blocked with stone infill at the time of Pillsbury A Mill tunnel construction.

(3) Railroad spur “bridge” imbedded in tunnel roof

The flat tunnel roof that begins at the northwest corner of the Pillsbury A Mill has been reinforced to carry a railroad spur aligned longitudinally directly above the tunnel and along the southwest wall of the mill. In 1949 closely spaced rows of steel I-beams were placed laterally across the top of the tunnel to create the railroad spur “bridge.”[48] Some I beams have recently been cut, creating a rectangular opening in the roof to provide access to the tunnel below.

(4) Catch basin lead through the river side wall

A rectangular opening is located high on the river side tunnel wall, opposite the forebay. It appears to have been cut into the stone masonry wall after the tunnel was constructed, and not part of the original masonry wall construction. However, research did not reveal the date this occurred. It reportedly functions as a manhole access tunnel.

(5) Location of nonextant trash rack

A large metal trash rack was located at the downriver edge of the forebay opening, where it originally extended across the width of the tunnel. It was removed in 2013 and remnants of the original metal hardware remain in the tunnel wall.

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[48] Great Northern Railway, “Bridge Over Intake Canal at Pillsbury Flour Mill General Plan,” August 1949.

(6) Headrace bypass

Along the southwest wall, several feet from the downriver end of the tunnel, the outline of a round tunnel is visible, similar in form to the Phoenix Flour Mill tailrace. It is sealed with a deteriorated circular metal door or gate, similar to the Phoenix Flour Mill tailrace door. Remnants of a gate operating mechanism, including a vertical shaft with central wheel and timbers, remain mounted to the stone masonry tunnel wall above the opening.

(7) Tunnel endwall

A rectangular vertical iron gate is mounted on the endwall, installed to control headrace flow into the machine shop headrace that is located beyond the main tunnel. The tunnel extends beyond the gate into the machine shop headrace, drop shaft, and turbine pit. Remnants of a gate operating mechanism are located on the stone masonry wall above the gate. Remnants of various unidentified pipes and hardware are visible on the inland wall and southeast corner of the tunnel.

C. Forebay

The forebay, located in the middle of the southwest wall of the Pillsbury A Mill, is a very large space, enclosed on three sides and open to the tunnel on the fourth side. The space is approximately 21 feet by 24 feet. The top of the forebay is open to the interior of the mill basement. The forebay directed water flow from the headrace into the two drop shafts. (The upper part of the forebay is visible inside the basement as a rectangular structure of thick, buttressed, stone-masonry walls extending into the basement area from the west wall of the mill.) In the tunnel area, the forebay is accessed through a wide arched opening in the tunnel’s inland wall. The lower sections of the arch, beginning at the tunnel floor and extending upwards, are faced with brick, creating battered brick corner piers with rounded corners. The brick is fastened to the stone arch with metal bolts. The back, or northeast, wall of the forebay is also sheathed in brick, which is severely deteriorated and contains remnants of unidentified wall-mounted hardware. A recently installed metal access ladder at the northwest corner extends from the forebay floor to the forebay top and into the interior of the basement.

(1) Sluice gates

On the upriver and downriver walls of the forebay, 6.5-foot by 10-foot metal vertical sliding gates open onto the drop shafts and turbine pits. Each wall has a pair of metal gates and each gate was independently operated. Remnants of the timber beam framework surrounding the gates, and gate operating systems, are visible above each pair of gates. The sluice gate mechanisms extended into the basement of the Pillsbury A Mill through the upper portion of the forebay; however, these mechanisms no longer remain in place.

D. Drop shafts and turbine pits

Beyond the gates, brick archways open onto rooms with drop shafts and turbine pits in the floors. The drop shafts appear to be metal-lined. Though the turbines were removed in 1992, the turbine rings remain in place at the bottom of the turbine pits, above the exits to the tailraces.

(1) Turbine service rooms

Adjacent to each drop shaft and turbine pit is a turbine service room. The rectangular upriver turbine service room is northwest of the upriver turbine pit, and the L-shaped downriver turbine service room is southeast of the downriver turbine pit. These rooms have concrete walls and a deteriorated iron access stairway and ramp leading up to the basement. The turbine service rooms are filled with remnants of original unidentified hardware and metal fittings and debris. The upriver turbine service room opens to the drop shaft turbine pit through a round opening; however, such an opening in the downriver service room is unconfirmed due to debris.

At an unknown date, the basement floor openings to the access stairways and ramps were sealed with corrugated steel panels covered with concrete. In recent years, however, two small rectangular holes were cut through the concrete above each turbine service room to allow limited access from the basement.

E. Tailraces

The two tailraces run diagonally from northwest to southeast under Main Street Southeast and on to the river. The machine shop tailrace empties into the downriver tailrace south of the turbine pit. The upriver tailrace exit at the Mississippi River is blocked by a steel bulkhead with an access door, while the arched downriver tailrace exit is open to the river.

5. Significance of the Pillsbury A Mill Tunnel System

The Pillsbury A Mill tunnel system is a contributing feature of the St. Anthony Falls Historic District and the Pillsbury A Mill complex. The Pillsbury A Mill was designated as a National Historic Landmark and listed in the National Register in 1975, and the St. Anthony Falls Historic District was listed in the National Register in 1971. This section provides a discussion of the National Register *Criteria for Evaluation* under which the tunnel is significant as a contributing resource to these listed properties. It also includes discussion of the tunnel's period of significance, character-defining features, and integrity.

A. Criteria

The criteria for evaluating the eligibility of a property for listing in the National Register includes:

- The quality of significance in American history, architecture, archeology, engineering, and culture is present in districts, sites, buildings, structures, and objects that possess integrity of location, design, setting, materials, workmanship, feeling, and association, and:

  A. That are associated with events that have made a significant contribution to the broad patterns of our history; or

  B. That are associated with the lives of significant persons in or past; or

  C. That embody the distinctive characteristics of a type, period, or method of construction, or that represent the work of a master, or that possess high artistic values, or that represent a significant and distinguishable entity whose components may lack individual distinction; or

  D. That have yielded or may be likely to yield, information important in history or prehistory.[49]

In addition to the National Register criteria, the criteria for evaluating the eligibility of a property for listing as a National Historic Landmark includes:

- The quality of national significance is ascribed to districts, sites, buildings, structures, and objects that possess exceptional value or quality in illustrating or interpreting the heritage of the United States in history, architecture, archeology, engineering, and culture and that possess a high degree of integrity of location, design, setting, materials, workmanship, feeling, and association, and:

  1. That are associated with events that have made a significant contribution to, and are identified with, or that outstandingly represent, the broad national patterns of United States history and from which an understanding and appreciation of those patterns may be gained; or

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[49] National Register of Historic Places, *National Register Bulletin 15: How to Apply the National Register Criteria for Evaluation* (Washington, D.C.: National Register of Historic Places, National Park Service), 1990.

2. That are associated importantly with the lives of persons nationally significant in the history of the United States; or

3. That represent some great idea or ideal of the American people; or

4. That embody the distinguishing characteristics of an architectural type specimen exceptionally valuable for a study of a period, style or method of construction, or that represent a significant, distinctive, and exceptional entity whose components may lack individual distinction; or

5. That are composed of integral parts of the environment not sufficiently significant by reason of historical association or artistic merit to warrant individual recognition but collectively compose an entity of exceptional historical or artistic significance, or outstandingly commemorate or illustrate a way of life or culture; or

6. That have yielded or may be likely to yield information of major scientific importance by revealing new cultures, or by shedding light upon periods of occupation over large areas of the United States. Such sites are those which have yielded, or which may reasonably be expected to yield, data affecting theories, concepts, and ideas to a major degree.[50]

B. Previous studies

Several previous studies have outlined the historic significance of the Pillsbury A Mill and St. Anthony Falls Historic District. Reports concerning the Pillsbury A Mill include the National Historic Landmark Nomination for the Pillsbury A Mill, completed in 1975; the Pillsbury A Mill National Register Nomination, also written in 1975; and the 1987 Historic American Building Survey (HABS) documentation for the Pillsbury A Mill. Reports regarding the St. Anthony Falls Historic District include a National Register Nomination written in 1971 and supplemented in 1991, and the Historic Preservation Certification Application for the East Bank Mill site. Although discussion of the tunnel is limited, it is considered contributing in several reports, and therefore assumed to be a contributing feature of the overall Pillsbury A Mill complex and St. Anthony Falls Historic District.

C. Significance of the Pillsbury A Mill tunnel

(1) *Criterion A*

The Pillsbury A Mill tunnel is significant under National Register *Criterion A* for its role in the historic development of waterpower at St. Anthony Falls. It is part of the St. Anthony Falls Waterpower Area within the St. Anthony Falls Historic District. This section of the district is significant for its contribution to the patterns of waterpower development at the falls.[51] The tunnel played a major role in the history of

[50] National Register Bulletin 15: How to Apply the National Register Criteria for Evaluation.

[51] Coddington, 7-1.

east bank waterpower development as the largest direct-drive water power project undertaken by the SAFWPC.

The tunnel is also significant under *Criterion A* for its role in supplying water power to the Pillsbury A Mill, a National Historic Landmark significant for its role as an iconic and influential mill in Minneapolis and the U.S. Minneapolis was the flour milling center of the country from 1880 to 1930, and the Pillsbury A Mill contributed greatly to the city's rise to prominence. It was the largest and most productive mill in the world at the time of its construction, and continued to improve efficiency in the following decades. The Pillsbury A Mill defined the east bank of the Mississippi River, and the massive complex was the most prominent member of the milling community along St. Anthony Falls.

(2) *Criterion C*

The Pillsbury A Mill tunnel is significant under *Criterion C* for engineering as part of the Pillsbury A Mill complex. It is significant as an integral part of the production system of the Pillsbury A Mill. The mill's architecture and record-breaking production capacity made it the largest mill in the country at the time of construction. Pillsbury hired local architect Leroy S. Buffington to design the mill, making it the only major mill designed by an architect rather than an engineer or builder/contractor. The design and form of the mill, with the primary facade on the long side of the building, made it stand out from vernacular mills, compounding the impressiveness of its size with its architectural design. The Pillsbury A Mill set record production numbers of 5,000 barrels of flour per day soon after construction, and doubled these numbers by 1894. Production continued to increase in subsequent years, hitting 14,000 barrels a day in 1921.[52] The tunnel system played a large role in production. The two identical Pillsbury A Mill machinery units were powered by the two turbines, and production was solely based on direct drive waterpower at the time of construction. Though eventually augmented with steam power, the tunnel and turbines continued to support the brunt of the production until the level of productivity necessitated greater steam power supplements after the turn of the century.[53] The turbines supplied power to the mill until 1955.

(3) *Criterion D*

The Pillsbury A Mill tunnel is also significant under *Criterion D* as an archeological site that could provide information pertaining to waterpower and milling.[54]

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[52] Coddington, 7-8, 27; Robert M. Frame, "The Progressive Millers, A Cultural and Intellectual Portrait of the Flour Milling Industry, 1870-1930, Focusing on Minneapolis, Minnesota" (PhD dissertation, University of Minnesota, 1980), 125.

[53] "Local and Personal," *Northwestern Miller,* 18 March 1889; *Minneapolis Journal,* 22 February 1901, 2 December 1901; *Minneapolis Tribune,* 6 December 1910; St. Anthony Falls Water Power Company, "Steam Power House for Pillsbury Flour Mills Company," 27 October 1909; "History of Pillsbury Property Expansion Land and Buildings," available at General Mills Archives, Minneapolis.

[54] Coddington, 8-1; "National Park Service Historic Preservation Certification Application-Part 1 Evaluation of Significance: Accessory buildings to the Pillsbury A Mill, East Bank Mills site."

(4) Period of significance

The period of significance for the Pillsbury A Mill tunnel is 1881-1955. It begins with the tunnel's construction date, 1881, and concludes in 1955, when tunnel use was discontinued and the tunnel was blocked off.

D. Character-defining features

Character-defining features are prominent or distinctive visual and physical aspects, qualities, or characteristics that contribute significantly to a of a historic property's physical character. Features may include form, materials, craftsmanship, engineering design, and structural and decorative details. The following character-defining features of the Pillsbury A Mill have been identified:

- Feature 1: The limestone masonry arch construction continuing uninterrupted from the tunnel intake, around the 90-degree curve about 45 feet northeast of the intake, and extending about 450 feet to the Phoenix Flour Mill tailrace. Though briefly interrupted by the Phoenix Flour Mill tailrace, it continues approximately 150 feet past the tailrace to the edge of the Pillsbury A Mill.

- Feature 2: Design of a complete and intact long tunnel structure and water power system with great integrity extending from the intake under the extension of Second Street Southeast, along Main Street Southeast, through the forebay, drop shafts, turbine pits, and tailraces, and ending under the Pillsbury A Mill at the Mississippi River.

- Feature 3: The unique underground design and construction of the forebay and turbine pits that included twin 1,200-horsepower turbines.

E. Integrity

The integrity of the Pillsbury A Mill tunnel has been evaluated using the seven aspects of integrity defined in *National Register Bulletin 15: How to Apply the National Register Criteria for Evaluation*. The seven aspects are: location, design, setting, materials, workmanship, feeling, and association. These aspects affect a property's integrity, or "the ability of a property to convey its significance."[55]

(1) Integrity of location

National Register Bulletin 15 defines location as "the place where the historic property was constructed or the place where the historic event occurred." The Pillsbury A Mill tunnel retains integrity of location because all aspects of the underground system, including intake, main tunnel construction, forebay, sluice gates, drop shafts, turbine pits, and tailraces, remain in their original 1881-1882 location.

(2) Integrity of design

National Register Bulletin 15 defines design as "the combination of elements that create the form, plan, space, structure, and style of a property." The layout and design of the tunnel to carry water from the Mississippi River to the turbines remains intact, reflecting the design of the original construction to power

[55] *National Register Bulletin 15: How to Apply the National Register Criteria for Evaluation*, 44–45.

the Pillsbury A Mill. With the exception of the removal of the turbines and secondary trash rack, and blocked intake and turbine pit access stairs, the tunnel retains integrity of design. There does not appear to be any other major alterations to the tunnel system.

(3) Integrity of setting

National Register Bulletin 15 defines setting as “the physical environment of a historic property.” Because the tunnel is underground, and the interior of the tunnel is the significant portion of the structure, its setting has remained intact. The portions of the tunnel facing outside still front the Mississippi River; and the forebay, sluice gates, drop shafts, and turbine pits remain within the Pillsbury A Mill structure.

(4) Integrity of materials

National Register Bulletin 15 defines materials as “the physical elements that were combined or deposited during a particular period of time and in a particular pattern or configuration to form a historic property.” The Pillsbury A Mill tunnel retains original materials with the exception of the removal of the turbines (1992) and trash rack (2013), and added roof support below the 1949 railroad spur (1949).

(5) Integrity of workmanship

National Register Bulletin 15 defines workmanship as “the physical evidence of the crafts of a particular culture or people during any given period in history or prehistory.” The limestone tunnel structure has not experienced major changes since construction and remains intact.

(6) Integrity of feeling

National Register Bulletin 15 defines feeling as “a property’s expression of the aesthetic or historic sense of a particular period of time.” The Pillsbury A Mill tunnel retains integrity of feeling as an underground industrial tunnel with little alteration. Though the tunnel has been blocked off from the river and the turbines have been removed, it retains original physical features, such the arched limestone form, connection to the Pillsbury A Mill and Mississippi River, and a small amount of water. These characteristics convey the feeling of an underground industrial tunnel at its time of construction and use.

(7) Integrity of association

National Register Bulletin 15 defines association as “the direct link between an important historic event or person and a historic property.” The Pillsbury A Mill tunnel is largely unaltered; it is still connected to the Pillsbury A Mill and only separated from the Mississippi River by bulkheads at the intake and tailraces. As such, it clearly conveys its original purpose and relationship with the Pillsbury A Mill and the Mississippi River.

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6. Geological and Hydraulic Assessment

A. Geological

(1) Stratigraphy

Based on existing records, the top half of the tunnel lies in soil overburden and the bottom half lies in bedrock as shown in Figure 6. These materials are described below.

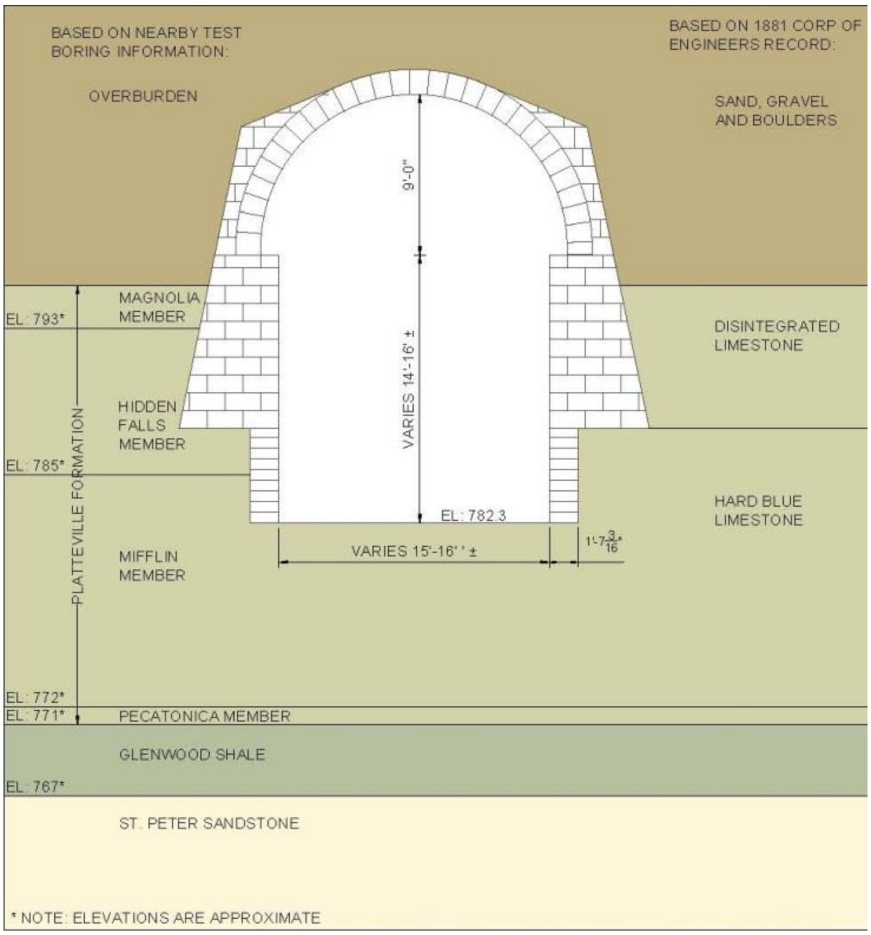

Figure 6. Tunnel construction and geology.

The Overburden most likely consists of sandy fill and glacially deposited sand and gravels with boulders.

The Platteville Formation is the uppermost bedrock at the site and consists of four members described below and shown in the tunnel section in Figure 6:

- The upper 6- to 8-foot-thick Magnolia member is a fossiliferous, finely crystalline dolomite.
- The middle 4- to 8-foot-thick Hidden Falls member is a massive, argillaceous, finely crystalline dolomite.

- The 10- to 13-foot-thick Mifflin member is a dolomitic limestone with crinkly-bedded shale partings. The tunnel floor lies in this member.

- The thin (10- to 16-inch) basal member, the Pecatonica, is a finely crystalline dolomite.

The unconfined compressive strength of unweathered rock in the Platteville formation typically ranges from 9,000 psi to 35,000 pounds per square inch (psi). The Hidden Falls member generally has the lowest compressive strength in tests on intact core, followed by the Mifflin, Magnolia, and the Pecatonica, respectively. Historical drawings produced by the Corps of Engineers label the upper 8 feet of the Platteville as “disintegrated limestone.” This could mean that this rock was weathered enough that it could be excavated without blasting.

The Glenwood Shale separates the basal layer of the Platteville limestone and the underlying St. Peter sandstone. It consists of a series of beds of soft, argillaceous, and sandy shale grading upwards to harder, shaley, dolomitic layers. The contact between the Glenwood and the Platteville limestone is distinct and irregular over a zone of 0 to 2 inches. The lower Glenwood is transitional into the St. Peter sandstone.

The Glenwood shale tends to weaken and slake off when exposed by excavation. It does form a relatively impervious layer so that water in the overlying limestone is commonly perched above it. Unconfined compressive strength of Glenwood shale has been found to be as high as 7,200 psi. However, considerably weaker shale occurs in layers in the formation.

The St. Peter Sandstone is a low-strength quartz sandstone. Most of the St. Peter sandstone is uniform, white, and friable sandstone and typically contains more than 98 percent silica. The sand grains are nearly all 0.15 to 0.4 millimeters in diameter. The larger grains are rounded, frosted, and pitted, while the smaller grains are more angular and form interlocking aggregates. Minor amounts of clay minerals and carbonates provide some cementing strength, but most of the strength is believed due to compaction and interlocking.

Water moving along a sandstone joint can erode the friable sandstone, and, where the loosened sand can migrate, voids may develop. Voids have been known to form near or next to lined tunnels and within hundreds of feet of river bluffs and buried valleys.

The unconfined compressive strength of the St. Peter sandstone typically ranges from 0 psi to 500 psi. However, nodules or concretions have been found with compressive strengths as high as 14,600 psi.

(2) Partial geologic history of St. Anthony Falls

Over a period of 10,000 years, St. Anthony Falls has retreated from the confluence of the Minnesota and Mississippi Rivers to its present location. This retreat was stopped in the 1800s when construction of a dam at St. Anthony Falls began. Before dam construction, retreat of St. Anthony Falls was controlled by the stratigraphy of the bedrock units. As water flowed over the edge of the relatively hard Platteville Formation, it eroded the softer St. Peter sandstone below. This erosion caused the Platteville to be undercut. When the undercutting reached vertical fractures in the Platteville, rock blocks would fall and St. Anthony Falls retreated upriver.[56]

(3) Tunnel stone masonry

The tunnel is constructed of rock masonry walls, arched roof, and a bedrock floor. The quarried stone blocks mined from the Platteville Formation, probably in nearby quarries.

The thicker stone masonry units were mined from the Hidden Falls member. The massive nature of this dolomite allowed the creation of these larger units. However, this is the weakest member of Platteville and it has a relatively higher clay mineral content than the rest of the formation, which leads to faster deterioration due to freeze/thaw and other weathering forces.

The thinner stone masonry units are from the Mifflin member. These are easily identified by the crinkly bedding of lighter dolomite and darker shale layers. The closely spaced shale layers limited the thickness of these units. The shale layers tend to weather faster, accentuating the contrast with the dolomite layers.

