Background Research, Technical and Options Analysis Report

AD Study

Regional Municipality of Durham

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1. Study Background

The Regional Municipality of Durham (Region) is continually evaluating options to improve the performance of its integrated waste management system for efficiency, changes to provincial policies and regulations and the continuing drive to increase waste diversion.

The Region currently needs to address the challenges it faces with expiry of organics processing contracts in 2019 and a set disposal capacity at the Durham York Energy Centre (DYEC).

The Region has one area of the current system that could be changed to improve the performance of the integrated waste system and meet contract expiry and DYEC capacity issues has identified the expansion of the Region's Organics Management Program.

The Region initiated an investigation of organics processing technologies in 2013, with a pre-feasibility study on Anaerobic Digestion technologies for Source-Separated Organics (SSO) and other biodegradable materials produced in the Region. This review explored whether Anaerobic Digestion and related pre-processing technology could provide an opportunity to expand the list of materials accepted in the Green Bin program, including pet waste, diapers and sanitary products. Various options were assessed to determine the feasibility of processing SSO and the expanded materials from single family and multi-family residential homes. This study identified that Anaerobic Digestion technology could provide a processing solution for the Region to expand its organics program to include more materials[1].

In 2014, the Region issued Request for Information (RFI) #677-2014 for technologies and received ten (10) responses for waste pre-sorting and organics processing solutions. The responses received only included Anaerobic Digestion solutions and were provided by a range of companies with several service delivery models proposed.

In April 2016, the Region development a comprehensive organics management plan. The key outcomes of the Organics Plan[2] included:

- Mixed Waste processing/pre-sorting (pre-sort) offers the best solution for increasing waste diversion from the multi-residential sector and has the potential to significantly increase organics recovery from the single-family sector.
- There is a range of Anaerobic Digestion processing technologies that could be applicable to the Region's organic waste stream. Further study is required to scope the technology (ies) that would best meet the Region's needs.
- A Business Case is needed to determine:
  - the optimal sorting configuration of a Mixed Waste facility
  - how best to recover both organic and non-organic materials
  - the effect of Mixed Waste processing on the quantity of waste available for processing at the DYEC; and

[1] Kelleher Environmental, Pre-Feasibility Study on Anaerobic Digestion - Final Report, November 2013
[2] HDR, Interim Report Version 3, Anaerobic Digestion Implementation/Organics Plan Development, April 2016

- the costs of the Anaerobic Digestion processing technologies.

The Region retained GHD and Ernst & Young to undertake a review of technical organics management options (this report), a preliminary organics management business case and an organic management service delivery model assessment.

The study is being undertaken in three parts as follows:

- Part 1 – Background Research and Technical Analysis.
- Part 2 – Options Analysis, Preliminary Business Case and Service Delivery Options.
- Part 3 – Procurement, Site Evaluation, Legislative Review and Project Implementation.

This Report provides the information for Part 1 and the Options Analysis in Part 2 as follows:

- A summary of the Region's existing integrated Waste Management System.
- An overview of the factors driving the need to examine alternative Pre-Sort and Organics Processing options.
- Identification and Evaluation of potential Pre-Sort and Organics Processing options.
- Identification of the viable options to be carried forward for evaluation in the Preliminary Business Case being presented in Part 2.

Reports for the Preliminary Business Case and Service Delivery Options have been prepared under separate cover.

1.1 Glossary

A glossary of relevant terms for this Report is provided in Appendix A.

2. Region of Durham Waste Management System

The Region manages municipal solid waste within its jurisdiction serving single-family (SF) residences and multi-family residential properties (multi-residential or MR). Figure 2.1, following the text, provides an overview of the approximate quantities of municipal solid waste currently managed by the Region in 2015[3] from the municipalities of Pickering, Ajax, Clarington, Brock, Scugog, Uxbridge, Whitby, and Oshawa.

The Region generated approximately 230,300 tonnes of municipal solid waste in 2015, of which approximately 120,000 tonnes was diverted from disposal. The majority of the Region's waste is collected curbside with the remainder being collected at the Region's three waste management facilities (WMFs) that are open to the public. The curbside mixed residual waste is collected and transferred through transfer stations operated by a private contractor.

3 2015 data for residual, SSO, and leaf and yard waste. 2014 data for remainder of waste streams from Region's 2014 Waste Management Annual Report.

Mixed residual waste is then disposed of at the Durham York Energy Centre (DYEC), which is operated by a private contractor.

The collected SSO material is processed by a private contractor in Pickering to generate compost that meets the current Ontario Composting Guidelines for 'AA' grade compost.

Leaf and yard waste collected within the Region is processed by a private contractor. The leaf and yard waste collected in Ajax and Pickering is collected concurrently with the SSO and processed at the private composting facility in Pickering.

Recyclable material is processed at the Region-owned Material Recovery Facility (MRF) in Whit, which is operated by a private contractor. Figure 2.1, following the text, provides an overview of the Region's managed waste in 2015. The locations of the WMFs are shown on Figure 2.2.

The following is a summary of the waste management facilities utilized by the Region:

- Oshawa Waste Management Facility, 1640 Ritson Road North, Oshawa.
- Brock Waste Management Facility/Landfill Site, C22480 Brock Sideroad #17, Brock Township.
- Scugog Waste Management Facility, 1623 Reach Street, Port Perry.
- Private Transfer Station, 1220 Squires Beach Road, Pickering.
- Private Transfer Station, 2000 Wentworth Street, Whitby.
- Durham Region Waste Management Centre – Material Recovery Facility/Central Transfer Station, 4600 Garrard Road, Whitby.
- Durham York Energy Centre (DYEC), 94-96 Osborne Rd, Courtice.

The following sections provide further discussion on the residential waste collection services managed in the Region, the residential waste diverted in the Region, and the waste disposal options available for residential waste in the Region.

2.1 Waste Collection

The following sections provide further discussion on the residential waste collection services managed in the Region, the residential waste diverted in the Region, and the waste disposal options available for residential waste in the Region.

2.1.1 Program Overview

The Region manages the collection of Mixed Waste, recyclables, SSO, and leaf and yard waste from the six lower-tier municipalities, with the exception of Whitby and Oshawa, which manage their own collection of Mixed Waste, SSO, and leaf and yard waste. The Region's collection services are contracted to private firms, who concurrently collect Mixed Waste and SSO. Mixed Waste is collected every two weeks; recyclables and SSO are collected weekly. Leaf and yard waste is collected every two weeks from May to September.

The Region also collects Mixed Waste, leaf and yard waste, recyclables and other materials at its WMFs in Oshawa, Scugog, and Brock. Other materials collected include household hazardous waste (HHW), bulky goods, waste electrical and electronic equipment (WEEE), metal goods, bulky white polystyrene, used tires, agricultural bale wrap plastic signs, porcelain, drywall, and wood.

The collection of the material from the WMFs is completed by private contractors or managed by material stewards.

The Region also has a program for the curbside collection of residential-used batteries, which are processed by a private contractor.

2.1.2 Services for the Single-Family (SF) Residential Sector

The Region provides Mixed Waste collection services, SSO and leaf and yard waste and recyclables pick-up to single-family homes in Pickering, Ajax, Clarington, Brock, Scugog, and Uxbridge.

Oshawa and Whitby provide the same collection services to single-family homes in their municipalities.

2.1.3 Services for the Multi-Residential (MR) Sector

The Region provides waste collection services and recyclables pick-up to approximately 24,000 low to medium density MR units (e.g., apartments, townhouses and condominiums) in Pickering, Ajax, Clarington, Brock, Scugog, and Uxbridge.

The Region also provides collection of SSO from low to medium density MR sites, along with collection of WEEE from 51 low to medium density MR units and residential-used batteries from 54 low to medium density MR units.

There is no SSO collection by the Region at high-density MR sites (high-rise apartments) and the Region is not considering the expansion of the SSO program to include these locations. These locations present unique challenges for collection of SSO based in part on the lack of local site infrastructure for separation of the waste stream. Therefore, the MR sector considered in this Study is limited to low to medium density MR sites.

2.1.4 Recyclable (Blue Box) Materials

The Region collects recyclable material from residents under its Blue Box program. The materials are collected using a two-stream recycling program (e.g., containers and paper fibres are separated). The materials collected by the Blue Box program are delivered to the Region owned Material Recovery Facility (MRF) for processing.

2.1.5 Source-Separated Organic (SSO) Materials

The Region's SSO program includes the collection of the following items:

- **Food Waste:** All vegetables (cooked/raw/whole/peelings), corn cobs and husks, all fish and fish products (cooked/raw), all fruits and fruit products (cooked/raw/whole/peelings/cores/seeds/pits), tea bags, bones, all meat and meat products (cooked/raw), all shellfish and shellfish products (cooked/raw), all poultry and poultry products (cooked/raw), seasonings and spices, frozen foods, breads, cakes, cookies, muffins, pasta, toast, coffee grounds, paper coffee filters, plate scrapings, baking wastes, and dairy products.

- **Paper Fibre:** Molded pulp paper egg cartons, molded pulp paper beverage trays, paper towels, tissues, napkins/serviettes, paper plates and paper cups (no lids), soiled paper food containers and wraps (i.e. frozen food boxes, pizza boxes, fast food boxes and wraps, special event paper food containers), muffin paper, butcher paper, paper table cloths.
- **Other Compostable Items:** Hair, sawdust, wood shavings, wooden stir sticks, wooden cutlery, dryer lint, bedding from pet cages, house plants with our without soil, flowers, cold fireplace ash, wooden toothpicks, garden fruit (e.g., crabapples), pet food, pet fur, Halloween pumpkins, gourds, dried decorative fruits and vegetables, natural wreaths, natural garland, cotton balls, and sawdust.
- **Liner Bags:** The Region permits residents to use ether paper or compostable bags to line their SSO bins (green bins)

The following materials are not currently collected by the Region's SSO program, but are part of other municipality programs in the Greater Toronto Area:

- **Animal Waste:** Animal waste and cat litter.
- **Personal Products:** Diapers, sanitary products, and incontinence products.
- **Paper Fibre:** Coffee cups.
- **Other Compostable Items:** Cotton balls.
- **Liner Bags:** Plastic bags.

The complete list of acceptable and non-acceptable household organic waste collection in the SSO program is provided in Schedule "F" to By-Law 46-2011[4].

2.1.6 Leaf and Yard Waste Materials

The Region permits the following materials in its leaf and yard waste collection program: brush and thatch, Christmas trees, fallen fruit from trees, gourds, garden trimmings, hedge and tree trimmings/branches, house and garden plants, leaves, pumpkins, and decorative corn stalks.

2.1.7 Waste Management Facilities

The Region currently operates three WMFs where residents can drop-off diversion materials in addition to black bag garbage.

Diversion materials accepted include blue box materials, wood, leaf and yard waste, household hazardous waste (HHW), waste electronic and electrical equipment (WEEE), tires, and other diversion materials.

[4] A By-law To Regulate the Provision of the Waste Management Services Under the Jurisdiction of The Regional Municipality of Durham.

The Region does collect Mixed Waste at its three WMFs. Based on available audit data this waste has an organic content that is low[5], which is expected given that most Regional residents make use of curbside waste collection and likely use the WMF for excess Mixed Waste.

The Mixed Waste collected at the WMFs has been removed from consideration for this Study, as it is a small portion of the overall tonnage of Mixed Waste collected and has been shown to have little organic content.

2.2 Waste Disposal

The Region disposes of Mixed Waste collected from the SF sector (curbside), the MR sector, and its three WMFs at the Durham York Energy Centre

2.2.1 Durham York Energy Centre (DYEC)

The Regional Municipality of Durham and the Regional Municipality of York jointly own the DYEC. The service area of the DYEC is the jurisdictional boundaries of The Regional Municipality of Durham and The Regional Municipality of York.

The DYEC is permitted under Environmental Compliance Approval (ECA) No. 7306-8FDKNX, which sets out the requirements for the development and operation of the DYEC.

The accepted waste is limited to solid non-hazardous residual waste from domestic waste and Industrial, Commercial, and Institutional (IC&I) waste from the Regions' curbside collection and/or from the Regions' WMFs.

The processing capacity of the DYEC is at a limit of 140,000 tonnes of waste per year by the ECA. Of this, the Region of Durham has an obligation to provide 110,000 tonnes of waste per year.

2.3 Current Diversion from Disposal

The Region currently maintains a diversion-from-disposal metric/target of 55 percent. This figure includes the following materials that make up the majority of this diversion metric:

- Recyclable (Blue Box) Material - approximately 50,000 tonnes were sent for processing in 2015 to the Region-owned Materials Recycling Facility
- Green Bin Composting (SSO) - approximately 28,000 tonnes were sent for composting in 2015 to a privately owned facility located in Pickering
- Leaf and Yard Waste - approximately 28,000 tonnes were sent for composting in 2015 at the same location
- Household Hazardous Waste -| approximately 1,100 tonnes were collected from the Region's WMFs and special events
- Other Diversion Programs - approximately 5,700 tonnes of material were diverted through Waste Electrical and Electronic Equipment (WEEE), bulky goods, metal goods, household

5 *AET Consultants, Waste Audit & Facility Review: Oshawa Waste Management Facility Audit & Review of Operations, December 2010.*

batteries, used tires, sign, polystyrene, composter and grass cycling and reuse diversion programs.

3. Study Drivers

The Region operates a highly integrated and unique waste management system. Effective management of organic materials and blue box materials coupled with final disposal that is not dependent on landfill makes the Region’s system one of the most unique in Canada, as very few other municipalities have access to this final disposal mechanism that produces proportionately such a high amount of energy output. In many respects, the Region's system has evolved towards a modern waste management system of a type that is common in Europe, where regulations and land limitations have sponsored highly-integrated systems, but that is very rare in North America.

The above notwithstanding, there are a number of drivers being encountered by the Region that dictate moving towards completion of its integrated waste management system.

The most complex component of the system has already been developed by the Region (the DYEC); the additional components of this system are in part dictated by the Region's waste profile and existing assets, the Region's goals, and the additional drivers and opportunities generated by new legislation. The individual drivers for the study are outlined below.

3.1 Capacity at the DYEC

The current capacity of the DYEC is 140,000 tonnes per year, and the asset's usage is restricted to waste from the Region and its partner, the Region of York. At this point, the Region is generating and having to deal with approximately 114,000 tonnes per year of Mixed Waste, which is in excess of its available capacity at the DYEC (110,000 tonnes per year nominated for the Region with the 30,000 tonnes per year balance dispensed to the Region of York). As of the current time, the DYEC is thus at capacity and offers the Region no opportunity to manage black bag waste unless an expansion is pursued. This is particularly problematic for the Region given that it is one of the fastest-growing population bases in Ontario. Growth expectations in the approximately 197,500 single family homes (SF) is expected to be in the 3 percent per year range in the near term, and not lower than 2 percent out to 2046. Even more pronounced, growth in the approximately 24,000 multi-family residences (MR) is expected to be over 3 percent in the near term and to increase to a maximum of 4.5 percent before stabilizing to a rate similar to the long-term projection for SF. This essentially means that the DYEC cannot under the current configuration and scenario accommodate any growth in the Region of Durham.

3.2 Diversion

The DYEC does not provide diversion from disposal. The Region's current metric is 55 percent, largely built on the foundational elements of the Region's leaf and yard, SSO and blue box programs, as well as a number of other programs and initiatives that have been developed over time, such as the implementation of WMF's to capture drop-off materials.

The Region has currently has all of the typical diversion programs that could be reasonably, practically and cost-effectively be implemented for a population base of this size and configuration. The overall goal of the Region is to attain 70 percent diversion, which will be difficult to achieve by simply using additional diversion programs or enhanced education.

A supplemental approach for the Region is required, namely to implement a further component of its uniquely-integrated waste management system to capture additional materials in its waste stream and to return these materials to viable markets. For example, at this point, the capture rate of SSO in the Region's SSO program is approximately 54 percent; this suggests that a large quantity of organic material resides in the Region's Mixed Waste. Should this material be diverted to appropriate uses, this would increase the Region's diversion metric markedly.

3.3 Expiration of Existing Contract(s)

While the DYEC operations contract has just begun and the Region has processing capacity into the future at its MRF where blue box recyclables are processed, the Region does not own or control the SSO processing facility in Pickering, which is owned and operated by Miller Waste and is operating at capacity. The Region's SSO contract concludes in 2018, this creates an additional need for finding processing capacity.

One of the foundational elements of organics processing that has occurred in Ontario over time is a relatively rapid shift from the provision of this service via merchant capacity to a model of municipal ownership or public-private-partnerships. This is due in part to a number of performance issues in merchant operated facilities, with short-term and long-term shut-downs, or even permanent closures. Service interruptions have been largely a result of either odour issues or inability to produce acceptable final quality product.

Given that the current SSO contract is expiring, the existing service provider is at capacity, and there is no other at-scale SSO processor with capacity in or near the Region, it is imperative that the Region develop or solicit processing capacity in the near future in order to continue effective and appropriate management of its SSO stream. This may include development of a new organics processing facility that is specifically intended to align with new regulations and to ensure that product quality complies with pertinent regulations.

The need to develop this capacity is imminent, as the development, permitting, design, construction and commissioning life cycle of these types of projects is on the order of years (3 years at absolute minimum). This emphasizes the urgent need for action for the Region.

Climate Change and Low-Carbon Economy Act

As Municipalities are not specifically noted as designated emitters by the Ministry of the Environment and Climate Change (MOECC), the Region has no obligations via the Climate Change and Low-Carbon Economy Act to reduce emissions from their operations, with the exception of the DYEC where the Region the region has a cap on its emissions. However, the Region does have the ability (through pre-sorting of Mixed Waste and use of Anaerobic Digestion technologies to further reduce greenhouse gas (GHG) emissions and in accordance with the Act) to participate in the following ways:

- Creation of emissions reductions that could be then sold to large emitters who are subject to a cap. Large emitters include the steel and cement industries and large users or distributors of natural gas. There are approximately 150 large designated emitters, including the DYEC, in Ontario that are required through the Climate Change Mitigation and Low-Carbon Economy Act to reduce their total GHG emissions. As their cap levels are to decline over time, there is a responsibility for them to continue to make these reductions. As part of the carbon market, this means that GHG emission reductions voluntarily created by the Region could be transacted to large emitters, providing revenues for the Region. Emissions reductions for the DYEC, including from a Region-owned emission reduction project, will most likely need to be transacted openly through the emerging Ontario carbon market. The details of this type of transaction will need to be confirmed. At present, no offset protocols have been released by the MOECC.
- Use of funds created by compliance with Climate Change Mitigation and Low-Carbon Economy Act to engage in emission reduction projects and initiatives. As part of the overall Program, the MOECC will collect funds from allowances issued to large emitters who cannot otherwise achieve compliance with their respective caps. The revenue from these allowances will be maintained in the Greenhouse Gas Reduction Account (GGRA) and may be dispensed to proactive companies and organizations, according to the standards outlined in the Ontario Climate Action Plan. The GGRA may become a possible source of funding for Regional implementation of this Region's project, subject to the MOECC's final rules for accessing this Account.

