Living Green and Saving Green: An Economic Assessment of Purdue's Food Waste Handling System

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In 2010 the American population generated more than 34 million tons of food waste, which is more than any other category of waste at 14% except for paper. Only 3% of food waste was recycled. That means that 33 million tons of food waste was thrown away, which was the largest component of Municipal Solid Waste that was put into landfills ("United States Environmental Protection Agency"). Yet, consumers seldom think of food waste when disposing of their trash. While food waste is not the dominant type of trash that is most commonly thought of when people think of waste, it is an essential type of waste generated by university dining centers. The Purdue University Dining Services serve approximately 3.5 million meals per year. (“Fun Facts.”) In order to support that many diners in a cafeteria style setting much food must be produced and some food is inevitably wasted. In a world where going “green” is a popular idea and groups pushing for sustainability, many are reconsidering how they dispose of their food waste at Purdue. There are different groups on the Purdue University campus that are interested in reducing the amount of food waste by supporting different initiatives. One initiative was a trial experience with Trayless Dining. Trayless dining reduced food waste within the Purdue University Dining Services by eighteen percent, but some students were against the change. (Purdue Sustainability Strategic Plan Report) Because trayless dining has not been continued, food waste still exists and the University will still have food waste to dispose of. The purpose of this research is to determine the most cost effective way of food waste disposal for University Residences Dining Services at Purdue University. The results of this research can be used by university administrators to monitor food waste recycling economics and by external environmental groups to assess Purdue University’s food recycling commitment.

Literature Review:

Previous research that has been conducted on food waste disposal options has compared and contrasted food centers of varying size and needs. Four different food service centers were considered in this review, a central food processing Center in a school district, a continuing care retirement center, an university dining center, and a commercial chain restaurant. The university dining center, which is left unnamed, was considered in this study and it was determined that strategy one out of four strategies was the most cost effective way for that particular dining center to dispose of food waste. At the time of the study the dining center had been using a combination of animal feeding, garbage disposal for food waste and the combination of landfill and recycling for packaging waste. The annual cost was calculated at $32,210 and the Net Present Worth (NPW) was $303,347. Instead, strategy one uses animal feeding for food waste and a combination of landfill and recycling for packaging waste. The annual cost was calculated to be $16,411 and the NPW was calculated to be $ 171,472. All of the strategies consisted of a combination of options and all of the packaging options included landfill and recycling. This means that the variances in the difference were in the food waste disposal options. Annual cost was determined by setting the initial study year to zero and then determine the cost of each strategy over ten years, to ensure that the most cost-effective strategy was selected. Using this method it was determined that options two and three would be the more costly. Both of these strategies relied heavily on the garbage disposal, which is high on cost due to electricity rates and labor. Because the University was currently using garbage disposal and animal feeding to dispose of food waste the University could save around $150,000 if they switched to animal feeding and off-site composting only. The issue with these methods is that the University would have to spend money to train the employees on the new system, more trash

containers, and more space to store the food waste. These costs were not calculated in the study so it is not known how much all of the changes would affect the cost effectiveness of strategy one. Within this study labor, electricity, and transportation fees were calculated. To determine the change in rate for electric, water, and sewer the Customer Price Index was used for the ten years prior to the study. Projected annual rates were used to determine hourly wages and waste-hauling fees. (Wie, Shanklin, & Lee, 2003)

This study also developed a decision tree that shows options that foodservice operations have for analyzing food waste decisions. The decision tree that was included has three different strategies to choose from. The foodservice operation can choose from the strategies which include the most cost effective strategy, the most environmentally friendly strategy, and a combination of the two. The tree focused on the economic parts of the decision making process. There are five stages to the decision making process. In the first stage, recognizing the new environment, this determines if the increase in cost under the current disposal plan are too much and if something should be done about it. If the food service director is concerned by this problem then it is time to move to phase two. Phase two is developing alternatives. This step allows for the food service director to explore the available alternatives to the current options of disposal and to also determine if they need to evaluate the food disposal methods, the packaging disposal methods or both. Phase three is establishing criteria, or extrinsic versus intrinsic characteristics. Extrinsic motivations are the outside forces that affect how the food service operation works, like money and position in the community. Intrinsic motivations are morals or other internal forces. The intrinsic values involve being environmentally conscious and position in the community. Phase four works with evaluating the alternatives. This is where the three different strategies mentioned above become the focus. The food service director has to choose