B. Hydraulic

(1) River pool levels

The invert elevation of the tunnel is located at approximately elevation 782 feet. The normal pool elevation above the upper dam is 799 feet. Therefore, the tunnel floor is approximately 17 feet below river level. The downstream normal pool elevation between the two dams is 750 feet, resulting in a hydraulic head of approximately 49 feet for the A Mill hydraulic structures.

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[56] Thomas Madigan, “The Geology of the MNRRA Corridor” in John O. Anfinson, *River of History: A Historic Resources Study of the Mississippi National River and Recreation Area* (St. Paul: Army Corps of Engineers, 2003), 23.

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7. Structural Assessment

A. General system description

The Pillsbury A Mill water power structure complex consists of a number of different components including the following:

- Tunnel (headrace)
- Tunnel intake
- Forebay
- Upriver drop shaft
- Upriver turbine service room
- Upriver tailrace
- Downriver drop shaft
- Downriver turbine service room
- Downriver tailrace

Drawing 1 in Appendix B is the Tunnel Level Site Plan, a graphical diagram of the Pillsbury A Mill tunnel level power structure complex.

The tunnel structure was predominantly constructed of limestone locally quarried from the Mifflin and Hidden Falls members of the Platteville Limestone formation. The upper 8 to 10 feet of weathered limestone were excavated with the invert (floor) of the tunnel bearing in the Mifflin member. The limestone blocks were laid in a squared-stone (or ashlar) fashion. Based on the thickness of tunnel buttresses, the stone masonry behind the facing stones was likely from rubble masonry.

B. Structure condition ratings

The structural condition is the primary factor used to determine the capability of the tunnel or structure to continue to function as intended. The following condition ratings categorize the structure by the likelihood that the structure will continue to deteriorate and the risk of failure.

- Good: The tunnel or structure is structurally adequate and defects are not causing deterioration. The tunnel or structure requires monitoring but no maintenance or rehabilitation is currently necessary.

- Fair: The tunnel or structure is structurally adequate but defects are causing deterioration. The tunnel or structure requires monitoring and maintenance. No rehabilitation is currently necessary.

- Poor: The tunnel or structure is structurally inadequate, defects have caused advanced deterioration. The tunnel or structure requires rehabilitation.

- Urgent: The tunnel or structure is structurally inadequate or has a service-impeding defect. The tunnel or structure requires immediate corrective action.

Recommended repair and corrective actions are identified in each segment of the report by structure location.

C. Future hydrothermal and hydroelectric plans

Our current understanding is that a water supply from the Mississippi River's St. Anthony Lock and Dam Upper Pool will be conveyed via a 5-foot-diameter high density polyethylene (HDPE) intake pipe through the existing bulkhead and tunnel to the existing downriver drop shaft. The 5-foot-diameter pipe would be supported within the tunnel structure on a series of concrete saddles bearing directly on the existing tunnel limestone invert. The intake pipe will then be routed through the forebay and then down the downriver drop shaft to a turbine located at the base. After the water passes through the turbine, it will be discharged to the downriver tailrace and flow to the Mississippi River. Water for use in the hydrothermal system will be drawn off the proposed five-foot diameter HDPE pipe and then either discharged back into the intake pipe or into the downriver tailrace. The location of the generator and related equipment has not been determined.

D. Future interpretive center

Plans for the future interpretive center at the Pillsbury A Mill are still in the preliminary development stages. It is anticipated the future interpretive center would be located in the basement or mezzanine level of the Pillsbury A Mill near the forebay area. The interpretive center would continue the milling history story from the other side of the river at the Mill City Museum. The feasibility of providing an underground experience in the tunnel system that would provide a better understanding of how the tunnel connects to the Pillsbury A Mill and the rest of the milling system, and to compliment the activities in the interpretive center, is being explored. Providing access to the tunnel is the primary consideration in determining feasibility of the underground experience. It is recommended that existing access points or the reintroduction of former access points (e.g., access point established for tunnel clean-out process) are given priority consideration over the establishment of a new access point. It is also recommended that historic fabric impacts are minimized, to the greatest extent possible, and incorporated in the development of the tunnel access plans. As the more-detailed tunnel access plans are developed, a qualified professional engineer should review them to determine if any repairs and/or reinforcement to the tunnel system would be required.

E. Tunnel structure

The tunnel structure was visually inspected for signs of distress and deterioration. The lower 6 feet of the wall were routinely sounded to locate areas of delaminating stone and unbonded brick masonry. Due to the extreme thickness of the walls, drilling through the walls was attempted, but not be completed, with standard handheld hammer drills. The entire tunnel surface was photographed using digital photography. The photographs were then used to map the observed distress and deterioration. The tunnel structure walls were stationed every 25 feet to aid in determining the location of structural features, intersecting utilities and areas of deterioration. Drawings included in Appendix B illustrate the condition assessment for the tunnel structure. Figure 7 shows a section of the tunnel.

Figure 7. Rectangular tunnel section.

(1) Rectangular, steel beam roof segment

(a) Summary of field investigation

The tunnel structure from Station 0+00 to 1+12 consists of a rectangular cross section with quarried limestone masonry walls and a roof consisting of a steel wide-flange beam system supporting a corrugated steel and concrete deck. The tunnel cross section is approximately 16 feet wide by 28 feet tall. Within this tunnel segment, a number of substructures or features were observed and documented, including the following:

- Headrace bypass gate structure at Station 0+02 on the river side wall
- Headrace gate structure on southeast endwall, leading to the machine shop headrace
- Abandoned access tunnel on the southeast endwall, located just below the roof structure
- Brick arch structure on the inland side wall, from Station 0+40 to 0+75, leading to the forebay structure
- Catch basin lead through the river side wall at Station 0+57

The steel wide-flange roof beam structure was not specifically evaluated, as a comprehensive review and evaluation was performed by the building site developer.

(b) Qualitative structural rating

The rectangular tunnel section is in fair condition overall. No evidence of bulging walls or extensive cracking in the walls was observed. The main structural issues surrounding this segment of tunnel are missing mortar, deteriorating stonework due to freeze-thaw conditions, drummy (debonded) brick infills, and groundwater infiltration.

(c) Recommended maintenance repair options

The following table summarizes the recommended maintenance repairs for the observed structural deficiencies.

Table 1. Maintenance repair recommendations

Observed Deficiency	Recommended Repair
Missing mortar	Clean and tuckpoint missing mortar in excess of 1 inch
Deteriorating stonework	Remove deteriorating stonework, replace in kind where feasible, or replace with concrete or shotcrete in other locations
Debonded brickwork	Remove and replace with existing salvaged brick as necessary
Groundwater infiltration	Monitor and seal if excessive
Abandoned access tunnel	Construct permanent bulkhead with materials matching existing walls

(d) Feasibility of proposed hydrothermal and hydroelectric system

Based on the current hydrothermal and hydroelectric concept plans, the existing tunnel segment will be suitable for the proposed hydrothermal and hydroelectric systems, provided the recommended maintenance repairs are performed and the condition of the tunnel is routinely inspected and maintained.

(e) Representative drawings and photographs

Photographs of the rectangular tunnel segment are included in Appendix A. Graphical representations of structure configuration and the observed defects are included in the developed wall elevations in Appendix B.

(2) Circular stone arch roof segment

(a) Summary of field investigation

The circular arch section of the tunnel is approximately 510 feet long from Station 1+12 to 6+22. It extends from the headrace inlet bulkhead downriver to the rectangular tunnel segment. Starting from the headrace bulkhead, the arched section of the tunnel makes a 30-foot radius, 90-degree turn, running southeast for approximately 400 feet, with a slight S-curve occurring at Station 3+00. The circular stone arch roof cross section’s dimensions range from 15 to 16 feet wide, 23 to 25 feet high, with 14- to 16-foot-tall buttress walls. The circular arch section ends at Station 1+12. The arch roof structure was predominantly constructed of stone from the Hidden Falls formation, while the keystone was quarried from the Mifflin. See Figure 8 for the terminology of the circular stone arch.

At an unknown date, shotcrete was applied to numerous locations on the upper portion of the tunnel walls and roof arch structure, presumably to repair lost mortar, deteriorating stonework and seal out groundwater infiltration.

This segment of tunnel also contains a number of features, including the following, which were observed and documented:

- Tunnel roof access location at Station 2+78, the arched stone roof has been removed and replaced with hollow-core prestressed concrete plank.

- The Phoenix mill headrace connection, which is discussed in greater detail in Section 7.E.(3), below.

- A 6-inch sanitary service passing through the circular arch structure at Station 4+02.

- A 6-inch sanitary service that enters the river side wall of the tunnel structure at Station 4+55, which is suspended from the crown of the tunnel arch and exits the structure at Station 5+50 on the inland side wall.

- Catch basin connection on the inland side wall at Station 1+35 at the 1 o'clock position.

- Catch basin connection on the inland side wall at Station 1+86 at the 1 o'clock position.

- Groundwater relief/drain pipes on the inland side wall from Station 5+31 to Station 5+71, located approximately 3 feet off the invert.

- An 8-inch connection on the inland side wall at Station 4+13 at the 3 o'clock position. The origin and status of the pipe is unknown.

- A 6-inch connection on the riverside side wall at Station 2+77 at the 7 o'clock position, and located within the Phoenix mill headrace bulkhead.

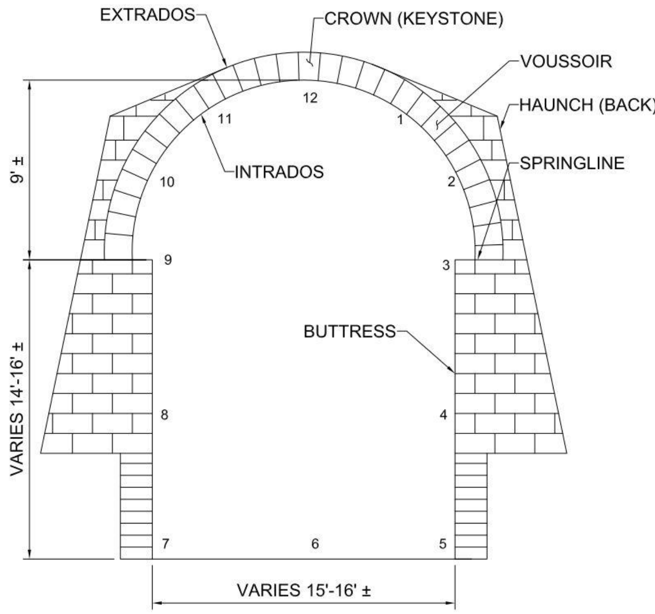

Figure 8. Circular stone arch terminology.

(b) Qualitative structural rating

The circular stone arch tunnel section is in fair condition overall (see Figure 9). No evidence of bulging walls or extensive cracking in the walls was observed. The main structural issues surrounding the tunnel are missing mortar, deteriorating stonework, drummy (debonded) brick infills, and groundwater infiltration. A few areas of deteriorating rock near the keystone were observed.

A related concern is the presence of a leaking watermain immediately adjacent to the tunnel from Station 4+25 to 4+80. The leaking watermain could cause piping of soil into the tunnel structure, which could locally destabilize the arch structure. The City of Minneapolis is aware of the leak and is working to repair the leaking watermain in the near future.

While not a structural concern, the recently repaired sanitary connection and associated piping from Station 4+55 to Station 4+93 should be routinely monitored and inspected.

Figure 9. Circular arch roof tunnel structure.

(c) Recommended maintenance repair options

The following table summarizes the recommended maintenance repairs for the observed structural and non-structural deficiencies in the circular stone arch roof tunnel segment.

Table 2. Maintenance repair recommendations

Observed Deficiency	Recommended Repair
Missing mortar	Clean and tuckpoint missing mortar in excess of 1 inch
Deteriorating stonework	Remove deteriorating stonework, replace in kind where feasible, or replace with concrete or shotcrete in other locations
Debonded brickwork	Monitor and remove and replace as necessary with existing salvaged brick
Groundwater infiltration	Monitor and seal infiltration if excessive or damaging
Leaking watermain	Repair broken watermain and restore backfill

(d) Feasibility of proposed hydrothermal and hydroelectric system

Based on the current hydrothermal and hydroelectric concept plans, the existing tunnel segment will be suitable for the proposed hydrothermal and hydroelectric systems, provided the recommended maintenance repairs are performed and the condition of the tunnel is routinely inspected and maintained. One potential consideration is the existence of catch basins located on Main Street Southeast, which discharge into the tunnel. The discharge of storm water into the tunnel could lead to corrosion concerns with the hydrothermal and hydroelectric piping and support system. In addition, these locations could allow other undesirable materials into the tunnel including fuel spills, debris, and other chemicals.

(e) Representative drawings and photographs

Photographs of the circular arch tunnel segment are included in Appendix A. Graphical representations of the structure configuration and observed defects are included in the developed wall elevations in Appendix B.

(3) Phoenix headrace intersection

(a) Summary of field investigation

The Phoenix headrace intersects the Pillsbury A Mill tunnel at Station 2+80. The location of the Phoenix headrace is coincidental with the roof access location, which extends from Station 2+71 to Station 2+85. Construction of the Phoenix headrace predates construction of the Pillsbury A Mill tunnel, which was constructed with a slightly lower invert elevation.

The river side entrance of the Phoenix headrace has been abandoned and bulkheaded, and the inland side entrance is covered by a large steel cover that is bolted to the walls (see Figure 10). The Phoenix headrace is nominally 7 feet in diameter.

Figure 10. Phoenix headrace gate.

(c) Qualitative structural rating

The Phoenix headrace Intersection is in fair condition. The existing headrace has been substantially filled with mineral deposits from the surrounding limestone. The accumulation may begin to accumulate in the tunnel structure with time. This accumulation will not affect the structural capacity of the headrace intersection. While no water was observed flowing from the existing headrace, this condition could exist and affect the long-term condition.

(b) Recommended repair options

No repairs are recommended at this time; however, the headrace intersection should be routinely inspected for signs of deterioration and modified or repaired as necessary.

(d) Feasibility of proposed hydrothermal and hydroelectric system

Based on the current hydrothermal and hydroelectric concept plans, the existing headrace intersection will not negatively impact the proposed hydrothermal and hydroelectric systems, provided the condition of the headrace is routinely inspected and maintained.

(e) Representative drawings and photographs

Photographs of the headrace are included in Appendix A. Graphical representations of the headrace location and configuration is included in the developed wall elevations in Appendix B.

(4) Headrace bulkhead

(a) Summary of field investigation

The headrace bulkhead is located at the northwest end of the Pillsbury A Mill tunnel (entrance) and currently prevents water from entering the tunnel (see Figure 11). The interior side of the structure is approximately 16 feet wide by 23 feet tall. The cast-in-place concrete bulkhead was likely constructed using double sided forms, and has an offset construction joint located approximately 15 feet above tunnel floor. Although unlikely, it is speculated that the bulkhead may consist of two individual concrete walls, separated by a gap of some unknown distance. However, this has not been field verified, nor did this feature show up in any existing records. It is more probable that the bulkhead is actually made up of one solid, continuous concrete pour.

The bulkhead was visually inspected for evidence of deterioration and distress. In addition, the surface of the bulkhead was sounded to determine integrity of the concrete and to look for shallow delaminations.

The bulkhead currently contains two penetrations. There is a 1-foot by 1-foot opening in the bulkhead centered approximately 5 feet above invert. The opening is currently closed by a sliding steel plate gate. Centered along the bottom of the bulkhead, approximately 1 foot above the invert is an 8-inch pipe penetration that has been capped. Water is currently seeping through both penetrations. A number of plant or tree roots penetrate through the crown of the tunnel within a 5-foot region of the bulkhead.

Figure 11. Headrace inlet bulkhead.

(b) Qualitative structural rating

Overall the bulkhead is in fair condition. No evidence was found of excessive flexural cracking, spalling, or delaminations.

(c) Recommended repair options

When the tunnel is retrofitted for hydroelectric power a new penetration will be constructed through the existing bulkhead. To perform these modifications, a cofferdam will likely be constructed around the intake structure to allow access. At that time, we would recommend either replacing the sliding steel gate with a more durable material or permanently sealing the penetration. The lower steel pipe penetration should also be permanently sealed.

(d) Feasibility of proposed hydrothermal and hydroelectric system

Based on the current hydrothermal and hydroelectric concept plans, the existing bulkhead will have to be evaluated to determine the most structurally suitable location for the proposed 5-foot-diameter penetration. If necessary, the existing bulkhead may require some level of reinforcement.

(e) Representative drawings and photographs

Photographs of the tunnel bulkhead are included in Appendix A.

F. Forebay and drop shaft gates

(1) Summary of field investigation

The forebay is connected to the tunnel via an arched penetration in the building foundation wall from Station 0+40 to 0+75. Beneath the arched wall penetration and extending into the tunnel are the remnants of a timber wall. The forebay is approximately 21 feet (NE-SW) by 24 feet (SE-NW), with a pair of upriver and downriver turbine gates located on the northwest and southeast ends, respectively. The gates are constructed of cast metal, presumably cast-iron, and are approximately 6.5 feet wide by 10 feet high. Both of the upriver drop shaft gates are currently closed. One of the downriver drop shaft gates is open and allows water to flow into the downriver drop shaft. However, both the upriver and downriver drop shafts sluice gates are heavily corroded and not operable (see Figure 12).

The walls of the forebay are primarily constructed of brick. The inland side wall of the forebay contains a domed brick projection, presumably to improve the hydraulic flow of water into the gates and shaft.

Figure 12. Downriver drop shaft gates.

(2) Qualitative structural rating

Overall the forebay and drop shaft gates are in poor condition. The brickwork on the inland side wall of the forebay has deteriorated 4 to 8 inches in depth. The operating mechanisms of all of the gates appear to be severely corroded and no longer operational.

(3) Recommended repair options

The damaged brickwork on the inland side forebay wall should be removed and replaced in kind. Due to the proposed size of hydroelectric piping and severely deteriorated condition of the downriver drop shaft gates, the construction of the gates should be documented and then removed.

(4) Feasibility of proposed hydrothermal and hydroelectric system

Based on the current hydrothermal and hydroelectric concept plans, the existing forebay will be suitable for the proposed hydrothermal and hydroelectric systems, provided the necessary modifications to the drop shaft gate are made and the brickwork repaired.

(5) Representative drawings and photographs

Photographs of the forebay and drop shaft gates are included in Appendix A. Graphical representations of the forebay location and configuration is included in the developed wall elevations in Appendix B.

G. Upriver drop shaft

(1) Summary of field investigation

The base of the upriver shaft and tailrace is full of water and the gates to shaft from the forebay are closed. Due to a lack of accessibility, the upriver drop shaft was not observed. A limited number of photos were taken of the shaft through a penetration previously cut in the gate structure.

(2) Qualitative structural rating

No structural rating is provided due to the lack of accessibility.

(3) Recommended repair options

No repair recommendations are provided due to the lack of accessibility.

(4) Feasibility of proposed hydrothermal and hydroelectric system

The current hydrothermal and hydroelectric plans do not utilize the upriver drop shaft and tailrace.

(5) Representative drawings and photographs

Photographs of the upriver drop shaft are included in Appendix A. Graphical representations of the upriver drop shaft location and configuration are included in Appendix B.

H. Upriver turbine service room

(1) Summary of field investigation

The upriver turbine service room was only visually inspected due to the limited access into the space. The room was accessed through a hole cut in basement floor. The service room is approximately 10 feet wide and varies in height from approximately 3 to 30 feet (see Figure 13). The walls are predominantly constructed of cast-in-place concrete, with some areas of limestone exposed in the lower elevations of the service room near the drop shaft. The service room contains a number of smaller, yet notable features including:

- Steel and concrete stairs on the northeast wall
- Remnants of a steel platform near the bottom of the pit
- Access ladder on the river side wall
- Wall penetration leading to the upriver drop shaft
- The deck structure over the pit consists of either a galvanized metal decking with cast-in-place concrete or wood joists with wood board subflooring

The turbine service room base has approximately 18 inches of standing water and a significant amount of construction demolition debris.

Figure 13. Upriver turbine service room.

(2) Qualitative structural rating

The overall condition of the service room is fair. The cast-in-place walls do not show significant signs of distress, but are cracked, have holes, and are passing water and allowing mineralization to build up on the walls in certain locations. The steel members and hardware are heavily corroded. The galvanized metal decking is beginning to show signs of corrosion. Due to the limited access, the galvanized metal decking and wood joists could not be closely examined.

(3) Recommended repair options

If the basement is to be renovated and repurposed, a complete evaluation should be performed on the structural members composing the basement flooring system.

(4) Feasibility of proposed hydrothermal and hydroelectric system

The current hydrothermal and hydroelectric plans do not utilize the upriver turbine service room.

(5) Representative drawings and photographs

Photographs of the upriver turbine service room are included in Appendix A. Graphical representations of the upriver turbine service room location and configurations are included in Appendix B.

I. Upriver tailrace

(1) Summary of field investigation

Currently the upriver tailrace is not accessible and thus no observations were made.

(2) Qualitative structural rating

No structural rating is provided due to the lack of accessibility.

(3) Recommended repair options

No repair recommendations are provided due to the lack of accessibility.

(4) Feasibility of proposed hydrothermal and hydroelectric system

The current hydrothermal and hydroelectric plans do not utilize the upriver drop shaft and tailrace

(5) Representative drawings and photographs

Photographs of the upriver tailrace were not taken or available. Graphical representations of the upriver tailrace location and configuration are included in Appendix B.

J. Downriver drop shaft

(1) Summary of field investigation

The downriver drop shaft was viewed from two locations: through the open sluice gate from the forebay and from the downriver tailrace.

The portion of the drop shaft extending through the limestone is approximately 11 feet, 8 inches in diameter and was lined with a series of riveted steel plates. The bottom of the shaft liner was cut off just below the limestone, presumably during the turbine removal process. The upper reaches of the area surrounding the drop shaft were also lined with steel plates.

The edge of the drop shaft is located approximately 14 feet from the sluice gate frame. The sluice gates are partially supported on a timber and steel header. The timber portion of the header has suffered severe deterioration. The channel between the sluice gates and drop shaft is brick lined, approximately 12 feet wide with a limestone invert. A stop log gate is located approximately 8 feet from the sluice gate. The channel roof structure consists of a pair of 3-foot-wide brick arches and timber decking. Figure 14 shows the downriver drop shaft.

Figure 14. Downriver drop shaft, tailrace service room. The white formations visible in the photo are ice.

(2) Qualitative structural rating

The overall condition of the drop shaft is fair. The brick walls are generally intact with minimal deterioration. The timber header located below the brick arch is in poor condition and should be shored or considered for removal after being documented. The steel portion of the drop shaft is intact and considered in fair condition.