Specific opportunities for GHG emission reductions could be achieved by the Region as follows:

- SSO processing using Anaerobic Digestion technologies. While both aerobic in-vessel and anaerobic Anaerobic Digestion technologies divert organics from landfill and generate emission reductions, Anaerobic Digestion also offers emission reductions from the production of renewable forms of energy.
- Capturing more SSO by increasing the allowable materials in the stream and by providing a more convenient system to its residents to drive participation. This incremental increase in organics diverted is a net increase over the Region's current practice. The extra emission reduction occurs because less organic material is directed to landfill, where a portion of the methane produced in the landfill is emitted to the atmosphere.
- Capturing additional recyclables from Mixed Waste through a pre-sorting system. This additional recyclable captures reduces the waste quantities directed to landfill, but more importantly generates additional recyclable commodity that can be sold to industry as a replacement for virgin product.
- Capturing organic fraction of Mixed Waste (capturing organic fraction from Mixed Waste [OFMW]), in particular from the MR sector of the Region, given the Region's project growth rate and the higher organic content in Mixed Waste from this sector. Additional organics capture diverts volume from landfill and prevents methane emission. Additional GHG emission reductions are created by producing and utilizing biogas from this incremental organics stream.

- Producing and utilizing biogas from the same increase in OFMW
- Using final organic products in a beneficial manner, where this will displace the use of conventional fertilizers and help with sequestration of carbon from the atmosphere.

Accounting of potential versus actual emission reductions will depend on the final rules issued by the MOECC in the form of protocols/methodologies. The Processing Options will have some differentiation in terms of how treatment processes and technologies will actually reduce emissions.

The following items are of note:

- High solids technologies (e.g., plug flow and percolated bunker Anaerobic Digestion technologies) tend to generate less biogas than continuously stirred tank reactors (CSTR), and correspondingly have less available emission reductions potential from biogas utilization.
- High solids technologies have inherent uncertainty in generating consistent generate quality final products that can be beneficially used. They are reliant on composting back-ends that are subject to the stringent Ontario Compost Quality Standards.
- Processed OFMW has some uncertainty with respect to its beneficial use. If beneficial use cannot be achieved and OFMW generate a final waste product, there is additional uncertainty with respect to emission reductions generated via beneficial use.
- Combined Treatment Approaches generate approaches further uncertainty, due to the variability in OFMW quality as a stand-alone product, or when mixed with SSO prior to anaerobic digestion.

Taking these factors into consideration, the overall GHG emission reduction potential for all the organic processing options considered is favourable, and the options with Anaerobic Digestion technologies have enhanced ability to reduce GHG emissions relative on their biogas generation potential.

3.3.1 Waste Free Ontario Act

The Waste Free Ontario Act is primarily focused on waste reduction by way of responsibilities for recyclables [e.g., End Producers Responsibility (EPR program]; however, the Draft Strategy for a Waste Free Ontario: Building the Circular Economy Strategy[6] (Strategy) that accompanied the Waste Free Ontario Act identified the need for organics diversion. In particular, the ministerial mandate letters released by the Province in 2016[7] specifically note that an Organics Action Plan to divert more organic waste from landfills is a priority that will enter the consultation period in 2017 with implementation in 2018. As noted in the Draft Strategy for a Waste Free Ontario items such as recovery of organics from high-rise and multi-residential dwellings is a component of this; one of the

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6 MOECC, Draft Strategy for a Waste Free Ontario: Building The Circular Economy, 2015, http://www.downloads.ene.gov.on.ca/envision/env_reg/er/documents/2015/012-5834_DraftStrategy.pdf, visited October 7, 2016.

7 Correspondence from Premier Kathleen Wynne to The Honourable Glen Murray Minister of the Environment and Climate Change, Re: September 2016 Mandate letter: Environment and Climate Change Premier's instructions to the Minister on priorities, September 23, 2016 https://www.ontario.ca/page/september-2016-mandate-letter-environment-and-climate-change, visited October 7, 2016.

instruments that has been discussed is the implementation of an organics ban from disposal (where disposal includes landfill and thermal treatment). This is a similar approach to that which has been used for commercial organics in several US States (California, New England states, New York City, British Columbia, Nova Scotia).

4. Pre-sorting and Organics Processing System Components and Potential Additional Diversion

4.1 Pre-sorting and Organics Processing System

There are two key components to the processing systems considered for this Study. The first is the Mixed Waste transfer and pre-sorting/component that isolates the recyclables and organics in the Mixed Waste. Recyclables are typically sorted, baled, and sent to secondary markets. The isolated OFMW along with SSO from the curbside Green Bin program are sent to an organics processing system.

Figure 4.1 illustrates the key components under consideration for the Region's organics (OFMW and SSO) management system.

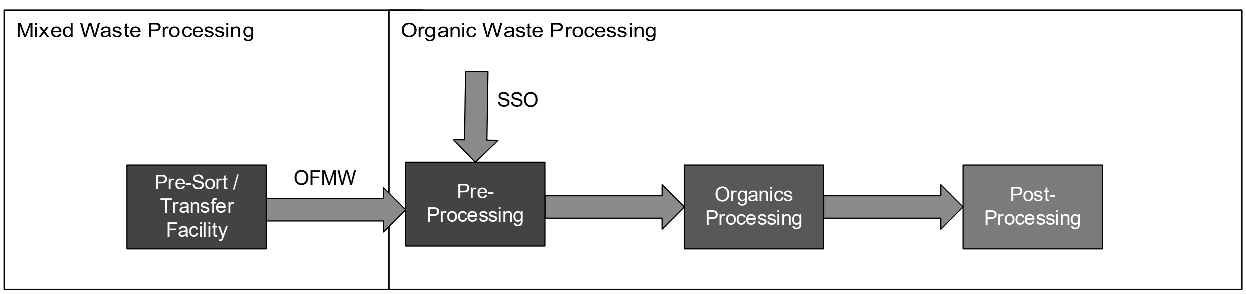

Figure 4.1 Organics Management System Components

4.1.1 Pre-Sorting

Pre-Sort systems generally open and access Mixed Waste garbage, remove any hazardous or dangerous materials using equipment or manual sorting, and then utilize mechanical equipment to remove and sort organics. Once organics are removed from the Mixed Waste stream, the remaining waste is sent through mechanical automated equipment that can sort and remove a variety of additional products - metals, aluminum, fibres, different grades of plastics, glass. These separated commodities are sent to their respective recyclables market to reduce the use of raw materials in manufacturing. These materials are all currently combusted in the DYEC.

The organic materials culled from Mixed Waste can then be processed using organics processing technologies to create energy and/or fertilizer products that displace these carbon-intensive commodities. The closest system to a Pre-Sort system owned by the Region is its MRF, although that facility is not equipped to receive Mixed Waste.

4.1.2 Organics Processing

There are two primary mechanisms of organics processing: composting or anaerobic digestion.

Composting utilizes energy, often in the form of airflow, to degrade organic matter into simpler humic molecules that can then be land applied as a solid fertilizer. No energy is produced in composting. The final product is only compost, suggesting that this technology is energy-intensive and can produce a very narrow band of final marketable products. Composting is also space-intensive, as the processing elements are built horizontally and consume large portions of space. Since composting involves pushing air through organic material, substantial amounts of odorous air are generated that must then be treated to avoid adverse effect/nuisance on adjacent properties. While composting has been employed successfully for a significant amount of time in Ontario, its deployment has been reduced over the last decade in favor of anaerobic digestion.

Anaerobic digestion occurs in the absence of oxygen, so there is no requirement for initial energy input as is required for composting. Breakdown of organic material in the absence of oxygen creates biogas, which is rich in methane (i.e., biologically based natural gas). Methane can be used to generate electricity, as renewable natural gas (RNG) for injection into the natural gas distribution system, as vehicle fuel for fueling trucks and buses, and possibly as liquid fuel to supplement ethanol blend requirements. The production of a fuel product further displaces fossil-based fuels and can generate revenues as a low-carbon fuel or from offsets.

Anaerobic digestion can produce a variety of final products, including liquid fertilizer, solid fertilizer, or compost. The ability of this technology to produce diverse outputs and to align with legislation such as cap-and-trade have given rise to its steady adoption in Ontario. Anaerobic digestion requires a much smaller processing footprint than composting. Since anaerobic digestion does not require aeration of the organic material, this technology has much less potential for generating odours. Specific types of anaerobic digestion are able to generate final organic products that can be beneficially utilized, further improving diversion metrics.

One of the critical items regarding energy streams produced from organics processing via anaerobic digestion is soliciting and finding a market for renewable electricity, RNG, vehicle fuel, liquid fuel, etc. This is a key challenge in the current climate and a possible mitigation for this risk factor is finding a partner who is tied into the energy markets to optimize revenue streams and market access.

4.2 Potential for Additional Diversion

The Region of Durham generated approximately 230,000 tonnes of municipal solid waste in 2015. Approximately 120,000 tonnes were diverted from disposal, a diversion rate of just over 52 percent.

Approximately 27,000 tonnes of organics were collected as SSO through the curbside collection program, out of an estimated 70,000 tonnes generated within the Region.

A Pre-Sort/Transfer System would enable the Region to recover additional organics from Mixed Waste (OFMW), as well as some of additional residual recyclables that are present in the Mixed Waste.

The following section identifies the potential for additional diversion through the implementation of a Pre-Sort Facility to recover recyclables and organic materials from SF and MR Mixed Waste.

4.2.1 Waste Composition

The Region commissioned a Mixed Waste composition study in 2011 to determine the amounts of divertable organic materials in the SSO stream and still present within disposed Mixed Waste.

The study found that:

- The estimated percentage of organic material captured by the SSO Program is 54 percent. This represents the percentage of the available household/kitchen organics in the total waste stream from the SF sector that is collected as SSO by the Green Bin program.
- The organics content of SF Mixed Waste has been estimated at 47 percent.
- The organics content of MR Mixed Waste stream has been estimated to be 49 percent.

4.2.2 Recyclables Recovery from Mixed Waste

Not all the recyclable material available in the Mixed Waste stream will suitable for removal by or in the Mixed Waste Pre-Sort Facility.

In order to project the amount of recyclables that can be isolated from the Mixed Waste stream the assumptions listed in Table 4.1 were used.

Table 4.1 Assumptions for Recyclables Recovery from Mixed Waste

Recyclable Material	Percent by weight in SF Mixed Waste[8]	Percent by weight in MR Mixed Waste[9]	Recovery Efficiency
Ferrous Metals	0.3%	0.7%	90%
Non-Ferrous Metals	0.5%	0.7%	90%
PET	1.2%	1.3%	85%
HDPE	0.4%	0.4%	85%
Rigid Mixed Plastic Containers	0.4%	0.5%	75%
Other Plastics	16.2%	6.5%	0%
Paper	6.2%	12.1%	0%
Glass	0.5%	1.0%	0%
Notes: Based on the organics capture rate of 54% (with population growth over time), an organic fraction of SF waste at 47% and an organic fraction of MR waste at 49%.			

A summary of the recovered recyclable material in the Mixed Waste based on available Mixed Waste audit data for the SF Mixed Waste stream and the MR Mixed Waste stream, as summarized in Table 4.1, is presented in Table 4.2.

[8] Region of Durham Large Blue Box Container Study, AET Group, December 2011, Average June & November Audits.

[9] Multi-Residential Waste Composition Study, AET Group, December 2013.

Table 4.2 Recoverable Recyclables from Mixed Waste

Year	2016	2021	2026	2031	2036	2041	2046
Recyclables	**tonnes/year**						
Ferrous Metals	300	300	400	500	500	600	600
Non-Ferrous Metals	500	500	600	700	800	800	900
PET	900	1,100	1,200	1,400	1,500	1,700	1,900
HDPE	300	300	400	400	500	500	600
Rigid Mixed Plastic Containers	300	300	400	400	500	500	600
Total	**2,300**	**2,500**	**3,000**	**3,400**	**3,800**	**4,100**	**4,600**

Notes:
Based on the organics capture rate of 54% (with population growth over time), an organic fraction of SF waste at 47% and an organic fraction of MR waste at 49%. Recovery of organic materials at 80% of incoming tonnage.

It is noted that the Mixed Waste Pre-Sort Facility will need to have a capacity to manage the total Mixed Waste quantity.

4.2.3 Organics Recovery from Mixed Waste (SF & MR)

Not all the organic material available in the Mixed Waste stream will be able to be harvested through the Mixed Waste Pre-Sort Facility.

In order to project the amount of organic material that can be isolated from the Mixed Waste stream the following assumptions where used:

- The current organics capture rate is 54 percent for the SSO single-family program.
- Approximately 80 percent of the incoming organics are recovered during pre-sorting.
- The contamination rate of the OFMW requiring pre-treatment is approximately 20 percent.
- Approximately 65 percent of the incoming organics are recovered through the pre-sorting and organics pre-treatment processes and treated by the organics processing technology.

The organics tonnage predicted based on recovery of organics from Mixed Waste and the existing SSO program is presented in Table 4.3.

Table 4.3 Recoverable Organic Material from Mixed Waste

Year	2016	2021	2026	2031	2036	2041	2046
Sector	**tonnes/year**						
Single Family (SF)	29,000	33,000	38,000	43,000	48,000	53,000	59,000
Multi Residential (MR)	5,000	6,000	7,000	8,000	9,000	10,000	11,000
Total	**34,000**	**39,000**	**45,000**	**51,000**	**57,000**	**63,000**	**70,000**

Notes:
Based on the organics capture rate of 54% (with population growth over time), an organic fraction of SF waste at 47% and an organic fraction of MR waste at 49%. Recovery of organic materials at 80% of incoming tonnage.

It is noted that the Mixed Waste Pre-Sorting Facility will need to have a capacity to manage the total Mixed Waste quantity that is estimated to be generated by the Region over the course of the facility's life.

4.2.4 Organics Recovery from SSO Program

The current estimated rate of organic material that is captured by the SSO program is 54 percent. This represents the percentage of the available household/kitchen organics in the total waste stream from the SF sector that are collected as SSO by the Green Bin program.

Uncaptured organics are those that have been misplaced into the Mixed Waste stream, although some may also have been inadvertently placed in the recyclables stream (blue box)[10]. Based on review of the SSO programs in other GTA municipalities, it may be possible through program changes (enhanced education/promotion, green bin size) to increase the capture of organics at the source.

There are SSO programs in the GTA that accept plastic bags such as green bin liners, which is more convenient for residents (no need to purchase a specialty compostable bag) and increases the tonnage of material sent for diversion. The acceptance of plastics bags, pet waste, sanitary products and diapers, may further increase the total tonnage of SSO collected and may also result in additional collection of organics through increased participation in the program.

The SSO tonnage predicted based on the existing SSO program using the current capture rate of 54 percent are presented in Table 4.4.

Table 4.4 SSO Waste Projections

Year	2016	2021	2026	2031	2036	2041	2046
Sector	**tonnes/year**						
Single Family (SF)	27,000	30,000	34,000	39,000	43,000	48,000	54,000
Total	**27,000**	**30,000**	**34,000**	**39,000**	**43,000**	**48,000**	**54,000**
Notes: Based on the organics capture rate of 54% and with population growth over time.							

4.2.5 Organics Recovery from Region WMF

Based on audit data of the Region's WMFs, recovery of organics based on 2016 data would be limited to less than 250 tonnes/year. The additional processing capacity required by the Pre-Sort Facility to sort the waste from the WMFs would be approximately 20,000 tonnes/year.

[10] AET Consultants, Region of Durham Large Blue Box Container Study, Waste Audit and Trend Analysis Report, December 2011

4.2.6 Total Organics Recovery

The total organic material considered available is the sum of the SSO material collected from SF units, the recoverable organics from the Mixed Waste collected from the SF sector, and the recoverable organics from the Mixed Waste collected from the MR sector.

The total available organic material is presented in Table 4.5, which combines the data previously presented in Tables 4.3 & 4.4.

Table 4.5 Total Recoverable Organic Material

Year	2016	2021	2026	2031	2036	2041	2046
Sector	tonnes/year						
Mixed Waste	34,000	39,000	45,000	51,000	57,000	63,000	70,000
SSO	27,000	30,000	34,000	39,000	43,000	48,000	54,000
Total	**61,000**	**69,000**	**79,000**	**90,000**	**100,000**	**111,000**	**124,000**
Notes: Based on the organics capture rate of 54% (with population growth over time), an organic fraction of SF waste at 47% and an organic fraction of MR waste at 49%. Recovery of organic materials at 80% of incoming tonnage for Mixed Waste stream.							

4.3 Modified SSO Program

The expansion of the Green Bin program has been identified by the Region as one area of the current system may be modified to improve its waste diversion. Implementation of a modified Green Bin program (one that accepts additional materials such as pet waste, sanitary products, diapers, etc.) would increase the quantity of SSO and decrease the quantity of OFMW by approximately the same amount.

The approach of adding materials to the Green Bin program increases the quantity of organics in the relatively clean stream of material (SSO) and decreases the potential of the remaining organic waste (OFMW) to be of lesser quality. Should the organics processing system process these SSO and OFMW separately, this increases the quantity of materials that have the potential to generate a cleaner final product. In Ontario, SSO material that contains materials similar to those suggested for modified Green Bin (SSO) program are being processed using In-Vessel and Anaerobic Digestion technologies to achieve products that have a high level of quality.

Should the digestate management system be designed to enable separate management of the digestate from SSO and from OFMW, it would provide the Region with improved confidence of the quality (and marketability) of the former product versus a digestate generated from a combination of SSO & OFMW.

