DRAFT REPORT

BUNCOMBE COUNTY AND CITY OF ASHEVILLE

ORGANIC WASTE PROCESSING FEASIBILITY STUDY

APRIL 2015

CDM Smith

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Appendix A – Waste Composition Study

Section 1
Study Scope and Objectives

The City of Asheville (City) and Buncombe County (County) are partnering to perform a feasibility study for an organic waste processing operation at the County's Solid Waste Management Facility. The study focuses on organic waste generated by residential units in the City with the objective of determining the most cost effective and sustainable means of collecting, hauling and processing residential organic waste from the City.

The study includes a waste composition field audit that estimated the percentage of organic items in the post-recycled waste stream from residential units within the City. The waste composition results were used to determine sizing and technological requirements for a processing facility and the quantity of waste that would be diverted from the Subtitle D landfill. Commercially available processing technologies were investigated including composting windrows, covered aerated static piles, aerated block composting, tunnel composting and anaerobic digestion. Conceptual layouts, preliminary costs, and an economic analysis of the preferred options were developed to determine the most cost-effective approach for the City and County.

Residential curbside collection options for organics were assessed to identify operational requirements and cost impacts to the City's current collection operation. Modifications to the existing transfer station are considered for transferring organics to dedicated transfer trailers for delivery to the organics processing facility at the landfill.

Section 2
Waste Composition Study

A waste composition study, provided in **Appendix A**, was conducted to assess the organic content of residential municipal solid waste (MSW) in the City of Asheville (City). A total of 24 samples of post-recycled, residential MSW were taken from waste hauling trucks representing the four collection districts of the City and sorted at the Buncombe County Transfer Station.

Approximately 6 tons of waste was sampled with an average sample weight of 500 pounds. The percentage of organic waste varied from 6 to 45 percent between the 24 samples. The weighted average of the samples was 26 percent with a standard deviation of 9 percent.

Organic waste, as defined for this study, included: food waste, food-contaminated paper products, household plants and yard waste. The list of items used by the sorters for the organic waste category is provided in **Table 2-1**. Only yard waste disposed in a MSW container was included in the organic waste fraction. The study did not include brush or leaves that are collected separately by the City.

Table 2-1 Organic Waste Items

Item	Subcategory
Fruit and vegetable scraps	Food Waste
Meat, shellfish, fish products	Food Waste
Pasta, bread, cereal	Food Waste
Dairy products	Food Waste
Egg shells	Food Waste
Candies and baked goods	Food Waste
Baking ingredients	Food Waste
Herbs and spices	Food Waste
Coffee and tea grounds	Food Waste
Pet food	Food Waste
Yard waste	Vegetative Waste
Household plants including soil	Vegetative Waste
Coffee filters and tea bags	Food Contaminated Paper
Paper towels and paper towel rolls	Food Contaminated Paper
Soiled paper food packaging	Food Contaminated Paper
Pizza boxes	Food Contaminated Paper
Cupcake/muffin wrappers	Food Contaminated Paper
Paper plates	Food Contaminated Paper

Table 2-2 and **Figure 2-1** provide the results of the study.

Table 2-2 Post-Recycled, Residential MSW Composition

Sorting Date /Category	11/4/13 (lbs.)	11/5/13 (lbs.)	11/6/13 (lbs.)	11/7/13 (lbs.)	Total (lbs.)	Mean	Std. Dev.
Organic Waste	958	898	612	739	3207	26%	9%
Recyclable Waste	711	472	558	461	2202	18%	5%
Other Waste	2,070	1,683	1,576	1,429	6,756	56%	11%
Total	3,738	3,053	2,746	2,629	12,166	100%	

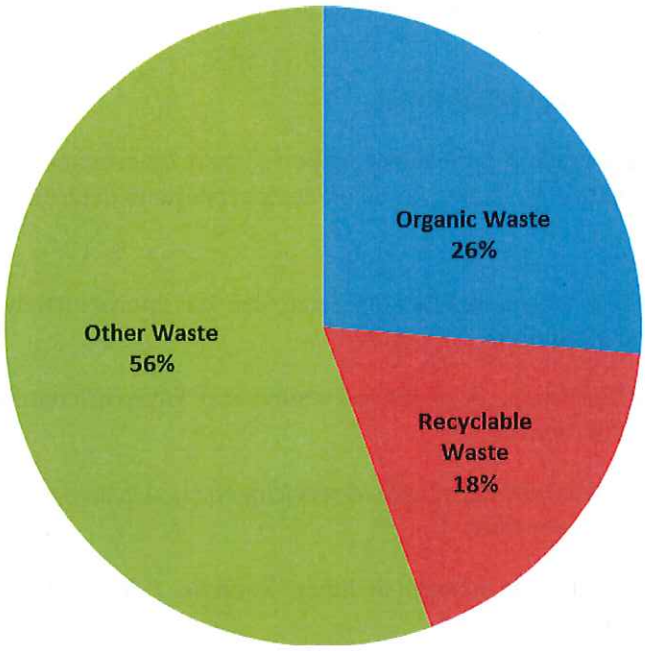


Figure 2-1 City of Asheville Post-Recycled, Residential MSW Composition

Table 2-3 provides the estimated annual quantities that could be diverted to an organic processing facility.

Table 2-3 Organic Waste and Yard Waste Quantities

Waste Type	Estimated Quantity (tons/year)
Residential Organic Waste[1]	5,900
Residential Brush and Leaves[2]	7,200

Notes:

1. Calculated based on 2013 reported MSW tonnage 22,616 tons x 26%
2. 2013 recorded Yard Waste tonnage. Estimated composition of Yard Waste is 80% brush and 20% leaves. Grass clippings are not collected.

Section 3
Site Assessment

Two potential sites were identified at the Buncombe County Solid Waste Management Facility for an organics processing facility based on the screening criteria described below:

- Areas not identified for future use in the Facility Plan.
- A minimum of four acres of reasonably level area that could be developed without requiring extensive earthwork.
- Suitable access for waste hauling trucks.

The 2 sites shown in **Figure 3-1** (Figure end of Section 3) were determined to meet the screening criteria. The sites were further evaluated based on design criteria to determine the preferred site.

Site 1

Site 1 is the current borrow source area for cover material. It is approximately 4.2 acres and has the potential to be expanded if required.

The site is relatively flat but is very rocky and has a number of large rock outcroppings that would possibly require blasting to remove.

The site is easily accessed from the existing road servicing the mulch area and HHW facility and is close to existing electrical power lines.

Stormwater would be routed to the adjacent Sediment Pond No. 7. Verification of the pond capacity would need to be performed.

Delivery of biogas from an anaerobic digestion facility to the landfill gas-to-energy facility would require installation of an 800-ft pipeline to connect to the perimeter gas main.

Site 1 is located in close proximity to the mulching area that uses a tub grinder to shred wood pallets and brush. The mulching area provides a potential location for stockpiling incoming material and could be used as a pre-processing area. The site is also close to the maintenance building providing convenience for servicing rolling stock.

Current plans for this area are to use it as a stockpile area for excess soil when Cell 7 is constructed. Use of this site for an organic processing facility would require an alternative plan for stockpiling the Cell 7 excess soil - estimated to be 200,000 cy.

Site 2

Site 2 is approximately 4.5 acres and is located within the plateau area of the new property parcel purchased in 2013. The parcel was added to the Facility Plan as a part of the Cell 7 construction permit application that is currently under review by the North Carolina Department of Environment and Natural Resources Solid Waste Section (NCDENR SWS).

The site is undeveloped, heavily wooded and subsurface investigations have yet to be performed; therefore, the presence of rock is unknown. Clearing, grubbing, grading and potential rock removal would be required to develop this site.

Access to the site would be challenging due to the steep terrain. A potential alignment for an access road is provided in Figure SD-1. Truck traffic to this site would have to be carefully controlled since the route goes through the citizen drop-off area.