(3) Recommended repair options

Based on the current hydrothermal and hydroelectric concept plans, the existing drop shaft and channel structure will require modifications for the proposed hydrothermal and hydroelectric systems. The timber sluice gate support should be removed in conjunction with the sluice gates. The top and bottom extents of the steel shaft liner will likely require trimming to facilitate installation of piping and the turbine. Consideration should also be given to applying a protective coating to the shaft to extend its useful design life and functionality.

(4) Feasibility of proposed hydrothermal and hydroelectric system

Based on the current hydrothermal and hydroelectric concept plans, the existing drop shaft will be suitable for the proposed hydrothermal and hydroelectric systems, provided the necessary modifications to the drop shaft are made. The nominal 11-foot, 8-inch-diameter shaft will readily accommodate the proposed 5-foot-diameter water supply pipe.

(5) Representative drawings and photographs

Photographs of the downriver drop shaft are included in Appendix A. Graphical representations of the downriver drop shaft location and configurations are included in Appendix B.

K. Downriver turbine service room

(1) Summary of field investigation

The downriver turbine service room was only visually inspected due to the limited access into the pit. The room was accessed through a hole cut in the Pillsbury A Mill basement floor (see Figure 15). The walls are predominantly constructed of cast-in-place concrete, with some areas of exposed limestone in the lower elevations of the wall, near the lower stair landing. The roof of the service room is constructed of a galvanized metal deck and concrete. The stairs are constructed of built-up structural steel members. A structural steel pipe column is located in the southeast corner and provides support to a basement level column. Based on observations made in the downriver tailrace, it is believed that this room originally extended through the Platteville limestone formation and provided an access route to the turbine located at the tailrace level. Currently, this space has been substantially filled with building construction debris, which extends to the tailrace level.

Figure 15. Downriver turbine service room.

(2) Qualitative structural rating

The overall structural condition of the downriver turbine service room is fair. The structural steel components, such as the stairs and support beams embedded at the base of the concrete walls are severely corroded with significant section loss.

(3) Recommended repair options

If the basement is to be renovated and repurposed, a complete evaluation should be performed on the structural members composing the basement flooring system.

(4) Feasibility of proposed hydrothermal and hydroelectric system

The current hydrothermal and hydroelectric plan does not currently utilize the downriver turbine service room. If the construction debris were removed from this space, a direct path from the basement to the tailrace could be established and may provide a suitable route for maintenance personnel and utilities.

(5) Representative drawings and photographs

Photographs of the downriver turbine service room are included in Appendix A. Graphical representations of the downriver turbine service room location and configurations are included in Appendix B.

L. Downriver tailrace

(1) Summary of field investigation

The downriver tailrace was accessed from the Mississippi River portal structure. The overall width of the tailrace is approximately 24 feet, 6 inches with a 3-foot-thick stone masonry wall dividing the tailrace into two separate channels. The tailrace channels are approximately 100 feet long. The exterior walls are predominantly constructed of limestone masonry walls extending from the invert to the limestone roof.

The southwest channel roof and walls are reinforced with massive 6-foot-wide brick arches, while the northeast channel roof and walls are reinforced with massive cast-in-place concrete arches of similar thickness. A secondary tailrace intersects the northeast channel approximately 50 feet from the tailrace portal. This secondary tailrace, which connects with the machine shop drop shaft, is approximately 5 feet, 6 inches wide and 50 feet long.

At the end of the channel structure is an elevated cast-in-place concrete beam and slab structure. This elevated structure is located approximately 5 feet, 6 inches above the tailrace invert or 12 feet below the limestone roof. At the end of the channel, constructed on top of the cast-in-place concrete slab structure is an 8-inch-thick concrete masonry wall.

Behind this wall is the downriver turbine access room. This room extends approximately 45 feet beyond the concrete masonry wall. The turbine access room has been substantially filled by construction debris, which was dumped into the downriver turbine service room and flowed down into turbine access room through a large penetration in the limestone roof.

Below the downriver drop shaft, a 5-foot-deep sump exists. At the base of the sump, two conduits exit the pit towards the southwest tailrace channel, below the elevated, cast-in-place concrete beam and slab structure. Figure 16 shows the downriver tailrace.

Figure 16. Downriver tailrace facing Mississippi River.

(2) Qualitative structural rating

The overall structural condition of the downriver tailrace is poor. While the cast-in-place concrete beam and slab structure did not show any evident signs of distress, the interior dividing wall of the channel is in poor condition and is showing evidence of bulging and localized areas of collapse. The brick arches in the southwest channel are in fair condition but showing obvious signs of deterioration. The northeast exterior walls, in the vicinity of the machine shop tailrace connection, have been severely undercut and are in poor condition. The limestone roof is in poor condition and requires scaling to remove delaminated and loose slabs of rock and may require rockbolting

(3) Recommended maintenance repair options

If the downriver tailrace is to be renovated for installation of a new turbine, a complete evaluation should be performed on the following structures and elements:

- Elevated cast-in-place concrete beam and slab structure
- Limestone roof structure
- Interior stone masonry walls
- Exterior stone masonry walls

Table 3 presents the maintenance repair recommendations for the downriver tailrace.

Table 3. Maintenance repair recommendations

Observed Deficiency	Recommended Repair
Deteriorated brick arches	Remove and replace damaged and missing brick in kind
Deteriorated stone masonry divider wall	Remove and replace in kind bulging and collapsed stone masonry
Undercut stone masonry walls at machine shop tailrace connection	Replace missing stone masonry in kind
Deteriorated limestone roof	Scale roof and evaluate need for rockbolt reinforcement

(4) Feasibility of proposed hydrothermal and hydroelectric system

Based on the current hydrothermal and hydroelectric concept plans, the existing tailrace will be suitable for the proposed hydrothermal and hydroelectric systems, provided the necessary structural evaluations, repairs and modifications to the tailrace are made.

(5) Representative drawings and photographs

Photographs of the downriver tailrace are included in Appendix A.

M. Machine shop headrace

(1) Summary of field investigation

The entrance to the machine shop headrace is located in the tunnel’s southeast end wall. It is partially obstructed by a 5-foot by 7-foot steel sluice gate. The sluice gate is highly corroded. The machine shop headrace is a 5-foot-diameter pipe constructed of bolted steel plate segments. The pipe has approximately 3 feet of sand in it. Figure 17 shows the machine shop headrace pipe.

Figure 17. Machine shop headrace pipe.

(2) Qualitative structural rating

The machine shop headrace pipe is in poor structural condition. The limited observations indicate the pipe's bolts are substantially corroded and their integrity in question. If a sufficient number of bolts were to fail, the pipe could collapse.

(3) Recommended repair options

The pipe should be cleaned and abandoned in place to minimize the potential for water migration through the pipe and subsidence of the soils below the building foundation and floor slabs.

(4) Feasibility of proposed hydrothermal and hydroelectric system

The current hydrothermal and hydroelectric plans do not utilize the machine shop headrace.

(5) Representative drawings and photographs

Photographs of the machine shop headrace are included in Appendix A. Graphical representations of the machine shop headrace location and configurations are included in Appendix B.

N. Machine shop tailrace

(1) Summary of field investigation

The entrance to the machine shop tailrace is located in the northeast channel of the downriver tailrace. It is approximately 5 feet, 6 inches wide and 50 feet long. At the end of the tailrace is a raised concrete ledge, approximately 10 feet long. Immediately downriver of the machine shop tailrace is an entrance to a drift tunnel approximately parallel, but located just below the limestone roof. This space was not accessible, but believed to possibly be an access passage to the machine shop turbine. Figure 18 shows the machine shop drop shaft and tailrace.

Figure 18. Machine shop drop shaft and tailrace.

(2) Qualitative structural rating

The machine shop tailrace pipe is in poor structural condition, due to the undermining of the stone masonry walls.

(3) Recommended repair options

The tailrace walls should be restored with matching stone masonry. Missing mortar between stones should also be cleaned and tuck pointed.

(4) Feasibility of proposed hydrothermal and hydroelectric system

The current hydrothermal and hydroelectric plans do not utilize the machine shop tailrace.

(5) Representative drawings and photographs

Photographs of the machine shop headrace are included in Appendix A.

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8. Archaeological Fieldwork Plan

Due to the significance of the Pillsbury A Mill and associated tunnel system, industrial archaeologists developed an archaeological fieldwork plan by examining extant structural elements as well as the more subtle modifications to the structure. The plan highlights areas within the tunnel that appear to have archaeological research potential or are otherwise unique. The plan also includes recommendations regarding treatment of potentially significant features if they need to be disturbed.

A. Purpose

The type of archaeological investigations that occurred as part of this project is typically categorized as "Industrial Archaeology," which refers to the study of sites created by industrial activities such as extracting, processing, transporting, communicating, producing, and powering on a large scale. Industrial archaeology projects examine a site's structural and artifactual remains, as well as numerous other resources including documents, social and business histories, and landscapes. Thus, industrial archaeology examines not only the physical remains of a site such as the structural remains and artifacts, or the documentary evidence relating to the site, but also the processes and technologies associated with the site. The water power system used at the Pillsbury A Mill provides a good example of the process and technology used not only at the mill specifically, but throughout the milling district. The purpose of this archaeological fieldwork plan is to guide the City as they consider future research, interpretation, and construction within the tunnel.

The fieldwork plan is necessary because the Pillsbury A Mill is part of the St. Anthony Falls Historic District, St. Anthony Falls Waterpower Area, and is a National Historic Landmark. The purpose of this plan is to help ensure that the integrity of the Pillsbury A Mill and its tunnel system remain intact through the site's rehabilitation and potential redevelopment. Integrity for the National Register is evaluated using seven aspects. These include:

- **Location** – the resource remains where it was originally constructed or located, or remains associated with the place where an event occurred
- **Design** – the elements that comprise the form, plan, space, and style of a resource remain unchanged
- **Setting** – the site's physical environment remains recognizable
- **Feeling** – the resource retains its aesthetic or historic sense of a specific period of time
- **Association** – the resource represents a link between the site and an important historic event, pattern, or person
- **Material** – the materials or elements used for construction are original and intact
- **Workmanship** – the labor or skill employed in constructing the site or carrying out the tasks performed at the site is evident

B. Field investigations

(1) Methods

In order to examine the physical features of the tunnel, an archaeologist visited the site in January 2014. During this visit the tunnel was video-taped, photographed, and documented descriptively. After the field visit, the video tapes and photographs were reviewed and additional notes were taken. Areas that appeared to have research potential or were otherwise unique were then flagged as potentially sensitive.

(2) Results

Six specific areas as well as several general tunnel features appear to have potential significance or research potential (see Figure 19). These areas include the machine shop headrace, forebay, manhole access, arch, Phoenix Mill headrace, and tunnel entrance and bulkhead area. The overall integrity of the tunnel walls, ceiling, and floor are also significant in that, as a whole, the tunnel retains significant integrity of design, setting, feeling, material, and workmanship. These areas of archaeological interest are discussed below.

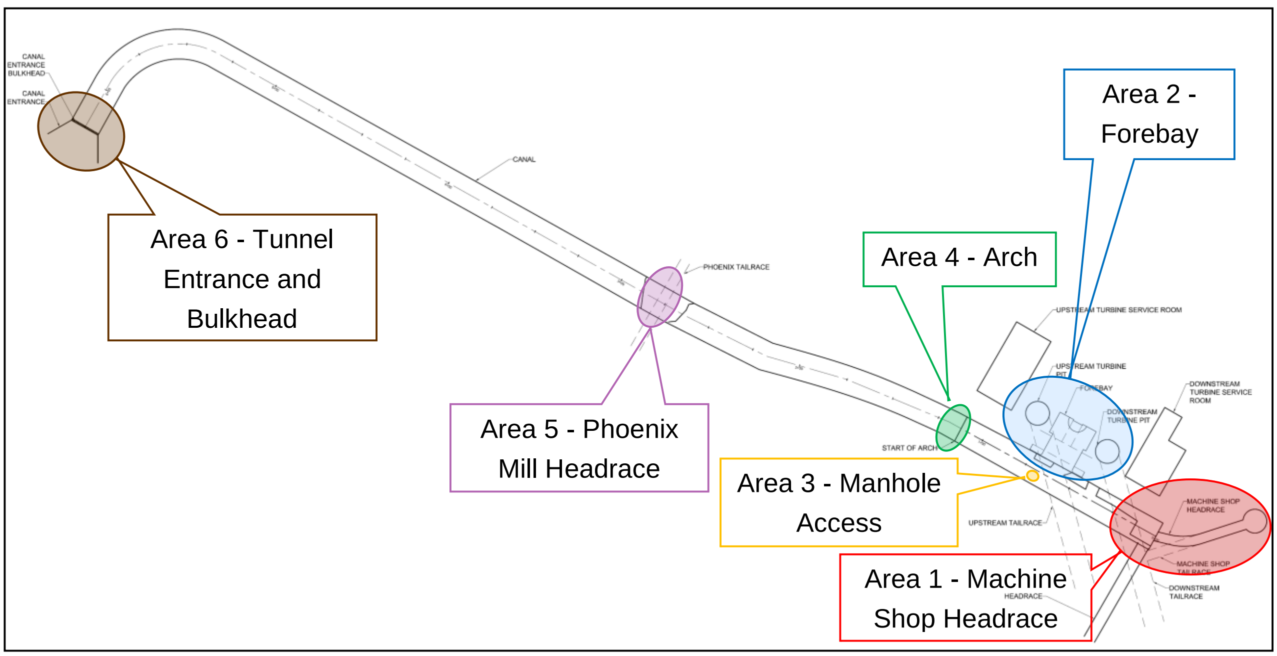

Figure 19. Map showing areas of archaeological interest. Prepared for the purposes of this Study using the tunnel level site plan as the base drawing.

(a) Area 1 – machine shop headrace

The machine shop headrace is located at the far downriver end of the Pillsbury A tunnel (see Figure 19 above). This area has several features, including a sluice gate (millrace), which controls water flow into the machine shop penstock and turbine. In addition to the gate and its associated mechanisms, the area has numerous pipes, spikes, and structural supports. Along the river side of the wall at the far end of the tunnel (0+00) is a small round hatch that appears to be a spillway for the tunnel which leads back to the river (see Figures 20 and 21).

Figure 20. Photograph of Area 1 – Machine shop headrace (center) showing spillway (right side).

Figure 21. Spillway hatch on west side of machine shop headrace area.

(b) Area 2 – Forebay

The forebay area is located slightly upriver from the machine shop headrace, at approximately 0+60 on the inland side of the tunnel (see Figure 19 above). This area diverges from the main tunnel through a large archway (see Figure 22). The forebay area is a rectangular room with passageways leading to the upriver and downriver drop shafts. Like the machine shop headrace area, the forebay has several features including sluice gates and associated mechanisms that control water flow into the penstocks and to the turbine drop shafts (see Figure 23). Several brackets are attached to the east (inland) wall above the level of the gates and the center of the wall has brick buttressing (see Figure 24). The area also has internal steel bracing, and evidences change over time. Specifically, two large filled-in archways are evident above the current sluice gates (see Figure 25).

Figure 22. Archway leading into forebay area with the upriver turbine drop shaft to the left, the downriver turbine drop shaft to the right, and buttressing in the center.

Figure 23. Sluice gates leading to the downriver turbine drop shaft, with buttressing along the inland wall to the far left.

Figure 24. Brackets in inland wall of the forebay, adjacent to the downriver turbine drop shaft.

Figure 25. Filled-in archway above the upriver turbine drop shaft.

(c) Area 3 – Manhole access

A manhole access-way is located at approximately Station 0+60 on the river side of the tunnel, across from the forebay area. The access consists of a brick-lined circular vertical access that presumably extends from street-level to approximately 15 feet above the tunnel floor (see Figure 26).

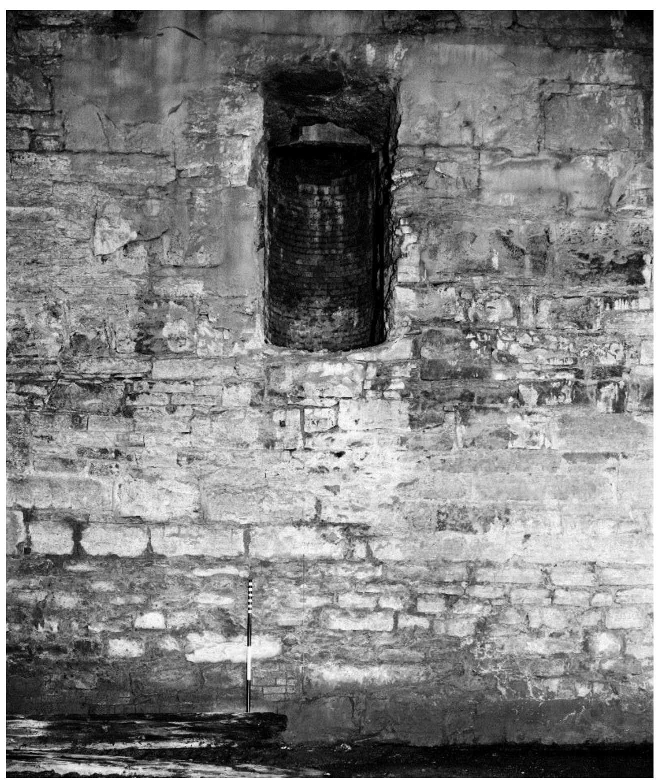

Figure 26. Manhole access across from forebay in 2010.

(d) Area 4 – Archway into main tunnel

At approximately Station 1+10, the structure of the tunnel changes from a flat-ceiling with visible I-beam supports to a stone arched tunnel with a springline (see Figure 27). As noted in Section 3 of this report, the steel I-beams were added in 1949 and comprised part of a tunnel roof reinforcement to accommodate a newly approved Great Northern Railway rail spur crossing over the tunnel. In all likelihood, the addition of the I-beams did not dramatically alter the sense of space and feel in that section of the tunnel, but it is the transition from the flat-ceiling area to the stone-arched area that is most significant in this instance. The transition is significant because the downriver, flat-ceilinged end of the tunnel feels fairly massive and open, whereas the main body of the tunnel (upriver from the arch) feels more restrained and confined. This shift in *feeling* is an integral part of the tunnel and thus an important aspect of the integrity of the system.

Figure 27. Start of arch, looking upriver in tunnel.

(e) Area 5 – Phoenix Mill headrace

The Phoenix Mill Headrace crosses the Pillsbury A Mill tunnel at a 90-degree angle between Station 2+70.4 and Station 2+84. A large hole covered by a steel plate punctuates the inland side of the tunnel, whereas the river side of the tailrace has been bricked-in (see Figures 28, 29, and 30). This feature is important because it evidences the evolution of the tunnel system and east bank milling district. The plate covering the inland side of the Phoenix Mill Headrace has been replaced since 2010 (see Figures 31 and 32). Unfortunately, the methods used to reattach the plate to the wall do not appear to have incorporated historic techniques, using bright galvanized bolts that are not in keeping with the historic nature of the tunnel.

Figure 28. Phoenix Mill headrace in Pillsbury A Mill tunnel's inland wall showing reattached plate.

Figure 29. Phoenix Mill Headrace in Pillsbury A Mill tunnel's riverside wall showing filled-in area.

Figure 30. Ceiling structure where the Phoenix Mill tailrace intersects with the Pillsbury A Mill tunnel.

Figure 31. Photo of Phoenix tailrace in Pillsbury A Mill tunnel's inland wall in 2010.

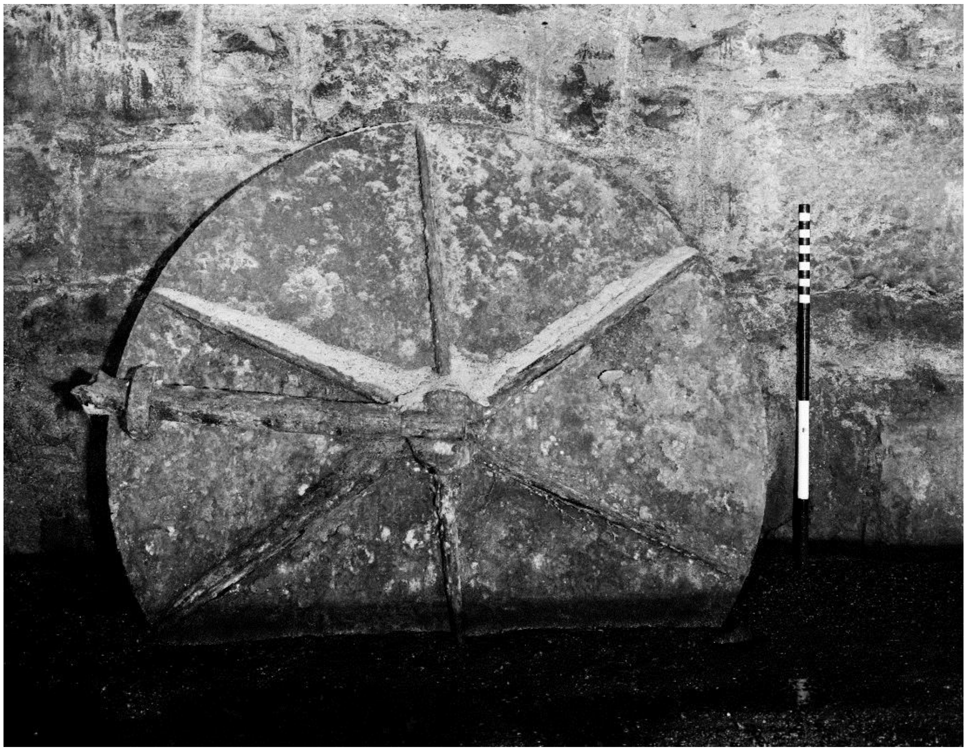

Figure 32. Plate used to cover Phoenix Mill tailrace against wall of Pillsbury tunnel in 2010.

(f) Area 6 – Tunnel entrance and bulkhead

At approximately Station 5+60, the tunnel turns at a 90-degree angle from its generally north-westward trajectory to head southwest toward the river. The tunnel entrance and bulkhead are located at the upriver end of the tunnel, at Station 6+09. During its period of operation, the tunnel entrance from the Mississippi River would have been open, theoretically with only a trash rack partially covering the entrance but also with some means of shutting off water flow to allow tunnel maintenance and repair (see Figure 33). Currently, a large concrete bulkhead over the opening prevents water from freely entering the tunnel. A small opening in the center of the bulkhead present in 2010 allowed water into the tunnel (see Figure 34). The opening has since been sealed (see Figure 35).

Figure 33. Exterior view of tunnel entrance in 2010.

