Background Information on Fats, Oils, and Grease (FOG) Management in Muskegon County

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Executive Summary

Muskegon is considering a number of alternatives with respect to its management of Fats, Oils, and Grease (FOG) it receives at its wastewater treatment plant. Managing FOG is a major issue facing wastewater treatment facilities (NEWEA). Unless separated, FOG will adversely impact the operation of a wastewater treatment plant. Staff at the Muskegon County Resource Recovery Center asked staff at the MSU Product Center to address the following questions.

1. Where can the FOG go? Who is handling the FOG?
2. What are the tipping fees for FOG?
3. How much can these facilities take? Currently the Muskegon County Resource Recovery Center handles 10.6 million gallons of FOG a year. Could other handlers of FOG be able to handle this amount of FOG?
4. What is the feasibility of operating an anaerobic digester to process the FOG?

It appears that fewer and fewer public entities are handling FOG. It appears that most commercial generators of FOG use a private firm to collect the FOG at their place of business. Local units of government are increasingly working on ways to reduce the amount of FOG entering their wastewater streams generated by households. Educational efforts and places for households to dispose their FOG appear to be the primary ways to reduce FOG entering wastewater streams from households.

As the private sector has become more involved in processing FOG, tipping fees have become less important as a revenue source. The value of the FOG is sufficient to keep tipping fees close to zero. Some restaurants receive payment from firms for their FOG.

While it may be difficult for a single firm to handle 10.6 million gallons of FOG, it may be possible for a combination of firms to process the FOG. The fact that this amount is at one central location would make it desirable source of FOG for some firms.

Much of the focus of this study is the potential feasibility of operating an Anaerobic Digester at its wastewater treatment plant. An anaerobic digester uses bacteria to convert organic wastes to gas and digestate. The gas can be used to generate heat and electricity, and the digestate can be used as a fertilizer or soil conditioner (Ohio State). Staff at the Michigan State University Product Center Food-Ag-Bio conducted a brief feasibility assessment to determine the likelihood of success of this venture. Topics covered are based on the instructions provided by USDA Rural Development and could conceivably be used to apply for grants and loans as well as assisting decision makers to decide whether or not to move forward with a digester.

The feasibility assessment is based on the following attributes: economic feasibility, technical feasibility, financial feasibility, marketing feasibility and management feasibility. The format is outlined in by the U.S. Department of Agriculture to analyze Value Added Producer Grants.

Economic feasibility deals with the resources available to a project. In this case it focuses on the amount of FOG handled and its potential to produce energy. Labor requirements are also considered as well as existing infrastructure at the wastewater treatment plant.

Technical feasibility deals with the equipment needed as well as the other operational aspects of the day to day operations of the digester. Regulatory issues will also be assessed; meeting regulatory issues is a key component to the success of this venture.

Market feasibility is not a major consideration. The energy could be used at the facility, sold to a utility or some combination of the two. The energy could be used to generate electricity and to heat the facility. Financial feasibility deals with the costs and revenues associated with the project. A prospective income statement is generated. The income statement needs to be considered a very rough estimate. It does provide a general idea of the costs and revenues generated.

Management feasibility focuses on three areas. The first is the ownership structure of the firm. The second factor is the organizational structure of the digester. The third factor is the experience necessary to operate the digester.

The project is technically and economically feasible. The technology used build and maintain an anaerobic digester is well understood. The primary technical concern is possible regulatory issues that may need to be addressed depending on the Department of the Environment Great Lakes and Energy (EGLE). A permit to operate the digester will be required and another permit may be required to land apply the digestate.

The biggest issue appears to be financial feasibility. It does not appear that the digester would be profitable, and the digester would be dependent on selling carbon credits. It could still be financially feasible if the current cost of managing the FOG is greater than the cost of operating the digester. While this is a preliminary finding, selling the FOG or giving it away appears to be a better option.

Introduction

This analysis attempts to answer several questions brought forth by the Muskegon Resource Recovery Center (MCRRC). The questions are as follows:

1. Where can the FOG go? Who is handling the FOG?
2. What are the tipping fees for FOG?
3. How much can these facilities take? Currently the Muskegon County Resource Recovery Center handles 10.6 million gallons of FOG a year. Could other handlers of FOG be able to handle this amount of FOG?
4. What is the feasibility of operating an anaerobic digester to process the FOG? This will be the focus of most of this publication.