the best strategy for his or her food service operation. The fifth phase is to implement the decision. This is when the food service director decides to put the plan into action or continue with the present waste system. (Wie, Shanklin, & Lee, 2003)

In the study "Cost of Alternative Methods of Disposal of Food Waste in a University Food Service Operation" by Wie and Shanklin a University Dining Court was studied to determine the costs of various disposal methods. This dining center served approximately 3,200 meals a day and has the solid waste separated into groups and post-consumer food waste was one of the groups. For food waste, the center used a garbage disposal to grind it up. At this time the cost to run the garbage disposal was $3,582.00 per year. Options that were available were animal feeding, hauling to landfills, garbage disposals to the sewers, bio converting waste into energy, incinerating and composting. (51). During the 14 days that the facility was monitored, 24,799.3 pounds of waste was collected of which 37.7% of that waste was food waste. A focus of this article was to show the importance of collapsing cardboard, paperboard, plastic containers, wooden containers and metal cans before disposal. Collapsing these containers lowered the volume by 49.1%. This study provided several formulas that are very useful for determining the cost of electric, cost of hauling waste, animal feeding revenue, and savings from hauling to the landfill instead of using garbage disposal. The formulas showed that if the dining center would be able to find an interested swine farmer to take the food waste for $2.00 a ton then the dining center would make $240.51 per year and would save a total of $3,582.00 a year since garbage disposal would not be used. The total savings would be $3,833.51 if animal feeding was used. Using a landfill was also an option that was considered in this study. Hauling costs were $15.00 per ton of waste, so the cost would be $1,803.90 per year. If the landfill was used the saving would amount to $1,778.10. For the solid waste that the dining center creates it

was recommended that the facility check into a recycling program which could potentially save the facility $1,361.59 a year. Fluctuation in consumption is not considered with this model. This article recommends that every food service facility should review their current waste disposal plan and revise the plan if practical and more beneficial options are available. (1993)

The study "Cost Effective Disposal Methods and Assessment of Waste Generated in Foodservice Operations" followed a similar format to the first study discussed. Wie and Shanklin looked at four different food service operations and one of those food service operations was a University Dining Center. The difference is that this study only worked with the cost of waste disposal after the food and packaging was removed from service and production areas. This means that the figures that were determined do not include extra materials like trash can liners and labor required activities like emptying trash cans. Administration costs were also not considered. The researchers observed the University Dining Center over a seven day period to determine the daily average weight and volume of food waste. The average weight and volume was multiplied by per day means to determine the amount of weight and volume of waste per day. The alternatives in this study are animal feeding, composting (off site), composting (on site), garbage disposal, incineration, landfill, pulper, food recovery, and recycling. To determine the best overall strategy the study predicted the cost of each strategy for the next ten years. The study also provided a step by step guide to performing a cost analysis.

"The six steps to performing a cost analysis are:

1) Conduct a waste stream analysis

2) Select alternative disposal methods

3) Determine costs for each disposal method for the year in which the study is conducted

4) Calculate cost increase for the next 10 years

5) Determine depreciation cost for initial items purchased and income tax and calculate the after-tax cash flow. (optional for tax paying facility)

6) Determine the most cost-effective disposal alternative." (Wie, & Shanklin, 2001)

These steps allow one to complete an effective cost analysis.

