Objectives:

This project aims to determine the feasibility of resource recovery technologies and processes that Brown County can implement in the future by utilizing existing technology to separate and sort target materials in the waste stream to achieve greater waste reduction at the new Brown County South Landfill. Separated materials can further be sorted and sold to private entities as materials for beneficial reuse.

Key Terms:

Resource Recovery, Solid Waste, Waste Diversion, Organics, Recycling

Abstract:

The Brown County Port and Resource Recovery Department has taken the first step in increasing the diversion of materials in the waste stream, by treating discarded materials as resources to be recovered instead of waste. This study aims to assist Brown County with finding feasible options for increasing the diversion potential of materials before they are sent to Brown County’s new South Landfill, which is estimated to begin operation in 2021.

Residential organic materials, construction and demolition (C&D) materials, and consumer plastics #3-7 have been targeted for diversion due to their prevalence in the overall waste stream in Wisconsin. Finding efficient, cost effective, and feasible methods to achieve increased diversion of these materials was the focus and was accomplished by identifying best practices, processes, and programs for achieving diversion of these materials from landfills. Additionally, an electronic survey was sent to identify municipalities and to ascertain how communities have begun to collect residential organic materials using drop-off collection programs. The results of the program and processes comparisons for each material category were examined. The programs or processes identified as feasible options for achieving waste diversion for each target material category was recommended to Brown County at the conclusion of this study. Recommended programs or processes for alternative uses for recovered materials that are implemented prior to the opening of the South Landfill in Brown County can generate value and can aid in developing new business opportunities associated with using recovered materials. This research will be useful for other communities looking to find cost effective and efficient ways to increase their diversion of discarded materials from landfills; thus potentially reducing the need to site and build new landfills in the future.

Introduction:

Resource management is one of the most important facets in developing a sound long-term plan for a community. Resource management is often examined through the lens of extraction and production of materials, ignoring the fact that large amounts of valued materials are also handled during the disposal of materials in many communities. Brown County is no exception to this disposal process. Brown County, in accordance with the Tri-County landfill sharing agreement with Outagamie and Winnebago Counties (BOW Agreement), is set to begin construction and operation of a new landfill in the township
of Holland, Wisconsin, in the year 2021. The BOW agreement was created in order to share administrative and disposal costs of an estimated 550,000 tons of generated solid waste material per year between the three counties (Brown County Waste Stream Committee, 2013). In order to cost effectively optimize resource management at the new landfill, the Brown County Port and Resource Recovery Department (BCPRRD) has begun to examine waste diversion programs and processes to divert and repurpose discarded materials destined for the landfill. Recovered materials would represent an extraction of value out of the waste stream.

The BCPRRD identified target material categories for future resource recovery efforts using the findings of the 2009 Wisconsin Waste Characterization Study conducted by the consulting firm Recycling Connections Corporation. The 2009 Wisconsin Waste Characterization study found that the overall waste stream in Wisconsin was comprised of 23.2% organic materials (10.6% food scraps and 4.2% yard waste), 21.3% construction and demolition (C&D) materials, 19.6% paper, 14.1% plastics (plastics #3-7 make up 0.1% of the total waste stream), 4.9% metals, 2.6% problem waste, 1.7% glass, 0.2% household hazardous waste, and 12.4% other uncategorized waste materials (Recycling Connections Corporation, 2009). The following figure illustrates the study’s findings.

![Figure 1: Recycling Connections Corporation](image)

The materials identified as having the greatest waste diversion potential were organic materials and C&D materials due to their prevalence in the waste stream. Consumer plastic containers #3-7 were also included as a target material category for waste diversion efforts due to the availability of existing techniques and technologies available to separate these materials from the waste stream. This study examines the diversion potential for each of the three target material categories by examining opportunities to collect the target materials, source separate and process the materials into useful end products, and identify local markets for the materials once processed.
Methodology:

1) A literature review was conducted on feasibility and post implementation studies of existing resource recovery facilities to determine best practices, equipment, and processes necessary to sort and separate the targeted materials determined by the waste characterization study.

Next, a review was conducted in an effort to determine the most efficient processes for beneficially utilizing each of the targeted materials. Finally, a plan was developed for integrating the most economically feasible and efficient infrastructure necessary to divert organic food scrap materials, recyclable/reusable construction and demolition materials, and plastics #3-7 from the waste stream, along with an estimated cost.

2) A survey was sent out to identified municipalities that utilize drop-off collection for residential food scraps in order to determine the costs of collection and diversion potential of each program. The survey is included in Appendix 1.

3) Based on the waste characterization assessment and the inventory of local businesses and non-profits, a strategic plan was developed for marketing source-separated materials from the Resource Recovery Facility, which could be sold to local industries to be utilized for reuse or repurposing. It is anticipated that the materials diverted from the waste stream via a resource recovery facility could promote private partnerships and increase other business opportunities and economic growth for the region.

4) Based on the opportunities identified during the initial steps of this project, an evaluation of the site of the new Brown County South Landfill was conducted to determine the amount of needed land required to construct a resource recovery facility on the landfill site with space to accommodate all the infrastructure and equipment necessary to efficiently and cost effectively divert the targeted materials via source separation and sorting processes. GIS analysis was then conducted to develop a preliminary plan for constructing the facility.

Literature Review: Waste Diversion and Resource Recovery Opportunities

Organic Materials:

Organic materials present the greatest opportunity for diversion from the waste stream due to Brown County’s underdeveloped infrastructure and policies to collect and process residential organic food scrap discards. Brown County is pursuing development of a pilot drop-off collection program for residential food scraps independently from the BOW in order to begin collecting and utilizing these materials on a manageable scale. Many municipalities in Brown County currently only collect organic yard waste at municipal drop-off collection points. Participation in the program is voluntary for residents looking to use the drop-off stations. This means that Brown County fails to capture much of the
organic materials in the waste stream, and especially food scraps. According to the 2009 Wisconsin Statewide Waste Characterization Study, 23.2% of the overall waste stream was organic material, food scrap and yard waste made up 10.6% and 4.2% of the overall waste stream respectively (Recycling Connections Corporation, 2010). Yard waste is collected with a combination of drop-off collection and curbside collection, depending on the type of yard waste being disposed of. Yard waste was banned from Wisconsin landfills in 1993. The ban of yard waste has led to high rates of residential participation in yard waste recycling efforts. The fact that the BOW counties currently have established collection programs for yard waste and not residential food scraps has driven Brown County to develop a pilot drop-off collection program to better utilize food scraps, which make up the majority of the total amount of organic materials that are discarded into landfills each year.

In order to remove food scraps from the waste stream and use these materials for beneficial uses, a collection system needs to be put into place. As of 2012, over 150 communities across the United States and Canada had implemented source separated organics collection programs for food scraps and yard waste. (Yepsen, 2012) The reason why many communities have developed collection programs specifically for organic materials is to avoid contaminating the organics with inorganic waste materials such as plastics. The two most common types of organics food scrap collection programs identified were curbside collection and drop-off collection. Depending on the type of program, food scraps and yard waste can either be collected together or separately depending on the collection infrastructure in place and the end uses for the collected materials.

Curbside collection utilizes house-by-house collection of organic materials using bins or compostable bags (so as not to contaminate the organic materials with inorganic plastics). Curbside collection can be used to accept a combination of food scraps and yard waste, but most often to collect food scraps. Curbside collection generally entices greater participation rates among residents due to the ease of only having to take the materials to the curb to be collected. Curbside collection is more expensive due to the number of stops necessary to collect the materials as well as the labor costs for collection crews and maintenance costs of the collection trucks. A study of municipal organic waste collection commissioned by the EPA in 2011 found that the average cost of curbside collection service for residential organics was $7.70 per household per month (Skumatz 2011).

Drop-off collection services utilize centralized collection points where residents can bring their organic materials whenever it is convenient for them. Drop-off collection systems usually have lower rates of participation due to the added time and effort it takes residents to bring their organic materials to the collection points. The benefits of drop-off collection are the lower capital and operational costs compared to curbside programs.

Organics Drop-off Collection Survey:

There is a wealth of information from organics curbside collection program studies due to the large number of curbside collection programs in existence. However, the study of the existing drop-off collection programs for food scraps has been largely understudied by the scientific community. Furthermore, a majority of the existing drop-off programs in
the United States only accept yard waste. This suggests that little information is known about drop-off collection programs for food waste.

The online survey in Appendix 1 was designed to gather more information about drop-off collection programs for residential food scraps. This survey was sent to communities identified during a literature review for organics drop-off collection programs. The communities were selected by being identified as having operated a drop-off collection program for organic food scraps or as having operated a drop-off collection program for organic materials. The latter category was also sent surveys in order to determine what types of organic materials were being collected. The survey process began as follows: first, a letter with the link to the online survey was sent to the target communities identified in the literature review. After two weeks, a follow up letter with the survey link was resent to the communities that had not yet responded after the initial inquiry.

Studying existing drop-off collection programs can be helpful in developing a strategic blueprint for communities considering implementing drop-off collection programs for residential food waste. The results from the survey responses can be seen in the table below that highlights important design and operational features of existing drop-off collection programs. The response rate for the survey was 61.9%.

**Survey Results:**

The Drop-off Organics Collection Survey was sent to 21 communities identified in the literature review. The list below shows the communities that were contacted; communities who responded are highlighted in bold / yellow.