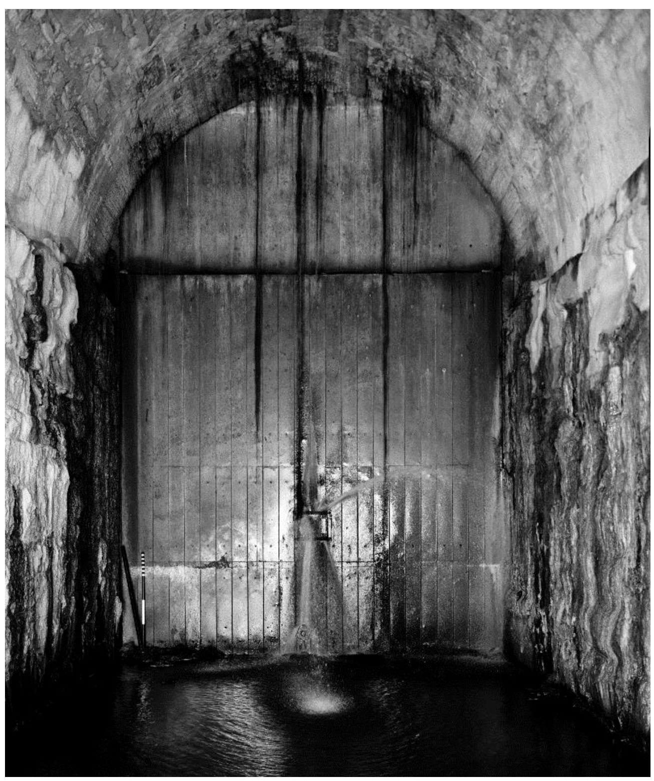

Figure 34. Interior view of tunnel entrance and bulkhead in 2010.

Figure 35. Sealed opening in center of bulkhead.

(g) Tunnel – General

Several general features relating to the tunnel are worth noting. Specifically, the tunnel construction and historic repairs, the ceiling arch, and ledges and small holes drilled along the walls and adjacent to the floor relate to the tunnel's integrity and evolution as part of a system. The arched ceiling, and stone- and brick-work not only give the tunnel its historic feeling, but also relate to the structure's integrity of design, material, and workmanship, all of which are integral aspects of the structure's integrity. Other features significant to the history of the tunnel are the ledges and small drilled holes located along the bottom of the walls and in the floors (see Figures 36 and 37). These features appear to be from deepening the tunnel and suggest how certain aspects of the system evolved over time, relative to changes in the Pillsbury A Mill specifically, and to Minneapolis' flour industry overall.

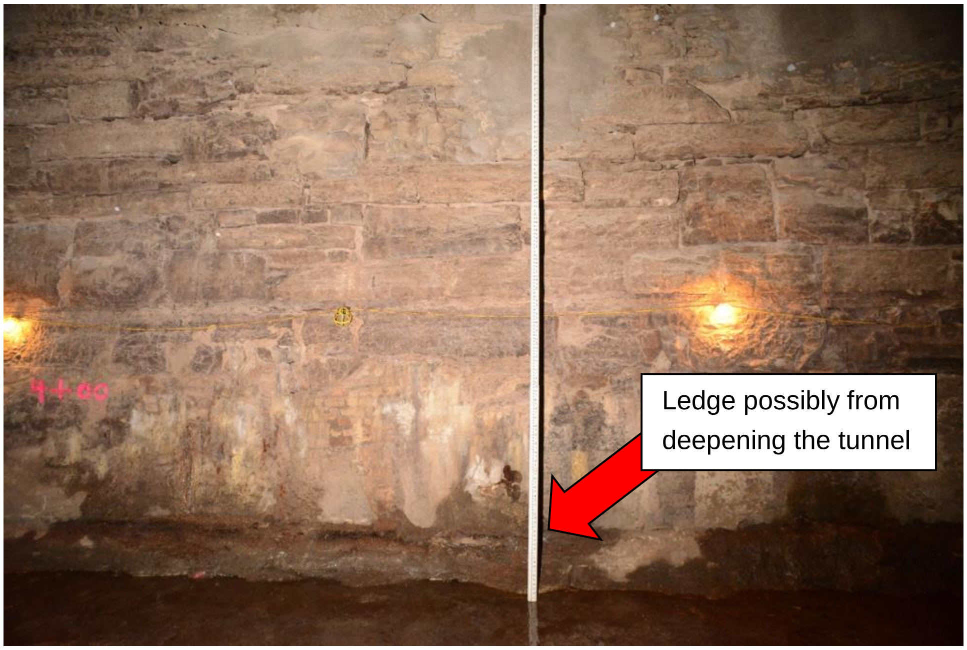

Figure 36. Ledge along floor, adjacent to wall.

Figure 37. Drill holes at floor level.

(3) Recommendations

If alterations need to occur in any of these archaeologically sensitive areas, an industrial archaeologist or historian should first be consulted. In addition to the tunnel proper, the Pillsbury A Mill water power system included other components such as drop shafts and turbine pits as well as numerous associated rooms and machinery. Because the historical significance of the tunnel depends on its integrity, adding components or removing historical elements can alter or diminish the tunnel's historic integrity. Thus, it is recommended that structural aspects, features, or artifacts associated with the tunnel not be removed or modified without first evaluating the action's impact on the historic fabric of the system.

During tunnel investigations in 2010, a trash rack for the machine shop turbine was still in place and attached to the tunnel walls at approximately Station 0+40 (see Figure 38). In 2013 the trash rack was removed as part of the overall tunnel cleanout. The rack was quite corroded and presumably bore rather little resemblance to its original appearance, so its removal does not appreciably threaten the tunnel's importance or the site's eligibility. Nonetheless, the trash rack constituted an integral part of the tunnel system and thereby contributed to overall site integrity. While it is good that the rack was photographed prior to its removal, it is unfortunate that the feature was not more fully documented with textual description and more in-depth illustrations because that documentation would have provided additional breadth and depth to the tunnel and site's permanent National Historic Landmark file.

Figure 38. Extant trash rack in-place as of 2010, near the downriver end of the tunnel in front of the machine shop headrace.

Another example of physical alteration to the tunnel includes the covering of the Phoenix Mill headrace on the inland side of the tunnel. In 2010 the cover was detached and resting on the tunnel floor, but it has since been attached to the tunnel wall over the inland headrace opening. Although re-attaching the artifact to the canal wall might have been both necessary and appropriate, the method used is not in keeping with the feel, design or materials used in the tunnel construction and maintenance. Because modern materials were used to attach the plate to the wall, the repair does not convey the historic sense of the feature and results in an unsympathetic alteration to the tunnel.

On the other hand, removal of intrusive features could improve the integrity of the tunnel. For example, if it is no longer necessary, simply removing the previous access ladder from the forebay area would enhance the historic nature of the tunnel by removing an intrusive element (see Figure 39).

Figure 39. Modern ladder located in the forebay area.

C. Conclusions

From an industrial archaeology perspective, the most important consideration is to ensure that the development plans adhere as closely as possible to the historical aspects of the site. A faithful representation of a structure's original construction should be an important part of that plan. However, for the industrial archaeologist it is equally important to document the evolution of a system or process, provided those changes occurred within the site's period of significance.

As noted above, in its current state the Pillsbury A Mill tunnel retains a good deal of research potential relative to both original construction and to changes through time. The tunnel also exhibits evidence of a number of changes made after the period of mill operation, but those changes tend to simply clutter or obfuscate rather than add to the interpretive potential. Examples of post-operational modifications are seen in the forms of addition (placement of an access ladder), subtraction (removal of a trash rack and a substantial section of the tunnel roof), and alteration (the historically unsympathetic replacement of the cap covering the Phoenix Mill headrace).

As development plans move forward for adaptive reuse of the Pillsbury A Mill tunnel, care should be taken to avoid adverse effects on the historic aspects of the tunnel. Ideally, this applies to the tunnel as a whole, but it especially and specifically applies to the six areas identified in this plan: 1) machine shop headrace, 2) forebay, 3) manhole access, 4) tunnel arch, 5) Phoenix Mill headrace, and 6) tunnel entrance and bulkhead. Modern day safety and liability considerations sometimes preclude strict historical accuracy in historic site representation. Nonetheless, in order to preserve the site's integrity and historic significance, development plans should strive to protect (and when possible, enhance) the historical fabric of the tunnel.

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Bibliography

"A Busy Scene." *Minneapolis Tribune,* 6 May 1881.

Anfinson, John O. *River of History: A Historic Resources Study of the Mississippi National River and Recreation Area*. St. Paul, Minn.: U.S. Army Corps of Engineers, 2003.

Anfinson, Scott F. "Archeology at the Riverfront." *Minnesota History* (Spring/Summer 2003): 320-331.

"Archaeology of the Central Minneapolis Riverfront." *The Minnesota Archaeologist* 48 (1989): 106-121.

A History of Pillsbury's "A" Mill. Minnesota: n.p., n.d.

Banker, J.T. "Location of Center Line of Main St. at Second Ave SE," 8 May 1891. *Northern State Power Company Records of Predecessor Companies.* Available at the Minnesota Historical Society, St. Paul, Minn.

Buchta, Jim. "Pillsbury A Mill Renovation Project is Back, On a New Track." *Star Tribune*, 30 October 2013.

CNA Consulting Engineers. "Typical Cross-Section Pillsbury A Mill." 19 February 2014.

CNA Consulting Engineers. "Tunnel Level Site Plan." 10 March 2014.

Coddington, Donn. *St. Anthony Falls Historic District*. Washington, D.C.: National Register of Historic Places, National Park Service, 11 March 1971.

Cross Section of Canal in Process of Construction by the St. Antony Falls Water Power Company. Prepared for the U.S. Army Corps of Engineers, 19 February 1881. Available at http://reflections.mndigital.org/cdm/singleitem/collection/mpls/id/10691 (accessed 14 February 2014).

"East Bank Quarry Site, Minneapolis, Minnesota." 1893-1897. Available at Minnesota Reflections, http://reflections.mndigital.org/cdm/singleitem/collection/hchm/id/778/rec/24 (accessed 5 March 2014).

"Electric Mill Power May Supersede Steam." *Minneapolis Morning Tribune,* 6 December 1910.

Frame, Robert M. "The Progressive Millers, a Cultural and Intellectual Portrait of the Flour Milling Industry, 1870-1930, Focusing on Minneapolis, Minnesota." PhD dissertation, University of Minnesota, 1980.

Great Northern Railway. “Bridge Over Intake Canal at Pillsbury Flour Mill General Plan.” August 1949. Available at Northwestern Architectural Archives, Minneapolis.

“History of Pillsbury Property Expansion Land and Buildings.” n.p., n.d. Available at General Mills Archives, Minneapolis.

Hunter, Louis C. *Waterpower, A History of Industrial Power in the United States, 1780-1930 vol. I*. Charlottesville, Va.: University Press of Virginia, 1979.

“Improvements to Pillsbury A Mill.” *Minneapolis Journal,* 2 December 1901.

“Intake of the Pillsbury A Mill, Minneapolis, Minnesota.”1893-1897. Available at Minnesota Reflections, http://reflections.mndigital.org/cdm/search/collection/hchm/searchterm/Intake%20of%20Pillsbury%20A%20Mill/order/nosort (accessed 11 March 2014).

Kane, Lucile M. *The Falls of St. Anthony.* St. Paul: Minnesota Historical Society, 1987.

“Local and Personal.” *Northwestern Miller,* 7 January 1881 – 20 January 1882.

“Map Showing Location of Property of the St. Anthony Falls Water Power Co. and the Minneapolis Mill Co.” 1893. Available at the U.S. Army Corps of Engineers Library, St. Paul, Minn.

“Map Showing the Mill Site and Water Power Belonging to the St. Anthony Falls Water Power Company.” Chicago: Chicago Lithographing Company, 1869. Available at *Minnesota Reflections,* http://reflections.mndigital.org/cdm/singleitem/collection/mpls/id/10668/rec/18 (accessed 14 February 2014).

Mead & Hunt, Inc. “Stone Arch Bridge.” Minnesota Historic Property Record, 2006. Available at *Minnesota Department of Transportation*, http://www.dot.state.mn.us/historicbridges/pdf/27004MHPR.pdf (accessed 31 January 2014).

“Minneapolis GE and Pillsbury A Mill Tail Race Tunnels.” n.d. Available at the U.S. Army Corps of Engineers Library, St. Paul, Minn.

Minneapolis, Minnesota, vol. 2. New York: Sanborn Map and Publishing Co., 1885. Available at *Digital Sanborn Maps 1867-1970,* http://sanborn.umi.com.ezproxy.hclib.org/mn/4339/dateid000001.htm?CCSI=8887n (accessed 25 February 2014).

Minnesota Historical Society. “Timeline.” *Mill City Museum*. www.millcitymuseum.org/timeline (accessed 6 February 2014).

Minnesota Title Insurance and Trust Co. “Abstract of Title to Lots 13, 14, 15, and 5 feet Lot 16 Near Lot 15 of Block 5 St. Anthony Falls.” Available at the General Mills Archives, Golden Valley, Minn.

"More Power for Pillsbury A." *Minneapolis Journal*, 22 February 1901.

"Much Ado About Nothing." *Minneapolis Tribune,* 16 August 1881.

"National Park Service Historic Preservation Certification Application-Part 1 Evaluation of Significance: Accessory buildings to the Pillsbury A Mill, East Bank Mills site." n.d.

National Register of Historic Places. *National Register Bulletin 15: How to Apply the National Register Criteria for Evaluation.* Washington, D.C.: National Register of Historic Places, National Park Service, 1990.

Office of the Inspector of Buildings. "Permit to build outside of fire limits No. B324320." 24 October 1951.

Office of the Inspector of Buildings. "Permit to build outside of fire limits No. B379999." 6 June 1962.

"Personal." *Engineering News,* 23 April 1881.

"Pillsbury A Mill." *Minneapolis Tribune*, 24 February 1881.

"Pillsbury A Mill, Elevator, and Surrounding Buildings, View of Mill and Elevators, Minneapolis, Minnesota." 1917. Available at *Minnesota Historical Society Online Collections,* http://collections.mnhs.org/cms/display.php?irn=10789060&websites=no&brand=cms&q=Pillsbury%20A%20mill%20&type[]=Photographs&startindex=151&count=25 (accessed 11 March 2014).

Pillsbury, Philip W. "The Pillsbury Story." n.d. Available at the General Mills Archives, Golden Valley, Minn.

Plan of Canal in Progress of Construction by the St. Anthony Water Power Company. Prepared for the U.S Army Corps of Engineers, 19 February 1880 (correction: 1881). Available at http://reflections.mndigital.org/cdm/singleitem/collection/mpls/id/10672 (accessed 14 February 2014).

Pratt, Daniel. "Minnesota Historic Property Record Index to Photographs, Pillsbury "A" Mill Water Power System." October 2010.

St. Anthony Falls Water Power Company. "Steam power house for Pillsbury Flour Mills Company." 27 October 1909. Available at Northwestern Architectural Archives, Minneapolis, Minn.

"Steel Structure Without Stopping a Wheel." *Minneapolis Journal,* 8 December 1913.

"Tailrace and East Side Mills, Minneapolis, Minnesota." 14 March 1901. Available at Minnesota Reflections, http://reflections.mndigital.org/cdm/singleitem/collection/hchm/id/906/rec/19 (accessed 11 March 2014).

“The Minneapolis Mills in 1884.” *Northwestern Miller,* holiday edition, 1884-1885.

“The Project Underway.” *Minneapolis Tribune,* 14 May 1895.

Turner, C.A.P. “Alterations to Pillsbury A Mill.” Plans prepared for the Pillsbury A Mill, 13 February 1912. Available at Northwest Architectural Archives, Minneapolis, Minn.

Weis and Loucks. “Pillsbury A-Mill.” Laser Scan, February 2014.

Appendix A. Engineering Condition Assessment Photographs

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Photo 1. Downstream endwall showing headrace bypass (right), and machine shop headrace gate structure.

Photo 2. Headrace bypass along river side wall at Station 0+02.

Photo 3. View inside abandoned machine shop headrace.

Photo 4. Trash screen at Station 0+38 in 2010 before it was removed, looking downstream.

Photo 5. I-beam remnants of cross-tunnel trash screen.

Photo 6. Catch basin lead through the river side wall at Station 0+57.

Photo 7. Inland side foundation wall arch into forebay.

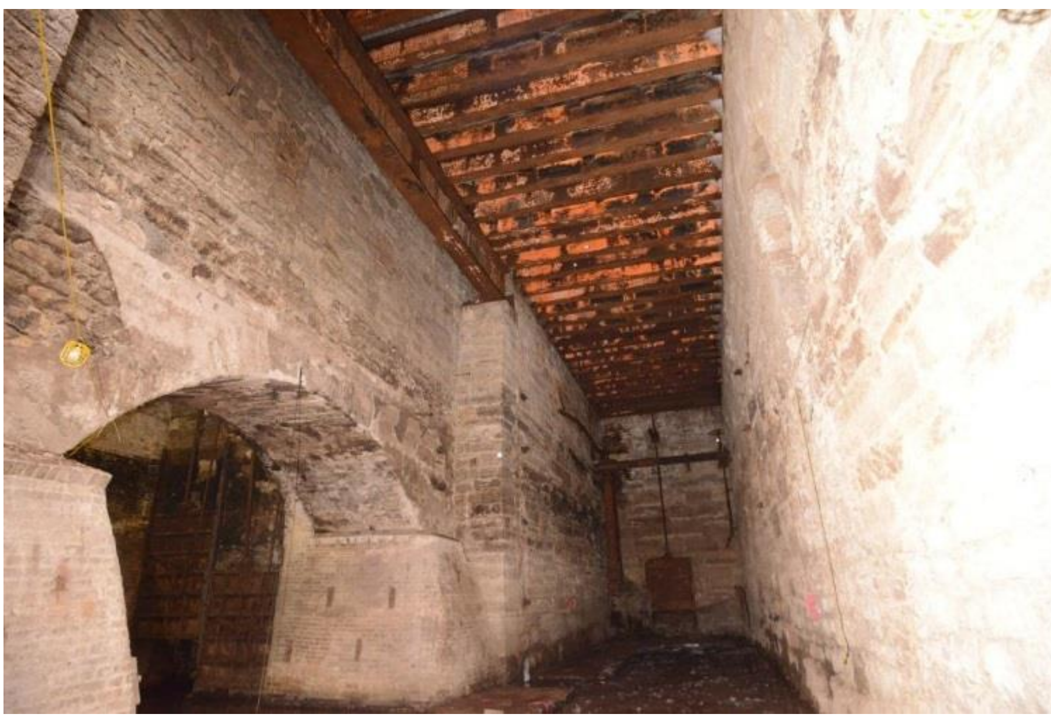

Photo 8. Overview of downstream tunnel section.

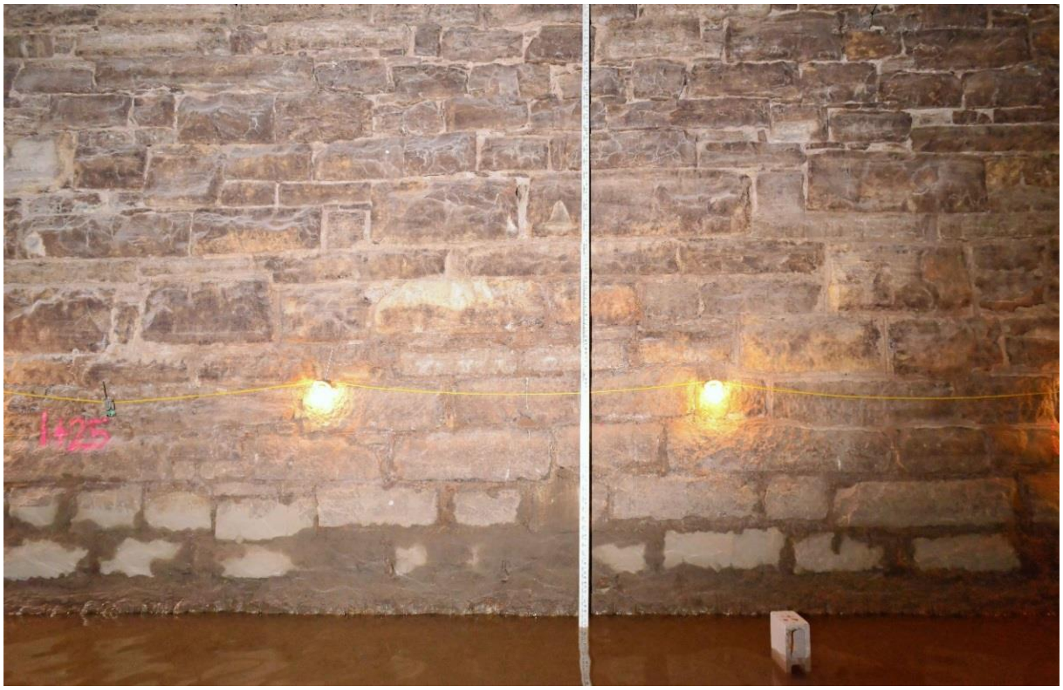

Photo 9. Wall segment in fair condition.

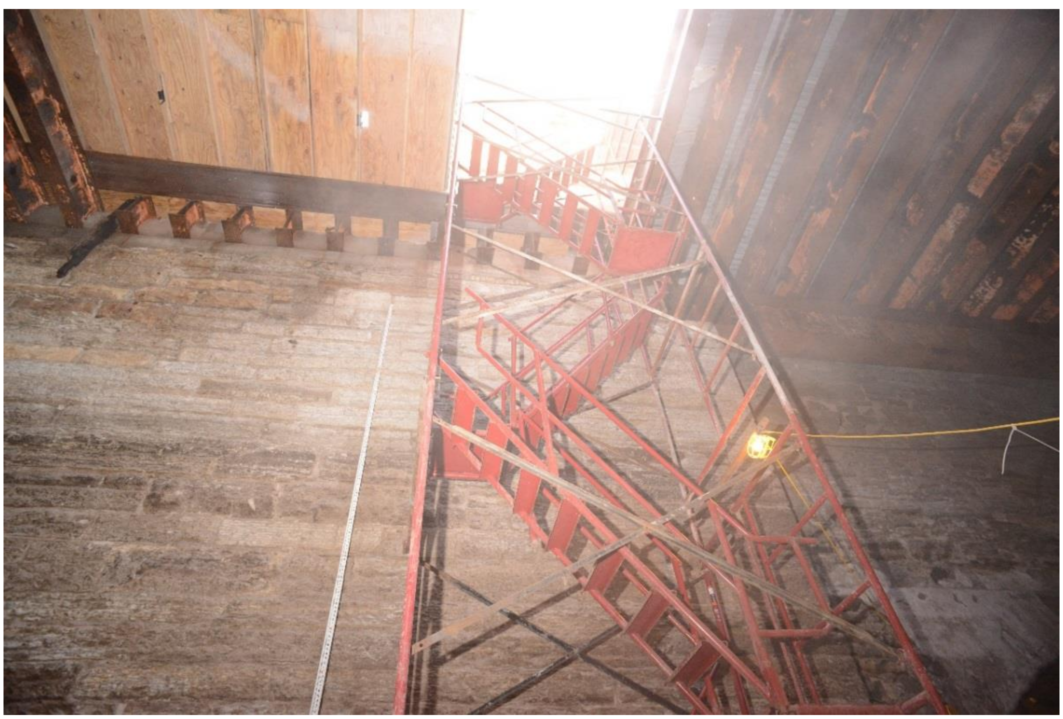
Photo 10. Access stairs and opening.

