Interlake Lock and Boat Transfer Station

Enhancing Navigation While Preventing Invasive Aquatic Species
Community Enhancement and Environmental Protection

Project Description

The Interlake Lock on River A links Lake Michigan to a large nearby lake (Lake B) in Wisconsin, USA. The lock was closed in 1988 to prevent the spread of aquatic invasive species (AIS) such as sea lamprey and spiny water flea. Movement of AIS from the downstream Lake Michigan side to the upstream Lake B side warranted a permanent barrier, but closure of the lock halted both upstream and downstream passage of recreational and commercial vessels.

Without the lock, community members are trusted to thoroughly clean their aquatic craft to remove AIS when transporting between bodies of water. The new Interlake Lock and Boat Transfer will give a means to regulate treatment and is expected to reduce the risk of AIS contamination into Lake B. While the current lock acts as an effective barrier in halting the spread of AIS, full navigation of River A is desired. A new lock will have the ability to transfer boats, while preventing the spread of AIS, and will benefit the local community and economy.

The project drew the engineering student team together with professional engineers and architects, community members, and the navigational authority. The students considered design alternatives, handled ethics and business questions, and prepared designs.

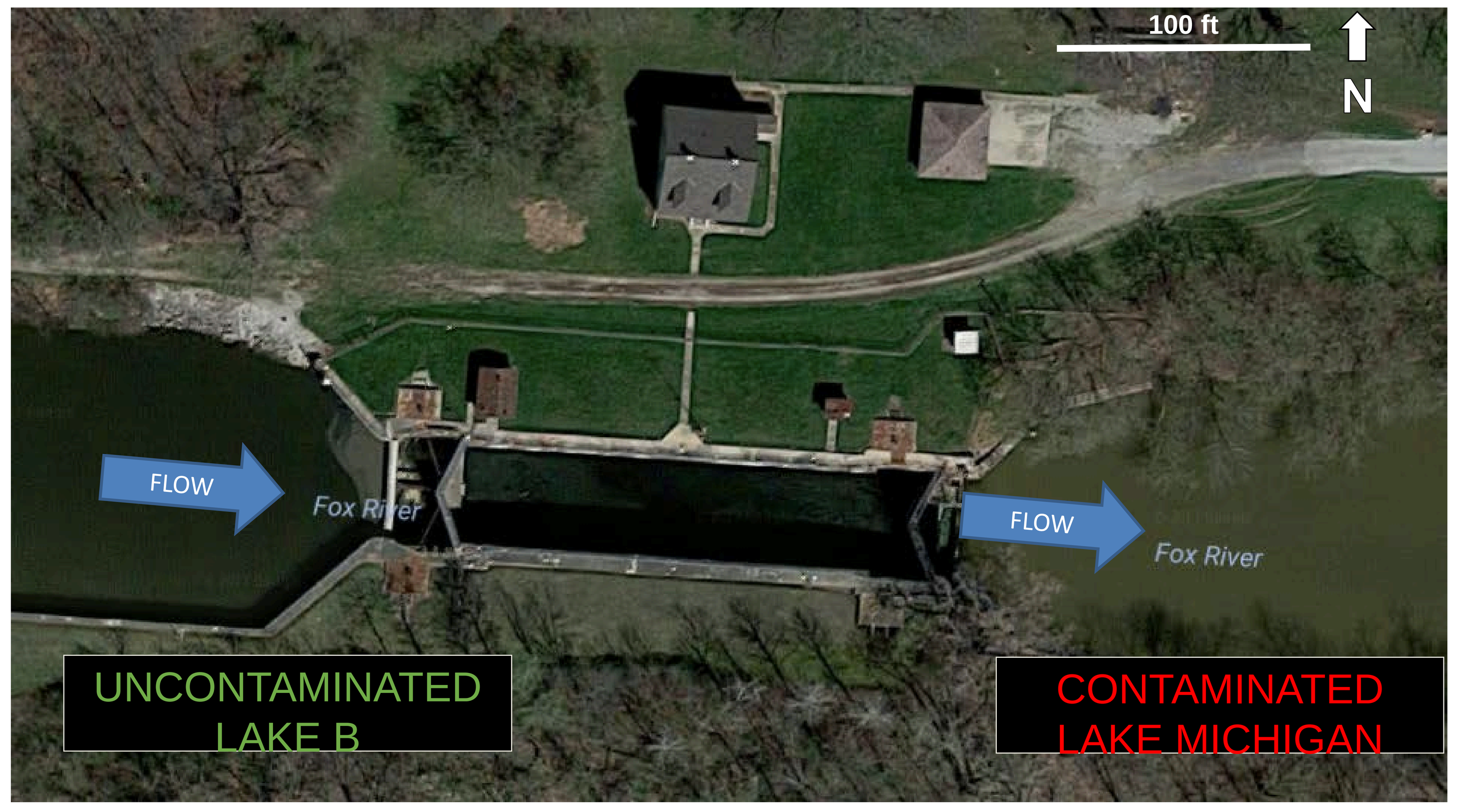

Figure 1. Interlake Lock and Boat Transfer

Student, Faculty and Professional Collaboration

Fields: Structural, Geotechnical, Environmental, Hydrological and Construction Engineering; estimating, scheduling, client and community interaction.

Design Team: Five Civil and Environmental engineering students; two volunteer registered engineers as mentors from the local engineering community; faculty and adjunct faculty members.

Professional Support: Structural, geotechnical, and environmental PEs, architect, project review by a board of multidisciplinary PEs.

Treating Aquatic Invasive Species