One of the methods that Purdue University is currently using for food waste disposal is an anaerobic digester. An anaerobic digester is a machine that takes ground up organic material and is able to turn that organic material into methane gas. The methane gas can then be turned into electricity. While most organic material can be used a study conducted by Zhang, El-Mashad, Hartman, Wang, Liu, Choate, and Gamble showed that food waste is a great material for an anaerobic digester. After twenty-eight days of digestion the anaerobic digester produced an average of 435 mL/gVS (volatile solids) of methane gas (2006). The study also leads to the point that the higher the ration of volatile solids to total solids, the higher amount of methane produced. Since the anaerobic digester is so successful when working with food waste Purdue University is able to have their food waste digested. The post consumer food waste is pulped at each of the dining courts into a material called yack, and is then transported to the West Lafayette Waste Water Treatment Plant. Purdue estimates that using the anaerobic digester saves ten thousand dollars a year. It is estimated that twenty tons of yack is sent to the anaerobic digester a month. (Purdue University)

Not only does Purdue University Dining Services have to worry about cost, they also have to keep safety in mind. Some outbreak in animal disease can be linked to animal feeding of food waste. For example, a 1999 in Belgium an outbreak of polychlorinated biphenyls and dioxins were released into animal feed lots by oil at a recycling facility. These chemicals have been linked to cancer, liver damage, reproduction issues, immune suppression and other diseases. Five hundred tons of contaminated feed was delivered to farms. Once the incident broke the government had to issue tests of over twenty thousand processed foods on grocery store shelves. This incident could have lead to the increase of cancer deaths. (Taylor, 2001) The disease that is most commonly thought of that is related to food waste disposal is Bovine spongiform encephalopathy, otherwise known as Mad Cow Disease. Mad Cow Disease when contracted by humans is known as Creutzfeldt-Jakob disease. Mad Cow is a prion disease that is not only deliberating but also fatal. The central nervous system has prions which are damaged and turn the brain into a sponge like tissue that leads to memory loss, imbalance, and dementia. Creutzfeldt-Jakob can be passed to humans by blood transfusion, by direct contact of infected tissues, or the ingestion of infected materials like food. (Priola) Food is the most common way that Mad Cow is transferred to humans which can be devastating for not only the individual, but the economy of a particular region or country. Losses in the United Kingdom have been estimated above 5.5 billion dollars. Seventy people had died by 2001 from Creutzfeldt-Jakob disease and a total of 500 thousand could die within the next thirty years. BSE created a catastrophe for the United Kingdom and “a crisis of confidence” with science and government was founded (Moore). Purdue University must keep events like this in mind. Food safety is a must and if a large outbreak of contaminated food was linked back to Purdue University they

would be facing not only liability issues but they would have to deal with the adverse impact on its reputation.

Previous studies have covered a great deal about the cost-effectiveness of food waste disposal options. Sustainability is a focus that is becoming important and different institutions are becoming more environmentally conscious while trying to stay under budget. The studies that were discussed above focused more on which option is the most cost-effective. This study will be different because Purdue University Dining Courts represents a large institution that serves more meals than the dining centers in the past studies. The data for this study will be from the five dining courts on campus, Earhart, Ford, Hillenbrand, Wiley and Windsor instead of just one dining court. One of the goals for this study is to determine if the flow of food waste differs from month to month, during the semester, and the semesters versus the summer and how dramatic the change is. If there is quite a large difference in the amount of food waste per time period it will be determined if this affects which option is the most sustainable.

For this case study the data was collected through interviews with the Director of the West Lafayette Waste Water Treatment Plant, David Henderson, the Director of Dining Services at Purdue University, Jill Irvin and Gary Evans, Director of Grounds at Purdue University. West Lafayette Waste Water Treatment Plant is the current acceptor of the yack. The partnership between Purdue University Dinging Services and West Lafayette Waste Water Treatment Plant was born when David Henderson read an article in *The Exponent* and contacted Purdue University. The pilot trial began back in May 2009 for two weeks and then the project was continued. At this point in time neither Purdue University nor the Waste Water Treatment Plant is paid for the trade of food waste. Both groups receive benefits from this partnership. Purdue is

able to save money on tipping fees and dispose of their food waste in a way that is believed to be better for the environment, whereas the West Lafayette Waste Water Treatment Plant is able to take the yack from the dining courts and use it to feed their anaerobic digester. Currently the digester is able to produce eighteen percent of the energy needed by the treatment plant with the yack and other inputs from the community.

