United States Department of the Interior

OFFICE OF THE SECRETARY
Office of Environmental Policy and Compliance
Custom House, Room 244
200 Chestnut Street
Philadelphia, Pennsylvania 19106-2904

IN REPLY REFER TO:

August 28, 2015

9043.1
ER 15/0430

Ms. Kimberly D. Bose, Secretary
Federal Energy Regulatory Commission
888 First Street N.E., Room 1A
Washington, D.C. 20426

Re: Review of Notice of Application Ready for Filing (Amendment of License) for the Crown Mill Hydroelectric Project; FERC No. 11175-025, Hennepin County, Minnesota (ER 15/0430)

Dear Secretary Bose:

The Department of the Interior (Department) has reviewed the Notice of Application Ready for Filing, Amendment of License, for Crown Mill Hydroelectric Project (Project), which is currently licensed by the Federal Energy Regulatory Commission (FERC; P-11175). The Department's comments follow and include comments from the U.S. Fish and Wildlife Service (FWS) and National Park Service (NPS).

The FERC order issuing the project license, dated March 19, 1999, stated that the Project would consist of: (1) a reconstructed upper canal and intake tunnel, (2) a powerhouse room containing two hydropower units with a total capacity of 3.4 MW, and (3) a reconstructed tailrace canal and an existing tailrace tunnel. Under the proposed amendment, the licensee plans to reconfigure the Project and relocate it within the property boundary of a U.S. Army Corps of Engineers (USACE) lock and dam. The USACE raised some concerns with this new alignment in a letter dated March 15, 2012. In a letter dated April 15, 2013, the FERC stated that the latest proposal to develop the Project would involve lands and environmental resources not previously analyzed when the license was issued in 1999 and that the license amendment process may not be the appropriate vehicle for the licensee to analyze and implement the proposal.

NATIONAL PARK SERVICE COMMENTS

The NPS and the Mississippi National River and Recreation Area (NRRA) have reviewed the Notice of Application Ready for Filing, Amendment of License, for the Crown Mill Hydroelectric Project (Project), which is currently licensed by the FERC (P-11175). The Project is located entirely within the NRRA, which was designated by Congress in 1988 to "preserve, protect and enhance the significant values of the Mississippi River and to provide for orderly public and private development in the Twin Cities metro area" (P.L. 100-696).

The Project has potential to seriously impact the nationally significant cultural resources of the St. Anthony Falls Historic District, as well as the visual integrity, recreational use, and economic vitality of the entire St. Anthony Falls area. The NPS continues to support FERC's April 15, 2013, determination that a new license application is the appropriate avenue for this continuously changing project and recommend FERC take this into consideration when reviewing these comments.

The laws pertinent to the NRRA's responsibilities related to hydropower development and to ensure the Project's compatibility with the Comprehensive Management Plan (CMP) for the NRRA include Sixteen U.S.C. § 460zz-3(b)(1), the Fish and Wildlife Coordination Act, 16 U.S.C. §661 666c; the Anadromous Fish Conservation Act, 16 U.S.C. §757a; the Fish and Wildlife Act of 1956, 16 U.S.C. §742f; the National Environmental Policy Act, 42 U.S.C. §4321 et.seq.; the Clean Water Act, 33 U.S.C. §1251 et. seq.; the Federal Power Act, as amended 16 U.S.C. §791(a) et seq. and 18 CFR Ch. 1, § 4.38 et. seq., which outlines consultation requirements and NPS authority to prescribe conditions to amended hydropower facilities; the Electric Consumers Protection Act of 1986, Public Law 99 945; the Fish and Wildlife Act of 1956, 16 U.S.C. §742f(a)(4), which directs the Secretary of the Interior to, "take such steps as may be required for the development, advancement, management, conservation, and protection of fish and wildlife resources … ", and Section 106 of the National Historic Preservation Act.

The specific authority under the Federal Powers Act that requires consultation with the NPS for amendments or modifications to an existing license is 18 C.F.R. §4.38 et. seq. NPS. The NPS offers the following specific comments on the proposed amendment:

Page B-2 – The NPS is concerned that the Project will be unmanned and controlled and monitored remotely. The NPS recommends that Crown Hydro, LLC (Applicant) prepare an emergency management plan to ensure the safety and security of the project under unusual and emergency conditions,.

Page B-4 – Aesthetic Resources - The Project has potential to affect the amount of water flowing over St. Anthony Falls. There is serious disagreement amongst various resource protection agencies with the amount of water that should flow over St. Anthony Falls to maintain its integrity as a natural, cultural, visual, and economic resource. Since 2003, the position of the NPS has been that the minimum surface flow of 100 cubic feet per second (cfs) proposed by the

Applicant is inadequate to maintain the recreational, economic and aesthetic significance of the St. Anthony Falls area and is in conflict with the "Low Flow Contingency and Management Plan for St. Anthony Falls", which recommends a minimum of 200 cfs for both the Crown Hydro Project and Xcel Energy's St. Anthony Falls Project. Since the mid-1980's, the Minneapolis Park and Recreation Board (MPRB) has maintained that flows over St. Anthony Falls not fall below 2,000 cfs. This discrepancy in minimum flows reflects broad disagreement and concern for the Crown Hydro Project and its impacts to St. Anthony Falls, especially since FERC authorized Xcel Energy to use an additional 341 cfs of water at its St. Anthony Falls Project (FERC No. P-2056) located on the other side of the river.

Page 1-3, Sec. 1.2.6 – National Historic Preservation Act – One of the biggest concerns the NPS has with the proposed Project is with its impact to the structural stability of the sandstone geology. The combination of the head of the limestone ledge, just upstream from the project area, the underground dike completed in 1876, the several earlier tunnels in this area, and other construction over the years that impacted the sandstone layer have may have already compromised this fragile rock to the point where further excavation downstream (as is proposed for the new tailrace) would result in catastrophic collapse. The Farquar 1883 map illustrates this configuration and can be found at http://content.mnhs.org/maps/archive/fullsize/g4144-m5_2s15-1883-a4-thumb_0d1dd78c7d.jpg .

The borings that were done for this Project or any others around the falls, (including those completed by Barr Engineering) should be reviewed to help determine the stability of this sandstone formation. Water can get into sandstone just upstream from the Dike at the end of the limestone ledge and can easily dissolve large cavities in this barely cemented formation. Since the Dike only extends 40 feet into the sandstone layer, the NPS's concern is that Applicant's plan for digging another tailrace tunnel upstream and excavating a significant area for the power house could result in a disaster similar to the Eastman Tunnel collapse in 1869. The engineers for the new I-35W bridge found that the sandstone just downstream from this Project was less stable than they had expected. The Applicant needs to determine if this is also a problem within the proposed project area. Enclosed is a pdf of information pulled from USACE records about the construction of the dyke and the challenges they faced with this formation in the 1870s (Enclosure 1).

The National Historic Preservation Act section 106 consultation process needs to address any potential impacts to the integrity of the St. Anthony Falls Historic District as related to the new infrastructure proposed on Page 2-2 including:

- Impacts to the remaining historic fabric that represents the lumber milling at the falls. A remnant of the stone portion of the platform lumber mills is still extant at the back end of the USACE parking lot, which is very close to where the work on powerhouse is proposed. Another concern is for impacts to the very fragile ruins of the Cataract Mill adjacent to the road that runs down from Portland Avenue into the USACE's parking lot. It is unclear if the

proposal to build a temporary, different road will have impacts on the Cataract Mill remains, which are currently held together by some bracing right next to the roadway.

- There is indication from the borings that there are significant historic remains that were excavated out of the area during the lock construction. From archaeological work done at Mill Ruins Park it has been determined that not all the remains of the mills were demolished as originally specified in the USACE's contracts and far more remained than was expected.

Page 2-3 – The visibility of the generator housing is a concern. The NPS would like to see a visual simulation prepared of the housing to determine if there will be any visual impacts to the general area and/or the St. Anthony Falls Historic District.

Page 2 -4 – Recreational Resources – The NPS appreciates the Applicant's commitment to working with all interested parties and resource agencies to establish a safe portage route in or near the project area. The proposed Project will impact the put-in location in lower Mill Ruins Park identified in the St. Anthony Falls Regional Park Master Plan and supported by many agencies, as a priority for 2015. The put-in location is exactly where the outfall location would be. Mitigation and continued consultation with all parties will, therefore, be necessary to address the impacts to recreational access in the project area. Figure 28 in the St. Anthony Falls Regional Park Master Plan identifies proposed portage routes including put-in and takeout locations (Enclosure 2). The MPRB submitted a letter on April 20, 2015 detailing their comments on the Project (Enclosure 3). Also see the St. Anthony Falls Regional Park Master Plan (https://www.minneapolisparks.org/_asset/kff8kx/stanthony-falls-regional-master-plan-3-4-2015.pdf), and the Central Mississippi Riverfront Regional Park Master Plan (https://www.minneapolisparks.org/park_care__improvements/park_projects/current_projects/central_mississippi_riverfront_regional_park_master_plan/).

The NPS is currently developing a plan for the Mississippi River National Water Trail, in coordination with the Minnesota Department of Natural Resources (MN DNR) and other agencies. The plan will identify access needs and issues, including the proposed portage route previously discussed with the NPS, the COE, the MPRB, and the MN DNR, signage for safely navigating the water trail, and new infrastructure needs. The NPS encourages you to continue to work with all parties in regards to recreational enhancement and mitigation opportunities. Consultation with the NPS is a requirement of all FERC licenses pursuant to the Outdoor Recreation Act of 1963 (16 U.S.C. § 4601-1), the NPS Organic Act (16 U.S.C. §1 et seq.), and the National Trails Systems Act of 1968 (16 U.S.C. § 1246 (a))

U.S. FISH AND WILDLIFE SERVICE COMMENTS

GENERAL COMMENTS

Regulations created pursuant to the Federal Power Act (FPA), as amended, require consultation with the FWS and other resource agencies (18 C.F.R. § 4.38(a) and 18 C.F.R. § 5.1(d)). This

response is provided in accordance with provisions of the National Environmental Policy Act (NEPA) of 1969 (83 Stat. 852; 42 U.S.C. 4321 et seq.), the Endangered Species Act (ESA) of 1973 (87 Stat. 884, as amended; 16 U.S.C. 1531 et seq.), the Bald and Golden Eagle Protection Act (BGEPA) (54 Stat. 250, as amended, 16 U.S.C. 668a-d), the Migratory Bird Treaty Act (MBTA) (40 Stat. 755, as amended; 16 U.S.C. 703 et seq.), and the Fish and Wildlife Coordination Act (FWCA) (48 Stat. 401, as amended; 16 U.S.C. 661 et seq.).