The SSO tonnage predicted based on a modified SSO program that accepts additional materials and applying the current capture rate of 54 percent is presented in Table 4.6.

Table 4.6 SSO Waste Projections – Modified SSO Program

Year	2016	2021	2026	2031	2036	2041	2046
Sector	tonnes/year						
Single Family (SF)	35,000	40,000	45,000	52,000	57,000	63,000	70,000
Total	**35,000**	**40,000**	**45,000**	**52,000**	**57,000**	**63,000**	**70,000**
Notes: Based on the organics capture rate of 54%, with pet waste, sanitary products, diapers and plastic bags accepted by SSO program, and with population growth over time.							

The corresponding recovery from the Mixed Waste with the implementation of a modified SSO program applying the current capture rate of 54 percent is presented in Table 4.7

Table 4.7 Recoverable Organic Material from Mixed Waste – Modified SSO Program

Year	2016	2021	2026	2031	2036	2041	2046
Sector	tonnes/year						
Single Family (SF)	24,000	27,000	31,000	35,000	39,000	43,000	48,000
Multi Residential (MR)	5,000	6,000	7,000	8,000	9,000	10,000	11,000
Total	**29,000**	**33,000**	**38,000**	**43,000**	**48,000**	**53,000**	**59,000**
Notes: Based on the organics capture rate of 54%, with pet waste, sanitary products, diapers and plastic bags accepted by SSO program, and with population growth over time. Organic fraction of SF waste at 47% and organic fraction of MR waste at 49%. Recovery of organic materials at 80% of incoming tonnage to the Pre-Sort Facility.							

On this basis, the range of available total organics has been developed based on a modified SSO program.

The available organic material estimated based on the modified SSO program with the material capture rate of 54 percent is presented in Table 4.8, which combines the data previously presented in Tables 4.6 and 4.7.

Table 4.8 Total Recoverable Organic Material – Modified SSO Program

Year	2016	2021	2026	2031	2036	2041	2046
Sector	tonnes/year						
Mixed Waste	29,000	33,000	38,000	43,000	48,000	53,000	59,000
SSO	35,000	40,000	45,000	52,000	57,000	63,000	70,000
Total	**64,000**	**73,000**	**78,000**	**95,000**	**105,000**	**116,000**	**129,000**
Notes: Based on the organics capture rate of 54%, with pet waste, sanitary products, diapers and plastic bags accepted by SSO program, and with population growth over time. Organic fraction of SF waste at 47% and organic fraction of MR waste at 49%. Recovery of organic materials at 80% of incoming tonnage for Mixed Waste stream.							

The decision to modify the materials accepted in the Green Bin program is one that requires review and considerations.

While both In-Vessel and Anaerobic Digestion technologies can process the expanded suite of materials, the potential for contamination of the final product increases for technologies that do not include wet pre-processing. Wet pre-processing technologies are associated with CSTR Anaerobic Digestion technologies, which are proven in their ability to remove the increased level of contaminations, specifically plastics, which would be present in SSO from a modified Green Bin program.

To maintain the option for a range of organic processing technologies for the Region, this study has not specified a modified Green Bin program. The need to increase the types of materials accepted by the Green Bin program will need to be considered by the Region based on the selection of an organics processing system as well as other considerations, such as its desire to change a successfully operating program.

5. Technical Options

The organic processing systems that are available for managing the organics include:

- **Open-Windrow Composting**
- **In-Vessel Composting and Covered Windrow(s)**
- **Anaerobic Digestion**
  - CSTR
  - Plug Flow Reactors
  - Percolate Bunker Reactors

Open windrow and covered windrow processing are not considered appropriate for the management of the Region's organics given the large quantities of organics to be processed. Open windrow and covered windrow systems have no and/or limited odour control. The MOECC has indicated that these systems are not considered appropriate for most composting operations other than for small leaf and yard waste operations or at remote facilities. The MOECC encourages an enclosed building or structure for processing materials other than leaf and yard waste[11]. Open windrows and covered windows have therefore been eliminated from further consideration.

Common to all options examined will be a Mixed Waste pre-sorting and transfer (Pre-Sort/Transfer) facility. Within each option there is a subset of technologies that could be applied. These can be broadly categorized as follows:

[11] Ontario Ministry of the Environment Waste Management Policy Branch, Guideline for the Production of Compost in Ontario, July 25, 2016.

- **Pre-processing**
  - Wet pre-processing
  - Dry pre-processing
- **Post-processing**
  - Dry post-processing

The overall Mixed Waste pre-sort/transfer and organics process is discussed in the next section.

5.1 Organics Management System

The following process steps have been identified as typical within a Pre-Sort/Transfer and Organics Management Facility:

- **Transfer:** Unloading area for Mixed Waste and SSO from curbside collection vehicles and transfer of residual to DYEC.
- **Material Receipt:** Acceptance of the Mixed Waste and removal of unwanted and unacceptable material prior to processing.
- **Mixed Waste Pre-Sorting:** Primary and secondary staged dry separation equipment to isolate from the feedstock materials items such as residual materials, recyclable materials, and organic materials.
- **Organics Pre-Processing:** The primary and secondary equipment (dry and/or wet separation equipment) or mechanism for preparing the organic feedstock for processing. This may include pre-processing equipment specific to the organics processing technology.
- **Organics Processing:** The specific technology used for the organic processing.
- **Post-Processing:** Equipment used to polish or refine the organic product, including screening, dewatering, or further composting.
- **Product Management**: Equipment used to further sort or treat the various products (e.g., recyclables, residue, biogas utilization, etc.) generated from the pre-processing and organics processing systems.

Each of the steps is described in more detail in the following sections, and the major technologies used are identified. The interrelation of the components chosen for these steps is considered to demonstrate typical system configurations. The selection of the Mixed Waste Organics Management System requires consideration of feedstock characteristics, primary pre-sorting technology, and the the organics processing system.

The typical process flow for a Mixed Waste Organics Management Facility designed to recover organics is summarized in Figure 5.1.

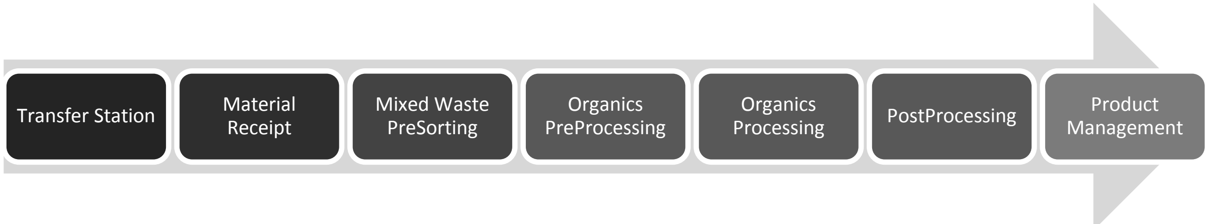

Figure 5.1 Typical Mixed Waste Pre-Sort/Transfer and Organics Management Facility

The following sections provide a general description of the processes.

5.1.1 Transfer Station

The Pre-Sort/Transfer Facility would include a transfer station component. The transfer station accepts both Mixed Waste and SSO from the curbside collection program. In addition, residue produced at the Mixed Waste Pre-Sort Facility would be transfer through the Transfer Station to the DYEC.

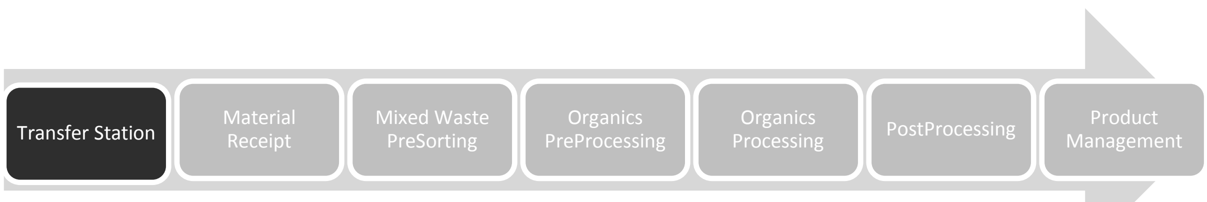

Figure 5.2 Transfer Station Step

5.1.2 Material Receipt

Following the transfer of material, the next step in the Pre-Sort Facility is to receive the Mixed Waste. Mixed Waste may be delivered either directly onto a tip floor or into a feed hopper.

Large contaminants are manually sorted upon receipt on the tip floor or at a sorting/screening station manned by facility staff, prior to bag breaking.

There is a trade-off between mechanical automation and minimizing further contamination of the Mixed Waste feedstock materials. Options to automate certain elements of the receiving steps can be explored; however, it is common that manual waste sorting be undertaken prior to any mechanical sorting to minimize the potential for further contamination of the organics and to protect downstream equipment.

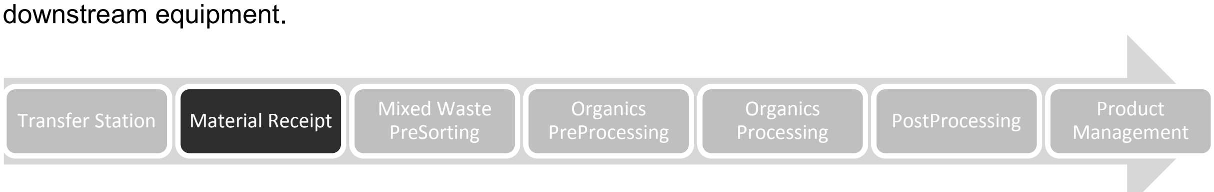

Figure 5.3 Material Receipt Step

5.1.3 Mixed Waste Pre-Sorting

Selection of the primary and secondary pre-sorting equipment is dependent on the organics processing technology, the required quality of the final organics stream, and the need to recover specific materials from the incoming waste stream. Pre-sorting technologies typically involve dry processes and specific equipment as described below.

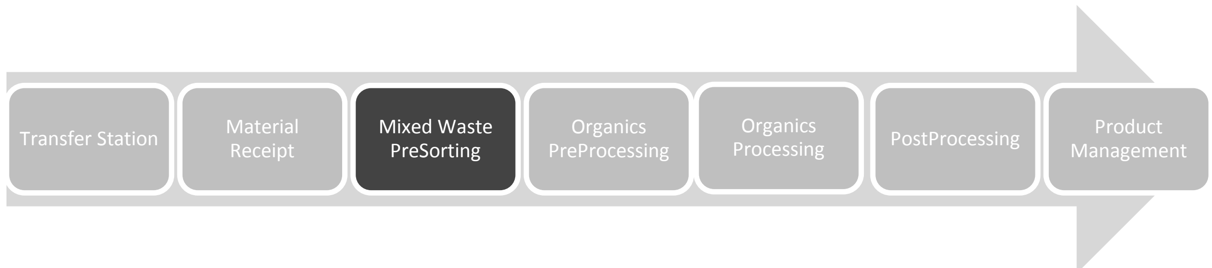

Figure 5.4 Mixed Waste Pre-Sorting Step

5.1.3.1 Dry Separation

The purpose of the dry separation of Mixed Waste is to recover dry recyclables of value and isolate the OFMW for further processing. Dry separation requires removal of bulky physical contaminants preventing any further contamination of the target organic materials and the recovery of marketable recyclable products.

This step typically includes sorting the material by size (size fractionation), with the possible incorporation of magnetic removal for ferrous metals, eddy current separation of non-ferrous metals, and optical sorting equipment, depending on the market value of the recovered products.

The organic fraction is typically negatively sorted (i.e., the organics are considered the small fraction after size fractionation). Sorting out larger materials, without breaking them apart, reduces the potential for further contamination of the organic fraction.

The dry separation stage may involve the following basic steps:

- **Oversize Waste Screening:** Mixed Waste is sorted manually by personnel for oversized items prior to the bags being opened.
- **Bag Opening:** Bag openers tear open plastic bags (film plastic) without damaging harder plastic and metal containers
- **Size Separation:** Following the bag opener, there will be at least one mechanical screen to sort out large materials (e.g., >100 mm) and a manual picking station. The small fraction is considered to contain the organics and would be conveyed for further preparation as needed, prior to the organics processing. Further size separation may be required depending on the final equipment selection and final recyclable products to be recovered.
- **Other Separation (Optional):** Additional separation equipment may be included in the process to recover additional recyclables. Further cleaning of the recovered recyclable may be required to achieve recycled product quality requirements and to harvest additional organics.

The selection of equipment is based on the materials targeted for recovery (based on revenues and/or diversion targets), the level of quality/cleanliness of the material, and the cost to recover the material versus the potential revenue from the material.

5.1.4 Organics Pre-Processing

Pre-processing of the organics stream is dependent on the type of organics processing technology selected – dry only, wet only, or a combination of dry and wet.

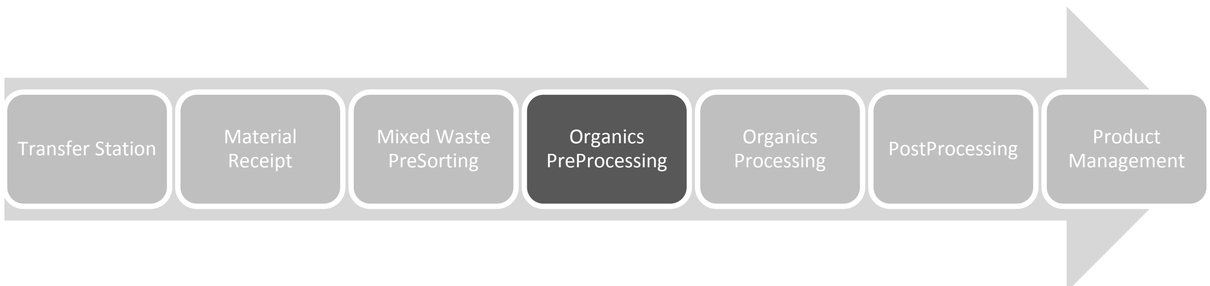

Figure 5.5 Pre-Processing Step

5.1.4.1 Dry Pre-Processing

Dry pre-processing is commonly used with in-vessel systems and Anaerobic Digestion processes requiring a higher solids content. Dry pre-processing includes upfront screening of the organic materials and any blending of amendment materials with the organic material.

5.1.4.2 Wet Pre-Processing

Wet pre-processing is required for Anaerobic Digestion processes that have lower solids content. In wet pre-processing, the organics are processed into a mixed pulp or slurry for the subsequent Anaerobic Digestion processing. This stage typically requires a mechanical size reduction (e.g., shredding or grinding) to break down larger particles into a size that can be digested.

Contaminants remaining with the organics will be ground and mixed into the organics. It is therefore important to further remove any of the smaller inorganic materials remaining in the organics fraction.

There are a number of options to accomplish wet organics pre-processing:

- **"Wet Screen or Trommel"** is mechanical size separation that relies on water pressure to wash smaller material through specific size slots or holes in a screen. The pulp that washes through the screen is pumped to subsequent polishing steps (such asgrit removal). This is considered to be non-destructive wet separation equipment. Screens/trommels have been used successfully in Mixed Waste Anaerobic Digestion processing facilities in Europe. There are a number of suppliers of this type of standard and relatively low-cost industrial equipment.
- **A "Hydropulper"** functions in much the same way top-loading washing machines work. The organic feedstock is loaded into a cylindrical tub and water is added. Heavy contaminants sink and are extracted from the cone-shaped bottom of the tub. A "washing" cycle is initiated and the contents of the tub are vigorously mixed to further break apart the organic materials and produce a pulp. The cycle ends and the heavy contaminants are allowed to re-settle and light

contaminants are given time to rise to the surface. The floating materials are skimmed off the top and the additional heavy materials are extracted from the bottom. The remaining pulp is then pumped to subsequent polishing steps.

There is typically a great deal of energy supplied during the cycle where contaminants collide against each other and surfaces in the tub, but this energy can be adjusted to minimize the potential for specific contaminants such as batteries to be further damaged. Suppliers include BTA International and GE Power Water & Process Technologies (formerly Monsal).

- **"Hydraulic Presses"** may be used to separate the wet organic stream from dry contaminants. Under pressure, the press squeezes the wet material from the dry material; the pressure is sufficient to crush and flatten almost everything that is introduced to the press.
- Other equipment or methods available for wet processing include hydrocyclones, grit separators, and self-cleaning tanks, the latter being specific to CSTR.

The organics recovery efficiency varies among of these technologies and is a function of the level of contamination the material entering the equipment and how the equipment is operated and optimized for the nature of the materials being handled.

Table 5.1 presents the possible combinations of pre-processing and organic processing technologies.

Table 5.1 Pre-Processing Technologies and Organic Processing Technologies Paring

Pre-Processing Technologies	Organics Processing Technology	
	In-Vessel Composting	Anaerobic Digestion
Dry Pre-processing	✓	✓
Wet Pre-processing	NA	✓

5.1.5 Organics Processing

The selection of an organics processing technology is key to the overall operating success of the facility. Organics processing typically occurs after the pre-processing phase and may requires some post-processing to remove contaminants, depending on the technology selected, as shown in Figure 5.6 below.

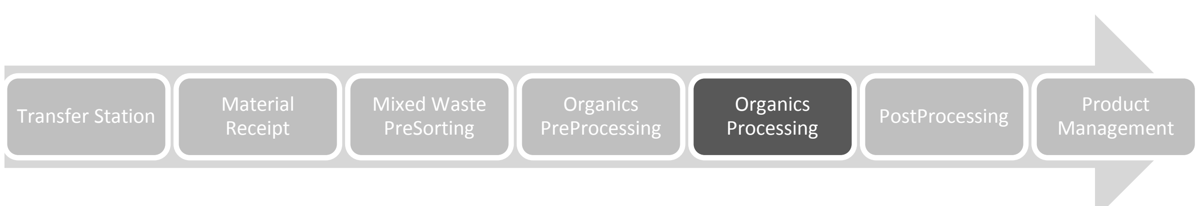

Figure 5.6 Organics Processing Step

5.1.5.1 Feedstock

The composition of the incoming feedstock is an important consideration when assessing technologies, as organic feedstocks vary physically, chemically, and biologically. Pre-processing and processing technologies that are not appropriate for the condition of the incoming feedstock will be quickly overwhelmed and can potentially cause the facility to fail to meet its objectives

5.1.5.2 In-Vessel Composting

In-vessel composting systems are the most technically advanced method of aerobically composting organic material. Positive or negative pressure is used to force or draw air through the composting mass and computerized control systems are used to monitor temperatures, aeration rates, and other composting parameters. Process air is typically sent to a biofilter for treatment of the odorous air. The process vessels can be constructed either inside a fully enclosed building or as standalone structures. Material after initial processing will require curing, which can be accomplished in windrows on a composting pad. In-vessel composting systems are common in Ontario for processing SSO, but have limited application worldwide for OFMW material.