- Amherst, Massachusetts
- **Athens-Clarke County, Georgia**
- Boston, Massachusetts
- **Boulder County, Colorado**
- Brattleboro, Vermont
- Cambridge, Massachusetts
- **Cedar Rapids, Iowa**
- Chittenden, Vermont
- **Duluth, Minnesota**
- Fargo, North Dakota
- **Fennimore, Wisconsin**
- Grant County, Washington
- Laurens County, Georgia
- Minneapolis, Minnesota
- New York, New York
- **Northampton, Massachusetts**
- Olympia, Washington
- Portland, Oregon
- San Mateo, California
- State College, Pennsylvania
- Vancouver, Canada

Of the 13 communities that responded to the survey, only four communities operate drop-off collection programs to collect residential food scraps. These communities were Boulder, Duluth, Fennimore, and Northampton. Three communities, San Mateo, State College, and Portland utilize curbside collection systems for recovery of food scraps instead of drop-off collection. Five communities that were identified as having drop-off collection programs for “organic materials” were found to be programs for collecting yard waste only. One community, Minneapolis, Minnesota, is planning to launch a drop-off collection pilot program for food scraps on Earth Day 2014. Of the four communities that currently operate a drop-off collection program, information collected during the
surveys was organized and summarized in an Excel spreadsheet to identify commonalities between the programs.

The pie charts and bar graphs below illustrate some of trends and characteristics of the four drop-off collection programs for residential food scraps. A case study is also included for Northampton, Massachusetts. The case study serves as a more in depth look at an existing drop-off collection program for residential food scraps. Northampton, Massachusetts was chosen for the case study because their municipality completed the survey more thoroughly than the other three identified municipalities.

![Program Years of Operation](image)

**Figure 2: Number of Years of Operation of the Residential Food Scrap Drop-off Programs**

Of the four identified drop-off collection programs, Northampton Massachusetts has operated its drop-off program for the fewest years. Boulder Colorado, Duluth Minnesota, and Fennimore Wisconsin all have long established programs for drop-off collection of food scraps.
The one commonality among all respondent drop-off programs regarding security measures was the presence of fencing around the drop-off collection area and bins. Fencing deters after-hours drop-offs or unwanted drop-offs by community members utilizing the program. Fencing also serves to dissuade animals from gaining access to collected organic food scraps as well as preventing the bins to be stolen.

In order to further secure their drop-off sites, both Fennimore Wisconsin and Duluth Minnesota both utilized staffing during operational hours on site and a locked gate to secure the drop-off collection areas after operational hours. Boulder Colorado’s drop-off collection program invested in bear proof locked bins to prevent bears from eating the collected food scraps and prevent human/bear interactions at the drop-off sites.
Program type:

Participation in all four drop-off collection programs is voluntary for residents. Northampton Massachusetts has residents subscribe to take part in the voluntary program in order to obtain more sound estimates for the number of people and households participating in their drop-off collection program. Making a drop-off collection program voluntary from the start helps to slowly build support for the program through word of mouth instead of attempting mandatory participation in the program.

Use of biodegradable bags:

Biodegradable bags are composed of materials that can be decomposed by living organisms or bacteria. Biodegradable bags are an effective way of transporting and disposing of food scraps and are an excellent liner for food scrap collection bins as opposed to normal plastic bags. Plastic bags are not effective because they cannot be discarded with the organic materials. Plastic contamination within organic food scraps can prohibit the collected materials from being used to create compost.

Case Study: Northampton, Massachusetts

Northampton Massachusetts is a city of a little more than 28,000 people (2012 census estimate). Northampton has been operating a drop-off collection program for residential food scraps since 2012. Their program is voluntary for residents to participate. Interested residents can subscribe to join the program; the subscription of households serves to better track participation in the program. 400 households have subscribed to take part in the voluntary program with about 1,000 residents taking part in the program.

All food scraps, soiled paper, and waxed cardboard are collected in the drop-off program. The materials are collected at one drop-off location Monday through Saturday from 7am-4pm. The drop-off is located on city owned land at their municipal transfer station.
The drop-off site is a fenced-in area with a locked gate. The food scraps are deposited in 65-gallon totes under a three-sided covered shed. Depending on the season, between 4 and 18 65-gallon totes are available for storing the collected food scraps. The program has collected about 50 tons of organic food scraps per year since the program began in 2012. This equates to about 100,000 lbs. of food scraps collected annually.

The food scraps are collected twice a week on Monday and Wednesday in order to cut down on odors from the breakdown of the collected food scraps. The use of biodegradable bags for transporting and depositing food scraps at the drop-off site are not allowed.

The annual operational cost of the program is around $10,000. The program is partially paid by the private waste haulers who agreed to pay $20 per participating household per year. The rest of the program is paid for by all Northampton residents through a small fee added onto the cost of their yearly vehicle sticker fee. The organic materials are hauled to a local composting facility that then pays the haulers for the collected materials.

This program was advertised extensively to the community via flyers, newspaper articles, and pre-implementation surveys. The program is reportedly still very popular, and the number of participating households continues to grow.

**Options for Organics Materials After Collection:**

**Option 1: Windrow Aerobic Composting**

Once organic materials are collected they must then be processed into usable end products such as compost or as a feedstock for waste-to-energy facilities. One option for beneficially reusing organic yard waste and food scraps is to break down the materials aerobically (with oxygen) in a windrow composting system. Windrow composting facilities shred organic materials (food and yard waste) using grinders, in order to break down the materials into small uniform organic bits. Once shredded, the organic materials are laid out in long (3-5 ft. tall) rows on a paved composting pad. “Composting is a natural process of decomposing organic materials by using micro-organisms under controlled conditions. During the composting process, micro-organisms consume oxygen while feeding on organic matter.” (Vermeer, 2008). The piles are manually turned in order to aerate the pile that helps the bacteria break down the organic materials. Piles are continually turned and cured until the composted materials are aged and dried to the correct specifications for the end state of the compost. The aerobic digestion process can take up to 45 days to complete. Once completed the materials are sent through a trommel screen in order to breakdown the material into uniform size.

The benefits of composting include volume reduction and creation of a beneficial end use material from the original organic waste materials. The end product of this process is a nutrient rich soil amendment that can be sold to residents, farmers, golf courses, or landscaping companies.

The environmental byproducts of the aerobic composting process include carbon dioxide emissions from the decomposition of the organic materials. These emissions can only be captured if closed cell aerobic digestion systems are used which is more expensive than
windrow composting. Wastewater runoff that accumulates throughout the drying process and during precipitation events must also be captured. If the wastewater byproducts are not captured and treated, then it has the potential to pollute the local waterways and groundwater. Another limitation to windrow composting is that, meat and dairy products are generally not used for composting because these materials can introduce pathogens into the compost and also throw off the desired pH level of the compost.

An example of an existing windrow composting facility is the Linn County Composting Facility in Cedar Rapids, Iowa. The Linn County Composting facility accepts: fruits, vegetables, trimmings, clean wood (chips, sawdust, timber), tree stumps and branches, leaves, grass, brush, and paper pulp. The facility receives 30k-40k tons of organic materials each year from residential, commercial, and municipal sources. Incoming materials are charged $18 per ton opposed to $38 per ton landfill tipping fee. The $20 per ton cost savings versus the landfill tipping fee creates a strong market incentive for suppliers of organic materials to the facility.

Arriving organic materials are screened by a trommel to remove unwanted inorganic materials. The screen organics are then sent through a grinder that breaks the organic materials down to uniform size. The ground up organics are then laid into 200-700 ft. long windrow piles to break down aerobically. The piles of organic materials are periodically turned by a Scarab turner in order to aerate and mix the materials. The finished compost products are given away to Linn County residents for free and sold to area businesses for $8 per cubic yard (Cedar Rapids / Linn County Solid Waste Agency, 2012).

Option 2: BIOFERM™ Dry Fermentation System

Another option for beneficially reusing collected food scraps and other organic materials is building a BIOFERM™ Dry Fermentation System. BIOFERM™ Dry Fermentation System is one technology that has emerged recently that can produce methane by processing organic materials. BIOFERM™ Dry Fermentation Systems work by feeding organic materials into garage style fermenters that are heated via in-wall radiant heat, and sprayed with a mixture of water and bacteria that serve to enhance the fermentation process. Further processing can be done with the left over materials from the BIOFERM™ process in order to produce compost.

The fermentation garages are sealed air tight as well drained internally via floor drains to protect against the release of gases or liquids during the process. The gases given off by the breakdown of the organic materials are then captured by ceiling ventilation that stores the gas in large flexible balloon-like chambers above the fermentation chambers. After 28 days the remaining materials in the fermenters are shredded and cured aerobically to eventually be sold as compost. The gases collected during the process are continually fed to the biogas utilization source that can produce natural gas or energy from combusting the captured biogas.

The benefit to the BIOFERM™ Dry Fermentation System is that the technology is scalable. Depending on the amount of organic materials collected, more fermentation garages can be built as needed to handle greater amounts of organic materials. (BIOFERM Energy Systems, 2012) The capital and operation costs vary based on the
size of the facility. The following figure outlines the instant generating capacity of the dry fermentation technology.

