Systems Analysis of the Impact of Act 148 on Solid Waste Management in Vermont

Final Report

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EXECUTIVE SUMMARY

Vermont's Act 148 specifies a number of key changes to solid waste management in Vermont designed to increase diversion of materials and organics from landfill disposal, including:

- A requirement that all households and businesses have equal access to recycling collection and solid waste collection beginning in 2015;
- Variable rate pricing (referred to as Unit Based Pricing in this report) of solid waste to encourage households and businesses to recycle instead of dispose of recyclables in refuse, with the cost of recycling embedded in the cost of refuse collection by July 2015;
- A ban on leaf and yard residuals disposal at landfills in 2016;
- Implementation of public space recycling throughout Vermont beginning in July 2015; and,
- Mandated source separation of food residuals, and a ban on landfill disposal, by 2020, with a phased in requirement for large generators of food residuals to begin separating food residuals as early as 2014.

The Vermont Agency of Natural Resources (ANR) contracted with DSM Environmental Services, Inc. and its' subcontractors Robert Spencer and the Tellus Institute (Project Team) to conduct a comprehensive cost analysis of the "existing and foreseeable expansion of the solid waste system to manage anticipated adjustments to the waste stream based on Act 148." This included analyzing the capacity of Vermont's existing infrastructure to implement Act 148, the costs and operations of solid waste management entities (e.g., districts, municipal alliances and municipalities), and the "costs of the existing and an expanded bottle bill compared to existing zero sort, single stream recycling costs."

METHODOLOGY

ANR's scope of work required the Project Team to collect and assimilate data on every aspect of Vermont's solid waste management system, including: existing residential and commercial collection activity and costs; solid waste facility ownership, operations and throughput; solid waste management entities' operating budgets and program revenues; and, existing bottle bill costs and revenues.

Act 148 changes many aspects of the management of solid waste in Vermont. While there is often a desire to view each in isolation, these changes interact with one another. Because collection typically consumes 60 to 70 percent of all solid waste management costs, particularly in a rural state like Vermont, it was essential for the analysis to first define the current collection system for waste, recyclable materials and organics, and then estimate total collection system costs. Processing and disposal costs, as well as the cost of administration and educational programs were added to estimate total current system costs, and provide the basis for estimating changes in system costs associated with implementation of Act 148.

Act 148 phases in many requirements from 2014 through 2020. For this reason, the systems analysis begins in 2014 and runs through 2022 (nine years), allowing for two full years of implementation of the changes in solid waste management practices from the time that the full organics source separation requirement goes into effect.

This report presents an economic analysis, not a financial analysis, with capital costs assumed to be incurred in the year of construction or purchase (versus financed over time). Inflation is ignored over the nine year time period with all costs assumed to be in current (2013) dollars. For each system analyzed, annual costs (in current dollars) are summed across the nine years to compare total system costs. Annual costs change from year to year as the various provisions of Act 148 are implemented, which is why total costs for each system are presented over the nine-year period.

VERMONT BASED DATA

Vermont-based data were used for this analysis whenever possible, as required in the Project Team's contract. For example, the Vermont Waste Composition Study (May 2013), combined with ANR's data on diversion and disposal of solid waste and recyclables in Vermont in 2011, provide the basis for the amount of potentially recyclable materials available in the waste stream, current material recovery rates, and the potential recovery of additional material with the changes required by Act 148. Sales and return rates for beverage containers reported by Vermont distributors were used in the analysis of the bottle bill, and potential expansion of the bottle bill, as opposed to national or regional beverage sales data. And surveys conducted at Vermont redemption centers of Vermont consumer behavior when returning beverage containers were used in the cost analysis of the bottle bill.

Finally, audited loss rates reported by buyers for materials sold by Casella, operator of the Rutland and Chittenden materials recovery facilities (MRFs)[1], as well as audits conducted by the Project Team of residue from the Rutland MRF, were used to determine actual loss rates for recyclables. This is an important distinction because data in the literature on loss rates from single stream systems vary widely depending on many factors that may or may not be germane to Vermont's system.

SURVEYS OF KEY PARTICIPANTS

Vermont's solid waste management system is managed by two key groups, private businesses and public entities. Private waste management companies collect 58 percent of residential solid waste and recyclables, and the vast majority of commercial waste and recyclables. They also process the majority of recyclables collected in Vermont, and own/operate most of the large transfer stations in Vermont as well as virtually all of the landfill capacity. Public entities (regional solid waste districts, alliances and individual municipalities) manage many of the special waste collection systems, provide on-going education and promotion of recycling and special waste management, and operate many smaller transfer stations and drop-offs. A review of district operations as part of this analysis illustrates that there is a wide range of district involvement in solid waste management in Vermont, ranging from a major presence in Chittenden County (and several other districts) to almost no presence in Bennington County.

The Project Team expended significant resources attempting to gather accurate data on the activities of both the private sector and the public sector as part of this analysis. These data, together with data collected by ANR form the basis for the description of the existing base case system and inform the analysis of the alternative systems.

[1] Casella operates the Rutland single stream MRF, and operates the Chittenden single-stream MRF in Williston under contract to the Chittenden Solid Waste District. Together these two MRFs process an estimated 70 percent of all recyclables collected in Vermont.

DATA LIMITATIONS

While the Project Team was able to use certain Vermont-specific data as described above, for other programs there were limited sources of uniform data available to the Project Team from ANR and solid waste management entities, making it challenging to aggregate and analyze state-wide data. In addition, there are no data collected by ANR on the operation of the existing bottle bill, nor is there a reporting mechanism for licensed redemption centers to report returns, or for distributors to report materials handled or costs. There are also very limited data on private sector costs of solid waste management services in Vermont, requiring the Project Team to use proprietary cost and pricing data gathered through surveys of the private sector.

SYSTEMS ANALYZED

Four alternative solid waste management systems (and one variant) were analyzed. System 1, Base Case, represents current conditions carried forward over the nine-year analysis period assuming that Act 148 is not enacted. Systems 2, 3 and 4 all represent the changes envisioned by Act 148, including single stream (zero-sort) recycling, but with different assumptions about the bottle bill. In addition, at ANR's request the Project Team analyzed one variant, System 3(A), which assumes that the roughly 30 percent of recyclables that are currently managed through source separated and dual stream collection systems in Vermont continue under Act 148.[2] The four systems are:

- ***System 1, Base Case,*** assumes all existing programs (including the current bottle bill) are on-going through 2022, with the only change to current costs being an expected upgrade of the Chittenden MRF in 2014.

- ***System 2, Universal Single Stream with No Bottle Bill,*** assumes the bottle bill is eliminated and key changes to solid waste management in Vermont designed to improve diversion of materials and organics from landfill disposal are implemented as specified in Act 148, including:
  - Parallel collection of recyclables and solid waste for all households;
  - Unit based pricing of solid waste with recycling embedded in the cost of refuse collection (i.e. "free" collection of recyclables);
  - A disposal ban on leaf and yard residuals at landfills;
  - Implementation of public space recycling throughout Vermont; and,
  - A ban on landfilling of food residuals by 2020 with a phased-in requirement for large generators to source separate food residuals beginning in 2014.

- ***System 3, Universal Single Stream with Bottle Bill,*** assumes that the provisions of Act 148 listed above in System 2 are implemented and that the existing bottle bill (which only requires deposits on carbonated and malt beverages) remains in place over the nine-year time period of the analysis. System 3(A) is essentially the same as System 3 but evaluates the impact of maintaining existing dual stream and source

[2] There is no provision in Act 148 requiring that these systems move to single stream collection and processing. However Act 148 specifies that ANR compare "zero-sort" recycling against the bottle bill, and implementation of separate collection of organics will put more pressure on private haulers and municipalities to move to single-stream recycling.

separated recycling collection facilities in Vermont (and assumes dual stream curbside recycling collection continues to occur for deliveries to those facilities).

- ***System 4, Universal Single Stream with Expanded Bottle Bill,*** is identical to System 3 except that the bottle bill is expanded to include all beverage containers covered by Maine's expanded bottle bill (including water, wine, and other non-carbonated beverages, except dairy products and unprocessed cider). This expansion moves material currently disposed or recycled under System 1 (Base Case) to the bottle redemption system created by distributors to collect beverage containers.

Systems 2 – 4 are assumed to have much higher diversion rates for materials and organics than the Base Case (System 1) because Act 148 essentially adopts what many solid waste professionals consider best management practices to maximize recyclable materials and organics diversion. As such, the materials recovery rates for Systems 2 – 4 are all at the high end of what has been achieved to date in the U.S.

RESULTS OF SYSTEMS ANALYSIS

The total cost of Vermont's current solid waste management system is estimated to be $1.36 billion over the nine-year analysis period through 2022, or an annual average of $150 million. The current system achieves a 50 percent materials diversion rate, and reduces greenhouse gas (GHG) emissions by 70,000 (rounded) metric tons carbon equivalent when compared to landfill of all of Vermont's generated solid waste and recyclables.

Act 148 has the potential to increase recyclable materials recovery rates to between 63 and 68 percent (depending on the system chosen) and divert roughly 60 percent of food and yard residuals, and compostable paper, currently going to landfill. This increased diversion further reduces GHG emissions by roughly 23,500 to 27,300 metric tons carbon equivalent per year, with the higher end of the range of reductions in GHG emissions associated with the bottle bill (System 3) or expanded bottle bill (System 4) over the existing system.

To achieve the highest recovery rates and the greatest environmental benefits envisioned under Act 148, Vermonters will have to spend more than they are currently spending on solid waste management. As illustrated by Table ES -1System 2, with Universal Single Stream recycling and no bottle bill has the lowest overall system-wide cost increase under Act 148 over the nine year analysis period (an increase in the sum of annual costs of $33.4 million over the nine year period). Keeping the existing bottle bill, or expanding the bottle bill increases estimated annual system-wide costs by $124.2 million and 158.5 million, respectively over the current system.

TABLE ES-1. COMPARISON OF MATERIALS AND ORGANICS DIVERSION, GHG EMISSION REDUCTIONS, AND CUMULATIVE SYSTEM COSTS (2014 – 2022)

SYSTEMS EVALUATION	SYSTEM 1	SYSTEM 2	SYSTEM 3	SYSTEM 3A	SYSTEM 4
Metrics	Base Case, No Act 148	Act 148, Universal Single Stream, No BB	Act 148, USS, BB	Base Case With Act 148,BB	Act 148, USS, EBB
Diversion, in Tons (2022)					
Materials					
Plastic	5,120	5,580	5,870	5,753	7,190
Aluminum	2,300	1,750	2,680	2,626	2,760
Glass	23,880	16,320	24,000	23,520	25,080
Fiber	60,570	87,560	87,560	85,809	87,560
Steel Cans	1,620	1,690	1,690	1,656	1,690
Organics	0	48,098	48,098	48,098	48,098
Total:	93,490	160,998	169,898	167,462	172,378
Percent Increase over Base:	***na***	72%	82%	79%	84%
GHG Emissions Reductions					
Total, in Metric Tons Carbon Equivalent:	(70,019)	(93,568)	(96,597)	(96,000)	(97,293)
Percent Decrease over Base:	***na***	34%	38%	37%	39%
Sum of Annual System Costs (2014 - 2022)					
Operating	$ 1,357,405,811	$ 1,350,218,700	$ 1,441,033,746	$ 1,449,314,157	$ 1,475,387,582
Capital	$ 1,900,000	$ 42,450,455	$ 42,427,062	$ 45,467,476	$ 42,414,492
Total	***$ 1,359,305,811***	***$ 1,392,669,154***	***$ 1,483,460,808***	***$ 1,494,781,633***	***$ 1,517,802,074***
Change in Total System Cost over Base:	***na***	***$ 33,363,344***	***$ 124,154,997***	***$ 135,475,823***	***$ 158,496,264***
Percent Change from Base:	***na***	2%	9%	10%	12%
Unit Costs (2022)					
Average Per HH Monthly Cost	$ 33.29	$ 34.98	$ 36.70	$ 38.07	$ 37.30
Percent Change from Base:	***na***	5%	10%	14%	12%
Average Per Ton Cost, ICI	$ 202	$ 206	$ 221	$ 220	$ 225
Percent Change from Base:	***na***	2%	9%	9%	12%

SEPARATE TRIP COSTS

Due to the numerous comments received from stakeholders on earlier drafts of this report concerning the inclusion of separate trip costs, ANR requested that the Project Team estimate system costs both with and without the separate trips.

The system cost model included separate trip costs for all households who do not contract for curbside collection of refuse and recycling but instead choose to drive to a local transfer station or drop-off facility, as well as those consumers who make separate trips to redeem deposit containers under the bottle bill based on the surveyed behavior of consumers at redemption centers in Vermont.

Table ES-2 presents the same information as Table ES-1, except that all separate trips have been removed. As illustrated by ES-2, the cost of implementing Act 148 over the current system increases. This is because removal of separate trips ignores one of the benefits of Act 148, which is to require that all haulers offering curbside collection of refuse offer parallel collection of recycling, eliminating the need for some households to drive to drop-offs to deliver recycling. Excluding separate trips also reduces the difference in cost between System 2, which does not include a bottle bill, and Systems 3 and 4 which include the existing and an expanded bottle bill, respectively. This is because the bottle bill is in essence a separate collection system for a portion of the recycling stream. While it

results in higher recovery rates than System 2, it does so, in part, by increasing the number of separate trips by households to redeem containers and recover the deposit.

TABLE ES-2. COMPARISON OF MATERIALS AND ORGANICS DIVERSION, GHG EMISSION REDUCTIONS, AND CUMULATIVE SYSTEM COSTS (2014 – 2022), WITHOUT INCLUSION OF SEPARATE TRIPS

SYSTEMS EVALUATION	SYSTEM 1	SYSTEM 2	SYSTEM 3	SYSTEM 3A	SYSTEM 4
Metrics	Base Case, No Act 148	Act 148, Universal Single Stream, No BB	Act 148, USS, BB	Base Case With Act 148,BB	Act 148, USS, EBB
Diversion, in Tons (2022)					
Materials					
Plastic	5,120	5,580	5,870	5,753	7,190
Aluminum	2,300	1,750	2,680	2,626	2,760
Glass	23,880	16,320	24,000	23,520	25,080
Fiber	60,570	87,560	87,560	85,809	87,560
Steel Cans	1,620	1,690	1,690	1,656	1,690
Organics	0	48,098	48,098	48,098	48,098
Total:	93,490	160,998	169,898	167,462	172,378
Percent Increase over Base:	***na***	72%	82%	79%	84%
GHG Emissions Reductions					
Total, in Metric Tons Carbon Equivalent:	(70,019)	(93,568)	(96,597)	(96,000)	(97,293)
Percent Decrease over Base:	***na***	34%	38%	37%	39%
Sum of Annual System Costs (2014 - 2022)					
Operating	$ 1,212,692,940	$ 1,246,034,056	$ 1,305,811,407	$ 1,314,091,818	$ 1,328,703,772
Capital	$ 1,900,000	$ 42,450,455	$ 42,427,062	$ 45,467,476	$ 42,414,492
Total	***$ 1,214,592,940***	***$ 1,288,484,510***	***$ 1,348,238,468***	***$ 1,359,559,294***	***$ 1,371,118,264***
Change in Total System Cost over Base:	***na***	***$ 73,891,570***	***$ 133,645,528***	***$ 144,966,354***	***$ 156,525,324***
Percent Change from Base:	***na***	5%	10%	11%	12%
Unit Costs (2022)					
Average Per HH Monthly Cost	$ 28.33	$ 31.29	$ 33.01	$ 34.38	$ 33.61
Percent Change from Base:	***na***	10%	17%	21%	19%
Average Per Ton Cost, ICI	$ 202	$ 206	$ 221	$ 220	$ 225
Percent Change from Base:	***na***	2%	9%	9%	12%

POTENTIAL FOR REDUCING ACT 148 IMPLEMENTATION COSTS

Increases in system costs will fall mainly on the users of the system, paid through the higher monthly fees they are expected to pay for services. Haulers will also need to invest in new equipment as they improve their capacity to provide new services. Total capital investments are estimated at $42 - $45 million over the nine-year implementation period, or an average about $5 million per year. Almost half of this capital investment is assumed to be for new organics processing capacity necessary for the increased diversion of food residuals and other organics, with the balance for collection vehicles and new containers for recyclables and organics.

While it is not required for areas of Vermont that have not switched to single stream collection to do so in 2015, it is likely that switching to single stream collection will allow for reduced costs as separate collection of organics is fully implemented by 2020, as illustrated by a comparison of System 3 and System 3(A).

Key areas that could reduce system costs include:

- ***Consolidation of districts and alliances –*** Especially once there is a state-wide requirement for parallel collection of recyclables which should allow for a single recycling message and enforcement State-wide.

- ***Reduction or elimination of the bottle bill handling fee*** – The largest single cost associated with the bottle bill (and an expanded bottle bill) is the 3.5 or 4 cent handling fee (depending on comingling). Reducing the handling fee to 1 cent, or eliminating it, would significantly reduce bottle bill costs, but have a huge negative impact on existing redemption centers and retailers.

- ***Consolidation of collection routes*** – Subscription collection, with multiple haulers operating in the same area has been shown to be more costly than consolidated or managed/organized collection. Managed collection is one way to reduce overall system costs, especially as Vermont moves to residential organics collection. For example, if average route sizes were to double because of organized collection, the Project Team estimates that system costs would be a reduced by roughly $20 million on an annual basis, which would be sufficient to cover much of the cost increase associated with implementation of Act 148. However, this change would disrupt the existing private hauling sector in Vermont in ways that need substantial additional analysis to determine.

- ***Increased implementation of every-other-week collection of refuse and recycling*** - With implementation of source separated organics it is likely that many households and businesses could reduce their need for refuse collection to once every other week. This analysis has assumed that at least one-third of households will move to every-other-week collection by 2020, reducing total system costs associated with implementing Act 148.