The new design must prevent Aquatic Invasive Species (AIS) such as the Sea Lamprey, Gobi fish, Spiny Waterflea, and Zebra Mussel from spreading through the lock to Lake B. Currently, the State Department of Natural Resources supports the use of pressure washers and flush muff to treat aquatic craft and avoid transmission of AIS. The final design utilizes multiple measures to avoid transmission of AIS during the following treatment process. Watercraft will first enter the contaminated bay and be lifted out of the water on a universal boat stand. Trained employees will use heated pressure washers to treat the hull while flush muffs will cleanse the engine intake. Once treated a marine travel lift will complete the transfer process by lifting the craft from the contaminated to the uncontaminated bay.

Figure 2. Gobi Fish

Figure 3. Spiny Waterflea

Figure 4. Existing Lock

Knowledge and Skills Gained

The students applied their engineering curriculum to a real-world problem. They used their knowledge of civil engineering to evaluate alternatives, considered risks and benefits, and created a viable final design, while meeting the time and budget constraints of their client and internal organization. Their interaction with mentors and other members of the engineering profession taught them valuable communication skills, and gave them insights into questions about ethics, professional responsibilities, and the logistics of taking a design project to completion.

Design Options

The student team developed three design options: Basic Re-Use; Bay and Lift; and Elevated Rail with Hot Wash. The Basic Re-Use design utilized much of the existing lock to create a cleansing station. The Bay and Lift design included a wall to create two bays, with a boat lift on top of the lock for transfer and cleaning. The Elevated Rail with Hot Wash design integrated an elevated rail system for lifting watercraft into a hot water bath.

Final Design

After analyses, evaluation through a decision matrix, and consultation with the navigation authority, the Bay and Lift design was selected for final design.