Photo 11. Frozen infiltrating groundwater at Station 1+10 on river side wall.

Photo 12. Brick patch and missing mortar (Station 1+00 to Station 1+25).

Photo 13. Transition at Station 1+12 from rectangular tunnel to arched tunnel.

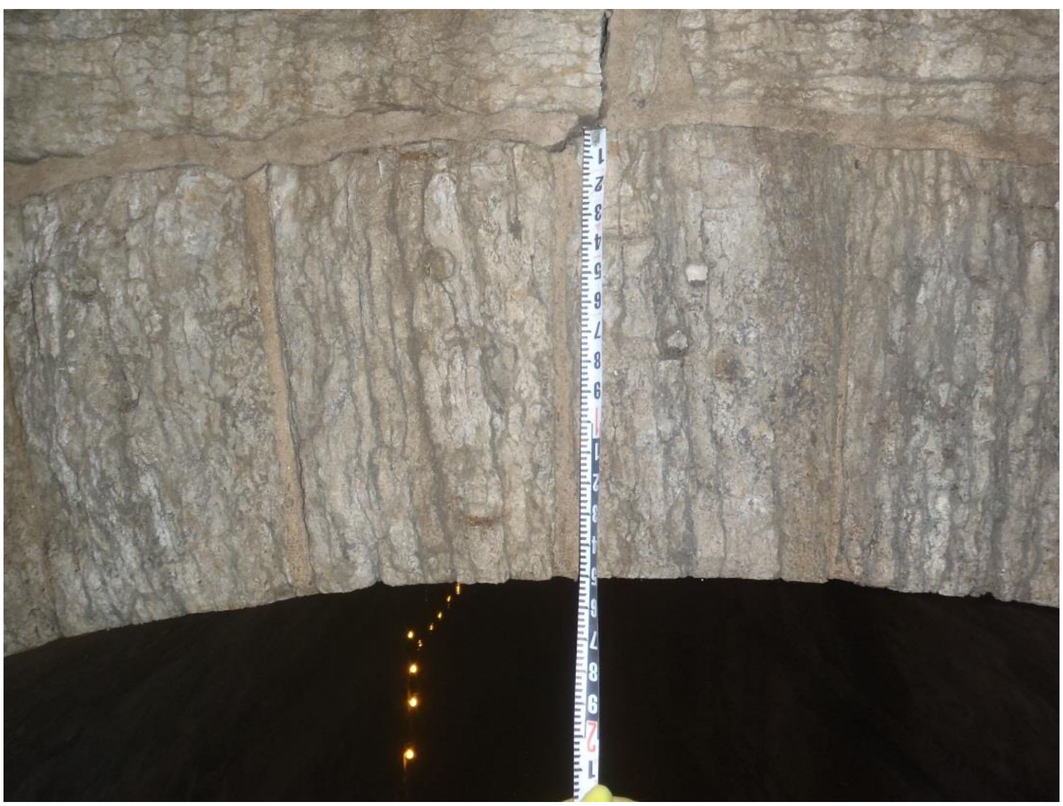

Photo 14. Close-up of the crown at the transition zone to rectangular tunnel.

Photo 15. Infiltration above brickline, under catch basin at Station 1+35.

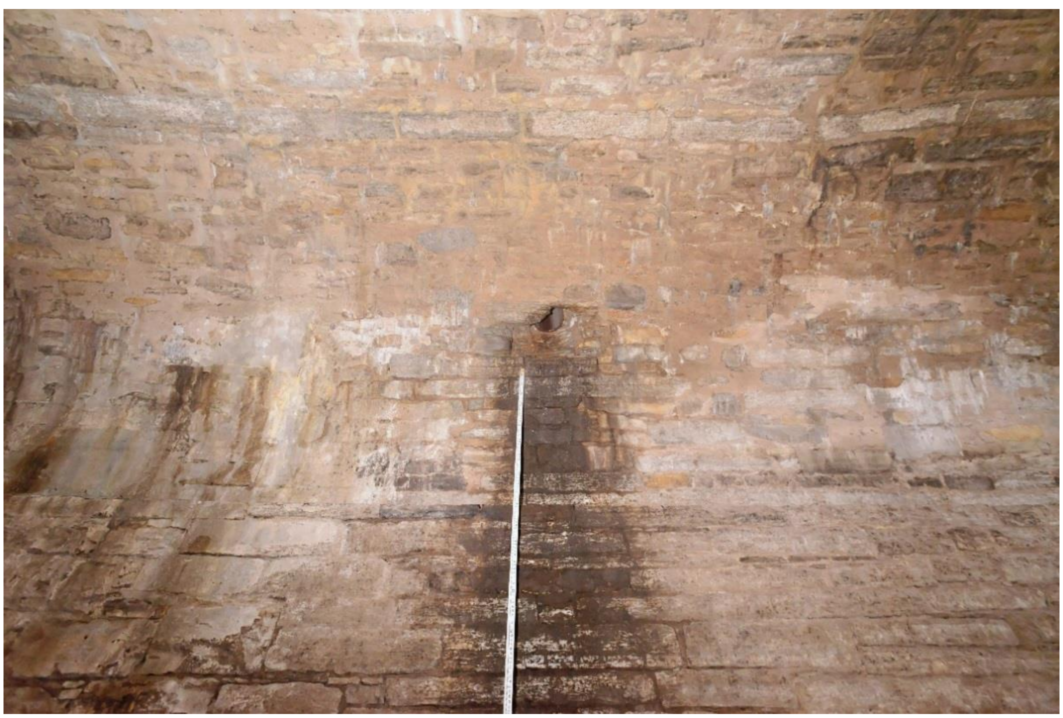

Photo 16. Catch basin connection at Station 1+35 on inland side wall.

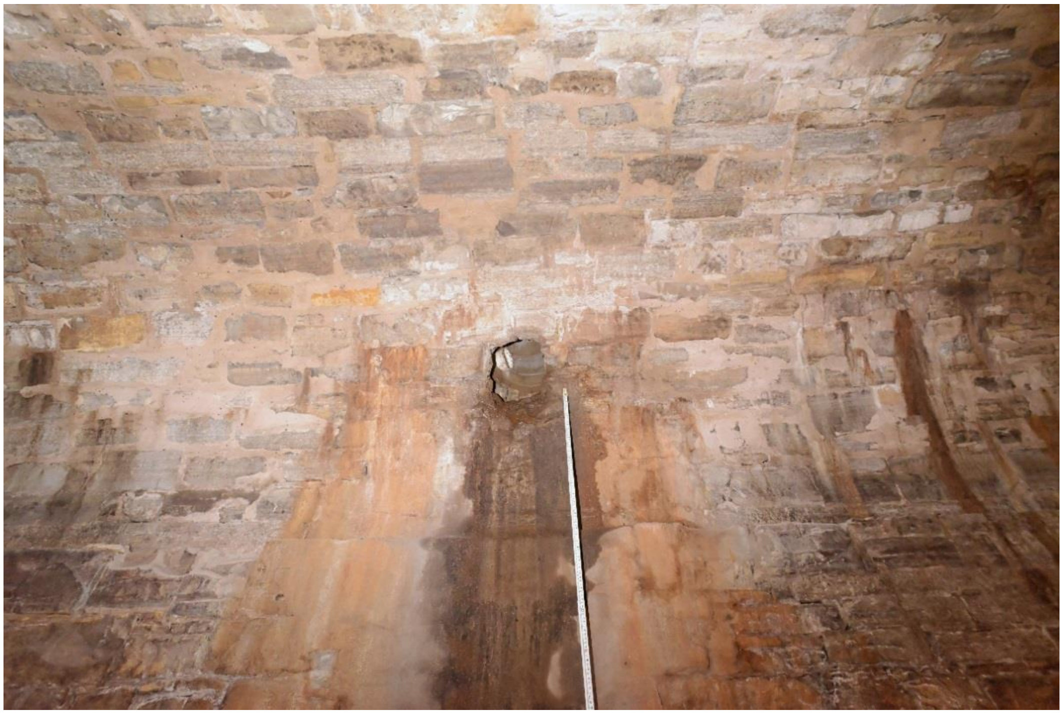

Photo 17. Catch basin at Station 1+86 on inland side wall.

Photo 18. Close up of catch basin at Station 1+35.

Photo 19. Close-up showing wall thickness at catch basin Station 1+86.

Photo 20. Fractured Limestone and missing stone.

Photo 21. S-curve in arched tunnel. Picture taken from Station 1+75 looking upstream.

Photo 22. Precast roof section change over Phoenix headrace at Station 2+75.

Photo 23. Inland side wall of Phoenix headrace intersection.

Photo 24. Inland side wall of Phoenix headrace intersection before steel gate cover placement.

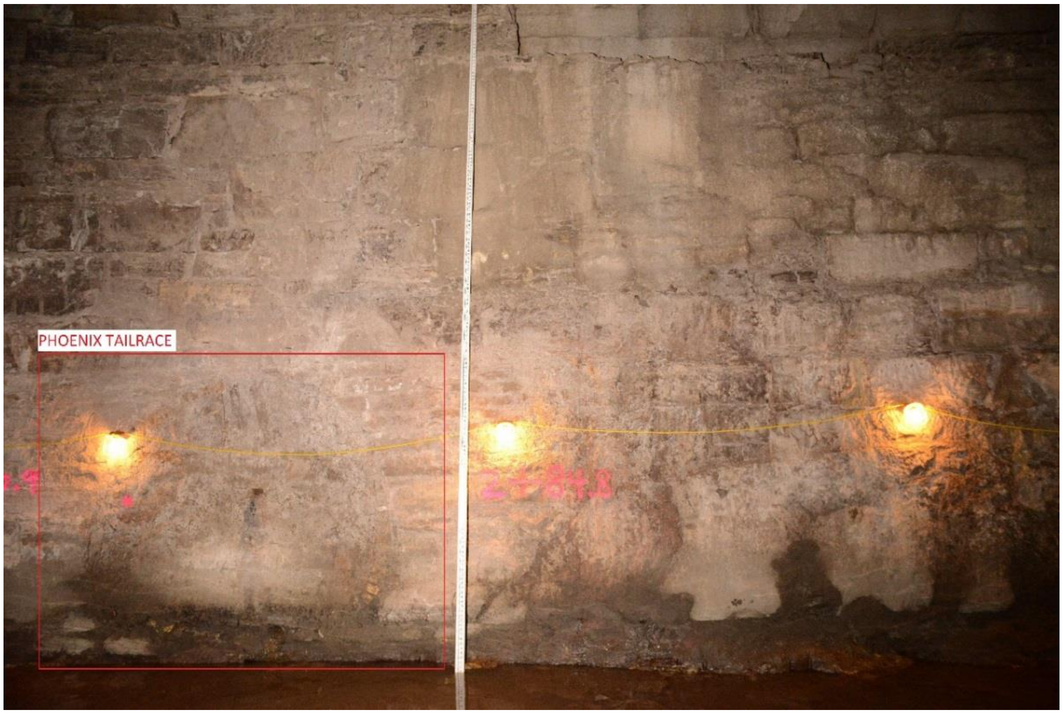

Photo 25. River side wall bulkhead where Phoenix headrace once intersected the tunnel.

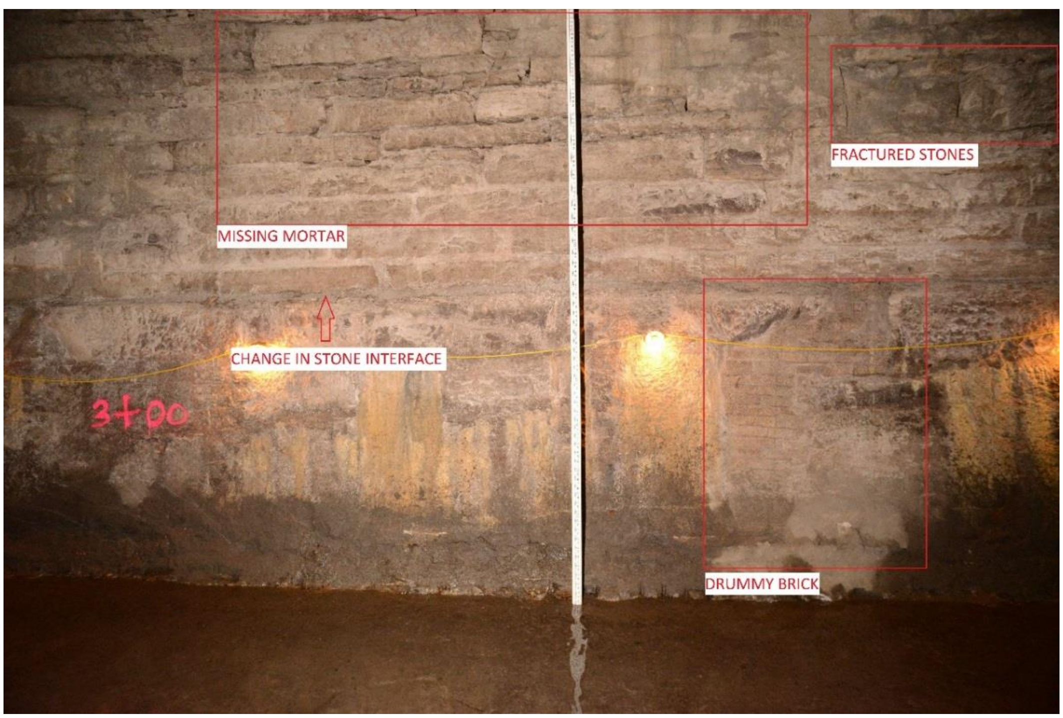

Photo 26. Drummy brick patches, change in stone 7 inches from invert, missing mortar and missing stones.

Photo 27. Undercutting of stone wall near invert.

Photo 28. 2-inch pipe penetration at Station 3+45.

Photo 29. Sanitary intersection near crown of tunnel at Station 4+02, and pipe infiltration at Station 4+13.

Photo 30. Water infiltration from leaking water pipe.

Photo 31. Downstream end of broken live sanitary pipe intersecting arch near crown at Station 4+55.

Photo 32. Upstream end of broken live sanitary pipe on crown of tunnel at Station 4+93.

Photo 33. Looking upstream from STA 4+97 towards 90-degree bend.

Photo 34. Shotcrete on river side wall 90-degree bend, and missing ledge.

Photo 35. Groundwater pipes on inland wall at 90-degree bend.


Photo 36. Roots penetrating through arch roof in front of bulkhead.

Photo 37. Headrace bulkhead.

Photo 38. 8-inch pipe on headrace bulkhead.

Photo 39. 1-foot by 1-foot steel sliding gate on headrace bulkhead.

Photo 40. Forebay inland side wall.

Photo 41. Forebay brick arch and timber roof.

Photo 42. Upstream dropshaft sluice gates.

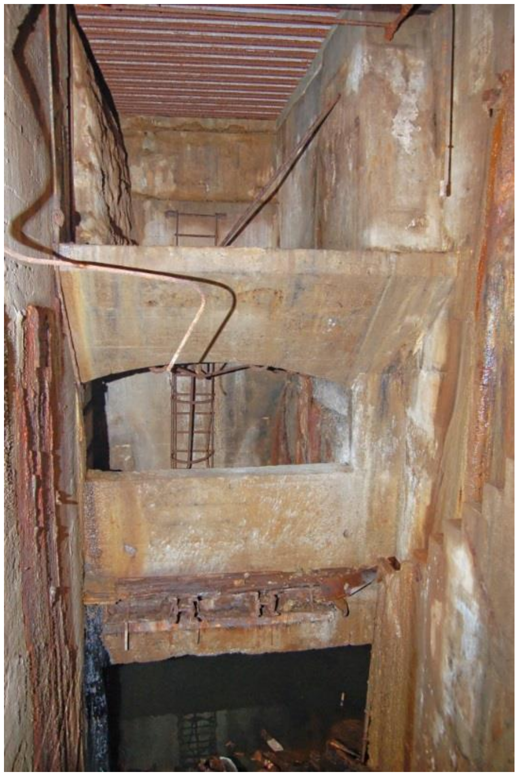

Photo 43. Upriver turbine service room.

Photo 44. Downstream dropshaft sluice gates.

Photo 45. Downriver dropshaft in tailrace, view from tailrace service room. White formations visible in photo are ice.

Photo 46. View from tailrace looking up downriver dropshaft. White formations visible in photo are ice.

Photo 47. View from the NW corner of the downriver tailrace. White formations visible in photo are ice.

Photo 48. Debris pile coming from hole in downriver turbine service room. White formations visible in photo are ice.

Photo 49. Downstream turbine service room.

Photo 50. Downriver tailrace portal.

Photo 51. Downriver portal – looking towards Mississippi River from southwest channel.

Photo 52. Downriver tailrace – southwest channel portal.

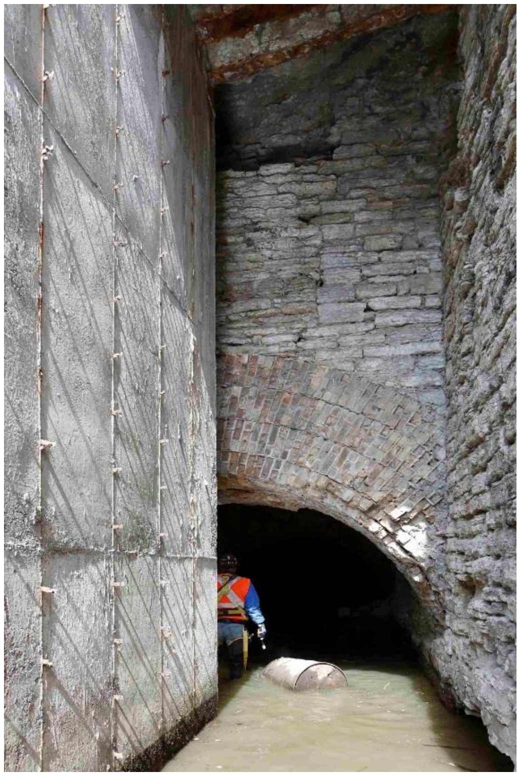

Photo 53. Arch at the entrance of the downriver tailrace southwest channel.

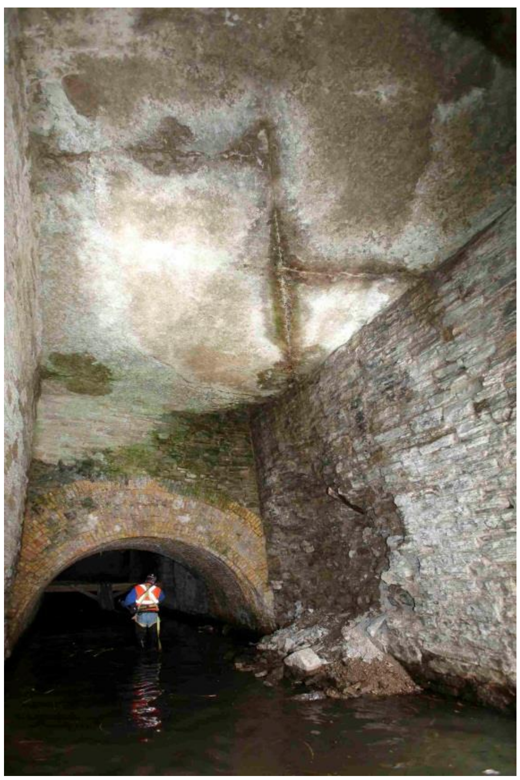

Photo 54. Brick arch in downriver tailrace southwest channel.

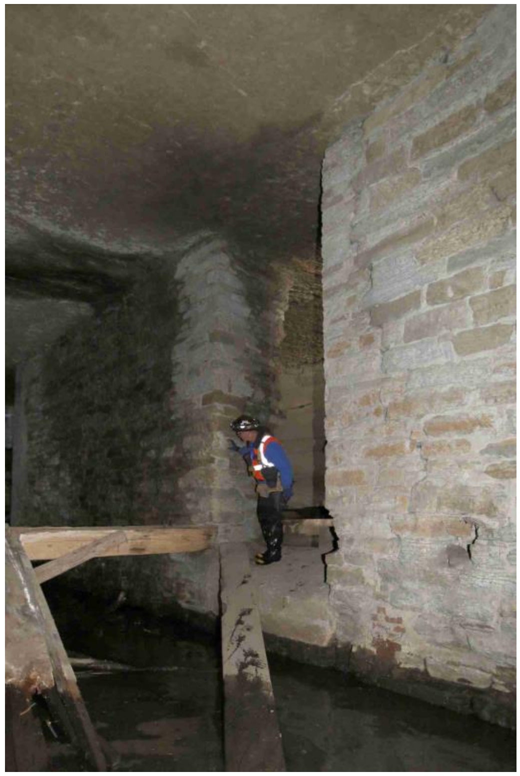

Photo 55. Downriver tailrace – penetration in interior stone masonry dividing wall.

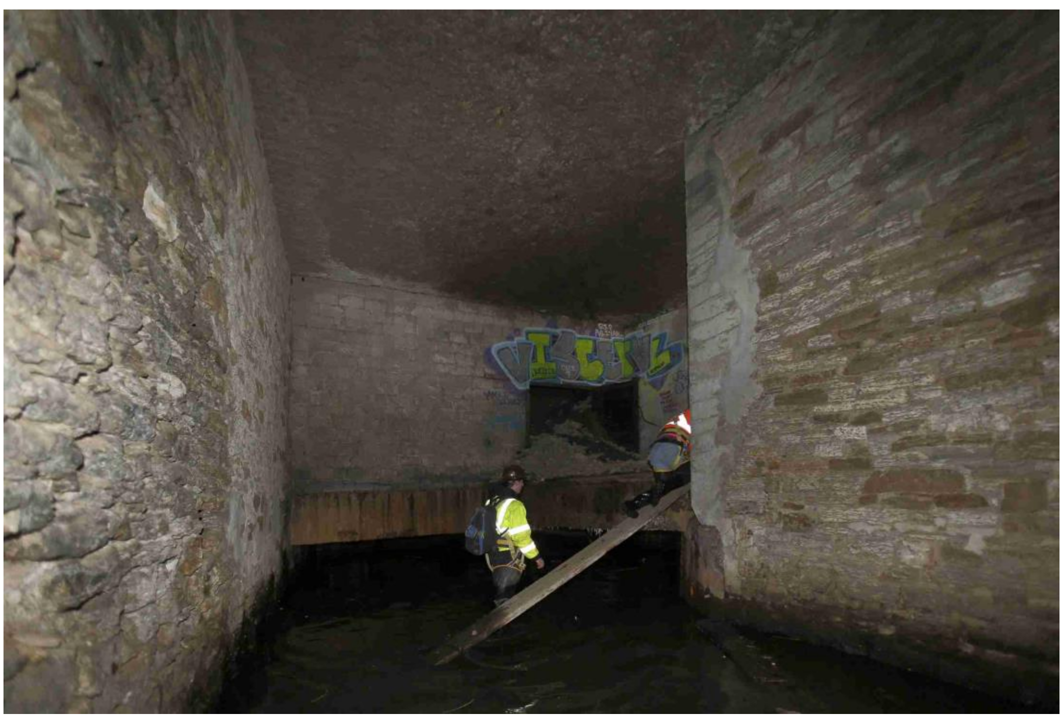

Photo 56. End of the downriver tailrace southwest channel.