Local units of government are increasingly leaving the FOG management sector. For the most part, large scale generators of FOG use private sector firms. There are several firms that collect and process FOG. Local governments are reaching to households to reduce the amount of FOG that enter wastewater treatment facilities through households' pipes.

Over time as the value of FOG has increased tipping fees have declined. Some restaurants get paid for their FOG. While it may be difficult to find a single firm to handle the FOG a combination of firms might be interested. The Muskegon Resource Recovery Center may need to construct a holding tank for the FOG, but this would ensure that the FOG would not adversely impact the operation of the wastewater treatment facility. Selling the FOG to a handler may be the most profitable outlet for the wastewater treatment facility.

This feasibility assessment analyzes the potential likelihood of success of a potential anaerobic digester at the Muskegon wastewater treatment facility. An anaerobic digester converts organic wastes to gas and digestate. In this case the feedstock is the FOG. The gas can be used to generate heat and electricity, and the digestate can be used as a fertilizer or soil conditioner (Ohio State). Digestion also has the benefit of reducing odors (Ohio State). In Michigan, most anaerobic digesters are located on dairy farms, but the potential for energy production is greater with FOG compared to manure. This is because FOG has a higher energy content than manure. The assessment is based on the following attributes: economic feasibility, technical feasibility, financial feasibility, marketing feasibility and management feasibility. The format is outlined in by the U.S. Department of Agriculture to analyze Value Added Producer Grants. This feasibility analysis could be used to apply for grants and loans as well as informing the decision whether or not to move forward with an anaerobic digester.

The project is technically feasible. The technology used to build and maintain an anaerobic digester is well understood. Permitting from EGLE may be the biggest technical barrier. Also, the feedstocks needed to operate an anaerobic digester are readily available. The project is economically feasible. This biggest issue is financial feasibility. While generating an accurate estimate is extremely difficult, the costs of operating a digester is slightly higher than the revenues generated. However, operating a digester may potentially reduce the cost of handling the FOG.

Where Else Can the FOG Go, and What are the Tipping Fees?

There are several private sector firms that handle FOG. Table 1 shows a fairly complete list. FOG appears to be increasingly valuable, especially as the demand for biodiesel has increased. Yellow grease is much more valuable than brown grease.

Table 1: Firms in Michigan that Receive FOG

Firm	**Location**
Allen Environmental, Inc.	Canton
Biologix	Farmington Hills
Crystal Clean	Wyoming, Jackson, Saginaw, Detroit
Darling	Melvindale
Detroit Grease	Detroit
Evergreen Grease Service	Ann Arbor, Detroit, Grand Rapids, Sag
Grand Natural	Orange, CA
Greasezilla	Lansing, WV
Mahoney Enviromental	Joliet, IL
Power Vac	Novi, Grand Rapids, Traverse City
Thumb Bioenergy	Sandusky

Of the firms listed Crystal Clean, Darling (doing business as DarPro), Evergreen Grease Service, Grand Natural, Greasezilla, Mahoney Environmental, and Thumb Bioenergy, operate in the Muskegon area. Detroit Grease operates in Southeast Michigan. Most of these firms drive to the restaurant or food manufacturer and pick up the grease. Power Vac appears to be primarily a grease trap cleaning service although it also recycles the grease it collects from the trap. To obtain a quote or negotiate an agreement Muskegon County will need to contact the handler.

Obtaining good information about tipping fees is difficult. Some firms, like Evergreen Grease Service, pick up the grease for free, others like Thumb Bioenergy pay for the grease. As FOG has increased in value, collection fees have declined. Greasezilla provides a processing system at the wastewater treatment plant that recycles most of the grease. Tipping fees appear to be a declining source of revenue as restaurants and food processors increasingly use private sector firms to handle their grease.

Some local units of governments do accept grease from households. Emmet County, Ann Arbor and Delhi Township in Ingham County are three local units of government that accept household grease. The households bring the grease to a central collection point These programs are designed to limit the amount of grease entering the wastewater treatment system and clogging pipes.

How Much can FOG Handlers Take?

The Muskegon County Resource Recovery Center handles 10.6 million gallons of FOG a year. This translates to approximately 78.44 million pounds a year or 39,220 tons. It may be difficult for a single firm to handle all of this additional FOG in their supply chain, but a combination of the firms likely would be able to handle this additional FOG.