- ***Implementation of more on-farm organics diversion programs than envisioned in this report*** –More on-farm organics diversion will require the Department of Agriculture and ANR to develop rules that protect health and the environment while fostering greater on-farm use of organics. One area of significant potential is the ability to add slurried food residuals to existing on-farm AD facilities through off-farm processing and delivery of cleaned and slurried food residuals to participating farms.

IMPLEMENTATION AND ENFORCEMENT ISSUES

The success of Act 148 will depend on how the key provisions of Act 148 are implemented over time. The following five stakeholder groups will all play important roles:

- Agency of Natural Resources;
- Solid waste districts, alliances and municipalities;
- Private haulers;
- Owners and developers of organics management facilities, including existing farms; and,
- Business and household generators of waste, recyclables and organics.

Implementation issues associated with each of the key provisions of Act 148 are summarized below.

MANDATED SEPARATE COLLECTION OF RECYCLABLES FOR ALL HOUSEHOLDS

Act 148 states, "*Solid Waste Management Facility Certification*: *A facility certified under this section that offers the collection of solid waste shall: Beginning in July 1, 2014, collect mandated recyclables separate from other solid waste and deliver mandated recyclables to a facility maintained and operated for the management and recycling of mandated recyclables… facility certified under this section that offers the collection of solid waste shall not charge a separate fee for the collection of mandated recyclables."*

There are two primary implementation issues associated with this mandate: how mandated separate collection of recyclables is enforced and how parallel access to recycling and refuse collection is offered.

Enforcement of mandated separation of recyclables is relatively easy at small transfer stations and drop-off facilities if municipalities and/or solid waste districts are willing to provide recycling drop-off adjacent to the transfer/disposal location at no cost as well as adopt and enforce ordinances requiring separation. However, enforcement at large private transfer stations and of subscription collection (currently representing 58 percent of all households) will be more difficult. Without adequate enforcement, haulers who do not require separation, or provide limited collection of recyclables, would be able to charge a lower price than those who strictly enforce mandated separation of recyclables. This lack of a level playing field for all haulers will be an important issue for municipalities, districts, private haulers and ANR unless there is enforcement at the point of transfer or disposal. For example, Massachusetts DEP was only fully effective with landfill bans of recyclable materials when they began regular enforcement activities at transfer stations, as well as at disposal facilities.

Parallel Access, where refuse and recycling collection are offered in the same way, is not defined by Act 148. While the Project Team assumes parallel access means recyclables and refuse collection is offered to households on the same day, Act 148 is silent on this. If refuse and recycling collection are offered on different days, or recycling on a much reduced schedule than refuse collection, lower materials recovery rates than estimated in this analysis will result. This is only an issue for curbside collection as drop-offs and transfer stations that offer refuse collection will also be required to offer drop-off of recycling at the same locations and times.

UNIT BASED PRICING

Act 148 requires, *" By no later than July 1, 2015, a municipality shall implement a variable rate pricing system that charges for the collection of municipal solid waste for disposal based on the volume or weight of the waste collected."* Variable rate or unit based pricing (UBP) is the second of the three legged stool necessary to drive high diversion rates for materials, and a key factor in increasing organics diversion. While a wide range of UBP programs exist throughout the United States, with many successful in reducing waste disposal and increasing diversion, some do not provide sufficient economic incentives to change household behavior. Because of the mixed success of these programs, it will be necessary for ANR to provide specific guidance on what UBP programs will be considered acceptable under Act 148. It will then be necessary for municipalities and/or districts to adopt and enforce UBP ordinances that apply both to transfer stations and to private haulers providing curbside collection of solid waste.

DISPOSAL BAN ON LEAF AND YARD WASTE

Just as with mandating separation of recyclables, this ban will require enforcement at the transfer or disposal facility site, and ANR will need to establish regulations for implementation and enforcement. ANR will also need to

issue permits for new yard waste processing locations, which the Project Team expects will be a combination of municipal/district facilities and private facilities.

PUBLIC SPACE RECYCLING

Act 148 states that *"Beginning July 1, 2015, when a container or containers in a public building or on a public land are provided to the public for use for solid waste destined for disposal, an equal number of containers shall be provided for the collection of mandated recyclables."* While Act 148 only discusses recycling in public spaces, private convenience stores and gas stations that are used by the public have the potential to generate significant quantities of recyclables. Consideration should be given to how recycling can be fully implemented at these facilities.

Furthermore, permanent public space recycling containers can be expensive to ensure they are secured, vandal resistant, and aesthetically pleasing. Consideration should be given to funding from outside sources other than municipal and state general fund budgets. In addition, municipalities will need would benefit from ANR's guidance in areas such as standard color and messaging for bins and/or lids, efficient collection approaches, and control of contamination.

DISPOSAL BAN AND SOURCE SEPARATION OF ORGANICS

The requirement to source separate organics raises the most important implementation issues, in part because Vermont is the first state in the United States to require source separation of all food residuals (residential and ICI) by 2020. As such there are many issues to address that will require work by all of the stakeholders over the next seven years.

Key implementation issues include:

- ***Enforcement of Ban*** - Separate residential organics collection will cost significantly more than collection of the material as refuse. Because haulers are not required to embed the cost of organics collection in their price for refuse collection, without adequate enforcement many generators would opt not to separate organics. This will be especially critical in 2020 when all generators of food residuals, including households, will be required to source separate food residuals. The Project Team estimates that adding separate food residuals curbside collection will cost the average household an additional $7 to $9 per month. With an estimated 58 percent of households currently subscribing to private curbside refuse collection services, mandatory separation ordinances and enforcement are going to be necessary or many households will not comply.

- ***Funding of new capital costs –***While roughly 30 percent of food residuals are assumed to be delivered to low-cost farm operations, the remaining 70 percent require construction of new organics management facilities at an estimated total investment of at least $20 million. Doubling the state franchise fee from $6 to $12 per ton on landfill disposal could raise roughly $2.5 million annually at current disposal rates, but other funding sources will also be necessary, particularly as disposal quantities fall as Act 148 is implemented.

- ***Carbon constraints*** - Finding adequate sources of carbon will be difficult if composting is the preferred alternative for managing organics. Using "free" sources of carbon, such as dirty paper (not suitable for

recycling), will increase diversion from landfills but will also increase contamination by other materials, especially plastics. This will result in increased operating costs and/or a reduced value of the final product.

GENERAL IMPLEMENTATION ISSUES

Finally, there are a number of more general implementation issues that will need to be addressed if Act 148 is to realize its full potential of sustainable materials management, as outlined below.

Equalized Programs and Enforcement across Vermont – There are currently large variations in how Act 78 has been implemented across Vermont, with some districts actively involved in materials diversion programs and operations and others having little or no involvement. This is not likely to change unless ANR equally enforces all the provisions of Act 148 consistently across the state. Without equal enforcement, it is unlikely that Vermont will meet the materials and organics diversion levels that are feasible under Act 148.

Consolidation of Solid Waste Administration - With roughly 70 percent of all recyclables currently going to two single stream MRFs that accept the same materials, and with uniform Act 148 requirements for parallel collection and organics diversion throughout Vermont, careful consideration should be given to the potential for consolidating district administration and recycling (and organics) education across the state. This would have the benefits of reducing system-wide administration costs, leveling the playing field for all generators and haulers, and providing consistent messaging State-wide.

Data Collection and Analysis - Collecting, compiling *and analyzing* the data necessary to complete this report required the Project Team to bring uniformity to large amounts of non-standardized data available from districts and ANR. Given the emphasis on data collection and analysis contained in the implementation plan for Act 78, and the quarterly report data provided to ANR over the years by districts and the private sector, the lack of coherent data compilation and analysis available for this report was discouraging. Because Vermont cannot manage what it cannot measure, the success of Act 148 will depend in part on the collection, compilation and analysis of specific and standardized performance data, either through a fully funded and staffed group at ANR that is not subject to budget cuts and does not have regulatory responsibilities, or through the creation of a new entity with the capacity to request, synthesize and analyze data in a timely manner.

Broad-Based Funding Source - There has been huge interest, both in-state and from out-of-state interests, associated with the bottle bill, which represents roughly 1 to 2 percent of the total material generated in Vermont. There has been virtually no discussion of the 100,000 tons of other paper and packaging materials found in the waste stream which is growing, and which is either not recyclable, or only recyclable with new investments in collection and sorting technologies. With source separation of food residuals adding an entirely new source of material requiring significant new resources to manage, consideration should be given to a broad-based fee that covers the full range of packaging and food residuals generated in Vermont. Such a broad-based fee could be used to invest in the management and capital necessary to truly move Vermont to a sustainable materials management system.

It is highly unlikely that sustainable materials management can be funded entirely on the backs of municipal property taxes, landfill surcharges and unit based fees for trash collection (and disposal). The failure to include the large producers of packaging and food products not impacted by the bottle bill leaves out an essential component of any attempt to internalize the cost of sustainable materials management in Vermont.

PREAMBLE

Solid waste management in Vermont is big business; with total annual, current (c.2013) system costs ranging from an estimated $135 to $151 million. Therefore, it stands to reason that changes to the way solid waste is managed envisioned by Act 148 could have significant financial impacts on numerous parties that depend on the current system and/or stand to gain or lose under the new system. These interests include businesses, solid waste management entities, and various state and municipal government agencies in the State of Vermont; as well as many businesses outside of Vermont who are part of the current system and/or may be impacted by the changes envisioned under Act 148. These include:

- Large private haulers who collect, process, and dispose of the majority of solid waste and recyclables in Vermont and will be required to make the greatest investments in new collection capacity to meet the requirements of Act 148;
- Small private haulers with limited resources who will need to adapt and change to meet the requirements of Act 148, often without access to capital or technical assistance necessary to make the required changes;
- One hundred and seventeen (117) full-time equivalent (FTE) employees of the solid waste districts operating in Vermont;
- Existing entities managing organics, either in centralized composting facilities or on farms, as well as firms and organizations outside of Vermont who provide organics composting and processing services, including the planning, construction and operation of new facilities;
- Owners of landfills and transfer stations who stand to gain or lose depending on how much of the current waste stream is diverted to new organics processing facilities;
- Beverage distributors and many retailers in Vermont who will be impacted by whether the bottle bill is retained, expanded, or repealed;
- Redemption centers who have built their business on the handling fees paid under the existing bottle bill and who would not be in business if the bottle bill were repealed;
- Third party contractors who stand to lose business if the bottle bill is repealed or stand to gain if the bottle bill is expanded;
- PET reclaimers outside of Vermont who are squeezed by low margins and are worried that if the bottle bill is repealed they will lose their most reliable source of clean, recycled PET;
- Glass reclaimers and manufacturers outside of Vermont who rely on low-cost, clean glass from bottle bill states as a substitute for relatively low cost virgin materials, to meet commitments to reduce greenhouse gas emissions and increase the recycled content of their product;
- Private and public owners and operators of materials recovery facilities in Vermont who stand to lose valuable materials if the bottle bill is expanded, or gain tonnages if the bottle bill is repealed; and ultimately,
- Residential and business consumers who pay the cost of the current system and will be required to pay the cost of any changes to the system over time.

There is no way that the Project Team can reconcile all of these competing interests with this report. As such, the goal of the report is to present, as transparently as possible, a detailed economic analysis of the costs associated with the current and potential future alternative systems. Recognizing these divergent interests, it will then be up to the Agency of Natural Resources (ANR) and to the Legislature, informed by the analysis contained herein, to establish the regulatory and policy framework for a materials management system that maximizes waste diversion in a cost-effective and equitable manner.

I. INTRODUCTION

The Vermont Legislature adopted sweeping changes to Vermont's solid waste legislation in 2012, designed to dramatically increase diversion of materials from landfills. The most far-reaching change is to the way Vermonter's will manage food residuals and other organics over the next eight years. Act 148 also attempts to significantly increase diversion of recyclable materials by requiring a parallel infrastructure for recycling and solid waste collection, and the implementation of variable-rate pricing[3] for residential solid waste as an incentive for households to divert more materials.

Act 148 also requires additional evaluations and planning by the Vermont Agency of Natural Resources (ANR), including:

- Adoption of a new statewide Solid Waste Management Plan (now called a Materials Management Plan) by November 2013, and then every five years;
- An assessment of solid waste management costs and infrastructure for the current system, and one or more systems that meet the requirements of Act 148;
- A report to the Legislature every two years on the status of solid waste and packaging; and,
- An evaluation of the costs and benefits of expansion of the beverage deposit redemption program and an alternative single stream recycling system.

ANR contracted with DSM Environmental Services, Inc., and DSM's sub-contractors, the Tellus Institute and Robert Spencer (Project Team) to:

- Conduct the assessment of the current solid waste management system's infrastructure, governance and costs (referred to as Local Governance Evaluation and Infrastructure Analysis) and project what additional infrastructure will be necessary to meet the objectives of Act 148, and what it might cost; and,
- Assess the costs and benefits of the existing beverage redemption program, a universal single stream system without a beverage redemption program, and an expanded beverage redemption program.

This report presents the systems analysis undertaken by the Project Team. It is based on the best available data from Vermont, supplemented by a series of assumptions necessary to fill the many data gaps that exist with respect to the current and projected systems.

[3] There are many names for variable rate pricing including Pay-As-You-Throw (PAYT), Save Money and Reduce Trash (SMART) and Unit Based Pricing (UBP). This report uses UBP to represent all variable rate pricing programs.

II. METHODOLOGY

The methodology followed to complete the analysis is outlined below.

SYSTEMS ANALYSIS

Act 148 changes many aspects of the management of solid waste in Vermont. While there is often a desire to view each of these changes in isolation, the reality is that the changes interact with each other and combine to create significant changes to the overall system and its associated costs in Vermont. For example, changes in the beverage redemption system would impact Vermont's redemption centers, third party contractors who collect most of the containers from the redemption centers, private waste haulers who collect and process recyclables, the Chittenden District, which owns the largest single stream MRF in Vermont, and the PET, glass and aluminum industries that rely on the material generated by the bottle bill. For this reason, the Project Team has attempted to identify how these changes impact the entire system and incorporate them into one comprehensive systems analysis.

Collection costs are typically the largest single cost associated with managing solid waste. This is especially the case in a rural state like Vermont. Therefore, it is essential that the analysis begin by defining the current collection system for waste, recyclable materials and organics. Processing and disposal costs, as well as the cost of administration and educational programs, can then be added to the collection system. Together, these represent the total current system costs and provide the basis for estimating changes in system costs over time due to the addition of new or revised programs.

TIME PERIOD

Act 148 phases in many requirements over the time period 2014 through 2020. For this reason, the systems analysis begins in 2014 and runs through 2022, allowing for two full years of implementation of the changes in solid waste management practices from the time that the full organics ban goes into effect.

ECONOMIC ANALYSIS

This report presents an economic analysis, not a financial analysis. As such capital costs are assumed to be incurred in the year of construction or purchase, not financed over time. In addition, inflation is ignored over the nine year time period. That is, all costs are assumed to be in current (2013) dollars. This is an acceptable simplifying assumption in an economic analysis unless there is reason to believe that one or more costs are going to be impacted by inflation differently from other costs. While there are several candidates for this (e.g., fuel and materials prices), there is so much uncertainty regarding these commodity prices that no attempt has been made to address them separately from all other costs.

For each system, annualized costs (in current dollars) are summed across the nine years to compare total system costs for each system over the nine year time period of the analysis. Normally the current dollars would be discounted to account for the time value of money. However, in today's historically low interest rate environment the discount rate would be so low to not have any significant impact.

SYSTEMS ANALYZED

Four systems (and one variant) are presented in this report. **System 1** is the ***base case*** system which assumes that if Act 148 was not enacted, all existing programs (including the existing bottle bill) would be on-going through 2022. The only change to current costs under the Base Case is that a capital cost is carried for the expected upgrade of the Chittenden MRF anticipated to be completed in May 2014.

The other three systems described below all assume implementation of Act 148, as specified in the statute. The *only* difference among the three systems is the change in the bottle bill, as discussed below. By varying only the beverage deposit program, ANR can readily assess the costs and benefits of the current bottle bill (BB), versus an expanded bottle bill (EBB), or elimination of the bottle bill after implementation of Act 148. It should be noted here that the bottle bill and any expanded bottle bill impacts the tons of recyclables and refuse in each system. These impacts are reflected in the relevant System Costs.

At the request of ANR, the Project Team also analyzed one variant (called **System 3 (A)**) in the cost analysis. This assumes that the current dual stream MRF in Windham and various source separated recycling programs at some transfer stations and drop-offs continue under Act 148, and that the System implements all other provisions of Act 148. There is no provision in Act 148 requiring that these systems move to single stream collection and processing, and therefore it will be up to the various municipalities (and haulers) to make that decision over time.

SYSTEM 2: IMPLEMENTATION OF ACT 148 WITH COLLECTION OF BOTTLE BILL MATERIAL COMINGLED WITH OTHER RECYCLABLES (UNIVERSAL SINGLE STREAM)

Act 148 specifies a number of key changes to solid waste management in Vermont designed to improve diversion of materials and organics from landfill disposal. Many solid waste professionals (but not all) consider the following key provisions of Act 148 as the most likely to lead to the highest diversion rates achievable:

- Parallel collection of recyclables and MSW for all households assumed to begin in 2015;
- Variable rate pricing of solid waste with recycling embedded in the cost of refuse collection (i.e. free collection of recyclables);
- Disposal ban on leaf and yard residuals at landfills in 2016;
- Implementation of public space recycling throughout Vermont; and finally,
- A disposal ban on food residuals to landfill by 2020, with a phased in requirement for large generators of food residuals to begin separating their food scraps as early as 2014.

System 2 assumes that the bottle bill is repealed and that all bottle bill material is potentially available for collection and processing through the parallel recycling collection system specified in Act 148. While there is currently a mix of source-separated, dual-stream and single-stream collection systems in Vermont, the analysis of the impacts of Act 148 under Systems 2, 3 and 4 focus on single-stream collection of recyclables.