A major component of the two organizations joining together was equipment. The treatment plant has owned the anaerobic digester since the 1950s and pulpers, like the WastePro 1200 made by Hobart Corporation, which create yack, have been used at Purdue University for the past fifty to seventy-five years. Most food waste can be turned into yack except for celery, pineapple, bones and food with similar textures (Irvin). The last upgrade to the digester made the digester able to accept yack. The anaerobic digesters are required to use ninety percent organic material which the dining court is able to provide. Most of the waste from the dining court is food waste, with a small amount of packaging and napkins. The pulpers were originally used to create yack because yack has a smaller volume of the food waste since the water is drained out. Yack is required for the use of the anaerobic digester (Henderson). Without the pulpers already in place the project would have been stopped because the cost for a new pulper is approximately $100,000. The anaerobic digester is able to save Purdue University ten thousand dollars per year. Purdue is able to give about twenty to twenty-five tons a month to the treatment plant (Irvin).

There are some factors that could affect the current partnership between the University and the Waste Water Treatment Plant. Trayless dining is one of the factors. The dining courts at Purdue University currently use trays that allow people to carry several dishes at a time. The

idea of trayless only works in “all-you-can-eat” dining facilities because patrons are not paying any more for the food they take, so they are less motivated to completely think out their choices or consider the option of going back to get more food later if still hungry. Studies have been conducted at Universities that went trayless and reported savings in food waste has varied from five percent to thirty percent. If Purdue decided to go trayless it would be beneficial to the University because of the savings and the view of it is a “good” thing to do. For the treatment plant, trayless dining has a negative impact. When the amount of food waste decreases, the amount of yack available to the treatment plant also decreases, this results in less energy produced by the anaerobic digester. Trayless dining is currently not in the plans at Purdue University due to the lack of student support but is expected to happen in the future. Another option that would affect the partnership would be if Purdue invested in an anaerobic digester. At this point in time Purdue University is not looking at getting its own anaerobic digester. Even though Purdue is not receiving any compensation in the form of money or energy, the cost and space requirements alone would be expensive to the University (Irvin).

With the current arrangement Purdue is getting some benefits but not all of the benefits that could be received. If Purdue was willing to invest in an anaerobic digester then not only would still be able to save the money that is saved with the current method, but would also be able to use the electricity that is generated by the digester for the University to reduce electricity that is generated by the local coal burning power plant.. Purdue University Dining Services produces approximately one ton of food waste on an average day of operation. Anaerobic digesters have a cycle between twenty-five and thirty days, which would result in twenty-five to thirty tons of food waste per cycle. Commercial digesters are currently used at few universities so the energy can be harvested, but these universities are using other inputs beside food waste

during the cycles, like grass clippings. From the information provided by BIOFerm Energy Systems the case study system which uses dry fermentation requires between six thousand and eight thousand tons of organic waste per year. This case study digester is located at the University of Wisconsin-Oshkosh. Another digester line, the EUCOline, is in the works for release in the United States. The EUCOline is smaller so less waste would be needed. The amount needed annually is unknown, but the fermenting space size ranges from 3,420 to 8,720 sq ft (Chappell). On food waste alone Purdue University would not be able to successfully operate a commercially built anaerobic digester during the school months nor the summer months because of the low volume it generates. Therefore, the option of Purdue purchasing their own generator is not considered in this analysis.

The data used in this analysis was provided by staff from Purdue University. One of the most important factors for this analysis is how much food waste is produced.