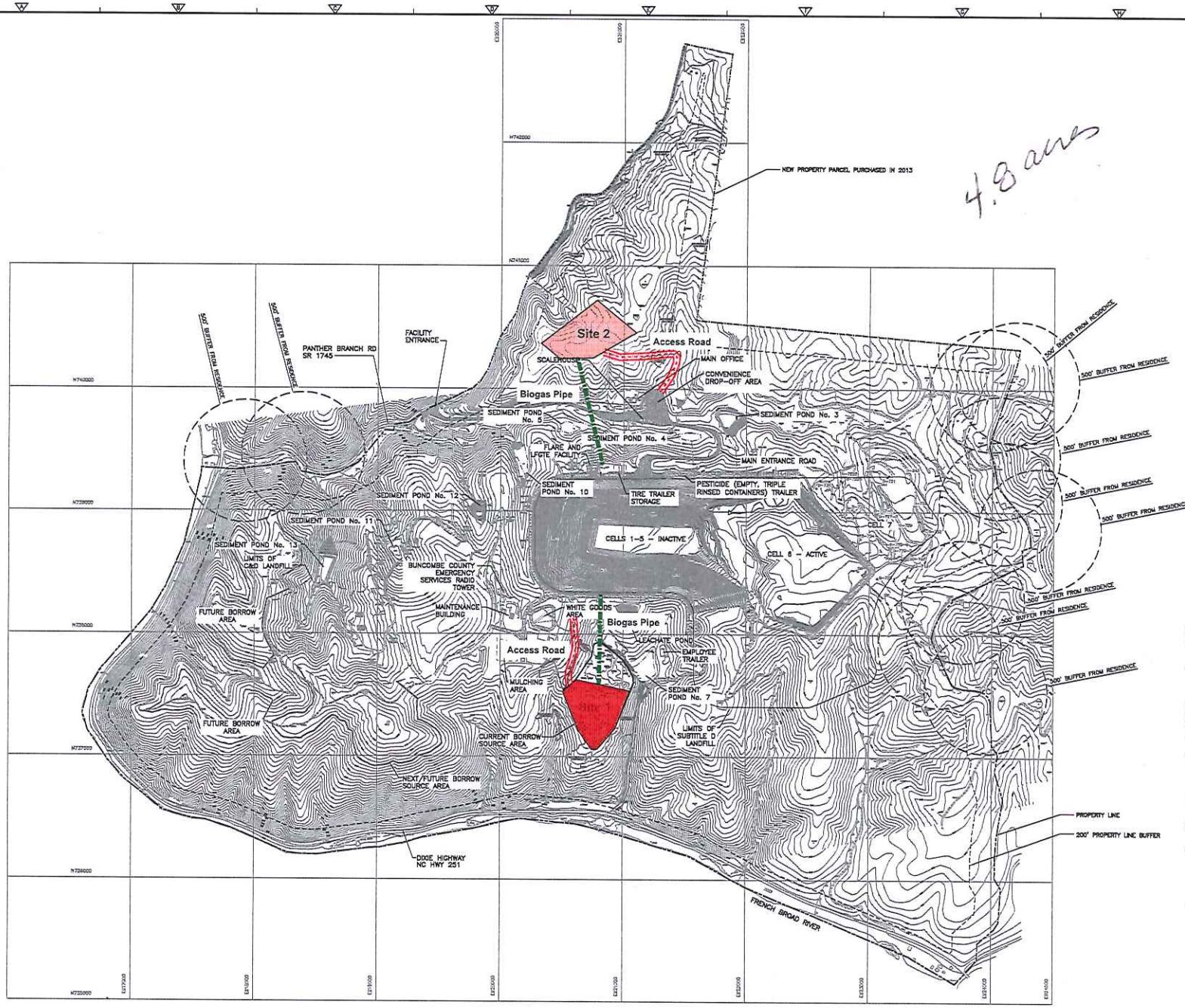
Stormwater management would also be challenging for this site. Delivery of stormwater to Sediment Pond No. 5 would require constructing a stormwater channel down the steep south slope and installing a culvert under the main access road. The capacity of Sediment Pond No. 5 would need to be checked to determine if expansion of the pond would be required.

Delivery of biogas from an anaerobic digestion facility to the landfill gas-to-energy facility would require installation of a 1,000-ft pipeline and crossing of the main access road.

This site is remote in relationship to operations at the facility and would require a long travel distance to the maintenance building for servicing rolling stock. Electrical power lines would also have to be run to this site.

Conclusions

Site 1 is the preferred location for an organics processing facility assuming the facility can be located without removal of the large rock outcroppings or the outcroppings can be removed without blasting. Site 1 advantages include: clearing and grubbing are not required, ease of access, stormwater management is provided by existing infrastructure and it is in close proximity to power and the mulching area.



NOTES:

1. SURVEY OF NEW PROPERTY PURCHASE LOCATED NORTH OF ADMINISTRATION BUILDING BY ED HOLMES AND ASSOCIATES DATED JANUARY 2014.
2. SURVEY OF MSW LANDFILL (CELLS 1-5) BY ED HOLMES AND ASSOCIATES DATED APRIL 2008. SURVEY OF MSW LANDFILL (CELL 6) BY ED HOLMES AND ASSOCIATES DATED AUGUST 2010. SURVEY C&D LANDFILL BY ED HOLMES AND ASSOCIATES DATED JUNE 2008. SURVEY OF MSW LANDFILL (CELL 7) BY ED HOLMES AND ASSOCIATES DATED SEPTEMBER 2012.
3. TOPOGRAPHY OUTSIDE OF MSW AND C&D BOUNDARY LIMITS DERIVED FROM AERIAL SURVEY PROVIDED BY AERODYNAMICS, CHARLOTTE, N.C. JULY 1993.
4.
5. NORTH CAROLINA 1983 GRID DATUM.
6. THIS MAP MEETS NATIONAL MAP ACCURACY STANDARDS FOR 1"=100' SCALE, 10' CONTOUR INTERVAL.
7. CONTOURS WITHIN DENSE FOLIAGE AREAS INDICATE DOUBTFUL ACCURACY DUE TO OBSCURED VIEW FROM VEGETATION, SHADOWS, ETC.

LEGEND

- 2010 — INDEX CONTOUR
- PROPERTY LINE
- PARCEL PROPERTY LINE PURCHASED IN 2013
- ASPHALT ROAD (MAIN ACCESS ROAD)
- UNIMPROVED ROAD
- STONE ROAD
- BLEVIN BRANCH (PERENNIAL STREAM)
- TREELINE
- STRUCTURE
- 200' PROPERTY LINE BUFFER
- MW-10 — EXISTING GROUNDWATER MONITORING WELL
- M-3 — EXISTING METHANE MONITORING WELL
- SW-2 — SURFACE WATER MONITORING LOCATOIN

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BUNCOMBE COUNTY
NORTH CAROLINA

Organics Processing Feasibility Study

Siting Options for Organics Processing Facility

PROJECT NO. 6447-97593
FILE NAME: SD-1.DWG

FIGURE NO.
3-1

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Section 4
Review of Organics Processing Technologies

4.1 Organics Composting Equipment and Processes

Technological evolution in organics processing and biogas utilization has been rapid and profound in the last several years, reflecting the implementation of "zero waste" initiatives across the country and the corresponding focus on full resource recovery. This focus has led to an increasing interest in relatively new high solids digestion processes, as well as resurgence in "traditional" technologies (composting and anaerobic digestion). This is especially true in the area of in-vessel composting, where technologies that had been relatively dormant for decades are being re-examined.

Depending on the technologies that could be used and the types of organic waste that would be targeted, consideration will be given to whether the organic waste can be collected together or needs to be separated by waste type. For example, if an aerobic process like composting is proposed, it may be practical to combine food waste and yard waste in a single collection container. If an anaerobic process like wet digestion is proposed, food waste would need to be kept separate from yard waste.

Co-composting of food waste with yard waste is a well-developed process with a number of successful reference facilities demonstrating a variety of technologies. Most evolved from yard waste composting in response to the demand for food waste recycling. Much of the practical understanding of large scale food and yard waste co-composting was developed at privately operated facilities in the Pacific Northwest—Washington and the Vancouver, British Columbia region.

The production of energy from organic waste is most commonly accomplished through the use of an anaerobic digestion process. In this process, volatile organic materials within the waste are broken down by microorganisms in the absence of oxygen. This biological process produces biogas which is principally composed of methane and carbon dioxide and can be used to produce energy. Anaerobic digestion facilities are more complex than the other technologies described in this section.

Although energy is not recovered, aerobic composting offers some advantages, especially if the feedstocks are high in woody material and seasonally variable. Because of the relatively high construction and operating costs of mechanized in-vessel systems, two simpler technologies have gained prominence in recent years:

- Tunnel-type systems in which tunnels are filled and cleared using front-end loaders. There is no mixing except when material is transferred out of the tunnel to another tunnel or to a curing pile.
- Membrane-covered aerated static pile facilities, in which conventional aerated static piles are covered with a fabric to contain odor emissions.

The turned windrow operation is simple and highly efficient for composting of yard waste. This section discusses alternative equipment and processes that might be considered in the future to meet specific site constraints or to process additional organic waste materials.

The management of organic waste materials through either composting or anaerobic digestion processes involve multiple steps including collection and transportation; receiving and pre-processing; mixing; composting or digestion; and post-processing requirements. The following discussion on processing technologies focuses on the active composting or digestion step only. Post-processing steps, curing and screening for windrow operations, or energy recovery for digestion, are not fully evaluated in this section.

4.2 Turned Windrow Composting

Composting is a biological process that converts organic materials such as biosolids into a humus product. Essentially, it is an acceleration of the same process that breaks down leaves and other organics in nature. The acceleration of this process can generate high temperatures, which significantly reduce any pathogens in the materials composted.