The FWS concurs with comments provided by the USACE, the FERC, and the NPS and recommend that the licensee fully analyze any potential impacts from the construction and operation of the proposed amendment, including any concerns raised by the public, other stakeholders and the Department. Public involvement is critical and the FWS recommends involvement of all stakeholders early in the process. Please consider that the Environmental Assessment (EA) conducted as part of the 1999 license may be inadequate given the scope of the proposed changes and how the environment may have changed over the past 16 years.

RECOMMENDATIONS PURSUANT TO SECTION 10(a) OF THE FEDERAL POWER ACT

Consultation

It is recommended that the licensee consult with the FWS on matters affecting fish and wildlife resources throughout the term of the new license.

Rationale: Issues frequently come up throughout the term of a license, such as power outages, low flows, and unexpected emergencies that may pose a threat to fish and wildlife resources in the vicinity of the Project. It is recommended that the licensee consult with the FWS on any matter, as a direct or indirect result of hydroelectric operations, which may affect fish and wildlife resources.

RECOMMENDATIONS PURSUANT TO SECTION 10(j) OF THE FEDERAL POWER ACT

Project Operations

A. The FWS recommends that any proposed development be operated as run-of-river with no hydroelectric (hydro) peaking.

B. The FWS is concerned with the current operational scenario, as is detailed in Article 404 of the project license. Allowing St. Anthony Falls to become dewatered, even partially, as a result of project operation may have significant ecological and aesthetic consequences.

Basis: Hydro peaking produces fluctuating water levels in the project tail water and reservoir, which adversely affect fish and other aquatic life. Under run-of-river operation, the reservoir, tail water, and downstream areas undergo changes occurring under natural hydrological conditions which fish and other aquatic life have adapted. Reducing water level fluctuations

minimizes adverse impacts to wetland, shallow water, and shoreline habitats important to fish and wildlife resources. Operational dewatering of St. Anthony Falls would produce downstream effects similar to hydro peaking and could have significant impacts on sensitive mussel populations, aquatic invertebrates and fish habitat.

Fish Protection

A. Any proposed powerhouse should include trash racks above the intake to minimize fish entrainment and turbine mortality. The FWS recommends installing trash racks with a maximum of one inch clear horizontal spacing between the bars to minimize juvenile fish entrainment.

B. It is recommended to maintain average normal inflow velocities immediately upstream of the trash rack of the powerhouse to be no greater than two feet per second to protect fish from impingement and entrapment.

Basis: Numerous entrainment and turbine mortality studies conducted over the past 20 years in the Midwest have shown fish are entrained at hydro projects and that a portion of the fish entrained (up to 20+ percent) are killed by the turbines.

Thank you for the opportunity to comment on the Project's license amendment and for your attention to these comments. For further coordination on matters related to the subject Project, please contact Nick Utrup of the FWS at (612) 725-3548, extension 2204 or nick_utrup@fws.gov and John Anfinson of the NPS at (651) 293-8432 or john_anfinson@nps.gov.

Sincerely,

Lindy Nelson
Regional Environmental Officer

Enclosures: 1: Abstract of Available Historical Data on Saint Anthony Falls – USACE
2: Figure 28 - St. Anthony Falls Regional Park Master Plan
3: MPRB letter on draft FERC license application

cc: John Anfinson, NPS, john_anfinson@nps.gov
Nick Utrup, FWS, nick_utrup@fws.gov
Jeff Gosse, FWS, jeff_gosse@fws.gov

ABSTRACT OF AVAILABLE HISTORICAL DATA ON ST. ANTHONY FALLS

Prepared by Merlin H. Berg,
Junior Engineer, from the
files and records of the U.S.
Engineer Office, St. Paul,
Minnesota.

whenever undercutting reached beneath a transverse joint plane. In this manner St. Anthony Falls migrated from Fort Snelling to its present location leaving the gorge about as it appears today.

"The St. Peter sandstone is a rather unusual formation, especially for one as old as Ordovician age. It is normally a white friable sandstone with practically no cementing material . . . . The grains of the St. Peter sand have beautifully frosted surfaces and are well rounded. The result of these characteristics, especially the absence of cement, is that the sandstone is extremely friable as a rule and may be scraped off of an exposure with the hand. Running water easily and quickly erodes it."[2]

HISTORY OF STRUCTURES

Father Hennepin is generally credited with being the first white man to see the Falls. It was he who named the cataract in 1680 for his patron saint, St. Anthony of Padua. It is interesting to note that from the point at which Hennepin gazed at the Falls, they cannot be seen today because of the recession mentioned previously. Following Hennepin the Falls were viewed by Carver in 1766, Pike in 1805, Long in 1817, Keating in 1823, and Featherstonehaugh in 1835.

In the Annual Report of the Chief of Engineers for 1870 may be found a report of Franklin Cook, an engineer, which describes the situation at the Falls prior to 1868. A portion of his report follows:

"The St. Anthony Falls Water Power Company has constructed a dam from the left bank of the river out into the stream between Hennepin and Nicollet Islands 700 feet, (see red outline on Fig. 1) thence upstream, at nearly right angles to the main dam, 130 feet, thence diagonally upstream 800 feet to the center of the river.

"S. W. Farnham & Company has built a dam out from the right bank of Hennepin Island 115 feet, thence extending upstream nearly parallel with the right bank of the Island to near the St. Anthony dam. Their dam was built in 1856; it extended out from the island about 30 feet above the crest of the fall. On this side of the river the falls have receded 600 feet upstream, leaving the crest of the ledge just outside of the dam.

"The Minneapolis Mill Company built its dam in 1857, commencing on the right bank of the river about 300 feet above the crest of the falls, and extending out into the river 352 feet, thence upstream nearly parallel with the bank of the river 530 feet, thence diagonally upstream 645 feet to the center of the river, when it joins the wing dam from St. Anthony. Thus, with the St. Anthony dam forming the weir or part over which the water flows, the other parts of the dam being overflowed only at times of very high water.

"These dams are constructed of timber firmly bolted to the ledge and filled with stone. They hold the water so that it is from five to six feet deep on the upstream edge of the limestone ledge, thus protecting it from wearing away on that edge, as it evidently did before they were built, and forming slack water for a considerable distance up the river."[4] (See Fig. 1)

By 1868 certain minor steps had been taken to halt the further recession of the Falls and more permanent protection works would probably have been constructed before many years had not the driving of the famous Eastman tunnel aggravated the already dangerous situation and precipitated the disaster of October 1869, forcing the execution of the construction measures described in the following pages.

The 1874 Annual Report of the Chief of Engineers, states:

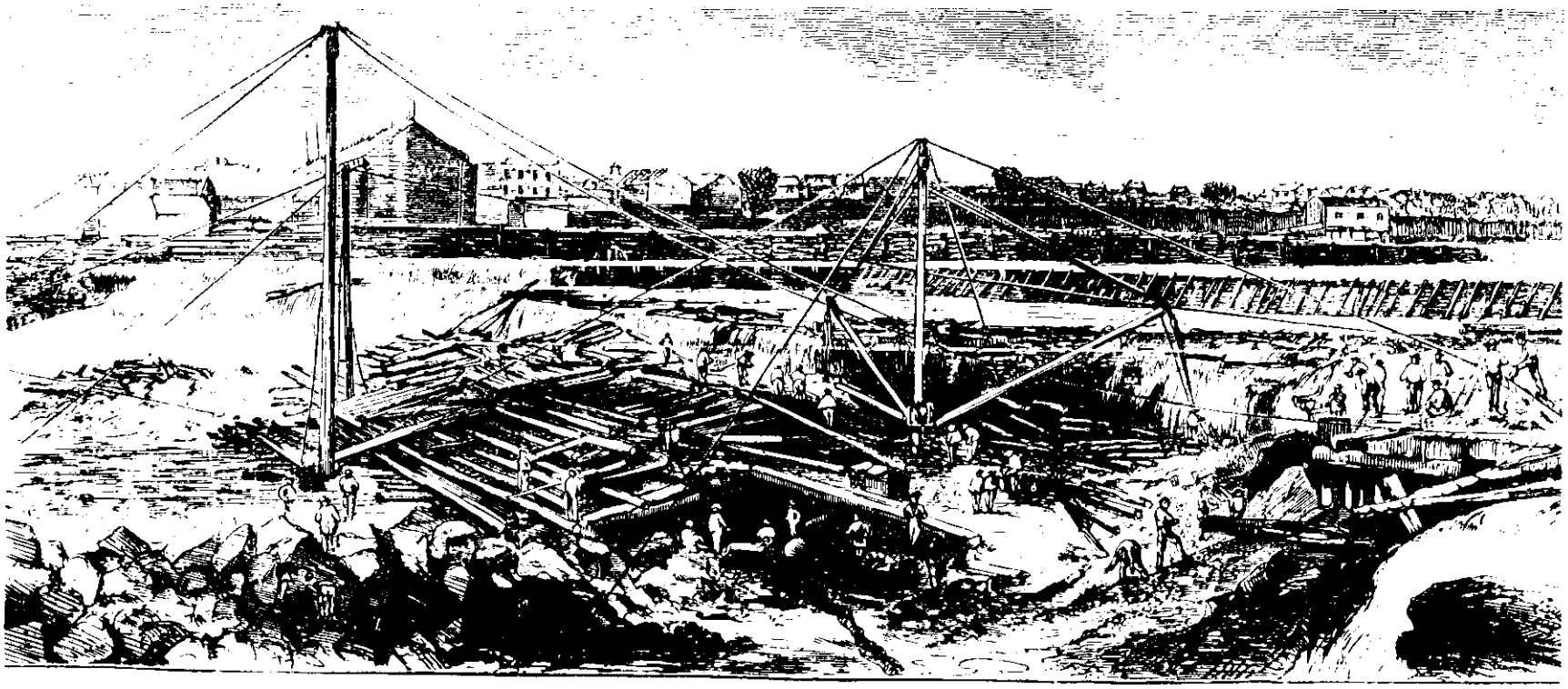
"On the 7th of September, 1868, a company known as the Tunnel Company, consisting of Messrs. W. W. Eastman, W. S. Judd, A. H. Wilder, and John I. Merriam, owners of Nicollet Island, commenced the excavation of a tunnel at a point near the foot of Hennepin Island, and continued this up under the island towards the foot of Nicollet Island. This was excavated for the purpose of forming a tailrace under the sites of manufactories to be built. The water to furnish the power for these manufactories was to be introduced from the level of the mill-ponds on either side of Nicollet Island.