<table>
<thead>
<tr>
<th>Organic Input (tons)</th>
<th>Number of Fermenters</th>
<th>Biogas Production (million scf)</th>
<th>Installed Electrical Capacity (kW)</th>
</tr>
</thead>
<tbody>
<tr>
<td>8,000</td>
<td>4</td>
<td>24</td>
<td>300</td>
</tr>
<tr>
<td>20,000</td>
<td>8</td>
<td>60</td>
<td>760</td>
</tr>
<tr>
<td>50,000</td>
<td>16</td>
<td>150</td>
<td>1,900</td>
</tr>
<tr>
<td>70,000</td>
<td>24</td>
<td>210</td>
<td>2,600</td>
</tr>
</tbody>
</table>

**Figure 6: BIOFERM Energy Systems**

The figure above shows the potential of the dry fermentation technology to produce large amounts of biogas as well as energy. The digestate generated by this process represents a 40% volume reduction from the original volume of the feedstock input over the 28 day holding cycle. The benefit of implementing a BIOFERM™ Dry Fermentation System is the flexibility, scalability, and the creation of different types of useful outputs such as compressed natural gas (CNG, Heat, Electricity) from the system. BIOFERM™ Dry Fermentation Systems also have the added benefit of being able to use a variety of inputs in the digestion process. Food and yard waste can be co-digested with manure, a waste material that Wisconsin generates massive amounts of from the dairy industry. One local example of the BIOFERM™ Dry Fermentation System is the University of Wisconsin-Oshkosh facility that began operating in 2011. This facility was the first of its kind built in the western hemisphere. Some of the UW-Oshkosh facility’s highlights include:

- A daily operating capacity up to 8,000 tons of organics at a time (28 day cycle) including: food waste, yard waste and crop residue
- 4 chamber fermentation facility
- Produces 2,320,000 kWh on average a year
- Supplies as much as 15% of UWO’s electrical needs
- Total building footprint: 19,000 ft²
- Fermenter: 70 ft. x 23 ft. x 16.7 ft.
- Total Fermenter Volume: 26,887 ft³
- Storage Area: 2,000 ft²
- Mixing Area: 7,800 ft²
- Installed Electric Capacity: 350 kW

Sources: (Bollier, 2010), (Sonnleitner et al. 2011), (BIOFERM Energy Systems, 2014)

This facility cost $2,000,000 to construct and initial operational costs are not yet published. (Bollier, 2010) Other BIOFERM™ Dry Fermentation Systems in the United States and Europe have documented operational costs for larger facilities, drawing cost comparisons based on the scale of the facility is not appropriate for determining the
Oshkosh facility’s yearly operational cost. Building a facility the size of the Oshkosh BIOFERM™ facility could nearly handle all of the materials collected by the BOW, if the BOW began to collect organic materials. Of the 550,000 tons of waste generated annually in the BOW, 23.2% or about 126,500 tons of organic materials are generated. The 126,500 tons divided by the 28-day holding period (8,000 tons at a time) of the organic materials, means that it would take 15.8 28-day periods to process all the organic materials generated by the BOW in one year. Since there are only 13 28-day periods in a year, a facility the size of Oshkosh’s BIOFERM™ facility would nearly handle all of the organic materials being generated by the BOW in a given year.

Option 3: Wet Fermentation

A third option for beneficially reusing residential food scraps and other organic materials would be to invest in a wet anaerobic digestion system. Wet anaerobic digestion systems operate similarly to dry anaerobic digestion systems, with a low-solids feedstock (usually less than 10%) whereas dry-fermentation systems such as the BIOFERM™ dry-fermentation system generally have high-solids feedstock of greater than 20% (Worrel and Vesilind, 2012). A presort of organic materials occurs first to prevent unwanted or hazardous inorganic materials from entering the system. Wet anaerobic digestion systems often mix food waste with organic liquids such as sewage or manure to achieve the desired solids level. The mixture is then digested in enclosed single or multiple batch systems that capture the methane gas released during the decomposition process. Wet anaerobic digestion systems must be monitored frequently to ensure that the pH level stays above 6.2, the lowest level at which methane can be produced. The temperature range, Carbon to Nitrogen (C:N) ratio, and retention time must all be carefully monitored throughout the anaerobic wet-digestion process.

Methane rich biogas produced from the wet-fermentation anaerobic digestion process can be refined to create compressed natural gas that can be used to fuel vehicles or be burned to heat buildings or create electricity. “Typically, the methane content of biogas ranges from 40-70 percent (by volume).” (Rapport et al. 2008)

The downside of a wet fermentation system versus the dry fermentation system is that the end product of the wet fermentation process has a very high liquid content that must either be piped to a wastewater treatment facility for further processing or they must be land applied on farmland nearby. This suggests that a wet fermentation system would either have to install large pipes to connect their facility to the municipal sewage system, or find many farmers in the local area willing to land apply the liquids that have high nitrogen and phosphorus levels. Land application can be beneficial if farm fields have low nitrogen or phosphorus levels in their soils. Over application or misapplication of organic liquid by-products from the wet fermentation process could potentially degrade riparian ecosystems and pollute well water systems if not applied properly. The end product of wet-fermentation systems can be dewatered in order to create a solid compost end product instead of an organic liquid by-product. Dewatering is an energy intensive process which requires either waste heat created from the digestion process or additional energy and heat from outside the facility in order to efficiently dewater the anaerobic wet-fermentation liquid byproduct using a centrifuge. Water separated from this process may still need to be piped to a wastewater treatment facility for further processing.
Another drawback of using a wet-fermentation system for food waste mixed with other organic liquids, is that pump and pipe clogs can occur frequently if the food wastes are not shredded very finely before being digested in a wet system. Adding a shredder to prevent clogs in a wet anaerobic digestion system is another added cost to the process. Due to these constraints, dry systems have become prevalent in Europe, making up 60 percent of the single-stage digester capacity installed by 2008. (Rapport et al. 2008)

An example of an existing wet fermentation anaerobic digestion facility that processes food waste is the East Bay Municipal Utility District (EBMUD) in Oakland, California. The EBMUD is located at an existing wastewater treatment facility that added capacity to process source separated organic food waste in its anaerobic digestion system. The EBMUD was the first facility in the United States to anaerobically digest food scraps with wastewater byproducts. The decision to add food scraps into the existing anaerobic digestion feedstock was spurred by a significant excess capacity that developed at the plant due to a decline of regional food processors. Some of the highlights of the EBMUD facility include:

- Facility processes 35,000 tons of food scraps per year (2011)
- Publically owned facility and anaerobic digestion equipment
- Digester gas is used to power three 2.2 MW generators
- 6.5 MW total energy produced annually
- Quality food scraps produce 220 kWh/ton
- Excess electricity not used on site is sold to local utility
- Pretreats incoming material by pumping slurry through a rock trap, grinding food scraps, and sending the food scrap slurry through a paddle finisher to remove grit.
- Food waste resulted in 3.5 times the amount of energy as municipal sludge.
- By-product digestate is dewatered to about 25% solids and is either used as alternative daily cover for landfills or is land applied on farm fields.
- Capital costs of two to five million dollars to add food waste capability to existing wastewater digester
- Operational costs equivalent to $40-$55/ton

Source: (ILSR, 2010)

Combining food wastes with municipal sewage or liquid manure may be a feasible solution for communities with anaerobic digestion systems in place at a wastewater treatment facility with excess capacity. This type of wet anaerobic digestion system is not feasible for Brown County currently because the Green Bay Municipal Sewage District (GBMSD) does not have an anaerobic digester. GBMSD currently incinerates the dewatered solid by-product of their wastewater treatment facility. GBMSD is currently researching anaerobic digestion technologies in order to upgrade and renovate their facility in the future. Further studies should focus on identifying anaerobic digestion technologies that GBMSD could implement to better utilize the organic component of their facility’s by-products.
Construction and Demolition Materials:

Diversion of some C&D materials from the waste stream in Brown County is already occurring due to the public/private partnerships between the BCPRRD and their various partners in the C&D recycling industry. Loads of C&D coming from new construction, demolition, and renovation sites are taken to the Brown County’s Transfer Station in western Green Bay where it is weighed and separated by material types by front-end loaders. The Brown County Transfer Station serves as a central collection point for C&D materials to be weighed and sorted.

After sorting, private recycling entities pick up the sorted C&D waste for further separation and processing at private facilities. According to the BCPRRD the list of currently recyclable C&D materials and their percentage of the overall C&D waste stream include:

- Wood – 28.1%
- Residential Shingles – 29.5%
- Vinyl Siding – 0.1% Anticipated Percentage*
- Aggregate (concrete, rock, brick, stone, porcelain, tile) – 13.2%
- Drywall – 5.2%
- Metal – 5.7%
- Cardboard – 6% Anticipated Percentage**

**Total: 87.8% (18.7% of overall waste stream)**

Sources: Percentages - (Recycling Connections Corporation, 2010)
Accepted Materials - (Brown County Port and Resource Recovery Department, 2014)
* Based on North Carolina C&D Waste Composition Study (Mid-Atlantic Solid Waste Consultants, 2008)
**Based on Massachusetts C&D Waste Characterization Study (DSM Environmental, 2008)

These recyclable C&D materials make up a large percentage of the C&D waste stream. However, the actual amounts of these materials that make it to the Brown County transfer station to be recovered are unknown. Despite the high percentage of technically recyclable materials of C&D materials, there is room for improvement for C&D recycling. “In total, from almost any job site, 90% to 95% of all waste materials can be recycled.” (Lennon, 2005) Two materials that aren’t currently included in the C&D recycling scheme in Brown County are carpeting and glass, comprising 3% and 1% of the overall waste stream respectively, in Wisconsin in 2009. (Recycling Connections Corporation, 2009) According to the Wisconsin Department of Natural Resources, HJ Martin and Son Inc., Schleis Floor Covering Inc., and Maccos all recycle carpet and carpet padding in Brown County, but only from customers and company projects (Wisconsin Department of Natural Resources, 2012).