Windrow composting is a cost-effective and flexible approach for managing organic waste materials. The flexible operation allows for the operator to make adjustments to the process to account for changes in feedstock characteristics, weather, and overall process control (temperature, moisture, air circulation, decomposition rate and time, and product consistency). The turned windrow process provides a high degree of flexibility in handling the seasonal variations in woody waste, green waste, and fall leaf collection.

The overall process of windrow composting organic material involves several basic steps regardless of the specific composting technology. A brief description of the steps is provided below.

- ***Bulking Agent Preparation*** — Typically clean wood/brush wastes and yard wastes are the primary sources of bulking agent for a composting operation. Wood wastes must be ground, utilizing a tub grinder, to ensure that they are the appropriate particle size for composting. Utilizing windrows to compost food waste and other organics requires the addition of a bulking agent to ensure proper air circulation through the pile. Ground bulking agents can be stored in stockpiles at the compost facility.

- ***Mixing*** — Bulking agent and organic wastes are often mixed as part of the windrow building process. All materials are brought to the windrow using a front-end loader. A windrow turner or other front-end loader can be used to mix the materials together.

- ***Active Composting*** — Active composting period typically ranges between 21-30 days depending upon the process utilized and the desired compost quality. During this time, the temperature of the composting material is monitored to ensure that it meets pathogen reduction requirements. The composting windrows are turned periodically during this period to aerate the material and meet regulatory requirements. The primary design criteria for active composting are feedstock quantity and quality.

- ***Screening*** — Woody materials and other contaminants (such as plastics, glass, and rocks) are separated from the compost using a trammel screen with screen sizes on average between ¼ to 3/8 inches. Some facilities will sell the screened wood wastes as mulch.

- ***Curing*** — Once regulatory requirements are met, windrows are broken down using a front-end loader and the composted material is taken to curing piles. Composted material remains in the curing piles for about 2-3 months.

In accordance with the *Compost Facility Operating Guide* published by the Compost Council – 9994 Edition, the ideal solids content entering the composting process is 55 percent and upper limit is 60 percent which yields a moisture content range of 40-45%, by weight. At a moisture content higher than 60 percent, the flow of air through the material is constrained. Also, productivity of final screening is greatly decreased if the moisture content is higher than 40 percent because compost with higher moisture content clumps and sticks to the screen.

In some senses, composting is as much art as science, and the importance of in-depth process knowledge cannot be overlooked. Cost-effectiveness and ease of maintenance and operations are key advantages of the turned windrow process. The primary disadvantage is the increased risk of odors and excessive moisture is with the windrow processes. Our experience has shown that over-drying of the windrows can be an issue. If over-drying occurs, the piles may be irrigated with water from a stormwater pond.

Utilizing windrows to process compost from food waste requires additional operational steps to control nuisance animals and odors. Often times a cover material (sawdust, finished compost, or ground yard waste) is placed over the windrow to control odors and access by animals. Windrows are harder to control moisture conditions of the initial mix of food waste and bulking agents as well as during the composting process due to exposure to weather conditions. Higher moisture levels can impact the ability of the composting process to achieve and maintain the high temperatures required to effectively eliminate pathogens in the resulting compost.

The openness and minimal containment associated with windrow operations also make it harder to contain and manage leachate generated during the active composting process. A unique consideration associated with managing food waste is the large amounts of liquid that accompany food deliveries. The US Composting Council has reported that 20 cy dumpster deliveries can contain 20-30 gallons of liquids; and, they recommend that facilities provide for an absorbent bed of material to help control liquids.[1]

In order to maximize the amount of material processed on a particular site utilizing the turned windrow approach, some facilities have switched to a side discharge windrow turner. **Figure 4-1** (Composting Alternatives) shows a side discharge windrow turner where the material is flipped horizontally to an adjacent windrow. All new material is loaded into windrows at one side of the pad and finished material is removed at the opposite side of the pad. This type of operation does not require the use of truck roadways between each pair of windrows. The effective width per windrow is reduced from 30 feet to 24 feet and loader and truck operations become more efficient.

Based on the potential of receiving and processing approximately 15,000 tons per year of material (food waste and leaves/bulky waste), CDM Smith estimates that the required composting area would be in a range of 4-6 acres.

4.3 Aerated Static Pile Composting

The aerated static pile (ASP) composting option is similar to the turned windrow process except the piles/windrows are not typically turned during the active composting step. ASP composting uses

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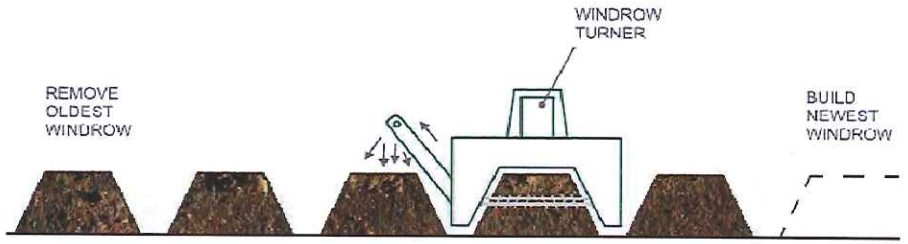
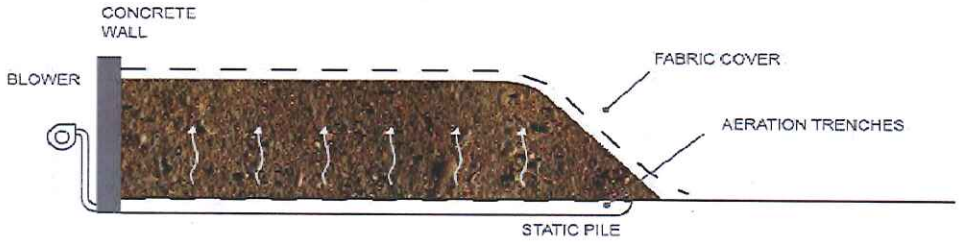
[1] US Composting Council: Best Management Practices for Incorporating Food Residuals into Existing Yard Waste Composting Operations.

SIDE-DISCHARGE WINDROW TURNER



FABRIC-COVERED AERATED STATIC PILE



AERATED BLOCK TURNING
(INSIDE BUILDING)

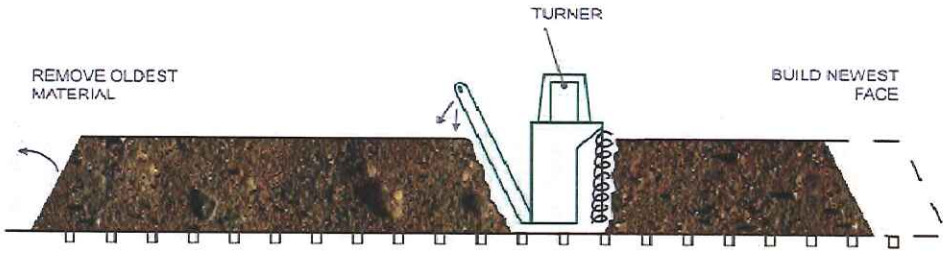


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Figure 4-1
Composting Alternatives

forced air from trenches below the pile (instead of turning the material) to maintain the oxygen content and remove heat and water vapor. This approach results in a more efficient air transfer system than the natural convection occurring in windrows, resulting in shorter processing times, less land area exposed to contact run-off, and less odor emission surface. In the initial generations of aerated static pile composting, the pile was covered with a layer of finished compost to filter out odor emissions. This cover method is used at many biosolids composting operations throughout the country. Aeration may be either positive, in which the air is forced upward through the pile and discharged to the atmosphere, or negative, in which the air is drawn down through the pile and discharged through the blower. One benefit of a negative system is that the air is captured and can be treated with odor control equipment, if necessary. However, even with negative aeration, a significant portion of the odor escapes from the top of the pile due to localized convection currents at the pile surface.

4.3.1 Covered Aerated Static Pile Composting

The next generation of aerated static pile composting processes greatly reduces emissions from the pile surface with a fabric cover over the pile. The covers are unrolled onto the pile and rolled up using a mobile gantry with a roller, that straddles the pile. Fabric covered aerated static pile composting is a practical way to introduce food waste composting on a small scale and ramp up gradually without putting a large amount of capital at risk. A simplified cross-section of this process is shown in Figure 4-1. There are fabric cover versions that use both positive and negative aeration as described below:

1. Positive Aeration with Semi-permeable Fabric Covers:

   This process was developed by W. L. Gore and Associates, Inc., using a semi-permeable fabric cover, similar in principal to Gortex fabric used in water resistant apparel. The process is not proprietary, and there are other manufactures of this type of fabric. Each pile has a blower supplying positive aeration, controlled by temperature probes in the pile and temperature feed-back algorithms. As moisture-laden air reaches the cover, the air can pass through but most of the moisture condenses on the underside, since the pile is hotter than the ambient air. The condensed moisture carries ammonia, volatile organic compounds, and other odorous gasses back into the pile, which helps prevent the release of odors. **Figure 4-2** shows this process being used at the Cedar Grove Composting Facility in Everett, Washington.