"On the 4th of October, 1869, this excavation had reached a point under the foot of Nicollet Island, when the workmen were driven away and the tunnel invaded by the waters of the Mississippi River coming in from a point marked B at the head of the limestone ledge. The original cross-section of the tunnel was 6 by 6 feet, but in a very short time the rushing waters excavated a much larger cross-section, 16½ feet high by from 10 to 90 feet wide. In a few days so much of the sand-rock between Nicollet and Hennepin Islands was washed out that a large portion of the superincumbent lime-rock fell into the tunnel, (opening marked F Fig.1). After great effort on the part of the citizens a crude cofferdam was constructed inclosing a space extending from above the point B on the west side of Nicollet Island downstream to the head of Hennepin Island, and another connecting the east sides of the foot of Nicollet and head of Hennepin Islands."[3]

A correspondence file continues the story.

"During the winter of 1869-1870 the St. Anthony Falls Water Power Company constructed at the lower end of the second break a timber bulkhead, made tight with clay and flax-straw, and puddled the bottom of the gorge above. They also commenced an excavation from the surface of Hennepin Island through the roof of the tunnel, about 400 feet farther down, intending to put in a masonry bulkhead at this point. On the 5th of April 1870 the ice in the river broke up, destroying part of the cofferdams around the second break. The water at once washed out the sand rock on both sides of the timber bulkhead, enlarging the breach in the limerock and undermining a large area of Hennepin Island at the mouth of the tunnel, where several mills and other buildings were destroyed. (See photo No. 3) The flow of water was at last stopped May 7, 1870 by the construction of new cofferdams. The Water Power Company then proceeded to fill the entire second break with a heavy cribwork of logs to the level of the top of the ledge where it was covered with a water tight flooring of timber. This work was completed June 3, 1870, and water for the supply of the St. Anthony Mills passed over this structure during the season without accident.

"The first examination of the Falls by a U. S. Engineer Officer, after the break in the tunnel, was made by General G. K. Warren, Major, Corps of Engineers, U. S. A., November 16, 1869." [23]



ST. ANTHONY FALLS DAM, MINNESOTA.—[PHOTOGRAPHED BY WHITNEY AND ZIMMERMANN, ST. PAUL, MINNESOTA.]

Photo. No. 2. Retouched photograph showing construction of the apron. (Harper's Weekly, 1869. Mpls. Library Clipping).

Following General Warren's examination, he ordered Frank Cook, a civil engineer, to make a detailed survey. The results of this survey are embodied in the Report of the Chief of Engineers for 1870. We have already quoted the portion of this report in which Mr. Cook described the situation at St. Anthony Falls as it existed previous to that time.

In addition, Mr. Cook reported, probably for the first time, on the feasibility of carrying transportation through the Falls by means of a system of locks. He also suggested the construction of a timber apron to remove the danger from further degeneration of the Falls and the construction of a dam at the edge of the existing ledge in connection with the apron so that there would always be, particularly in winter, a depth of 5 or 6 feet of water over the limestone cap. To justify the construction of the dam Mr. Cook says, "The dams above the falls are so constructed that during the low water in the winter nearly all of the water is drawn through the mills, sluices, and canal, leaving the ledge below the dam at times nearly uncovered, thus permitting the frost to come in contact with the ledge and freeze it to a considerable depth, which causes it to split up in thin laminae so that the water, with the abrasion of the accompanying logs and ice in the spring, is slowly and surely wearing away the surface of the ledge the entire width of the river below the dams."[5]

The Annual Report of the Secretary of War for 1879 records, "Mr. James B. Francis, an eminent engineer of Massachusetts, was summoned in May, 1870, to examine the falls and give his opinion as to the best means of accomplishing the desired object . . . He recommended a substantial apron of timber with heavy crib-work at the bottom. . . . He advised uncovering the tunnel for a distance of some 400 feet from the second break and filling it with puddle of clay and gravel . . . . He reiterated the recommendation previously made by Mr. Franklin Cook: to keep the limestone flooded by low-dams."[19]

The river and harbor appropriation bill approved July 11, 1870, made the first appropriation for the preservation of St. Anthony Falls. The amount appropriated was $50,000. Under this appropriation Colonel J. N. Macomb took charge of the work and Franklin Cook was made engineer in local charge.

Mr. Cook started his work August 9, 1870 and from that date to September 20 he was engaged in closing the leakage in the existing cofferdam. He then commenced work on a cofferdam which is shown approximately on Fig. 2 in red. Before this dam was entirely completed, the St. Anthony saw mills burned down.(shown in red on Fig. 1). This occurrence removed the necessity for drawing water from the main channel of the river and Mr. Cook therefore extended his dam as shown in blue on Fig. 2 and later removed the portion O-N.

Mr. Cook reports, "The dam was built of timber-cribs sunk in from 6 to 12 feet of water, and well loaded with broken stone, planked on the river side with 2-inch plank. I built and rigged three derricks for handling stone, and commenced building the permanent wall around the upper breach into the tunnel, commencing on the westerly bank of Nicollet Island,

Photo. No. 3. Collapse of tunnel at lower end of Hennepin Island following spring flood of 1870. (Minnesota Historical Society).

above the gorge, extending out to within about 25 feet of the gorge, (see green outline at "B" on Fig. 1) leaving a space across the gorge till I could get the water out so as to clear it out from the bottom. I commenced building, and extended the wall down on the westerly side of the gorge, extending the foundations nearly down to the first cofferdam extending out from the westerly bank of Nicollet Island to the cofferdam on the outside of the first breach. . . . . I then commenced clearing out the debris from the gorge at the place I had left to cross with my permanent wall of masonry."[6] While excavating in this area a leak occurred and Mr. Cook immediately filled up the excavated pit in the gorge. He filled out on his embankment in an effort to stop the leak. This effort having no success he "extended the embankment on the outside into the river and upstream from 60 to 100 feet (probably M-B, Fig. 1), letting it lap over on the limestone ledge about 35 feet."[6] On top of the embankment he placed stone 5 feet high to make it heavy enough to close the leak. "I then commenced clearing the debris out of a section 50 feet long, at the lower end of the first breach intending to go to the bottom of that place and build a wall of masonry across the gorge, and puddle up a sufficient distance to make a secure dam, then go back and commence at the head of the gorge, and make another effort to clear it out and put in my wall of masonry, having the above wall for protection in case of accident. After getting this place cleared out to within about 2 feet of the bottom, the water broke in, coming along on the bottom, on the westerly side of the gorge. I at once tried to find the place where the leak came in through under the head of the cofferdam. After hunting about two days, I found a place in the bed of the river, about 20 feet outside of my embankment, inclosing the cofferdam. The usual depth of the water in the river at that place was 14 feet, while, for a space about 3 feet across, the water was 20 feet deep. I at once ran out an embankment from the one built previously, and, in closing over the deep place, the leak stopped, so that there was much less water running through the tunnel than at any previous time. It appears that this leak occurred by the water coming in under a stratum of the sandstone under the embankment, thus preventing the material in the embankment from falling, to choke up the place through which the water passed."[6]

On the night of July 3, 1871, the entire tunnel was found filling with water. The water, after considerable search, was found to be coming from the opening marked "C" on Fig. 1. The Annual Report for 1871 records, "It was found running under the bed-rock in the river on the easterly side of Nicollet Island, near the middle of the channel, immediately under one of the large piers that were put in for a cofferdam by the St. Anthony Falls Water Power Company a year ago last spring (spring of 1870), at the time they attempted to shut the water out of the tunnel after it had broken through their plug at the foot of the second breach. The pier was placed in the river so that the upper end of it rested on the sand-rock, and the downstream end on the lime-rock, in place. After planking up the dam to stop the water from passing, it commenced running under this pier, so that it excavated a very deep cavity in the sandstone immediately under the limestone.

"This summer (1871), during the low water in the latter part of June, when the saw mills were running on the New St. Anthony Falls dam, they drew the water down in this part of the river, so that it made a very strong current under these piers, which, no doubt, washed deeper into the

exposed sand-rock beneath, thus permitting the water to come in direct contact with a very soft layer in sand-rock strata, which is usually found about 13 feet below the limestone, the water finding its way through this soft stratum into the tunnel at about the same place where the first break from the westerly side entered."[7]

In order to preclude any further damage a temporary dam was hastily constructed across the channel between Boom (located upstream from Nicollet Island) and Nicollet Islands, through which water flowed into the channel on the east side of Nicollet Island. Mr. Cook continues, "By the evening of the same day I had completed the dam, turning all the water on the west side of the island, thus leaving the St. Anthony mill-pond dry. I found the chasm through which the water had passed to be 16 feet wide and 8 feet deep from the ledge to the debris in the bottom."[7] To protect this breach from being washed out in case of a freshet the cofferdam shown in orange on Fig. 1 was constructed.

"Another new feature in the case is, that at the lower end of the old tunnel it became so choked up with the debris that the water found its way through a new channel into the main river, coming out under the ledge about 50 feet below the apron on the westerly side of Hennepin Island."[7] (See point "D" on Fig. 1) "The new channel . . . caused great alarm, and the citizens at once set to work to raise necessary funds to line the tunnel. By the last of August, 1871, they had raised $100,000 for the lining of the tunnel and the building of the apron to protect the foot of the falls."[3]

The 1872 Report includes an account by Mr. Cook of operations performed from April 14, 1871 to November 28, 1871, part of which was reported in the 1871 Report. He tells in some detail of the clearing out of the debris and soft sandstone and the replacement of these with concrete walls, gravel, and clay. A minor leak occurred September 16, 1871 which was stopped and caused no great damage. He also reports on the results of borings which were made under his direction. He suggests, "The most feasible way to prevent further leaks into the tunnel and to guard against the water finding its way under the ledge and coming out at the brink of the falls, thereby rendering the destruction of the falls certain, would be to commence a wall at the southerly side of the main wall that I have built across the gorge, and carry it across the entire width of the river near the head of the limestone ledge, commencing the foundation on this hard stratum 14 feet below the bottom of the limestone ledge, bringing it up even with the top of the ledge, and joining it on to the same . . . . This wall I would extend into the banks of the river sufficiently far to prevent the water from finding its way around the ends, and protect the ends with wing-walls in the manner which would seem the most likely to accomplish the desired object."[8] This is the first time that a cutoff wall is mentioned in any report.