5.1.5.3 Anaerobic Digestion

The increased implementation of Mixed Waste pre-sort processing plants in Europe has pushed the development of Anaerobic Digestion technologies that are designed and tested to process Mixed Waste. The OFMW has a higher contamination rate than most SSO streams.

Anaerobic Digestion technologies can be split into three broad categories, as follows:

1. CSTRs
2. Plug Flow Reactors
3. Percolate Bunker Reactors

These categories are defined based on both the method of maintaining the material in the digester and the total solids (TS) content of the material in the digester.

5.1.5.3.1 Continuously Stirred Tank Reactors - Wet Digestion

Typical characteristics of CSTRs include the following:

- Low TS slurries are used to facilitate continual (or regular) agitation of the digestate to achieve complete mixing and prevent settling of heavy and light fractions.
- Mixing of the slurry in the tank may be done by several different methods including gas injection, impellors, plunge mixers, or pump mixing.
- The digestate must be regularly agitated to prevent floating of light and settling of heavy contaminants in the tank that may reduce the effective volume of the digester, reducing the effective capacity and, therefore, biogas yield from the system.
- CSTRs produce biogas and liquid digestate.

The TS in CSTR digesters are typically less than 12 percent, which forms liquid slurry. CSTR digesters can be mixed continuously or at a frequent interval (e.g., hourly).

5.1.5.3.2 Plug Flow Reactors – High Solids

Plug flow reactors are designed in either vertical or horizontal flow directions. Vertical plug flow reactors utilize minimal amounts of agitation, sufficient only to slowly move the material from one point to another through the digester during the retention period. Characteristics of vertical plug flow tanks typically include the following:

- A vertical column tank is used.
- A conical base to facilitate digestate removal is used.
- Digestate is pumped to the top of the tank and allow it to pour onto the surface of the digestate.
- Digestate is removed from the bottom of the tank. During the retention period, the digestate slowly moves downwards through the vessel towards the outflow point. The ability to recycle digestate from the outflow to mix with fresh incoming material can be incorporated into the design to assist with inoculation of the incoming material and to increase gas yields.
- The reactor is operated with TS in the range of 18 to 40 percent, and is adjustable.
- Amendment material (e.g., yard waste) may be required to increase the TS of the slurry.
- The high solids content precludes extensive pre-processing; therefore, composting is typically used as the post-processing step to clean the digestate to meet beneficial use criteria.
- They produce biogas, liquid digestate, and a high solids digestate.

Horizontal plug flow reactors operate on the same principal as vertical plug flow reactors. The differences of horizontal plug flow reactors to horizontal reactors include the following:

- Long and slender horizontal digester vessel.
- A horizontal shaft with widely spaced paddle arms. These paddles are used to slowly move the digester forward as a plug while created a minimal amount of mixing.
- A headspace above the material pile where biogas collects and is syphoned from the reactor.

The TS level in plug flow digesters is typically in the 15 to 30 percent range or sometimes higher, depending on the feedstock. The digestate is moved through the digester as a single mass rather than being mixed.

5.1.5.3.3 Percolate Bunker Reactors - Dry Digestion

Percolate bunker reactors are similar in design to enclosed composting vessels but are operated in an anaerobic environment. Typical characteristics of percolate bunker reactors include the following:

- Vessels are typically constructed of concrete, but may be constructed of steel, and are large enough to drive material handling equipment (e.g., front end loader) into the bunker to place the organic feedstock.

- Feedstock requires little pre-processing beyond bag opening or shredding, depending on feedstock characteristics.
- Feedstock is loaded into the digester and the door is sealed for the duration of the retention period, typically 21 to 28 days.
- Percolate water is sprayed onto the material piles to create anaerobic conditions and to harvest organic liquid from the feedstock. The anaerobic conditions create biogas within the reactors, and the harvested organic liquid can be separately digested to produce additional biogas.
- Percolate water may also be collected and sent for further digestion through a CSTR system to recover additional biogas.
- The high TS content needed for the anaerobic process may require amendment material (e.g., yard waste) to increase the percentage of total solids.
- Bunker reactors produce biogas, liquid digestate, and a high solids digestate.

The TS in percolate bunker digesters is typically from 20 to 40 percent. Percolate bunkers are typically loaded with a front end loader into a long pile and the material remains in place for the duration of the digestion period.

5.1.5.3.4 Digester Temperatures for Biogas

An additional factor in the selection of an Anaerobic Digestion technology is the temperature of the process and its effect on biogas generation.

Digesters can be operated in either mesophilic or thermophilic temperature ranges. Mesophilic refers to operation in the range of 30 and 38 degrees Celsius (°C) with an average typically around 35°C. Thermophilic digesters operate in a range above 50°C.

Advantages of digestion in the mesophilic temperature range (versus thermophilic) include

- Lower energy input required to initiate and maintain reactor biology and conversion.
- Less sensitivity to changes in feedstock characteristics.
- Overall ease of operation.

Advantages of digestion in the thermophilic temperature range include:

- an increase in the rate of volatile solids destruction, requiring smaller size of reactor(s).
- an increased level of pasteurization and pathogen reduction.
- Shorter reaction time required to produce equivalent biogas yields.

Table 5.2 presents the end products that can result from each of the organic processing technologies.

Table 5.2 Potential End Products from Organic Processing Technologies

Organic Processing Technology	End Products	
	Liquid Product	Dry Product
In-Vessel Composting	NA	✓
Anaerobic Digestion	✓	✓

5.1.6 Post Processing

Following the digestion process, the resulting compost or digestate may require further processing as a function, of the processing technology used.

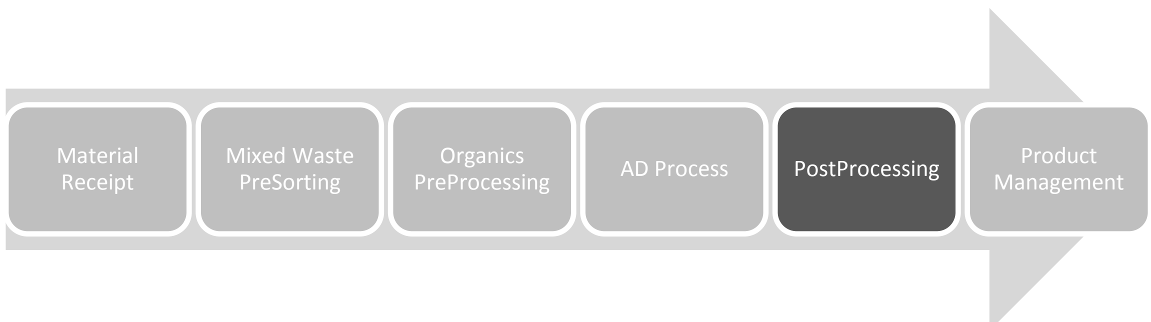

Figure 5.7 Post- Processing Step

The In-Vessel Composting system will produce a compost product.

The digestate from CSTR digesters will be clean but have a low TS content below 10 percent. This digestate can be land applied for beneficial use but the higher water content will result in higher transportation costs for the net volume of nutrients. Further post-processing equipment may be used to dewater the digestate to create a more valuable and flexible beneficial use product.

Plug flow reactors and percolate bunker reactors digesters both produce a drier digestate, in the range of 20 percent TS, however, this digestate may still be contaminated as a function of the level of pre-processing completed. This digestate is usually further composted to create a drier, cleaner product that can have a beneficial use.

Composted digestate produced directly from OFMW through these technologies is not suitable for beneficial use according to Ontario regulations. Following composting, the composted digestate must be screened to remove contaminants, and may need to be processed with additional equipment to remove contamination such as small hard plastic and shards. These are required to meet the current Ontario Compost Quality Standards (Ontario, 2012).

GHD is not immediately familiar with an application of this technology to Mixed Waste that has resulted in an organics stream suitable for land application in Ontario. Analytical results from compost-like-output (CLO) from Mixed Waste facilities as reported by Golder Associates (May 2009) are provided in Appendix B. Of note are the concentrations of copper, lead, molybdenum, nickel, and zinc, which exceed the criteria for Category AA and A compost under the Ontario Compost Quality Standards and the Nutrient Management Act regulations for land application of non-agricultural source material (NASM).

5.1.7 Product Management

Several products will be generated from the Mixed Waste organic processing systems that could be further sorted or processed.

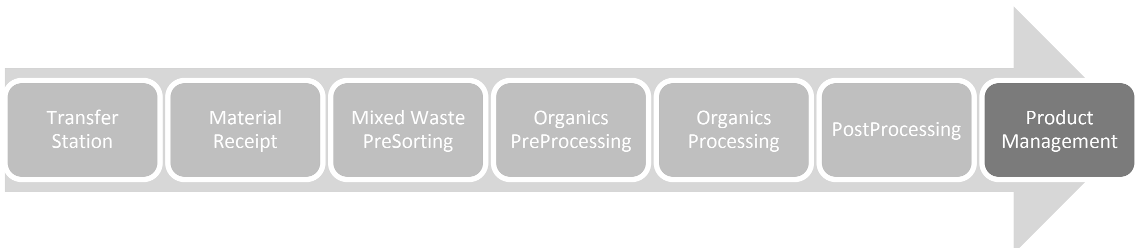

Figure 5.8 Product Management Step

Products that could be further treated and managed include:

- Recovered recyclables may warrant additional sorting or treatment to further separate and clean the products to obtain a higher market value.
- Residue could be shredded to create a refuse derived fuel (RDF) and further dried to create a solid recovered fuel (SRF). RDF and SRF could be either used in energy-from-waste (EFW) facilities or potential supplied to the cement industry as an alternative fuel. It is noted that regulations exist for the use of solid fuels as an Alternative Low Carbon Fuel (ACLF) in cement plants under Ontario Regulation, O. Reg. 79/15 and the use of any RDF or SRF would need to be in compliance with this regulation.
- There are several options for biogas utilization, which include co-generation to produce electricity and heat for on-site and off-site use, upgrading to RNG for injection into the local utility pipeline, and direct biogas combustion for industrial process heat. The equipment requirements for the management of the biogas will be dependent on the option selected.

5.2 Supporting Services and Infrastructure

There are several services and infrastructure necessary for a complete Organics Management Facility. Typical ancillary facilities include:

5.2.1 Process Related

- Building for Mixed Waste Pre-Sorting
  - Oversize Screening, Bag Opening, Size Separation, Other
- Building for Organics Pre-Processing
  - Dry Separation Equipment, Wet Separation Equipment
- Building for Organics Processing

- Composting Vessels, CSTRs (Outdoor), Plug Flow Reactos (Indoor), Percolate Bunker Reactors (Indoor)

- Building for Post Processing
  - Composting Curing Pads / Storage Area, Liquid Digestate Storage, Digester Solids Storage, Fuel Feedstock Storage

5.2.2 Process Support

- Material Receipt
  - Weigh Scale Facility, Initial Mixed Waste Storage/Buffering Capacity
- Product Management
  - Final Recyclables, Residual Waste, Refuse/Solid Waste Fuel, Biogas Conditioning, Biogas Treatment & Utilization, Biogas Flare
- Traffic Management
  - Chemical Delivery, Outbound Loading for Final Products

5.2.3 Facility Operations

- Non-Waste Treatment
  - Process Water Treatment, Process Wastewater Treatment, Odour Management System, Electrical Stormwater Management
- Facilities
  - Administration, Control Room, Power Supply and Distribution, Parking, Emergency Access

5.3 Current Facilities Processing SSO and/or OFMW

5.3.1 In-Vessel Composting Systems

There are two In-Vessel Composting systems under construction/in operation in North America (Edmonton and Halifax) that receive OFMW.

5.3.2 Anaerobic Digestion Systems

A listing of 14 facilities in North America and 93 facilities in Europe that currently treat SSO and/or OFMW by anaerobic digestion processing is provided in Appendix C.

There are a small number of Mixed Waste pre-sorting facilities in North America; there are 61 European facilities listed in Appendix C that accept Mixed Waste (with or without SSO).

There are Anaerobic Digestion facilities receiving post-consumer organics in North America. Two are operate in Ontario, which are standalone (not a farm Anaerobic Digestion system)[12].

[12] Environmental Research & Education Foundation. Anaerobic Digestion of Municipal Solid Waste A Report on the State of Practice, 2015.

There are no Anaerobic Digestion facilities in North America receiving OFMW; 44 of the 93 European Anaerobic Digestion facilities listed in Appendix C process OFMW; however, none of the European facilities that treat OFMW are permitted to land apply digested OFMW.[13].

6. Evaluation of Processing Options

6.1 Description of Processing Options

The following four combinations of Pre-Sorting and Organic Processing are assessed in this Evaluation:

- Pre-Sorting with In-Vessel System - Composting
- Pre-Sorting with Continuous Stirred Tank Reactors – Anaerobic Digestion
- Pre-Sorting with Plug Flow Reactors – Anaerobic Digestion
- Pre-Sorting with Percolate Bunker Reactors – Anaerobic Digestion

6.2 Evaluation Drivers

6.2.1 Categories and Evaluation Indicators

The Evaluation Drivers for the Study fall into the four broader categories that reflect the Study Drivers and the Region's own objectives for its integrated waste management system:

- Sustainability
- Growth Management
- Compatibility with Provincial Legislation
- Responsible Waste Management

The Evaluation Drivers were framed by the Region's commitment to creating an integrated waste management system where waste is seen as a potential resource and its value is realized in an environmentally and economically responsible manner.

- **Sustainability:** The Region is taking a forward-looking approach to waste management that is not solely driven by diversion but also by overall environmental and economic sustainability. To enhance diversion, the organics management program needs to consider increasing the quantity and types of organic material diverted within the Region and the expanding the sources of organic materials (from Mixed Waste or the MR sector).

  A sustainable system is one that promotes reduction of waste generation, reuse of materials, and recycling of materials that enter the waste stream (commonly referred to as the 3Rs). To expand the scope of sustainability in the management of the waste remaining after implementation of the 3Rs, a fourth R (- recovery (of energy from waste) has been implemented by the Region through the operation of the DYEC. The Region is receptive to implementing the

[13] Land application standards vary by country.

concept of additional energy recovery for the organics management program. While the diversion of its managed organic material is a preferred option for the Region, it is also considering options to recover energy from the organic material to complete an integrated waste management system.

  - **Evaluation Indicator** Additional organics diversion, Additional recycling, Energy recovery

- **Growth Management:** The Region is seeking to enhance its waste management system to lead the way in diverting an even higher percentage of waste while the total waste volume increases with the projected urban intensification in the Region and within the confines of the limited processing capacity (maximum of 110,000 tonnes per year) at the DYEC. This will require increasing the quantity of organic material collected and diverted from the SF and the MR sectors, where the significant growth is expected and where the collection of organic materials is currently facing the most challenges. Organic material collection from the MR sector will become an increasing challengewith the Provincial emphasis on urban intensification in the Places to Grow Act (2005). This will likely increase the MR sector's contribution to the Region's waste.

  By increasing organic material diversion, the Region can continue to work within its fixed waste processing capacity at the DYEC. This set disposal quantity will become an increasing challenge to the Region as the population increases over the next 30 years.

  - **Evaluation Indicators** Enables MR organics recovery, Maintains SF SSO recovery, Enables additional SF organics recovery from Mixed Waste.

- **Compatibility with Provincial Legislation:** Alignment with new regulations in Ontario enacted in 2016) will create opportunities for incoming revenues to the Region from waste products and/or byproducts.

  - **Evaluation Indicators:** Climate Change and Low Carbon Economy Act, Waste Free Ontario Act

- **Responsible Waste Management:** The Region is looking for an economically, environmentally, and socially responsible alternative to their existing organics management system.

  The preferred option for organics management must be a proven combination of technologies that have been individually and collectively assessed.

  Evaluation must also consider the costs of improved waste management relative to the existing status quo to accurately present the financial impacts to the Region.

  The economic analysis also addresses the inherent risks of the project and provides opportunities for potential future benefits. The preferred option will have a proven technical and environmental performance record and provides a socioeconomic benefit to the community.

  - **Evaluation Indicators** Cost recovery potential, Proven environmental performance, Socioeconomic benefits (including Employment) Proven system operation, Permitting requirements,

6.2.2 Evaluation Responses

Using the four categories and their specific indicators, the four Processing Options were evaluated in the Sections 6.2 to 6.6. Within each section, the evaluation is summarized in a table, where the evaluation metrics are presented as questions to capture the relevant considerations required to assess the advantages and disadvantages of the various Processing Options.

For each Processing Option the evaluation indicators for each Evaluation Driver were answered with Favourable, Uncertain, or Not Favourable. The combination of the responses for all the evaluation indicators under an Evaluation Driver was used to develop the overall response for that driver.

The overall response (i.e., Favourable, Uncertain, and Not Favourable) for each Evaluation Driver and ultimately each Processing Option was selected using the following approach:

- Where a Processing Option received predominately Favourable indicators, the overall evaluation would also be considered 'Favourable'.
- Where the majority of the indicators for a Processing Option received Uncertain indicators, the overall evaluation would be considered 'Uncertain.
- Where the majority of the indicators for a processing option received Not Favourable indicators, the overall evaluation would be considered 'Not Favourable'.

Tables 6.1 to 6.4 present the Evaluation under each of the four Categories, with their evaluation indicators applied to each of the Processing Options.

The overall evaluation results for each of the Processing Options are presented in Table 6.5.

6.3 Sustainability

The Evaluation Driver for the Sustainability Driver focusses on the concepts of waste diversion, recycling of materials and recovery of energy.

Diversion of materials from landfills and/or the DYEC was evaluated based on the ability of the Region to capture a greater amount of recyclables and organic material, and the potential for the Region to meet and report a higher diversion rate.