Option 1: Public Private Partnerships

Since Brown County doesn’t currently own any C&D recycling infrastructure, it would make sense to partner with private businesses that have experience recycling carpeting and glass from C&D projects. For example, Brown County could partner with Interface
Flooring, a national leader in carpet recycling in order to accept carpet from incoming C&D loads to be recycled at Interface Flooring’s carpet recycling facilities.

Option 2: Local Ordinances for Waste Management and Reduction Plans

To increase the recycling rate of C&D materials within Brown County, local municipalities could pass ordinances that compel private construction contractors to submit waste management plans that estimate the types and amounts of waste generated at each project site as well as outline plans to reduce waste and increase recycling. Implementing waste management plans would serve to make contractors cognizant of C&D recycling as well as increase the efficiency of their operations by working to waste fewer materials. Appendix 3 is an example of a waste management plan designed by the Massachusetts Energy and Environmental Affairs in 2014.

Option 3: State Landfill Bans for Recyclable C&D Materials

Another policy option for increasing C&D recycling as a whole would be to push for the introduction of a statewide ban of recyclable C&D materials from landfills. Banning recyclable C&D materials from landfills could spur the development of C&D recycling industries as well as improve market opportunities for recycled C&D materials. Implementing waste management plans and banning recyclable C&D materials would help to divert these materials from landfills. Some recycled C&D materials could be reused by construction companies or sold to customers at prices lower than retail of virgin materials.

**Consumer Plastics #3-7:**

Consumer plastics are an important diversion target for the counties in the BOW agreement, so much so, that in 2009, the BOW built a state of the art single stream materials recycling facility (MRF) in Appleton to better sort and separate recyclables and divert them from the waste stream. When the MRF first opened, it was the largest publicly owned, publicly operated recycling facility in the United States, serving over 65 communities in Wisconsin. (Outagamie County, 2014) Today, the BOW MRF has sorting processes and technology in place to source separate paper materials, ferrous and non-ferrous metals, consumer glass products, and consumer plastics #1 and #2 from the incoming single stream recyclables collected. Once sorted, the plastic and paper materials are baled and resold to industries that further process or reuse the materials. The overall impact of the investment made by the BOW is profound. The MRF has the capacity to process up to 80,000 tons of recyclables a year utilizing two full-time work shifts a day. The map below illustrates all of the counties that currently send recyclables to the MRF in Appleton.
Spurred by the great accomplishments and waste diversion achieved due to the BOW MRF, BOW is investing in new infrastructure and technologies to further increase the amounts and types of materials that can be sorted and diverted from the waste stream.

**Option 1: Optical Sorting**

Earlier this year, the BOW MRF considered adding optical sorting technology to its existing source separation infrastructure that would source separate consumer plastics #3-7 from the waste stream in addition to plastics #1 and 2. Optical sorting technology utilizes light detection boxes with sensors that sense color differences relative to various color background slides to sort particles by color. Particles of plastic that do not match a given color background slide are sorted from the stream by getting hit with a jet of compressed air that sends the material to a separate sorting line. Optical sorting works best with particles of similar size, therefor, plastics may be sent through a shredder to create uniform particle sizes prior to optical sorting. Once the plastics have been sent through the optical sorting mechanism, the separate plastic streams are sent through manual sorting lines so that a worker can inspect the accuracy of the sorting mechanism and remove unwanted plastics that may have been missed.

If implemented, installing optical sorting capacity at the BOW MRF would cost the BOW an estimated $1.5 million. Some of these costs could eventually be recovered by being
able to sell plastics #4 – Low Density Polyethylene (LDPE) and #5 – Polypropylene (PP). Markets for recycled plastics #4 and 5 are currently much stronger than the markets for plastics #3, #6, and #7. Another added benefit of being able to source separate the seven major types of consumer plastics is that by adding the capacity to handle these materials, it allows residents to throw any consumer plastic with the triangular recycling symbol into the bin instead of having to carefully check the number label of each piece of plastic they discard. The graph below shows the national estimates for plastics recycling by resin type in 2011 (including bottles and non-bottle plastics).

![2011 National Plastics Recycling Types (%): Non-Bottle + Bottle](image)

**Figure 8: 2011 Plastics Recycling Percentages**
Sources: (Moore Recycling Associates Inc., 2013) – Non-Bottle Recycling Estimates
(American Chemistry Council, 2012) – Bottle Recycling Estimates

Of the total amount of non-bottle and bottle plastics recycled in 2011 the percentages of each resin type constituted the following: #1 PET - 47.4%, #2 HDPE – 35.5%, #3 PVC – 10.1%, #4 LDPE – 0.44%, #5 PP – 1.86%, #6 PS – 0.21%, and #7 “Other” – 4.33%. This means that nearly 83% of plastics (#1 & #2) could potentially be recycled in the BOW’s single stream recycling scheme. Plastics #3-7 make up the remaining 17% of recycled plastics according to national estimates. Appendix 4 shows the raw number estimates of the national non-bottle and bottle recycling figures for the year 2011.

Increasing the ease of recycling for residents also increases the amount of plastics being recycled, further increasing the revenue potential at the BOW MRF for accepting and sorting the plastic recyclables. Professor David Folz stated that “Clearly, it cost cities more to divert more materials from the waste stream, but an important result was a lower cost per ton. This suggests that the sizeable investments communities made in their recycling programs helped to improve both diversion performance and program efficiency.” (Folz 1999) By adding optical sorting, the BOW MRF could accept more types of materials into their single stream recycling facility, creating jobs and new markets for recycled plastics #3-7. The return on investment from adding optical sorting capacity at the MRF could be further enhanced in the future if markets for plastics #3, #6, and #7 become stronger.
Option 2: Adding Manual Sorting Lines

To source separate all consumer plastics #1-7, the BOW MRF is now considering adding additional manual sorting to sort the seven types of consumer plastics. Adding manual sorting lines would involve reorganizing or adding new sorting platforms at the BOW MRF to accommodate space for more workers who would be sorting the seven plastic types by hand. Cost estimates for this facility upgrade are unknown so far. A request for proposal was sent out in February of 2014 to companies interested in designing and building the additional manual sorting platform at the BOW MRF. The advantage of adding manual sorting capacity instead of optical sorting is that optical sorting takes longer to build and accurately calibrate to effectively sort plastics. Optical sorting sensors are also expensive to replace if defective or broken. Adding or extending the manual plastics sorting line at the BOW MRF will also create more full-time jobs than implementing an optical sorting system. Further studies are needed to determine the future impacts and diversion potential once the manual sorting lines are operational at the BOW MRF.

End markets for consumer plastics include plastics and packaging companies that can use recycled plastics in their facilities at a lower cost than using virgin materials. The only potential problem with using source separated recycled plastics is the contamination rate of the baled plastic. MRFs must try to separate plastics with the lowest amount of contamination possible from other types of plastic or different types of recyclable materials. Recycled plastics with high percentages of contamination threaten to ruin the end product’s specific performance (rigidity, strength, heat deflection, etc.) based on the type of plastic used in a manufacturing process. Fortunately, optical sorting technology, when calibrated correctly, produces separate streams of sorted plastic with very low contamination rates.

Marketing Plan and End Uses for Target Materials:

To market the recycled and reprocessed end products of the various reuse and recycling technologies and processes outlined above, it is important to match the types of recycled materials being recovered by local businesses and industries who use those types of recycled or virgin materials. Selling recovered recyclable materials could be marketed as being the environmentally friendly alternative to using virgin materials. Companies that use recycled materials can improve their company image by using and marketing their products as being produced with recycled materials. In most cases using recycled materials is also cheaper than using virgin materials, which helps justify the use of recycled materials in their production processes from a cost avoidance standpoint as well. To support the effort for promoting reuse and recycling of recovered and reprocessed materials from the waste stream is to work on convincing businesses that currently use virgin materials in their production processes to either fully switch to using the same types of recycled materials or use a portion of recycled materials in their production processes. To effectively match companies to the types of recycled materials being recovered, a further study is needed to reexamine the Wisconsin Market Directory, and keep the directory up to date.

Once the links between businesses who use recycled materials in the region and currently available recycled material types and quantities recovered in the BOW region are
established, it is important to find suitable beneficial reuses for the recycled materials and by-products generated by aerobic and anaerobic digestion processes.

Beneficial Reuse of Organic Materials:

Organic By-Products of BIOFERM™ Dry Fermentation System process:

The remaining organic material from the BIOFERM™ Dry Fermentation System process could be marketed to landscaping companies, golf courses, or residents for use as a soil amendment rich in nutrients. The end products of the dry fermentation may require additional aerated composting in windrows in order to meet the safety standards of compost materials. By-products from the BIOFERM™ Dry Fermentation System process could be sold and shipped to windrow composting facilities in the area to further finish the compost and achieve the desired safety standards of compost materials before being marketed to residents and companies.