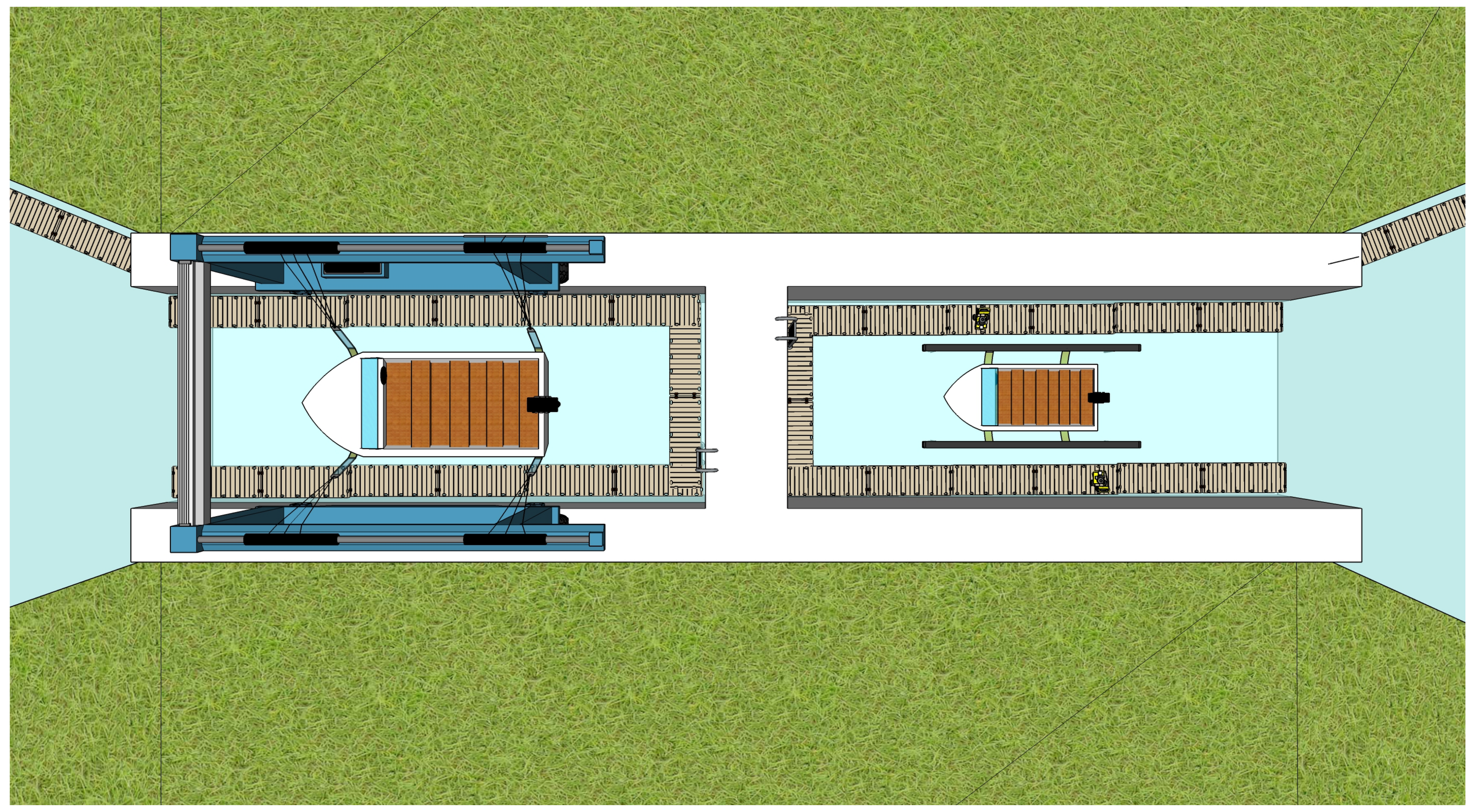

Figure 5. Overhead view of the final design; Bay and Lift.