Food Waste Generated in Tons

Tons	Day	Week	Month	Year
Number of Pulped Tons Generated	0.96	6.25	25.00	255.00
Number of Un-pulped tons	4.06	28.40	113.60	1148.98

Source: Purdue University

The difference in food waste tons for pulped and unpuled food waste was calculated based off of a food waste density of 2,000 pounds per cubic yard, otherwise known as 1 ton per cubic yard (Miller). Volume reduction is 88% (Hobart Corporation).

Methodology

For the Purdue University Dining Services case study there are four types of disposal that can be considered: anaerobic digester, compost, landfill with pulped food waste and landfill unpulped food waste. Each plan has been considered separately and analyzed for the yearly cost to Purdue University. To calculate yearly cost the following equation has been created:

*Pulper electricity cost + Travel cost+ Maintenance + (tons*tipping fee) = weekly amount*

Without the pulper, three of the four options would not be available. Not only does the pulper have one cost but actually two, electricity cost and maintenance. To calculate pulper electricity cost, the formula *of kWh per week * cost per kWh* was used. Two different analyses were performed for this section, zero cents and 11 cents. Purdue is able to generate its own electricity so there is not a fee that is charged for the use of the pulper. Because the pulper is used in three of the four disposal methods, an opportunity cost assessment was needed. Within the cost of the landfill, one disposal option does not use the pulper where the other one does. It would not be an accurate calculation without the electricity to the pulper considered. At the rate of eleven cents per kWh an opportunity cost analysis has been produced. Maintenance is the second cost that is created by the pulpers. Each dining court has a pulper that has been installed into the dish room over fifty years ago. Equipment needs maintenance over time. Average maintenance cost by Purdue University Dining Services was estimated at five-hundred dollars per pulper, the average maintenance cost for all of the pulpers is one-thousand dollars per year.

Unlike the landfill system that provides pick-up services to residents for a charge that is calculated into the tipping fee, Purdue University is required to haul the food waste to the

disposal site with its own vehicles. The cost of transportation is called travel cost. Travel cost is the cost to the University for transporting the food waste to the food waste disposal site and to travel back to the University. In order to calculate the cost of travel, the amount of miles traveled must be calculated and multiplied by the cost of fuel for the vehicle.

Distance of Disposal Locations in Miles

Location	Mileage 1-way	Mileage Round Trip
WLWWTP	1.6	3.2
Soilmaker	3.9	7.8
Trash Transfer Station	4	8

Mileage Provided by GoogleMaps

Mileage was determined by Google maps starting from the Windsor University Dining Court, a central location for all of the dining courts. Only one Ford F-750 is used to haul the food waste to the disposal site. The truck hauls the food waste in thirty-five gallon containers. The Ford F-750 requires diesel for fuel (Drake). The price of fuel is held at the assumption of three dollars and ninety-nine cents, which was the price on February 18, 2012 in West Lafayette, Indiana.

Because food waste is not a desirable product, a fee is charged to the person or organization that is doing the disposing. This fee is called a tipping fee. The tipping fee is charged for the maintenance of handling the food waste. Each site has a different maintenance plan that requires different cost; the compost site, Soilmaker, actually provided two different costs, depending on the amount of effort that Purdue University would put in. To calculate the tipping fee the formula is: *tons*tipping fee per ton.*

The data used in this analysis was provided by Purdue University. One of the most important factors for this analysis is how much food waste is produced. Data provided by

Purdue University Dining Services set food waste at twenty-five tons per month once the food waste has been pulped into yack. To calculate weekly food waste tonnage the formula of *monthly tons/number of weeks.* Calculations were also performed to determine the amount of food waste generated on a daily and yearly basis. Yet, one of the options, the landfill without pulper, uses whole food waste instead of yack. Unfortunately there are not any records of the weight of food waste before pulping for any time period available. That required a calculation based off of the information provided by the manufacturer of the pulper and the weight of the pulped food waste. On the Hobart website, the WastePro 1200, is able to reduce the volume of waste to 88%. With the assumption that there is one ton of food waste in one cubic yard, then the equation used is: *tons of pulped food waste*tons in a cubic yard/volume=amount in cubic yards.* This result generates the amount of the pulped food waste and is then divided by .22 to determine the amount that the pulped food waste is reduced from. The result for one week of unpulped food waste is 28.4 tons.