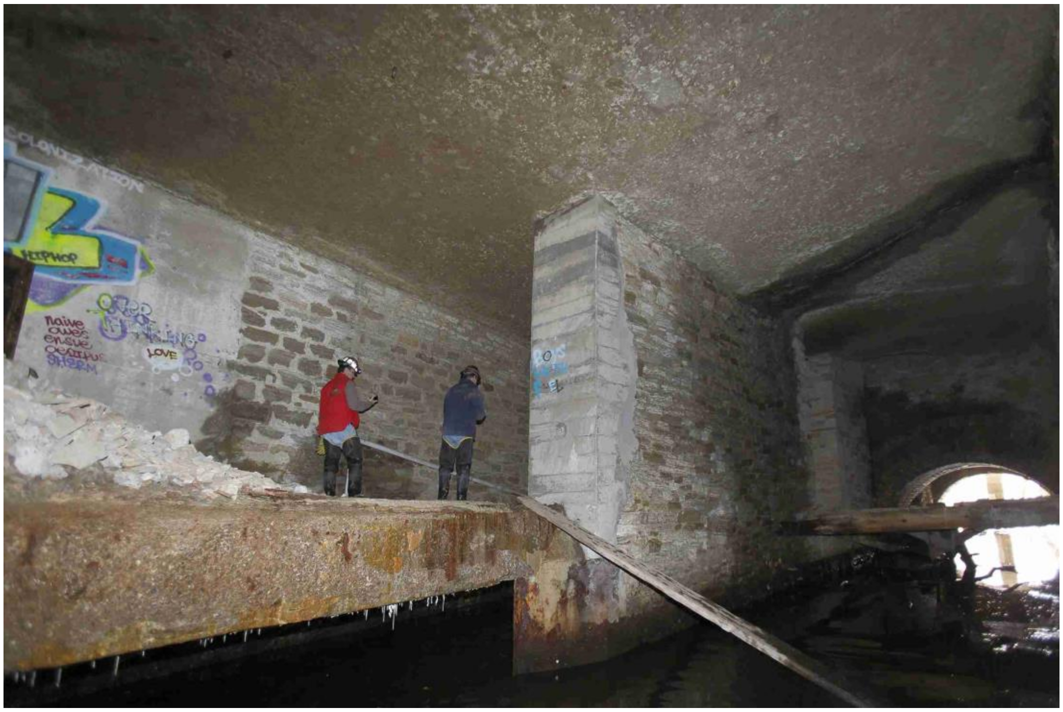

Photo 57. Southeast corner of the southwest downriver tailrace channel looking out towards the river.

Photo 58. View beneath elevated platform structure in downstream tailrace.

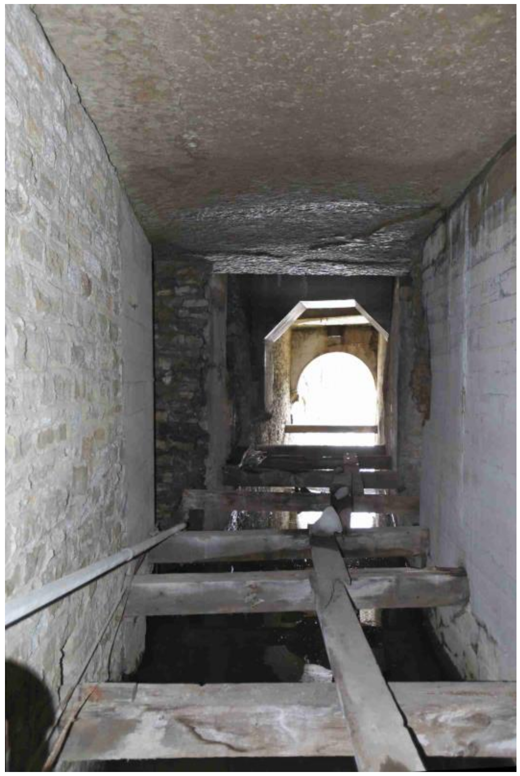

Photo 59. Downriver tailrace northeast channel looking out towards river.

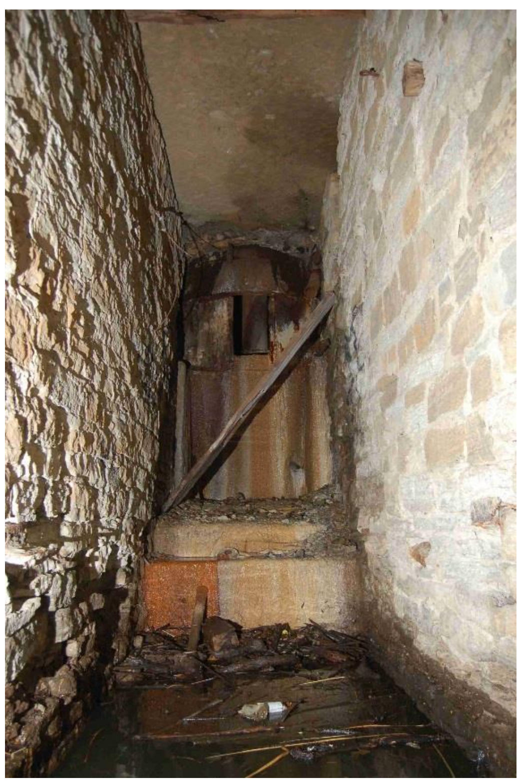

Photo 60. Machine shop dropshaft as seen from Machine shop tailrace tunnel.

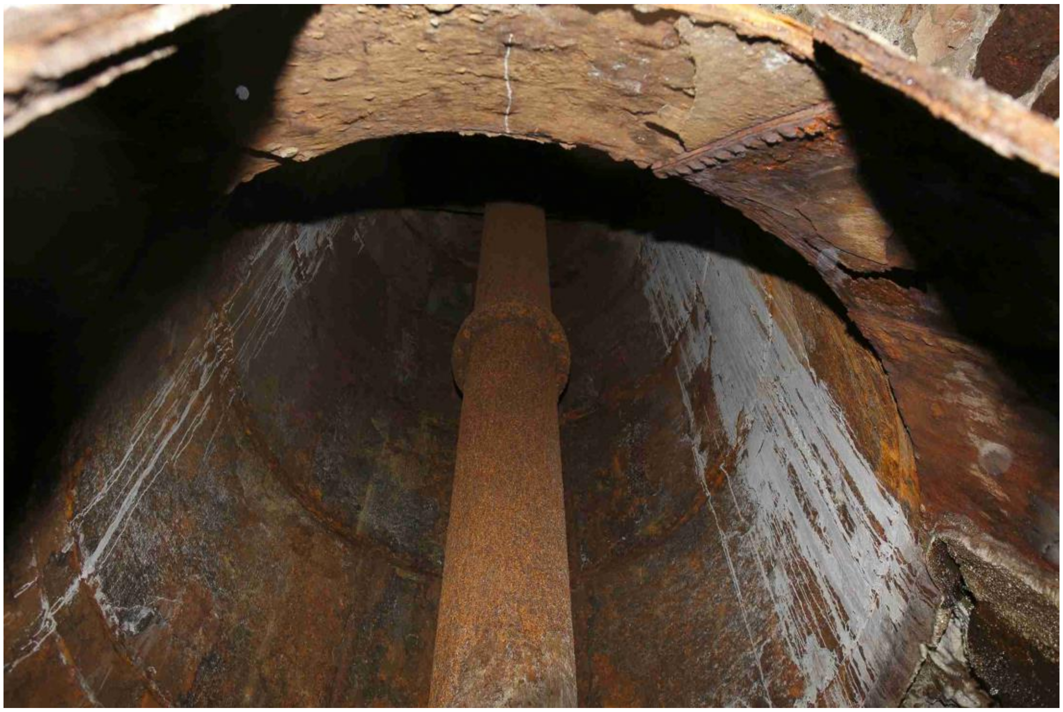

Photo 61. View looking up the Machine shop dropshaft.

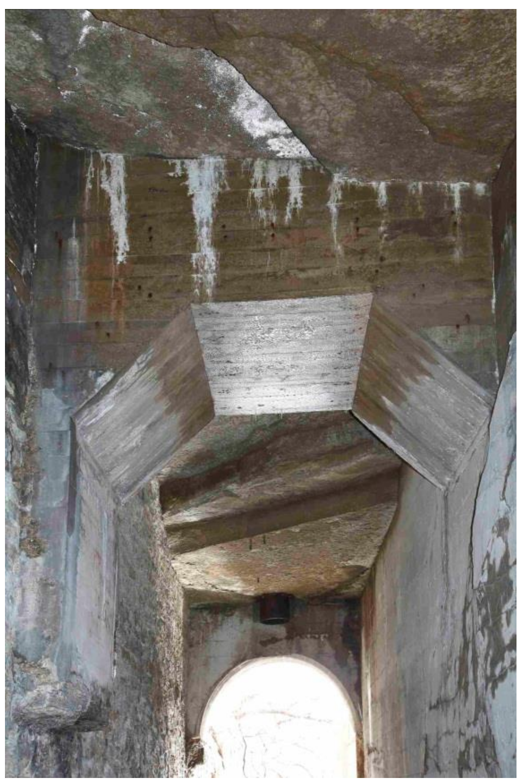

Photo 62. Concrete arch in northeast channel of downriver tailrace.

Photo 63. Upriver and Downriver tailrace portals.

Appendix B. Engineering Condition Assessment Drawings

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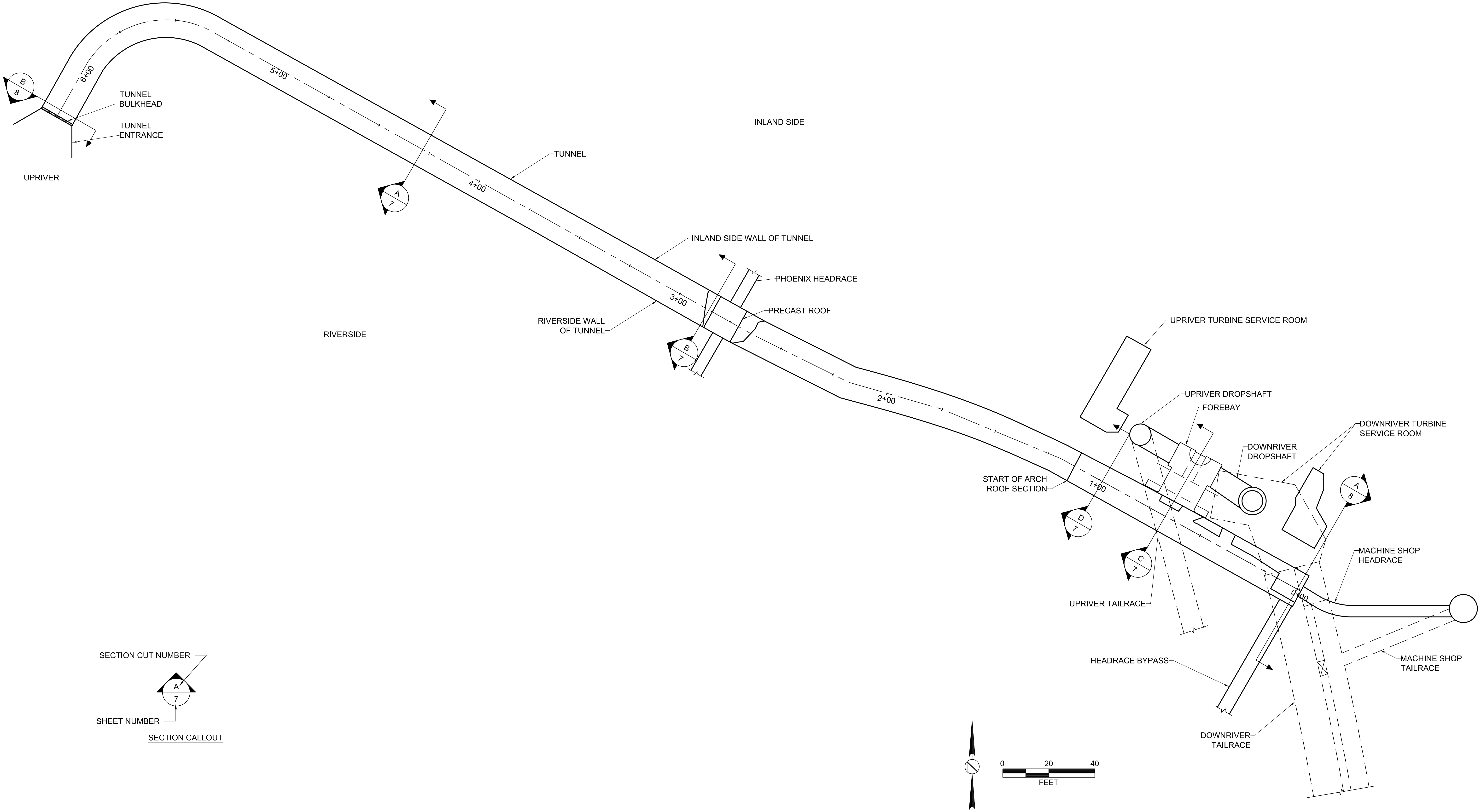

CNA CONSULTING ENGINEERS

PILLSBURY A MILL TUNNEL
HISTORIC AND ENGINEERING CONDITION STUDY

TUNNEL LEVEL SITE PLAN

DRAWING

1

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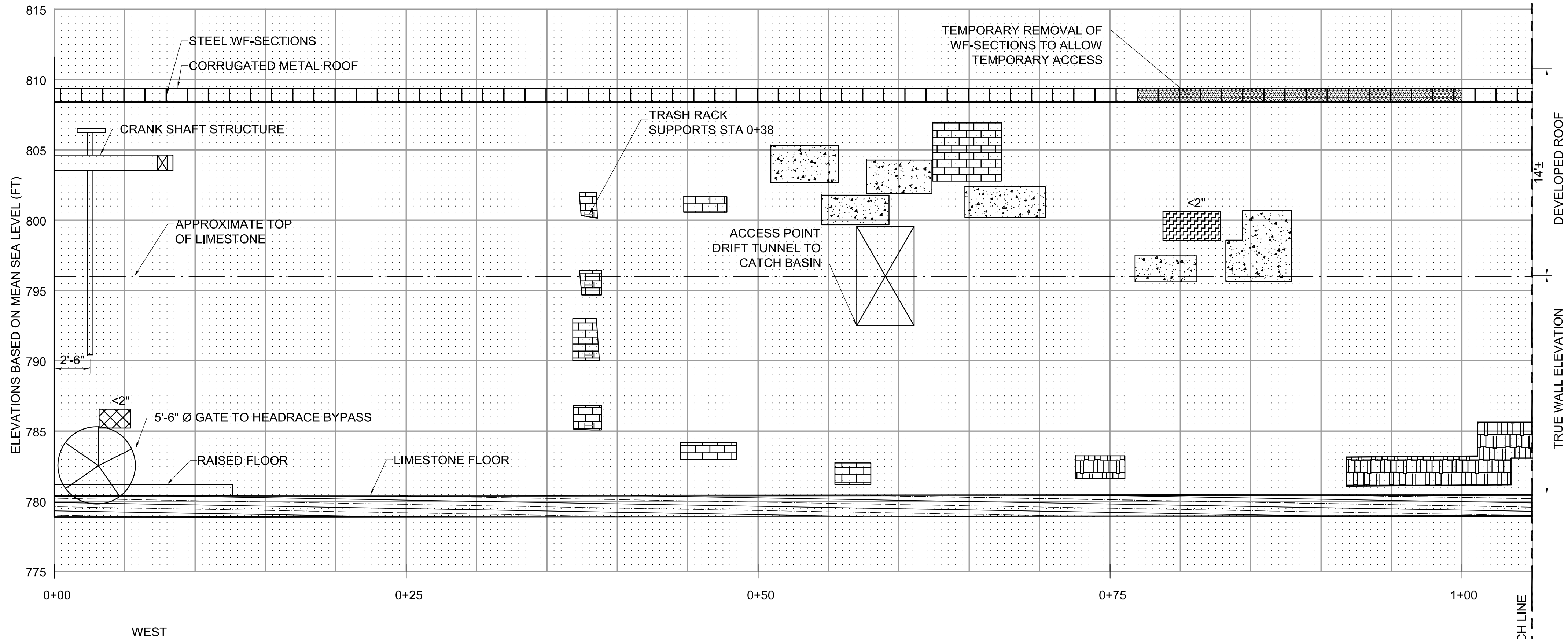
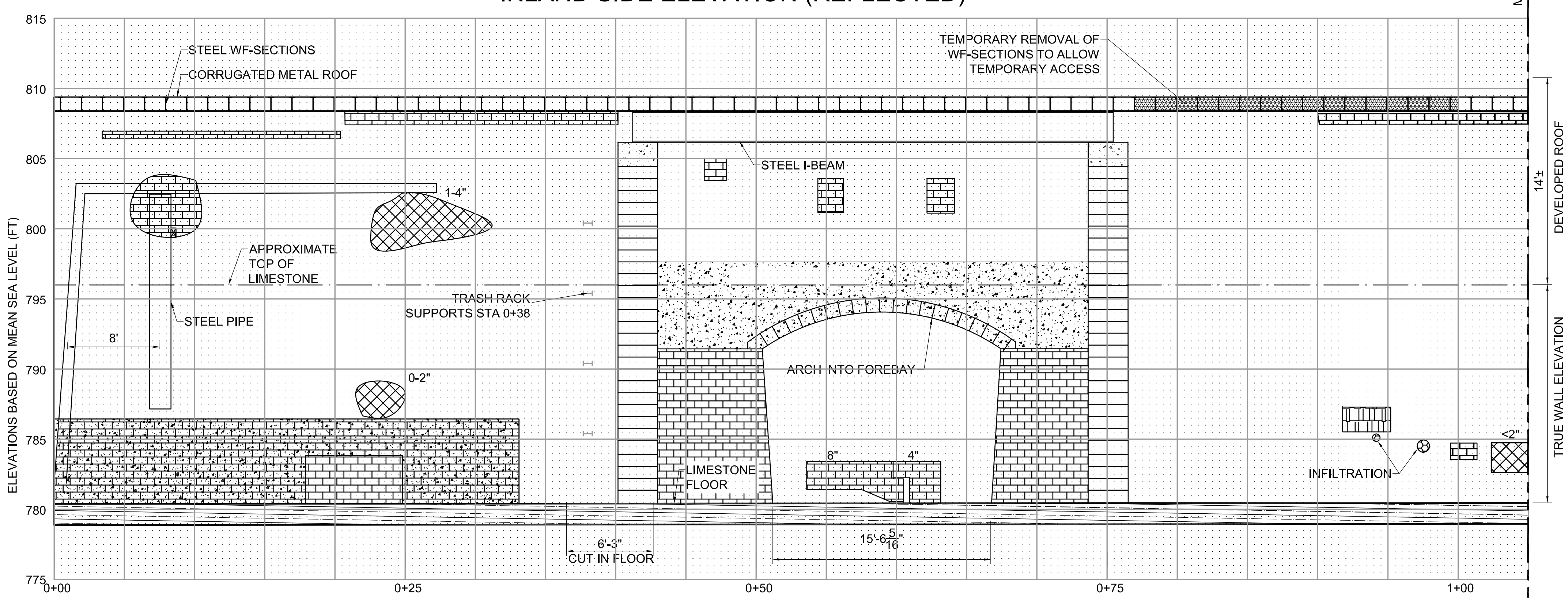
RIVER SIDE ELEVATION



INLAND SIDE ELEVATION (REFLECTED)



GENERAL NOTES:

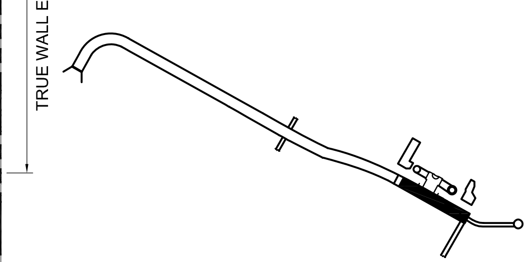
1. LOCATION AND SIZE OF TUNNEL FEATURES AND OBSERVED CONDITIONS ARE APPROXIMATE

LEGEND:

- BRICK MASONRY
- BRICK - DRUMMY
- MORTAR MISSING #"-#" = DEPTH MISSING
- MISSING STONE MASONRY #"-#" = DEPTH MISSING
- UNDERCUT MASONRY WALL #"-#" = RANGE
- SHOTCRETE PATCH
- INFILTRATION RUNNER
- INFILTRATION WEEPER
- PIPE