2. Negative Aeration with Impermeable Covers and Centralized Aeration Systems.

   This process was developed by Engineered Compost Systems, Inc. (ECS). The fabric cover is an impermeable plastic with vents cut into it at spacing of about 24-inches on center. All the aeration trenches are connected to a single pair of headers, one supplying positive aeration, and one drawing negative air. The pile is connected to the two headers through a valve that can be switched between positive and negative through a central process control system. The air and moisture distribution is enhanced by the ability to alternate negative and positive aeration. The negative header is connected through its fan to a biofilter to remove odor from the exhaust. **Figure 4-3** shows this fabric covered pile process at the Silver Spring Facility in Ranier, Washington.

Figure 4-2
Covered Aerated Static Pile at Cedar Grove in Everett, Washington

Figure 4-3
Covered Aerated Static Pile at Silver Spring in Rainier, Washington

This option offers somewhat greater process control and, potentially, greater odor control as well. The process is costly; however, and is likely to be labor and maintenance intensive. From an operating cost standpoint, significantly higher electrical energy costs for air handling systems utilized is the most significant differentiator between the aerated alternatives and windrowing.

4.4 Aerated Block Composting

Aerated block composting combines aeration with a highly compact turning process, in which there are no windrows, but, instead a single extended pile. A major benefit of the process is space savings — because of the way piles are constructed, there is much less "wasted" space with this process than with windrow operations.

The pile has a vacant moving aisle in which the turner moves material from the face of the aisle to the opposite side of the aisle. As with the side discharge windrows, new material is loaded at one side and completed material is removed on the opposite side. The turner starts at the side with the completed material, displacing it from the composting block, and makes successive passes towards the loading side. When it reaches the last position on the loading side, it leaves the vacant aisle at that side for loading of new material. It is more compact than windrow composting and incorporates the process control of an aerated pile system. Figure 4-1 shows a cross-section of a block composting operation. Turning machines are shown in **Figure 4-4** and **Figure 4-5**. The turner in Figure 4-4 is a Backhus machine. The turner in Figure 4-5 is manufactured by Vermeer Corp, formerly Scat.

Odorous air collected from the process is conveyed to a biofilter (similar to the one provided under the aerated windrow option) for treatment. This composting process is often conducted inside a building to provide complete containment of odor. One building option that is relatively low-cost and resistant to corrosion is a fabric building with an aluminum frame. The Nantucket MA composting facility is an aerated static pile process in a fabric building and is shown in **Figures 4-6** and **4-7**.

4.5 Tunnel Composting

Tunnel composting (also referred to as in-vessel aeration) provides the highest degree of containment and process control. Aerated static piles are built by a loader in covered bins with concrete common walls. Each bin has a sliding door that opens to full width to allow access by the loader for filling and empting the tunnel. The aeration trenches in the floor can supply both positive and negative aeration, and all exhaust is contained in the tunnel. Air is re-circulated and make-up air is added in response to temperature, moisture, and oxygen levels. An equal volume of exhaust air is removed and treated in an odor control system. **Figure 4-8** shows a tunnel system constructed by ECS.

4.6 Anaerobic Digestion

Organic material may be decomposed and stabilized in an anaerobic digestion process. Anaerobic digestion systems are generally categorized based on the solids content of the waste they are able to process. Instead of producing carbon dioxide as the waste gas, anaerobic digestion produces biogas that is typically 60 percent methane and 40 percent carbon dioxide with a heating value that typically ranges from 500 to 650 BTU/cubic foot. This gas may be used as a fuel in stationary engines after it is cleaned to remove moisture and trace acid gases. Engine/generator sets are used to generate electricity from biogases such as methane. Alternatively, the gas may be refined to pipeline quality by removing the carbon dioxide. This high-BTU pipeline quality gas may be fed into a distribution grid or compressed for use as vehicle fuel.

Figure 4-4
Block Turner Machine by Backhus

Figure 4-5
Block Turner Machine by Vermeer

Figure 4-6
Fabric Composting Building at Nantucket-Interior

Figure 4-7
Fabric Composting Building at Nantucket-Exterior

Figure 4-8
Tunnel Composting Building by Engineered Compost Systems, Inc.

Digestion facilities include equipment to process in-coming wastes in order to produce a product that can be easily digested. Processing is expected to include machinery to screen and pulp the wastes, remove contaminants (e.g., glass, plastics, metals, and cardboard), and produce a uniform pumpable material that is readily digestible. The efficiency of an anaerobic digestion system is contingent upon the ability to feed it at a relatively constant rate. Highly variable loading or 'slugs' of feed material being introduced into the process creates a potential for upsets (significant decrease in biogas production), foaming and/or an overall reduction in volatile solids destruction efficiency. As a result of the continuous feeding needs, pre-digestion food waste storage tank(s) may be required if material receiving rates are insufficient to meet the feeding requirements.

Anaerobic digestion plants are typically privately owned and operated merchant facilities, although they may be hosted by public sector agencies and financed using tax-advantaged bonds. With all anaerobic digestion facilities, the gas or energy sales constitute a significant part of the revenue stream. There are two types of anaerobic digestion that could be considered for Buncombe County (County) and the City of Asheville (City).

4.6.1 Wet Anaerobic Digestion

This process is best suited for semi-solid or liquid food waste from food processors because of the need to pump into and mix the waste within a digestion tank. The material is digested in mixed tanks at about 12 to 15 percent solids and the process results in a digestate and biogas. The digested liquid must then be either land-applied if possible, or dewatered and composted. For wet food waste, such as from produce markets, food processors and kitchens, high solids anaerobic digestion is emerging as a highly viable technology and business model. Quasar Energy designs, constructs and operates merchant bio-energy facilities using anaerobic digesters, operating at about 12 percent solids. **Figure 4-9** shows a Quasar Energy facility in Cleveland, OH.

Based on industry research, food waste is often delivered to these facilities at a solids percentage of around 31% (69% water). At this high percentage of solids, even following pre-processing, the resultant product is not conducive to pumping to or mixing within anaerobic digestion tanks. As a result, food waste must be diluted to approximately 13% solids content prior to being introduced to the digestion facility which requires a source of dilution water at the facility.

The high solids liquid digestion process is a compact and odor-free process that may be reproduced anywhere there is a viable market for disposal of industrial food production waste and a market for energy. The wet digestion process provides more opportunity for process monitoring and control. Wet digestion is a proven process and has a significantly larger experience base compared to a dry process,

4.6.2 Dry Anaerobic Digestion

Dry digesters (also referred to as High Solids Anaerobic Digesters (HSAD)) are generally designed to receive waste with between 20% and 50% solids. The HSAD process relies on the feedstock being of a quality that is able to be stacked into a digester tunnel and generally requires a bulking material (generally yard waste) to be added to a source separated organic (SSO) stream to ensure permeability. A SSO stream typically consists of compostable material including food, agricultural, biodegradable products, biodegradable paper, and yard waste, and vegetative materials.

This process can be utilized for a mixture of yard waste and food waste consisting typically of 50 percent of each material. The material is stacked in tunnels similar to tunnel composting; but, the tunnels are heated with hot water pipes in the side walls and are completely sealed to prevent entry of

Figure 4-9
Quasar Energy High Solids Anaerobic Digestion Facility in Wooster, OH

oxygen. Leachate is re-circulated through the pile using overhead sprayers and underdrains. The leachate picks up high concentrations of volatile fatty acids from the anaerobic digestion. The gas may be extracted entirely from the tunnel headspace, or the leachate may be further digested in a tank. The end product does not need to be dewatered, but is composted using one of the aerated processes described above.

Harvest Power operates a facility in Richmond B.C. that is a dry digestion facility as well as a conventional composting facility. Additional dry digestion facilities include the Zero Waste Energy facility in Monterrey, CA and the BioFerm facility in Oshkosh, WI. There are a number of facilities in Europe as well as several proposed for sites in the United States. This technology is rapidly moving into the main stream due to the advantages of co-collection of yard waste with food waste.

Dry digestion requires additional safety concerns and mitigation requirements due to the need to purge the tunnels of biogas following each batch. Dry digestion is inherently less efficient in volatile solids reduction and biogas production and provides minimal opportunity for processing of liquid organic waste (i.e. food processing wastes). Significant volumes of yard waste (or other organic bulking material) are typically required as part of the waste stream on a continuous basis to ensure suitable pile stability, low bulk density and proper percolation within the digester.