The price of yellow grease varies from about 18 cents a pound to about 50 cents depending on the quality of the material, and the supply and demand for the products made from the FOG. The price of yellow grease sells for much more than brown grease. Brown grease tends to be dirtier and may need to be strained before it can be used. Products produced from FOG are generally feed additives and are a feedstock for biodiesel. FOG can also be used for lubricants and cleaners. For the Muskegon facility the value of the FOG handled could be in the range of $5 million to $15 million. This may be the highest and best use for the FOG.

There are a number of alternatives that the Muskegon County Resource Recovery Center can consider. It can work with current customers that currently use the facility to find an alternative outlet for the FOG. It could also continue to collect the FOG and then sell it to a third party. This will require a separate collection point and storage. Nonetheless, it could be the most profitable way to handle the FOG. It would keep the FOG from entering the wastewater stream. A third option is for the Muskegon County Resource Recovery Center to operate an anaerobic digester.

Feasibility Study of an Anaerobic Digester

Resource Feasibility

The Muskegon County Resource Recovery Center handles 10.6 million gallons of FOG a year. This translates to approximately 78.44 million pounds a year or 39,220 tons. If the facility is open 250 days a year, that translates to approximately 157 tons a day. If the facility wants to generate its own electricity it will have to install a broiler or turbine to generate heat or electricity.

There are a number of other potential feedstocks that could be used to generate gas from a digester. These are shown in Table 2. Some sources have been aggregated to protect the names of individual firms.

Table 2: Potential Feedstocks for an Anaerobic Digester

Feedstock	Total Loading 2024 (lbs.)
Septic Haulers	1,012,855
Fat Oils Grease	8,010,803
Dairy	4,699,967
Eggs and Egg Processing	1,081,461
Restaurant Chain	1,128,402
Fruit and Vegetable Process	2,040,946
Meat Processing	669,057
Total	**18,643,491**

Source: Muskegon County

It should be noted that these feedstocks have different BTU levels which makes estimating the amount of energy produced difficult. However, the more diverse types of feedstocks the better a digester operates, and the more energy is produced.

The Muskegon County facility has several advantages. The feedstocks are already at the facility and is not located in a heavily populated area. Storage of the wastewater is also at the site. If the facility wants to generate its own electricity it will have to install a broiler or turbine to generate heat or electricity.

FOG has the potential to increase the efficiency of an anaerobic digester. However, these feedstocks may need to be grinded or shredded into smaller pieces in order to take full advantage of the digester. Food waste generates 210 cubic meters of methane per ton of food waste, and food grease generates between 250 and 340 cubic meters of methane per ton of grease (AgSTAR).

The digester will need a permit from the Michigan Department of Environment, Great Lakes, and Energy (EGLE). The fee is $1,000 and the permit lasts 5 years. Also, if additional chemicals are used in the digester, they need to be reported to EGLE. Even though the feedstocks are organic, additional regulation may be required for the land application of the digestate. Obtaining a permit may be more difficult if multiple feedstocks are used.

An air permit may be required if the gas is flared or used in a broiler. It depends on the sulfur dioxide content of the gas. If the gas exceeds more than 1.24 pound of sulfur dioxide per hour an air permit will be needed. It may be easier to sell the gas to a utility than work through the regulatory requirements.

If the Muskegon County wastewater treatment facility has a Comprehensive Nutrient Management Plan for the application of the digestate it will have to be updated. An operation and maintenance for the plan for the digester may also be required (EGLE).

Marketing Feasibility

Marketing feasibility is dependent on outlets for the gas. It is anticipated that the digestate will be applied to the farmland surrounding the facility. The gas could be used for heat and electricity at the wastewater facility, or it could be sold to the grid. Staff at the Wastewater treatment plant prefer using the gas to generate electricity and heat at the wastewater treatment plant. The potential cost saving could be greater if the facility used the gas itself, but regulatory requirements and the higher cost of maintaining a boiler or turbine may make it easier to sell the gas to the local utility.

A utility is likely to be interested in the gas if it can be obtained at the wholesale price. There is a great deal of variation in the price of natural gas during a given year. Prices are highest in the winter, when heating demand is the highest and lowest in the summer when the demand for heating is at a minimum. According to the Energy Information Administration, in 2024, the price of natural gas in Michigan varied from $4.14 per 1,000 cubic feet in February to $2.39 per 1,000 cubic feet in August. Natural gas prices in 2025 appear to be trending higher. In 2024, the industrial price of natural gas was $7.57 per 1,000 cubic feet. Another source of revenue for the gas is carbon credits. Muskegon County could sell carbon credits from the gas generated because the gas generated from FOG is a renewable resource, that reduces the need for natural gas from non-renewable sources.