SYSTEM 3: IMPLEMENTATION OF ACT 148 WITH CONTINUATION OF CURRENT BOTTLE BILL (UNIVERSAL SINGLE STREAM WITH BOTTLE BILL)

System 3 assumes that the provisions of Act 148 as listed in System 2 are in place and that the *existing bottle bill* (which only requires deposits on carbonated and malt beverages) remains in place over the nine year time period of the analysis. As stated above, at the request of ANR, the Project Team has also evaluated what the impact on

system costs would be if the existing dual-stream and source-separated recycling facilities in Vermont did not switch to single-stream collection and processing (called System 3 (A)) but based on this System 3 with continuation of the existing bottle bill. The Project Team's review of the data indicate that these dual-stream and source-separated systems represent such a small part of the overall system in Vermont that the impact would be relatively insignificant, as discussed in more detail in later sections of this report.

SYSTEM 4: IMPLEMENTATION OF ACT 148 WITH EXPANSION OF THE BOTTLE BILL (UNIVERSAL SINGLE STREAM WITH EXPANDED BOTTLE BILL)

System 4 is identical to System 3 except that the bottle bill is expanded to cover all beverage containers covered by Maine's expanded bottle bill (including water, wine, and other non-carbonated beverages, except dairy products and unprocessed cider). This expansion moves material that is currently either disposed or recycled under System 1 (Base Case) to the separate bottle redemption and recycling system created by distributors to collect beverage containers. The impacts on collection and processing of recyclables are included in the cost analysis for this system.

It is important to note that Systems 2 – 4 are assumed to have much higher diversion rates for materials and organics than the Base Case (System 1). That is because Act 148 essentially adopts best management practices, including the requirement for the provision of parallel collection of recyclables and MSW, with the cost of parallel collection of recyclables embedded in the cost of MSW collection, and the requirement for unit based pricing (UBP). As such the materials recovery rates for Systems 2 – 4 are all going to be at the high end of what is potentially achievable. These potentially achievable materials recovery rates are discussed in more detail in Section IX.

USE OF VERMONT DATA

The Project Team's contract with ANR specifies that Vermont-based data are to be used whenever possible. This is a key requirement of this analysis. Of special significance is the use of the recently completed State of Vermont Waste Composition Study (May 2013) conducted by DSM. This study, when combined with ANR data on diversion and disposal of MSW and recyclables in Vermont in 2011, forms the basis for the amount of potentially recyclable materials available in the waste stream, current recovery rates, and the potential recovery of additional material with the changes required by Act 148.

It should be noted here that, as discussed in detail in the Waste Composition Study, the sample size for both residential waste and ICI waste was small because of budget limitations. In several cases, especially with respect to quantities of beverage containers found in the waste stream, the Project Team has taken the high end of the 90 percent confidence interval as a way to increase the potential availability of beverage container material.

Equally important is the use of sales and return rates for beverage containers reported by the distributors in Vermont, as opposed to the use of national or regional beverage sales data. In addition, as required by ANR, the Project Team carried out surveys of Vermont consumer behavior when returning beverage containers to Vermont redemption centers.

Finally, while there are many articles and other sources concerning potential loss rates associated with single-stream collection and processing of recyclable materials, this analysis uses actual reported audited loss rates for

materials sold by Casella from the Rutland and Chittenden MRFs[4], as well as audits conducted by the Project Team of residue from the Rutland MRF. This is an important distinction because data in the literature on loss rates from single-stream systems vary widely depending on many factors that may or may not be germane to Vermont's system.

SURVEYS OF KEY SYSTEM PLAYERS

Vermont's solid waste management system is managed by two key groups, private businesses and public entities. Private businesses collect and haul residential and commercial waste and recyclables, process the majority of the recyclables, and own/operate transfer stations and the only landfills in the State. Public entities include regional solid waste districts or planning entities as well as individual municipalities. These municipally-controlled districts and alliances collectively represent roughly 90 percent of Vermont's population, manage many of the special waste collection systems, provide on-going education and promotion of recycling and special waste management, and operate many smaller transfer stations and drop-offs.

The Project Team has expended significant energy attempting to gather accurate data on the activities of both the private sector and the public sector as part of this analysis. These data, together with data collected by ANR form the basis for the description of the existing base case system, and impact the analysis of the alternative systems.

In addition, ANR formed a stakeholder group for this project, which included representatives of both the private and public entities involved in the state's solid waste management system, and required the Project Team to consult these parties in shaping the final scope of work. A kick-off meeting occurred in November 2012 to finalize the details of the analysis and request input from these stakeholders. An interim report to ANR was released in March 2013 - *Draft Comparison of Systems Costs and Materials Recovery Rates: Implementation of Universal Single Stream Recycling With and Without Beverage Container Deposits* – to share with the Vermont stakeholder group, but this report ultimately went to an expanded group that included interests outside of Vermont.

ANR consolidated comments from this extended stakeholder group for incorporation into the Project Team's July, 2013 Draft Report, *Analysis of the Impact of Act 148 on Solid Waste Management in Vermont.* A second round of comments was solicited from the expanded stakeholder group with ANR again consolidating comments for the Project Team. This Final Report attempts to address the many comments received. Ultimately, however, this Final Report represents the professional judgment and analysis of the Project Team.

DATA LIMITATIONS

ANR collects a wide range of data from the solid waste districts and planning entities (e.g., Solid Waste Implementation Plans or SWIPs, Household Hazardous & CEG Collection Program Activity reports, quarterly facility reports). However, not all of the data has been compiled by ANR in a way that it is useful, and quarterly facility reports for 2012 had not been compiled in time for this report; therefore data compiled by ANR for 2011 was used

[4] Casella operates the Rutland single stream MRF, and operates the Chittenden District MRF in Williston under contract to the Chittenden Solid Waste District.

in most cases. Moreover, although solid waste professionals in the districts throughout Vermont were generally quite responsive to the Project Team's data requests, it became clear that the districts use different categories and methods for reporting their data, making it challenging to aggregate and/or compare data across districts. As discussed in Section XII, guidance from ANR on standardizing data collection and reporting methods would be an important step towards addressing this challenge.

Furthermore, the State does not collect data on the operation of the existing bottle bill, as there is no reporting mechanism for licensed redemption centers to report returns or for distributors to report materials handled or costs. In addition, with the exception of two pricing studies contracted by ANR, ANR collects little information on the cost of solid waste management services in the state. One of the major challenges to developing a detailed understanding of the relative costs and benefits of the alternative systems under Act 148 is that much of the data necessary to conduct the analysis is proprietary. This is especially the case for the existing bottle bill, but is also the case for the analysis of the existing curbside collection system, which is primarily operated by private companies.

The Project Team relied on a number of parties to share data, signing confidentiality agreements in some cases to gain access to this data. In all cases the Project Team has provided summaries of the proprietary data as allowed under the confidentiality agreements.

Specific limitations related to data ultimately used for the bottle bill and expanded bottle bill systems analyzed are summarized below in those two sections of the report – *Recycling through the Bottle Bill* and *Estimated Recovery of Material Under an Expanded Bottle Bill.* These sections also include discussions of the Project Team's data collection activities undertaken to overcome these limitations.

Finally, the scope of work for this report did not include an analysis of the impact of Act 148 on job development. Considering job development through the entire solid waste management system would be complex and is well beyond the scope of work (and budget) for this analysis.

III. SOLID WASTE MANAGEMENT BASE DATA

Data used for municipal solid waste generation, recycling and disposal are outlined below.

RECYCLING DATA

The Project Team used CY 2011 data (the most recent year available) from the Vermont DEC facility reporting system on the source, volumes and destination of materials managed for recycling in Vermont. In CY 2011, a total of **413,517 tons** of municipal solid waste generated in Vermont were disposed and an estimated **80,796 tons** of fiber and packaging materials were collected for recycling.[5] In addition to fiber and containers, other materials were also recycled as shown below in Table 1.

TABLE 1. MATERIALS RECYCLING, CY 2011 (1)

Material Category	Recycling, CY 2011 (tons)
Fibers and Containers (2)	80,796
Bottle Bill Material (3)	17,800
Appliances and White Goods (4)	6,500
Special Wastes (5)	1,978
Organics (6)	
Certified Compost Facilities	11,620
Exempt Facility Estimate	866
Yard Waste (7)	1,157
Stumps, Brush, Wood (7)	4,151
Total:	**124,868**

(1) Excludes economic recycling and scrap metal recycling, other than that reported by facilities to ANR, and estimates of reuse and backyard composting.
(2) Total different from 2011 ANR Solid Waste Diversion Report to account for 5,000 tons of OCC and paper handled by reporting VT facility that was generated in NH. Includes other non-container packaging handled at MRFs.
(3) Source: Northbridge Environmental for 2011 returns.
(4) Scrap metal, appliances and white goods reported to ANR in 2011 by certified recycling facilities.
(5) Includes electronics, textiles, paint, auto and household batteries, fluorescent bulbs, ballasts, propane tanks, used oil and oil filters as reported by ANR in 2011 Diversion Report.
(6) As reported by ANR Solid Waste Diversion Report, 2011, Table 2 Worksheet.
(7) Also reported in Table 2 worksheet as handled by facilities other than composting facilities. Note that CSWD states that they process about 8,000 tons of stumps, brush and wood a year although lower volumes were included in the data managed and reported by ANR for the CSWD region and included in Table 1.

Missing from Table 1 are *three estimates* that significantly boost Vermont's reported recycling rate: economic recycling, scrap metal recycling (other than appliances and white goods reported from solid waste and recycling

[5] This includes some material residue and materials lost during processing and reclamation, and excludes 5,000 tons reported to DEC as generated in VT but were actually generated in NH.

facilities) and backyard composting. Adding these estimates to the quantities shown in Table 1 above (an estimated 86,000 additional tons) results in a statewide recycling rate of 34 percent.[6] Because this analysis focuses on materials impacted by Act 148 – packaging, fiber and organic materials – a more narrow focus on Vermont's municipal solid waste stream is represented throughout this report when calculating diversion and recovery rates to enable a closer comparison of the impacts of Act 148 against the current (base case) system.

BREAKDOWN OF FIBERS AND CONTAINERS

DSM used the breakdown of materials recycling provided in the CY 2011 facility reports to VT DEC. However, because not all materials reported by facilities were done so at the commodity level, DSM reallocated material reported as single stream and commingled containers to specific commodity categories based on the material blend reported at the Chittenden Solid Waste District (CSWD) MRF for FY 2012. This reallocation is shown below in Table 2, and is used to estimate material losses when compared to bottle bill materials as well as serve as the basis for future materials recycling.

TABLE 2. REALLOCATION OF MATERIAL REPORTED AS SINGLE STREAM AND AS COMMINGLED CONTAINERS TO SPECIFIC MATERIAL CATEGORIES

MATERIAL	Single Stream (tons)	Commingled Containers (tons)	All Other Reported (tons)	TOTAL (tons)
Reallocation (1) of:	**10,556**	**2,193**		
Books	0		195	**195**
Boxboard/Paperboard	0		147	**147**
Corrugated Cardboard (2)	3,939		27,984	**31,923**
Magazines	0		244	**244**
Newspapers	3,239		19,033	**22,272**
Fibers, co-mingled (3)			3,696	**3,696**
Mixed Paper	545		4,403	**4,948**
Subtotal, fibers:	7,722	0	55,702	**63,424**
Cans, Aluminum or Steel (4)	231	179	1,456	**1,866**
Glass	2,084	1,613	7,465	**11,162**
PET Plastics	208	161	1,014	**1,382**
HDPE Plastics	219	169	1,029	**1,417**
Other Plastics	93	72	1,379	**1,544**
Subtotal, containers:	2,835	2,194	12,343	**17,372**
Total:	**10,557**	**2,194**	**68,045**	**80,796**

[6] A rate of 35%, as reported by VT ANR, would include the 5,000 tons of material mistakenly reported by one facility to VT ANR as generated in VT, but actually generated in NH.

TABLE 2 NOTES:

(1) This row shows tons reported to ANR as Single Stream and as Commingled Containers, which are then reallocated to the material categories sold below based on the material blend at the CSWD MRF. This does not represent the total tons of material collected as single stream and as commingled containers, only that portion for which sales data by commodity were not available.

(2) Reduced by 4,500 tons to reflect estimated 65 percent of material from one facility from NH sources.

(3) Reduced by 500 tons to reflect estimated 65 percent of material from one facility from NH sources.

(4) An estimated breakdown of the 1,866 tons of cans reported based on the CSWD MRF Materials Blend is shown below and is used in our estimates of Aluminum Beverage Containers, Other Aluminum and Steel Can recycling:

Aluminum - Other	*1%*	*25*
Aluminum - UBC	*6%*	*105*
Metal - Mixed Cans	*93%*	*1,736*
Total:		***1,866***

Because Table 2 contains materials recycling estimates for CY 2011 that represent both materials sold from MRFs as specific commodities, and incoming materials reported in aggregate, Table 3 below adjusts incoming material reports for losses to represent estimates of all materials sold from Vermont for use in the Base Case system. Table 3 also includes estimates of Aluminum and Steel Cans made from the Mixed Cans reported to ANR.

TABLE 3. ADJUSTMENT OF MATERIAL REPORTED AS RECYCLED TO REFLECT MATERIAL SOLD FOR RECYCLING FROM VERMONT IN BASE CASE

Materials	Total *(tons)*	Adjusted for Losses in Base Case *(tons)*
Books	195	190
Boxboard/Paperboard	147	100
Corrugated Cardboard (1)	31,923	31,300
Magazines	244	240
Newspapers	22,272	21,800
Fibers, co-mingled (2)	3,696	3,600
Mixed Paper	4,948	4,900
Subtotal, fibers:	63,424	62,100
Aluminum - UBC	105	100
Aluminum - Other	25	20
Steel Cans	1,736	1,700
Glass	11,162	10,950
PET Plastics	1,382	1,350
HDPE Plastics	1,417	1,390
Other plastics	1,544	1,510
Subtotal, containers:	17,372	17,020
Total:	**80,796**	**79,120**

(1) Reduced by 4500 tons to reflect estimated 65 percent of material from one facility (NE Waste) from NH sources.
(2) Reduced by 500 tons to reflect estimated 65 percent of material from one facility (NE Waste) from NH sources.

RECYCLING THROUGH VERMONT'S BOTTLE BILL

In addition to the fibers and containers reported in Table2 (80,796 tons, adjusted down to 79, 120 tons in Table 3), Northbridge Environmental Management Consultants (Northbridge) reports that 242 million carbonated beverage containers weighing an estimated 16,725 tons were redeemed through distributors or a third party in 2011 as part of Vermont's bottle bill.[7] In addition, the Vermont Department of Liquor Control reports 2.86 million liquor containers redeemed in FY 2012, estimated to total 1,000 tons of glass and 67 tons of PET.[8] These volumes (17,800 tons rounded) significantly boost container recycling in Vermont.[9] A breakdown of this data by material type is included below in the section *Estimated Recovery of Material Under an Expanded Bottle Bill*.

SINGLE STREAM MATERIAL LOSSES

One important difference between bottle bill material and recycled materials recovered from single stream collection and processing systems is that there are typically more losses associated with the single stream system. This is because bottle bill material is typically kept separate from other recyclables throughout redemption, consolidation and processing, providing less opportunity for contamination with other, non-bottle bill recyclables, and refuse. Therefore, as advocates of bottle bills rightly point out, it is not accurate to compare tons of single stream materials collected for recycling with similar tons of materials collected through a deposit system because there will be losses of materials as they are processed through a single stream MRF, and as they are further processed by material reclaimers.

Losses through single stream systems vary significantly depending, first, on how the material is collected and then, more importantly, how the material is processed at the single-stream MRF. The amount of citizen education and enforcement, the length of time recycling collection has been in place prior to implementation of single-stream collection, use of automated or semi-automated collection equipment, and carts all play a role in determining how much contamination is delivered to the MRF. Inside the MRF, the age of the sorting equipment is important as there continues to be significant improvements in sorting equipment design; and the types of equipment used to initially separate glass from other materials can make a big difference in both glass recovery and contamination of other materials by broken glass. Just as importantly, whether a material is positively or negatively sorted will have a large impact on the quality of the outgoing material, with positively sorted material typically cleaner than negatively sorted materials. Finally, the number of sorters the MRF operator assigns to quality control at the end of the sorting lines can have a large impact on the quality of the outgoing material and cross-contamination of materials.

Based on comments received by ANR after the Draft Report on the bottle bill[10] was submitted by the Project Team, the ANR directed that Vermont-specific data on losses be incorporated in the final report. The Rutland MRF

[7] Through Vermont's beverage container return commingling agreement, Northbridge audits sales and returns to allocate handling fees and related expenses to participating distributors (representing roughly 70 percent of total beverage sales in the state) and reimbursements to participating redemption centers. In addition, Northbridge surveyed other distributors (representing an estimated 23 percent of sales in Vermont) to develop total statewide sales and return estimates.

[8] Year ending June 30, 2012.

[9] See *Vermont Bottle Bill Analysis, Prepared to Support Analysis Required Under Act 148*, July 2013. Northbridge Environmental Management Consultants.

[10] *Comparison of System Costs and Materials Recovery Rates: Implementation of Universal Single Stream Recycling With and Without Beverage Container Deposits*, Draft Report, March 4, 2013.

(operated by Casella) was used as the baseline MRF because it has been recently converted to a single stream MRF and represents state-of-the art sorting equipment. The Project Team requested and received from Casella audit reports from their buyers of different commodities. Some of these buyers purchase material from both the Rutland and Chittenden MRFs, but in the case of glass the audits represent material only from the Rutland MRF. Haycore of Ontario, Canada purchases the PET plastic from both facilities and provided audits of PET bales, and Strategic Materials in Georgia purchases glass from the Rutland MRF and provided audits of samples of glass deliveries. Anheuser-Busch Recycling purchases aluminum from all of Casella's New England MRFs and provided bale audit data for all New England bales sold. Casella provided paper bale audits, but stated that the buyer was proprietary.