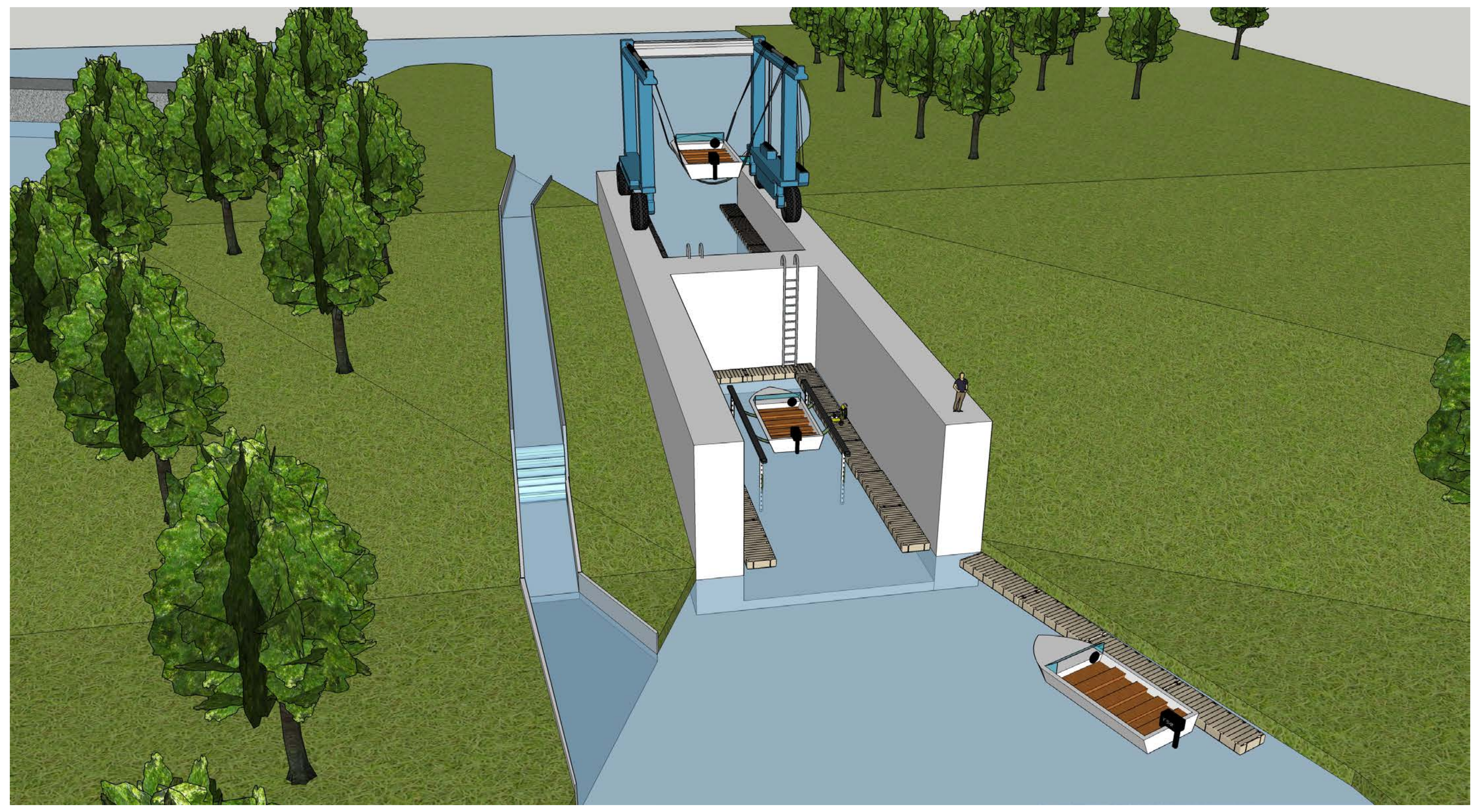

Figure 6. Isometric view of the final design; Bay and Lift.

Interlake Lock and Boat Transfer Station Abstract

The Interlake Lock formerly linked Lake Michigan to a large nearby lake (Lake B) in Wisconsin, USA. In collaboration with the local navigational authority, a team of five undergraduate civil and environmental engineering students worked with two P.E.s, an architect, and other consultants to design a new lock and boat transfer which would allow passage of vessels while preventing the spread of aquatic invasive species (AIS) such as sea lamprey and spiny water flea. The former lock was constructed in 1851 and renovated in the 1930s, but was closed in 1988 to prevent the movement of AIS from the downstream Lake Michigan side to the upstream Lake B side. Closure of the lock halted both upstream and downstream passage of recreational and commercial vessels. Without the lock, community members are trusted to thoroughly clean their aquatic craft to remove AIS when transporting between bodies of water.

The student team was challenged to design an interlake transfer facility that provided a means to regulate treatment to reduce the risk of AIS contamination into Lake B while providing full navigation of River A, thereby benefitting the environment, the local community, and the area economy. The existing lock is listed on the National Register of Historic Places, and preserving historical integrity was an important factor in the design.

The students developed three design alternatives, preparing a concept design for each. Then, having achieved an understanding of the engineering, environmental, and public constraints, they prepared an evaluation matrix in which weighted decision criteria were applied to each concept design. The team made a recommendation to proceed with a Bay and Lift design, in which parts of the existing lock are preserved and a new wall added to separate the lock into two zones.