6.3.1 Additional Organics Diversion

For organic material to be considered as 'diverted' from disposal for the purposes of reporting to the provincially mandated reporting process, it must be reused and/or recycled[14]. Information collected by the Province is utilized to generate Ontario Residential Waste Diversion reports that report a diversion rate[15] which enable municipalities to compare their diversion success to others.

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14 Waste Diversion Ontario, Glossary, http://wdo.ca/learn/glossary, visited October 7, 2016.

15 Calculated as a percentage, with the numerator representing the amount diverted, and the denominator representing the amount diverted plus the amount disposed (WDO).

6.3.1.1 Capture of Additional Organics

The baseline for this evaluation is the amount of material captured by the existing SSO program. Through the pre-sort system at the start of each of the Processing Option, each will be able to capture a greater quantity of organic material in the form of OFMW. It is the OFMW material that offers the greatest potential for additional organics diversion. As such, each Processing Option was considered Favourable in terms of capture of additional organics.

6.3.1.2 Increase of Organics Diversion - Reported to Province

While additional organics capture is favourable for each Processing Option, the ability to divert the captured OFMW material is dependent on the organics processing technology. The OFMW captured in the pre-sort step needs to be processed and refined to meet standards for a reuse, avoiding the disposal of this material in landfills or the DYEC.

6.3.1.3 SSO Diversion

Although processing of SSO by the technology options is not a direct indicator of additional diversion potential, it is worth noting the current challenge faced by the SSO processing industry in Ontario with respect to the Ontario Compost Quality Standards.

6.3.1.3.1 In Vessel Composting

The Ontario organics management industry largely uses In-Vessel processing technologies to produce compost from SSO. The challenge in meeting the Ontario Compost Quality Standards has evolved because of the more stringent standard coupled with the challenges of using mechanical equipment during the back-end screening process at composting facilities to remove foreign matter and sharp foreign matter to below the maximum concentrations required by these same Standards.

The general trending in the SSO composting industry in Ontario has been towards utilization of other beneficial use approaches for the final product, including use of the material as Non-Agricultural Source Material (NASM) under the Ontario Nutrient Management Act (2002).

6.3.1.3.2 CSTR Anaerobic Digestion Processing

The operators of SSO processing CSTRs currently in use in Ontario have successfully provided an end product that has consistently complied with the Ontario Compost Quality Standards for metals concentrations in feedstocks, and has also consistently produced an end product in compliance with the Ontario Compost Quality Standards during final processing. This is has been driven by the use of water in a wet process to further separate contaminant materials according to density, where materials lighter than water (plastics) and denser than water (metals) can be isolated for removal.

6.3.1.3.3 Plug Flow and Percolated Bunker Anaerobic Digestion Processing

Both plug flow and percolate bunker reactors are high solids digestion processes that require bulking through additions such as leaf and yard waste. The resulting high solids slurries/mixes are then dried using conventional composting techniques, and thus provide limitations with respect to the final product as it relates to the Ontario Compost Quality Standards (as identified above).

Treatment of SSO streams through plug flow and percolate bunker reactors are subject to the limitations of mechanical screening equipment at the back end of the process – a challenge also documented by a number of In-Vessel composting systems in Ontario. Combinations of equipment and approaches including star screens, ballistic separators, and re-processing have been tried in Ontario with minimal success. These limitations are more pronounced as additional materials are introduced into the SSO stream.

The ability of these two Anaerobic Digestion treatments to make other final products (liquid fertilizers) has had limited success.

The diversion of processed SSO material as a compost material in Ontario is challenging, however it remains possible and there are other potential end uses that will classify the processed material as having been diverted.

As the benefits / restrictions of diversion of SSO were consistent among the Processing Options, it was not considered as a determining factor in further evaluation.

6.3.1.4 OFMW Diversion

The ability of the Processing Options to process OFMW to a material that can be diverted presents a challenge.

In Vessel Composting

With the challenges faced by the Ontario in producing compost from SSO, it is anticipated that OFMW will present a further challenge for the Industry. With the higher level of contaminants in OFMW compared to SSO and the same need to meet the stringent standard required by the Ontario Compost Quality Standards, production of acceptable compost from OFMW is not likely. It can be reasonably expected that compost from OFMW (where the organics have been potentially exposed to other contamination found in Mixed Waste) will be more contaminated than SSO and will be more difficult to convert into acceptable final product that contributes to the Region's diversion.

CSTR Anaerobic Digestion Processing

Anaerobic digestion offers a system that can generate a number of different high-quality final products and is generally pursued where incoming organics are contaminated. Anaerobic digestion can offer greater potential for diversion of OFMW. Wet processing of the organic material that has the ability to separate contaminant materials according to density, has the potential to produce a material that can be diverted from disposal. This may be a compost material, or more likely a liquid fertilizers type product.

On the basis that the incoming OFMW contains largely physical contaminations, the use of CSTR processing is considered favourable to divert OFMW to a useable product.

It should be noted that it is not currently possible to remove dissolved substances, solvents, paints or metals from organic materials from an OFMW source.

Plug Flow and Percolate Anaerobic Digestion Processing

Both plug flow and percolate bunker reactors are high solids digestion processes that require bulking through additions such as leaf and yard waste. The resulting high solids slurries/mixes are then dried using conventional composting techniques. There are limitations with respect to the final compost product as it relates to the Ontario Compost Quality Standards (as identified above).

The ability of these two Anaerobic Digestion treatments to make other final products (liquid fertilizers) has had limited success.

As a result, both plug flow and percolate bunker reactors have been marked as uncertain with respect to generating final product that can be diverted.

6.3.2 Additional Recycling

Additional recycling was evaluated based the potential for a Processing Option to contribute to add to the capture of recyclables (e.g., plastics, metals, paper, etc.) that are currently recycled by the Region in its Blue Box program.

A Mixed Waste pre-sorting facility, which is common to all the Processing Options, can be designed to remove recyclables as well as the organic fraction from the incoming Mixed Waste. The extent of effort required to remove recyclables can vary from hand sorting to a multi staged mechanical and density sorting system and can be focused on limited to a single or couple of materials to many materials.

Additional recovery of recyclables from Mixed Waste is expected to be low based in part on the success of the Blue Box program. The quality and quantity of the recyclables recovered is considered under the Cost Recovery evaluation indicator of the Responsible Waste Management driver.

As a Pre-Sort facility is also common to all the Processing Options, recycling does not become a differentiating criteria in this evaluation and is considered Favourable for the Processing Options reviewed.

6.3.3 Energy Recovery

Energy recovery can be one benefit of organics processing. The four Processing Options were evaluated based on both the potential for biological energy recovery and the ability to generate a solid alternative fuel.

Biological Energy Recovery

Biological energy recovery refers to generating, recovering and utilizing biogas from Anaerobic Digestion processes.

Recovered biogas can be used as a direct fuel replacement, be upgraded to a renewable natural gas (RNG) product or vehicle fuel, or used for electricity production. CSTR approaches generally produce more biogas per tonne of incoming organics than either plug flow or percolate systems, as agitation and mixing provided in this approach enhances biological activity and distribution of favourable conditions for biological activity through the entire organics mass. Plug flow systems offer less overall mixing, and percolate bunkers offer no mixing of the organics mass as static piles.

The In-Vessel Processing Option is aerobic and does not generate biogas and accordingly was considered Unfavorable with respect to biological energy recovery.

The three Anaerobic Digester options were considered Favourable in their ability to recover energy from a biological process.

Solid Alternative Fuel – Thermal Energy Recovery

Materials such as mixed plastics, film plastic and fibres that are rejected in the Mixed Waste pre-sort step have the potential to be used after further processing, to produce a solid fuel for thermal energy recovery, or to be sent directly to the DYEC for energy recovery at that location. These materials have little or no saleable value in recycling markets.

The four Processing Options were all considered to be Favourable with respect to thermal energy recovery potential.

Recovery and processing of high calorific content material can also be prepared as fuel for the cement industry, displacing the use of fossil fuels. The market potential for a solid fuel product is considered under the Cost Recovery evaluation indicator of the Responsible Waste Management driver.

Table 6.1 summarizes the review of the sustainability driver for the Processing Options under consideration.

Table 6.1 Processing Options Evaluation – Sustainability

Evaluation Indicator	Evaluation Question	Pre-Sort with In-Vessel System	Pre-Sort with CSTR System	Pre-Sort with Plug Flow Reactor System	Pre-Sort with Percolate Bunker System
Additional Diversion	Will the processing option allow the Region to capture more materials (e.g., tonnes) than current SSO program?	Favourable	Favourable	Favourable	Favourable
	Will the processing option allow the Region to increase its organics diversion rate reporting to the Province?	Unfavorable	Favourable	Uncertain	Uncertain

Evaluation Indicator	Evaluation Question	Pre-Sort with In-Vessel System	Pre-Sort with CSTR System	Pre-Sort with Plug Flow Reactor System	Pre-Sort with Percolate Bunker System
Additional Recycling	Does the processing option have the potential to recover additional blue box recyclables?	Favourable	Favourable	Favourable	Favourable
Energy Recovery	Does the processing option have a potential for biological energy recovery?	Unfavorable	Favourable	Favourable	Favourable
	Does the option have the potential to create an alternative solid for thermal energy recovery?	Favourable	Favourable	Favourable	Favourable
	Overall Evaluation	**Favourable**	**Favourable**	**Favourable**	**Favourable**

6.4 Growth Management

Enhancements to the Region's organic management system will require increasing the quantity of organic material collected and diverted from the SF and the MR sectors, where the significant growth is expected and where the collection of organic materials is currently facing the most challenges.

6.4.1 Multi-Residential

Organics from the MR sector's organics are currently not captured collected as part of the Region's Green Bin program.

This residential sector has a projected growth rate that exceeds that of the SF sector that is also served by the Green Bin program.

To capture organics from the MR sector now and in the future, the Region has proposed the use of Mixed Waste pre-sorting to recover the OFMW in that waste stream. Percentage recovery of organics from a Mixed Waste stream is expected to be about 50 percent of the total incoming organics, but actual levels depend on the pre-sort system employed. The expectation suggests that recovery of all organic material from complex Mixed Waste streams would be difficult.

As Mixed Waste Pre-Sorting is common to all Processing Options, they are all considered Favourable with respect to the ability to divert organics from the MR sector.

6.4.2 Single Family

The Region's Green Bin program is well received by the Region's single family residents and has been effective at diverting SSO material for a number of years. Maintaining this system is important in the overall context of the Region's integrated waste management system.

It is also important to emphasize that the certainty by which quality of final products (e.g., fertilizers, compost, etc.) from organics can be created from SSO is currently greater than it is for Mixed Waste organics (OFMW).

Each of the Processing Options has the ability to enable the Region to maintain is Green Bin program.

Table 6.2 Processing Options Evaluation – Growth Management

Evaluation Indicator	Evaluation Question	Pre-Sort with In-Vessel System	Pre-Sort with CSTR System	Pre-Sort with Plug Flow Reactor System	Pre-Sort with Percolate Bunker System
Multi-Residential	Will the option enable recovery of organics from the MR sector?	Favourable	Favourable	Favourable	Favourable
Single Family	Will the option enable the existing single-family curbside Green Bin (SSO) program to be effectively maintained?	Favourable	Favourable	Favourable	Favourable
	Overall Evaluation	Favourable	Favourable	Favourable	Favourable

6.5 Compatibility with Provincial Legislation

There are significant changes occurring around regulations that govern and impact municipal waste management in Ontario. Two new pieces of provincial legislation have been considered in our evaluation of Facility Options including:

- Climate Change and Low-Carbon Economy Act (2016).
- Waste Free Ontario Act (2016).

The implications of each of these regulations on the Region and its organics management approach are discussed below.

Climate Change and Low-Carbon Economy Act

As Municipalities are not specifically noted as designated emitters by the Ministry of the Environment and Climate Change (MOECC). Therefore, the Region has no obligations via the Climate Change and Low-Carbon Economy Act to reduce emissions from their operations, with the exception of the DYEC where the Region the region has a cap on its emissions. However, the Region does have the ability (through pre-sorting of Mixed Waste and use of Anaerobic Digestion technologies to further reduce greenhouse gas (GHG) emissions and in accordance with the Act) to participate in the following ways:

- Creation of emissions reductions that could be then sold to large emitters who are subject to a cap. Large emitters include the steel and cement industries and large users or distributors of natural gas. There are approximately 150 large designated emitters in Ontario, including the DYEC, that are required through the Climate Change Mitigation and Low-Carbon Economy Act to reduce their total GHG emissions. As their cap levels decline over time, there is a responsibility for them to continue to make these reductions. As part of the carbon market, this means that GHG emission reductions voluntarily created by the Region could be transacted to large emitters, providing revenues for the Region.
- Use of funds created by compliance with Climate Change Mitigation and Low-Carbon Economy Act to engage in emission reduction projects and initiatives. As part of the overall Program, the MOECC will collect funds from allowances issued to large emitters who cannot otherwise achieve compliance with their respective caps. The revenue from these allowances will be maintained in the Greenhouse Gas Reduction Account (GGRA) and may be dispensed to proactive companies and organizations, according to the standards outlined in the Ontario Climate Action Plan. The GGRA may become a possible source of funding for Regional implementation of this Region's project, subject to the MOECC's final rules for accessing this Account.

Specific opportunities for GHG emission reductions could be achieved by the Region as follows:

- SSO processing using Anaerobic Digestion technologies. While both aerobic in-vessel and anaerobic Anaerobic Digestion technologies divert organics from landfill and generate emission reductions, Anaerobic Digestion also offers emission reductions from the production of renewable forms of energy.
- Capturing more SSO by increasing the allowable materials in the stream and by providing a more convenient system to its residents to drive participation. This incremental increase in organics diverted is a net increase over the Region's current practice. The extra emission reduction occurs because less organic material is directed to landfill, where a portion of the methane produced in the landfill is emitted to the atmosphere.
- Capturing additional recyclables from Mixed Waste through a pre-sorting system. This additional recyclable captures reduces the waste quantities directed to landfill, but more importantly generates additional recyclable commodity that can be sold to industry as a replacement for virgin product.
- Capturing organic fraction of Mixed Waste (capturing OFMW), in particular from the MR sector of the Region, given the Region's project growth rate and the higher organic content in Mixed Waste from this sector. Additional organics capture diverts volume from landfill and prevents methane emission. Additional GHG emission reductions are created by producing and utilizing biogas from this incremental organics stream.
- Producing and utilizing biogas from the same increase in OFMW
- Using final organic products in a beneficial manner, where this will displace the use of conventional fertilizers and help with sequestration of carbon from the atmosphere.

Accounting of potential versus actual emission reductions will depend on the final rules issued by the MOECC in the form of protocols/methodologies. The Processing Options will have some differentiation in terms of how treatment processes and technologies will actually reduce emissions.

The following items are of note:

- High solids technologies (e.g., plug flow and percolated bunker Anaerobic Digestion technologies) tend to generate less biogas than CSTR, and correspondingly have less available emission reductions potential from biogas utilization.
- High solids technologies have inherent uncertainty in generating consistent generate quality final products that can be beneficially used. They are reliant on composting back-ends that are subject to the stringent Ontario Compost Quality Standards.
- Processed OFMW has some uncertainty with respect to its beneficial use. If beneficial use cannot be achieved and OFMW generate a final waste product, there is additional uncertainty with respect to emission reductions generated via beneficial use.
- Combined Treatment Approaches generate approaches further uncertainty, due to the variability in OFMW quality as a stand-alone product, or when mixed with SSO prior to anaerobic digestion.

Taking these factors into consideration, the overall GHG emission reduction potential for all the organic processing options considered is favourable, and the options with Anaerobic Digestion technologies have enhanced ability to reduce GHG emissions relative on their biogas generation potential.

6.5.1 Waste Free Ontario Act

The Waste Free Ontario Act is primarily focused on waste reduction by way of responsibilities for recyclables [e.g., End Producers Responsibility (EPR program];); however, the Draft Strategy for a Waste Free Ontario: Building the Circular Economy Strategy[16] (Strategy) that accompanied the Waste Free Ontario Act identified the need for organics diversion. In particular, the ministerial mandate letters released by the Province in 2016[17] specifically note that an Organics Action Plan to divert more organic waste from landfills is a priority that will enter the consultation period in 2017 with implementation in 2018. As noted in the Draft Strategy for a Waste Free Ontario items such as recovery of organics from high-rise and multi-residential dwellings is a component of this.

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16 MOECC, Draft Strategy for a Waste Free Ontario: Building The Circular Economy, 2015, http://www.downloads.ene.gov.on.ca/envision/env_reg/er/documents/2015/012-5834_DraftStrategy.pdf, visited October 7, 2016

17 Correspondence from Premier Kathleen Wynne to The Honourable Glen Murray Minister of the Environment and Climate Change, Re: September 2016 Mandate letter: Environment and Climate Change Premier's instructions to the Minister on priorities, September 23, 2016 https://www.ontario.ca/page/september-2016-mandate-letter-environment-and-climate-change, visited October 7, 2016

6.5.1.1 Recyclable Capture

Each of the Processing Options all have the potential to contribute to the capture of recyclables (e.g., plastics, metals, paper, etc.) that are currently recycled by the Region in its Blue Box program.

A Mixed Waste pre-sorting facility, which is a common component of each of the Processing Options, can be designed to remove recyclables as well as the organic fraction from the incoming Mixed Waste.

As all of the Processing Options have the same front end recycling potential with the pre-sort system in place, this evaluation indicator driver is considered Favourable for all of the options.

It is noted that additional recovery of recyclables is expected to be low based in part on the success of the Blue Box program. The quality and quantity of the recyclables recovered is considered under the Cost Recovery evaluation indicator of the Responsible Waste Management driver.

6.5.1.2 Organics Capture

The increase in organics capture offered by each of the Processing Options is well aligned with the Draft Strategy for a Waste Free Ontario: Building the Circular Economy Strategy[18] (Strategy) that accompanied the Waste Free Ontario Act. The additional capture of organics from Mixed Waste from each of the Processing Options will have the net effect of increased diversion of organics from landfills and the associated reduction in GHG emissions.

The Region will be very favorably placed with respect to the Waste-Free Ontario Act going forward, as it harvests more useable commodities from its waste stream and proportionately sends much less of its waste to landfill, especially considering the DYEC as a final disposal and energy production asset.