Losses include actual losses of commodities to residue at the Rutland MRF (confirmed through sampling and sorting of residue by DSM during the course of this project) and losses of commodities from contamination by other recyclable materials (confirmed through material audits performed by buyers of paper, glass, and PET sold from the Rutland MRF).

Table 4 below summarizes total losses by material type. The first column of losses in Table 4 presents the amount of each recyclable material that is lost to MRF residue (and is disposed). This column was derived through a multi-step process. First, DSM collected 16 grab samples of MRF residue over the course of three full days of sampling and sorting at the Rutland MRF. These sixteen samples were each sorted to a 3/8 inch minus screen size, and all potentially recyclable aluminum, glass, PET, and mixed paper were pulled out of the residue sample and weighed. All material falling through the 3/8 inch minus screen was also weighed and assigned to the glass category even though not all of it was glass. The weight of each recyclable material pulled out of the residue was divided by the total residue sample weight to derive the percent of each recyclable material in the residue sample.

The weighted average of the 16 samples, expressed as a percent was then multiplied by the total amount of residue disposed from the Rutland MRF in a year, yielding the total tons of glass, PET, aluminum and mixed paper that went out of the MRF as residue.

The final step was to compare the tons of each material estimated to be lost to residue against the total tons of each of these materials reported to be sold by the Rutland MRF over the same year. For example, it was estimated from the residue sampling that 159 tons of glass went out of the MRF as residue. However, 4,359 tons of glass was reported sold over the same time period. Dividing the 159 tons of glass lost to residue by the 4,359 tons sold plus the 159 tons lost yields a loss rate for glass of 3.52 percent, as illustrated in the first column of Table 4.

TABLE 4. LOSSES OF POTENTIALLY RECYCLABLE MATERIAL IN MRF RESIDUE AND IN SOLD MATERIAL

MATERIAL	MRF Residue	End User or Reclaimer Losses							Total All Losses
		Trash	Glass	Al Food	Al UBC	PET	Paper	*Total*	
Mixed Paper	**1.94%**	1.96%	0.06%	0.00%	0.00%	0.43%	0.00%	**2.46%**	**4.41%**
Containers									
PET	**0.89%**	5.94%	0.00%	0.04%	0.04%	0.00%	0.98%	**7.00%**	**7.89%**
Aluminum	**17.05%**	1.00%	0.00%	0.00%	0.00%	0.00%	0.05%	**1.05%**	**18.10%**
Glass	**3.52%**	6.00%	0.00%	0.32%	0.02%	0.58%	4.08%	**11.00%**	**14.52%**

It should be noted in reading the first column of Table 4 that the total material recovered and sold has a significant influence on the loss rate. The loss rate for glass is relatively low, in part because of the relatively large amount of

tons of glass sold when compared to the amount lost through residue. However, because most aluminum does not go through the MRF, but instead through the deposit system, relatively small quantities of aluminum are recovered and sold by the MRF, resulting in a relatively high loss rate when compared against the estimate of the amount of aluminum lost to residue.

The next six columns of Table 4 present the results of buyer audits, showing the percentages of each material received that were not the materials they intended to purchase. Again, using glass as an example, Strategic Materials provided Casella with audits of samples of loads of glass delivered to them.[11] The sum of these sample audits showed that: 6 percent by weight of the glass samples audited by Strategic was trash; 4.08 percent was paper; 0.58 percent was PET; 0.32 percent was aluminum food cans; and, 0.02 percent was aluminum beverage containers. The sum of losses at the reclaimer (or buyer) level (shaded grey column under End User or Reclaimer Losses), are added to losses in MRF residue (first column) to represent ***total losses*** for each material. These loss rates are important as they enable the Project Team to estimate actual materials recovery under Systems 2 through 4 of this analysis.

Three important points should be kept in mind when reading Table 4. First, these results are unique to the Rutland MRF and should not be compared against MRFs using different equipment. As discussed above, the Project Team has used the Rutland MRF because it currently processes a significant amount of Vermont single-stream material and will continue to do so in the foreseeable future; and, because the Chittenden MRF is aging and is due for modifications, which the Chittenden District and Casella (the current operator) are jointly considering. These modifications are likely to include equipment configurations similar to those at the Rutland MRF.

Second, again using glass as an example, while the calculations of net material recovery rates included in this report are based on the total loss rate of 14.52 percent for glass (last column in Table 4), the real loss rate for glass is actually only 8.52 percent since 6 percent of the glass loss rate is actually trash that entered the MRF and ended up being sold as glass.[12]

Third, there are additional losses of material, especially for PET, at the reclaimer level. The Association of Postconsumer Plastic Recyclers (APR) reported to the Project Team that roughly 20 percent of PET deposit bales is "lost" during the reclamation process. This consists of rings and caps, labels, and more recently growing numbers of shrink wrap labels on the PET bottles. This 20 percent reclaimer loss is *not* included in the material loss rates because this material is lost whether the PET bottle is recovered through a bottle bill or through a single stream system.[13]

However, the single stream PET does tend to have a higher contamination rate than deposit PET due to: (1) trash and non-PET materials included in the bales (which are accounted for in the Table 4 losses above); and (2) food contamination, since PET food containers are included in single stream bales but not in bottle bill bales. This report accounts for trash and other materials loss (the 7 percent reclaimer loss in Table 4), and the cost analysis accounts

[11] DB Report #101, Mixed Glass – Detail by Supplier by Plant, Test Results of five loads received from the Rutland MRF between April 10, 2013 and May 6, 2013.
[12] Strategic Materials does not consider glass that is smaller than 3/8 inch to be useable glass. The loss rates presented above do not account for this because other glass processors sell the 3/8 inch minus glass for fiberglass.
[13] If Vermont were to adopt an expanded bottle bill the impact of shrink wrap labels will increase because many of the "new age" beverages which are currently not covered by the deposit are sold with shrink wrap labels.

for the loss from food contamination because single stream bales are typically sold at a discount compared to bottle bill PET bales.[14]

MATERIALS DISPOSED

A solid waste composition study was carried out in 2012 to characterize Vermont's municipal solid waste disposed by the residential and commercial sector. While sampling of both residential and commercial waste was completed based on the origin of the waste reported by the driver during sampling, there is no reporting on the total quantity of residential versus commercial waste in Vermont. In order to better understand how much disposed materials each sector is generating and the amount of each material potentially available for recycling or organics management, the Project Team allocated the 413,517 tons of waste to residential and commercial sources based on data from other states, and from work conducted by DSM in Chittenden County. The allocation used assumes 60 percent of the MSW disposed is generated by the residential sector and 40 percent by the commercial sector.

Figures 1 and 2 below show the results for major material categories sorted during the waste composition study.

FIGURE 1
RESIDENTIAL MSW COMPOSITION (BY WEIGHT)

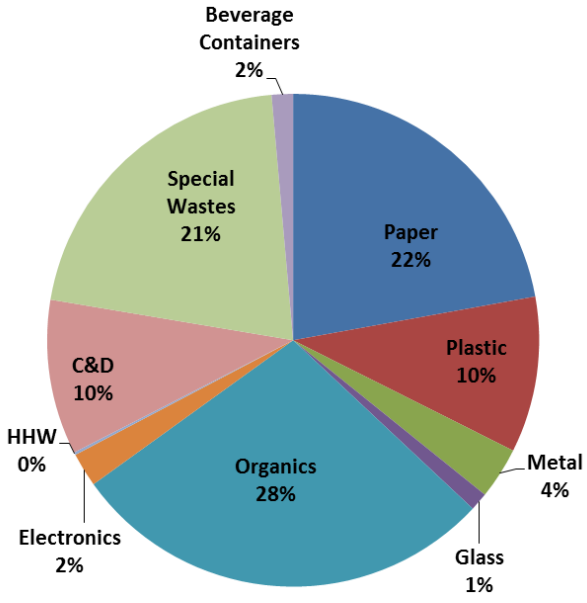
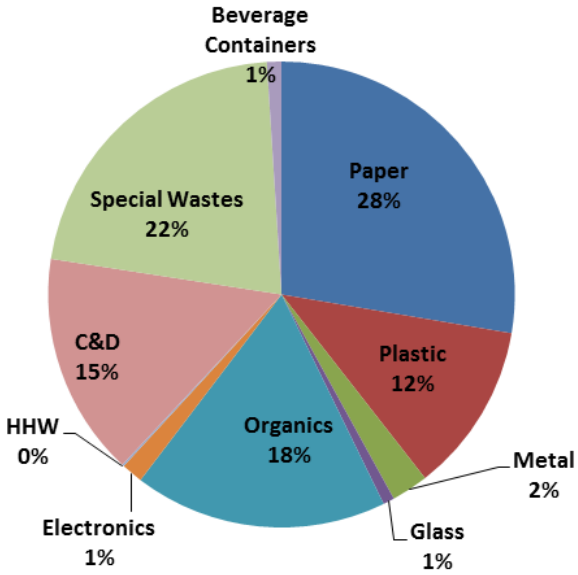


FIGURE 2
COMMERCIAL WASTE COMPOSITION (BY WEIGHT)



[14] This cost differential accounts for any difference in contamination rates in deposit vs. non-deposit PET bales. While the APR reports that this price differential is typically 10 cents per pound comments received from the CSWD and Casella indicate that because they positively sort PET, the cost differential for VT PET is significantly less than 10 cents per pound. As such this analysis assumes a 5 cent per pound differential.

Three important areas of the Waste Composition Study results impact on this Act 148 analysis. First, organics represent 28 and 18 percent of the residential and commercial (ICI) waste streams, respectively. As illustrated by Table 5, below, the organics category includes food residuals, yard waste, fines and dirt, and other organics. In addition, a certain percentage of the paper category (compostable paper) is also potentially available for organics management. Compostable paper includes waxed corrugated and dirty paper which cannot be recycled. The compostable paper is especially important because it can serve as a carbon source, reducing the need to purchase carbon for composting of food residuals (which are high in nitrogen). This is especially the case in New England where there is a relatively short growing season, meaning that for roughly six months of the year there is no yard waste available, unlike the west coast cities of Portland, Seattle and San Francisco that have organics diversion programs that rely on a year-round supply of yard waste as part of the carbon source. The result is that if compostable papers are not collected with food residuals, processing costs for composting may increase due to the need to purchase carbon sources such as wood chips.

Second, Figures 1 and 2 (above) illustrates that only roughly 2 and 1 percent, respectively of disposed residential and commercial waste is containers that would be subject to either the existing bottle bill or an expanded bottle bill. While these may be important materials for the PET, aluminum and glass industries, they do not drive overall recovery rates when compared to paper (fiber) or, organics.

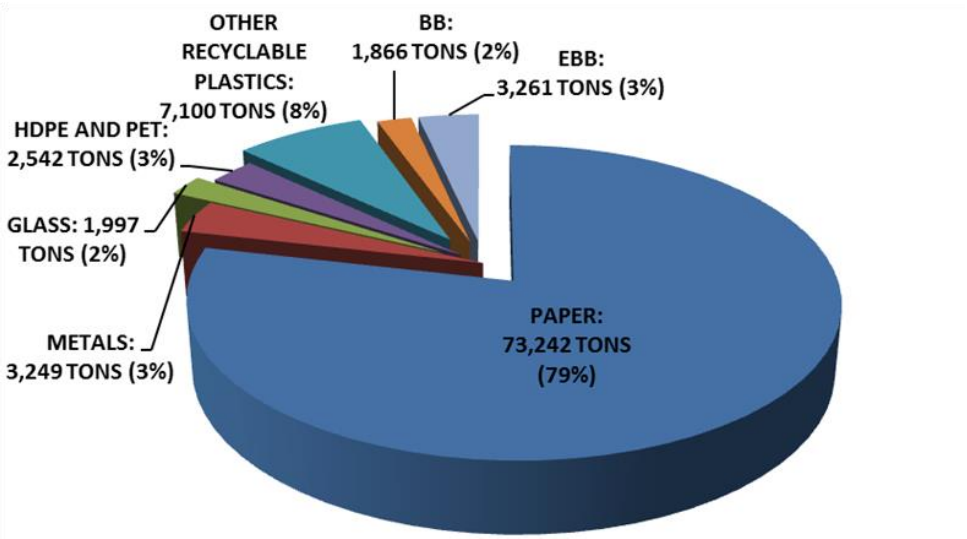
TABLE 5. ORGANICS DISPOSED IN VERMONT'S MSW AND AVAILABLE FOR COMPOSTING (1)

MATERIALS	RESIDENTIAL MSW				ICI MSW			
	Disposed		Recovered	Net Recovered	Disposed		Recovered	Net Recovered
	(%)	(tons)	(%)	(tons)	(%)	(tons)	(%)	(tons)
PAPER								
Compostable Paper	6.2%	15,506	60%	9,304	3.8%	6,345	60%	3,807
ORGANICS								
Food Waste	16.7%	41,486	60%	24,892	11.2%	18,592	60%	11,155
Mixed Yard Waste Leaves, Branches, & Stumps	3.2%	7,913	60%	4,748	2.9%	4,818	60%	2,891
Fines / Dirt	2.8%	6,960	0%	0	2.5%	4,135	0%	0
Other Organics	5.4%	13,349	60%	8,010	0.9%	1,486	60%	892
Total:	**34.3%**	**85,214**		**46,952**	**21.4%**	**35,376**		**18,745**

(1) See Section VII for a discussion of the 60 percent recovery rate assumptions.

Third, Figure 3, below, presents the total estimated tons of fiber and packaging left in the combined residential and commercial waste stream that could be recycled through a MRF. This recyclable paper and packaging represent nearly 100,000 tons of municipal solid waste, based on the waste composition study. The composition of this material is shown below in Figure 3.

FIGURE 3. COMPOSITION OF RECYCLABLES (PAPER AND PACKAGING) DISPOSED IN VERMONT'S MSW (BY WEIGHT)



Finally, given the importance of paper in the disposed waste stream, Table 6 provides a breakdown of the paper category, showing the composition of paper found in the residential and the ICI municipal solid waste stream.

TABLE 6. BREAKDOWN OF PAPER DISPOSED IN RESIDENTIAL AND ICI MSW

	RESIDENTIAL MSW		ICI MSW	
Material Category	Average (%)	Total (tons)	Average (%)	Total (tons)
Newsprint	1.4%	3,472	2.1%	3,498
High Grade Office Paper	0.6%	1,483	1.8%	2,962
OCC (Old Corrugated Cardboard)	5.7%	14,177	12.4%	20,577
Magazines/Catalogs	1.6%	3,896	0.4%	657
Mixed Recyclable Paper	2.3%	5,739	2.8%	4,618
Boxboard (chipboard)	2.1%	5,265	2.1%	3,400
Books	0.8%	1,884	0.2%	310
Polycoated / Aseptic Containers	0.2%	402	0.0%	71
Polycoated / Aseptic Containers, Dairy	0.3%	629	0.1%	204
Compostable Paper	6.2%	15,506	3.8%	6,345
Non-Recyclable R/C Paper	1.0%	2,525	1.9%	3,111
Total, Paper:	**22.2%**	**54,978**	**27.7%**	**45,752**

IV. EXISTING SOLID WASTE MANAGEMENT INFRASTRUCTURE

The Project Team analyzed demographics, solid waste diversion and disposal data by facility, and the infrastructure for managing solid waste in Vermont to determine what infrastructure will be necessary to meet the objectives of Act 148. This included the following tasks:

- Compilation and analysis of data on permitted municipal solid waste collection and transfer facilities by region and the volumes handled by material type for each;
- Collection and analysis of data from the state's four materials processing facilities (two single stream, one dual stream and one source separated);
- Analysis of volumes collected and composted at permitted organics composting facilities and the capacity permitted (See section on Organics Management Assumptions);
- Surveying of haulers outside of CSWD to estimate the number of households that subscribe for refuse and recycling collection (vs. use drop-offs) and determine current residential access to curbside refuse; and
- Collection and updating of data from solid waste planning entities on management of HHW, Universal wastes and special wastes including detailed budgets and cost data.

From these sources, the Project Team was able to develop reasonable assumptions about material flows in Vermont, and which entities manage what types of materials.

POPULATION AND DEMOGRAPHICS

Roughly 257,300 households make up Vermont's resident population (rounded, US Census, 2010). There are an additional 67,000 housing units (rounded, US Census 2010) in Vermont which are seasonal or unoccupied, some of which require solid waste management services at least part of each year.[15] For this analysis, to account for the impact of seasonal households on the system, the Project Team assumed that roughly 269,900 housing units require collection service. Roughly 61 percent of the population is considered rural, making Vermont the second most rural state in the United States (after Maine) according to the 2010 census.

Vermont is also home to roughly 79,000 (rounded) businesses, which also generate wastes that require management. And, because of the rural nature of Vermont, the state also has over 3,000 livestock farms (dairy, sheep, hog and chicken), approximately 500 vegetable and 550 fruit farms and another 435 farms selling nursery stock and greenhouse products.[16] While many of these farms are small, some of them could potentially utilize food residuals for animal feed and/or compost.

[15] According to the 2010 Census, 50,198 housing units are seasonal (Housing Characteristics 2010, Census Summary File 1, 2011 American Community Survey). Assuming these seasonal units are occupied three months out of the year, they represent another 12,550 households annualized that require some type of solid waste collection service. Vacant households were not included in the final adjusted household count of 269,900 households (rounded) generating waste and materials.

[16] From 2007 Census of Agriculture, the most recent year published.

COLLECTION INFRASTRUCTURE

Collection costs are often the largest single component of total solid waste management system costs. As such it is necessary to have a detailed understanding of how collection occurs in Vermont, and how this infrastructure can be expanded to meet the goals of Act 148.

Solid waste, recycling, and organics collection in Vermont is carried out by private haulers as well as some municipalities and solid waste districts (or other solid waste management entities as described in local governance evaluation). In addition many households and some small businesses self-haul their waste and recyclables to transfer stations and drop-off facilities.

With the exception of municipal and district operated drop-off facilities, which serve some small businesses, commercial waste and recycling is almost exclusively handled by private haulers.[17] Private haulers also handle the majority of residential waste collected at the curb (or roadside), including entering into contracts with several municipalities to provide refuse and recycling collection service to all or the majority of their residents. Burlington is the only municipality that collects recycling using City crews.