The 1872 Report also includes a report of a board of army engineers on conditions at the falls and the necessary steps to be taken in order to preserve them. It includes, in addition, a report of the "Board of construction for the preservation of the Falls of Saint Anthony," and of the "Union Committee" of citizens for the same purpose. "The 'board of construction' was authorized to construct an apron of timber and rock at the falls, to conduct the water from the brink of the same, and protect the soft sand-rock which underlies the lime-rock, from being worn away by the under tow of water. . . . The 'Union Committee' had in charge the arresting of injury to the falls, occasioned by the breaking of the river into a tunnel excavated

from below the falls upward underneath Hennepin Island, and extending to the lower end of Nicollet Island."[9] This report records the method followed in lining the tunnel and requests appropriations for further work. It recommends that a permanent bulkhead be constructed, that further tunnel lining be accomplished, that a sewer for drainage be placed, and that puddling with gravel to the head of the ledge be effected.

On August 28, 1872, Captain W. H. H. Benyaurd was assigned local charge of the work. Beginning October 3, 1872 the lining of the tunnel was continued. The work of excavating had proceeded but a short distance when water appeared and it was deemed advisable to put in at once the bulkhead recommended by the "Union Committee." The appropriation of $37,500 was exhausted by February 6, 1873 and work was suspended until the following spring. Captain Benyaurd reports, "In the latter part of March work was resumed, with a small force, in building up the outside of the cofferdams and in loading them with stone. There being evidences that we would have a high stage of water, this small force was kept on hand, in case of any sudden break occurring to the works. Everything was thought to be secure, when, on the 15th of April,(1873) the cofferdam on the west (east ?) side of Nicollet Island, near the second break, was pushed in and a gap about 150 feet wide opened in the dam. (Probably X-Y, Fig. 2). The tunnel was filled with water and the entire work flooded. One man was drowned; the others escaped. Early next morning a force was put at work, securing the remainder of the dam from damage, and in getting cribs ready for a new dam to fill the gap. In the meantime, the embankment at the head of the ledge had been undermined and was being rapidly carried away. A force was put to work at this and its further destruction prevented, but not before some of the holes leading to the tunnel had been uncovered, which would allow the water to find its way into the tunnel when the cofferdams were repaired.

"Before the broken dam had been repaired, another portion, on the west side of the island, had been pushed outward, and this threatened the entire destruction of the work. The whole force was immediately put to work upon this and the disaster averted. Work was then continued upon the portion that first gave way, and, while in operation, the entire management was transferred to Major Farquhar."[10] From April 26, 1873 to March 17, 1873, Assistant Engineer J. P. Allen was in local charge. He was relieved on the latter date by Assistant Engineer J. L. Gillespie.

Major Farquhar continues, "On taking charge of this work, the breach, made April 15, 1873, through the east cofferdam, was being closed. When the breach was repaired, and the water drawn off from the tunnel, it was found that the masonry bulkhead, built during the winter, was destroyed, and that the tunnel-lining on the west end of the bulkhead was gone. Work was at once commenced to repair the damages, and to build a wooden bulkhead under the shaft; as soon as the water was drawn off a great deal of water was discovered coming from under the limestone ledge, through the west upper branch of the tunnel. May 17 a great breach occurred under the earth dam at the head of the ledge, soon filling up the tunnel and space inclosed by the cofferdams. (See Fig. 2).

"To relieve the head of water at the head of the ledge, the lower cofferdams were opened, and so there was little or no current under the ledge, measures were taken at once to repair and extend the earth dam at the head of the ledge, so as to inclose the holes made by the falling down

of the limestone into the cavities worn in the soft sandstone by the stream of water running under the head of the ledge. No other work was attempted until the waters of the Mississippi River subsided."[11]

Major Farquhar's 1874 report continues from this point. "As soon as the high water of the Mississippi River had sufficiently subsided, work was commenced to repair the damages caused by breaches through the cofferdams and through the soft sand-rock underlying the limestone between the head of the ledge and the mouth of the tunnel between Hennepin and Nicollet Islands. The damaged portions of the lining of the tunnel were rebuilt and a new bulkhead was constructed, so that the gate in it could be worked from the shaft. A 36-inch cast iron drain pipe was laid from the bulkhead to the upper end of the opening between the above mentioned islands. The tunnel for 250 feet above the bulkhead was carefully filled with well rammed gravel. In filling the tunnel great care was taken to prevent any water from passing along under the flooring. At two places cross-trenches were excavated to 4 feet below the floor, and carefully filled with concrete.

"It was found that during the high water an entirely new channel from the head of the ledge under the limestone to the tunnel had been made. It is a significant fact that the bottom of this new channel was at the bottom of the soft stratum, and the top in many places did not reach to the lime rock. This 'soft stratum' is 16½ feet below the lime rock, and its bottom was the lower limit of the tunnel-floor before it was lined, and it was through it that the water made its appearance in 1869, while the original tunnel was being excavated. The head of the new channel was closed by extending the earth embankment at the head of the ledge.

"The work above described was finished November 29, 1873. On December 2 the gate through the bulkhead was closed, and the water filled up the pit between the islands. The accompanying report of Assistant J. L. Gillespie gives the result of this raising of the head of water.[12] It will be seen that no water passed through the bulkhead, the only increase of water at the back of the bulkhead being from a seam in the lime rock, the lower stratum of the lime rock having fallen, leaving a ragged projection. The water coming through this seam was perfectly clear, which showed that it had not come through the gravel plug. But while I feel not the least anxiety about the bulkhead, the effect of the increased head of water on a spring 370 feet below the bulkhead causes me much uneasiness. . . . . The excavators of the (original) tunnel did not think that there was any connection between it and the river above the head of the ledge, but with the results before us it cannot be doubted that it has, and that this connection is outside of the line of the tunnel. I am more than ever convinced that the proper place to build the proposed watertight dam, to cut all the water flowing through the sand rock, is as near the crest of the natural falls as possible. There are two prominent reasons for this: 1st, that it will cut off all the water percolating through the sand rock; and second, that in the process of its construction we will run no risks not already existing."[13]

The report of a board of engineers which met April 14, 1874 continues: "From all the experience gained during the past year there can be no doubt that there is a connection between the river above the limestone

ledge through the soft stratum of sand rock (about 14 feet below the lime rock) and the spring at the bifurcation of the tunnel below the gravel plug. Whether this is a uniform channel or a series of cavaties connected together is not known, but from experiments made by raising the head of the outflow of the spring it would seem that for a difference of 2 feet 5 inches in height the volume of the cavities amounts to 8,000 cubic feet."[14]

The board recommended the following items:

"1st. Two dams should be constructed along the lines G and H, (See Fig. 2) of timber cribs, well bolted to the rock and filled with stone.

"2nd. The apron should be put in thorough repair, and extended downstream on the west side of Hennepin Island.

"3rd. . . . . The wall at the head of the limestone ledge, proposed by the board of 1872, would effectually cut off the percolations through the soft stratum beneath the limestone and prevent the dangers arising from such percolation, but its construction now would be attended with greater difficulty as well as greater risk, and the cost would be much greater than was formerly estimated."[14] The board then recommends that the dike be placed in the location shown on Fig. 2 for the same reasons as given by Major Farquhar.

Major Farquhar's 1875 report records, "A small break occurred July 17, 1874, in the lime rock on the Saint Anthony (East Minneapolis) side of Nicollet Island, the water finding its way into the tunnel through the break of 1871 and the spring. This was stopped by rebuilding that portion of the upper cofferdam that had given way in 1873. The break itself was filled with gravel." [15]

The 1875 Report also includes an account of the dike construction commencement. The most complete record of this period, however, is found in a correspondence file from which is quoted the following: "On July 9 (1874) the work of sinking a shaft on Hennepin Island to reach the level of the bottom of the proposed dyke was commenced. At a depth of 30 feet the bottom of the limestone was reached. This portion of the shaft being 14 x 6 feet in the clear, lined with timber and concrete to exclude water, and divided into two sections, one used for hoisting, the other for a stairway, driving shaft for pumps, air pipe, etc. This part of the shaft was completed August 28, 1874.

"A drift 4 feet wide and 8 feet high was then excavated just below the limestone from the foot of the shaft to the west branch of the tunnel on the line of the dyke to give an outlet for water to be raised by pumps from the shaft and for excavated material. A turbine water wheel 42 inches in diameter, was set up at the mouth of the west branch of the tunnel, the power for driving pumps, etc., being transmitted by wire rope to the head of the shaft. Vertical centrifugal pumps 6" discharge set in wooden frames and lowered as the excavation progressed were used to raise the water. The first difficulty encountered was in the old tunnel where the sand rock had been washed out to a depth of 25 feet and replaced by quicksand.

"The progress through this was very slow. Many streams of water were met with flowing out from between strata of the sand rock, generally sinking to a lower level as new seams were reached. These streams were confined to pipes and after the lining of the shaft was completed the pipes were closed.

"The shaft was carried to a depth of 45 feet below the limerock and lined with brick and concrete to the level of the upper drifts. An arched recess was formed near the bottom of the lining on each side of the pump well in which the two permanent pumps were set. As soon as the lining was completed, the shafting being supported by timbers set in the brick work, headings were then commenced east and west, the bottom being 39 feet below the lime rock.

"The first plan was to drive the upper and lower heading for about 100 feet, laying the foundation of the dyke containing a drain pipe 12 inches in diameter as the excavation progressed, then to break down the sand rock between the drifts, and build up the dyke to the level of the upper drift. After the excavation of the lower west drift had proceeded about 100 feet, it was decided to make an arched passage way through the base of the wall for convenience in clearing the drains, removing the sand excavated, and bringing in concrete for the foundation. The lower drifts were accordingly widened to 7½ feet. Under this plan the first section of 140 feet of the dyke west of the shaft was built, but it was abandoned, as the sand rock over the lower heading would not stand without timbering and when the works were flooded large amounts of sand caved down." [29]

The report of operation for October 1874 relates, "After much trouble from incoming water, the central shaft has been sunk 43 feet below the lime rock. The last 12 feet no horizontal seams in the sand rock containing water were found.