The venture is feasible from a marketing perspective. The county could sell the gas to a utility if the gas is pure enough. It could also use the gas itself to generate heat and electricity. While it would be easier to sell the gas to a utility, the cost savings could be greater if the energy generated was used by the facility. However, selling the FOG to a handler may be the option with the greatest potential.

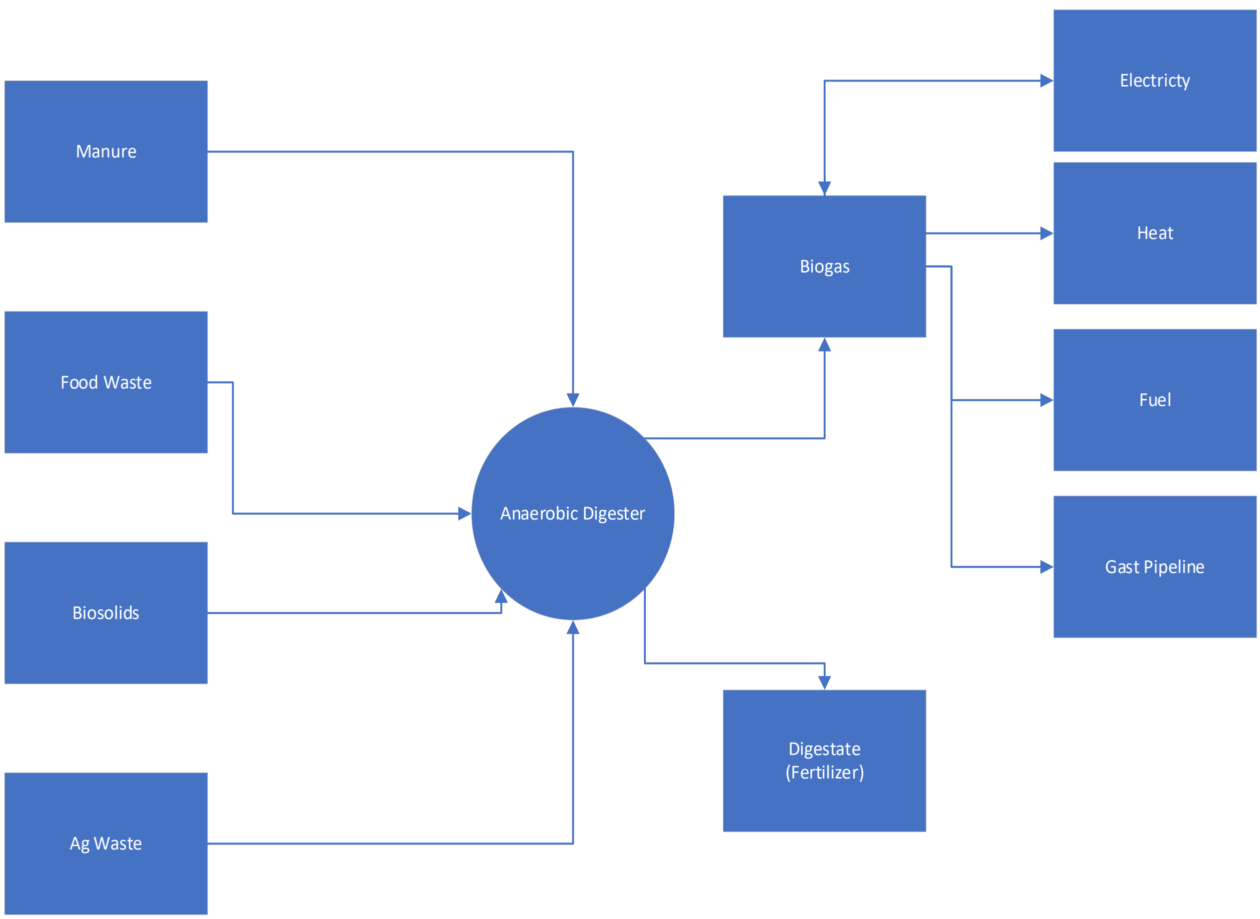
It may be the case the that the highest and best use for FOG collected by the Muskegon facility could be for agricultural and industrial uses. Greases can be used for feed additives, surfactants, plastics, resins, textiles, cosmetics, soaps, lubricants, and biodiesel. Collecting the FOG and selling it to a third party may be both more profitable and less costly than operating a digester.