The biogas created from this process could be sold to utilities or businesses looking to utilize the electricity or natural gas for heating. Creation of natural gas by-products from this process could spur the growth of industries that utilize natural gas for vehicle fuel in northeast Wisconsin.

Organic By-Products of Windrow Composting:

After the organic materials have been fully degraded and cured in the aerobic digestion process, the organic compost could be sold or given away to local residents for free. The compost could also be sold to landscaping companies, golf courses, or road construction companies to be used as a nutrient rich soil or clean fill.

Beneficial Reuse of Recycled C&D Materials:

The recycled and recovered C&D materials can be resold to construction companies, or subsidiary industries that could use the recycled C&D products for other uses such as using recovered waste wood to make wood chips for landscaping companies. Clean pieces of wood could be ground down into chips and turned into pellets for boiler feedstock. Asphalt shingles can be melted down to be used as asphalt for roads. Concrete, cement, and brick aggregate can be ground down and sold to road construction companies to be used as a base material. Recovered metals from construction projects could be resold to scrap-metal dealers. High quality C&D discards can be sold to consumers at C&D used goods resale businesses such as ReStore in Northeast Wisconsin at prices lower than buying virgin materials.

Beneficial Reuse of Consumer Plastics #3-7:

Once the new manual sorting lines or optical sorting process come online at the BOW MRF some time in fall of 2014, the source-separated plastics can be resold to plastics wholesalers, packaging companies, or plastics manufacturers. Initially, recycled plastics #1, #2, #4, and #5 will be the easiest to resell due to the strength of the markets for these materials.
Final Recommendations:

To recover and utilize the target materials identified in the 2009 Wisconsin Waste Characterization Study, a variety of options are available. The strategies outlined previously are the suggested courses of action that Brown County could take to divert and utilize residential organic food scraps, C&D waste materials, and consumer plastics #3-7 respectively.

Brown County could invest in a BIOFERM™ Dry Fermentation System to accept organic materials after a drop-off collection system for residential food scraps is implemented if the program is overwhelmingly successful. The BIOFERM™ Dry Fermentation System could utilize collected residential organic food scraps collected from the drop-off collection program as well as excess manure from local farms or organic materials from area businesses and institutions if found to be cost effective. Using this technology has the advantage of being able to accept meat and dairy products in addition to fruit and vegetables. The BIOFERM™ Dry Fermentation System technology could be utilized because it is scalable and could be expanded as more organic materials are collected from the BOW region. Utilizing this technology could safely divert large amounts of organic materials such as food scraps and yard waste as well as manure. This technology requires less processing during and after the digestion process compared to wet anaerobic digestion systems. Dry-fermentation systems also avoid having to safely deal with low-solids byproducts that are created by wet-fermentation systems. The facility could be placed in the recommended Resource Recovery Park section of the South Landfill site. A preliminary site plan for the resource recovery park is shown below.

To recover more C&D materials from the waste stream, Brown County could consider writing and passing waste reduction ordinances for construction and demolition projects within the county to compel construction companies to write material management and waste reduction plans for each project. Applying for Federal grants to assist companies in writing material management plans could be examined as well. Implementing local waste management plan ordinances may be difficult to pass in the current political climate; additional education efforts would also have to accompany any newly created waste management plan ordinances.

The BCRRD could also seek out a partnership with private companies to increase recycling rates of carpet and glass from construction projects. By partnering with Interface Flooring, used carpet could be collected at the resource recovery park and sent to Interface Flooring’s recycling facilities.

To increase diversion of plastics #1-7, Brown County could develop an education campaign in collaboration with Outagamie and Winnebago counties to increase recycling rates of all consumer plastics prior to the additional manual sorting technology coming online at the BOW MRF in fall of 2014. A BOW-wide education campaign for consumer plastics recycling should use a consistent message and use of symbols across a wide range of media to educate and generate excitement about plastics recycling.
Proposed Site Plan for Resource Recovery Infrastructure:

Overall Site Characteristics:

The site plan shown below, is a map of the Brown County South Landfill Site in the town of Holland. The parcel of land chosen by the BCRRD as the site for the future South Landfill is located in the southwest corner of Brown County. The property to the southeast corner of South landfill site is a privately owned farm that is shaded light yellow on the site map. Screening berms (light green) created from extraction of soil during the landfill construction process could be moved to the outskirts of the landfill site and made into screening berms that would serve to eliminate much of the visual access to the landfill site once it begins operation. The screening berms surround most of the southern, eastern, and northern exposures of the landfill. The screening berms were designed to be 30ft wide and 10ft high. A forest flanks the western side of the landfill, so creating a visual screening berm on the western side of the landfill may be unnecessary. The municipal/industrial landfill itself appears in orange on the site map and takes up most of the overall site. Streams were identified and surrounded by a 200ft buffer to prevent the areas close to streams from being developed. This would serve to reduce the risk of water pollution and erosion issues to the streams located on the property.

Front Entrance Characteristics:

The front entrance to the landfill site can be accessed by the western entrance off of Mill Road in the town of Holland. The exit is to the east of the western entrance. Trucks entering the site can be weighed on one of two scales (black) next to the administrative building (yellow); two scales are suggested in order to avoid traffic jams that may occur when incoming trucks are being weighed in. The Outagamie County landfill also has two scales for this reason. Parking for the administrative office is located to the western portion of the paved area in the front entrance area. The south access road to the landfill surrounds the administrative office and scales to the north and south in order to allow better flow of traffic at the landfill site for vehicles that do not need to be weighed in. In the eastern part of the landfill entrance area, a proposed BIOFERM™ Dry Fermentation facility appears in light orange. The size of the facility was measured and recreated on the Brown County South landfill site by measuring the existing BIOFERM™ facility in Oshkosh, Wisconsin. The expansive paved area between the administrative building and the proposed BIOFERM™ facility could be used as a staging area for materials destined either for the BIOFERM™ facility or the landfill. The area south of the administrative building could be used as a storm-water collection basin.

Central Site Characteristics:

The central area of the landfill is accessible by a two-lane road leading to various areas of the municipal/industrial working face of the landfill. The light blue building in the central area is a maintenance shed, whose size was determined of measuring the Outagamie County landfill’s maintenance shed. A landfill gas-to-energy facility that appears in light blue is centrally located to reduce the distance needed to pipe landfill gas to the facility after the landfill has been capped. A leachate collection and pumping building that appears in light purple is also located centrally to reduce the distance needed to pipe leachate to the pumping station. The access road extends south to the central area of the site. A large cul-de-sac was created for large trucks to turn around and safely exit the
landfill site after depositing their contents in the working face of the landfill. The area to the east of the access road to the central landfill site could be used in the future for siting resource recover infrastructure such as a wet MRF to source separate valuable materials from the trash. This area could be used for siting an aerobic windrow composting facility or a repair/materials reuse center.

Proposed Resource Recovery Site Plan at South Landfill:
Front Entrance:

Brown County South Landfill: Theoretical Site Plan

Legend

- Administrative Office
- BIOFERM Digester Facility
- Scales
- Road / Parking Lot
- Screening Berm
- Stream Buffer 200ft

Created By: Kyle Sandmire
Creation Date: 4/15/2014
Central Site:

Brown County South Landfill: Theoretical Site Plan

Legend:
- Leachate Collection
- Maintenance Shed
- Landfill Gas-to-Energy Facility
- Municipal/Industrial Landfill Site
- Screening Berm
- Road / Parking Lot
- Stream Buffer 200ft
- Stream

Created By: Kyle Sandmire
Creation Date: 4/15/2014
Conclusion:

It is clear that there are plenty of opportunities to increase BOW’s recovery of residential organic food scraps, recyclable C&D materials, and consumer plastics #3-7. In order to beneficially use residential organic food scraps instead of sending these materials to the landfill, a collection scheme must be implemented. Brown County has taken preliminary steps, through the data collected in the survey in Appendix 1 to begin design of a drop-off collection program to collect food scraps in the county. Once collected, the food scraps could be digested either aerobically to produce compost, or anaerobically in wet or dry fermentation systems to capture methane gas during the decomposition process. The methane gas collected through the anaerobic digestion system could be further processed to create CNG to fuel vehicles, or combusted to create electricity and heat for the onsite operations. With most of the space at Brown County’s South Landfill site, it makes more sense to build an anaerobic digestion facility that takes up less space than an aerobic windrow composting operation. Building an anaerobic digestion facility at the South Landfill site could also allow for a CNG fueling station to be built that would allow the hauling vehicles a fueling station on site, making it a one stop shop. This has the potential to increase routing efficiencies and fuel economies of waste hauling fleets if they begin to transition away from gasoline powered vehicles and towards CNG vehicles. Further studies should be conducted to study the potential benefits of adjusting collection and hauling routes should a CNG fueling station be sited at the South Landfill.

Wisconsin landfill bans of certain C&D materials have helped to spark the creation of a C&D recycling industry in Wisconsin. To improve recovery of C&D materials, BOW could look to create public/private partnerships for recycling carpeting and construction grade glass. Local ordinances could also be considered for implementing mandatory Waste Reduction Plans for construction and demolition projects to promote resource recovery and recycling of C&D materials on the job site. Implementing statewide landfill bans for materials such as construction grade glass and carpet would also help spur business opportunities for recycling these materials.