Table 6.3 Processing Options Evaluation – Compatibility with Legislation

Evaluation Indicator	Evaluation Question	Pre-Sort with In-Vessel System	Pre-Sort with CSTR System	Pre-Sort with Plug Flow Reactor System	Pre-Sort with Percolate Bunker System
Climate Change and Low-Carbon Economy Act	Does the option have the potential to generate GHG emission reductions?	Unfavourable	Favourable	Favourable	Favourable
	Does the option have the potential to generate GHG off-set credits under the Climate Change and Low-Carbon Economy Act?	Unfavourable	Favourable	Favourable	Favourable
	Overall Evaluation	**Unfavourable**	**Favourable**	**Favourable**	**Favourable**

18 MOECC, Draft Strategy for a Waste Free Ontario: Building The Circular Economy, 2015, http://www.downloads.ene.gov.on.ca/envision/env_reg/er/documents/2015/012-5834_DraftStrategy.pdf, visited October 7, 2016.

Evaluation Indicator	Evaluation Question	Pre-Sort with In-Vessel System	Pre-Sort with CSTR System	Pre-Sort with Plug Flow Reactor System	Pre-Sort with Percolate Bunker System
Waste Free Ontario Act	Does the option have the potential to enhance recovery of recyclables?	Favourable	Favourable	Favourable	Favourable
	Does the option position the Region as a leader in organics management with respect to the Strategy for a Waste Free Ontario: Building the Circular Economy Strategy?	Favourable	Favourable	Favourable	Favourable
	Overall Evaluation	**Favourable**	**Favourable**	**Favourable**	**Favourable**

6.6 Responsible Waste Management

The Region is looking for economic, environmental, and socially responsible alternative to the existing organics management system. Processing Options were evaluated based on cost recovery, environmental performance, social & economic benefits as well as technical considerations in Ontario.

6.6.1 Cost Recovery Potential

The opportunity to sell off end products including recovered recyclables, treated organics, biogas and solid residual waste provides potential cost recovery for the operation and maintenance of the Facility.

6.6.1.1 Recyclables

Cost recovery of recyclables removed by the Mixed Waste pre-sorting facility included in each Processing Options will depend on the condition of the recyclables and the market's willingness to accept the material. There is limited experience in North American and none in Ontario with the recovery and sale of recyclable material from Mixed Waste. While it is possible to recover recyclables, in particular metals and plastics, the extent of effort and cost required to achieve a material stream that is clean and free of contamination may outweigh the price the market will pay for the end recovered material.

There are some materials, such as ferrous and non-ferrous metals, that are commonly removed in Mixed Waste facilities; metals can be selectively removed using commonly available magnets (ferrous metals) and eddy current (non-ferrous metals, such as aluminum) equipment. Industry data suggests that the recovery rate for metals is in the range of 1 to 5 percent of the total incoming Mixed Waste tonnage, with the recovery rate typically being reported at the lower end of this range. The Region's available Mixed Waste composition study from 2011 indicates that there is less than 1 percent metals in the Mixed Waste stream by weight. The recovery of metal from Mixed Waste facilities is also driven by the local market conditions or local regulations.

Processing Options were considered to be Uncertain with respect to a consistent market present for recovered recyclables.

6.6.1.2 Treated Organics

The In-Vessel composting Option was considered uncertain in terms of the potential to generate revenue from the final organic product. This is a direct correlation to the unfavorable assessment of the ability of this Processing Option to generate a final organic product that could be diverted.

The CSTR Anaerobic Digestion Processing Option provides the opportunity for a greater range of marketable products market, such as dilute liquid digestate, enhanced thickened liquid fertilizer, or a dewatered cake that can be used as a feedstock for composting. This Option was considered Favourable with respect to its relative ability to generate a revenue from the final organic product.

Plug Flow and Percolate Bunker (high solids) Options can only typically generate compost, limiting the overall availability of markets. The degree of product quality diminishes with the Options that are reliant on composting at the back-end, and subject to limitations of mechanical equipment to fully remove contaminants from compost.

As there is limited potential product and uncertainly in the processing of the organic material, the high solid Anaerobic Digestion options were considered uncertain with respect to revenue generation from the final organic material.

6.6.1.3 Biogas

Biogas production is possible only from the three Anaerobic Digester Processing Options.

The potential uses for production and quality of biogas are varied and can be function of both the Anaerobic Digestion technology and feedstock.

There are a variety of potential uses and markets that exist for biogas, including:

- ***Production of Renewable Natural Gas (RNG):*** Removal of impurities in biogas creates a product that is similar to natural gas. RNG can be used in Region-owned facilities, used in Regional collection trucks as a compressed natural gas (CNG) product, sold to a natural gas distributor (Enbridge or Union Gas), or sold as a transportation fuel under the Renewable Identification Number (RIN) process in the United States.
- ***Production of Electricity***: Electricity produced by biogas can be sold to the public distribution system. Electricity is derived from conventional reciprocating engine technology and is a common use of biogas. However, the ability to obtain favourable pricing and a long-term contract from the Province has diminished in recent years as the government has suspended, as of September 27, 2016[19], procurement of long-term contracts and pricing for Large Renewables with the Independent Electricity System Operator (IESO). Given the amount of organic material that the Region controls, a project for electricity generation would fit into the so-called Large Renewables Procurement, which is now halted. As a result, this is not an option for the Region at this time. It is still possible that electricity could produce and sold to the grid at

[20] The Pembina Institute and Environmental Defense, 2014.

the spot market price, this offers little certainty to the Region but the possible variability in terms of economics prices prevents the Region from considering income as stable from this source. It is also possible to sell up 500 kW to the grid the Provincial Feed in Tariff program through the IESO at premium rate.

- ***Production of Electricity for Through existing contract(s)***: This option would include the possibly of biogas to be utilized at the DYEC in a manner that leverages the Region's existing power purchase agreement (PPA) for supply of electricity. It is also possible to deploy biogas for electricity generation that feeds the Region's own infrastructure in a behind-the-meter scenario. The viability of these options depends on the cost-benefit of these approaches.
- ***Direct Use***: Distribution of biogas itself for use as fuel. Biogas has appreciable energy content and can be used in boilers or furnaces as a direct fuel source. The Cambridge Landfill owned and operated by the Region of Waterloo, for example, dispenses landfill gas to a neighboring steel plant. This option is highly subject to the siting of the location selected for the site of an Anaerobic Digestion facility.

The three Anaerobic Digestion Processing Options were considered Favourable with respect to the potential for cost recovery of biogas.

6.6.1.4 Solid Fuel Cost Recovery

Solid residual waste will be generated from the Mixed Waste Pre-Sort Facility, common to each of the four Processing Options.

Solid Residual Waste may be processed into one of the following solid fuel alternatives: refuse derived fuel [RDF], solid refuse fuel [SRF], or a low carbon alternative fuel [LCAF].

The provincial Alternative Low Carbon Fuel (ACLF) regulation (O. Reg. 79/15) came into force on May 1, 2015 with the intention of reducing coal use in energy-intensive industries. This legislation reduced a significant barrier to the use of RDF as an ALCF in cement plants in Ontario, thereby opening up potential market for solid fuel recovery from the Durham this Project.

While it is possible that residual material from the Mixed Waste pre-sort facility could be processed into an RDF product, what is uncertain is the size of the market for the cement industry to accept this material, given that LCAF is already being produced and utilized in the Province.

Ontario has six cement plants that represent half of Canada's cement production capacity, producing approximately six million tonnes of cement[20].

The six plants are listed below, along with available information regarding the status of any RDF projects at each facility:

- Essroc Canada Inc. (Picton). This facility was the first in Canada with permission to use RDF in 1997 but as of 2005 had yet to do so[21].

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[20] The Pembina Institute and Environmental Defense, 2014.

[21] A.J. Chandler & Associates Ltd. . (2012, March 15). Guidelines for the Safe and Beneficial Use of Mixed Fossil & Biomass Fuel Sources in the Cement Industry with a Focus on Railroad Ties. Retrieved October 12, 2016, from Cement 2020: www.cement2020.org/download/file/fid/191.

- Federal White Cement Inc. (Woodstock).
- Lafarge Canada Inc. (Bath). Currently utilizes woody biomass ALCF, including rail ties and telephone poles (RDF)[22].
- CRH Canada Group Inc. (Mississauga).
- St. Mary's Cement (Bowmanville and St. Mary's): The: Bowmanville plant has ECA applications to utilize woody biomass ALCF currently under review with MOECC[23].

The state of this industry is currently in flux as it responds to the new ALCF Rregulation; it is not yet clear how the market will evolve in the short term. As an example, the former Dongara Pellet Plant in Vaughan closed in 2014 reportedly due to a lack of available market for its RDF product. With the new ALCF regulation now in place, the Dongara facility was recently purchased by Canada Fibers[24] and Fibres[25],renamed the Canada Fibers High Diversion Material Recovery Facility, and is reportedly being recommissioned by the new owner.

The market for the material has also been created by the implementation of the Climate Change Mitigation and Low-Carbon Economy Act, driving the cement industry to utilize LCAFs; however, there is some uncertainty in how much LCAF can and will be used.

This evaluation indicator is considered favourable for all four Processing Options, as each will have a Mixed Waste pre-sorting system that will isolate materials that could be used to produce RDF.

6.6.2 Environmental Performance

Environmental Performance refers to the Operation of Facilities in a manner that does not produce an adverse impact on neighbors and the public. This is especially important for the Region, an urbanized and growing area, where maintaining adequate environmental performance is very important.

In-Vessel composting systems exist in Ontario for the management of SSO. These facilities, where there has not been a suitable location, or there are operational and design considerations, have been challenged by odour issues. Anaerobic Digestion systems in use for waste management are increasing in number in Ontario, and have been deployed with modern abatement and mitigation systems allowing for successful operations.

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22 CemNet. (2005, December 08). Ontario cement plant to burn tyres and waste. Retrieved October 12, 2016, from CemNet: http://www.cemnet.com/News/story/143062/ontario-cement-plant-to-burn-tyres-and-waste.html.

23 HDR Engineering. (2014, May). Documents. Retrieved October 2016, 2016, from St Marys Cement: http://www.stmaryscement.com/Documents/SMC-Design-Operations-Report_ECAApplication.pdf#search=design%20operations%20report.

24 Canada Fibers News Release, CANADA FIBERS ANNOUNCES ANOTHER BOLD SOLID WASTE RECYCLING INITIATIVE, May 10, 2016. http://www.canadafibersltd.com/news/canada-fibers-announces-another-bold-solid-waste-recycling-initiative/, visited October 7, 2016.

25 Canada Fibers News Release, CANADA FIBERS ANNOUNCES ANOTHER BOLD SOLID WASTE RECYCLING INITIATIVE, May 10, 2016. http://www.canadafibersltd.com/news/canada-fibers-announces-another-bold-solid-waste-recycling-initiative/, visited October 7, 2016.

6.6.2.1 Anaerobic Digestion

Regulations in Ontario place a significant emphasis on odour abatement strategies and systems for waste management facilities where organics are processed. The strategies and equipment to address these issues has matured to the point where Anaerobic Digestion technologies can be successfully deployed.

Strategies and odour control system requirements systems are affected by processing technology choice. Back-end composting systems for Plug Flow and Percolated Bunker technologies will generate a large volume of process air requiring treatment prior to discharge. While technologies do exist to undertake this treatment (e.g., ammonia scrubbers, photoionization systems, inorganic or organic biofilters, thermal oxidation), it is overall more challenging to treat these air streams versus those from Anaerobic Digestion (CSTR systems)that do not require post-treatment composting.

In the composting industry, there have been a number of issues with respect to odour from SSO compost. However, by taking into consideration a facility's location, good design and operational practices, these odour conditions and concerns can be mitigated.

On this basis, the In-Vessel composting and high solids Anaerobic Digestion technologies with back-end composting (Plug Flow and Percolate Bunker Reactors) are considered Favourable with respect to Environmental Performance.

6.6.3 Social

6.6.3.1 Employment Opportunities

Each of the Processing Options provides the opportunity for direct and indirect local jobs during construction of, and permanent positions for the operation of, the Facility. The number of jobs during the operation of the Facility will depend on the technology and other components of the facility but it is currently estimated that each of the Processing Options considered will require up to 30 employees. Each of the Options is considered Favourable with respect to employment opportunities.

6.6.3.2 Operations and Waste Management within Region Boundaries

The organic management system options considered can be constructed, operated and maintained within the Region of Durham.

6.6.4 Technical Considerations

The technical feasibility of Mixed Waste Pre-Sorting, In-Vessel Composting, and Anaerobic Digestion has been reviewed by the Region and found to be at a level sufficient to provide the Region with a number of options for a reliable System.

The components of the proposed Facility Options were evaluated with respect to both Proven Operation and Permitting Requirements in Ontario.

6.6.4.1 Proven Operation

Operations experience with Mixed Waste Pre-Sorting, In-Vessel Composting, and Anaerobic Digestion in a number of locations throughout the world was assessed for comparison with the Processing Options.

The Evaluation Indicator for successful operation of a Facility was set at a minimum of two years.

6.6.4.1.1 Mixed Waste Pre-Sorting

There are some sixty Mixed Waste pre-sorting facilities in operation outside North America. A former Mixed Waste pre-sorting facility in Vaughan was closed in 2014 (Dongara Facility) and one in Edmonton is under construction.

Three quarters of the European Mixed Waste pre-sorting facilities produce OFMW intended for land application (e.g., disposal). The remaining facilities are not designed to separate an OFMW, due either to regulatory restrictions or the intended use of the waste material. In Edmonton, the Mixed Waste is to be sorted prior to being sent to a biofuels facility; the former Dongara facility in Ontario was intended to produce RDF material.

On the basis of global and North American experience, the Mixed Waste pre-sorting facility component of each of the four Processing Options is considered Favourable with respect to the 2 year Operating Driver.

Based on total number of Mixed Waste facilities currently operating outside North America, the Mixed Waste pre-sorting facility component was considered Favourable for each of the Options.

6.6.4.1.2 Anaerobic Digestion

There are examples of all three Anaerobic Digestion technologies (CSTR, Plug Flow & Percolate) in use worldwide, operating with either SSO or OFMW for more than two years. It should be noted that individual facilities identified appear to accept only one of these two sources.

In North America, the seven identified existing facilities that process post-consumer organics accept only SSO, and none of these use Plug Flow technology.

There are two planned facilities, in Edmonton and in Santa Barbara, California, that are intended to receive OFMW.

Over half of the European facilities identified use Plug Flow Reactors. However, the use of a specific Anaerobic Digestion technology is dependent on the location and the material sourced.

There are a sufficient number of operating facilities for each of the three Anaerobic Digestion technologies to confirm that the proposed Processing Options that have an Anaerobic Digestion component have been successfully operation for more than two years.

As each Reactor type has been used to process either SSO material and OFMW on a global scale, all three of the Anaerobic Digester Options are considered Favourable for this driver.

6.6.4.2 Ontario Permitting Requirements

The ability to permit each of the Processing Options under assessment is considered Favourable.

The City of Toronto and private developers have successfully completed permitting for In-Vessel and Anaerobic Digestion facilities for SSO, as well as Mixed Waste pre-sorting facilities for the production of Refuse Derived Fuel (RDF).

It is acknowledged that there will be some challenges with the permitting of the organic processing component for Mixed Waste. These issues are not insurmountable if the product of the organic fraction processing is effectively managed to meet existing standards.

For any organics processing facility, the Region will need to ensure that all environmental impacts of the facility including odour, noise, and air emissions are addressed to the satisfaction of the MOECC.

The successful operation of In-Vessel and three existing Anaerobic Digestion facilities in Ontario (Disco Road and Dufferin Organics in Toronto, Woolwich Bio-En Biogas in Elmira) plus the former Dongara facility in Vaughan are evidence that with effective planning and design these requirements can be met.

The three Anaerobic Digestion facilities named above, all of which process SSO on a large scale, are Continuous Stirred Tank Reactors and utilize off-site facilities for the curing of their digestate.

Both Plug Flow and Percolate Bunker reactors will require the removal of contaminants following digestion, creating a potential discharge point for odours. These two high solids technologies are in operation in two very stringent environmental jurisdictions in British Columbia and California.

The permitting of a Mixed Waste processing facility for municipal solid waste will have some challenges, as this will be a newer type of waste processing within the Province. Similar facilities have operated in Ontario however there are none currently in operation.

However, with the successful operation of similar waste processing facilities (e.g., construction and demolition material recovery facilities and organics processing facility) in the Province, permitting of a Mixed Waste facility is consider possible. Additionally, this type of facility will also align with the recently implemented legislation.

There have been only a handful of relevant facilities permitted in Ontario prior to passage of the Waste-Free Act and the accompanying specifically the Strategy for a Waste Free Ontario: Building the Circular Economy Strategy. These two regulations and policies suggest that the Province is behind the advancement of the waste industry and is open to the use of technologies that have been successful around the world. It is anticipated that the MOECC's approval process will align with the Provincial policy on organics management.

Table 6.4 presents the evaluation of Technical Considerations driver.

The overall evaluation of the Processing Options was considered to be Favourable.

Table 6.4 Processing Options Evaluation – Responsible Waste Management

Evaluation Indicator	Evaluation Question	Pre-Sort with In-Vessel System	Pre-Sort with CSTR System	Pre-Sort with Plug Flow Reactor System	Pre-Sort with Percolate Bunker System
Cost Recovery Potential	Do markets exist for the treated organics output from SSO and OFMW?	Uncertain	Favourable	Favourable	Favourable
	Do markets exist for the recovered recyclables?	Favourable	Favourable	Favourable	Favourable
	Does a market exist for fuel generated from the residual waste (e.g., RDF, SRF, LCAF)?	Uncertain	Uncertain	Uncertain	Uncertain
	Do markets exist for revenue from the biogas?	N/A	Favourable	Favourable	Favourable
Environmental Performance	Does the system have a proven environmental track record?	Favourable	Favourable	Favourable	Favourable
Social	Does the option provide the Region with employment for skilled workers?	Favourable	Favourable	Favourable	Favourable
	Does the option provide the Region the potential to manage its waste within its borders?	Favourable	Favourable	Favourable	Favourable
Proven Operation	Has a similar Mixed Waste pre-sorting system been successfully operating for more than 2 years?	Favourable	Favourable	Favourable	Favourable
	Has the organic processing component been successfully operated for more than 2 years?	Favourable	Favourable	Favourable	Favourable

Evaluation Indicator	Evaluation Question	Pre-Sort with In-Vessel System	Pre-Sort with CSTR System	Pre-Sort with Plug Flow Reactor System	Pre-Sort with Percolate Bunker System
Proven Permitting	Is there a reasonable likelihood of permitting a Mixed Waste pre-sort facility in Ontario?	Favourable	Favourable	Favourable	Favourable
	Is there a reasonable likelihood of permitting the Anaerobic Digestion component in Ontario?	Favourable	Favourable	Favourable	Favourable
	Overall	**Favourable**	**Favourable**	**Favourable**	**Favourable**

6.7 Driver Evaluation Summary

Using a similar approach summarizes the Evaluation Indicators within each of the Project Drivers.

