The future of our fragile, beautiful planet home is in our hands. As God’s family, we are stewards of God’s creation. We can be wantonly irresponsible, or we can be caring and compassionate. God says, “I have set before you life and death... Choose life.” (Deut. 30:19) -Desmond Tutu, Foreword, The Green Bible, 2008

Carving through Michigan’s Kent, Ionia, and Berry Counties, the Coldwater River is a major river system that is home to some of the largest trout populations in the state. Tyler Creek, tributary to the Coldwater River, has become polluted with E. coli bacteria and nutrients that likely came from agricultural waste and home septic systems. The contamination is harming aquatic life and human recreational activities. Tyler Creek Restoration has designed a waste management solution for the local farming community that will prevent further pollution of Tyler Creek. The solution consists of a short term plan, Don’t Runoff With It, and a long term plan, Dairy Digest.

**Short Term Design**

The short term solution makes use of agricultural best management practices (BMPs) to improve the hydrological elements of the Tyler Creek watershed. This includes restoring wetlands, installing a buffer/filter strip, and planting trees to slow or block the flow of contaminated runoff into Tyler Creek.

**Long Term Design**

The long term solution is designing a complete mix anaerobic digester system for a farm of 3000 head of cattle. An anaerobic digester uses bacteria to break down livestock waste, producing biogas and a solid-liquid effluent. Biogas is rich in methane and can be used to produce heat and electricity. Dried digested sludge can be used as bedding for the farm animals.

**Digester Prototype**

Team 10’s anaerobic digester prototype was designed and built to model the long term waste management design. The biogas produced has been analyzed for its methane content. At a methane content of 65%, the digester prototype is functioning properly.
The short term solution makes use of agricultural best management practices (BMPs) to improve the hydrological elements of the Tyler Creek watershed. This includes restoring wetlands, installing a buffer/filter strip, and planting trees to slow or block the flow of contaminated runoff into Tyler Creek. Two sites are chosen to design examples of BMPs appropriate to implement.

**Site 1: Filter/Buffer Strip**

The objective of implementing the filter/_buffer strip BMP is to decrease the amount of contaminants in storm water runoff through filtration. Currently, there is no existing buffer between the agricultural field edge and Tyler Creek, allowing contaminated runoff to easily be deposited in the river. A 100 foot filter/buffer strip on each side of Tyler Creek has been designed. The first 25 feet from the river contains trees and shrubs to ensure stream bank stability, and the next 75 feet is composed of native grasses.

**Site 2: Constructed Wetland**

Team 10 designed a wetland to greatly reduce the amount of pollutants and E. coli in Tyler Creek. While base flow continues along the existing creek, excess rain runoff will instead flow through the wetland. The soil excavated for the wetland will be used for a storm water storage levee surrounding the wetland.

The constructed wetland is designed for a detention time of 4 days to ensure that at least 80% of the E. coli is removed. The forebay is the primary settling pond for particles larger than 5-microns. After the plunge pool, the water is further filtered through biological remediation in the marsh areas.

GIS was the primary tool used to delineate the watershed. GIS was also utilized to make topographic, land use, and soil maps to help locate and designing the BMPs. HEC-HMS modeled the hydrologic characteristics of the Tyler Creek Watershed, including the amount of runoff that flows into the stream during storm events.
Team 10’s long term solution is designing a complete mix anaerobic digester system for a farm of 3000 head of cattle. An anaerobic digester uses bacteria to break down livestock waste, producing biogas and a solid-liquid effluent. Biogas is rich in methane and can be used to produce heat and electricity. Dried digested sludge can be used as bedding for the farm animals. The long term solution minimizes the volume of waste to be land applied and eliminates the E. coli levels.

The manure collection pit is a storage container for the agricultural waste that is directly removed from the farm facility. The manure pit is sized for one 24-hour period of waste collection. At 3000 head of cattle, the manure pit is sized for 40,000 gallons.

The water dilution tank adds water to reduce the solid content of the agricultural waste from 15% to 13% for optimal biogas production. The tank is positioned just after the manure pit and before the digester. A 6,000 gallon poly storage water tank.

The mechanical room combines the slurry that comes from the manure pit and the dilution water from the water tank before the slurry enters each digester. The room allows access to the check and gate valves and is used as an electrical or mechanical control room.

The long term design system includes three digesters, two digesters in operation, and the third for redundancy. The total volume of each digester is 536,000 gallons. The volume was calculated based on the total volume of slurry produced each day and a retention time of 18 days.

The heat supplied to the digester is used to raise the incoming manure slurry up to 95°F and to offset the heat losses through the walls, roof, and floor of the digester. Heat is supplied by burning a portion of the biogas produced by the digestion process and dissipating the heat to the slurry through heat exchangers.

The slurry agitation is the method of mixing within the anaerobic digestion tanks. The design of slurry agitation mixes the contents uniformly while conserving as much energy as possible.

The slurry agitation design is three submerged mechanical mixers: a scum buster, a blender, and a solids eliminator.

The pumps in the manure pit and slurry tank are hydraulic submersible pumps. A standard Centrifugal series pump will be used to pump water into the system.

A solids separation system will be located directly following the digester slurry outlet. Some of the water removed from the processed slurry will be used as dilution water for fresh manure input, and the remaining water will be stored in a nearby lagoon for land application, depending on the farm’s needs the solids removed during separation will be dried down and used for animal bedding.

The biogas collected from the digester system will burned in the boilers to heat the digester tanks and used elsewhere to power the digester system or the farm.