0 5 10
FEET

KEY PLAN



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PILLSBURY A MILL TUNNEL
HISTORIC AND ENGINEERING CONDITION STUDY

PROFILE

DRAWING

2

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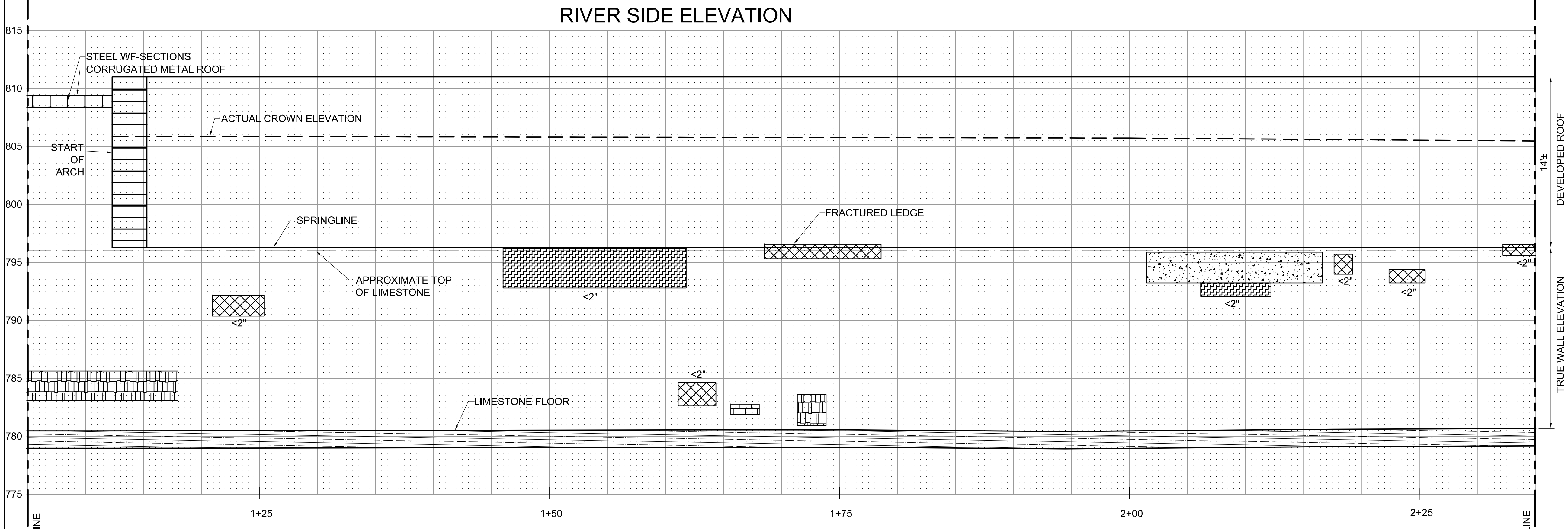
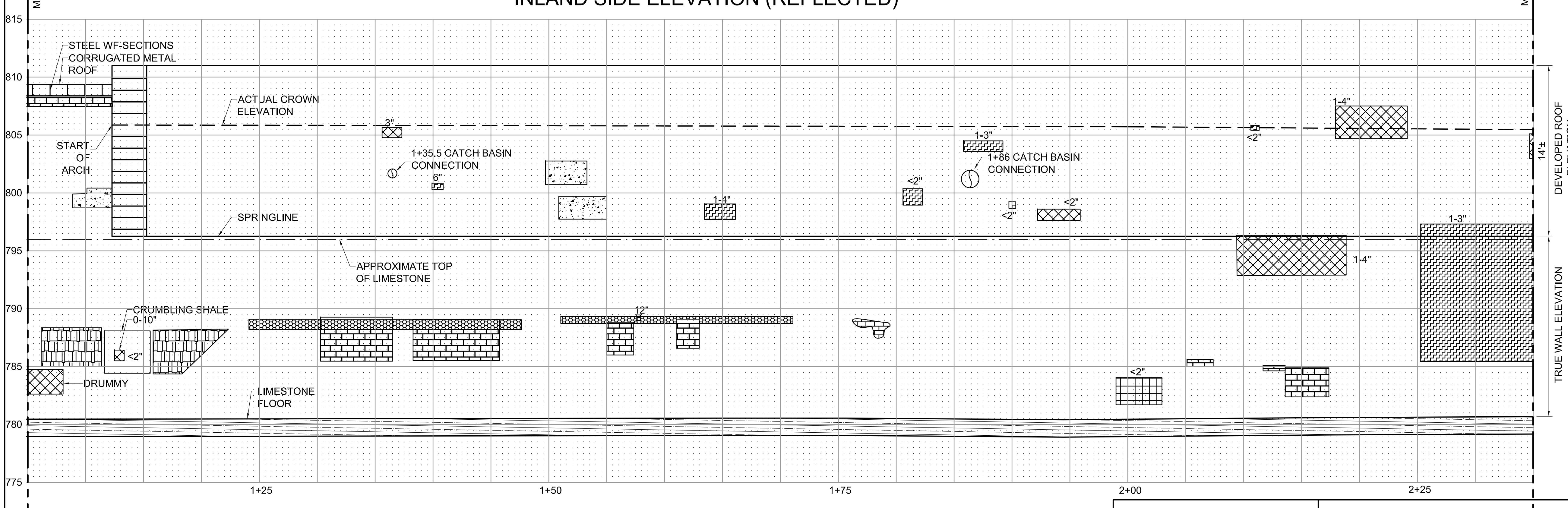
RIVER SIDE ELEVATION



INLAND SIDE ELEVATION (REFLECTED)



1. LOCATION AND SIZE OF TUNNEL FEATURES AND OBSERVED CONDITION ARE APPROXIMATE
2. ELEVATIONS ARE BASED ON MEAN SEA LEVEL (FT)

LEGEND:

- BRICK MASONRY
- BRICK - DRUMMY
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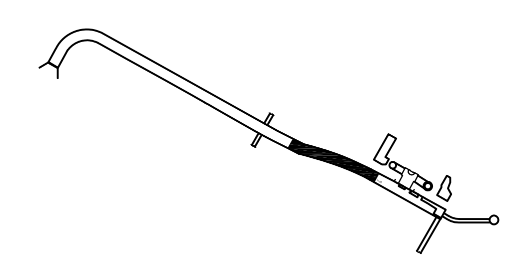
- MISSING STONE MASONRY #"-#" = DEPTH MISSING
- UNDERCUT MASONRY WA #"-#" = RANGE
- SHOTCRETE PATCH
- INFILTRATION RUNNER
- INFILTRATION WEEPER
- PIPE

0 5 10
FEET

KEY PLAN



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MINNEAPOLIS, MN

PILLSBURY A MILL TUNNEL
HISTORIC AND ENGINEERING CONDITION STUDY

PROFILE

DRAWING
3

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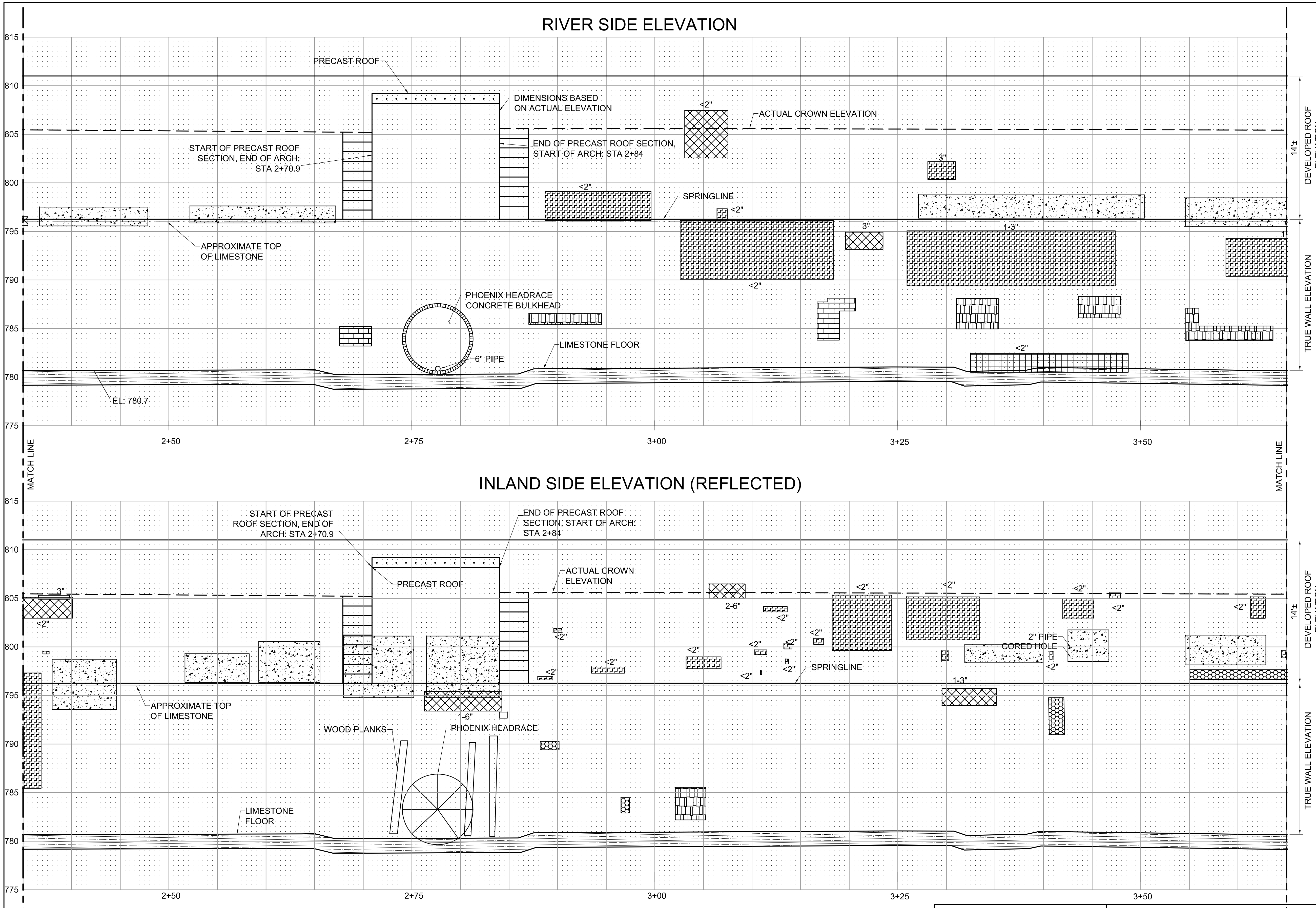

GENERAL NOTES:

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- PIPE

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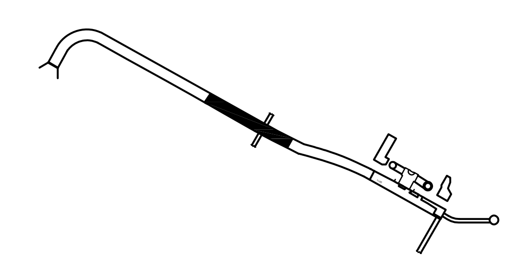
FEET

KEY PLAN



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PILLSBURY A MILL TUNNEL
HISTORIC AND ENGINEERING CONDITION STUDY

PROFILE

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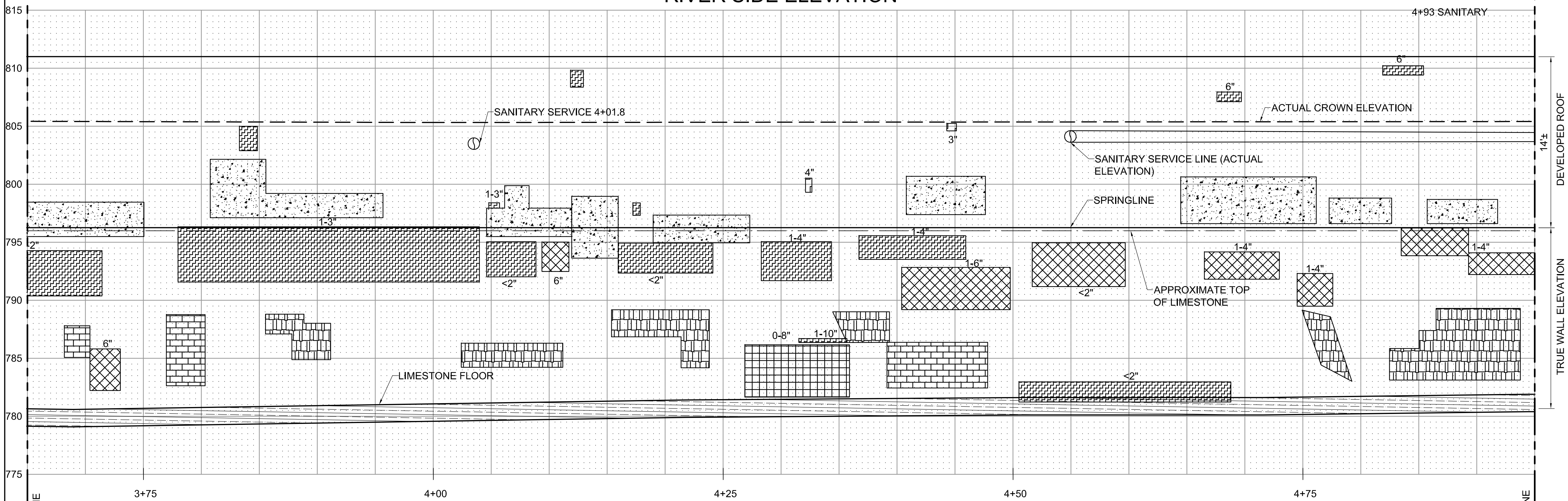
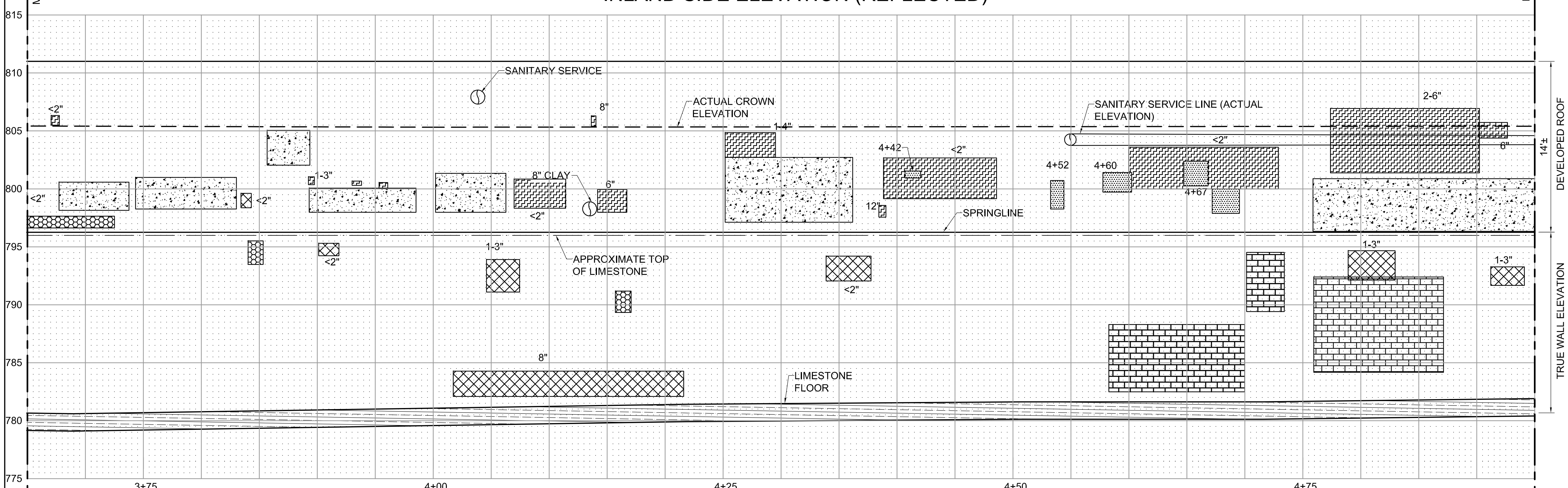
RIVER SIDE ELEVATION



INLAND SIDE ELEVATION (REFLECTED)



GENERAL NOTES:

1. LOCATION AND SIZE OF TUNNEL FEATURES AND OBSERVED CONDITION ARE APPROXIMATE
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LEGEND:

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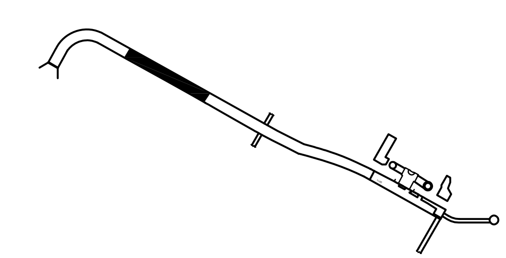
- UNDERCUT MASONRY WA #"-#" = RANGE
- SHOTCRETE PATCH
- INFILTRATION RUNNER
- INFILTRATION WEEPER
- PIPE

0 5 10
FEET

KEY PLAN



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PILLSBURY A MILL TUNNEL
HISTORIC AND ENGINEERING CONDITION STUDY

PROFILE

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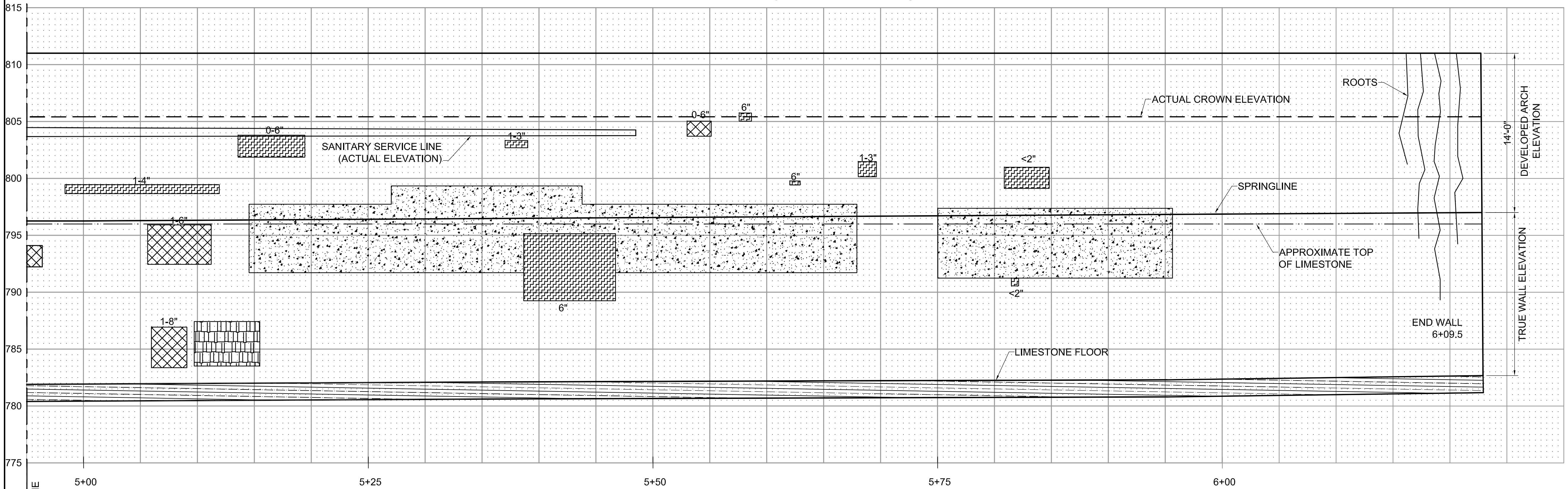
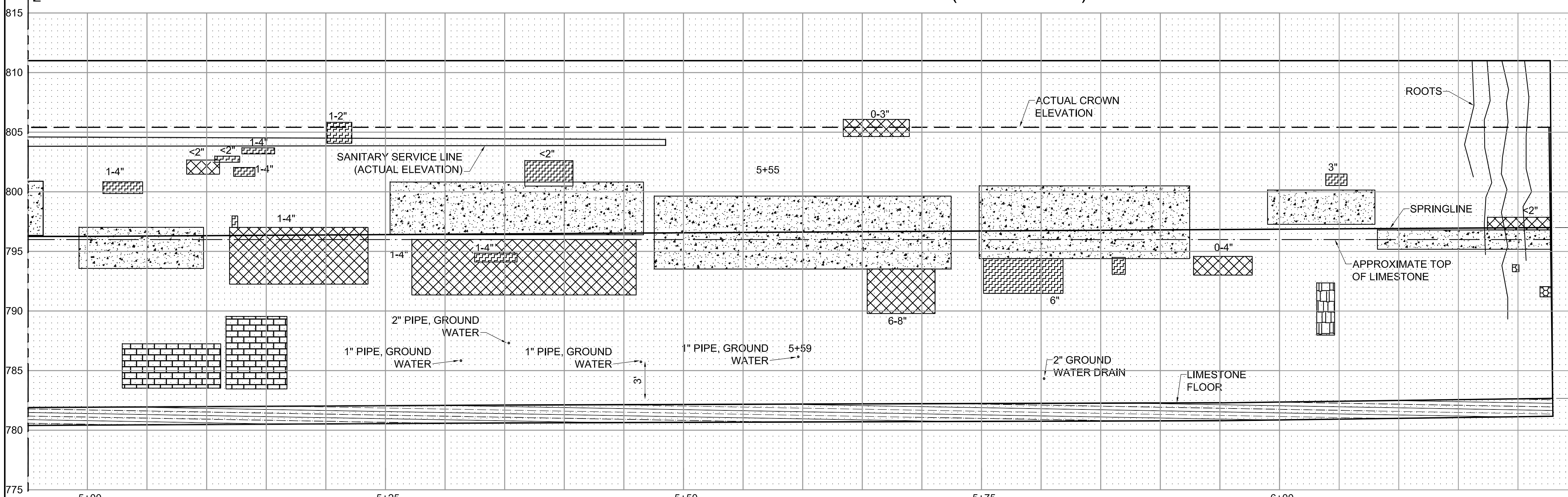
RIVER SIDE ELEVATION



INLAND SIDE ELEVATION (REFLECTED)



GENERAL NOTES:

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- SHOTCRETE PATCH
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- INFILTRATION WEEPER
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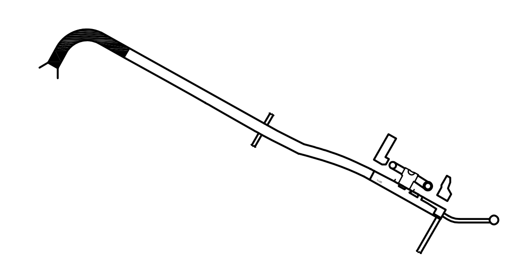
0 5 10
FEET