Unfortunately there is no accurate count of the number of households and businesses contracting for collection as opposed to self-hauling waste or recyclables.

DSM recently completed an analysis of refuse and recycling collection in Chittenden County, which developed detailed baseline data on residential and commercial refuse and recycling collection. This included data on the number of households served through individual subscription haulers, organized municipal curbside collection contracts, containerized collection, and use of the CSWD drop-off facilities. The baseline data included cost and service information for commercial collection in the CSWD.[18]

To develop estimates for the rest of Vermont, the Project Team met with the Vermont Solid Waste District Managers Association Compliance Officer in February 2013 to classify the ANR-supplied list of licensed solid waste haulers into large, medium and small size categories. DSM also consulted several district officials to determine the primary haulers operating in their region.

The Project Team then attempted to contact and survey all of the large and medium haulers, and a sample of the small haulers. The survey asked them to provide information (on a confidential basis) on the number of residential customers they have for refuse collection, the percent of those customers who also have recycling collection, and whether households have to pay extra (subscribe) for recycling collection. Surveys were not conducted of haulers in Chittenden County because DSM already had relatively accurate data for the CSWD.

The Project Team also obtained and analyzed data from quarterly and annual facility reports to ANR on the quantity of municipal solid waste and recycling collected at certified transfer stations and drop-off facilities throughout Vermont. These data were used to determine how much refuse and recycling is handled via drop-offs as opposed to curbside and collected through municipal and district versus private facilities.

[17] There are a few exceptions to this, including the CVSWD and the Highfields Center for Composting, which collect and process organics from businesses and institutions.

[18] DSM Environmental Services, Inc. with GBB. *Analysis of Consolidated Collection Systems for the Chittenden Solid Waste District.* FINAL REPORT, January 20, 2012.

RESIDENTIAL COLLECTION

The results of the hauler surveys, combined with an analysis of drop-off refuse and recycling tonnage data and data from the Chittenden District formed the basis for the Project Team's best estimate of:

- The number of households served by curbside (or the equivalent) refuse and recycling collection;
- Current access to parallel recycling collection;
- The percent of households currently served curbside by single stream collection versus dual or source separated collection;
- The balance of households who rely on drop-off refuse and recycling collection or some form of fast trash collection[19]; and,
- The number of households that may be recycling at drop-offs where there is no refuse collection, and are making a separate trip to recycle.

Table 7 presents the aggregate estimates based on the hauler surveys and the facility data analyzed. "Organized collection" refers to municipalities who have entered into a contract or some type of agreement with a single hauler to serve all, or some portion of households in that municipality with a uniform service (e.g., weekly refuse collection and/or weekly recycling collection). Note that with the exception of curbside recycling in Burlington, all curbside and containerized refuse and recycling collection from households is carried out by private haulers; with a small amount under contract through a municipality.[20]

TABLE 7.
ESTIMATES OF HOUSEHOLDS SERVED BY COLLECTION METHOD

	CURRENT SYSTEM	
	Refuse *(households)*	**Recycling** *(households)*
Organized Curbside		
Chittenden County	1,200	17,300
Rest of Vermont	10,700	17,500
Subtotal, Organized:	**11,900**	**34,800**
Subscription Collection		
Chittenden County		
Curbside	38,900	22,800
Containerized	13,400	13,400
Rest of Vermont		
Curbside	70,000	29,900
Exempt Haulers and Fast Trash	14,000	5,950
Containerized	21,500	2,150
Subtotal, Subscription:	**157,800**	**74,200**
Drop-off Collection		
Chittenden County	8,300	8,300
Rest of Vermont	91,900	90,100
Subtotal, Drop-off:	**100,200**	**98,400**
Total:	**269,900**	**207,400**

Lack of Parallel Access	**62,500**
Percentage of Vermont Households	***23%***

[19] *Fast trash* is defined as a refuse truck arranging to be at a certain location at a specific time for households to use to dispose of waste and in many cases recyclables.

[20] The following towns have contracted, organized refuse and/or recycling collection: Brattleboro, Goshen, Hartford, Lyndon, Middlebury, Bristol, Proctor, Westford, Underhill, Westmore, Guildhall, Bloomfield, Brunswick, Maidstone, Westminster (refuse only, no recycling), and Vernon (refuse only, no recycling).

Based on the hauler surveys and the review of transfer station and drop-off tonnage data (no household use data are available), roughly 62,500 households (or 23 percent) do not have parallel recycling.

However, roughly 23 drop-off sites throughout the State have only recycling and no refuse, requiring some households to make a separate trip to recycle. Eleven of these sites are available 24/7 and collect large volumes of material over the course of the year. The remaining sites are manned and open limited hours. In total, an estimated 3,000 tons were collected from these recycling-only sites in 2011 throughout the State. These 3,000 tons represent separate trips made by households (and some small businesses) to recycle their material under the current system. The cost of these separate trips are estimated as part of the cost analysis and total system costs are shown with and without these separate trips.

THE ROLE OF DROP-OFFS AND TRANSFER STATIONS

Drop-off facilities play a large role in refuse and recycling collection in Vermont. A total of 148 facilities are certified to collect municipal solid waste refuse and/or recyclables and another 18 are certified to compost materials. In addition, there are a number of drop-off sites that are not certified but serve as fast trash and recycling sites or recycling-only drop-offs.

Of these MSW and/or recycling-only facilities or drop-off sites, 98 are operated by municipalities and 38 are operated (or owned but contract operated) by solid waste districts. The balance are operated by the private sector.

Though publicly-owned drop-off and transfer stations dominate numerically, the volumes managed by these facilities tell a different story. Table 8 presents a breakdown of the number of certified transfer and drop-off facilities and the volume collected in CY 2011, organized by facility operator/ownership. As shown in Table 8, 70% of the total volume of MSW, C&D and recyclables (i.e., materials that could be managed at a MRF) are handled by the private sector but the majority of that volume is MSW destined for disposal.

TABLE 8. ANNUAL THROUGHPUT OF PERMITTED MSW, C&D AND RECYCLING COLLECTION AND PROCESSING FACILITIES BY OPERATOR/FACILITY PERMITTEE (1), (2), (3), (4), (5)

Facility Permittee	Number of Facilites	MSW (tons)	C&D (tons)	Recycling (tons)	Total (tons)	*Percent of Total (%)*
Municipalities	98	24,302	4,118	8,521	36,942	*7%*
Solid Waste Entitites	37	54,595	16,042	15,284	85,921	*16%*
Private Operators	30	293,990	36,913	90,302	421,205	*77%*
Total:	**165**	**372,887**	**57,073**	**114,107**	**544,068**	*100%*

(1) Facility Permittee is the entity holding the permit, and/or the facility operator. In some cases, such as Highgate Transfer Station, CSWD MRF and the Rutland MRF, the operator is private but the site or facility is owned by the municipality or District.
(2) Tonnage is only shown for MSW, C&D and traditional blue bin recyclables (fibers and containers) and does not include scrap metal, appliances, tires and other types of special wastes in any totals.
(3) Tonnage is included for several recycling drop-off locations that are not certified by VT ANR.
(4) Public facilities with private operators are included in Private Operators.
(5) Numbers may not add due to rounding.

Finally, Table 9 presents the average annual throughput of MSW, C&D and recyclables per individual facility for each type of operator/facility permittee, and illustrates that while municipalities operate the most facilities, they do so with a very low average throughput. The private sector, in contrast, operates significantly fewer facilities but with a much higher throughput. (More details on local governance infrastructure are provided in that section of the report.)

TABLE 9. AVERAGE ANNUAL MSW, C&D AND RECYCLABLES THROUGHPUT PER FACILITY, BY FACILITY OWNERSHIP (1)

Facility Permittee	Number of Facilites	MSW (tons/facility)	C&D (tons/facility)	Recycling (tons/facility)	Total (tons/facility)
Municipalities	98	248	42	87	**377**
Solid Waste Entitites	37	1,476	434	413	**2,322**
Private Operators	30	9,800	1,230	3,010	**14,040**
Statewide:	165	2,260	346	692	**3,297**

(1) Tons per facility represent the average annual throughput per facility and include both drop-offs, transfer stations and processing facilities. Landfills and other disposal facilities are not included in the totals. Statewide totals are weighted averages.

Figures 4 and 5, below, present MSW and recycling tonnages collected/processed in CY 2011 by type of facility ownership (See Table 8 for tonnages). Note that both Table 8 and Figures 4 and 5 ignore curbside and containerized collection which is almost exclusively performed by the private sector and only capture throughput from existing drop-off, transfer station and processing facility infrastructure.

FIGURE 4 - MSW COLLECTED BY TYPE OF ENTITY (1)

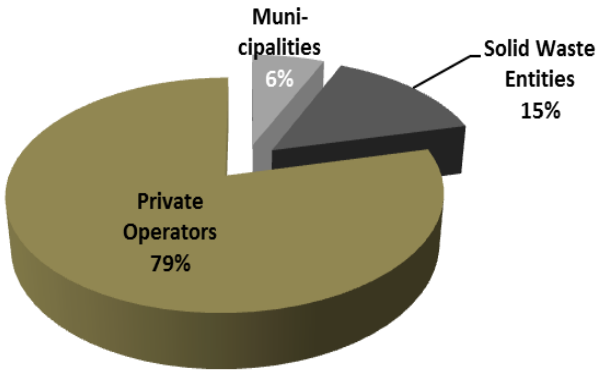
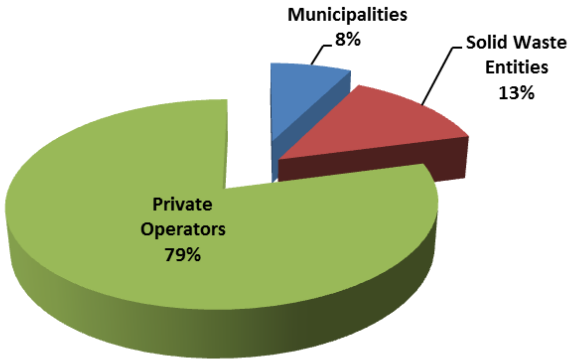


FIGURE 5 – RECYCLING BY TYPE OF ENTITY (2), (3)



FIGURES 4 AND 5 NOTES:
(1) Based on reported 2011 MSW tonnage collected at certified facilities.
(2) Based on reported 2011 Recycling tonnage (fibers, containers and commingled materials) collected at certified facilities.

It is important to note here that households (and small businesses) that drive to these transfer stations and drop-off facilities are avoiding the cost of contracting with a private hauler to collect their MSW and recyclables and transport it. However, that does not mean that they are not incurring a cost, they are simply internalizing their driving cost. This cost is none-the-less real, both in monetary terms and in terms of the impact on the environment. As such, the systems cost model includes the Project Team's best estimate of the number of miles driven multiplied by the IRS mileage rate, and total system costs are shown with and without the estimated cost for these separate trips.

COMMERCIAL COLLECTION

Most businesses (ICI generators) engage the services of a private hauler to handle refuse and recycling. While drop-offs and transfer stations provide access to businesses to deliver their own waste, most businesses find private haulers more cost -effective.

DSM developed relatively detailed data on commercial (ICI) refuse and recycling collection in the CSWD during a 2011 study and used these data to extrapolate how commercial collection might be performed in the rest of the State, taking into account differences in economic activity and access to single-stream recycling. Table 10 below outlines these estimates of the percentage of total ICI waste and recyclables assumed to be collected by each method: delivered directly to drop-offs; collected at the curbside using toters; collected in 2 – 12 cubic yard containers (dumpsters); and, collected in roll-off containers, loose or compacted (generally in 30 – 40 cubic yard containers).

TABLE 10. COMMERCIAL REFUSE AND RECYCLING COLLECTION, ESTIMATED TONS BY COLLECTION METHOD

Type of Collection	Refuse *(tons)*	Refuse *(%)*	Recycling *(tons)*	Recycling *(%)*
Drop-off	6,600	4%	1,600	4%
Curbside	16,500	10%	15,400	37%
Containerized	112,900	68%	23,100	56%
Roll-offs	29,400	18%	1,000	2%
Total:	**165,400**	**100%**	**41,100**	**100%**

As shown in Table 10, while nearly 70% of waste is assumed to be collected in large containers and only 10 percent in toters or cans curbside, 37% of containerized refuse customers are assumed to use toters for recycling based on the Project Team's analysis of collection in the CSWD and surveys of private haulers.

HOUSEHOLD HAZARDOUS WASTE AND UNIVERSAL WASTE[21]

Because of their hazardous characteristics, household hazardous waste (HHW) and Universal Waste may pose risks to public health and Vermont's environment. To minimize such risks, Vermont statutory requirements specify that these materials be collected and managed separately from MSW. Though HHW and the other hazardous waste types are a very small fraction of the overall Vermont stream,[22] even small amounts of the toxins found in these materials can contaminate soil and water if managed improperly. Vermont law (Title 24 V.S.A. Section 2202a) outlines planning requirements and priorities for solid waste management entities (districts, alliances, and municipalities) to address the volume and toxicity of HHW in the waste stream. Since 1992 each district, alliance or municipality is required to develop and implement a Solid Waste Implementation Plan (SWIP) that is consistent with the State's Solid Waste Management Plan (now called Materials Management Plan), and SWIPs must include a minimum of two HHW collection events per year, as well as a public education and outreach component.

Some districts, alliances, and municipalities provide HHW collection services not only to residents but also to small businesses that generate less than 220 pounds of HHW per month and are classified as Conditionally Exempt Generators (CEGs). Waste collected from CEGs falls under Vermont Hazardous Waste Management Regulations and should be segregated from HHW so that the waste collected from households remains exempt from these regulations.

FACILITIES AND PROGRAMS

There are four ways to collect HHW and universal waste:

1. Permanent HHW facilities and drop-off centers accepting universal wastes – generally owned and operated by a solid waste management district (or municipality).
2. Mobile HHW facilities – either owned and operated by a district or group of districts, or contracted privately.
3. One-day HHW and/or Universal Waste collection events – usually organized by a district or municipality and run by a HHW contractor.
4. Retail Locations – Retailers that sell products are registered to take back materials usually as part of EPR legislation or agreements.

Many drop-off centers for refuse and recycling also accept some types of universal wastes. These locations and the types of materials collected are listed in Appendix B, organized by solid waste district.

Of the 16 solid waste management districts in Vermont five have permanent household hazardous waste (HHW) collection facilities, generally co-located at a transfer station and/or a recycling center. The remaining districts and the independent municipalities utilize one-day HHW collection events through contracts with private companies

[21] This section is based on several primary data sources including: 2010 Annual Diversion and Disposal Report, Table 7: Summary of 2010 Vermont HHW/CEG Hazardous Waste Program Activity, VT ANR (the most recent compiled data available); responses to a DSM/Tellus survey of Vermont solid waste management districts; follow-up telephone communications with district staff; Quarterly Solid Waste Facility Reports provided by the districts to ANR, and a review of the websites of various Vermont solid waste districts.

[22] The recent State of Vermont Waste Composition Study, Final Report, May 2013 (p. iii) estimates that HHW comprises only about 0.1% of the MSW stream (both residential and industrial/commercial/institutional or ICI), with electronics accounting for another 1.4% of MSW.

(e.g., Clean Harbors, ENPRO, and others) and do not maintain their own HHW infrastructure. The following districts operate permanent HHW facilities (though some are seasonal):

ADDISON COUNTY SOLIS WASTE MANAGEMENT DISTRICT- Addison County's HazWaste Center is located at the District Transfer Station in Middlebury. Residents of the District's 19 member towns may drop off most HHW free of charge, though there is a $2.00 fee per visit for any amount of residential latex paint or joint compound. The District reported 208 collection days in 2010. Since January 1, 2011 the HazWaste Center has been open six days per week and in 2012 there were 307 collection days. The HazWaste Center also accepts hazardous wastes from businesses that qualify as CEGs. All businesses are responsible for paying the full disposal cost of their hazardous waste.

CHITTENDEN SOLID WASTE DISTRICT - CSWD's permanent Environmental Depot is located in South Burlington and accepts a wide variety of HHW as well as electronics. The facility is open 4 days per week and by appointment. Residents from the 18 member communities may use the Environmental Depot at no charge; businesses that qualify as CEGs may also use the Environmental Depot, with a fee charged for some items. In addition to its Environmental Depot and Drop-Off Centers, CSWD operates a mobile HHW collection unit for residents called the Rover. Business waste is not accepted at the Rover. The Rover operates on Saturdays from July through October (17 dates in 2013), and each week serves a different location at a public facility within the District.

NORTHEAST KINGDOM WASTE MANAGEMENT DISTRICT - The NEKWMD relies on a combination of a permanent facility in Lyndonville, which is open (by appointment) from June through September, and about a dozen collection days from May through September at District or other public facilities within member communities. The Lyndonville facility is open free of charge to residents of its 48 member towns; CEGs within the District may use the facility as well. As in other districts, CEGs must pay the cost of disposal. The District reported 106 collection days in 2010, reflecting the seasonal nature of the Lyndonville facility.

NORTHWEST SOLID WASTE DISTRICT - In 2012 the NWSWD opened its new HHW site at the Georgia Recycling Center. The Georgia facility accepts HHW from residents five days a week and from CEGs within the District from May 1 through October 15 by appointment. Prior to the seasonal opening of the Georgia HHW facility, in 2010 the NWSWD held 13 one-day HHW collections at various public locations throughout the District. To maintain convenient HHW collection services the District has scheduled 11 one-day HHW collections in 2013.