As for recovering consumer plastics #3-7, the BOW MRF has already decided to add new manual sorting lines to recover these plastic resin types. By allowing all consumer plastics to be recycled in the BOW’s single stream recycling scheme, resident participation and recovery of all plastics will increase due to being able to throw all plastic with a triangular recycling symbol into the recycling bin. Further education campaigns for plastics recycling could help to further increase participation as well as reduce the chances of improper participation. Future studies could be developed to examine the effects of adding the capacity to recycle consumer plastics #3-7, and the effects the decision had on recycling rates and tonnages in the BOW as a whole.

These proposed technology and policy tools, if implemented, could greatly increase the recovery rate of the valuable target materials from the waste stream for BOW. Diverting residential organic food scraps, recyclable C&D materials, and consumer plastics #3-7 from the waste stream would generate revenue from the resale of the source separated end products to area businesses and industries thereby extracting value from materials once destined for the landfill. These steps would begin the overall transition away from wasting these target materials via landflling, extend the life of the new landfill and move closer towards the goal of creating zero waste.
Works Cited:


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Appendix 1. Drop-off Organics Program Survey

Brown County Residential Organics Management Drop-off Options Survey

Please respond to the survey as completely and accurately as possible. If you have any questions regarding the survey or would prefer to discuss this matter by phone, please call Dean Haen at (920) 492-4950. If more space is needed to respond adequately please send additional information to Dean Haen at Haen_DR@co.brown.wi.us.

1. Name of Municipality: ________________________________

2. Contact Name: ________________________________

3. Contract Work Address: ________________________________

4. Phone Number: ________________________________

5. Email Address: ________________________________

Could you please explain your PREVIOUS or EXISTING residential drop-off organics collection program.

6. Has your municipality used, or is currently using a drop-off collection program for residential organic materials?

   Yes       No

7. Number of years the drop-off program has been operating?

   <1 year       6 years
   1 year       7 years
   2 years       8 years
   3 years       9 years
   4 years      10 years
   5 years   > 10 years
8. Is your program mandatory, voluntary, or subscription?
Mandatory
Voluntary
Subscription

9. What types of each type of residential organic material do you collect?

<table>
<thead>
<tr>
<th>Food Scraps (all)</th>
<th>Seafood</th>
<th>Pizza Boxes</th>
</tr>
</thead>
<tbody>
<tr>
<td>Vegetables</td>
<td>Egg Shells</td>
<td>Yard Waste</td>
</tr>
<tr>
<td>Fruits</td>
<td>Coffee Grounds</td>
<td>Grass Clippings</td>
</tr>
<tr>
<td>Meat</td>
<td>Dairy Products</td>
<td>Compostable Cutlery</td>
</tr>
<tr>
<td>Poultry</td>
<td>Soiled Paper</td>
<td>Biodegradable Take-out Containers</td>
</tr>
<tr>
<td>Fish</td>
<td>Waxed Cardboard</td>
<td>All of These</td>
</tr>
</tbody>
</table>

10. Municipality Population?

<table>
<thead>
<tr>
<th>Population Range</th>
<th>Number</th>
</tr>
</thead>
<tbody>
<tr>
<td>&lt; 50,000</td>
<td></td>
</tr>
<tr>
<td>50,001 - 100,000</td>
<td></td>
</tr>
<tr>
<td>100,001 - 250,000</td>
<td></td>
</tr>
<tr>
<td>&gt; 250,001</td>
<td></td>
</tr>
</tbody>
</table>

11. Tons of municipal solid waste generated annually in your municipality?

12. Tons of food scrap organic materials generated annually?

Could you please provide the following information regarding the drop-off locations.

13. How many drop-off sites did your program have when it was first started?

14. How many drop-off sites does your program have today?

15. Which days of the week are the drop-off locations open?

Sunday   Monday   Tuesday   Wednesday   Thursday   Friday   Saturday
16. What are the hours of operation for the drop-off locations each day?

Sunday: 
Monday: 
Tuesday: 
Wednesday: 
Thursday: 
Friday: 
Saturday: 

Could you please explain the layout and infrastructure present at each drop-off location.

17. How many bins and or dumpsters are present at each drop-off site?

1  
2  >4

18. What size bins are used at the drop-off site?

19. How do you deal with or prevent odor, contamination, and unwanted drop-offs during non-operating hours at the drop-off locations?

20. Do your drop-off locations utilize fencing or any other security mechanisms? If “YES”, what types?

Fencing Security Camera

Locked bins Secured Access for Residents

Other (please specify)

21. Describe your facility’s layout and design (photos or site plans via email)?

Could you please explain the frequency of services (pick-ups) at the drop-off sites.
22. How often do you service bins at drop-off sites?

Daily

Every other day

Once per week

Other (please specify)

Could you please explain the following measures of performance.

23. What is the frequency of participating households (drop offs/household/week)?

24. Amount (lbs.) of residential organics collected per year?

Could you please explain the costs of the following.

25. Total costs of the program per year?

26. Annual operating cost of the drop-off location(s)?

27. Cost per month or year for residents?

28. Initial construction cost of individual drop-off site? If possible breakdown the bins, fencing, and signage cost, ect.?

If your program allows for use of compostable bags for residents, could you please respond to the following questions.

29. Does your program allow compostable bags? If “YES”, which types do you allow?

Biobags

We do not allow the use of biodegradable bags.

Biotuf bags

Other (please specify)
30. If the program is “subscription”, what information is needed from residents wishing to participate?

- Personal ID
- Subscription Membership ID
- Drivers License
- Other (please specify)

Could you please respond to the following questions.

31. Do you know of any other communities that use drop-off for residential food scraps? If “YES” please list these communities.

32. What kind of educational and promotional efforts have you used for your drop-off collection program (could you please provide examples via email or hard copy)?

33. Overall what did your program do well and or poorly?

34. Are there any other unforeseen problems or changes you would recommend if you had to do it all over again?
Appendix 2. Survey Results

Brown County Residential Organics Management Drop-Off Collection Municipality Survey Responses:
Northampton, Massachusetts
Boulder, Colorado
Duluth, Minnesota
Fennimore, Wisconsin

1. Name of Municipality:
   Northampton, Massachusetts
   Boulder, Colorado
   Duluth, Minnesota
   Fennimore, Wisconsin

2. Contact Name:
   Northampton, Massachusetts:
   David Veleta
   Boulder, Colorado:
   Jeff Callahan
   Duluth, Minnesota:
   Susan Darley-Hill
   Fennimore, Wisconsin:
   Dennis Biddick

3. Contact work Address:
   Northampton, Massachusetts:
   125 Locust Street, Northampton, Massachusetts 01060
   Boulder, Colorado:
   1901 63rd St, Boulder CO, 80301
   Duluth, Minnesota:
   2626 Courtland St., Duluth, MN 55812
   Fennimore, Wisconsin:
   860 Lincoln Ave, Fennimore, WI

4. Phone Number:
   Northampton, Massachusetts:
   413-587-1570 x4310
   Boulder, Colorado:
   720-564-2221
   Duluth, Minnesota:
   218-740-4787
   Fennimore, Wisconsin:
   608-822-6501
5. Email Address:
Northampton, Massachusetts: dveleta@northamptonma.gov
Boulder, Colorado: jcallahan@bouldercounty.org
Duluth, Minnesota: susan.darleyhill@wlssd.com
Fennimore, Wisconsin: dpw@fennimore.com

6. Has you municipality used, or is currently using a drop-off collection program for residential organic materials?
Northampton, Massachusetts: Yes
Boulder, Colorado: Yes
Duluth, Minnesota: Yes
Fennimore, Wisconsin: Yes

7. Number of years the drop-off program has been operating?
Northampton, Massachusetts: 2 years
Boulder, Colorado: > 10 years
Duluth, Minnesota: 8 years
Fennimore, Wisconsin: > 10 years

8. Is your program mandatory, voluntary, or subscription?
Northampton, Massachusetts: Voluntary and Subscription
Boulder, Colorado: Voluntary
Duluth, Minnesota: Voluntary
Fennimore, Wisconsin: Voluntary
9. What types of residential organic materials do you collect?