Technical Feasibility

The anaerobic digestion process is shown in figure 1. In this case FOG is fed into the digester, the digester in turn converts the feedstocks into biogas and digestate. The digester liquefies the feedstock by bacteria. Additional bacteria further break downs the feedstock into gas and digestate (Ileleji, Martin, and Jones). Methane forming bacteria are very sensitive to the conditions in the digester. Managing the balance in the digester is important to keep the digester operating efficiently.

The biogas can be used directly in a gas-fired combustion engine to generate heat or electricity or a microturbine to generate electricity (Ileleji, Martin, and Jones). As noted in the market feasibility section of the report, the biogas can either be used by the wastewater treatment plant or it could be sold to a utility. The digestate can then be applied to land as a fertilizer or a soil conditioner.

Figure 1: The Anaerobic Digester Process



Source: Ohio State University

The other output of the digester is biogas, in the form of methane and carbon dioxide. This can then be burned to generate electricity, and heat onsite, compressed to be used as vehicle fuel or finally it can be injected into the existing gas grid. Biogas can maximize its efficiency by separating the methane from the carbon dioxide and burning only the methane (Ohio State). If Muskegon County decides to use the energy onsite it will need to build its own turbine or boiler. This would increase the capital costs of the project but reduce the utility costs for the facility.

It should be noted that some pretreatment of the feedstocks will be necessary, as a wide range of items find their way into a wastewater treatment plant. The FOG will need to be screened to eliminate items that are not the feedstocks listed in figure 1. The FOG will most efficiently be utilized if they are consistently blended before it enters the digester.

There are two types of ways of managing the facility: operating a batch system or using a continuous system. The advantage of a continuous system is that it would more closely match the flow of FOG at the Muskegon facility, it also avoids the need to empty the digesters. The primary drawback is that it is somewhat more difficult to manage. Biogas output may be lower (Global Methane Initiative), and capital costs are likely to be higher. A batch system has the advantage of starting and ending in a single vessel.

Most digesters operate in the rage of 86 to 104 degrees (30 to 40 degrees Celsius). This minimizes the cost of heating the system while making sure the digestion is complete. Monitoring the process is very important; a digester is similar to a human digestive system in that it can easily be upset. Items that need to be monitored are pH, carbon, methane, volatile fatty acids, alkalinity, ammonia concentration, trace elements, and retention time (Global Methane Initiative). Some of the maintenance requirements are engine maintenance, removal of impurities, electrical, fuel and air system inspection, inlet and outlet pump cleaning, value, and pipe leakage checks, and mixing equipment servicing (Global Methane Initiative).

The pH for a digester should be in the range of 6.5 to 8.5. Lower pH levels tend to kill the bacteria needed to produce methane. This can be an issue if food wastes are used as a feedstock because they break down faster than manure. Other sources believe the optimal pH should be 6.8 to 7.2 (DEQ). Sodium bicarbonate can be used to balance the pH (AgSTAR).

Designing the facility takes about three months, planning and permitting takes about three to six months, construction takes about 12 months and commissioning will take about four months. It should take about 18 months to two years from when a decision is made until the digester begins operations. It may take longer given if there is a shortage of skilled workers needed to build a digester.

If Muskegon handles 10.6 million gallons of waste a year or 42,400 gallons a day (assuming the facility is open 250 days a year), and the size of the digester was 500,000 gallons, the detention time of the waste is approximately 12 days. Detention time is the size of the digester divided by the amount of feedstock pumped into the digester per day (DEQ).

Roughly speaking, a digester produces about one cubit foot of gas per gallon. Given the high quality of the feed stock used in Muskegon, the figures could be somewhat higher. If 10.6 million gallons of feedstock is fed through a digester, about 10.6 million cubic feet of natural gas could be produced.