The results of the evaluation of the Drivers were summarized to identified those Processing Options that should be further evaluated in the Preliminary Business Case Financial Analysis.

In-Vessel Composting is challenged in its relative ability to remove contaminants, to produce a usable end product from the organic material, and to produce biogas. The inability to produce biogas resulted in an unfavourable indicator for the Climate Change and Low Carbon Economy Act drivers.

An organics management system that include an in-vessel processing option could still meet the Region growth challenges, help the Region comply with the Waste Free Ontario Act, and would be considered responsible waste management.

We have recommended that the Processing Option with In-Vessel Composting is recommended to be to be carried forward to the business case financial analysis.

The three Processing Options that included Anaerobic Digestion technologies were well suited to meeting each of the Region's Divers. These three Options are recommended to be carried forward to the Preliminary Business Case Financial Analysis.

The summary of the evaluations is provided in Table 6.5.

Table 6.5 Evaluation of Processing Options – Final Summary

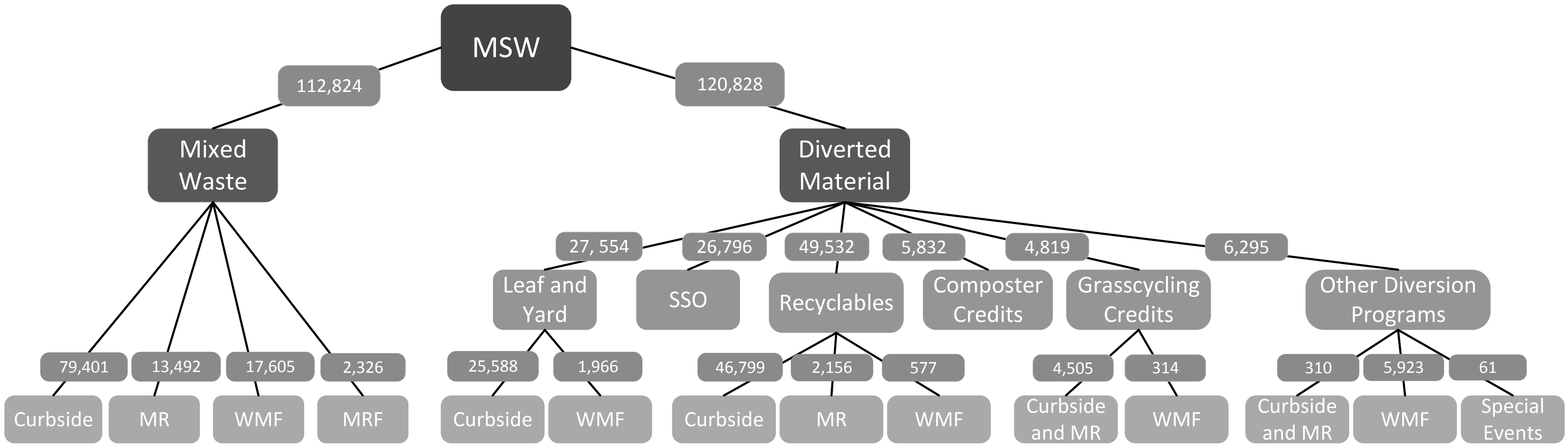
Driver	Pre-Sort with In-Vessel System	Pre-Sort with CSTR System	Pre-Sort with Plug Flow Reactor System	Pre-Sort with Percolate Bunker System
Sustainability	Favourable	Favourable	Favourable	Favourable
Growth Management	Favourable	Favourable	Favourable	Favourable
Compatibility with Legislation				
Climate Change and Low-Carbon Economy Act	Unfavourable	Favourable	Favourable	Favourable
Waste Free Ontario Act	Favourable	Favourable	Favourable	Favourable
Responsible Waste Management	Favourable	Favourable	Favourable	Favourable
Carried Forward to Preliminary Business Case	**YES**	**YES**	**YES**	**YES**

Further, as there is a significant similarity between the Anaerobic Digestion options these Processing Options are recommended to be considered collectively within the preliminary business case analysis as the Anaerobic Digestion option.

Based on the Evaluation above it is recommended that the following two options be carried forward to the preliminary business case financial analysis:

- Pre-Sort with In-Vessel.
- Pre-Sort with Anaerobic Digestion.

Figures

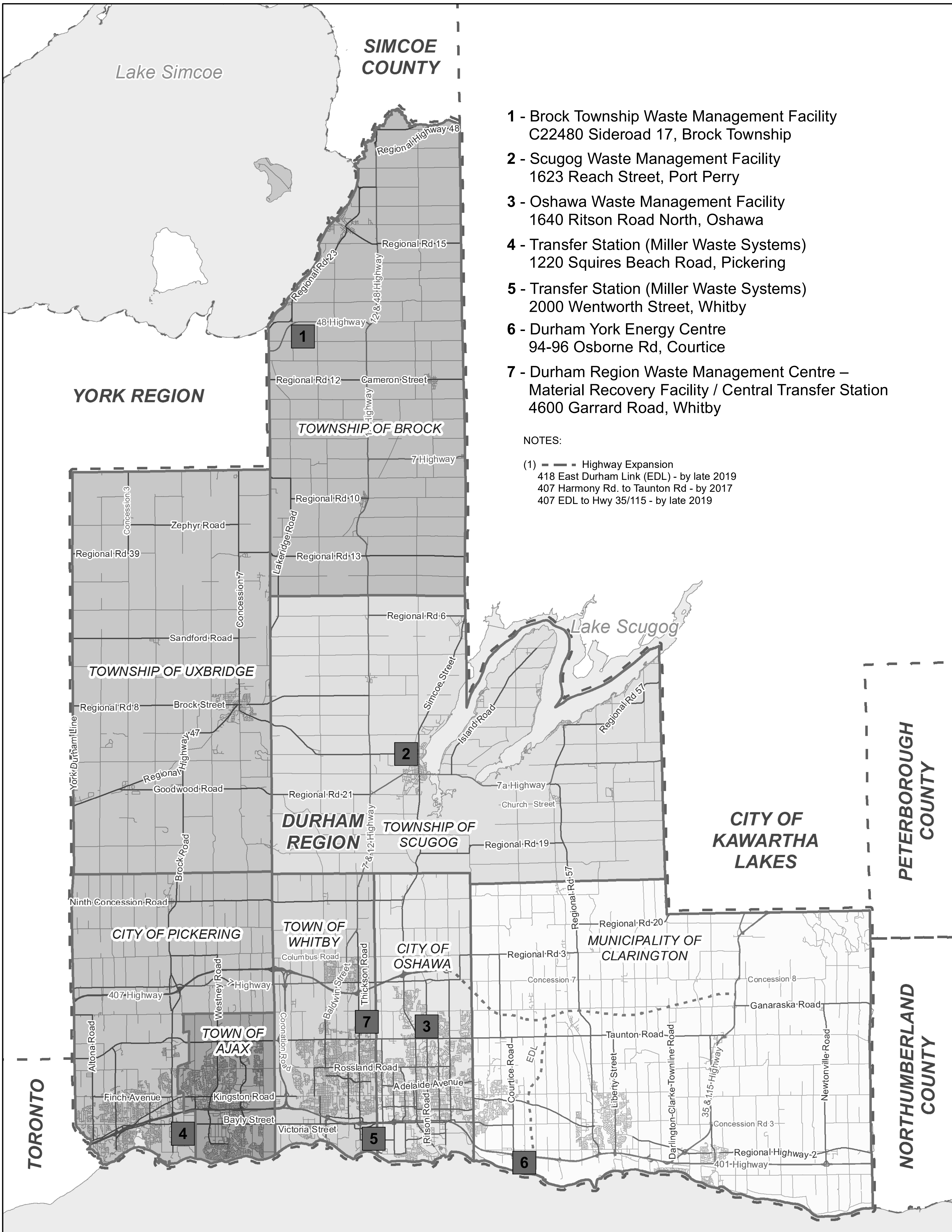


THE REGIONAL MUNICIPALITY OF DURHAM
DURHAM REGION, ONTARIO

REGION OF DURHAM 2015 MANAGED WASTE OVERVIEW

PROJECT NO. 11116808
DATE October 7, 2016

FIGURE 2.1



Source: Road Network: Durham Region GIS Services, 2012. MNR NRVIS, 2011. Produced by GHD under licence from Ontario Ministry of Natural Resources and Forestry, © Queen's Printer 2016

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Coordinate System:
NAD 1983 UTM Zone 17N

GHD

THE REGIONAL MUNICIPALITY OF DURHAM
DURHAM REGION, ONTARIO

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Oct 7, 2016

BACKGROUND RESEARCH AND TECHNICAL ANALYSIS REPORT
WASTE MANAGEMENT FACILITIES

FIGURE 2.2

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Appendices

Appendix A
Glossary of Terms

Appendix A Glossary of Terms

Aerobic composting	Decomposition of organic matter using microorganisms that require oxygen.
Anaerobic Digestion (AD)	A process in which organic matter is degraded by a microbial population of bacteria in the absence of oxygen.
Biogas	A combustible gas composed primarily of carbon dioxide and methane resulting from Anaerobic Digestion.
Collection Rate	The amount of a designated waste actually collected, compared to the amount estimated to be available for collection. Calculated as a percentage, with the numerator representing the amount collected, and the denominator representing the amount available for collection.
Digestate	Material remaining after the anaerobic digestion of biodegradable feedstock.
Digester Solids	The solid, partially stabilized organic material resulting from the dewatering of digestate.
Disposal	In Ontario, disposal refers to the final destination of waste to landfill. Other examples of disposal (not counting towards diversion rates in Ontario) include incineration (with or without energy recovery), pyrolysis, and gasification.
Diversion	In Ontario, diversion refers to the management of designated waste through reduction, reuse, and/or recycling.
Diversion Rate	The amount of designated waste kept out of landfills (not including energy-from-waste). Calculated as a percentage, with the numerator representing the amount diverted, and the denominator representing the amount diverted plus the amount disposed.
ECA	The approval provided to a business that releases pollutants into the air, land or water and/or stores, transports or disposes of waste. An environmental approval sets out rules of operation for these activities that are intended to protect the natural environment and are legally enforceable of designated wastes.
Fertilizer	Fertilizers means packaged products regulated under the Fertilizers Act (Canada).
Greenhouse Gas (GHG)	A gas in an atmosphere that absorbs and emits radiation within the thermal infrared range. The primary greenhouse gases in Earth’s atmosphere are water vapour, carbon dioxide, methane, nitrous oxide, and ozone. By trapping and holding heat in the atmosphere, greenhouse gases produce the greenhouse effect.
Leaf and Yard Waste	Leaf and yard waste consists of green grass clippings and thatch, leaves, weeds, brush, and small tree prunings.
Mixed waste	“Black bag” waste collected from single-family and multi-residential units.

MOECC	Ontario Ministry of Environment and Climate Change
MRF	Material Recovery Facility
Municipal solid waste (MSW)	The municipal solid waste stream is diverse and contains a variety of organic and inorganic materials.
OFMSW	Organic fraction of a municipal solid waste stream.
Organics	The mixture of solicited materials, bin liners and contaminants separated from other components of the solid non-hazardous waste stream by the waste generator generally in accordance with directions provided by the Region and that is collected by or on behalf of the Region.
Pre-processing	
Pre-sort	Dry separation of recyclables and unwanted materials from mixed waste.
Recycling	In Ontario defined as any operation by which waste materials are reprocessed into products, materials or substances, whether for the original or other purposes. It includes the reprocessing of organic material, but does not include energy recovery and reprocessing into materials that are to be used as fuels.
Recycling Rate	Expressed as a percentage, this is the amount of materials actually recycled by a processor versus the amount of materials that consumers made available for collection.
Region	The Regional Municipality of Durham, its successors and assigns.
Residue	Solid non-hazardous waste resulting from waste processing that is disposed of as waste.
Source-Separated Organics (SSO)	SSO waste is a commonly used term that refers to the combination of the municipal solid waste organic fraction from residences and the industrial, commercial, and institutional sector.
Waste Diversion	Management and treatment of designated waste materials or products through reuse and/or recycling, instead of disposal to landfill or incineration with or without energy recovery.
Waste Diversion Rate	The percentage calculation used to measure the quantity of a material kept out of landfill. The numerator is the amount of the material diverted, and the denominator is the total amount of waste diverted plus disposed.
WMF	Waste Management Facility owned by the Region.

Appendix B
Analytical Results from Compost Like Output (CLO) from Mixed Waste Facilities

Table B.1

Analytical Results of Compost-Like-Output (CLO)
Produced from Mixed Waste Facilities

Technology	Unit	Analytical Results: Canada Edmonton Alberta[1] 2008 Average of 3 samples Rotating Drum	USA Delaware County, New York 2008 Rotating Drum	USA Rapid City, South Dakota 2008 Average of 3 samples Rotating Drum/Agitated Bay	UK Enclosed Windrom 2005 Enclosed Windrow	UK Bedminister 2005 Rotating Drum	Provincia and Federal Standards and Guidelines for Land Application: Ontario Compost Quality Standards (Category AA Compost) 2012	Ontario Compost Quality Standards (Category A Compost) 2012	Ontario Compost Quality Standards (Category B Compost) 2012	CCME Guidelines for Compost Quality (Category A) 2005	Nutrient Management Act O.Reg. 267/03 (Receipt of Off-Farm AD Materials as NASM) 2003	Fertilizers Act administered by the Canadian Food Inspection Agency 1985
Metal												
Arsenic	mg/kg	2.57	1.43	5.1	n/a	n/a	13	13	75	13	13	75
Cadmium	mg/kg	2.12	5.11	2.63	1.68	0.37	3	3	20	3	3	20
Chromium	mg/kg	112.63	44.8	20.67	30	11.5	210	210	1060	210	2010	
Cobalt	mg/kg	5.28	n/a	2.9	n/a	n/a	34	34	150	34	34	150
Copper	mg/kg	494.95	415.18	236.67	159	90	100	400	760	400	100	
Lead	mg/kg	124.63	165.65	97.33	433	11	150	150	500	150	150	500
Mercury	mg/kg	0.72	0.24	1	0.7	0.31	0.8	0.8	5	0.8	0.8	5
Molybdenum	mg/kg	5.42	5.94	5.33	n/a	n/a	5	5	20	5	5	20
Nickel	mg/kg	83.43	44.5	28.33	29.8	7	62	62	180	62	62	180
Selenium	mg/kg	BDL	0.79	BDL	n/a	n/a	2	2	14	2	2	14
Zinc	mg/kg	1,138.92	648.6	506.67	503	157	500	700	1850	700	500	1850
Pathogens												
Faecal Coliform	cfu/g	<3	3.6 MPN*	<1.3 MPN	n/a	nd	<1,000MPN/g	<1,000MPN/g	<1,000MPN/g	<1,000MPN/g	<1,000MPN/g	<1,000MPN/g
Salmonella	P-A/25.0g	<3	n/a	BDL	n/a	nd	<3MPN/4g	<3MPN/4g	<3MPN/4g	<3MPN/4g	<3MPN/4g	Non-detect
Maturity												
Compost Stability Index (Solvita)		8	n/a	n/a	n/a	n/a						
Respiration - CO2-C/g OM Day	mgCO2	0.87	n/a	2.8	n/a	n/a	4 mg CO2/day	4 mg CO2/day	4 mg CO2/day	4 mg CO2/day		

Notes:

n/a means analysis not undertaken
BDL means Below Detection Limit
nd means not detected
MPN means most probable number
Exceeds Ontario Standards (Category AA Compost)
Source of analytical results: Golder Associates. (2009). Planning Study for the Assessment of Mixed Solid Waste Processing Technology and Siting Options. Prepared for the City of Toronto.
(1) Waste stream is not considered reflective of mixed waste or SSO waste streams as it includes biosolids which are known to have higher levels of contaminants including metals

Appendix C
Anaerobic Digestion Facilities Processing Source Separated Organics (SSO) or Organic Faction Municipal Solid Waste (OFMSW)

Appendix C

SSO and OFMSW AD Technology Reference Facilities

Facility	Location	AD Technology (Technology Provider)	Status	Commencement of Operation	Mixed Waste Received (tpy)	Organic Fraction of Mixed Waste Processed by AD System (tpy)	SSO Received (tpy)
North American Facilities							
CSTR							
Disco Road Organics Processing Facility	Toronto, Ontario	CSTR (BTA)	Operating	2013			75,000
Woolwich Bio-En Biogas Plant	Elmira, Ontario	CSTR (Agrinz GmbH Technologies)	Operating	2014			70,000
Dufferin Organics Processing Facility	Toronto, Ontario	CSTR (Anaergia)	Expansion Under Construction				55,000
Halton Recycling Ltd. Facility	Newmarket, Ontario	CSTR (BTA)	Closed in 2006	2000	150,000		
Varennes	Varennes, Quebec	CSTR (BTA)	Planned	2017			51,000
Percolate Bunker Reactor							
Harvest Power Energy Garden	Richmond, British Columbia	Percolate Bunker Reactor (GICON)	Operating	2013			40,000
Zero Waste Energy Development Corp.	San Jose, California	Percolate Bunker Reactor	Operating	2013			90,000
Monterey Regional Waste Management District	Monterey, California	Percolate Bunker Reactor (SMARTFERM)	Operating	2013			5,000
SSF Scavenger	San Francisco, California	Percolate Bunker Reactor (SMARTFERM)	Operating	2015			11,200