Northampton, Massachusetts:
Food Scraps (all), Vegetables, Fruits, Meat, Poultry, Fish, Seafood, Egg Shells,

Boulder, Colorado:
All of These

Duluth, Minnesota:
Food Scraps (all), Vegetables, Fruits, Meat, Poultry, Fish, Seafood, Egg Shells,
Coffee Grounds, Dairy Products, Soiled Paper, Compostable Cutlery, Biodegradable
Take-out Containers

Fennimore, Wisconsin:
Vegetables, Fruits, Yard Waste, Grass Clippings

10. Municipality Population?

Northampton, Massachusetts:
< 50,000 (28,592 – 2012 Census)

Boulder, Colorado:
> 250,001 (305,318 – 2012 Census)

Duluth, Minnesota:
50,001 - 100,000 (86,211 – 2012 Census)

Fennimore, Wisconsin:
< 50,000

11. Tons of municipal solid waste generated annually in your municipality?

Northampton, Massachusetts:
~3,000 TPY. Excludes private collection and private transfer station

Boulder, Colorado:
220,817 Tons

Duluth, Minnesota:
~100,000 Tons needs context

Fennimore, Wisconsin:
800 tons solid waste

12. Tons of food scrap organic materials generated annually?

Northampton, Massachusetts:
~50 TPY collected from users of the municipal transfer station

Boulder, Colorado:
91,000 Tons

Duluth, Minnesota:
3,200 Tons

Fennimore, Wisconsin:
500 cubic yards of yard waste
13. How many drop-off sites did your program have when it was first started?
Northampton, Massachusetts: 1
Boulder, Colorado: 1
Duluth, Minnesota: 3
Fennimore, Wisconsin: 1

14. How many drop-off sites does your program have today?
Northampton, Massachusetts: 1
Boulder, Colorado: 2
Duluth, Minnesota: 6
Fennimore, Wisconsin: 1

15. Which days of the week are the drop-off locations open?
Northampton, Massachusetts: Monday-Saturday
Boulder, Colorado: Monday-Saturday
Duluth, Minnesota: Sunday-Saturday
Fennimore, Wisconsin: Monday, Thursday, Saturday

16. What are the hours of operation for the drop-off locations each day?
Northampton, Massachusetts: 7am-4pm daily
Boulder, Colorado: 8am-4pm daily
Duluth, Minnesota: Varies by site.
Fennimore, Wisconsin: Monday and Thursday 4-7pm, Saturday 12-4pm
17. How many bins and or dumpsters are present at each drop-off site?
Northampton, Massachusetts: >4
Boulder, Colorado: 2
Duluth, Minnesota: 2
Fennimore, Wisconsin: No Response

18. What size bins are used at the drop-off site?
Northampton, Massachusetts: 65 gallon totes
Boulder, Colorado: 2 cubic yard
Duluth, Minnesota: Multiple sizes: 1-2 yd. + 65 gallon carts
Fennimore, Wisconsin: No Response

19. How do you deal with or prevent odor, contamination, and unwanted drop-offs during non-operating hours at the drop-off locations?
Northampton, Massachusetts: Odor is controlled in summer months by adding periodic layers of wood chips as a tote is filled. The bins are contained in an open shed with a chain link gate that is locked when the facility is closed.
Boulder, Colorado: These are sites with operators, gates, etc. All is secured at end of day.
Duluth, Minnesota: Weekly disposal; some lime/peat moss treatment
Fennimore, Wisconsin: We only accept yard wastes during posted hours while an attendant is on duty.

20. Do your drop-off locations utilize fencing or any other security mechanisms? If “YES”, what types?
Northampton, Massachusetts: Fencing
Boulder, Colorado: Fencing
Duluth, Minnesota: Fencing, Locked Bins, Staffing at some: vigilant overseers at others
Fennimore, Wisconsin: Fencing, Secured Access for Residents
21. Describe your facility’s layout and design (photos or site plans via email)?
**Northampton, Massachusetts:**
The facility is part of the residential transfer station adjacent to the main DPW building. Food waste is collected in up to 18, 65-gallon totes that are lined with Bio Bags. The totes are in a 3-sided, covered shed with a lockable, chain link gate. Full totes are collected on Mondays and Wednesdays.
**Boulder, Colorado:**
Transfer Station
**Duluth, Minnesota:**
Each site is different.
**Fennimore, Wisconsin:**
We have one drop off site that is just an open yard area next to our composting windrows and cured compost pile. We also accept brush and tree limbs for chipping.

22. How often do you service bins at drop-off sites?
**Northampton, Massachusetts:**
2 times per week
**Boulder, Colorado:**
Unknown. County does not operate; we pay them to receive from the residents.
**Duluth, Minnesota:**
Once per week
**Fennimore, Wisconsin:**
We do not have bins. We push up our pile with an end-loader as needed.

23. What is the frequency of participating households (drop-offs/household/week)?
**Northampton, Massachusetts:**
>400 households participate. Variable drop off frequency, say, 1-2 times/week?
**Boulder, Colorado:**
No Response
**Duluth, Minnesota:**
No Response
**Fennimore, Wisconsin:**
Some are weekly. We also have contractors dropping off more than once a week.

24. Amount (lbs.) of residential organics collected per year?
**Northampton, Massachusetts:**
~50 TPY
**Boulder, Colorado:**
No Response
**Duluth, Minnesota:**
About a tone per week...52 tons
**Fennimore, Wisconsin:**
We collect about 500 cubic yards of yard waste.
25. Total costs of the program per year?
   Northampton, Massachusetts:
   ~$10,000
   Boulder, Colorado:
   Unknown – private sector
   Duluth, Minnesota:
   No Response
   Fennimore, Wisconsin:
   $5500

26. Annual operating cost of the drop-off location(s)?
   Northampton, Massachusetts:
   Not separated from transfer station operations
   Boulder, Colorado:
   No Response
   Duluth, Minnesota:
   Only private hauler pick-up costs (put out for bid); staffing is cost neutral, as they are already there
   Fennimore, Wisconsin:
   $4480

27. Cost per month or year for residents?
   Northampton, Massachusetts:
   Included in vehicle sticker fee for transfer station users. $20/hh/yr for contract bicycle waste haulers
   Boulder, Colorado:
   None
   Duluth, Minnesota:
   Zero Cost
   Fennimore, Wisconsin:
   Built into taxroll.

28. Initial construction cost of individual drop-off site? If possible break down the bins, fencing, and signage cost, etc. ?
   Northampton, Massachusetts:
   Utilized existing space at the transfer station. Bins supplied as part of hauler's contract. Signs made in house. Essentially, $0.
   Boulder, Colorado:
   Zero
   Duluth, Minnesota:
   Purchased sign standards and some magnetic sign door dumpsters: minimal. Fencing was already in place at WLSSD facilities.
   Fennimore, Wisconsin:
   The city already owned the property.
29. Does your program allow compostable bags? If “YES”, which types do you allow?

Northampton, Massachusetts:
We do not allow the use of biodegradable bags. Biobags are used only to line the collection totes.

Boulder, Colorado:
We allow composting bags

Duluth, Minnesota:
Biotuf bags, All BPI-approved bags; we hand out Bag-to-Nature

Fennimore, Wisconsin:
We do not allow the use of biodegradable bags.

30. If the program is “subscription”, what information is needed from residents wishing to participate?

Northampton, Massachusetts:
Other (please specify) - Vehicle registration for transfer station users. Name and address for bicycle contract haulers.

Boulder, Colorado:
Other (please specify) - They get curbside with waste collection.

Duluth, Minnesota:
No Response

Fennimore, Wisconsin:
No Response

31. Do you know of any other communities that use drop-off collection for residential food scraps? If “YES”, please list these communities.

Northampton, Massachusetts:
Amherst, MA Cambridge, MA

Boulder, Colorado:
No

Duluth, Minnesota:
No Response

Fennimore, Wisconsin:
No

32. What kind of educational and promotional efforts have you used for your drop-off collection program (could you please provide examples via email or hard copy)?

Northampton, Massachusetts:
Flyers, local newspaper articles, questionnaires

Boulder, Colorado:
It varies. Our contractor can process meats and fats, so it's everything organic

Duluth, Minnesota:
Neighborhoods community center meetings; civic events and festivals; home show; newspaper, website, radio
**Fennimore, Wisconsin:**
We provide inserts in our utility bills.

**33. Overall, what did your program do well and or poorly?**

**Northampton, Massachusetts:**
Our program has generally done quite well. We started with about 100 households and have grown to over 400. At first we charged $15/HH but, when vehicle permit fees increased, we decided to include food waste drop off in that permit fee. Curiously, about half of our HH food waste is delivered by Pedal People, an independent, bicycle powered waste hauler. They continue to pay us a HH fee of $20/yr for the privilege of using our drop off location. Information about them can be seen at [http://www.pedalpeople.coop/](http://www.pedalpeople.coop/) Our contract hauler delivers all our food waste to a composting site registered

**Boulder, Colorado:**
Should not have promoted bags early. We didn't but City of Boulder did. Residents eventually got used to having their counter top bins and stopped worrying about odors that don't occur if you empty once and a while.

**Duluth, Minnesota:**
Excellent low-problem program

**Fennimore, Wisconsin:**
No Response

**34. Are there any other unforeseen problems or changes you would recommend if you had to do it all over again?**

**Northampton, Massachusetts:**
There is great enthusiasm for this program within the City. Our problem will arise when we exhaust existing available space for food waste collection. We aggressively promote home composting by selling compost bins at cost, but not all food wastes are appropriate for that, so this program fills a need.

**Boulder, Colorado:**
We have a bear problem here near the mountains. We have purchased bear proof bins. But the food sits there with the waste anyway, so composting gets blamed. Not sure if all bear proof containers would have been worth it and whether this extra expense would have tanked the program.

**Duluth, Minnesota:**
Take it slowly!!! Much prefer to speak over the phone about our past 8 years...too much info and not enough time to write all of this down...feel free to call me. Susie

**Fennimore, Wisconsin:**
We only have the site open parts of three days a week. It doesn't always work with citizen’s schedules. We tried leaving the site's gates open unattended for a period to see how things went. Overall, things were fine but we decided to go back to an attended gate just as precaution.
Appendix 3. Sample Waste Management Plan  
Source: (Massachusetts Energy and Environmental Affairs, 2014)

Waste Management Plan

General Contractor: Project:

Designated Waste Management Coordinator:

WASTE MANAGEMENT GOALS:
• This project will recycle, reuse, or salvage at least XX% of the waste generated on-site.