RUTLAND COUNTY SOLID WASTE DISTRICT The RCSWD operates a permanent HHW Depot at the District transfer station on Gleason Road in Rutland. Residents from all of the District's 17 member towns may use the HHW Depot. The District reported that the Depot was open 251 days in 2010. The 2013 schedule indicates the Depot is open Tuesdays, Wednesdays, and Thursdays plus one Saturday per month or approximately 165 days. In addition, RCSWD holds one-day collection events at various facilities in member communities as well as in Solid Waste Alliance Communities (SWAC) nearby. The District reported events on 20 days in 2010 and has scheduled 20 dates in 2013. On 18 of the RCSWD's 20 HHW days in 2013, the contractor serves more than one location on the same day (e.g., morning hours at one location and afternoon hours at one or two other locations), so there are actually 40 separate collection events, 10 of which are in SWAC communities. The events held in SWAC communities are paid for by those towns. This approach is aimed at increasing convenience for residents of the District and SWAC in a cost-effective manner.

OTHER COLLECTION PROGRAMS

As noted in Appendix B, many municipalities and other districts offer collection of a range of Universal Wastes, and some that would be considered hazardous, but not the full range of HHW materials that are collected at permanent facilities.

For example, the ***Windham Solid Waste Management District's*** "Convenience Center" on Old Ferry Road in Brattleboro operates six days a week and accepts certain HHW items from residents of the 19 member towns. The District reported that this permanent facility operated 312 days in 2010. The Convenience Center accepts the following items on a daily basis: rechargeable and lead-acid batteries, uncontaminated used motor oil (which it uses to heat the District's MRF), oil filters, fluorescent light bulbs and ballasts, mercury–containing devices, medical needles, and oil-based paints. Consistent with the recent VT electronic waste law, the Convenience Center also accepts computers, monitors, printers, computer peripherals, and televisions, as well as cell phones, at no charge.

Other residential HHW items beyond those routinely accepted at the Convenience Center must be brought to District-sponsored one-day collection events. The District also operates "Seasonal Rural Rover" collections in multiple member communities on the third Saturday in May and an Annual Collection at the Convenience Center on the first Saturday in November. It should be noted that as of the beginning of FY 2012/2013 the District no longer staffs the one-day collection events or utilizes its own equipment. Rather, due partly to the higher participation rates the District is experiencing, it hires a licensed contractor with box trucks to collect the HHW at rover sites. HHW from CEGs is only accepted at the Convenience Center during the Annual HHW collection event. In addition, in 2010 the District sponsored 17 one-day collection events in 14 different communities (three communities had two events each).

As summarized in Table 12 below, most other solid waste planning entities implement between two and five HHW collection days per year. Thus, the current HHW management infrastructure and programs result in unequal access to HHW collection facilities and/or events. Approximately 134,000 Vermont households (or 46% of the total) have access to permanent year-round or seasonal facilities, while the remaining 54% of households rely on the periodic HHW collection events. These five districts and their permanent facilities account for 70% of the total HHW pounds collected (and about 89% of reported CEG pounds collected).

PRODUCT STEWARDSHIP AND EXTENDED PRODUCER RESPONSIBILITY

Consistent with the priorities identified in the ANR November 2012 Draft Vermont Materials Management Plan, Vermont continues to be a leader in implementing product stewardship strategies for waste prevention and toxics use reduction in consumer products. [23] Legislation related to collection and disposal of certain products was passed in 1991 for certain dry-cell batteries and in 2006 and 2008 for automotive switches containing mercury and mercury added thermostats respectively. Finally in May 2011, legislation addressing disposal of mercury containing lamps was passed. Specific collection programs were funded or initiated around these items; however some were limited in scope.

[23] The earlier 2008 report by the Vermont Waste Prevention Steering Committee, Life Beyond Garbage: Vermont Waste Prevention and Diversion Strategies (p. 4), also identified product stewardship as a priority strategy.

Two pieces of legislation targeted to implement more comprehensive collection programs were passed in 2010 and 2013. In 2010, "An Act Relating to the Recycling and Disposal of Electronic Waste" was passed and is discussed below. And most recently, An Act Relating to Establishing a Program for the Collection and Recycling of Paint passed in May 2013, which will likely follow model collection programs for paint established in other states.

Some retail locations are also registered to take back materials, usually as part of EPR legislation or agreements. Retailers in Vermont serve as collection depots for specific HHW or universal waste products that they sell. This includes certain batteries, mercury containing light bulbs, cell phones, electronics, and most recently, oil-based paints. Retailers operate these material-specific collection programs as a result of extended producer responsibility legislation or voluntary take back programs initiated by the manufacturer or, in some cases, national retailers.

ELECTRONICS

Recognizing the rapid growth of consumer electronics in the waste stream ("e-waste") and that such devices may contain lead, mercury and other hazardous substances, in 2010 the Vermont Legislature passed Act 79 (of the Acts of 2009), An act relating to the recycling and disposal of electronic waste.[24] Act 79 bans the disposal of a wide range of electronic devices and provides for a manufacturer-funded program to recycle computers, computer monitors and peripherals, printers, televisions, and cathode ray tube (CRT) containing devices. The law required manufacturers of covered electronic devices to register (with ANR) by July 1, 2010 and the landfill ban of such devices went into effect January 1, 2011.

To implement the first year of the E-Cycle program ANR contracted with the Northeast Resource Recovery Association (NRRA), a non-profit cooperative. NRRA provides project administration; education, outreach, and training; data collection, management, and reporting; and e-waste recycling services. NRRA worked closely with collectors, transporters and recyclers by providing training, inspections, and guidance to program operators. The contract with NRRA was extended for 15 months (to September 30, 2013) to carry through the second year of the program.

ANR developed the State Standard Plan for the Collection and Recycling of Electronic Waste, which identified standards for the program and a minimum number of collection locations in each county. Key features of the Plan aimed at maximizing diversion, including the establishment of collection locations within 15 miles of any point in the state, and that the recycling collection locations are required to collect covered e-waste at no charge to households, charities, school districts, and businesses with 10 employees or less.[25] According to VT ANR's 2013 E-Cycles Report to the Legislature, by the end of June 2012 there were 91 permanent locations throughout the state that offer free collection of the covered electronics (many of which, such as transfer stations and recycling centers, were already collecting e-waste prior to the program), and five additional locations have been established since that date. In addition 27 collection events were held throughout the state, supplementing the permanent collection locations. The collected e-waste is handled by Good Point Recycling in Middlebury, VT.

[24] See http://www.leg.state.vt.us/DOCS/2010/ACTS/ACT079.PDF.

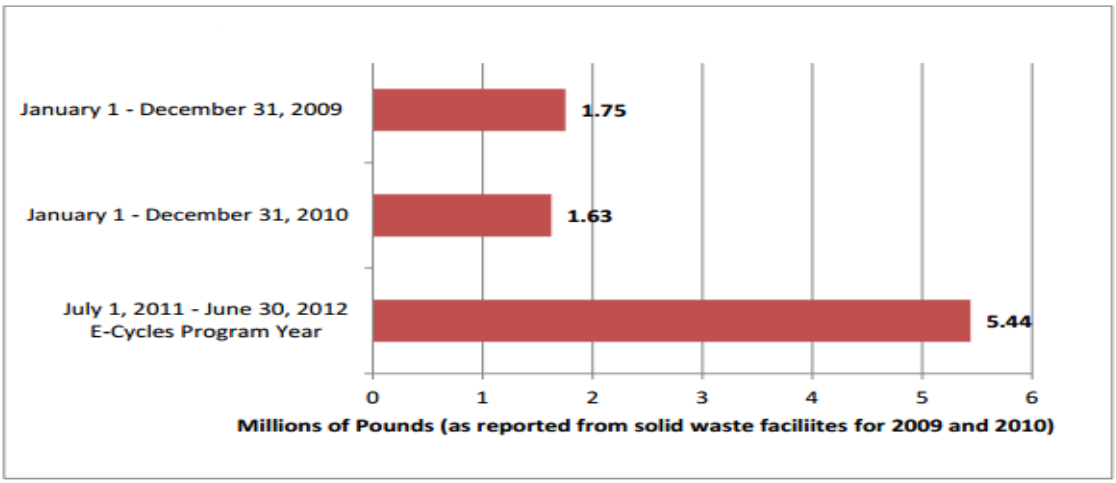
[25] In addition to the covered devices, collection locations in the program are required to take other banned devices, though they can charge customers for taking such devices since they are not paid for under the program. The other banned devices include: PDAs, MP3 players (and other personal e-devices), electronic game consoles, fax machines, wireless phones, telephones, answering machines, VCRs, DVD players, digital converter boxes, stereo equipment, and e-device power cords and chargers.

Act 79 set a first-year e-waste recycling goal of 5.5 pounds per person. In the first-year of the program (July 1, 2011 – June 30, 2012) a total of 4,819, 602 pounds of covered devices were collected, equivalent to 7.7 pounds per capita, far exceeding the goal. An additional 620,675 pounds of other banned electronic devices were also collected at these locations.

The funding mechanism in the law is from the manufacturers of covered devices based on their market share of sales into Vermont. By June 30, 2012, 83 manufacturers had registered with the program, though 27 were exempt from the law because they sold less than 20 units in the state or registered a device that is not currently covered in the program. Minor legislative changes went into effect in July 2012 to improve program effectiveness. Among other things, these changes reset the second program year (and subsequent years) to run from October 1, 2012 through September 30, 2013 and increased the collection goal to 6 pounds per capita.

Based on the amount of e-waste diverted, Vermont's E-Cycles program is considered a great success. As indicated in Table11, below, e-waste collection more than tripled from 2009 and 2010 (1.75 and 1.63 million pounds, respectively) to the first year of the E-Cycles program in 2011-2012 (over 5.4 million pounds, 4.8 million pounds of covered devices plus .6 million pounds of other devices).

TABLE 11. ELECTRONICS COLLECTED IN VERMONT2009/2010/2011[26]



The implementation contract with NRRA specifies a payment method for each pound of materials collected, along with set amounts for performance milestones. According to the 2013 E-Cycles Report, "For the first program year the cost was approximately 29 cents per pound for the collection, transport, and recycling of e-waste, plus a per-pound equivalence of approximately 3.5 cents for the contractor's performance-based milestone payments."[27] The total program cost of about 32 cents per pound was less than the 35 cents per pound that ANR had budgeted. In addition, the DEC Program Administration Fees were about $175,000.

ANR's contract with NRRA sets overall program costs for the manufacturer. NRRA contracts with the recycler (Good Point Recycling) for its services, which in turn reimburses locations for the e-waste collection.

[26] From 2013 E-Cycles Report to the Vermont Legislature (p. 8), VT ANR, 2013.
[27] 2013 E-Cycles Report to the Vermont Legislature (p. 15), VT ANR, 2013.

MATERIAL COLLECTION, PARTICIPATION RATES AND COSTS

VT ANR produces an annual Diversion and Disposal report that summarizes the tonnage of solid waste generation, diversion, and disposal, as well as the state's disposal capacity, tonnage and management of biosolids, and collection and management of HHW/CEG waste. Table 12 presents a Summary of 2010 Vermont HHW/CEG Hazardous Waste Program Activity (the last year for which ANR has compiled this data). In addition to HHW and CEG waste, the summary table reports on collection of mercury-containing products, fluorescent lamps, and electronics (prior to the implementation of the E-cycles program). It also presents data on program participation rates and costs.

Table 12 indicates that in 2010 Vermont solid waste entities collected over 871,000 pounds of HHW and more than 162,000 pounds of CEG waste at a cost of about $1.4 million. Though the absolute tonnage of HHW/CEG waste is a very small fraction of the overall Vermont stream (about 1,300 tons out of a total MSW generation of 413,517 tons, or about 0.3%), releases of these materials through improper management can result in significant environmental contamination.

ANR provides about $410,000 in grants to districts and solid waste entities per year to offset some of the HHW costs.[28] In addition, the average cost per program participant in 2010 was about $67, though this varied greatly by district and the reported cost figures represent only some of the cost associated with the overall HHW/CEG and Universal Waste management programs.[29] CSWD (which has about 21% of the households in the state) accounted for over 50% of the total HHW collected and almost 79% of the CEG waste collected in 2010. CSWD achieved this at a cost of about $517,000 or almost 37% of the total state expenditures. With a permanent HHW collection facility (the Environmental Depot) and a well-established program, CSWD attracted about 10,000 participants in its HHW/CEG collection program in 2010 for a participation rate of over 16%, the highest rate in the state.

The overall participation rate in Vermont in 2010 was about 7.5% meaning that the vast majority of residents and CEGs are not utilizing either the permanent HHW collection facilities or the one-day events.[30] This represents a significant challenge, which calls for new efforts to increase awareness of the available services, and public education on the types of materials considered HHW and their need for special disposal.

[28] Bryn Oakleaf, VT ANR, July 10, 2013.

[29] The HHW-related cost figures in the 2010 Diversion and Disposal Report were compiled by ANR from data submitted by Districts, Alliances, and municipalities as part of the reporting requirements to receive state Solid Waste Management Assistance Funds. The reporting form, "Vermont Local Household Hazardous & CEG Waste Collection Program Activity 2010," is apparently supposed to reflect costs of HHW only, not CEGs or Universal waste, and direct labor costs, supplies, and contractor costs, not any of the allocated salaries or indirect expenses, which were not grant eligible. Based on our follow-up communications with the Districts, it is clear that Districts differed in which costs they included in their grant reports.

[30] Some small businesses may be managing their hazardous materials through private contractors, though no data on such practices are available.

TABLE 12. HHW ACTIVITY SUMMARY (2010)

SUMMARY OF 2010 VERMONT HHW/CEG HAZARDOUS WASTE PROGRAM ACTIVITY

	TOWN/DISTRICT	COLLECTION EVENTS	HH UNITS	PARTICI-PANTS	BUSINESSES	% TOTAL PROGRAM PARTIC	PROGRAM COST	$/PARTIC	HHW POUNDS	CEG POUNDS	POUNDS PER HHW PARTIC	POUNDS PER CEG PARTIC	POUNDS MERCURY-ADDED PRODUCTS	POUNDS ELEMENTAL MERCURY	FLUORESCENT LAMPS (FT)	POUNDS OF ELECTRONICS
1	Addison County SWMD	208	12,706	1,156	89	9.80	$78,515	$68	45,861	10,439	40	117	55	5	35,285	211,346
2	Bennington CRC[1]	2	6,575	180	2	2.77	$27,428	$152	9,224	48	51	24	813	0	10,578	nr
3	Central Vermont SWMD[2]	5	27,751	620	19	2.30	$114,437	$185	60,743	1,808	98	95	120	0	4,266	30,887
4	Chittenden SWMD	272	62,358	9,384	659	16.11	$516,613	$55	440,363	127,549	47	194	659	0	287	570,000
5	Greater UVSWMD(GUV)[3]	2	14,955	366	8	2.50	$37,022	$101	2,430	250	7	31	20	0	21,483	61,000
6	Lamoille RSWMD	3	12,780	389	20	3.20	$23,467	$60	20,680	6,560	53	328	38	0	26,376	125,140
7	Londonderry Group	2	1,889	96	1	5.13	$9,675	$101	7,472	400	78	400	0	0	0	0
8	Mad River RMA	2	8,111	330	24	4.36	$27,000	$82	7,950	975	24	41	<1	0	3,416	0
9	NE Kingdom SWMD	106	23,088	2,482	4	10.77	$53,668	$22	48,800	400	20	100	1	0	36,746	73,374
10	Northwest SWMD	13	13,758	1,090	5	7.96	$61,832	$57	22,165	1,280	20	256	0	0	8,478	42,912
11	Rutland County SWMD	271	22,500	795	77	3.88	$199,438	$251	48,944	4,800	62	62	3,491	9	56,640	182,777
12	Solid Waste Alliance Committee	8	6,546	202	11	3.25	$21,040	$104	8,800	1,260	44	115	0	0	2,134	12,700
13	S. Wind/Windham SWMD	5	20,104	448	9	2.27	$38,639	$86	36,830	1,262	82	140	285	0	28,000	122,500
14	Tri-town Agreement	2	3,074	363	3	11.91	$27,088	$75	4,848	110	13	37	nr	0	1,500	15,874
15	White River Alliance	2	4,769	279	0	5.85	$12,445	$45	8,000	0	29	0	0	0	52	nr
16	Windham SWMD	316	19,468	839	7	4.35	$23,991	$29	29,040	2,048	35	293	0	0	3,794	141,900
17	Waste USA (NEK)[4]	2	5,760	289	7	5.14	$33,624	$116	14,365	1,000	50	143	0	0	5,522	14,333
18	Bennington/Woodford	2	6,908	327	8	4.85	$26,224	$80	14,285	2,000	44	250	nr	15	5,932	nr
19	Bristol	2	1,546	240	0	15.52	$7,338	$31	2,475	0	10	0	nr	nr	nr	6,207
21	Canaan	2	181	18	0	9.94	$1,104	$61	400	0	22	0	0	0	287	0
22	Fairfax	2	1,249	188	0	15.05	$8,631	$46	14,480	0	77	0	9	0	0	6,865
23	Franklin/Highgate	2	2,111	94	0	4.45	$3,310	$35	2,253	0	24	0	0	0	836	nr
24	Salisbury	2	628	43	0	6.85	$8,253	$192	2,310	0	54	0	0	0	0	1,603
25	St. Albans Town	2	2,257	234	0	10.37	$11,251	$48	2,800	0	12	0	0	0	0	463
26	St. Johnsbury	2	3,482	188	27	6.17	$13,514	$72	3,325	100	18	4	400	9	7,350	5,949
27	Shaftsbury[5]	2	3,524	85	0	2.41	$11,091	$130	7,608	0	90	0	0	2	8,000	0
28	Swanton	2	2,689	135	0	5.02	$6,585	$49	4,920	0	36	0	30	0	1,180	0
	TOTALS	**1241**	**290,767**	**20,860**	**980**	**7.51**	**$1,403,000**	$67	**871,371**	**162,289**	**42**	166	**5,921**	**40**	**268,142**	**1,625,830**

1. Includes the towns of Arlington, Dorset, Manchester, Rupert, Sandgate, and Sunderland.
2. Includes Towns of Corinth, Fairlee and Newbury wastes.
3. Includes the Town of Hartford.
4. Includes the towns of Barton, Burke, Coventry, Glover, Lowell, and Newport City.
5. Includes the towns of Pownal and Stamford.