In the downstream zone, vessels will have been exposed to AIS. When traveling upstream, vessels will enter the lower portion of the lock via the existing doors, the doors will close, and the water level will drop within the lock. The vessel will lower onto a universal stand where it will be prepared for treatment. Using pressure washers, the boat will be sprayed down with water heated to 200-degrees Fahrenheit. Flush muffs will be attached to engine intakes on the treated vessel and the engine will be started, running hot water through the intake to provide comprehensive treatment. Hot water spray treatment will kill and deactivate spiny water fleas and zebra mussels. All water used in treatment will only be in contact with this exposed zone, reducing the risk for cross contamination upstream. Upon completion of treatment, a sling crane will hoist the craft out of the exposed zone and into the clean zone located in the upstream side of the lock. The vessel will be lowered into clean upstream water to complete the boat transfer.

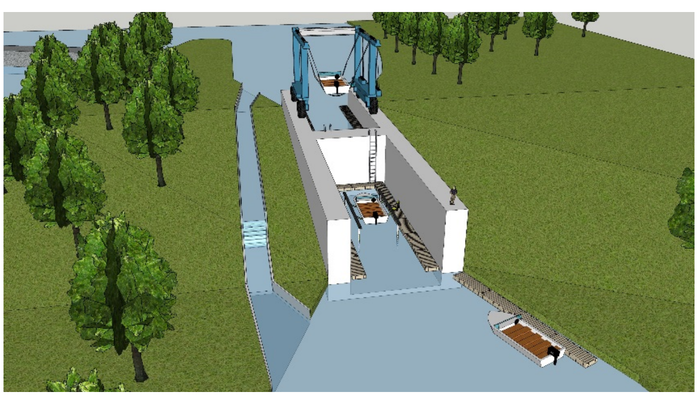

Figure 1: Recommended Design

Interlake Lock and Boat Transfer Station Project Description

Project Description

The Interlake Lock is a historic lock on River A that formerly linked Lake Michigan to a large nearby lake (Lake B) in Wisconsin, USA. The lock was constructed in 1851 and renovated in the 1930s, but was closed in 1988 to prevent the movement of aquatic invasive species (AIS) from the downstream Lake Michigan side to the upstream Lake B side. Since its closure, the lock has remained an impermeable barrier to AIS but has also closed the river to boat traffic.

Figure 1: Existing Lock

AIS have become an increasingly prevalent issue throughout the Great Lakes region. Species resilient to Great Lakes predators and conditions have infiltrated into the area and are continuously causing adverse effects to native species. When the lock closed, sea lamprey were the primary invasive species, risking the native sturgeon and walleye populations in Lake B. Since the mid-1980's, other AIS have become prevalent in Lake Michigan, so preventing their spread into Lake B is of prime importance. Zebra Mussels, Spiny Waterflea, and Goby have now all been found on the downstream side of the Interlake Lock, but not above.

The local community requested the lock be made available for passage again, with the goal of preventing the upstream spread of AIS and safely transferring boats in both directions along River A. The navigational authority challenged a team of civil and environmental engineering undergraduate students (the student team) to design a solution to the problem. The existing lock is listed on the National Register of Historic Places, and preserving historical integrity was an additional crucial factor in the design.

With the project goals established – navigation along the river, preventing spread of AIS, and preserving historical integrity – the student team began collaborating with faculty members, professional engineers, mentors, public, and the navigational authority. The design included application of engineering principles in geotechnical, structural, hydrologic, environmental, and construction engineering. The student team prepared and submitted: a proposal (as though they were competing for the project); a formal preliminary design report describing the three concept designs; a listing of pertinent regulatory standards and professional codes; a geotechnical report; contract documents (construction contract, technical specification, construction plans); regular project management reports; regular peer evaluation reports; opinions of cost; and project schedules. Their work included three formal presentations along with a public meeting.

The student team developed three concept designs for the lock and boat transfer facility: Basic Re-Use; Bay and Lift; and Elevated Rail with Hot Wash.

Figure 2: Basic Re-use

The Basic Re-Use Design utilized much of the existing lock to create a cleansing station. Comments from the public included: "Producing local jobs," "Low cost," and "simplistic design that is easy for boaters to understand." However, this design also raised public concerns based on the high amount of concrete or impervious surfaces to be installed.

