Village Stormwater Mitigation Project

A Cross-Disciplinary Engineering Design Project with Multiple Constraints

Project Description

This project takes place in a small Midwest village known for its scenic views and Swedish heritage. The community hosts hundreds of tourists every year who visit its local attractions. Many businesses and homes are located close to one another and adjacent to an old concrete channel that runs through the center of the Village. The community is concerned about damage from increasingly frequent and intense rainfall events. Prior efforts including the central channel and upland farm ponds have proved inadequate. Several homes and bridges are at risk of destruction.

This project brought together a team of engineering students, professional engineers, and community members to design a stormwater management system to reduce upland runoff flowing into the Village, reduce sediment and pollutant loads, and enhance the overall safety of conveyance through the Village.

Design Options

The student team developed three concept designs that differ in cost and effectiveness:

- Central Pond Location – Building a large, centrally located retention pond north of the Village with adequate stormwater storage and additional space for public amenities.
- Multiple Pond Locations - Building five farm ponds that are strategically placed along the upland forested area and farmland to reduce peak runoff with minimal cost.
- Concrete Channel Rehabilitation - Refurbishing the concrete channel that runs through the Village to increase flow capacity and improve the aesthetic appeal.

Mitigation Strategy & Final Design

The objective of stormwater mitigation on this project is to spread the flow of water out over a longer period to minimize peak flow and convey water at a more manageable rate.

To determine the best solution, the students developed a decision matrix that applies five weighted criteria to all three design alternatives. The criteria are as follows:

1. Reduction in peak flows
2. Economic sustainability
3. Social sustainability
4. Environmental sustainability
5. Constructability

After analyses and evaluation using the matrix, the Central Pond Location was recommended as the best option.