Source: Adapted from VT ANR Diversion and Disposal Report 2010

To provide a sense of the recent history of the HHW/CEG program, the Project Team reviewed previous HHW/CEG Hazardous Waste Program Activity reports compiled by ANR.[31] Table 13, below, summarizes program costs, quantities collected, and participation rates from 2006 through 2010. Over this period program costs have increased modestly (2.6% per year on average), the quantity of HHW collected has not shown a consistent pattern, and the overall state-wide participation rate has remained under 10%.

TABLE 13. POUNDS HHW COLLECTED, PRORGRAM COSTS & PARTICIPATION RATES, 2006-2010

HHW Programs	2006	2007	2008	2009	2010
Program Costs	$1,267,000	$1,300,968	$1,379,135	$1,378,866	$1,403,000
Lbs. Collected	855,916	738,798	728,534	966,287	871,371
% Participation	6.3%	7.1%	8.9%	7.8%	7.5%

To get a more comprehensive and up-to-date understanding of how overall District costs are allocated across programs and functions, including overall HHW program costs, the Project Team conducted a survey of the Districts. Reported HHW/Universal Waste management costs last year[32] and the fraction of overall District costs they represent from those Districts that responded is presented in Table 14.[33]

TABLE 14. COST OF DISTRICT HHW/UNIVERSAL WASTE MANAGEMENT (1)

Solid Waste Planning Entity	HHW and Universal Waste ($)	*Percent of Total Budget (%)*
Addison County SWM District	$206,100	7%
Bennington RPC	$10,000	20%
Central Vermont SWMD	$96,700	11%
Chittenden SWD	$677,700	8%
Greater Upper Valley SWMD	$33,200	5%
Lamoille Regional SWMD	$30,600	3%
Londonderry Group	$18,000	5%
Mad River RMA	$28,500	30%
Northeast Kingdom WMD	$79,000	13%
Northwest Vermont SWMD	$106,800	13%
Rutland County SWD	$146,500	10%
Solid Waste Alliance Com.	$12,000	29%
So. Windsor/Windham SWMD	$62,000	36%
Windham SWMD	$65,000	4%
Total:	**$1,572,100**	**8%**

(1) Results of survey conducted April – June 2013 and includes either 2012 or 2013 annual budget data.

[31] See http://www.anr.state.vt.us/dec/wastediv/HHW/publications.htm.
[32] Costs were reported by Districts for FY 2012, CY 2012, FY 2013 budgeted.
[33] Cost allocation data was received from 14 of the 16 districts, but not from Tri-Town Alliance or White River Alliance.

Overall the 14 responding solid waste entities expended over $1.5 million on HHW/Universal Waste management out of a combined total budget of $19.3 million, which represents about 8% of District costs. Reflecting the unique character of each of the Districts and the services they provide, the fraction of Districts' budgets devoted to HHW/Universal waste varies greatly from 5% or less in Greater Upper Valley SWMD, Lamoille Regional SWMD, and Windham SWMD, to almost 30% or more in Mad River RMA, Solid Waste Alliance Communities, and Southern Windsor/Windham County SWMD.

The Project Team also requested that Districts provide data concerning the fraction of HHW/Universal Waste program costs associated with labor (employee costs plus benefits) and number of full-time equivalent employees working on the HHW/Universal Waste programs. Unfortunately, most Districts do not track labor costs by program area. The Districts that provided estimated labor costs and/or FTEs ranged from less than 10% of overall HHW/Universal Waste program costs (Central Vermont SWMD) to about 22% of total program costs (Rutland County SWMD).[34] This is another reflection of the disparate nature of the Districts, the organization of their respective programs, and the emphasis placed on HHW/Universal Waste.

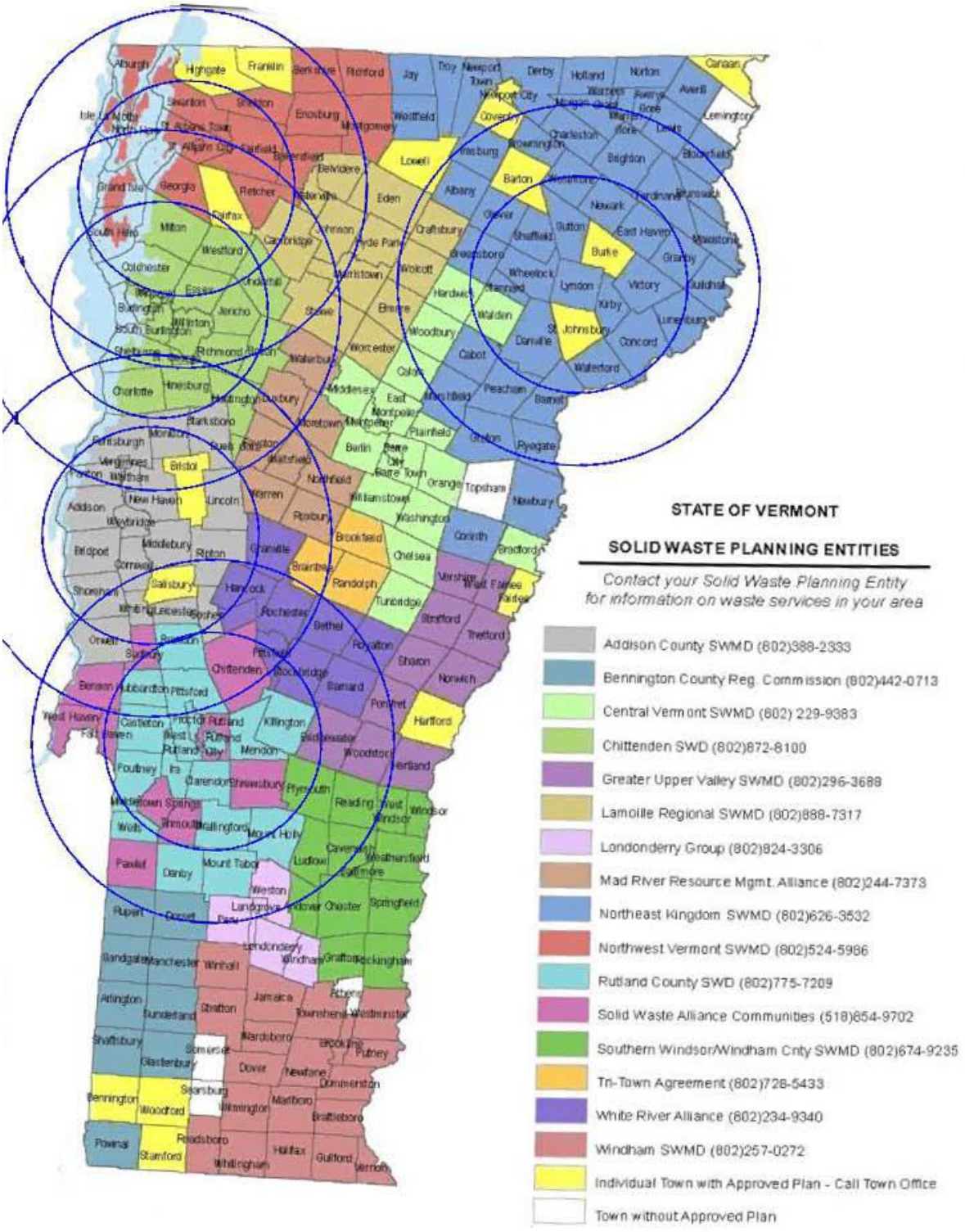
While households in communities served by the permanent facilities certainly have a more convenient HHW management option and tend to have higher participation rates than those in other communities (except for Rutland County SWMD), the differences among the facilities and the populations served, as well how each District accounts for and reports program data and costs, do not allow for broad conclusions about the relative cost effectiveness of permanent facilities versus reliance on one-day collection events.[35]

If increased convenience and participation are goals regardless of cost, additional permanent facilities would be needed in regions of the state that are underserved, including the entire southern part of the state (including Bennington County Regional Commission, Windham SWMD) as well as eastern VT (from Central VT SWMD to Greater Upper Valley to Southern Windsor/Windham County SWMD). This is depicted in Figure 6 below, which shows the five existing permanent HHW facilities with two circles around each, one with a 15-mile radius and one with a 25-mile radius. The optimal number of additional permanent facilities depends on the criteria ultimately developed by ANR in its effort to balance the desire for convenient universal access against the cost of such facilities.

[34] The labor associated with the CSWD HHW/Universal Waste Program budget represents as much as 40 percent of the annual costs.

[35] As with other solid waste planning entity reporting, future HHW-related reports would benefit from expanded and more explicit reporting requirements from ANR (e.g., concerning which materials to include, units for each, cost categories, etc.) as well as additional ANR staff to process the data on a timely basis, follow-up with reporting entities to clarify discrepancies, and provide publically available statewide reports that synthesize the data. To improve upon data reporting and tracking, ANR has adopted ReTrac and is in the initial stages of using this program.

FIGURE 6 – PERMANENT HHW FACILITIES WITH 15 MILE AND 25 MILE RADII



BIOSOLIDS/SEPTAGE

One of the largest changes associated with Act 148 is the eventual banning of yard waste and food residuals from disposal. Based on the 2012 Waste Composition Study, roughly 12,700 tons of yard wastes and 60,000 tons of residential and ICI food residuals was disposed in Vermont in 2011. To place these tonnages in perspective, biosolids generated from the treatment of Vermont waste water and septage represented another 56,000 wet tons in 2011.[36] Twenty-nine percent of these biosolids were treated and applied to soils in Vermont, but the remaining 71 percent were either landfilled (in Vermont or out-of-state), or incinerated[37].

Four facilities in Vermont -- Lyndon, Stowe, Brattleboro and South Burlington -- produce a Class A product which can be land applied just as food residuals compost is land applied. In addition, both Hartford and Essex produce a Class B material for land application on non-food crops. Essex Junction also utilizes Anaerobic Digestion (AD) with energy production which could potentially become a location for the addition of food residuals, similar to the AD facilities at dairy farms.

In total, there are 23 Land Application certifications in place in Vermont for either septage or biosolids, some which may include multiple sites. There are 10 certified compost and other treatment sites for public distribution, and 78 Sludge Management Treatment Plants where treatment or storage occurs at wastewater treatment facilities and biosolids are sent to another facility for treatment.

In total, an estimated 4,452 dry tons of septage were managed in 2011, as shown below in Table15. Of these, roughly 85 percent of the total managed was done so in-state and nearly 40 percent was managed for beneficial use.

TABLE 15. 2011 ACTUAL QUANTITIES OF SEPTAGE MANAGED IN AND OUT OF STATE (1) (AS REPORTED TO ANR BY ALL SEPTAGE HAULERS OPERATING IN VERMONT)

Management Option	In-State *(dry tons)*	Out-of-State *(dry tons)*	Total *(dry tons)*	Percent of Total *(%)*	Percent Managed *(%)*
Beneficial Uses:					
Land Application (2)	1,205	20	1,225	27.5%	
EQ Biosolids (3)	378	111	489	11.0%	
Subtotal:	***1,583***	***131***	***1,714***		***38.5%***
Non-Beneficial Uses:					
Landfill4	0	0	0	0.0%	
Incineration	0	353	353	7.9%	
WWTF	2,184	200	2,385	53.5%	
Subtotal:	***2,184***	***553***	***2,738***		***61.5%***
Total:	**3,767**	**684**	**4,452**	**100%**	**100%**
Percent of Total, In & Out of State	**84.6%**	**15.4%**			

[36] *Biosolids Management in VT,* Presentation at Organics Management in Vermont – Workshop and Roundtable, April 16, 2013, Presented by Ned Beecher, Executive Director, North East Biosolids & Residuals Association.
[37] Ibid

TABLE 15 NOTES:

(1) Includes all septage generated in Vermont regardless of where disposed, and all septage disposed in Vermont regardless of where generated. It is estimated that <1% of the total volume is generated out-of-state and disposed in Vermont.
(2) Includes septage that is directly land applied or that is disposed at a WWTF that manages biosolids via land application.
(3) Includes septage that is directly treated in an EQ process or disposed at a WWTF that produces EQ biosolids.
(4) Includes solids from dewatered septage that is disposed at a landfill.
(5) Table Source and all data: VT ANR

CONSTRUCTION AND DEMOLITION WASTE

According to ANR's Diversion and Disposal Report, 192,750 tons of Construction and Demolition (C&D) waste was generated in Vermont in 2011.[38] This total is based on an estimate of per capita generation of 1.7 pounds per day.[39] [40]

C&D is generated both by the residential sector and the ICI sector. Unfortunately, the quality of data for C&D, in terms of generation as well as management/disposition, is relatively poor in Vermont. For example, of the 192,750 tons of C&D estimated to have been generated in 2011 (Table 16), the Diversion and Disposal report includes almost 89,000 tons (46% of the total) as "C&D Unaccounted – Diverted or Disposed (Estimated)" to reconcile the tonnage of C&D handled and reported by VT facilities and the estimated overall C&D generation.

TABLE 16. VERMONT CONSTRUCTION & DEMOLITION WASTE (C&D) GENERATION AND MANAGEMENT (2011)[41]

Construction & Demolition Waste (C&D) & Wood	Tons
C&D/Wood Used in Landfills - VT Waste	2,776
C&D Disposed - in VT	81,059
C&D Disposed - in Other States	20,022
C&D Unaccounted - Diverted or Disposed (Estimated)	*88,893*
Total Generation:	**192,750**

[38] Vermont Annual Solid Waste Diversion and Disposal Report, VT ANR, "VT Solid Waste Generation - Summary 2011" table.
[39] ANR's 1.7 pounds per person per day figure from the Diversion and Disposal Report is cited as "2007 Massachusetts Construction and Demolition Debris Industry Study," DSM Environmental Services, May 2008. This figure is for building debris and excludes infrastructure debris (primarily from the construction and demolition of roads and bridges) or land clearing debris (trees, stumps, and rocks). If these types of C&D were included the per capita and statewide generation totals would be significantly higher.
[40] Per capita C&D waste generation in Massachusetts in CY 2007 may not be a good measure to estimate per capita C&D waste generation in Vermont in 2011 because of the differences in the base year, economy, and housing/building starts, renovations and demolitions. However in the absence of any other data on C&D generation in Vermont for this study, the Project Team utilized ANR's estimates.
[41] Source: Diversion and Disposal Report, "VT Solid Waste Generation - Summary 2011" table. Note that CVSWD reports that 2,715 tons of C&D/Wood was sent to Coventry for use in the landfill so ANR's Diversion Report estimate appears low.

Note that Tropical Storm Irene likely had some impact on C&D waste generation in 2011. While facilities clearly had increased quantities of C&D waste and related storm debris to handle as a result of the storm, there was no separate reporting of this material.

Due to the data challenges described above, there are no comprehensive data compiled by ANR on the tonnage of C&D recycled statewide. One source of such information is the quarterly reports filed with ANR by solid waste management facilities throughout the state. For 2011, 15 different facilities reported recycling a total of 27,281 tons of C&D waste. The vast majority of this (23,706 tons or 87%) was asphalt/concrete or unspecified road, bridge or highway debris that was reused locally.[42] The remaining 3,575 tons of recycled C&D was from seven facilities; almost all was classified as "Con/Demo Debris Recycling" with 22 tons of recycled dry wall (sheet rock). Table 17 summarizes the facilities that reported recycled C&D other than asphalt/concrete or road, bridge or highway debris and the amounts recycled in 2011. Two private facilities, the Hubbard Brothers Transfer Station in the Town of Rutland and the Casella Transfer Station in Williston handled over 85% of the reported non-ABC C&D waste.

TABLE 17. 2011 RECYCLED C&D (INCLUDING ABC) FROM FACILITY QUARTERLY REPORTS (1)

Facility	Material	Tonnage
Various	Asphalt/Concrete & Road Debris	23,706
Casella Transfer Station, Williston	Con/Demo Debris Recycling	2,331
Northwest SWD Recycling Station, Georgia	Con/Demo Debris Recycling	731
Castleton Transfer Station, Castleton	Con/Demo Debris Recycling	350
Hubbard Brothers Transfer Station, Rutland Town	Con/Demo Debris Recycling	130
Bethel/Royalton Transfer Station, Royalton	Dry Wall (Sheet Rock)	22
Weathersfield Transfer Station, Weathersfield	Con/Demo Debris Recycling	9
Rutland County SWD Transfer Station, Rutland City	Con/Demo Debris Recycling	2
Total:		**27,281**

(1) In addition, C&D recoverable materials are routinely pulled from loads at transfer stations and may not be included in these totals.

Based on data from the some of the solid waste districts it is clear that the quarterly facility reports are not comprehensive and present only part of the C&D management picture (see discussion of Chittenden County, below).

The recently published Vermont Waste Composition Study reports on C&D materials found in the MSW waste stream, and characterizes the C&D waste stream delivered to the four transfer stations included in the study. C&D waste accounted for an estimated 25,217 tons or about 10% of residential municipal solid waste (MSW) disposed in 2011 and a similar amount, an estimated 25,625 tons (or 15%) of ICI disposed MSW in 2011.[43] The Composition Study identifies two broad categories of C&D in the MSW waste stream: C&D materials (except clean wood), and

[42] The facility quarterly reports include C&D from roads and bridges, creating a mismatch with the statewide C&D generation estimate, which as described above included only building-related C&D and excluded infrastructure C&D.

[43] Tonnages are based on ANR's reported statewide MSW disposal figure for 2011, the most recent year data was available and reflect C&D disposed with MSW. Source: State of Vermont Waste Composition Study, Final Report, prepared by DSM Environmental and MidAtlantic Solid Waste Consultants for VT DEC, May 2013.

clean wood. Clean wood accounts for an estimated 4,354 tons of the residential waste disposed, and an estimated 11,289 tons of the ICI disposed waste.

For the C&D waste stream, the Vermont Waste Composition Study provides a detailed breakdown comprising 8 major categories and 16 subcategories for the C&D category.