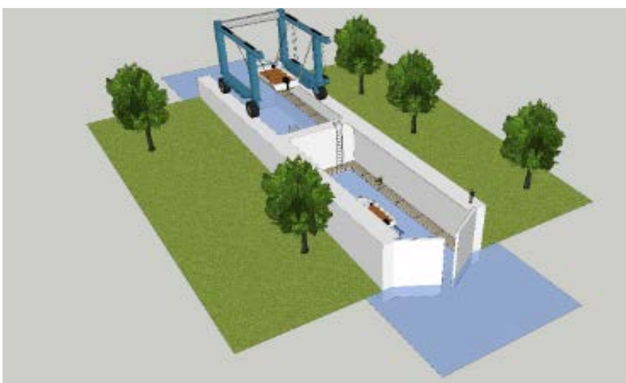

Figure 3: Bay and Lift

The Bay and Lift Design included a wall to create two bays, with a boat lift on top of the lock for transfer and cleaning. It received approving comments like: "Producing local jobs" and "Least invasive with partial reuse of lock."

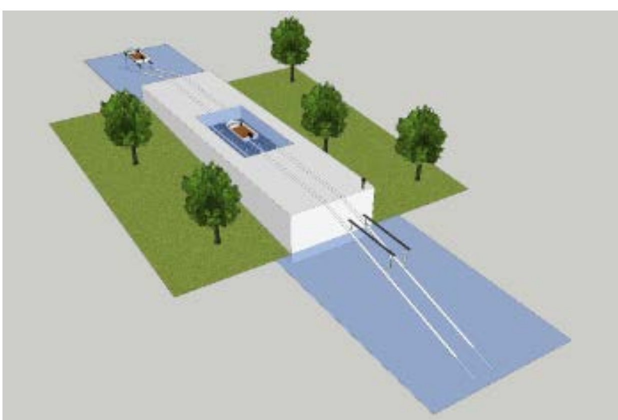

Figure 4: Elevated Rail with Hot Wash

The Elevated Rail with Hot Wash Design integrated an elevated rail system for lifting watercraft into a hot water bath. Community members believed it could provide a time-efficient solution with high safety aspects but did not see the point of a more expensive option to produce the same results.

The Bay and Lift Design was ultimately recommended by the student team, and the recommendation was accepted by the navigation authority. The final design is efficient and accomplishes the project objectives. In the downstream zone, vessels will have been exposed to AIS. When traveling upstream, vessels will enter the lower portion of the lock via the existing doors, the doors will close, and the water level will drop within the lock. The vessel will lower onto a universal stand where it will be prepared for treatment. Using pressure washers, the boat will be sprayed down with water heated to 200-degrees Fahrenheit. Flush muffs will be attached to engine intakes on the treated vessel and the engine will be started, running hot water through the intake to provide comprehensive treatment. Hot water spray treatment will kill and deactivate spiny water fleas and zebra mussels. All water used in treatment will only be in contact with this exposed zone, reducing the risk for cross contamination upstream. Upon completion of treatment, a sling crane will hoist the craft out of the exposed zone and into the clean zone located in the upstream side of the lock. The vessel will be lowered into clean upstream water to complete the boat transfer.

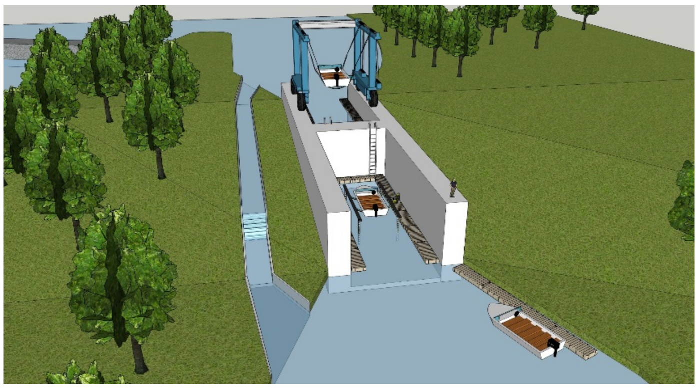

Figure 5: Recommended Design

Collaboration of Faculty, Students and Licensed Professional Engineers

Were licensed professional engineers (P.E.s) involved?