4.7 Co-Composting of Food Waste with Wood and Yard Waste

Co-composting of food waste with yard waste is a well-developed process with a number of successful reference facilities demonstrating a variety of technologies. Most evolved from yard waste composting in response to the demand for food waste recycling. Much of the practical understanding of large scale food and yard waste co-composting was developed at privately operated facilities in the Pacific Northwest—Washington and the Vancouver, British Columbia region.

A balanced mix for composting contains dry carbonaceous material such as ground brush and leaves, and wet material with higher nitrogen content. Most food waste falls in the latter category, and the balance between dry carbonaceous material and wet high-nitrogen material is critical. If there is insufficient wet high-nitrogen material, microorganism growth is nitrogen-limited and the result is a very slow composting process. The ideal carbon/nitrogen ratio is in the range of 25-40:1, with the optimum at 30:1 based on the *Compost Facility Operating Guide* published by the Compost Council. Excess nitrogen results in the release of ammonia and other odorous compounds.

In many facilities, food waste is received in an enclosed building to prevent odor emissions. The loads are visually examined and gross contaminants are removed on the tipping floor. Some facilities have picking lines to remove even more of the contaminants. Picking lines are applicable if there are significant amounts of glass, metal, and other packaging materials in the food waste. The food waste is ground in a slow-speed shredder, mixed immediately with ground yard waste, and placed in the composting process. Many facilities have indoor batch mixers to blend the food and yard waste instead of relying on the windrow turner to make the initial mix. The food waste receiving and processing building is usually ventilated to an odor control system such as a biofilter.

Food waste is likely to contain some plastic, glass, and other contaminants. Small contaminant particles are easier to remove after composting. Following composting, the material is typically refined using a fine screen and an air separator to remove plastics. The moisture content should be no greater than 45 percent for efficient refining. Ideally, the screen and air separator are located in the building to prevent flying litter; however, some facilities refine the product outdoors.

The operators at these facilities determined that the maximum feasible percentage of food waste in a food/yard waste composting mix is in the range of 20-25 percent by weight; therefore, a conservative value of 20 percent is used in this assessment. This mix percentage provides a good range of carbon/nitrogen ratio and moisture content.

The initial 45 days of co-composting requires the degree of process control and containment provided by covered aerated static pile, aerated block composting inside a building, or tunnel composting. The co-composting process is controlled through aeration where the forced aeration continuously delivers oxygen to all the pore spaces in the pile and removes heat and water vapor. If the process maintains aerobic conditions and prevents over-heating or over-drying, the compost will generate little odor after 45 days and the subsequent curing stage can take place in outdoor windrows.

4.8 Conclusions

Compared to a windrow turner, a side-discharge turner does not offer any process control or containment advantages, but it will slightly reduce the windrow area footprint and will keep the windrow building and windrow removal activities in stationary locations outside the windrow area, which means trucks and loaders would not have to pass between the windrows. The new windrow is always built along one side of the windrow pad, and the oldest windrow, to be removed, is always on the opposite side of the windrow pad.

Fabric-covered aerated static pile composting provides process control and containment and is used at Cedar Grove and Silver Spring in Washington with mixes that contain 20 percent food waste. If the County and City are interested in co-composting food waste, fabric covered aerated static pile composting would be a good starting point because this process does not require a building. However, process start-up would require extensive civil and electrical construction. In addition, an aerated static pile approach would require a windrow composting area for final curing of the partially completed compost from the aerated static piles; and, handling the excess yard waste and leaves during peak seasons.

Aerated block composting and tunnel composting provide the highest degree of containment and process control. The relative advantages of each would need to be evaluated, considering the following issues:

- Tunnel composting has a higher capital cost than turned block composting in a fabric building.
- More air has to be treated in a fabric building, increasing energy cost.
- A static pile process such as aerated static pile or tunnel composting does not provide the physical break-down of woody material that is provided in a turned process. If the compost from a static process is well screened, it will produce a smaller quantity of higher quality compost but more oversize material that has to be recycled back into the process.

Anaerobic digestion recovers valuable energy which the County can incorporate into the existing power production facility at the Subtitle D landfill. Anaerobic digestion can accept higher percentages of food waste and liquid organic waste. These facilities are relatively complex and typically owned and operated by private sector companies.

Organic processing technologies vary in terms of operational flexibility, odor control, land requirements, processing rates and control, and liquids management (stormwater, leachate, and food residual liquids). **Table 4-1** provides a summary of the primary process differences of the five technologies discussed in this section. A simple rating scheme of low, medium, and high was used to compare each of the technologies to each other. For example, the windrow composting process received a low rating for operational complexity because the windrow composting process is the least complex of the technologies reviewed.

Table 4-1 Summary of Organics Processing Technologies

Organic Waste Processes	Operational Complexity	Process Area Requirement	Odor Control	Liquid Management Requirement	Energy Recovery	Process Control	Processing Rate
Windrow Composting	Low	High	Low	High	N/A	Low	Low
Aerated Static Pile Composting (fabric cover)	Med	Med	Med	Med	N/A	Med	Med
Aerated Block Composting	Med	Med	Med	Med	N/A	Med	Med
Tunnel Composting	Med	Med	High	Low	N/A	High	High
Anaerobic Digestion	High	Low (wet) Med (dry)	High	Low	High	High	High

Section 5
Organic Waste Collection and Hauling Analysis

5.1 Collection Containers

Organic waste from residential units are typically collected curbside in a separate cart that is designed to control odors and prevent leakage. The preferred container is a 24 to 64 gallon wheeled waste receptacle that has a tight fitting or sealable lid. Lockable lids are available for areas prone to bears. The size of the container depends on the frequency of collection and the variety of organic waste items included in the collection program. Compostable bags or replaceable liners can be used to maintain cleanliness. Small containers (often buckets with handles) are commonly used for convenience to temporarily store organic wastes in the kitchen. They are usually 1-3 gallons in size and can be equipped with charcoal filters and compost bags to control odors and maintain cleanliness.

5.2 Organic Waste Categories and Quantities

One of the first steps for developing a household organics waste collection program is to determine which organic waste categories will be included in the program. Food waste, food-contaminated paper waste and yard waste are the three main categories for residential organic waste. Once the categories of collection are selected then a more detailed listing of items can be developed such as the list that was used for the waste composition study (refer to Table 2-1). Quantity estimates are made based on the results of a waste composition study to determine the frequency of collection and sizing of the processing facility.

5.3 Collection Analysis

5.3.1 Existing Residential MSW Collection Program

The City collects approximately 23,000 tons per year of residential municipal solid waste (MSW). Waste is collected once per week from residents placing their bagged waste in 95-gallon roll carts. The City waste collection staff work four, 10-hour days per week and operate 6 trucks two days per week and 7 trucks the other two days. They collect an average of 110 tons of MSW per day.

The City owns 9 automated side-loading trucks (4 CNG and 5 diesel) for MSW collection. Of the 9 trucks the City maintains a minimum of two trucks as spares to ensure that uninterrupted service is always provided to the residents. The CNG trucks purchase cost is $315,000 and the diesel trucks cost $275,000. An average cost of $295,000 is used in the study since the City intends to maintain a 50/50 mix of CNG and diesel collection trucks.

Truck payload capacity is 12.5 tons but the City limits drivers to a maximum payload of 11 tons to avoid overages. The trucks average 2 miles per gallon and the average cost per mile for fuel and maintenance was calculated by the City to be $2.26/mile. Total annual mileage for the MSW collection fleet is approximately 80,000 miles.

Only one employee is required to operate the automated trucks as the driver also operates the side loading device to empty waste containers. The drivers average 1,120 pickups per day and make 2 deliveries per day to the Buncombe County Transfer Station. Drivers start their routes at 7:00 am and

typically make their first delivery to the transfer station between 10:00am – 12:30 pm. The second delivery is generally between 3:00 pm – 5:00 pm. The average round trip haul distance to the transfer station is estimated to be 17 miles. Including queuing and unloading the round trip hauling time is estimated to be approximately 1 hour.

The City also operates a yard waste collection service that includes tree limbs, brush and leaves (lawn clippings are not included). The collected yard waste is taken to Riverside Stump Dump Inc. located at 769 Riverside Drive, Asheville, where it is made into mulch and sold to the general public. As this current service already provides an economical and sustainable means of managing yard waste this study does not consider yard waste in the collection and hauling analysis.

5.3.2 Organic Waste Collection

Daily tonnages for weekly collection of MSW and organic waste are provided in **Table 5-1**. Weekly collection of organic waste would require the purchase of new trucks since the existing fleet is fully accounted for in the current MSW collection operation. Based on the mileage and number of pickups per collection route the City would need to purchase 6 or 7 new trucks and hire 5 or 6 new drivers depending on the hauling option as described below.