"The bottom of the shaft is the hardest rock yet found - on boring 4 feet farther, a soft layer was struck and a pipe was inserted to test the flow if any from it. The water came up slowly and barely trickled over the top of the pipe. The last 8 feet of rock through which the shaft was driven was quite hard and I think a good foundation for the proposed dyke has been reached . . . . The fact of finding no water flowing in the horizontal seams of the rock near the bottom of the shaft gives me great encouragement. Our great trouble has been from a large stream of water which has followed us down the shaft through a vertical seam in the rock. However, it has not followed down the last 4 feet and as soon as the concrete lining to be placed is sufficiently set I think we can plug the pipes through which it flows."[25]

A correspondence file outlines the construction procedure: "When the work was fairly started it proceeded in the following order: (See Fig. 3). A drift was first driven 4 feet wide and 6 feet high under the limestone on the proposed line, the heading being closely followed by a temporary track. The upper portion of the shale 18 inches thick formed a water tight roof to the drift. A crew of eight men at a heading, 4 picking and shovelling alternately and 4 running cars advanced from 8 to 10 feet in eight hours. The average cost of excavation for the whole work including the removal of sand caved down and carried in by water was $2.194 per cubic yard.

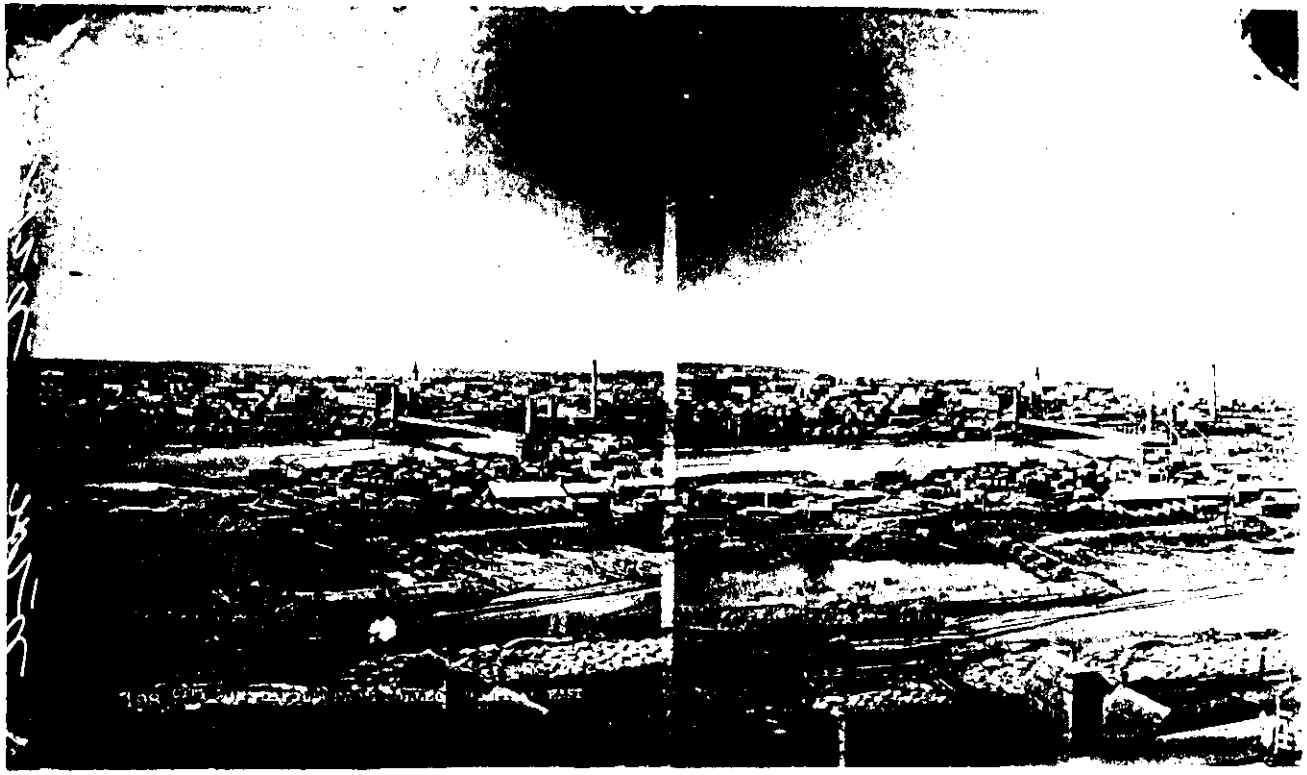


Photo No. 4. View showing lower end of Nicollet Island surrounded by cofferdams, 1878. (Minnesota Historical Society. Jacoby Negative)

"When the heading had advanced about 50 feet, the drift was deepened 6 feet beginning at the outer end and working back, throwing the sand up to the track. Slots were cut in the sand rock at the level of the first drift in which cross ties for the permanent track were inserted. The drift was widened to allow of side tracks every 200 feet. In sinking the cut below this level, the sand excavated was thrown into a car below, whence it was raised on an inclined track, laid against the end of the last completed section of the dyke. At a depth of 27 feet below the lime-rock the cut was gradually widened to 6½ feet, to allow of a passage through the lower part of the wall. Along the centre of the bottom of the cut a ditch was dug, 3 feet wide at the top and 2 feet deep. In this was laid an open box drain 18" wide and 10" deep with a grade of 1 in 300 towards the pump well, a floor of concrete 18 inches thick was then laid, and the space below and around the drain carefully filled with concrete being brought in by cars through the lower passage. On this foundation mining frames of 2" x 4" scantling, 3 feet 4 inches wide were set up along the centre of the cut 4 feet apart, supporting a lagging of inch boards, which served as a form for the side walls of the passage 18" in thickness. Concrete for the side walls was brought in by cars on the upper track and dumped through a spout to a platform on the end of the last section from which it was shovelled to place, the board lagging being added as the walls were built up. When the concrete reached the top of the frames, wooden centres 4 feet long were placed upon them, to give form to the arched roof of the passage. The concrete was then built up continuously to the level of the upper track. The end of each section being finished in steps to receive the inclined track for excavating the succeeding section. At points about 200 feet apart the lower passage was widened to 6½ feet to give room for side tracks. The forms and centres could be safely removed after the concrete had been in place forty-eight hours.

"At each end of the dike a cross wall was built forming a T with the main wall, extending 8 feet each way from the centre line and three feet in thickness. Spur walls of similar dimensions were built on the upper side at distances of 25 and 50 feet from each end of the dike. In completing the end sections, after the lower side walls were built the space between them was filled and the wall carried up solid from the bottom to the level of the upper track.

"Whenever a water bearing seam was opened it was cut out to a V shaped groove, clay tamped in to stop the flow of water, followed up with mortar of quick setting cement, iron pipes with collars shrunk on being inserted whenever necessary to carry the water through the side walls. When the walls were sufficiently set these pipes were plugged. The excavation for the dike was usually dry until a depth of 28 feet below the limerock was reached.

"At points about 100 feet apart, sumps were formed in the foundation to serve as catch basins for the sand carried by the water in the drains. In the earlier sections of the dike the drains consisted of vitrified earthen pipes, 12 inches in diameter surrounded by concrete. A chain was carried through these for stirring up and washing out the sand deposited.

"In building the portion of the dyke west of the main shaft, three vertical shafts were constructed in the body of the wall, between the upper and lower drifts. The first of these was used as a hoistway, the fall being carried to the hoisting engine in the shaft house.

"The filling of the lower passage way was commenced at intermediate points between these shafts, pipes being laid where an open drain had been used, and the filling advancing in both directions, thus allowing of work at several headings at the same time. The concrete was run in on the upper track and dumped through spouts to cars on the track below. When the filling reached the foot of a shaft, the drain pipes were plugged, and the shaft filled. The filling of the upper drifts progressed continuously from the outer ends to the main shaft where the final carload was put in November 24, 1876."[24]

"Tracks of 18 inches gauge were laid through both the upper and lower drifts as fast as they advanced. At the crossing of the west branch of the tunnel a turn table was set from which a track ran to the west mouth where all excavated material was dumped. Where the upper track crossed the shaft a traverse table was put in which was drawn aside to allow of lowering cars, etc. to the lower level. On the surface tracks were laid wherever required for moving material. A "T" rail weighing 16 pounds per yard was used for all tracks, laid on cross ties and secured by 4-inch spikes. The cars consisted of a four wheeled truck on which rested a movable box holding 16 cubic feet arranged with iron bands and eyes for hoisting, with a swing door at the forward end for dumping. The wheels were of chilled iron 12 inches in diameter running loose on axles 1½ inches diameter for convenience in passing sharp curves."[30]

The November 1874 report of operations resumes the construction history: "No trouble was experienced in driving the upper drifts, except perhaps some foul air, which, however, was soon expelled by blowing in fresh from the compressor. In the lower drifts less trouble from water is experienced than had been anticipated. There is hardly any water coming in from horizontal seams, but some from vertical. ."[26]

The annual report of 1875 continues, "Most of the water is from the river below the falls, its temperature being within a few degrees of that of the water in the river, while the temperature of the streams from the north side of the excavation is about 50° F.

"Everything progressed satisfactorily, but slowly, until the 6th of April, 1875. Then for some cause or other the turbine-wheel, which furnished the power to drive the pumps and other machinery, broke through its seat and fell into the flume. Another one was at once purchased, and the work of setting it commenced.

"The steam-pump was at once put in motion, but after running one day the eccentric-rod broke, and the works were flooded.

"On April 9, 1875, the river, which had been steadily rising, suddenly rose 4 feet 3 inches, owing to the breaking of an ice-gorge just above Minneapolis. The water rose above the water power company's dams, and for about half an hour completely flooded Hennepin Island and poured down the shaft. Fortunately, there were no men in the excavation, and after the water subsided it was found that no damage had been done to the excavation or wall. The timber-cribs, built to protect the outer extremity of the gravel-bank west of Nicollet Island, were somewhat injured by the running ice, and the toe of the apron was entirely carried away. The dams of the

water-power companies were all more or less injured, and in some places portions were carried away.