Financial Feasibility

The costs incurred with operating an anaerobic digester are primarily labor, depreciation, interest paid and other capital costs. Capital costs are the biggest cost of anaerobic digesters (Ohio State). In the case of the Muskegon County facility, the benefits are either revenues from selling the gas back into the grid, or offsetting electricity and heating costs currently incurred by the facility. Up front capital costs are the major cost contributor of anaerobic digesters (Ohio State). Additional equipment may be needed to collect, separate, and pretreat the feedstock (SKS). Gas conditioning and upgrading equipment may be necessary if Muskegon County decides to sell the gas to a utility. This would include filtration systems, gas compressors, storage tanks, and pipelines (SKS). The Muskegon wastewater facility has the advantage of having a free source of feedstocks. Carbon credits are another source of revenue that could enhance the profitability of a digester

Costs can be divided into three stages:

- Predevelopment: siting, permitting, planning and design
- Construction: infrastructure, building the facility, installing the equipment
- Operations: manager, staff, materials, service providers, depreciation, interest expense, insurance, additional permits (Global Methane Initiative)

Predevelopment and construction expenses are one-time costs. Once the digester is constructed most of these costs will no longer be incurred. Operation expenses are ongoing and will primarily be comprised of electricity and acid expenses. If Muskegon County decides to sell the gas to the grid, utility costs will rise because the digester will need electricity to operate. Conversely, revenues from selling to the grid would be higher.

There are two sources of revenue, the first is carbon offsets, revenues from selling credits for reducing greenhouse gas emissions. The second is either reduced costs from using heat and/or electricity generated by the digester. An alternative that has the same impact is to sell the gas to a utility. A utility may be interested in buying the gas at the wholesale price. It will not pay the retail price for the gas. Selling may be the best option because electricity and heat would be available if there was a problem with the digester, and the digester was offline (Keske).

Another alternative is to operate a boiler to generate heat and/or electricity on site. The city of Appleton Wisconsin has installed a boiler that saves $100,000 a year in heating costs. The cost of the boiler was $790,000 and received a $167,000 grant to offset some of the cost. The expected payback was six years (Behnke).

A *very rough* estimate of an income statement is shown in table 1. The income statement is based on an enterprise budget developed by the USDA and Washington State University. It can be found here: https://csanr.wsu.edu/enterprise-budget-calculator/. The Producer Price Index was used to update the figures to adjust for inflation since 2018. The following are assumptions of the analysis:

- Lifespan of the digester is 20 years with 0 salvage value.
- Costs are assumed to rise three percent a year.
- Labor is handled by existing employees.
- Price of natural gas is an of about $3 per 1,000 cubic feet.
- Price of credits is about 3.6 cents per gallon
- The gas is sold to a utility.
- Additional revenue is generated by selling carbon credits.
- The cost of the digester and the natural gas hookup is estimated to be $5.63 million. Downpayment is 50 percent and 50 percent is borrowed for 20 years at an interest rate of 4.5 percent. This might overestimate the cost if there is a natural gas line close to the wastewater treatment plant.

Table 3: Rough Estimate of an Anaerobic Digester Five Year Income Statement

	Year 1	Year 2	Year 3	Year 4	Year 5
Revenue					
Credits	$383,182	383,182	383,182	383,182	383,182
Natural Gas	31,800	31,800	31,800	31,800	31,800
Total Revenue	**$414,982**	**414,982**	**414,982**	**414,982**	**414,982**
Costs					
Depreciation	$281,500	281,500	281,500	281,500	281,500
Labor	11,664	12,014	12,374	12,746	13,128
Electricity	54,741	56,383	58,075	59,817	61,611
Insurance	400	412	424	437	450
Permit	1,000	-	-	-	-
Interest	124,857	120,775	116,506	112,040	107,370
Maintenance	6,877	7,083	7,296	7,515	7,740
Acid	60,656	62,476	64,350	66,280	68,269
Total	**$541,695**	**540,643**	**540,525**	**540,335**	**540,069**
Net Profit	**$ (126,713)**	**$ (125,661)**	**$ (125,543)**	**$ (125,353)**	**$ (125,087)**

As noted this income statement should be considered a very rough estimate and is based on an anaerobic digester at a dairy farm. It may be the case that the actual acid cost may be lower, and the amount of gas produced may be greater. However, labor costs may be understated. Also, if grants and other sources of financing are used, interest costs could be reduced. What these numbers indicate is that the amount borrowed makes a major difference in the potential profitability of the venture. For example, if no funds are borrowed the digester almost breaks even. Also, the venture is very dependent on carbon credits; without this source of revenue a digester is not feasible.