Appendix C

SSO and OFMSW AD Technology Reference Facilities

Facility	Location	AD Technology (Technology Provider)	Status	Commencement of Operation	Mixed Waste Received (tpy)	Organic Fraction of Mixed Waste Processed by AD System (tpy)	SSO Received (tpy)
City of Napa and Napa Recycling & Waste	Napa, California	Percolate Bunker Reactor (SMARTFERM)	Under Construction				25,000
City of Surrey Facility	Surrey, British Columbia	Percolate Bunker Reactor (Shanks)	Under Construction				115,000 SSO and yard waste
Edmonton Facility	Edmonton, Alberta	Percolate Bunker Reactor (BIOFerm Energy Systems)	Under Construction		48,000		SSO from industrial, commercial and institutional (ICI) sources, yard waste
Gloucester City Facility	Gloucester City	Percolate Bunker Reactor (Bekon)	Under Construction				65,000
Santa Barbara Facility	Santa Barbara, California	Percolate Bunker Reactor (Bekon)	Planned			70,000	
Other Facilities							
CSTR							
Villacidro	Sardinia, Italy	CSTR (BTA)	Operating	2002	45,000		
Maresme	Maresme, Spain	CSTR (BTA)	Operating	2013	190,000	35,000	
Manchester Bredbury Parkway	Manchester, UK	CSTR (BTA)	Operating	2011	110,000	86,000	
SBI-Friesland	Oudehaske, The Netherlands	CSTR (Waasa)	Operating	2002	218,000	113,000	
Glasgow Facility	Glasgow, Scotland	CSTR (BTA)	Under Construction	2016	90,000		

Appendix C

SSO and OFMSW AD Technology Reference Facilities

Facility	Location	AD Technology (Technology Provider)	Status	Commencement of Operation	Mixed Waste Received (tpy)	Organic Fraction of Mixed Waste Processed by AD System (tpy)	SSO Received (tpy)
Northern Malta	Malta	CSTR (BTA)	Under Construction	2016	162,000		
Ypres	Ypres, Belgium	CSTR (BTA)	Operating	2003			50,000
MBT Valorlis	Valorlis, Portugal	CSTR (BTA)	Operating	2010	50,000	30,000	
Reliance Street	Manchester, UK	CSTR (BTA)	Operating	2010	100,000	63,000	
Suldouro	Soldouro, Portugal	CSTR (BTA)	Operating	2011	43,000	30,000	
Dagenham	Dagenham, UK	CSTR (Anaergia)	Under Construction	2016			49,000
Kloh	Kloh, Germany	CSTR (Anaergia)	Operating				18,000
Plug Flow Reactor							
Doha Facility	Doha, Qatar	Horizontal Plug Flow (Kompogas)	Operating	2011	840,000	274,000	
Montpellier Agglomération Facility	Montpellier, France	Horizontal Plug Flow (Kompogas)	Operating	2008	203,000	105,000	
Angers Facility	Angers, Germany	Horizontal Plug Flow (Kompogas)	Operating	2012	90,000	50,000	
Botarell Facility	Botarell, Spain	Horizontal Plug Flow (Kompogas)	Operating	2010	100,000	54,000	
Rostock Facility (EVG / Veolia)	Rostock, Germany	Horizontal Plug Flow (Kompogas)	Operating	2007	135,000	40,000	
Rioja	Rioja, Spain	Horizontal Plug Flow (Kompogas)	Operating	2005		75,000	150,000
Amiens Plant	Amiens, France	Horizontal Plug Flow (Valorga)	Operating	1988	85,000		
Hanover Plant	Hanover, Germany	Horizontal Plug Flow (Valorga)	Operating	2002	100,000		25,000 sewage sludge
Varennes-Jarcy plant	Varennes-Jarcy, France	Horizontal Plug Flow (Valorga)	Operating	2001	100,000(1)		

Appendix C

SSO and OFMSW AD Technology Reference Facilities

Facility	Location	AD Technology (Technology Provider)	Status	Commencement of Operation	Mixed Waste Received (tpy)	Organic Fraction of Mixed Waste Processed by AD System (tpy)	SSO Received (tpy)
Cadiz Plant	Cadiz, Spain	Horizontal Plug Flow (Valorga)	Operating	2000	115,000		
Mons plant	Mons, Belgium	Horizontal Plug Flow (Valorga)	Operating	2000	23,000		35,700 SSO
Bassano Plant	Bassano Del Grappa, Italy	Horizontal Plug Flow (Valorga)	Operating	2002	44,200		8,200 SSO 3,000 sludge
Ecoparc II	Barcelona, Spain	Horizontal Plug Flow (Valorga)	Operating	2003	218,000		22,000
La Coruña plant	La Coruna, Spain	Horizontal Plug Flow (Valorga)	Operating	2001	182,500		
Shanghai Plant	Shanghai, China	Horizontal Plug Flow (Valorga)	Operating	2008	227,500		
Las Dehesas plant	Las Dehesas, Spain	Horizontal Plug Flow (Valorga)	Operating	2008	485,000		
Zaragoza plant	Zaragoza, Spain	Horizontal Plug Flow (Valorga)	Operating	2008	95,500		
Saint Priest La Roche plant	Saint Priest La Roche, France	Horizontal Plug Flow (Valorga)	Operating	2010	85,000		
La Paloma plant	La Paloma, Spain	Horizontal Plug Flow (Valorga)	Operating	2008	110,000		
Abrunheira Plant	Abrunheira, Portugal	Horizontal Plug Flow (Valorga)	Operating	2010	160,000		
Waste Management Centre of Bayonne	Bayonne, France	Horizontal Plug Flow (Valorga)	Operating	2013	83,696		
Château d'Olonne Plant	Sainte Foy, France	Horizontal Plug Flow (Valorga)	Operating	2012	36,000		
Organic Waste Systems (OWS)	Munster, Germany	Vertical Plug Flow (DRANCO)	Operating	2005	80,000	24,000	

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SSO and OFMSW AD Technology Reference Facilities

Facility	Location	AD Technology (Technology Provider)	Status	Commencement of Operation	Mixed Waste Received (tpy)	Organic Fraction of Mixed Waste Processed by AD System (tpy)	SSO Received (tpy)
Kaiserslautern Facility	Kaiserslautern, Germany	Vertical Plug Flow (DRANCO)	Operating	1999		20,000	25,000(2)
Biocompost de Alava UTE	Vitoria, Spain	Vertical Plug Flow (DRANCO)	Operating	2006	120,000	20,000	
Ute Planta Residuos Alicante	Alicante, Spain	Vertical Plug Flow (DRANCO)	Operating	2008	180,000	30,000	
Rome Facility (E. Giovi Srl)	Rome, Italy	Vertical Plug Flow (DRANCO)	Operating	2003			40,000(2)
Hydrybudowa 9 Facility	Leszno, Poland	Vertical Plug Flow (DRANCO)	Operating	2010	50,000	26,000	
Bourg-en-Bresse	France	Vertical Plug Flow (DRANCO)	Operating	2015	66,000	40,000	7,500 yard waste
Mirandela	Portugal	Vertical Plug Flow (DRANCO)	Operating	2011	55,000	10,000	
Wijster I	Wijster, The Netherlands	Vertical Plug Flow (DRANCO)	Operating	2012	57,000		
Wijster II	Wijster, The Netherlands	Vertical Plug Flow (DRANCO)	Operating	2013			40,000 SSO
SMET Nord-Est 71	Chagny, France	Vertical Plug Flow (DRANCO)	Operating	2015	73,000	35,000	
Pusan	Busan, South Korea	Vertical Plug Flow (DRANCO)	Operating	2005	70,000	35,000	8,000 yard waste
Hengelo Plant	Hengelo, the Netherlands	Vertical Plug Flow (DRANCO)	Operating	2011			50,000 SSO
Tenneville Plant	Tenneville, Belgium	Vertical Plug Flow (DRANCO)	Operating	2009			39,000 SSO
Kempten Plant	Kempten, Germany	Vertical Plug Flow (DRANCO)	Operating	2009			18,000 SSO & yard waste

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SSO and OFMSW AD Technology Reference Facilities

Facility	Location	AD Technology (Technology Provider)	Status	Commencement of Operation	Mixed Waste Received (tpy)	Organic Fraction of Mixed Waste Processed by AD System (tpy)	SSO Received (tpy)
Terrassa Plant	Terrassa, Spain	Vertical Plug Flow (DRANCO)	Operating	2006			25,000 SSO
AmeyCespa Facility	North Yorkshire, UK	Vertical Plug Flow (DRANCO)	Planned	2017	320,000	40,000	
Salzburg	Salzburg, Austria	Vertical Plug Flow (DRANCO)	Operating	2013	20,000	20,000	
Kielce facility	Kielce, Poland	LARAN Plug Flow (Linde-KCA)	Planned	2016	94,000	32,000	
Ljubljana facility	Ljubljana, Slovenia	LARAN Plug Flow (Linde-KCA)	Operating	2015	108,000	70,000	
Stalowa Wola Facility	Stalowa Wola, Poland	LARAN Plug Flow (Linde-KCA)	Operating	2015	75,000	15,000	
Tychy Facility	Tychy, Poland	LARAN Plug Flow (Linde-KCA)	Operating	2015	70,000	18,000	
Xiamen Facility	Xiamen, China	LARAN Plug Flow (Linde-KCA)	Operating	2013	84,000	50,000	
Brest Facility	Brest, Belarus	LARAN Plug Flow (Linde-KCA)	Operating	2011	100,000	45,000	
Salto del Negro Facility	Salto del Negro, Spain	LARAN Plug Flow (Linde-KCA)	Operating	2005	140,000	75,000	
Burgos Facility	Burgos, Spain	LARAN Plug Flow (Linde-KCA)	Operating	2005	75,000	40,000	
Madrid Facility	Madrid, Spain	LARAN Plug Flow (Linde-KCA)	Operating	2003	140,000	73,000	
Barcelona Facility	Barcelona, Spain	LARAN Plug Flow (Linde-KCA)	Operating	2002	300,000	150,000	
Valladolid Facility	Valladolid, Spain	LARAN Plug Flow (Linde-KCA)	Operating	2001	200,000	15,000	

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SSO and OFMSW AD Technology Reference Facilities

Facility	Location	AD Technology (Technology Provider)	Status	Commencement of Operation	Mixed Waste Received (tpy)	Organic Fraction of Mixed Waste Processed by AD System (tpy)	SSO Received (tpy)
Percolate Bunker Reactor							
Pohlsche Heide MBT Plant	Hille, Germany	Percolate Bunker Reactor (Bekon)	Operating	2005	100,000	40,000	
Bassum (Waste Management mbH)	Bassum, Germany	Percolate Bunker Reactor (Bekon)	Operating	1997	105,000	18,000	
Munich Waste Services	Munich, Germany	Percolate Bunker Reactor (Bekon)	Operating	2003			18,500
Saalfield Facility	Saalfield, Germany	Percolate Bunker Reactor (Bekon)	Operating	2007			20,000
Schmölln Facility	Schmölln, Germany	Percolate Bunker Reactor (Bekon)	Operating	2009			16,000
Iffezheim Facility	Iffezheim, Germany	Percolate Bunker Reactor (Bekon)	Operating	2013			18,000
Steinfurt Facility	Steinfurt, Germany	Percolate Bunker Reactor (Bekon)	Operating	2013			45,000
Vechta Facility	Vechta, , Germany	Percolate Bunker Reactor (Bekon)	Operating	2008			10,000
Cesena Facility	Cesena, Italy	Percolate Bunker Reactor (Bekon)	Operating	2009			35,000
Naples Facility	Naples, Italy	Percolate Bunker Reactor (Bekon)	Operating	2011			35,000

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SSO and OFMSW AD Technology Reference Facilities

Facility	Location	AD Technology (Technology Provider)	Status	Commencement of Operation	Mixed Waste Received (tpy)	Organic Fraction of Mixed Waste Processed by AD System (tpy)	SSO Received (tpy)
Voltana Facility	Voltana, Italy	Percolate Bunker Reactor (Bekon)	Operating	2012			35,000
Rimini Facility	Rimini, Italy	Percolate Bunker Reactor (Bekon)	Operating	2012			35,000
Baar Facility	Baar, Switzerland	Percolate Bunker Reactor (Bekon)	Operating	2009			18,000
Thun Facility	Thun, Switzerland	Percolate Bunker Reactor (Bekon)	Operating	2010			20,000
Rendsburg Facility	Rendsburg, Germany	Percolate Bunker Reactor (Bekon)	Upgrading facility	2008			34,000
Krauchthal Facility	Krauchthal, Switzerland	Percolate Bunker Reactor (Bekon)	Under Construction	2016			12,000
Heilbronn MBT Plant	Heilbronn, Germany	Percolate (ISKA GmbH)	Operating	2005	80,000	40,000	
Buchen MBT Plant	Bad Wurttemburg, Germany	Percolate (ISKA GmbH)	Operating	2006	151,000	80,000	
Eastern Creek UR-3R Facility	Sydney, Australia	Percolate (ISKA GmbH)	Operating	2004	175,000	75,000	
2 stage Process							
Kahlenberg ZAK MBT Plant	Ringsheim, Germany	Biopercolat (Wehrle Umwelt)	Operating	2006	100,000		
Leon MBT Plant	Leon, Spain	Haase	Operating	2005	200,000	50,000	
Salamanca	Salamanca, Spain	Hasse	Operating	70,000	30,000		

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SSO and OFMSW AD Technology Reference Facilities

Facility	Location	AD Technology (Technology Provider)	Status	Commencement of Operation	Mixed Waste Received (tpy)	Organic Fraction of Mixed Waste Processed by AD System (tpy)	SSO Received (tpy)
Lubeck	Lubeck, Germany	Haase	Operating	2006	150,000	55,000 + 25,000 sewage sludge	
Lauchhammer	Lauchhammer, Germany	Haase	Operating	2005	50,000		
Longley Lane Resource Recovery Facility	Greater Manchester, UK	Haase	Operating	2011	130,000	45,000	
Cobden street Resource Recovery Facility	Greater Manchester, UK	Haase	Operating	2010	90,000	35,000	
Schwarze Elster MBT Plant	Brandenburg, Germany	Haase	Operating	2005	50,000	24,000	
St. Antnin	St. Antnin, Malta	Haase	Operating	2008	90,000	43,000	
MBT Suedniedersachsen	Deiderode, Germany	Haase	Operating	2008	133,000	51,600	
MBT Arkwright	Greater Manchester, UK	Haase	Operating	2012	100,000		
MBT Schwarze Elster	Germany	Haase	Operating	2005	56,000		
West Sussex MBT	West Sussex, UK	Haase	Operating	2012	320,000	110,000	

Note:
(1) Includes both MSW and SSO

Appendix E

Organic Fraction Recovery from MSQ Existing Facilities

Facility	Location	AD Technology (Technology Provider)	Status	Year of Operation	Mixed Waste Received (tpy)	Organic Fraction of Mixed Waste Processed by AD System (tpy)	Approximate Percentage of Organic Fraction Receovered from MSW (%)
CSTR							
Maresme	Spain	CSTR (BTA)	Operating	2013	190,000	35,000	18
Manchester Bredbury Parkway	Manchester, UK	CSTR (BTA)	Operating	2011	110,000	86,000	78
SBI-Friesland	Oudehaske, The Netherlands	CSTR (Waasa)	Operating	2002	218,000	113,000	52
Plug Flow Reactor							
Doha Facility	Doha, Qatar	Horizontal Plug Flow (Kompogas)	Operating	2011	840,000	274,000	33
Montpellier Agglomération Facility	Montpellier, France	Horizontal Plug Flow (Kompogas)	Operating	2008	203,000	105,000	52
Angers Facility	Angers, Germany	Horizontal Plug Flow (Kompogas)	Operating	2012	90,000	50,000	56
Botarell Facility	Botarell, Spain	Horizontal Plug Flow (Kompogas)	Operating	2010	100,000	54,000	54
Rostock Facility (EVG / Veolia)	Rostock, Germany	Horizontal Plug Flow (Kompogas)	Operating	2007	135,000	40,000	30

Appendix E

Organic Fraction Recovery from MSQ Existing Facilities

Facility	Location	AD Technology (Technology Provider)	Status	Year of Operation	Mixed Waste Received (tpy)	Organic Fraction of Mixed Waste Processed by AD System (tpy)	Approximate Percentage of Organic Fraction Receovered from MSW (%)
Organic Waste Systems (OWS)	Munster, Germany	Vertical Plug Flow (DRANCO)	Operating	2005	80,000	24,000	30
Biocompost de Alava UTE	Vitoria, Spain	Vertical Plug Flow (DRANCO)	Operating	2006	120,000	20,000	17
Ute Planta Residuos Alicante	Alicante, Spain	Vertical Plug Flow (DRANCO)	Operating	2008	180,000	30,000	17
Hydrybudowa 9 Facility	Leszno, Poland	Vertical Plug Flow (DRANCO)	Operating	2010	50,000	26,000	52
Bourg-en-Bresse	France	Vertical Plug Flow (DRANCO)	Operating	2015	66,000 + 7,500 Green Waste	40,000	54
Mirandela	Portugal	Vertical Plug Flow (DRANCO)	Operating	2011	55,000	10,000	18
SMET Nord-Est 71	Chagny, France	Vertical Plug Flow (DRANCO)	Operating	2015	73,000	35,000	48
Busan	Busan, South Korea	Vertical Plug Flow (DRANCO)	Operating	2005	70,000 + 8,000 Green Waste	35,000	45

Appendix E

Organic Fraction Recovery from MSQ Existing Facilities

Facility	Location	AD Technology (Technology Provider)	Status	Year of Operation	Mixed Waste Received (tpy)	Organic Fraction of Mixed Waste Processed by AD System (tpy)	Approximate Percentage of Organic Fraction Receovered from MSW (%)
Percolate Bunker Reactor							
Pohlsche Heide MBT Plant	Hille, Germany	Percolate Bunker Reactor (Bekon)	Operating	2005	100,000	40,000	37
Bassum (Waste Management mbH)	Bassum, Germany	Percolate Bunker Reactor (Bekon)	Operating	1997	105,000	18,000	17
Notes: Median is 41% organics recovery Average is 39% recovery							