Tipping Fee Cost $/ton

Location	WLWWTP	Compost-High	Compost-Low	Landfill
Fee	$0.00	$60.00	$12.00	$40.00

Fees Provdied by West Lafayette Waste Water Treatment Plant, Soilmaker and Purdue University Grounds Dept.

The option of composting has two different tipping fees: high and low. The high tipping fee would be charged if Purdue would continue to haul the food waste to the site daily as it comes from the pulper. On the other hand, if Purdue wanted to be charged a lower tipping fee they would have to agree to the following guidelines set by Soilmaker:

1) The food waste would need to be stored from November fifteenth through March fifteenth. Cold weather requires the machinery used at Soilmaker to require more energy and money.

2) Food waste would need to be stored until a quantity between 12 and 30 tons has been stored. Sending food waste daily would require Soilmaker to operate machinery and pay employees for only a couple hours a day, instead of a full day or two a month.

3) Food waste that is being stored for composting needs maintenance. For composting food waste must be mixed as the waste comes in and select amendments would also be added. The food waste would then be stored in stacks until the waste would be transported to Soilmaker (Tishmack).

These guidelines would require Purdue to acquire a storage site for the food waste, preferably with a location that is near the Soilmaker site. Labor and amendments would also be needed for the food waste, to agree with the third guideline.

Results

After the analysis was completed the first results that were compared were the annual cost of each of the four disposal methods.

Cost of Disposal Method Annually $/yr

Method	Cost
Anaerobic Digestion	$3,833.64
Compost	$20,229.92
Landfill with Pulper	$15,064.54
Landfill without Pulper	$48,642.44

The result that has the lowest cost is the anaerobic digestion. At a difference of over eleven thousand dollars, anaerobic digestion beats out the option of landfill with pulper. Compost placed third with a difference over sixteen thousand dollars from anaerobic digestion and the last option was landfill without pulper, with a difference of forty-four thousand dollars. A couple of factors have been determined as the factors responsible for the difference in cost: tipping fees and use of the pulper.

West Lafayette Waste Water Treatment Plant does not charge a tipping fee to Purdue University due to the program's young age. Without a tipping fee charge, there is not a charge that is affected by the tonnage of food waste that sent by Purdue University Dining Courts. Every other option is affected by the tonnage of food waste that is sent to the disposal site. Since Mr. Henderson and Mrs. Irvin expressed that there has not been any discussion toward developing a tipping fee charged by the Waste Water Treatment Plant, yet the possibility of a tipping fee does exist. From this conclusion the project was then expanded to cover the possibility of a tipping fee and when would it become economically feasible for Purdue University to switch to the option of landfill disposal with pulper.

Tipping Fee Maximum for Purdue University to be charged by West Lafayette Waste Water Treatment Plan

Method	Cost $/wk
Landfill with Pulper	$355.81
Anaerobic Digester	$88.13
Difference	$267.68
Tipping Fee	$42.83 per ton

Electricity costs for the pulper and pulper maintenance are the same for both options due to the same amount of food waste is needed to be pulped for both disposal options. The differences lie within tipping fees and travel costs. The West Lafayette Waste Water Treatment Plant is closer to the University than the Tippecanoe Trash Transfer Station. It was determined that the highest tipping fee that can be charged by the treatment plant for an economic cost is $42.829 that Purdue will consider. After that price point Purdue University would have to consider how much the feeling of "doing right" and "being green" would be worth.

Purdue University produces its own electricity, which part of that goes toward the operation of the anaerobic digester. Yet, if the digesters were not used the electricity generated would be going toward a different equipment within the University.