"April 10 the new turbine-wheel was in place and the works pumped out.

"On the 15th the upper cofferdam in the Saint Anthony mill-pond broke at its base between the two outer cribs, and a few days later the toe of the next section gave way. (Probably between R and S. on Fig. 4) It is supposed that the frost reached the puddling at the toe of the cofferdam, and when the great pressure came upon it after the frost went out the puddling was washed out, and the toe having no support broke away.

"Work was at once commenced to repair these breaches, but before they could be entirely closed the water from within the cofferdam found its way through the break of 1871, along the line of the spring to just below the wooden bulkhead in the tunnel, under the lining of the tunnel, into the west end of the excavation. As soon as the lining of the tunnel was undermined it fell in, and the water then passed into the main tunnel and found its way into the lower river through both of its outlets. (See Fig. 4).

"As soon as the breaches in the cofferdams were closed, an examination was made of the new channel cut out, and means taken to close it and to recommence work. It was found that all of the excavation except where already filled with the wall was filled with sand to near the bottom of the lime-rock. Of course, the pumps in place were useless, being clogged with sand. It took nearly the entire month of May to clear out the sand and to get everything in order to carry on the work again.

"Timber-cribs were placed in the new channel, where the sand rock had been washed out to any great width, to insure the stability of the lime rock.

"A cut was made under the lining of the tunnel, where it was undermined, down to the undisturbed rock, and a heavy concrete wall built across the channel to prevent any water passing into the excavation. A bulkhead of timber was also built in the new channel just above where it left the channel of 1871, and the channel and opening in the cofferdam plugged with well rammed gravel.

". . . . At the close of the fiscal year (June 30, 1875) the foundation of the dike was laid for a distance of 479.6 feet, and the dike was completed to the upper level for 450.8 feet, (130.3 feet west of the main shaft on Hennepin Island).

"The contingencies constantly arising have made the cost of this work more than was estimated. The more cost of excavating and building the wall is less than the estimate, but the cost attending the repairs due to the effects of the water on the soft sand rock and the breaches in the old cofferdams, have swelled the cost of the whole very much. . . The many fissures in the limerock above and the porosity of the sandrock precluded the use of air-pressure to exclude the water from the excavations."[15]

Mr. J. L. Gillespie, assistant engineer in local charge of the work, reports on the progress of the dike construction in the Report for the fiscal year of 1876.

"On July 8 (1875) a spring was struck at the west heading, 370 feet from the shaft and 30 feet below the ledge, which increased rapidly for a few hours, bringing in sufficient sand to fill the lower drift west of the first sump. The increased flow at this time was due to the stoppage of the drain in the east passage, (break of April, 1875), the water from that point finding its way through seams in the sandrock to the west heading. The drain was re-opened, reducing the flow of the spring, which was then confined to a 6-inch pipe, the cavity formed by it being filled with concrete. During the remainder of the month the spring continued to flow steadily, frequently bringing in large quantities of sand and seriously delaying the progress of the work. On August 1 the spring again increased in volume, bringing in such quantities of sand as to fill the lower drift nearly to the top of the arch. This time it was found that the drain in the west passage (break of 1873) had been closed by the fall of a mass of sand rock and shale, and the water from this channel, together with a small stream from the first break, was draining into the west drift instead of the old tunnel, as heretofore. Two days later the pumps, driven by water power, were disabled by the breaking of the driving-shaft, and the Heald & Sisco steam-pump, after running a few hours, was also broken, allowing the excavation to fill with water nearly to the level of the upper drifts before the damage could be repaired and a jury-pump started. This, together with the spring above mentioned, caused the sand rock at the west heading to cave down, forming a channel from 10 to 15 feet wide, extending northward from the dike about 100 feet. From the 5th to the 23d of August work on the dike was confined to clearing out the sand which had accumulated in the pump-well and lower drifts.

"In the meantime the channel from the break of 1873 was reopened and cleared out to the head of the drain-pipe, a drift cut through the sand rock from this channel to the first break, and pipes laid to convey all drainage-water to the iron pipe in the main tunnel.

"This work reduced the flow of the spring at the west heading to about one-half the capacity of the 6-inch pipe through which it flows, and put an end to the incursions of sand. The spring continued in the same condition up to the time of stopping the pumps, March 31, 1876."[16]

As mentioned above, the work progressed without interruption from August 1875 to March 1876. Two excerpts from the reports of operations for September and October 1875, respectively, reveal the condition of the sandstone near the west end of the dyke.

"The sand rock in the west excavation has grown very much harder near the bottom, and it is hoped that the dangerous region has been passed . . . ."[27]

". . . . the west heading reached a distance of 715.8 feet from the main shaft . . . .

"The work of excavating on the west side is becoming more difficult owing to the increased hardness of the sand rock. This, however, is very encouraging as there is less danger from caving, and there is also very much less water coming out of the lower west seam . . . ."[28]

The 1876 Report continues, "The excavation for the west branch of the dyke was completed March 7, and the concrete finished to the level of the upper drift March 14, at which latter date work was suspended, the appropriation being nearly exhausted. The last 35 feet of the dyke was built up solid from the bottom, and cross and spur walls built similar to those at the east end. The length of the west branch of the dyke is 1275 feet, a reduction of 50 feet from the original plan, the firm character of the sand rock seeming to render any further extensions unnecessary. The west end of the dyke is 25 feet west of the river-shore line.

"The west branch of the tunnel, just above the crossing of the dyke, has been closed by a bulkhead of concrete. Three pipes, 12 inches in diameter, are laid through the concrete to carry off the drainage from the upper tunnel. The pumps were kept running until the evening of March 31, when they were stopped, and the lower drifts allowed to fill with water. The water rose slowly until it reached the discharge-pipe leading from the pump-well to the west branch of the old tunnel, where it has remained stationary, discharging through the pipe at the rate of about 10 gallons per minute.

"During the summer and fall of 1875, the ledge covering the channel from the first break on the west side of Nicollet Island was quarried out, the stone being used in the construction of the dyke, and the channel filled with gravel as the quarrying progressed."[16]

Gillespie's report of 1877 records the operations of that fiscal year. "Work on the dyke was suspended from March 14, 1876, until September 1, 1876, owing to lack of funds, the lower drifts in the meantime being allowed to fill with water. After resuming work the filling of the drifts was carried on without interruption and the dyke completed November 24, 1876, the total amount of concrete put in during the year being 3,398 cubic yards. The whole amount of concrete used in building the dyke was 14,882 cubic yards.

"The water from the large spring entering the lower drift at the angle in the dyke, 400 feet west of the shaft, was carried by an iron pipe 2 inches in diameter to the upper drift, and thence to the shaft, where a perforated pipe serves as a gauge of the head of water on the upper side of the dyke. A similar pipe connects directly with the original tunnel at the shaft.

"At the crossing of the main tunnel, the dyke was widened to about 10 feet and the shaft filled with concrete and gravel to within 8 feet of the lime rock. A heavy wall of masonry was then built across the shaft at right angles with the dyke to give greater strength at that point, and the space west of this wall filled with gravel.

"In building the dyke a drain-pipe 12 inches in diameter was laid through it in the west branch of the tunnel to carry off the drainage from the old tunnel above. On the completion of the work this drain was closed by a plug in which a pipe 3 inches in diameter provided with a stop-valve was inserted.

"When a head of water was raised on the upper side of the dyke by closing this valve it was found that a small stream passed over the dyke through a vertical seam in the lime rock about 100 feet west of the west branch of the tunnel, the water flowing through a cavity at the back of the wall and discharging in the west branch. To prevent this the cavity was cleaned out, a drift excavated along the back of the wall to the seam and the water conveyed by an iron pipe to the west branch. The cavity and drift were lined with concrete and refilled. A wall of masonry faced with brick was also built across the west branch of the tunnel at the back of the dyke to increase its strength at that point.

"It having been observed that the discharge of a spring entering the west branch of the tunnel about 50 feet below the dyke was somewhat affected by the head of water above the dyke, it was decided to cut through the lining of the tunnel and follow the stream to its source . . . ."[17]

Major Farquhar's 1878 report records, "The small exploring drift was carried on to a point 470 feet west of the west branch of the tunnel, and the leakages of the concrete dyke were taken into a drain. At all points where the drift reached the dyke the concrete was found well set, the leakage being at the bottom of the upper drift, where in places the concrete filling of the drift had not adhered to the main wall below. The leakage of the wall is gradually diminishing, and in time no doubt will cease altogether."[18]

Concerning the repair of the apron, the 1876 Report records, "Early in August, 1875, the work of repairing the apron at the face of the falls was commenced, the lower end of this structure having been entirely destroyed by the ice-freshet in the spring of 1875, and the bottom of the river below scoured out to a depth of 30 to 40 feet. Large timber-cribs filled with stone were sunk at the foot of the apron, upon which the plank covering was extended, with the same slope as above, to a depth of 2 feet below low water. A large amount of stone was also put in below with cribs. The original planking was renewed wherever necessary, the 4-inch pine covering extended over the east half, which had been left unfinished, and the more exposed portions protected with oak planking.

"Work was continued until December, when it was suspended on account of the severe cold, the repairs being then completed with the exception of leveling and covering a length of 140 feet at the foot on the west side. This portion of the work was finished during the month of March, funds ($1500) for the purpose having been furnished by the citizens of Minneapolis."[16]

The 1877 Report states that in that fiscal year, "Some necessary repairs have been made at the foot of the apron, and about 200 cubic yards of bowlders put in to check the abrading action of the water . . ."[17]

The 1877 Report records the construction of the "rolling" dams and the gravel filling, "The dams were built of 12-inch by 12-inch pine timber bolted together and to the rock with iron bolts, the crib-work filled compactly with stone and covered with two courses of plank 8 inches and 4

inches in thickness. The crests of the dams are protected by plates of tank-iron one-quarter inch thick. At each end of the upper dam, ice-piers are built on the Water Power Company's dam to protect it from falling ice. This dam is located 720 feet above the crest of the falls, and is about 5½ feet high. (See Fig. 4).

"The lower rolling dam is built at the crest of the falls, 6½ feet high, and forms a continuation of the apron. Crib-piers are built at each end, as a protection to neighboring property against high water. (See Fig. 4).

"The upper rolling dam was completed in October, 1876, and the lower rolling dam in January, 1877.