Table 5-1 Daily Quantities for Collection of MSW and Organic Waste

Collection Scenario	Tons Per Year	Average Tons Per Day[1]
Current MSW Collection	23,000	110
MSW Collection Less Organic Waste	17,100	82
Organic Waste Collection	5,900	28

Note 1: Based on 4-day workweek and 100% participation in the organics collection program

5.4 Hauling Analysis

The organic waste could be hauled directly by the collection trucks to the proposed processing facility at the Buncombe County Landfill or it could be hauled to the Buncombe County Transfer Station and delivered to the landfill via County transfer trucks. Analysis of the two options is provided below.

5.4.1 Hauling Analysis

The average round trip distance from Asheville to the landfill is estimated to be 28 miles. Including queuing and unloading time at the processing facility the estimated hauling time is 1.5 hours per trip (assuming an average speed of 25 mph and 20 minutes unloading time). Based on the current MSW collection operation a fleet of 6 trucks would be adequate to complete all of the pickups within the allotted time. If 6 trucks are used to collect organic waste then each truck will collect about 5 tons of organic waste per day (28 tons/6 trucks = 4.7 tons per truck). Since 5 tons is well below the payload capacity of 11 tons established by the City, the drivers will be able to deliver all of the waste on their route in one trip to the landfill.

The landfill closes the gates to haulers at 4:15 pm, giving the City drivers approximately 8 hours to complete their routes and depart for the landfill by no later than 3:30 pm. The hauling time for this scenario is less than the hauling time required for the current MSW collection (i.e.; 1 trip to the landfill at 1.5 hours < 2 trips to the transfer station at 1 hour each) so it is safe to assume that the

drivers would have sufficient time to complete their routes and get to the landfill before the gates are closed at 4:15pm. A summary of the direct haul option is provided in **Table 5-2.**

Table 5-2 Summary of Direct Haul Option

	Average Tons per Day[1]	Number of Collection Trucks Required to Complete the Routes	Number of Collection Trucks Required to Purchase[2]	Allotted Time to Complete Collection Routes[3]
Collection of Organic Waste	28	6	7	7.5 hours

Notes:
1. Based on 4 days of collection per week and 100% participation in organics program.
2. Includes 6 operating trucks and 1 spare truck.
3. Assumes 7:00 am start time, 0.5 hour lunch and route completion by 3:30pm.

5.4.2 Hauling to the Buncombe County Transfer Station

The Buncombe County Transfer Station has two receiving bays - one large bay for receiving MSW and one small bay for receiving recyclables as shown in **Figure 5-1.** The recycling bay is used primarily by residential customers to drop off recyclables at an average rate of 15 tons per week. The larger MSW bay is divided into two areas: one area for residential customers and one for commercial and City trucks.

Figure 5-1 Interior View of Buncombe County Transfer Station

The recycling bay is equipped with a feed hopper as shown in **Figure 5-2** that guides the materials to the lower floor of the transfer station where a hydraulic ram is used to push the material into a transfer trailer. If the residential recycling drop-off area were to be moved to a location outside the building this bay could be used for transferring organic waste from the City collection trucks into County transfer trucks for delivery to the landfill.

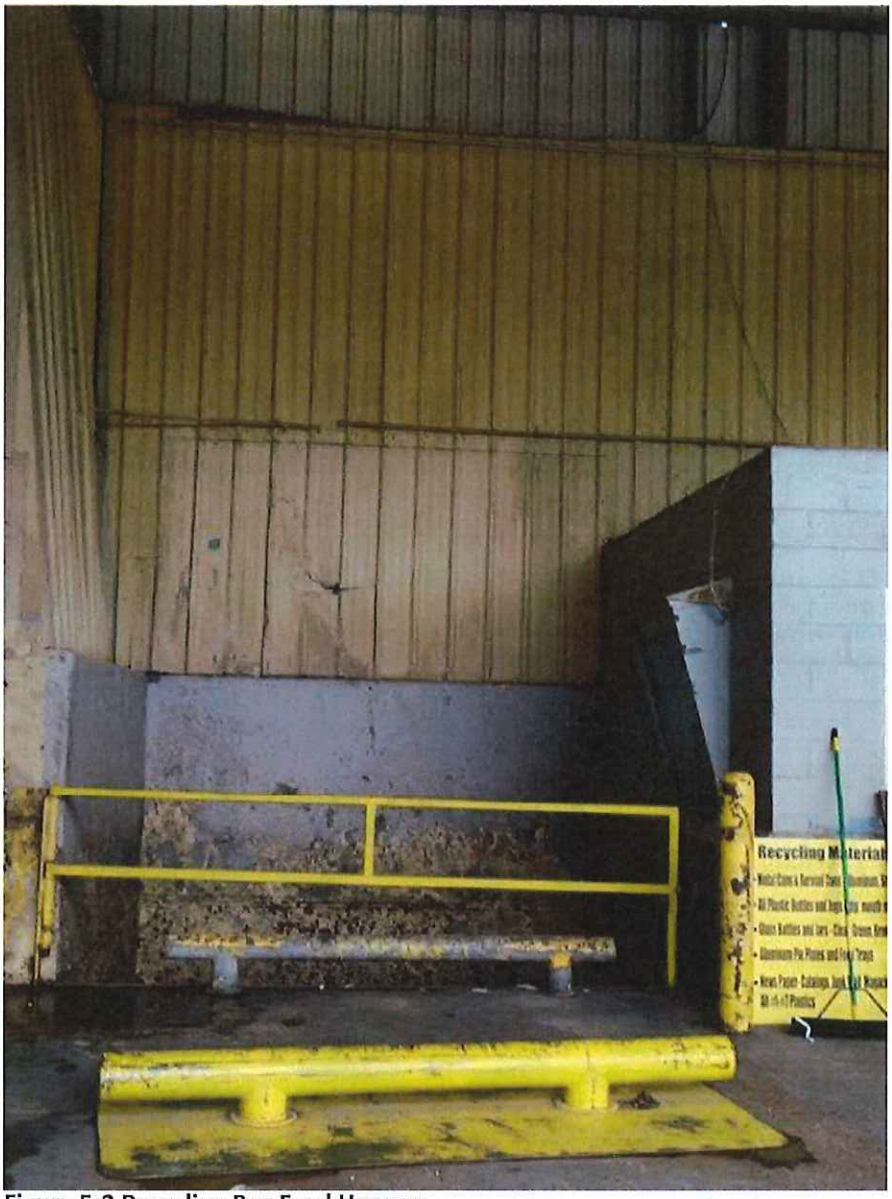


Figure 5-2 Recycling Bay Feed Hopper

Since the amount of organic waste collected is less than the payload of the collection trucks only one delivery per day to the transfer station would be required to complete the routes. Omitting a second delivery would provide an additional hour of collection time per route which would reduce the number of trucks required for organics collection from 6 trucks to 5 trucks.

The five transfer trucks owned by the County are fully utilized for the MSW transfer operation. Therefore, transfer of organic waste would require the purchase of new trucks at a cost of $210,000 per truck. The estimated fuel and maintenance cost for the transfer trucks is $2.40/mile as reported by the County. Due to the limited storage capacity of the recycling bay (estimated to be less than 5 tons) a minimum of two new transfer trucks would be required to allow offloading of the collection trucks within the operating hours of the transfer station and landfill.

Since all of the collection trucks would be arriving in the afternoon it is anticipated that one transfer truck would make a delivery in the afternoon and the second transfer truck would be held overnight at the transfer station and make its delivery in the morning. This would require expanding the containment area currently used for storing MSW transfer trucks. It is assumed that one additional transfer truck driver would be adequate to make the 2 trips to the landfill each day. **Table 5-3** provides a summary of the truck requirements for this option.

Table 5-3 Summary of Transfer Station Option

	Average Tons per Day[1]	Number of Collection Trucks Required to Complete the Routes	Number of Collection Trucks Required to Purchase[2]	Number of Transfer Truck Trips Per Day[3]	Number of Transfer Trucks Required to Purchase[4]
Collection of Organic Waste	28	5	6	2	2

Notes:
1. Based on 4 days of collection per week and 100% participation in organics program.
2. Includes 5 operating trucks and 1 spare truck.
3. Based on 16 ton payload capacity per transfer truck
4. Transfer trucks can make up to 2 landfill deliveries per day

5.5 Capital Costs

5.5.1 Direct Haul to the Buncombe County Landfill

Capital costs for the direct haul option include: indoor collection containers, curbside collection carts, and automated collection trucks. The estimated capital costs are provided in **Table 5-4.**

Table 5-4 Capital Costs for Collection and Direct Haul to Buncombe County Landfill

	Quantity	Cost Per Unit	Cost
Indoor Collection Containers	30,000	$20	$600,000
Curbside Collection Carts	30,000	$50	$1,500,000
Automated Collection Trucks[1]	7	$295,000	$2,065,000
Total Capital Cost			**$4,165,000**

Notes: 1. Assumes a 50/50 mix of CNG and diesel trucks at an average cost of $295,000

5.5.2 Hauling to the Buncombe County Transfer Station

Capital costs for hauling to the transfer station would include: indoor collection containers, collection carts, automated collection trucks, transfer trucks and relocation of the residential recycling dropoff area.

