FINAL REPORT

FOR
Lower Saint Anthony Falls Hydroelectric Project
(FERC License Number: 12451)

Fish Protection Effectiveness Monitoring Plan

Prepared for:

SAINT ANTHONY FALLS HYDRO, LLC
965 S Mississippi River Blvd
St. Paul, MN 55116

Prepared by:

739 Hastings Street
Traverse City, Michigan 49686
Phone: (231) 941-2230
Facsimile: (231) 941-2240
www.glec.com

Principal Contact Persons:
Christopher J. Turner
cturner@glec.com

Dennis J. McCauley
dmccauley@glec.com

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EXECUTIVE SUMMARY

The Lower St. Anthony Falls Lock and dam is located on the Mississippi River at river mile 853.3 in Minneapolis, MN. Constructed in 1956, it included a spillway with three tainter gates and an uncompleted auxiliary lock in its original design.

In 2006, SAF Hydro received a license from the FERC to install 16 modular Hydromatrix turbines within the auxiliary lock. Pneumatically operated Obermeyer spillway gates were also installed on top of the retaining wall which was constructed in the auxiliary lock chamber to house the draft tubes and control room. As part of the license (Article 403) SAF Hydro was to perform a Fish Protection Effectiveness Monitoring Plan once the project was installed and in operation. The Plan's overall objective (accomplished by field work, literature review and desktop evaluations) was to assess the impact of the LSAF Project by comparing the overall impact on fish moving through the dam both pre- and post-installation of the Hydromatrix turbines and Obermeyer gates. Prior to the installation, fish moving downstream through the spillway potentially encountered one of the two rows of seven foot tall energy dissipation blocks or the four foot high embedded piling running the entire width of the spillway. This condition has likely been causing an impact on the fish population since the construction of the dam.

Great Lakes Environmental Center, Inc. (GLEC) performed field investigations in 2011 and 2012 that included resident fish characterizations, evaluation of the Obermeyer gate for downstream fish passage, impingement monitoring, velocity profiling, and an evaluation of the potential effects of turbine entrainment on fish survival. Literature reviews included investigations into indirect mortality of fish, fish swim speeds and the impact of fish passing through the spillway gates versus through the turbines or over the Obermeyer gate. A desktop analysis was performed that estimated the annual fish entrainment and mortality that is potentially occurring at LSAF.

Field crews collected fish using boat electrofishing techniques during two sampling seasons and collected a total of 35 species representing 12 families of fish. Electrofishing in the areas above and below LSAF revealed a population of fish largely dominated by emerald shiners, bluegill, smallmouth bass, quillback and common carp. No threatened or endangered species were collected. Of the fish collected, over 70 percent measured 8 inches in length or less. The species composition and size distributions were found to be similar to two previous entrainment studies performed on the Mississippi River within six miles of LSAF.

Field work and literature reviews regarding the effectiveness of the Obermeyer gate to safely pass fish downstream revealed a high potential survival rate. The survival of fish (especially small fish) passing over the Obermeyer gate is likely to be greater than would be experienced by passage through either the turbines or the spillway's tainter gates. The positioning of the Obermeyer gates, the height of water drop and the depth of the receiving water all indicate that the Obermeyer can be an effective means for fish to pass downstream with limited mortality. Fish most likely to benefit from this passage route are newly hatched fry which often migrate downstream by natural drift as well as young-of-the-year and other fish that tend to utilize the upper few feet of the water column.

Water velocities in the approach area of the LSAF turbines are potentially as high as seven feet per second in small isolated areas, but the configuration of the submerged turbines combined with a large eddy behind the tainter gate in the forebay area will likely afford fish areas of refuge where they may avoid impingement and entrainment. The alternate downstream passage provided by the Obermeyer gate may also help to lessen the overall amount of impingement and entrainment occurring at LSAF. Smaller fish that may not be able to withstand the water velocity may become entrained through the turbines, while larger fish not able to pass through the two inch trash racks would likely be able to avoid impingement due to greater swim speeds. While on site, field crews searched for but found no evidence of fish impingement on the turbine trash racks.

Through field work and reviews of entrainment mortality studies performed at other facilities with propeller-type turbines, we estimate that there will be fish mortality as a result of turbine passage. The majority of the mortality is likely to be due to direct effects (blade strikes, contact with fixed objects, etc) and will therefore affect larger fish to a greater degree. Mortality of fish passing through the spillway's tainter gates is also likely to be caused mainly by direct effects (contact with energy dissipating blocks, shear forces, etc.) and may be as great if not greater than the mortality caused by turbine entrainment. Due to the relatively low head and the characteristics of the tailrace, indirect effects on fish (increased rates of predation or disease) are likely to be low for passage through both the turbines and spillway gates.

Through desktop analysis using a comparison of the LSAF project to other hydroelectric projects located on large Midwest rivers, we estimate an annual entrainment of 714,222 fish. This estimate is roughly 20 percent lower than what was initially calculated by SAF Hydro during the license application process. The primary species expected are emerald shiner, channel catfish and gizzard shad. The majority of the annual entrainment is expected to be comprised mainly of small fish. An estimated 95.9 percent of fish entrained at LSAF would be less than 200 mm (roughly 8 inches) in total length.

Mortality at LSAF is estimated to reach 42,971 fish annually (roughly 6.0 percent of all fish entrained). This estimate just under five percent lower than what was estimated during the license application process. Channel catfish are estimated to experience the highest losses, followed by emerald shiners and gizzard shad. Over 72 percent of the lost fish are expected to be less than 100 mm (roughly 4 inches) in length.

It is unknown how these estimated numbers of entrainment and mortality compare to the potential entrainment and mortality that occurs through the spillway gates each year. Given the physical characteristics of the spillway and the fact that equal or greater volumes of water often flow through the spillway than the turbines during the time of the year when fish are most mobile, it is reasonable to assume that the impact of the spillway on fish survival maybe at least as great as that of the turbines. Without data relating to injury and mortality rates as fish pass through the spillway at the Lower St. Anthony Falls Dam, we cannot state with any certainty what the chances of spillway entrainment survival are. It does seem likely, however, that due to the physical characteristics of the spillway, the overall impact on a spillway entrained fish would approach if not surpass the effect of entrainment through the hydro units at LSAF

Overall, the evidence suggests that the addition of the LSAF hydroelectric project to the Lower St. Anthony Falls Dam has not caused an increased negative impact on the fish

community in this reach of the Mississippi River. The preexisting impact of the spillway is likely to be equal to or potentially greater than that of the turbines. Moreover, the addition of the Obermeyer gate has potentially helped to mitigate some the impact of the spillway on downstream migrating fish in this portion of the river.

To get the unabridged version of this paper please contact:

ANDRITZ HYDRO GmbH
Lunzerstrasse 78
A-4031 Linz, Austria

Phone: +43 (732) 6986-0
Fax: +43 (732) 6980-2554
Hydromatrix@andritz.com