"A contract was executed . . . . for filling all tunnels and cavities in the sand rock above the dyke with gravel. Work under this contract was satisfactorily completed November 14, 1876. . . . The total amount of gravel-filling put in was 22,329 cubic yards. . . .

"With the completion of the above mentioned work on the apron, it is believed that everything necessary to the preservation of the Falls of Saint Anthony has been accomplished."[17]

Operations in 1879 were the construction of a wall at the westerly end of the apron forming a complete face of masonry on that side, the removal of the cofferdams below Nicollet Island, and the construction of a log sluice. From 1879 to 1885 when all operations were suspended, work was confined to the repair and remodeling of the timber apron. An examination of the Annual Reports of the Chief of Engineers discloses that no further work was done at St. Anthony Falls by the Government from 1885 to the present time (January 1939). All revisions, repairs, and maintenance of the dams in the area during this period have been carried on by the Minneapolis Mill Company and the St. Anthony Falls Water Power Company.

A brief history of the events prior to 1879 by Assistant Engineer J. P. Frizell is given on pp. 1161-1165, Report of the Secretary of War, 1879, Vol. II, Part II.

An abstract of appropriations for the "Preservation of the Falls of St. Anthony" is given on p. 1482, Annual Report of the Chief of Engineers, 1886, Part II. The total appropriated was $615,000. Included in this figure is the cost of the dyke which was about $212,000. About $334,500 was spent, in addition, by the citizens of Minneapolis, making a total of $949,000 expended on the preservation of St. Anthony Falls.

Little information is available in the St. Paul District Office on the construction of the lower dam since it was constructed by the St. Anthony Falls Water Power Company. It was apparently built about 1897. A reference is made to its construction by M. D. Bell, consulting engineer, in the 1932 hearing on the proposed Minneapolis Harbor. "When high water washed out the crest of the partially completed lower dam in 1897, it also carried out the west side log sluice. When the water lowered, it was found that a deep hole had appeared in the sand rock, below the spillway, which is above the end of the Minneapolis Western Railway trestle.

"In attempting to repair this break and to secure adequate foundations for the new wall, the hole was partly pumped out. At a certain elevation, the flow increased, and it was impossible to proceed further. A wooden crib or mattress was built, and weighted down with stone, and sunk at this point, and the surface was covered with two feet of concrete."[20]

During the same hearing Edward P. Burch made reference to the lower dam with these words: "In 1905, the footings failed on the west end of the lower dam due to water erosion, and a side wall fell in an 18 foot hole in the river. The bottom of the hole was paved with derrick stones and a two-foot mat of concrete. In this case it was not safe to build a cofferdam around the hole and to pump out the water because the underground springs eroded too rapidly. It is not safe at this point nor any other point in the vicinity to drive wood piling or to jet steel piling in the sandstone rock."[21]

Other evidences of difficulty of construction in this area are given by Mr. Burch in his 1932 testimony: ". . . at pier No. 13 of the stone arch bridge, there is a hole or pocket formed in the river bed by an old channel and the pier rests on a wooden grill. This pier has for years been settling and is still settling although many carloads of quarry rock have been dumped in the hole. . . . The Cedar Avenue bridge has one bad pier foundation over a great cavity in the St. Peter sandrock. For this hole many 60 foot piles were required."[22] There is some discrepancy between Mr. Burch's statement concerning the Cedar Avenue bridge and the City of Minneapolis plans which showed piles were 30 to 40 feet long.

RECENT HISTORY

In view of events which may occur, it is believed desirable to review briefly the hearings, Congressional Acts, surveys and reports which have been effected in recent years.

It is no doubt true that from the time that Franklin Cook, in 1870, reported on the feasibility of carrying river craft over the Falls of St. Anthony many have envisioned such an undertaking.

In 1925, Francis M. Henry, a Minneapolis civil engineer, acting on a request by A. L. Crocker, "River Commissioner" for Minneapolis, devised a scheme consisting of two locks and a connecting canal.[31] His plan was patented.

A report on the Mississippi River from Minneapolis to Lake Pepin dated December 14, 1926 states, "Other than at the present terminal (below Washington Avenue Bridge) there is no location in the City of Minneapolis at which a terminal could be developed except at great cost . . . . It would seem that the cost of development of a terminal at this location (above the Falls) would not be justified without a very extensive development of river commerce."[32]

The river and harbor act approved January 21, 1927 authorized a survey of "Mississippi River between Missouri River and Minneapolis, with a view to securing a channel depth of 9 feet at low water, with suitable widths."[33] Following this act surveys and borings were made and a resulting

report dated December 9, 1931, was prepared.[34] In Appendix B of the report (House Document No. 137) is given a plan whereby the Falls were to be surmounted by single locks at both lower and upper dams and which contemplated a single-lift lock at the lower dam and a double-lift lock at the upper. The lock chambers were to be 56' x 300'. The channel was to be 150' in width and was to extend to the Coon Rapids Dam. The cost of this project was estimated at $6,384,500 to the United States (including $450,000 for turning basin below the lower Northern Pacific Railroad Bridge) and $646,000 to other interests - a total of $7,030,500. The Board of Engineers for Rivers and Harbors states in this report, "the improvement of the Mississippi River between the Northern Pacific Bridge, Minneapolis, and the Coon Rapids Dam, is not worthy of being undertaken by the Federal Government at the present time."[35]

Following a resolution of the committee on Rivers and Harbors of the House of Representatives dated January 29, 1932, a report was prepared "in review of the adverse conclusion found in House Document No. 137 in so far as it relates to the navigable channel of the Mississippi River from its present head at the Northern Pacific Bridge to the northern limits of the City of Minneapolis."[36] No further borings or topographic surveys were made at that time. The report which is dated April 1, 1932 (transmitted to committee December 16, 1932) is mainly concerned with the economics of the situation. Appendix A of this report is a report of the public hearing which was conducted March 16, 1932. The recommendation of the district engineer, Colonel Wildurr Willing, follows:

"It is recommended that no project for the extension of navigation above its present head at the Northern Pacific Bridge be adopted at the present time, nor until such time as the development of traffic has shown the desirability and necessity of such an extension. No further survey or estimate of cost is necessary at the present time."[36]

A resolution by the Committee on Commerce of the U. S. Senate June 6, 1935 requested a review of the foregoing reports "with a view to determining if any modification of the conclusions concerning the situation at Minneapolis, Minnesota . . . . is advisable at the present time."[37] In accordance with the foregoing authority, after a hearing had been held in Minneapolis on August 28 and 29, 1935, a report was submitted by the District Engineer under date of November 4, 1935 and this was followed by a report by the Division Engineer, Upper Mississippi Valley Division, under date of February 20, 1936, both reports recommending adversely on the proposed extension of navigation facilities at Minneapolis."[37] The Board of Engineers for Rivers and Harbors held a public hearing in Washington, D. C. on May 19, 1936. Following this hearing, the Board of Engineers for Rivers and Harbors requested the Chief of Engineers for certain supplemental data and studies relative to the proposed project to be used in connection with the report of that body. As a result of this request, a resurvey of the area up to the north Minneapolis city limits and additional borings at the proposed lock sites were made. The resulting report, dated August 21, 1937, contemplated twin locks at both upper and lower dams with a single lift at the lower site and a double lift at the upper. The lock chambers were to be 56' x 400'. The channel was to be a maximum of 600' and a minimum of approximately 150' in width and was to extend to the Northern States Power

Company's transmission line crossing at the north Minneapolis city limits. The cost of this project was estimated at $11,918,700 to the United States and $3,056,600 to other interests - a total of $14,975,300. This report also recommends adversely on the project.[38]

Before this report reached Washington (on August 26, 1937) Congress passed a bill[39] authorizing the construction of the project substantially in accordance with the plan contained in House Document No. 137.[34] Following this authorization the Board of Engineers for Rivers and Harbors requested additional studies which resulted in a letter from the District Engineer to the Division Engineer dated December 31, 1937. This letter included a new estimate based on:

"a. Single lift lock at upper dam with thick floor integral with walls. (All earlier proposals suggested thin floors).

"b. Lock at lower dam with thick floor integral with walls.

"c. Channel 9 feet deep and 150 feet wide with minimum widening necessary to provide a suitable harbor."[40]

The estimated cost for this project was placed at $7,779,003 to the United States and $1,774,229 to other interests - total $9,553,232. This plan received the approval of the Board on February 8, 1938 and of the Chief of Engineers on February 26, 1938, although no construction money has been appropriated to date (January 1939). Preliminary examinations, borings, surveys, hydraulic model studies, and design studies are being made.

CONCLUSION

This history has been prepared to make the story of St. Anthony Falls readily accessible to those who will be actively engaged in this project. It is believed that a more complete knowledge of the difficulties and dangers encountered in the past will better enable those connected with the project to design and construct adequate and economical structures. It has been amply demonstrated that grave construction dangers exist in the area. In closing perhaps the best words to express this would be those uttered by General G. K. Warren who revisited St. Anthony Falls about 1880: "Only eternal vigilance will preserve the Falls of St. Anthony."

REFERENCES

1. Foundation Conditions, Proposed St. Anthony Falls Locks, G. M. Schwartz, pp. 2, 3.

2. Foundation Conditions, Proposed St. Anthony Falls Locks, G. M. Schwartz, pp. 8-10.

3. Annual Report of the Chief of Engineers, 1874, Part I, pp. 279, 280.

4. Message and Documents - War Department, 1870, Part 2, p. 280.

5. Message and Documents - War Department, 1870, Part 2, p. 279.

6. Message and Documents - War Department, 1871, Part 2, pp.295,296.

7. Message and Documents - War Department, 1871, Part 2, p. 297.

8. Annual Report of the Chief of Engineers, 1872, p. 300.

9. Annual Report of the Chief of Engineers, 1872, p. 304.

10. Annual Report of the Chief of Engineers, 1873, Appendix H,pp. 6,7.

11. Annual Report of the Chief of Engineers, 1873, Appendix H, p. 4.

12. Annual Report of the Chief of Engineers, Part I, 1874, pp.282,283.

13. Annual Report of the Chief of Engineers, Part I, 1874, pp.280,281.

14. Annual Report of the Chief of Engineers, Part I, 1874, pp.283-285.

15. Annual Report of the Chief of Engineers, Part I, 1875, pp.356-358.

16. Report of the Secretary of War, 1876, Vol.II,Part I, pp. 700-702.

17. Annual Report of the Chief of Engineers, 1877, Part I,pp.564-566.

18. Annual Report of the Chief of Engineers, 1878, Part I, p. 725.

19. Annual Report of the Secretary of War, 1879, Vol. II,Part II,p.1163.

20. Exhibit 11, p. 6, Folder #4, Examinations and Surveys,7/77A.

21. Exhibit 10, p.12, Folder #4, Examinations and Surveys,7/77A.

22. Exhibit 10, Testimony of Edward P. Burch, Consulting Engineer, p. 9. Folder #4, Examinations and Surveys, 7/77A.

23. Letters sent, Improvement of Falls of St. Anthony from October 1877 to December 1881, p. 4.

24. Letters sent, Improvement of Falls of St. Anthony from October 1877 to December 1881, pp. 24, 25, 26.

REFERENCES - Con't.