COMMUNICATION PLAN:
• Waste prevention and recycling activities will be discussed at each job site meeting with GENERAL CONTRACTOR employees and subcontractors.
• All GENERAL CONTRACTOR employees have been notified of GENERAL CONTRACTOR’S Source Separation & Recycling Plan on all GENERAL CONTRACTOR’S projects and are obligated to comply with the plan.
• All GENERAL CONTRACTOR employees and subcontractors will receive a copy of this Waste Management Plan (WMP) for PROJECT NAME.
• The subcontract used for this project clearly requires all subcontractors to comply with GENERAL CONTRACTOR’S Source Separation and Recycling Plan.
• Any incidence of contamination of source separated waste materials by a subcontractor will result in a $XXX fine (per the subcontract.)
• All recycling containers will be clearly labeled.
• GENERAL CONTRACTOR will submit detailed monthly reports documenting types and quantities (tons) of materials recycled, reused, salvaged, and disposed.

EXPECTED PROJECT WASTE & HANDLING METHOD:

The following chart identifies the expected waste materials and their expected methods of handling. The handling methods include but are not limited to the following: recycling, reuse, salvage, and disposal. The expected handling methods and/or plan may change if necessary. If additional materials are encountered, they will be added to this chart.

<table>
<thead>
<tr>
<th>MATERIAL</th>
<th>HANDLING METHOD</th>
<th>PLAN</th>
</tr>
</thead>
<tbody>
<tr>
<td>Asphalt</td>
<td>Recycle</td>
<td></td>
</tr>
<tr>
<td>Brick</td>
<td>Recycle</td>
<td></td>
</tr>
<tr>
<td></td>
<td>Reuse/Salvage</td>
<td></td>
</tr>
<tr>
<td>Concrete</td>
<td>Recycle</td>
<td></td>
</tr>
<tr>
<td>Concrete with Rebar</td>
<td>Recycle</td>
<td></td>
</tr>
<tr>
<td>Ledge</td>
<td>Recycle</td>
<td></td>
</tr>
<tr>
<td>Metal (steel, aluminum, copper, beverage containers, others)</td>
<td>Recycle</td>
<td></td>
</tr>
<tr>
<td>Metal Doors (36”x70”)</td>
<td>Salvage</td>
<td></td>
</tr>
<tr>
<td>Item</td>
<td>Action</td>
<td></td>
</tr>
<tr>
<td>----------------------------------------------------------------------</td>
<td>-----------------</td>
<td></td>
</tr>
<tr>
<td>Metal Dock Overhead Doors (8’x10’)</td>
<td>Salvage Recycle</td>
<td></td>
</tr>
<tr>
<td>Metal Dock Levelers</td>
<td>Salvage</td>
<td></td>
</tr>
<tr>
<td>Clean Wood</td>
<td>Recycle</td>
<td></td>
</tr>
<tr>
<td>Wood Stumps</td>
<td>Recycle</td>
<td></td>
</tr>
<tr>
<td>Wood Doors</td>
<td>Salvage</td>
<td></td>
</tr>
<tr>
<td>Gypsum Board (10,000 SF Old Demo)</td>
<td>Dispose</td>
<td></td>
</tr>
<tr>
<td>Gypsum Board – (100,000 SF New generates 10,000 SF Scrap)</td>
<td>Recycle</td>
<td></td>
</tr>
<tr>
<td>Cardboard</td>
<td>Recycle</td>
<td></td>
</tr>
<tr>
<td>Lighting Fixtures (Halide/Sodium Lamps &amp; Recessed Fluorescent Boxes)</td>
<td>Recycle</td>
<td></td>
</tr>
<tr>
<td>Electrical (Conduit &amp; Wiring)</td>
<td>Recycle</td>
<td></td>
</tr>
<tr>
<td>Ceiling Tiles</td>
<td>Recycle</td>
<td></td>
</tr>
<tr>
<td>Carpet</td>
<td>Recycle</td>
<td></td>
</tr>
<tr>
<td>Glass (Glass Block &amp; Windows)</td>
<td>Recycle</td>
<td></td>
</tr>
<tr>
<td>Office Furniture (Panel Desk Cubicles, Metal File Cabinets, Metal Bookcases)</td>
<td>Salvage</td>
<td></td>
</tr>
<tr>
<td>HVAC Duct</td>
<td>Recycled</td>
<td></td>
</tr>
<tr>
<td>HVAC Duct Insulation</td>
<td>Dispose</td>
<td></td>
</tr>
<tr>
<td>Other Insulation</td>
<td>Recycle</td>
<td></td>
</tr>
<tr>
<td>VCT/Linoleum</td>
<td>Dispose</td>
<td></td>
</tr>
<tr>
<td>Other Packaging Material (Plastics, Foam, etc.)</td>
<td>Recycle</td>
<td></td>
</tr>
<tr>
<td>White Paper</td>
<td>Recycle</td>
<td></td>
</tr>
<tr>
<td>Hazardous Materials</td>
<td>Dispose</td>
<td></td>
</tr>
<tr>
<td>Misc. Materials &amp; Any Non-recyclable material from above</td>
<td>Dispose</td>
<td></td>
</tr>
</tbody>
</table>

*Disposed by authorized hazardous wastes handler.*
Appendix 4: 2011 National Plastics Recycling Estimates

(Moore Recycling Associates Inc., 2013) – Non-Bottle Recycling Estimates:

### National 2011 Non-Bottle Recycling Estimates
(millions of lbs.) by Resin Type

<table>
<thead>
<tr>
<th>Plastic ID Code</th>
<th>Resin Type</th>
<th>Amount</th>
<th>%</th>
</tr>
</thead>
<tbody>
<tr>
<td>#1</td>
<td>PET</td>
<td>84.1</td>
<td>9.01%</td>
</tr>
<tr>
<td>#2</td>
<td>HDPE</td>
<td>288.9</td>
<td>30.93%</td>
</tr>
<tr>
<td>#3</td>
<td>PVC</td>
<td>365.1</td>
<td>39.09%</td>
</tr>
<tr>
<td>#4</td>
<td>LDPE</td>
<td>14.6</td>
<td>1.56%</td>
</tr>
<tr>
<td>#5</td>
<td>PP</td>
<td>22.5</td>
<td>2.41%</td>
</tr>
<tr>
<td>#6</td>
<td>PS</td>
<td>7.4</td>
<td>0.79%</td>
</tr>
<tr>
<td>#7</td>
<td>Other</td>
<td>151.3</td>
<td>16.20%</td>
</tr>
<tr>
<td><strong>Total:</strong></td>
<td></td>
<td>933.9</td>
<td>100.00%</td>
</tr>
</tbody>
</table>

(American Chemistry Council, 2012) – Bottle Recycling Estimates:

### National 2011 Bottle Recycling Estimates (millions of lbs.) by Resin Type

<table>
<thead>
<tr>
<th>Plastic ID Code</th>
<th>Resin Type</th>
<th>Amount</th>
<th>%</th>
</tr>
</thead>
<tbody>
<tr>
<td>#1</td>
<td>PET</td>
<td>1604</td>
<td>61.06%</td>
</tr>
<tr>
<td>#2</td>
<td>HDPE</td>
<td>973.9</td>
<td>37.08%</td>
</tr>
<tr>
<td>#3</td>
<td>PVC</td>
<td>43.8</td>
<td>1.67%</td>
</tr>
<tr>
<td>#4</td>
<td>LDPE</td>
<td>1.2</td>
<td>0.05%</td>
</tr>
<tr>
<td>#5</td>
<td>PP</td>
<td>1</td>
<td>0.04%</td>
</tr>
<tr>
<td>#6</td>
<td>PS</td>
<td>0</td>
<td>0.00%</td>
</tr>
<tr>
<td>#7</td>
<td>Other</td>
<td>2.9</td>
<td>0.11%</td>
</tr>
<tr>
<td><strong>Total:</strong></td>
<td></td>
<td>2626.8</td>
<td>100.00%</td>
</tr>
</tbody>
</table>

Total:

### 2011 Total Recycled Plastics Estimates (millions of lbs.) by Resin Type

<table>
<thead>
<tr>
<th>Plastic ID Code</th>
<th>Resin Type</th>
<th>Amount</th>
<th>%</th>
</tr>
</thead>
<tbody>
<tr>
<td>#1</td>
<td>PET</td>
<td>1688.1</td>
<td>47.41%</td>
</tr>
<tr>
<td>#2</td>
<td>HDPE</td>
<td>1262.8</td>
<td>35.46%</td>
</tr>
<tr>
<td>#3</td>
<td>PVC</td>
<td>366.3</td>
<td>10.29%</td>
</tr>
<tr>
<td>#4</td>
<td>LDPE</td>
<td>15.6</td>
<td>0.44%</td>
</tr>
<tr>
<td>#5</td>
<td>PP</td>
<td>66.3</td>
<td>1.86%</td>
</tr>
<tr>
<td>#6</td>
<td>PS</td>
<td>7.4</td>
<td>0.21%</td>
</tr>
<tr>
<td>#7</td>
<td>Other</td>
<td>154.2</td>
<td>4.33%</td>
</tr>
<tr>
<td><strong>Total:</strong></td>
<td></td>
<td>3560.7</td>
<td>100.00%</td>
</tr>
</tbody>
</table>