Two P.E.s from the local community served as mentors throughout the semester, meeting weekly with the student team. The mentors provided design supervision, lessons-learned experiences, critique and oversight for presentations and reports, and advice for client relationships and public meetings. In addition, overall instruction for the course was provided weekly by a P.E. and a licensed architect. Two student team presentations (at the preliminary and final design stages) were made to a panel of judges from the local P.E. community, thereby widening the students' exposure to other professionals and affording opportunities for additional critique of their work.

How did the students, faculty, and P.E.s interact?

The weekly contact between mentors and students allowed the students to benefit from the P.E.'s many years of experience. At the same time, the mentors and faculty expected the student team to retain responsibility for its own performance to the pre-established goals for time management, presentations, design components, deliverables, and schedules. Both mentors and faculty made themselves available for phone or email discussions as necessary, and provided review of the student deliverables.

What did the students learn through the collaboration that would not have been learned in the classroom?

Communication and Collaboration as Components of Design: Collaboration between engineers, stakeholders, regulatory agencies, and the public is difficult if not impossible to teach in the classroom. In this project, the student team spoke directly to the navigational authority and the public, learning to listen and balance the needs and requirements of various entities. The project constraints and needs then became critical elements of three concept designs.

Multiple Right Answers: Most classroom activities and problems are designed to promote an understanding of the theory by having a single "correct" answer. In this project, having achieved an understanding of the engineering, environmental, and public constraints, the students prepared an evaluation matrix in which weighted decision criteria were applied to three concept designs. The team made a recommendation to proceed with a Bay and Lift design, in which parts of the existing lock are preserved and a new wall added to separate the lock into two zones.

		Basic Re-Use		Bay and Lift		Elevated Rail	
Evaluation Criteria	**Weight of Criteria**	**Rating**	**Weighted Rating**	**Rating**	**Weighted Rating**	**Rating**	**Weighted Rating**
Benefit to Local Economy	2	2	4	2	4-	3	6
Environmental Impact	4	2	8	4	16	5	20
Safety	5	5	25	4	20	4	20
Efficiency of Transfer	4	2	8	4	16	5	20
Aquatic Invasive Species Prevention	5	4	20	5	25	5	25
Historical Preservation	3	2	6	5	15	2	6
Aesthetics	2	4	8	2	4	3	6
Schedule	2	3	6	5	10	1	2
Cost of Construction	4	5	20	4	16	1	4
Cost of Operation	3	2	6	4	12	3	9
	Total		**111**		**138**		**118**

Figure 6: Evaluation Matrix

Application/Integration of Multiple Disciplines: In this project, it was necessary for the student team to combine their individual skills for successful performance of the work, yet complete tasks in several disciplines of civil and environmental engineering. To do this, they identified the skill sets of each team member, assigned themselves tasks accordingly, and sought outside advice from mentors, faculty and other students in areas where needs remained.

Learn to Identify the Uncertainties: Engineering projects have uncertainties, and awareness of the uncertainties informs the designers and user of related risks. Many classroom activities present the student with data and/or a set of assumptions upon which analyses are to be based. In this project, students were challenged to themselves identify areas where they did not have or find pertinent information, or where certain information was not knowable prior to performing analyses. They correctly identified several items (geotechnical conditions, current-day quality of existing materials, site plans prepared by others, etc.) as items that should be noted and considered.

Protection of Health, Safety, and/or Welfare of the Public

The student team was challenged to design an interlake transfer facility that provided a means for regulated treatment to reduce the risk of AIS contamination into Lake B while providing full navigation of the river, thereby benefitting the environment and the local community. The existing lock was old, in poor condition, and unsafe to use from an environmental standpoint due to the probability of AIS contamination. Any members of the public who desired to navigate up-river from Lake Michigan were required to use trailer transport for their vessels, and were relied upon to properly cleanse their trailers and vessels prior to launching into the river or Lake B. Although a number of species are considered AIS for the area, the goby fish (below, left) and spiny water flea (below, right) are especially dangerous to the Lake B system. The design submitted by the student team implemented measures for preventing the spread of these and other species by cleansing the vessel's hull, wells, bilge and motors, removing plants attached to the vessel, and prohibiting bait to pass through the lock.