Opportunity Cost of Electricity $/yr

Method	Without	With	Difference
Anaerobic Digestion	$1,457.78	$3,833.64	$2,375.86
Compost	$17,854.06	$20,229.92	$2,375.86
Landfill with Pulper	$12,688.68	$15,064.54	$2,375.86
Landfill without Pulper	$48,642.44	$48,642.44	$0.00

As shown in the figure above, the opportunity cost for electricity used for the pulper is $2,375.86. Yet, once a comparison is made between the Landfill with Pulper and the Landfill without Pulper, use of the pulper reduces the cost of disposal by more than thirty-thousand dollars. That cost difference includes the opportunity cost of electricity and the yearly pulper

maintenance. The drastic reduction in price is related to the ability of the pulper to reduce volume of the food waste by 80% by removing the water. The volume was converted to tons to determine the tonnage for calculating the tipping fee.

If the West Lafayette anaerobic digestion was not an option for Purdue, then the next cost effective option would be for Purdue to send the food waste to the landfill. Yet, landfill disposal is not considered a "green" option by most people. The third lowest option of composting is more of a green friendly option. Yet, there is always the option of the lower tipping fee if Purdue is willing to agree to the guideline provided by Soilmaker. Once the twelve dollar tipping fee is considered over the sixty dollar tipping fee the yearly price decreases by twelve-thousand dollars.

High Compost Tipping Fee VS Low Compost Tipping Fee per year

High Rate	$20,229.92
Low Rate	$7,749.92
Yearly cost of compost work by Purdue (undiscounted)	$12,480.00

To receive the lower tipping fee, Purdue must purchase the amendments, pay for extra labor, and obtain a space for the compost. It was determined that the highest cost that can be acceptable for all the guidelines is $12,480.00. Since the analysis was for yearly cost, discounting was not applied. In order for composting to become the second best option, the yearly cost would need to be $7,314.62 or less.

The cost effectiveness for the pulpers already put into place was another point of exploration derived from the original analysis. To complete this analysis a cost comparison was made between the two different landfill annual costs. The only difference between two landfill options is the use of the pulper. The landfill with pulper costs includes the cost of electricity and maintenance.

Savings Generaged by the WastePro 1200 in $/yr

Landfill without Pulper	Landfill with Pulper	Difference
$48,642.44	$15,064.54	$33,577.89

The difference between the two different options is over thirty-three thousand dollars per year. Without the pulper Purdue University would be looking at a cost of $48,624.44 because three of the options would be eliminated by the lack of pulper.

Conclusion

Purdue University Dining Courts has a goal of disposing of food waste in a sustainable manner. The current method of anaerobic digestion has the lowest cost to the University and is considered a "green" practice. Anaerobic digestion is the best method due to the absence of a per ton tipping fee. The tipping fee is by far the highest component of cost in three of the four options, all of which had a tipping fee above zero. If Purdue University and West Lafayette Waste Water Treatment Plant would like to continue their partnership and charge a tipping fee, that tipping fee should not exceed $42.823 per ton. If the tipping fee does exceed that amount

then Purdue needs to evaluate the importance of the “green” option compared to the option of landfill disposal after the food waste has been processed by the pulper.

Composting is considered the other “green” option of the analysis. At the tipping fee of sixty dollars, composting came in as the third option. If the option of the anaerobic digester was no longer available, the extras for composting would need to be approximately twelve-thousand dollars per year. The extras would include a building to house the food waste throughout the winter, materials that need to be added to the food waste while waiting for composting, and labor to work with the composting process. If costs of the composting guidelines are higher than twelve-thousand dollars, then Purdue will have to decide how much the “green” option is worth compared to the landfill.

An unexpected discovery that was made during this research process was the importance of the use of the pulper on the post-consumer food waste when minimizing total cost. Due to the dramatic decrease of weight in tons the total price of the tipping the food waste is much lower. The pulper is also essential for the anaerobic digester and the composting option. If Purdue University did not pulp the food waste into yack and expected a partnership with either the West Lafayette Waste Water Treatment Plant or Soilmaker, then Purdue University would need to be prepared to pay a larger tipping fee to cover the extra equipment and labor that on site pulping would require.