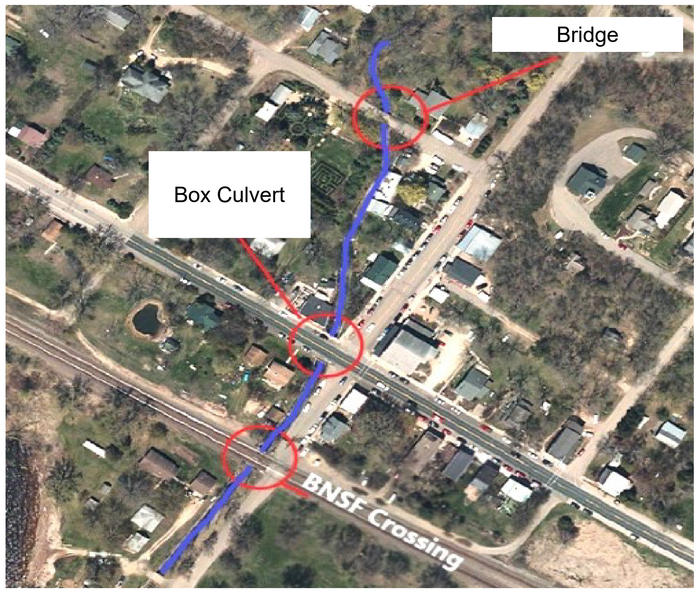

Figure 1: Aerial view of the project site

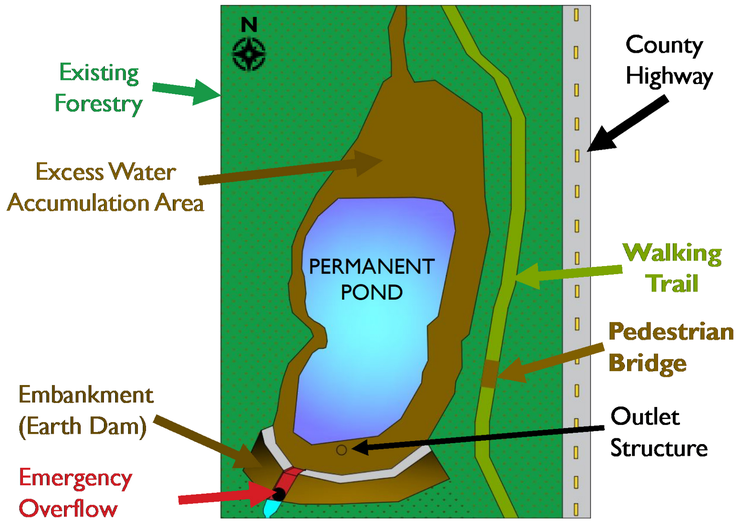

Figure 2: Conceptual site plan for the Central Pond Location alternative

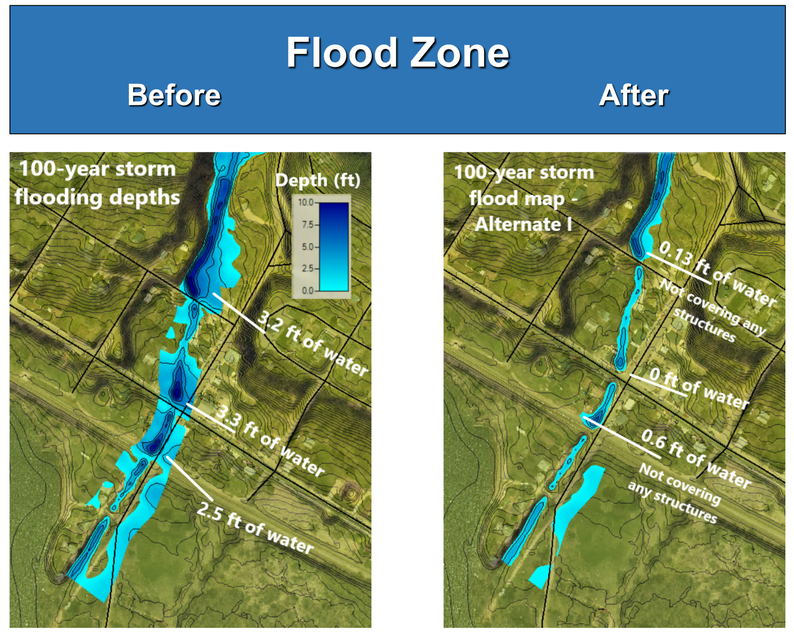

Figure 3: Flood area of a 100-year storm event before and after construction of the Central Pond Location

Student, Faculty and Professional Collaboration

Fields of Expertise: Hydrological, hydraulic, geotechnical, structural and construction engineering; estimating, scheduling, client and community interaction.

Design Team: Four undergraduate engineering students; two registered engineers from the local community serving as mentors; faculty and adjunct faculty members serving as advisors.

Professional Support: Structural, geotechnical, and environmental P.E.s, and an architect, with project review by a board of engineers that included two P.E.s.

Knowledge and Skills Gained

The students applied their engineering curriculum to a real-world problem. Both knowledge of civil engineering and experience gained on previous projects were used to evaluate the alternatives, with public safety and welfare at the forefront of the decision-making process.

The team considered risks and benefits, recommended one of its three design concepts, and created a viable final design, while complying with time and budget constraints. Collaboration with mentors helped with technical analysis, while demonstrating the necessity of communication, delegation, accountability, and organization. The project also emphasized the importance of ethics, professional responsibilities, and the logistics of carrying a design project to completion.

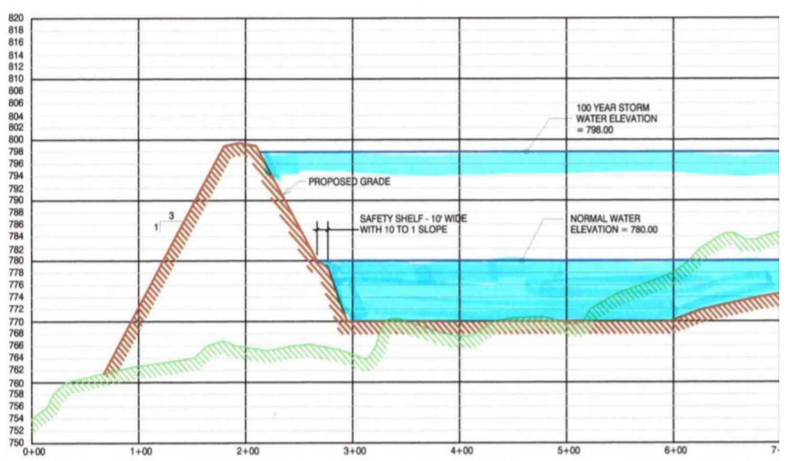

Figure 4: Central Pond Location cross section facing west (vertically exaggerated)