Thesis Project Portfolio

Otterdale Road Drainage Improvements

(Technical Report)

Buried Beneath the Reservoir: The Forgotten Injustice of the Kinzua Dam

(STS Research Paper)

An Undergraduate Thesis

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Executive Summary

Civil engineers are routinely tasked with solving technical problems that carry wide-ranging implications for both the built environment and the people who interact with it. In flood-prone areas, infrastructure design requires balancing a host of competing priorities, including cost-efficiency, public safety, environmental impact, and the needs of surrounding communities. At the same time, historical and contemporary case studies show that technical decisions can have profound ethical consequences, especially when stakeholder voices are overlooked. As both a practicing discipline and a profession governed by ethical standards, civil engineering must grapple with how decisions are made—and whose interests are served—in the development of public works. My undergraduate work this year reflects these dual challenges through a technical Capstone project focused on stormwater management and a research paper in Science, Technology, and Society (STS) examining ethical failures in historical infrastructure. While distinct in subject matter and methodology, these two projects share a core concern: the consequences of engineering decisions when technical goals are prioritized over social responsibility. This executive summary presents an overview of both projects and explores the following guiding question: *How can civil engineering decision-making processes effectively balance technical requirements with ethical responsibilities and stakeholder needs to produce sustainable and socially responsible flood-resilient infrastructure?*

To explore the technical side of this question, I have completed a Capstone project addressing flood concerns where a stream, Otterdale branch, underpasses Otterdale road in Chesterfield County, VA. The existing double box culvert under Otterdale road was insufficient to prevent flooding during heavy storm events, creating hazardous driving conditions. The goal of the Capstone project was to provide a solution to the flooding problem while also improving

the safety along Otterdale road. First, my Capstone team analyzed the streamflow of Otterdale branch using HEC-RAS, the Hydrologic Engineering Center's River Analysis System, to determine an appropriate hydraulic opening to disallow flooding during a 100-year storm – a storm with intensity seen once every 100 years, on average. To achieve a large enough opening for our design storm's stream discharge, we proposed a new bridge passing over the stream. To accommodate the new bridge structure and ensure that it met flood mitigation goals, we raised the roadway elevation and selected a precast concrete bridge design based on VDOT and AASHTO standards. We relied on established engineering guidelines to identify a feasible and cost-effective solution that satisfies the required hydraulic opening and roadway safety criteria. In addition, we addressed stormwater management concerns by ensuring the roadway profile would not trap water on the bridge deck. The project required careful consideration of design constraints such as right-of-way impacts, construction limitations, and long-term resilience to high-intensity storm events, highlighting the complexity of civil engineering design in flood-prone regions.

In parallel with this technical work, my STS research paper investigates the ethical dimensions of the Kinzua Dam project, with a specific focus on the decision-making processes of the U.S. Army Corps of Engineers (USACE). The dam's construction in the 1960s led to the forced displacement of Seneca Nation communities and the flooding of culturally significant land—consequences that raise important questions about the ethical obligations of engineers in large-scale infrastructure projects. Rather than evaluating the actions of all involved entities, my research centers on the USACE's role to identify how their decisions contributed to an ethical failure. Using a timeline of key events and relevant historical documents, I analyzed the Corps' decision-making through the lens of engineering ethics, particularly in relation to stakeholder

engagement and the evolving standards outlined in the ASCE Code of Ethics. The analysis reveals a pattern of neglect toward the Seneca people and a prioritization of technical and political goals at the expense of social responsibility—an oversight that continues to inform discussions on ethical engineering practice today.

Together, my Capstone project and STS research highlight the connection between engineering decisions, stakeholder engagement, and ethical responsibility. The Otterdale Road redesign shows how technical tools and design standards can be used to address real-world flooding challenges, while the Kinzua Dam case demonstrates the consequences of neglecting community input. Through these projects, I've come to recognize how difficult it can be to balance all priorities in complex infrastructure work. As the year progressed, my Capstone team had to narrow our scope due to time constraints, which limited how much we could explore additional improvements to the Otterdale Road area. This experience gave me a deeper understanding of how ethical failures—like those seen in the Kinzua Dam project—can occur even when engineers are well-intentioned. Budget limits, tight timelines, and limited experience can all restrict the effectiveness and thoughtfulness of a proposed solution. Despite these challenges, this year's work has been valuable in showing me how technical and ethical considerations are deeply intertwined, and it has emphasized the importance of staying attentive to both when designing infrastructure that serves the public.