Community Manure Treatment Facility Project Abstract

2024 NCEES Education Award Submittal: Energy and Sustainability Category

This project provides engineering design for the construction of a community manure treatment facility in the United States. The project aims to reduce watershed phosphorus levels by providing an alternative to spreading manure during frozen conditions.

A local non-profit organization dedicated to improving lakes, streams, and wetlands within the watershed served as the Client and provided a Request for Proposals (RFP) to students in a senior engineering design course. The RFP identified the following project components:

- Locate a potential site based on cow distribution in the watershed
- Design an effective and economical treatment process for manure from up to 40,000 cows
- Consider potential markets and potential revenue from digester byproducts
- Design for raw manure transportation from farms to the treatment facility
- Design for the transfer of byproducts to the location of demand for effective economic outcome

A team of five students responded with a formal engineering proposal and presentation. The students were mentored by two licensed engineers, while also consulting with a licensed engineer who has expertise in biogas utilization. The student team developed three design alternatives to meet the RFP objectives. All three designs include:

- General structures and facilities, such as roadways, truck weighing stations, loading/offloading terminals, a manure storage tank, solids storage building, liquid effluent storage tank, and pipe and pump networks.
- 16 stainless steel anaerobic digesters, each with a volume of 1.25 million gallons and heated to maintain optimal temperature for anaerobic digestion.
- Biogas upgrade system, which produces renewable natural gas from methane generated during anaerobic digestion.
- Centrifugal solids-liquids separator, providing mechanical separation of solids and liquids after digestion.

Alternative 1 focuses solely on renewable natural gas (RNG) as a byproduct. Alternative 2 includes RNG as well as reverse osmosis treatment of separated liquids to produce potable water and concentrated liquid fertilizer. Alternative 3 includes RNG and drying of separated solids.

The students presented a preliminary design report with the three alternatives to a panel of judges, mentors, the Client, instructors, and peers. The panel of judges included five licensed engineers, a university communications instructor, and an architectural historian.

The student team used an evaluation matrix to compare the merits of each alternative. Factors evaluated included environmental impact, capital and operating cost, byproduct revenue, community impact, and ease of system management. The team recommended Alternative 2, the facility focused on producing RNG and liquid byproducts, which ranked high in terms of positive environmental impact and ease of management.

With the Client's approval, the team proceeded with the final design. In addition to the proposal and preliminary engineering report, their work product includes a geotechnical report, technical calculations, construction drawings and specifications, monthly project management reports, community-based learning ethics reflections, and a final presentation. The drawings and specifications included bid forms, terms and conditions, and sections for key project elements. The final presentation included a construction schedule, opinion of probable cost, and details of the project design.