A conceptual design of a relocated recycling drop-off area was prepared based on discussions with the transfer station manager, Dane Pedersen. The design, as shown in **Figure 5-3** (provided at end of section), includes a paved area located south of the maintenance building with four, 40-cubic yard rolloff containers and a 4-ft high retaining wall. An opinion of probable construction cost was prepared by CDM Smith's construction division and is provided in **Appendix A.** Including a 25% contingency, the estimated cost for relocating the residential recycling drop off area is $220,000. The

relocated drop off area would also require a backhoe for densifying the waste in the containers and a rolloff truck to deliver recyclables to Curbside Management, Inc.

The estimated capital costs are provided in **Table 5-5.**

Table 5-5 Capital Costs for Collection and Delivery to Buncombe County Transfer Station

	Quantity	Cost Per Unit	Cost
Indoor Collection Containers	30,000	$20	$600,000
Collection Carts	30,000	$50	$1,500,000
Automated Collection Trucks[1]	6	$295,000	$1,770,000
Transfer Trucks	2	$210,000	$420,000
Relocation of the Residential Recycling Dropoff Area	LS	$220,000	$220,000
Backhoe	1	$100,000	$100,000
Rolloff Truck	1	$200,000	$200,000
Total Cost			**$4,810,000**

Notes: 1. Assumes a 50/50 mix of CNG and diesel trucks at an average cost of $295,000

5.6 Operation and Maintenance (O&M) Costs

5.6.1 Direct Haul to the Buncombe County Landfill

Additional O&M costs incurred by the City waste collection programe for collection and direct haul of organic wastes to the landfill include: salary and benefits for additional drivers and fuel and maintenance costs for new trucks. The additional O&M costs are provided in **Table 5-6.**

Table 5-6 Additional O&M Costs for Collection and Direct Haul to Buncombe County Landfill

	Quantity	Cost Per Unit	Cost
Collection Truck Driver[1]	6	$52,000/Driver	$312,000
Fuel and Maintenance for New Collection Trucks[2]	72,512	$2.26/mile	$164,000
Total Additional Annual O&M Cost			**$476,000**

Notes:

1. Assumes an hourly rate of $17/hr x 1.45 for benefits x 2080 hours/year
2. Recorded annual mileage for MSW trucks less the shorter mileage for making 1 landfill delivery instead of 2 transfer station deliveries. 80,000 – [((17 miles x 2) – 28 miles) x 6 trucks x 208 days] = 72,512

5.6.2 Hauling to the Buncombe County Transfer Station

Additional annual O&M costs incurred by the City waste collection operation and County waste transfer operation for collection and transfer of waste to the landfill include: salary and benefits for a recycling dropoff area and additional collection and transfer truck drivers and fuel and maintenance costs for new collection and transfer trucks. The additional O&M costs are provided in **Table 5-7.**

Table 5-7 Annual O&M Costs for Collection and Use of Buncombe County Transfer Station

	Quantity	Cost Per Unit	Annual Cost
City Collection Truck Driver[1]	5	$52,000/Driver	$260,000
County Transfer Truck Driver[2]	1	$57,000/Driver	$57,000
Fuel and Maintenance for New Collection Trucks[3]	62,320	$2.26/mile	$141,000
Fuel and Maintenance for New Transfer Trucks[4]	11,700	$2.40/mile	$28,000
Recycling Dropoff Area Operator[2]	1	$57,000/Operator	$57,000
Fuel and Maintenance for Backhoe and Rolloff Truck	10,000	$1.80/mile	$18,000
Total Annual O&M Cost			**$561,000**

Notes:

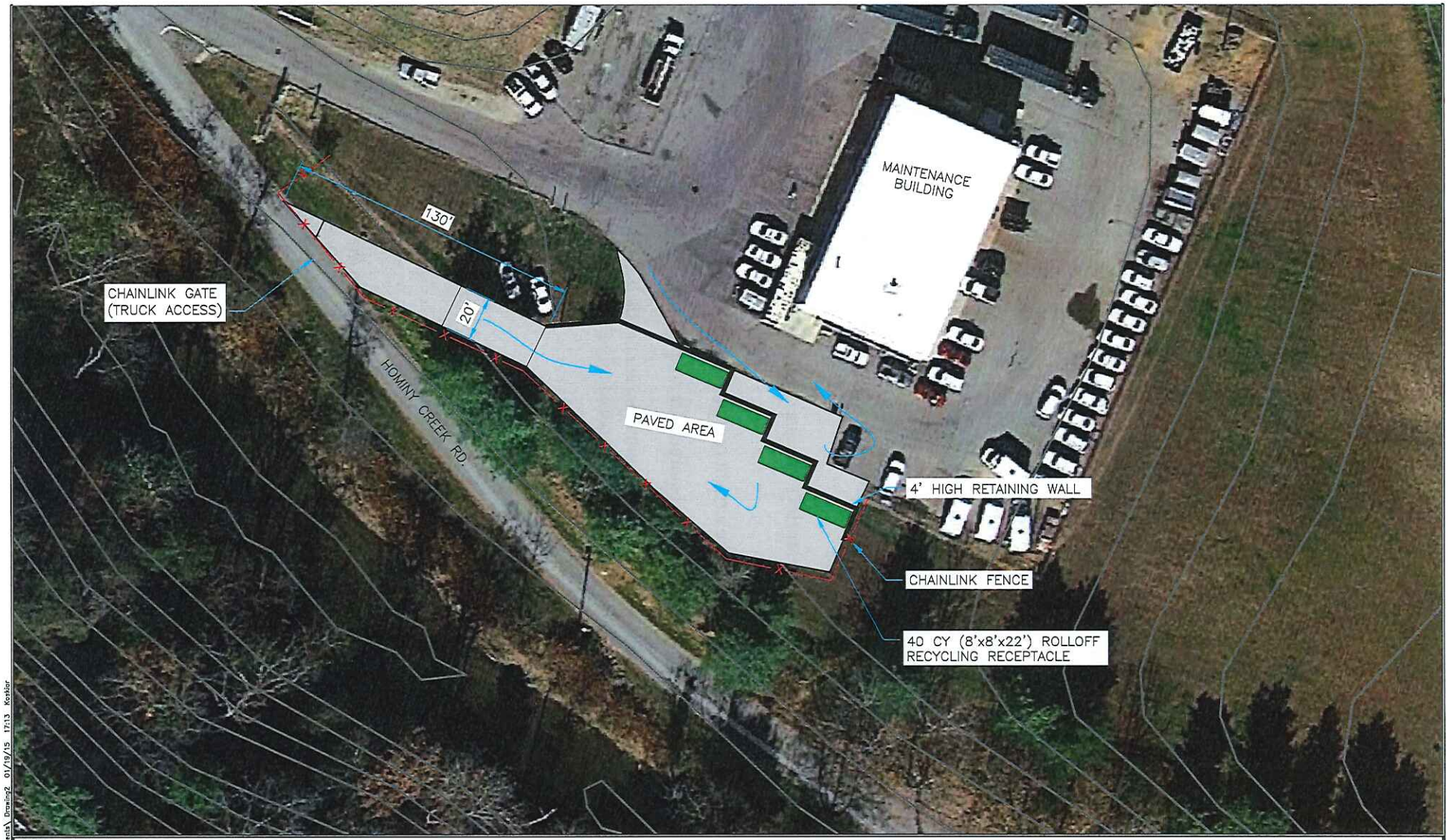
1. Assumes an hourly rate of $17/hr x 1.45 for benefits x 2080 hours/year
2. Assumes an hourly rate of $15.38/hr x 1.77 for benefits x 2080/year
3. Recorded annual mileage for MSW trucks less the shorter mileage for making 1 transfer stationl delivery instead of 2. 80,000 – [17 miles x 5 trucks x 208 days] = 62,320 miles
4. Assumes 28 miles/trip x 2 trips/day x 208 days/year = 11,700 miles

5.7 Cost Summary

A summary of the capital and O&M costs for the two options is provided in **Table 5-8**.