Pulpers require electricity, which has costs. Purdue University produces its own electricity so there is not a direct cost that is paid by the University. Instead, Purdue University faces an opportunity cost, because the electricity that is used by the digester could be used by other machinery or sold. The opportunity cost of the electricity used by the pulper is not enough

to justify not using the pulper. Pulper savings is over thirty-three thousand dollars. If Purdue considered the opportunity cost of electricity and the maintenance costs for pulpers, then twenty nine thousand dollars a year is saved. Purdue should always keep investing in pulpers.

Purdue University Dining Services is succeeding at their goal of disposing of food waste in an economical and "environmentally friendly" method at this time. Yet, life does change so Purdue University may want to conduct this study in five years to see if the best option has changed. Some of the factors that could be different include:

- Diesel Price
- Anaerobic Digester Requirements
- Tipping Fees
- Trayless Dining
- Safety/Health Concerns

Food waste will always be in existence for Purdue University, but with some careful planning Purdue University can continue to dispose of the food waste in the best way possible and do their part to reduce the amount of food waste that ends up in the landfill.

Works Cited

"Basic Information about Food Waste." United States Environmental Protection Agency. 2012. Web. 22. Apr 2012. <http://www.epa.gov/osw/conserve/materials/organics/food/fd-basic.htm>.

Chappell, Caroline. "Undergraduate Research Project Information." Message to Amy Winter. 9 Nov 2011. E-mail.

Drake, Randy. "Undergraduate Research Project." Message to Amy Winter. 8 Feb 2012. E-mail.

Ferris, D., & Shanklin, C. (1993). Cost of alternative methods of disposal of food waste in a university foodservice operation. The National Association of Colleges and University Food Services Journal, 17, 49-56.

Henderson, David. Personal Interview. 11 August 2011.

Hobart corporation. (2012). Retrieved from http://www.hobartcorp.com/products/warewashing/waste-equipment/wastepro-1200/

Irvin, Jill. Personal Interview. 16 August 2011.

Miller, C.. "Food Waste." Waste360.com. Penton Media Inc., 2011. Web. 2 Feb 2012. <http://waste360.com/mag/waste_food_waste_2>.

Moore, Julia. "More than a Food Fight." Issues in Science and Technology. 17.4 (2001): n. page. Web. 19 Sep. 2011. <http://www.issues.org/17.4/moore.htm>.

Priola , Suzette. "Animal prions," AccessScience, ©McGraw-Hill Companies, 2011, http://www.accessscience.com

"Purdue Sustainability Strategic Plan Report." Purdue University. Collaborative Project Consulting, 25 Jan 2010. Web. 20 Apr 2011. <http://www.purdue.edu/sustainability/articles/Purdue%20Sustainability%20Strategic%20Plan%20-%20Final%20Report.pdf>.

Purdue University. (n.d.). Fun facts. Retrieved from http://www.housing.purdue.edu/HTML/Dining/FunFacts.htm

Taylor, D. (2001, March). From animal feed to people food. Environmental Health Perspectives, 109(3), 133.

Tishmack, Jody. "Undergraduate Research Project." Message to Amy Winter. 9 Feb 2011. E-mail.

Wie, S, Shanklin, C & Lee, K(2003). A decision tree for selecting the most cost-effective waste disposal strategy in foodservice operations. Journal of American Dietetic Association, 103(4), 475-482.

Wie, S., & Shanklin, C. (2001). Cost effective disposal methods and assessment of waste generated in foodservice operations. Food Research International, 13, 17-39.

Zhang, R., Hamed, E., Hartman, K., Wang, F., Liu, G.,Choate, C., & Gamble, P. (2006). Characterization of food waste as feedstock for anaerobic digeston.Bioresource Technology, 98, 979-935. Retrieved from www.sciencedirect.com