Figure 7: Examples of Aquatic Invasive Species: Goby Fish on left and Spiny Water Flea on right

Multidiscipline and/or Allied Profession Participation

During this project, the work by the student team included Structural, Geotechnical, Environmental, Hydrological and Construction Engineering, drafting, estimating, scheduling, client and community interaction, review of regulatory requirements and professional standards, and preparation of written reports and construction documents. The five civil and environmental engineering students logged approximately 1,000 hours of design work, including team meetings and meetings with mentors and faculty.

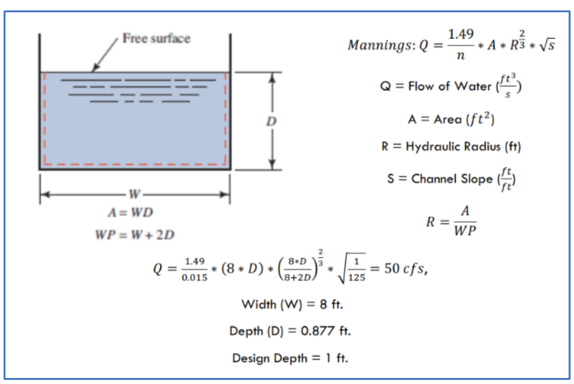

Figure 8 Example of design work

Two volunteer P.E.s served as the team's mentors, and a P.E. and licensed architect served as course instructors. These licensed professionals met at least once per week, and often twice per week with the students, and were available by telephone or email to answer questions and provide advice. Other faculty members served as advisors, and members of the local engineering community served as judges for two formal presentations by the student team. Marine industry representatives provided information about boat transfer and lifting equipment.

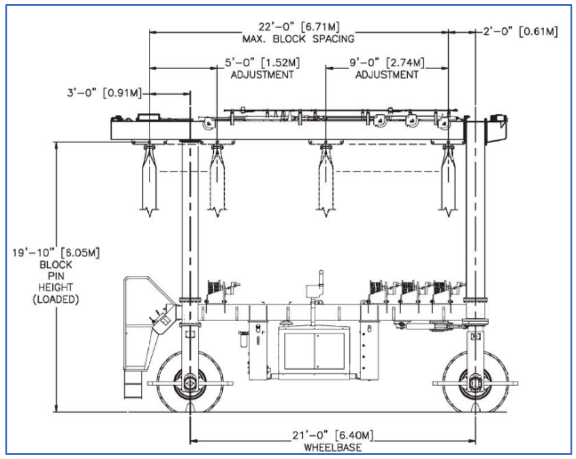

Figure 9 Example of design work

Knowledge and Skills Gained

The students applied their engineering curriculum to a real-world problem. They used their knowledge of civil engineering to evaluate alternatives, considered risks and benefits, and created a viable final design, while managing themselves to meet the time and budget constraints of their client and internal organization.

Their interaction with mentors and other members of the engineering profession taught them valuable communication skills, and gave them insights into questions about ethics, professional responsibilities, and the logistics of taking a design project to completion.

This unique project incorporated the requirements of several stakeholders, including the navigation authority, the public, the State Historic Preservation Office, and regulatory agencies. The students identified applicable codes and standards, prepared contract documents (contract, technical specification, plans), and answered Requests for Information. They learned to communicate effectively with other team members, as well as with the project stakeholders.

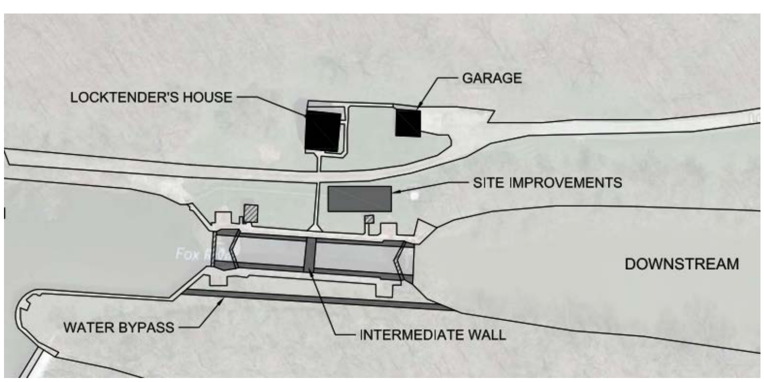

Figure 10: Excerpt from Plan Set prepared by student team