Another major point is that revenues are going to vary depending on the price of natural gas and the price of carbon credits. If the value of carbon credits or natural gas increases over time the digester become more economically feasible.

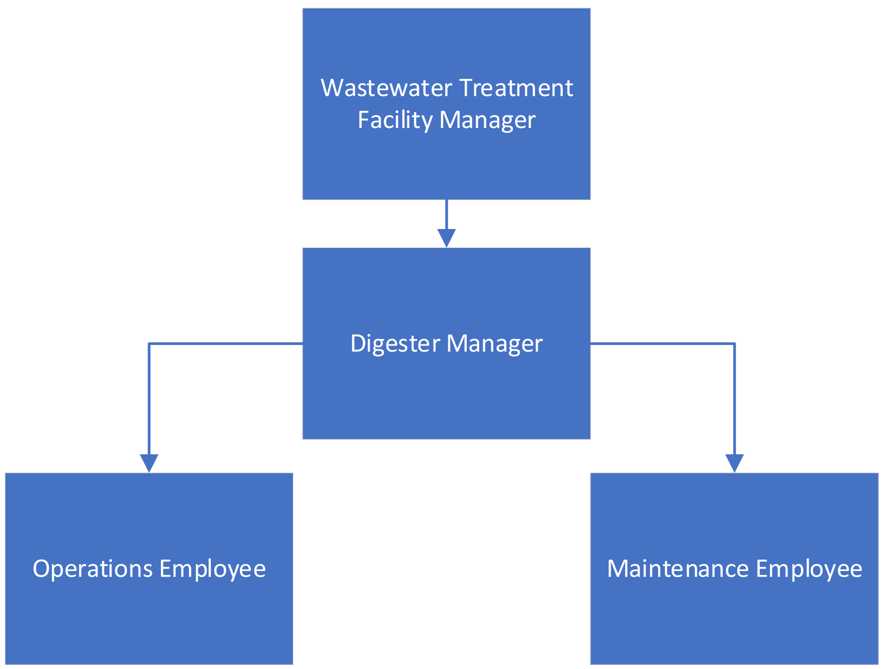
Another fundamentally important question is what is the current cost of managing the FOG. Using the rough estimate outlined in Table 3, if the current costs of managing the FOG is greater than about $120,000 a year, the anaerobic digester is financially feasible.

Management Feasibility

Large scale facilities usually have a site manager, maintenance staff and operators to load the waste (Global Methane Initiative). At least one employee needs to be at the site while the digester is operating. Administrative staffing needs could be met with existing staff at the facility. If properly trained, the maintenance staff could also oversee the operation of the boiler. The financial section of the feasibility study assumes additional part-time work from existing employees. If full-time digester employees are needed the operating costs rise fairly dramatically. This would reduce the financial feasibility of the digester.

The organization chart of the digester is shown in Figure 2.

Figure 2: Organization Chart of the Muskegon County Wastewater Treatment Digester



The digestate will be handled by the existing farm staff. This allows the digester to be managed in a cost effective manner.

The project is feasible from a management perspective. Anaerobic digestion is not a labor intensive activity, nor is operating a boiler. Training existing staff the manage the digester may be difficult, however the firm building the digester may have suggestions or supply support.

Summary and Conclusions

Muskegon County has several options with regard to how it handles FOG. Perhaps the best option is to sell it to firms that handle FOG. Over time the value of FOG has been increasing creating opportunities to sell the FOG or at least be able to dispose of it at zero or low cost. The products produced from FOG have a higher value than energy. Tipping fees are becoming less common as a source of revenue. There are several firms in the area that handle FOG. Muskegon County could negotiate an agreement with one or more firms.

Finding a single firm to handle all the FOG currently handed by Muskegon County may be difficult but two or more firms may be interested. Having a single location that has that much FOG could reduce transportation costs for a firm that handles FOG.

In most respects an anaerobic digester is feasible. There is sufficient FOG processed to support a relatively large digester. The technology used to operate a digester is well understood and there are several firms that build digesters. Labor costs could be minimized if existing staff could manage and operate the digester. If additional staff need to be hired, the cost of operating a digester would rise fairly dramatically.

While the estimates are very rough it appears that operating a digester is not financially feasible, unless the cost of managing the FOG is greater than the loss of operating the digester. The costs exceed the revenues even including the sales of carbon credits. As a result, it may be more advantageous to try to sell the FOG.

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