25. Letters sent, Preservation of the Falls of St. Anthony, 1874, p. 124.

26. Letters sent, Preservation of the Falls of St. Anthony, 1874, p. 119.

27. Letters sent, Preservation of the Falls of St. Anthony, 1875-1877, p.90.

28. Letters sent, Preservation of the Falls of St. Anthony, 1875-1877, p.94.

29. Letters sent, Improvement of the Falls of St. Anthony, Oct. 1877-Dec. 1881, pp. 12, 13, 14.

30. Letters sent, Improvement of the Falls of St. Anthony, Oct. 1877-Dec. 1881, pp. 19, 20.

31. Exhibit 16, Folder #4, Examinations and Surveys, 7/77A.

32. Document No. 583, House of Representatives, 69th Congress, 2d Session, p. 23.

33. Public - No. 560 - 69th Congress (H. R. 11616), p. 11.

34. House Document No. 137, 72d Congress, 1st Session, Appendix B.

35. House Document No. 137, 72d Congress, 1st Session, p. 30.

36. Report on Mississippi River between Missouri River and Minneapolis, Examinations and Surveys, 7/77A, Folder #3.

37. Review of Reports on Mississippi River - Nov. 4, 1935, 4005.2/1-1/2 SF.

38. Review of Reports on the Mississippi River Between the Missouri River and Minneapolis Covering the Situation at Minneapolis, Minnesota, Aug. 21, 1937, 4005.2/1-57/5 S.F.

39. Public - No. 392 - 75th Congress - Chap. 832 - 1st Session - H.R. 7051.

40. Letter - Mississippi River at Minneapolis, Minnesota, Dec. 31, 1937, 4005.2/1-57/9 SF.

ADDITIONAL REFERENCES

A number of maps, tracings, and prints on early St. Anthony Falls.

Gillespie's Construction Diaries, 1873-1876.

Photograph Folio - Upper Mississippi River, Proposed Channel Extension, Minneapolis, Minn. (1937)

Photograph Folio - Upper Mississippi River, St. Anthony Falls, Minneapolis; High Water - May 1938, Fissures in Limestone slab (1938)

Moving Picture - Minneapolis, Minn., High Water Conditions at St. Anthony Falls, May 11-12, 1938

Note: Copies of all the above references are on file in the U. S. Engineer Office, St. Paul, Minn.

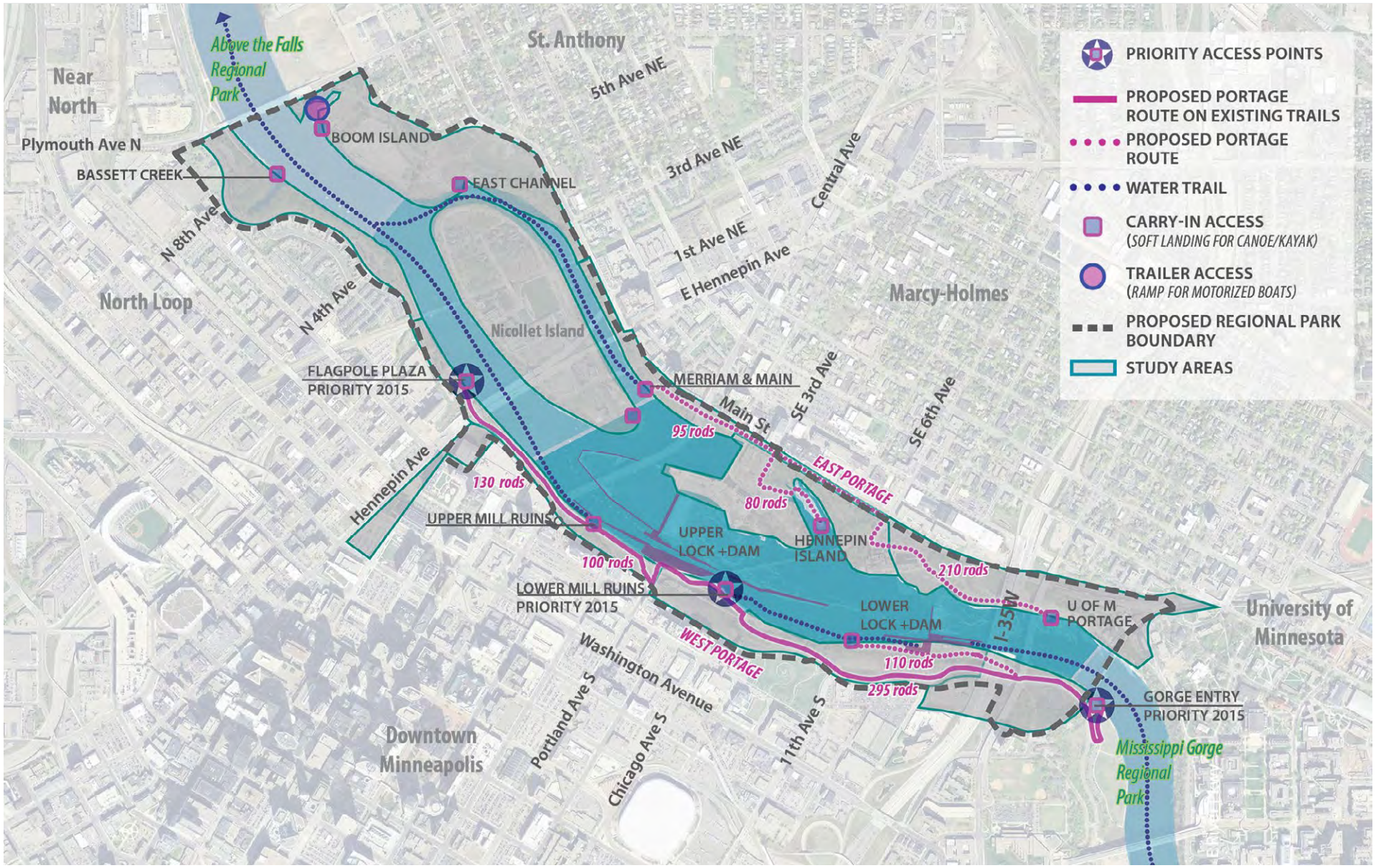


Figure 28: *Proposed Portage Routes*

Minneapolis
Park & Recreation Board

Administrative Offices
2117 West River Road
Minneapolis, MN 55411-2227

Operations Center
3800 Bryant Avenue South
Minneapolis, MN 55409-1000

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April 20, 2015

The Honorable Kimberly D. Bose
Secretary, Federal Energy Regulatory Commission
888 First Street NE
Washington, DC 20426

Re: Crown Hydro Draft License Amendment Application, FERC Project No. 11175

Dear Ms. Bose:

This letter is in response to the March 20, 2015, Draft License Amendment Application by Crown Hydro. The Minneapolis Park and Recreation Board (MPRB) has the following comments and concerns:

1. We remain concerned about the access to the proposed project site across MPRB-owned property and the Upper Saint Anthony Falls (USAF) property (under MPRB easement for recreational trail, street and recreational access to adjoining properties), all of which are heavily used for recreational purposes. Project construction, as well as ongoing operations and maintenance vehicle traffic through the property, would cause hazards to park users and undue wear and tear on MPRB land.

2. Specific to the discussion about the MPRB's easement from USACE for trail and other use, the response from the applicant recites portions of the easement in which MPRB will not impede access to the grantor's facilities. The discussion of the easement's terms, however, fails to mention Section 13 on page 4 of the easement in which it is agreed that such right of entry shall not interfere with any agreements between the MPRB and other agencies regarding the financing, construction, maintenance or repair of the improvements allowed by the easement. We are checking to see whether grant agreements for financing to construction those improvements contain terms that would be contrary to the easement's right of entry language.

3. Related to property rights, Exhibit E – Section 2.2.2 shows the proposed project boundary as entirely within federal government-

owned property. It should also refer to the MPRB recreational easement that currently encumbers this property, as discussed.

4. On Schedule A of the applicant's response to FERC questions, in the section regarding Exhibit E related to updated information about recreation and land use of the surrounding area, we bring to the agency's attention the recent approval by the MPRB commissioners of a new Central Mississippi Riverfront Regional Park (to be renamed Saint Anthony Falls Regional Park) Master Plan (SAFRP Master Plan). This plan contains revised information about the project area and surrounding property, and its contents should be included in any review of the proposed project.

5. One of the recreational uses of the area that is noted in the SAFRP Master Plan is kayaking and canoeing on the Mississippi River. We anticipate this use to increase significantly after the upper lock is closed in June, 2015. Portage locations will be important for access around the lock, and we are concerned about the project's effect – both during and after construction – on the selection and safety of the chosen locations.

6. We continue to be concerned about the stability and possible detrimental effects of the project on the Stone Arch Bridge, Mill Ruins Park and other historically sensitive features of the area, and do not feel the applicant's response to these concerns has as yet been adequate. In Exhibit E – Environmental Assessment of Proposed Modifications, section 3-27 refers only to an initial Section 106 consultation with the Minnesota State Historical Preservation Office.

7. We remain concerned also about the effects of the proposed project on potential need of the to-be-closed lock for emergencies and for flood mitigation purposes. Flood mitigation is an important ongoing use of the lock that will help to protect, among other things, significant riverfront parkland property and many recreational uses of that land upstream of the lock.

Sincerely,

Michael Schroeder
Assistant Superintendent for Planning

cc: Jayne Miller, Superintendent
Liz Wielinski, President

Document Content(s)