Table 5-8 Summary of Costs

	Capital Cost	Annual O&M Cost
Direct Haul to the Landfill	$4,165,000	$476,000
Haul to the Transfer Station	$4,810,000	$561,000



CDM Smith
Camp Dresser McKee & Smith

1" = 40'
20 0 40

BUNCOMBE COUNTY, NORTH CAROLINA
RELOCATED RECYCLING DROP OFF AREA
FIGURE 5-3

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Section 6
Economic Analysis

6.1 Introduction

This section provides an economic analysis of the collection and hauling options assuming processing of organic waste at a dry anaerobic digestion (AD) facility located at the Buncombe County Landfill. Dry AD technology was selected for the following reasons:

- It is well suited to processing low volumes of high solids organic material with high methane potential such as residential organic waste.
- It only requires 1 person to operate the facility.
- It is not sensitive to contamination.
- Power generation infrastructure is already in place at the landfill to utilize the biogas produced by the digester.
- The dry AD facility has a small footprint – limiting required sitework and rock removal at the preferred site.
- Odors are well controlled due to the airtight containment of the digesters and gas storage units.
- Liquids and stormwater management requirements are minimal.

The analysis is based on estimates for capital expenditures, annual O&M services and revenue from power sales. The capital and O&M estimates were prepared using budgetary quotes from vendors and planning level opinions of probable construction costs.

The following assumptions were used in the analysis:

- Project life is 20 years.
- Debt service is financed at 4% over a 20-yr term.
- Salvage value of the equipment is not considered.
- Digester biogas is 60% methane with an energy content of 600 Btu/ft^3
- The dry AD facility will operate at 90% availability (7,889 hours/year).
- A second generator will be installed at the Landfill Gas-to-Energy Facility (costs are not included in the analysis).
- Revenue from power sales is calculated at 7.8 cents/kwh per Aaron McKinzie of Buncombe County.
- The solid and liquid digestates will be landfilled.

6.2 Dry AD Facility Costs

CDM Smith contacted four companies that specialize in dry AD technology: Zero Waste Energy, Eisenmann, Harvest Power and BioFerm Energy Systems. Harvest Power and BioFerm Energy Systems stated that they do not make a model small enough to accommodate 5,900 tons per year. Budgetary quotes were received from Zero Waste Energy and Eisenmann as presented below.

6.2.1 Zero Waste Energy

The Zero Waste Energy dry AD facility, as shown in **Figure 6-1**, uses a thermophilic, batch process in which the organic waste is stacked inside one of four horizontal digesters for processing. The digesters are made of fabricated steel or cast-in-place concrete and include a subgrade percolate tank and roof-mounted double membrane bladder for storing biogas. The facility footprint is 0.25 acres. A concrete pad and small push wall is used in front of the facility for offloading and mixing the waste.

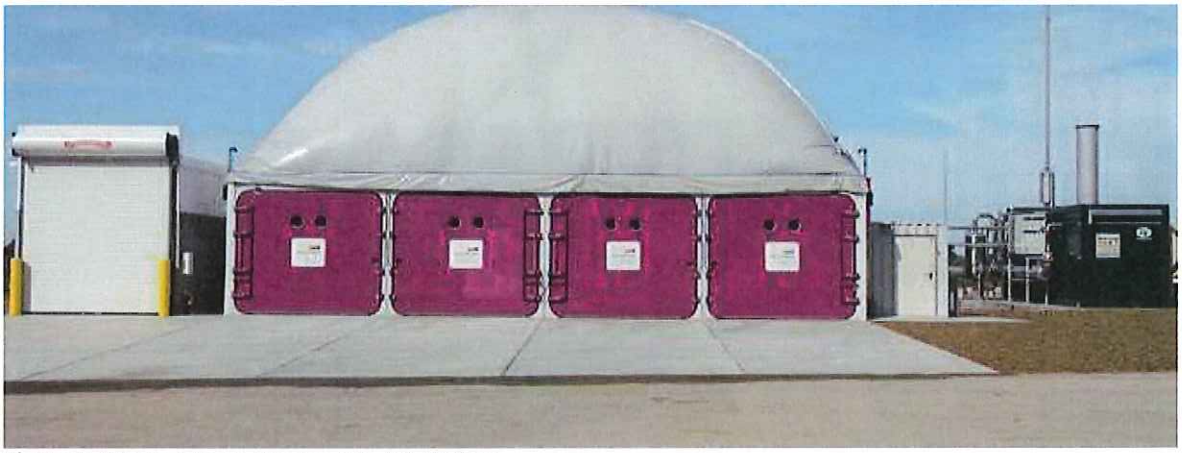

Figure 6-1 Zero Waste Energy Dry AD System

Budgetary costs for capital and O&M are provided in **Table 6-1**. The stacking process requires the addition of wood mulch or green waste to provide the necessary voids for air flow and percolation. The cost estimate includes using the wood mulch produced at the landfill for mixing with the organic waste. A wheeled loader is used for mixing the organic waste and wood mulch and loading the digesters bays. At the end of the 21-day digestion period the digested waste is unloaded and hauled to the landfill working face. Staffing requirements is estimated to be 15-20 hours/week.

Table 6-1 Zero Waste Energy Capital and O&M Costs

	Capital Costs[2]	Annual O&M[3]	Annual Cost for Mulch[4]	Annual Revenue from Power Sales[5]
Zero Waste Smartferm Dry AD 6,250 tpy unit[1]	$3.5M	70,000	$13,320	$77,000

Notes:

1. Includes 1,000 tons/year of wood mulch from County
2. Includes $2.9M for Smartferm System, $200,000 for a 3 CY wheeled loader and $400,000 for site development.
3. Includes $11/ton per Jeff Draper of Zero Waste Energy (includes labor) and $18/operating hour for wheeled loader at 690 hours/year.
4. County sells the mulch for $3.33/cy. Assuming 500 lbs/cy the cost is $13.32/ton
5. Assumes 790,000 kWh/year at 7.8 cents/kWh based on a biogas average flow of 40 scfm and 90% availability.

6.2.2 Eisenmann

The Eisenmann dry AD system, as shown in **Figure 6-2**, is a continuously operating system that processes organic waste in horizontal, cylindrical vessels. The feeding system can be sized to allow unmanned operation on weekends. The organic waste is preprocessed with a minus 2-inch grinder but requires no dilution. A wheeled loader is used for transferring the waste to the feeding system storage container. Paddle mixers are used inside the heated vessel to move the waste slowly through the digester. Bulking agents such as wood mulch are not required. In fact, wood materials cannot be processed in this system. The footprint for the 5,000 tons/day model is 0.25 acres. Biogas production is higher than the Zero Waste Energy system due to the preprocessing and mixing of the waste.

Figure 6-2 Eisenmann Dry AD System

Table 6-2 Eisenmann Capital and O&M Costs

	Capital Costs[2]	Annual O&M[3]	Annual Cost for Mulch[4]	Annual Revenue from Power Sales[5]
Eisenmann Dry AD 5,000 tpy unit[1]	$3.8M	100,000	-	$92,000

Notes:

1. Residential organic waste only (no wood or green waste)
2. Includes $3.0M for Eisenmann System, $200,000 for 3 CY wheeled loader, $200,000 for a grinder and $400,000 for site development.
3. Estimate per Bill Kosco of Eisenmann.
4. No mulch required for this system.
5. Assumes 1,185,000 kWh/year at 7.8 cents/kWh based on 60 scfm and 90% availability.

6.3 Comparison of Options

Annual costs for debt service, O&M and revenue from power sales are provided in **Table 6-3** for comparison of the options.

Table 6-3 Annual Cost and Revenue Estimates for Organic Waste Management Options

		Collection and Hauling		Processing			
Hauling Option	Processing Technology	Debt Service	O&M Cost	Debt Service	O&M Cost	Revenue from Power Sales	Net Annual Cost
Direct Haul	Zero Waste Energy	$306,544	$476,000	$257,600	$83,320	$77,000	$1,046,000
	Eisenmann	$306,544	$476,000	$279,680	$100,000	$92,000	$1,070,000
Haul to Transfer Station	Zero Waste Energy	$354,016	$561,000	$257,600	$83,320	$77,000	$1,179,000
	Eisenmann	$354,016	$561,000	$279,680	$100,000	$92,000	$1,203,000

6.4 Conclusions

The results of the analysis show that hauling residential organic waste directly to the landfill is more economical than hauling to the transfer station despite the reduced number of collection trucks required for hauling to the transfer station. The cost savings of one less collection truck is outweighed by the costs of additional transfer trucks, relocation of the recycling dropoff area and associated rolling stock required to use the transfer station for receiving organic waste. O&M costs are also higher for the transfer station option due to the need for a dedicated operator of the relocated recycling dropoff area.

Analysis of hauling costs shows that including yard waste in the proposed program would offer no advantage to the City since the current mulching operation at Riverside Stump Dump already provides an economical and sustainable management solution for yard waste and is a much shorter hauling distance than the Buncombe County Landfill.

Conversations with the technology venders indicated that including commercial and institutional sources of organic waste would allow the City to utilize a larger capacity digester and realize considerable savings through economy of scale. Net annual costs for larger systems could be provided if the City is interested in pursuing this option further.

Use of a pilot program is recommended to evaluate odors and address important aspects of an organics collection program such as achieving a high level of participation and limiting the amount of contamination.

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