KEY PLAN



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PILLSBURY A MILL TUNNEL
HISTORIC AND ENGINEERING CONDITION STUDY

PROFILE

DRAWING

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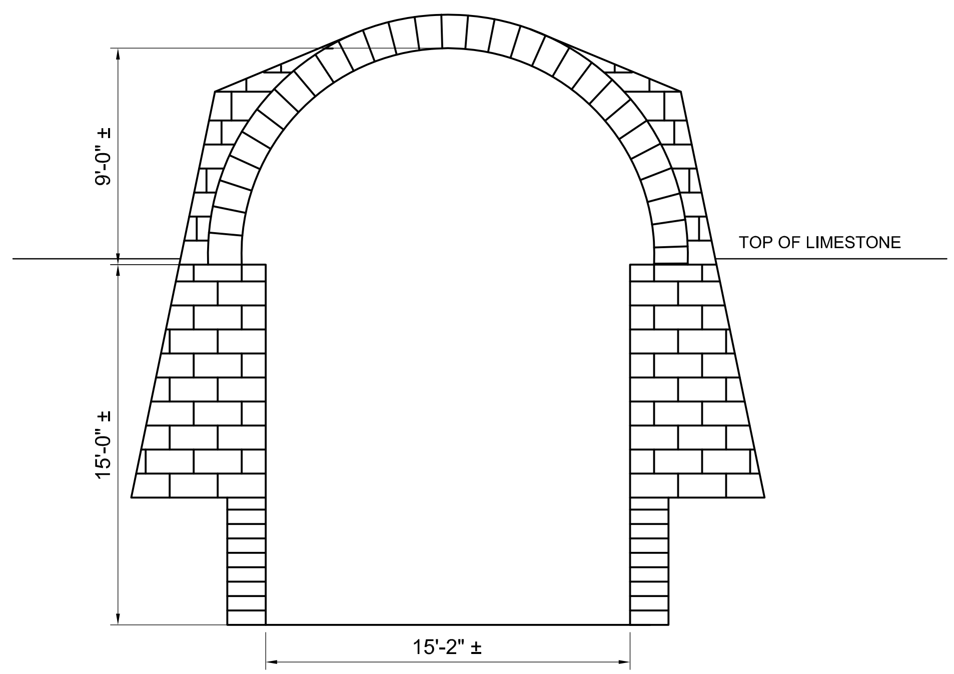

A / 7 **TYPICAL TUNNEL SECTION**

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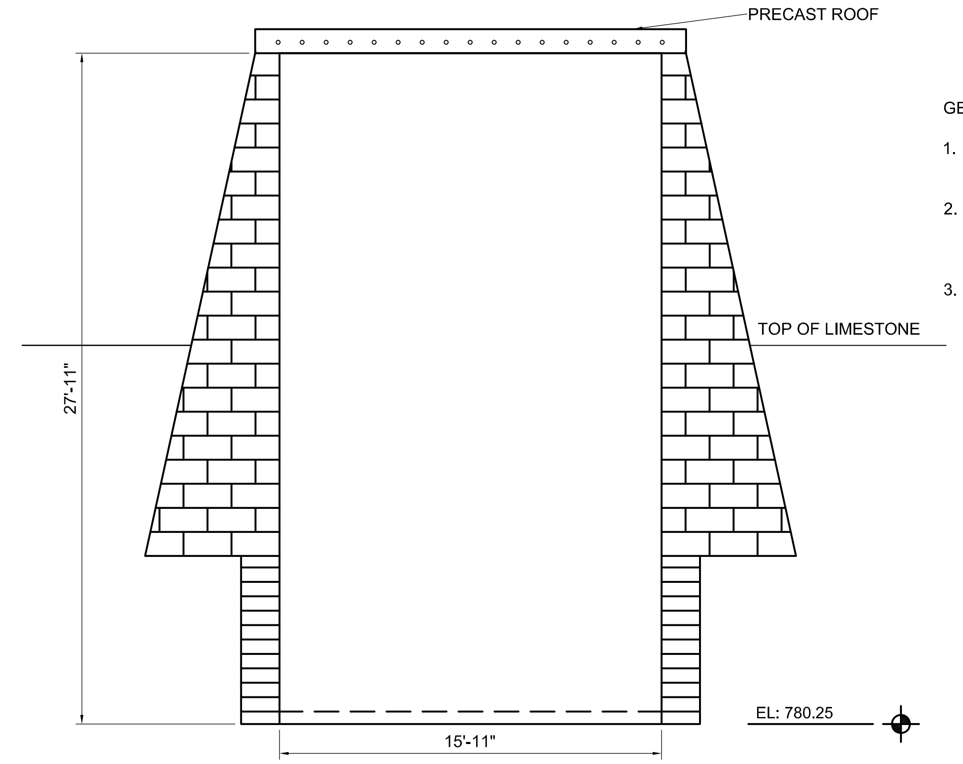
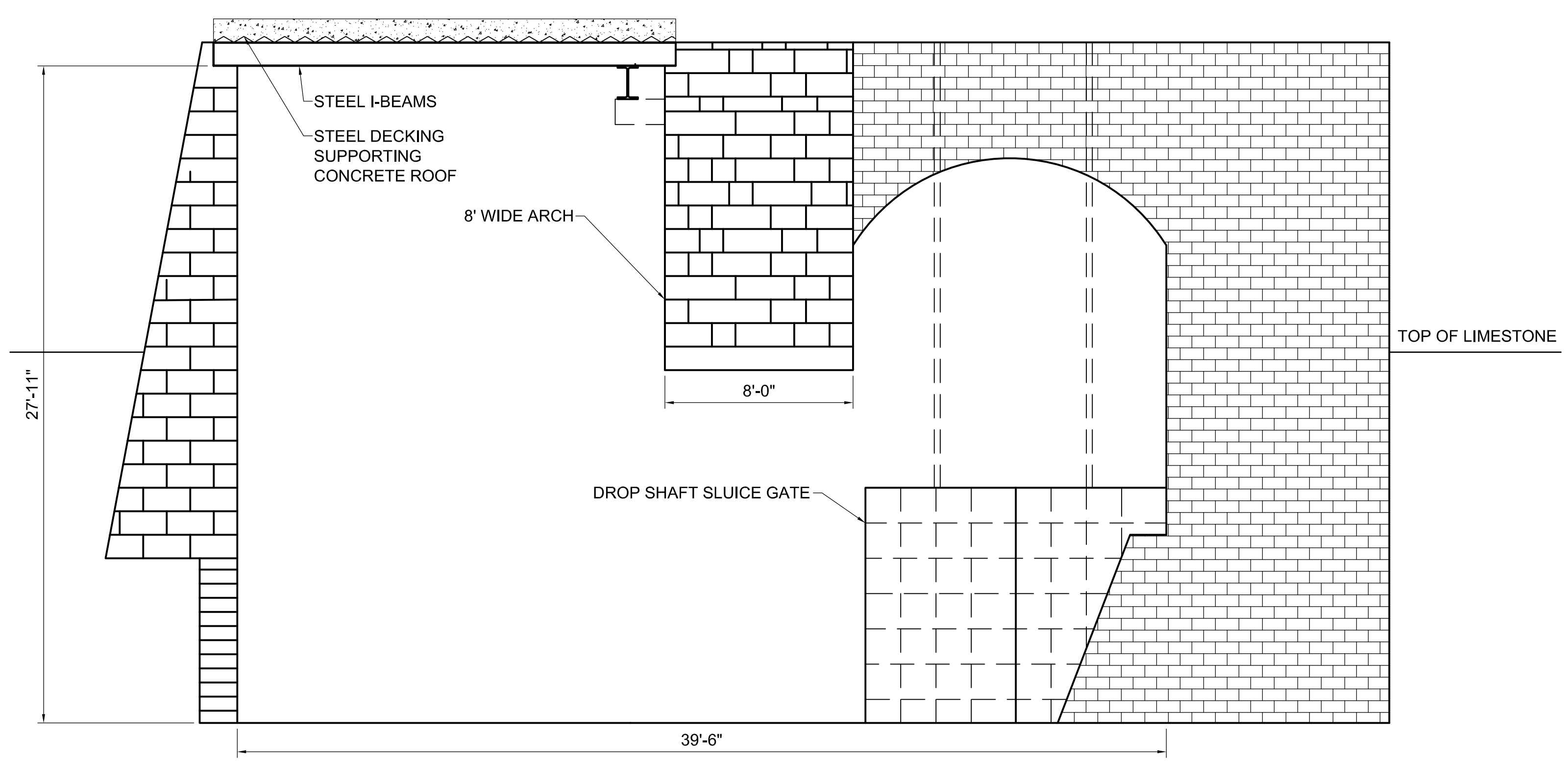


B / 7 **STATION 2+68**

0 4 8 FEET

GENERAL NOTES:

1. WALL THICKNESS SHOWN ARE BASED ON HISTORICAL DRAWINGS
2. LIMESTONE ELEVATIONS BASED ON AVERAGE ELEVATIONS FROM MEI BORING 9 & 61 4 120-5755
3. SEE SHEET 1 FOR LOCATIONS OF SECTIONS



C / 7 **FOREBAY SECTION**

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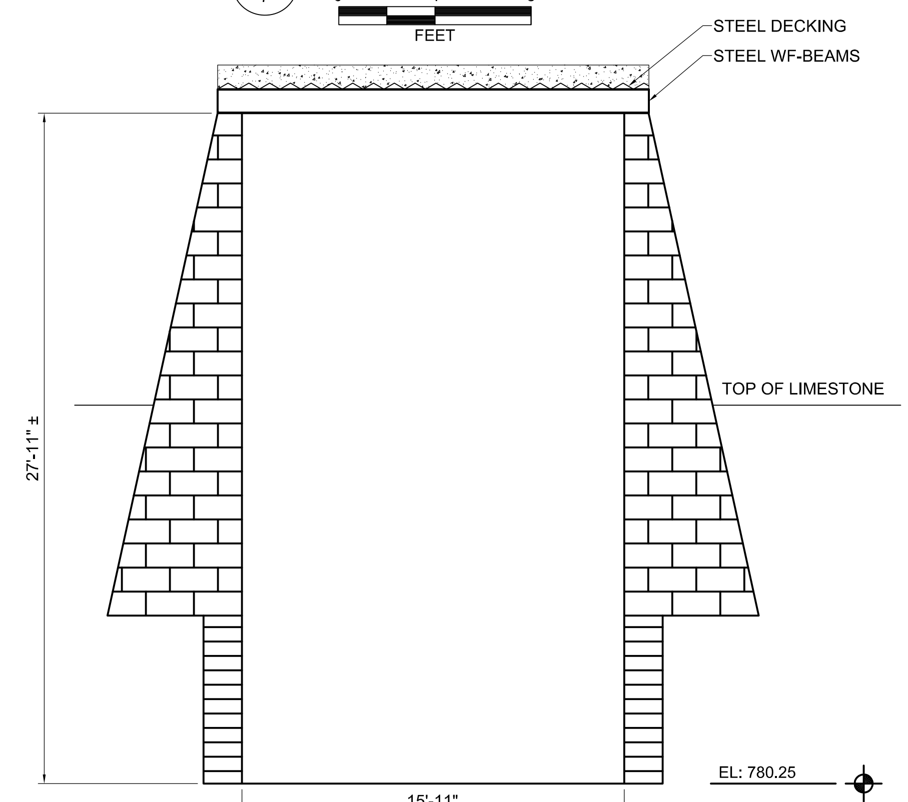

D / 7 **STATION 1+00**

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CNA CONSULTING ENGINEERS MINNEAPOLIS, MN	PILLSBURY A MILL TUNNEL HISTORIC AND ENGINEERING CONDITION STUDY TUNNEL SECTIONS	DRAWING 7

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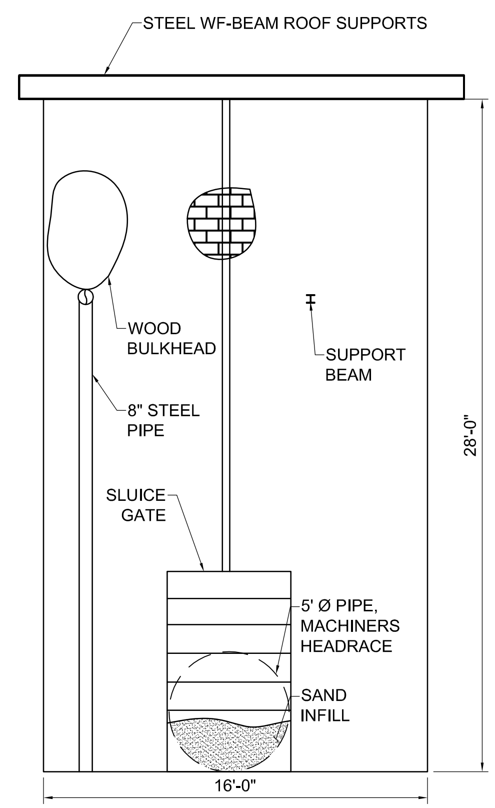

A/8 HEADRACE SOUTH ENDWALL ELEVATION

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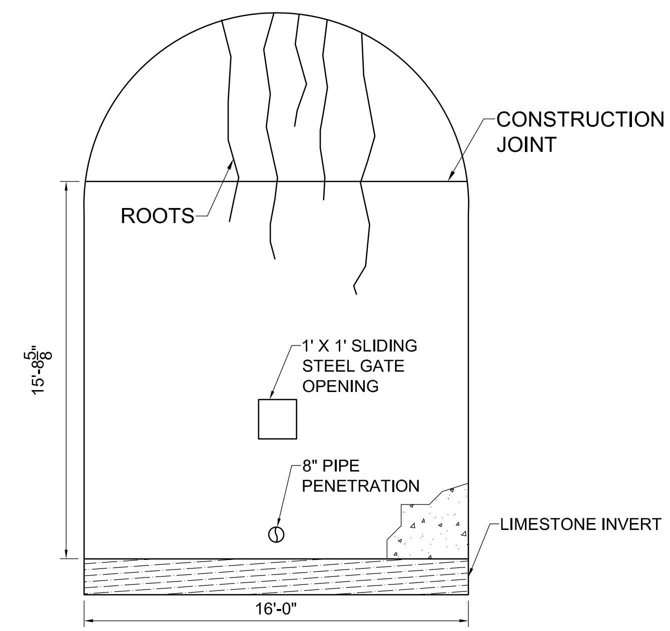
FEET



B/8 BULKHEAD ELEVATION

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FEET

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PILLSBURY A MILL TUNNEL
HISTORIC AND ENGINEERING CONDITION STUDY

TUNNEL ELEVATIONS

DRAWING

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Appendix C. A-Mill Artist Lofts Tunnel Laser Scanning Site Plan and Profile

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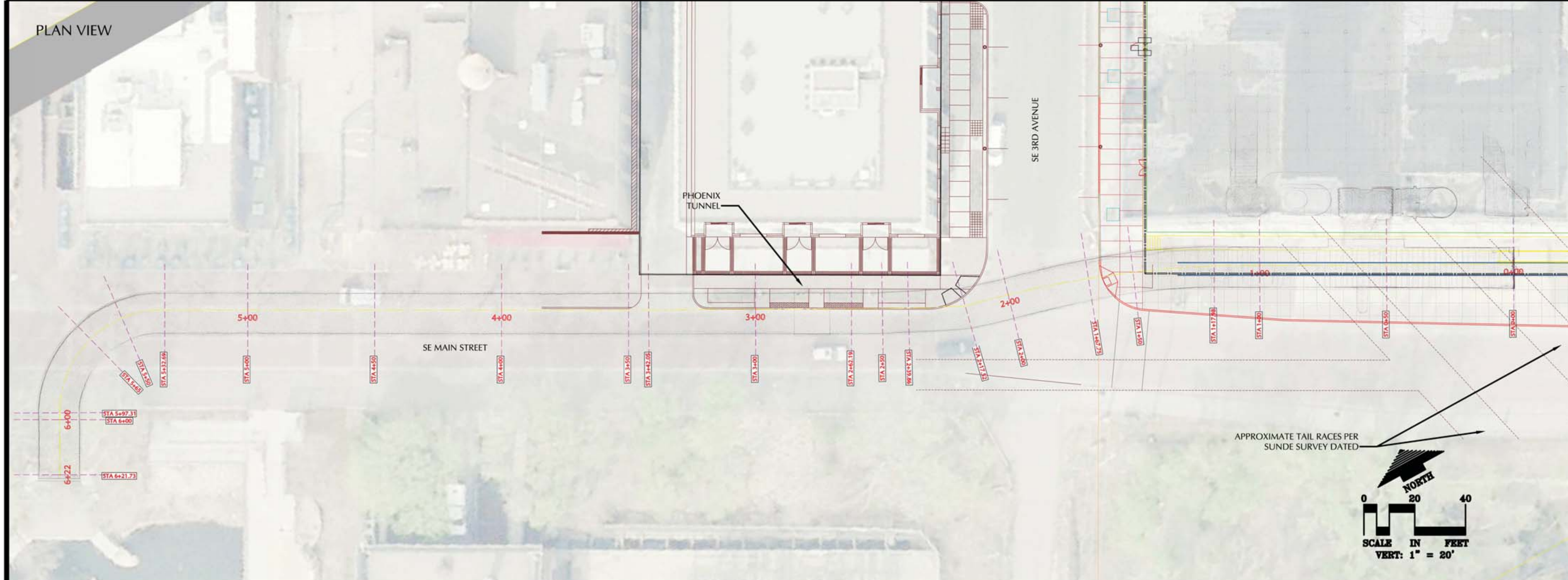

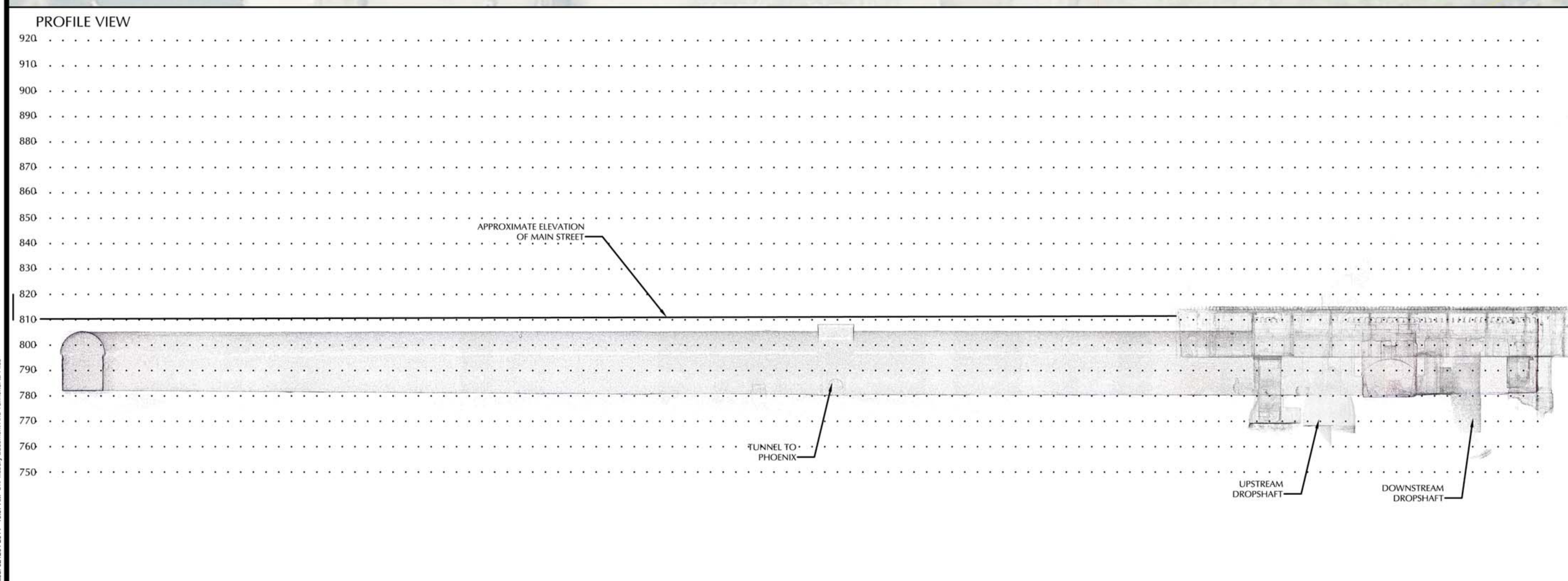

Project Name:

A-MILL ARTIST LOFTS TUNNEL LASER SCANNING

Minneapolis, Minnesota

Owner/Developer:

Minneapolis Leased Housing Associates IV, LP

2905 Northwest Blvd, Suite 150
Plymouth, MN 55441

Professional Services:

LOUCKS ASSOCIATES

Planning • Civil Engineering • Land Surveying
Landscape Architecture • Environmental

7200 Hemlock Lane - Suite 300
Maple Grove, MN 55369
Telephone: (763) 424-5505
www.LoucksAssociates.com

CADD Qualification:

Submittal:

Professional Signature:

Quality Control:

Project Lead: NMM	Drawn By: CDL
Checked By: NMM	Review Date: 02/21/14

Sheet Index:

Sheet Title:

A-MILL TUNNEL SITE PLAN & PROFILE

Project No.:

11282.00

Sheet No.:

EXHIBIT 1

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Appendix D. Supplemental Large-format Photographs of the Pillsbury A Mill Tunnel System

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HISTORIC AMERICAN BUILDINGS SURVEY

INDEX TO PHOTOGRAPHS

ADDENDUM TO
PILLSBURY MILLING COMPLEX, PILLSBURY “A” MILL HABS NO. MN-29-5-A
301 Main Street Southeast (page 4)
Minneapolis
Hennepin County
Minnesota

Daniel R. Pratt, Photographer, January to April 2014

Scale stick in photographs is 4 feet long.

NOTE: 22 photographs, 3 pages of written historical and descriptive data, and 6 sheets of drawings were previously transmitted to the Library of Congress in 1936 and 1987.

MN-29-5-A-23	ELEVATION VIEW OF PILLSBURY “A” MILL HEADRACE TUNNEL INLET, LOOKING SOUTHWEST.
MN-29-5-A-24	VIEW OF CURVE IN PILLSBURY “A” MILL HEADRACE TUNNEL NEAR INLET, LOOKING NORTHEAST.
MN-29-5-A-25	OBLIQUE VIEW OF DRILL HOLES IN FLOOR OF PILLSBURY “A” MILL HEADRACE TUNNEL NEAR PHOENIX MILL HEADRACE TUNNEL OPENING, LOOKING NORTHWEST.
MN-29-5-A-26	ELEVATION VIEW OF PILLSBURY “A” MILL HEADRACE TUNNEL ARCH, LOOKING NORTHWEST.
MN-29-5-A-27	ELEVATION VIEW OF PILLSBURY “A” MILL HEADRACE TUNNEL, AREA BEHIND FORMER TRASH RACK, LOOKING SOUTHEAST ADJACENT TO FOREBAY PORTAL.
MN-29-5-A-28	OBLIQUE VIEW OF PILLSBURY “A” MILL STRUCTURE BETWEEN HEADRACE TUNNEL AND FOREBAY, LOOKING SOUTHEAST FROM FOREBAY.
MN-29-5-A-29	ELEVATION VIEW OF PILLSBURY “A” MILL FOREBAY, LOOKING NORTHEAST.
MN-29-5-A-30	ELEVATION VIEW OF PILLSBURY “A” MILL UPRIVER DROP SHAFT GATES, LOOKING NORTHWEST FROM FOREBAY.

MN-29-5-A-31	ELEVATION VIEW OF PILLSBURY “A” MILL UPRIVER TURBINE ACCESS PIT, LOOKING SOUTHWEST.

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