Table 18 below summarizes the detailed composition of disposed C&D by weight. As indicated, there are small amounts of other wastes including paper, plastic, glass, organics, metal, special wastes, and mixed MSW found in C&D, which combined account for almost 15% of the disposed C&D waste stream. Of the remaining 85% that is C&D, the most common materials are: various types of wood (37.2% including painted/stained wood at 16.7%, and clean dimensional lumber at 9.2%), roofing materials (18.3%), and remainder/composite and other C&D (17.6%). These would likely be the priority materials to focus on in future programs to increase the diversion of C&D waste.

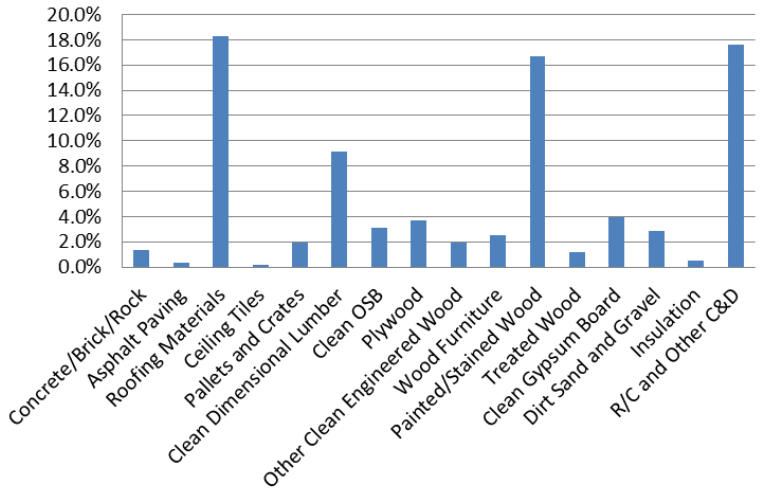
TABLE 18. VERMONT C&D WASTE COMPOSITION (PERCENT, BY WEIGHT)[44]

Group	Category	Average % by Weight	
Paper			**1.70%**
Plastic			**1.10%**
Glass			**0.70%**
Organics			**1.40%**
C&D			**85.30%**
	Concrete/Brick/Rock	1.30%	
	Asphalt Paving	0.40%	
	Roofing Materials	18.30%	
	Ceiling Tiles	0.20%	
	Pallets and Crates	1.90%	
	Clean Dimensional Lumber	9.20%	
	Clean Oriented Strand Board	3.10%	
	Plywood	3.70%	
	Other Clean Engineered Wood	2.00%	
	Woof Furniture	2.50%	
	Painted/Stained Wood	16.70%	
	Treated Wood	1.20%	
	Clean Gypsum Board	3.90%	
	Dirt Sand and Gravel	2.90%	
	Insulation	0.50%	
	R/C and Other C&D	17.60%	
Metal			**4.70%**
Special			**2.50%**
Mixed MSW			**2.70%**
Total			**100.00%**

[44] From State of Vermont Waste Composition Study, Final Report, Table 10, p. 22.

This composition data for the C&D fraction is presented graphically in Figure **7**.

FIGURE 7: COMPOSITION OF C&D DEBRIS FRACTION



Based on the detailed composition described above applied to the estimated 192,750 tons of C&D generated in Vermont, Table 19 presents estimated tonnages of C&D materials generated in Vermont.

TABLE 19. VERMONT C&D WASTE COMPOSITION (MATERIAL TONNAGES)

Group	Category	Tonnage
Paper		**3,277**
Plastic		**2,120**
Glass		**1,349**
Organics		**3,277**
C&D		**164,416**
	Concrete/Brick/Rock	*2,506*
	Asphalt Paving	*771*
	Roofing Materials	*35,273*
	Ceiling Tiles	*386*
	Pallets and Crates	*3,662*
	Clean Dimensional Lumber	*17,733*
	Clean Oriented Strand Board	*5,975*
	Plywood	*7,132*
	Other Clean Engineered Wood	*3,855*
	Wood Furniture	*4,819*
	Painted/Stained Wood	*32,189*
	Treated Wood	*2,313*
	Clean Gypsum Board	*7,517*
	Dirt Sand and Gravel	*5,590*
	Insulation	*964*
	R/C and Other C&D	*33,924*
Metal		**9,059**
Special		**4,819**
MSW		**5,204**
Total		**192,750**

The Draft Vermont Materials Management Plan (MMP) identifies C&D as one of five major categories of materials to refocus the state's waste reduction strategies.[45] The Draft Plan acknowledges that markets for reuse and recycling of C&D are not as well developed in Vermont as markets for "traditional" recyclable materials.[46] It attributes this to several factors including: C&D materials are not uniformly generated by all citizens, they are often mixed with non-recyclable wastes, and the materials are often bulky. As a result, there are no dedicated C&D processing facilities in Vermont, though there is a limited amount of salvage of reusable materials,[47] and metals and, to a lesser degree, cardboard are generally removed from C&D loads and recycled.

In order to facilitate increased diversion, ANR also indicates that it will continue to support the development of new markets for C&D materials (e.g., drywall, asphalt shingles, dimensional lumber). To improve data concerning the type and amount of C&D waste materials diverted and disposed, ANR is initiating an online reporting system called ReTRAC Connect in which solid waste management entities will report material throughput.

DISTRICT C&D MANAGEMENT PRACTICES AND COSTS

Vermont's districts and alliances have a variety of programs and facilities that manage C&D waste, though as described above, except for a few materials – metals, clean wood, asphalt/brick/concrete (ABC) – C&D recycling activity is not robust in the State and markets for such materials are underdeveloped. While several districts grind certain C&D materials for landfill applications and this reduces disposal costs, this is not considered the highest beneficial use.

Some of the districts and alliances track C&D-related activities and costs separately from MSW, while others do not. It is therefore difficult to present a comprehensive picture of the cost of statewide C&D management. Several of the more active district C&D management programs are described below. Information on C&D waste collection locations as reported by districts is shown in Appendix B. Note that this report does not provide a complete description of all C&D recycling and reuse activities carried out by the districts. Instead, the Project Team attempted to survey those districts which appeared to be more active in participating in or tracking C&D recycling activities.

The private sector also plays a significant role in C&D management, particularly in terms of transport and disposal, as well as scrap metal recycling. There are also several surplus and salvage entities, both private companies and non-profit organizations, that recycle and reuse a range of materials such as doors, windows, bathroom and kitchen fixtures, kitchen cabinets, flooring, hardware, plumbing, lighting and electrical, appliances, and others. While surplus and salvage operations divert a relative small fraction of the C&D waste stream, reuse represents

[45] The Draft Vermont Materials Management Plan, VT ANR, 2012, consisted of two main sections: History and Planning Update, which included background information regarding solid waste, and a separate Material Specific Management. The Materials Management Plan that is ultimately adopted through a formal rule making process will consist of a general materials management section and material specific chapters.

[46] Draft Vermont Materials Management Plan, VT ANR, November 8, 2012, p. 20. This section describes proposed material-specific goals, standards, and deliverables.

[47] For example, facilities that salvage used C&D materials include the ReSource Building Material Stores in Burlington, Barre, and Morrisville, the Habitat for Humanity Restore in Burlington and ReNew Salvage in Brattleboro.

the highest use for these materials as they do not need to be managed as waste and generally little processing is required.

CHITTENDEN SOLID WASTE DISTRICT

The CSWD estimates that C&D waste makes up 25% of the County's waste stream. While this is slightly more than the statewide figure, it is consistent with the general understanding that urban and more densely populated areas tend to generate higher amounts of C&D waste.

CSWD encourages residents and businesses within the District to recycle certain C&D materials including clean gypsum drywall (scraps and sheets); clean wood (lumber, tree limbs and brush); reusable dimensional lumber; asphalt pavement, concrete, bricks, and tile; scrap metal and appliances; surplus and salvage (including windows, doors, plumbing, lighting, and hardware). As summarized in Table 20, below, CSWD accepts some of these materials at District facilities, while other materials are managed by private facilities.

TABLE 20. C&D WASTE RECYCLING FACILITIES (INCLUDING SCRAP METAL AND APPLIANCES) OPERATING IN CHITTENDEN COUNTY (1)

Material	Facilities
Clean Gypsum Drywall	CSWD Williston Drop-Off Center
Clean Wood	CSWD Full-Service Drop-Off Centers (not Hinesburg or Burlington)
	CSWD Wood & Yard Waste Depot, Burlington
	McNeil electric generating plant, Burlington
Reusable Dimensional Lumber	ReBUILD Building Materials Center, Burlington
	Habitat for Humanity ReStore, Williston
Asphalt Pavement, Concrete,	A. Marcelino & Co., So. Burlington
Bricks & Tile	Pike Industries, Williston
	Ranger Asphalt & Concrete Processing, Colchester
Scrap Metal, Appliances	CSWD Drop-Off Centers
	Burnett Scrap Metal Recycling, Hinesburg
	Rathes Salvage, Colchester
	Queen City Steel, Burlington
Surplus & Salvage	ReBUILD Materials Center, Burlington
	Habitat for Humanity ReStore, Williston
	Mason Brothers Salvage, Essex Junction

(1) A C&D facility is being built in Colchester that will be operational in January 2014.

CSWD charges a fee for accepting clean gypsum drywall ($18/cu yd. up to 2 yards, $70 per ton for larger loads), while clean wood and scrap metal are accepted free of charge. The private facilities accept the reusable dimensional lumber, scrap metal/appliances, surplus & salvage, and clean asphalt at no cost, while there are varying fees for concrete, bricks, and tile.

In terms of disposal, small amounts of non-recyclable C&D waste (less than one cubic yard, which is less than a full-size pickup bed) can be brought to one of the CSWD drop-off centers for disposal. The District has seven drop-off centers (Burlington, Essex, Hinesburg, Milton, Richmond, South Burlington, and Williston), and all except the Hinesburg location accept C&D waste. Fees for C&D waste at the drop-off centers are based on volume, except at the Burlington center, where it is based on weight. As of July 2013 the fees range from $4 for an 18-gallon

container to $11.50 for a 45-gallon container and $60 for a cubic yard. At the Burlington center the fee is $0.15 per pound. Most drop-off centers also accept various bulky items associated with construction and demolition projects such as bathtubs, boilers, and air conditioners for a fee.

For C&D loads more than a cubic yard that do not contain recyclables, clean wood or scrap metal, two private transfer stations that accept such waste are located within District boundaries: All Cycle Transfer Station in Williston, which currently charges $123.11 per ton, and the Burlington Transfer Station, also located in Williston next to the CSWD Williston Drop-Off Center, which charges $115 per ton.

CSWD began accepting drywall for recycling in mid-July 2012. Through December of 2012, the District shipped 39 tons to USA Gypsum in Pennsylvania where it is made into a soil amendment. Participation has increased tremendously. In 2013 through June, CSWD shipped 243 tons.

Most of the District's recycled clean wood has gone to McNeil to generate electricity (4,765 tons in 2011) and Lamelle Lumber as fuel, and small quantities have gone to the compost facility. Some goes for reuse by CSWD (e.g., pallets), but this is not tracked.

In terms of asphalt recycling, CSWD reports that A. Marcelino & Co. in So. Burlington handled 8,654 tons in 2011 from CSWD, and two other local, private facilities handled another approximately 50,400 tons.

As part of its annual Waste Diversion Report the Chittenden SWD provides data on C&D recycling and disposal. Table 21 below presents these data for the last five years. These quantities are far larger than those reported in the facility quarterly reports. Changes is quantities of asphalt and concrete recycling reported have significant impacts on C&D waste generation, as shown in Table21. Excluding ABC waste would lead to much lower generation tonnages reported.

In addition, the CSWD drop-off centers handled 1,032 tons of scrap metal in 2011.

TABLE 21. CHITTENDEN SOLID WASTE DISTRICT C&D MATERIALS DIVERTED & DISPOSED (ANNUAL TONS)

	2008	2009	2010	2011	2012
C&D Reported Recycled	48,541	35,134	62,038	60,875	47,012
Total C&D Landfilled *	34,521	28,786	33,436	38,301	33,330
Total C&D Generation	83,062	63,920	95,474	99,176	80,342
Estimated C&D Diversion Rate	***58%***	***55%***	***65%***	***61%***	***59%***

**Excludes alternative daily landfill cover.*

RUTLAND COUNTY SWD

The Rutland County SWD's C&D program recycles clean wood, clean sheetrock and metal. However, the sheetrock program is currently on hold as the recycling firm in NH where the District was sending the material is not accepting it at this time. As a result, sheetrock is now being disposed as trash. In addition, limited amounts of concrete and brick is accepted and sent to the Markowski Brothers facility in Brandon for recycling. For certain other materials, the District also has a C&D grind program. The ground C&D material and sent out for landfill daily cover at no cost. C&D that cannot be ground (carpets, etc.) is disposed as trash.

Of the 14 District or municipal transfer stations, eight accept C&D materials including the District transfer station on Gleason Road in Rutland, which residents of any member town may use. Some transfer stations accept only clean wood and brush and burn it on site. The clean wood such as pallets and unused 2 x 4's collected at the Rutland transfer station is ground and sent to the McNeil electric generating plant in Burlington for fuel.

As summarized in Table 22 below, the District has a two-tiered fee schedule for various C&D materials at its transfer stations, one for those with a permit, and one for those without a permit.

TABLE 22. RUTLAND COUNTY SOLID WASTE DISTRICT'S FEE SCHEDULE FOR C&D AND APPLIANCES

Description	With Permit	Without Permit	Commercial & District Towns*
Construction & Demolition (includes couches & chairs)	$135 / ton	$155 / ton	$150 / ton
C&D (painted/treated wood)	$95 / ton	$110 / ton	--
Clean Wood	$45 / ton	$55 / ton	--
Refrigerators/Air Conditioners/ Microwaves	$12.50/each	$15/each	--
White Goods	Free	Free	--

The Rutland County District's C&D program is essentially self-sufficient from a cost standpoint. According to the District's December 2012 Budget Report, the C&D program cost about $40,000 in 2011 with revenues of about $36,000; for 2012 C&D program costs were about $34,000 with revenues of $40,000. Of the 2012 program costs, about $15,000 was for labor (including benefits), $12,000 for grinding, and $7,000 for hauling.

WINDHAM SWMD

Windham SWMD manages C&D waste. The District estimates that 388 tons of C&D waste were generated in FY 2011 and about 344 tons generated in FY 2012. Certain C&D waste – wood and wood products along with sheet rock – are accepted at the District's transfer station in Brattleboro and shipped to a facility in Hartford, VT. Windham SWMD does not grind any C&D waste. The District reports it spent about $21,600 ($56 per ton) managing C&D waste in FY 2011 and $18,600 ($54 per ton) in FY 2012.[48]

PRIVATE SURPLUS & SALVAGE FACILITIES

As mentioned above, a number of private companies and non-profits supplement the various district and municipal facilities. Examples of surplus and salvage non-profit organizations that recycle/reuse building materials and products that would otherwise end up in the waste stream are described below.

RESOURCE

[48] Data provided by Phil Baker, Windham SWMD, June 25, 2013.

ReSource is a mission-driven non-profit organization headquartered in Burlington that launched its ReBUILD program in 2001 to address the environmental and practical issues of building material salvage and supply. ReBUILD comprises three components: a Deconstruction Service, a Building Material Store, and Waste-Not-Products. The Deconstruction Service completed 48 deconstruction projects in 2011, salvaging building materials and creating jobs for low-income individuals.

The ReSource Building Material Store is located in Burlington and sells a variety of used building materials including lumber, plywood, cabinets, windows, doors, sinks, lighting, and others to homeowners, tenants, contractors and developers. Through its Essential Goods program, the Building Material Store donates some of these materials to non-profits throughout Vermont. The final piece of ReSource's building material salvage and reuse program is its Waste-Not-Products Shop showroom, co-located with the Building Material Store in Burlington. The shop transforms salvaged building materials into new products such as benches, tables, birdhouses, picture frames, cutting boards and others.

ReSource operates three retail shops that take in "gently used" building materials and household goods (e.g., major appliances, electronics, furniture) and sell them at low cost. The ReSource stores are located in Burlington, Barre, and Morrisville. ReSource reports that combined these stores and the ReBUILD program recycled/reused more than 1,100 tons of material in 2011.[49] As a mission-driven, non-profit organization, the ReSource retail shops also provide job and life-skills training, as well as needed household items to families and individuals in crisis.

RENEW SALVAGE

The non-profit Renew Building Materials & Salvage, Inc. ("Renew Salvage") in Brattleboro (within the Windham District) is a building materials reuse store and deconstruction services provider, which also offers job skills readiness training and public education. Its goal is "to reduce the amount of construction waste, project surplus items, and usable items that end up in the landfill or disposed of improperly."[50] The reuse store sells used building materials, much of which is collected from its deconstruction jobs, including lumber, hardware, doors, windows, bathroom and kitchen fixtures, kitchen cabinets, flooring, hardware, plumbing, lighting and electrical, appliances, tools, recycled latex paint, etc.

[49] ReSource Annual Report 2011.
[50] http://renewsalvage.org/index.php?option=com_content&view=article&id=8&Itemid=3

V. VERMONT'S BOTTLE BILL SYSTEM AND ESTIMATED RECOVERY UNDER AN EXPANDED BOTTLE BILL

VERMONT'S BOTTLE BILL SYSTEM

A systems analysis of the bottle bill requires consideration of all the key elements within the boundaries of the system, including the following:

- The bottler or distributor sells/distributes beverages to retailers, initiates the deposit, and is ultimately responsible for refunding the deposit on all returned containers, keeping the escheats (un-refunded deposits).
- The retailer pays the deposit on all containers sold to them, sells beverages to the consumer, and passes the deposit fee on to the consumer as part of the sale of the beverage.
- The consumer consumes the beverage and decides among the following options as to how to manage the empty container:
    - Bring the container back to a redemption center or retailer and redeem the container for the nickel deposit;[51]
    - Put the container in the recycling bin and forego the nickel – although the container may subsequently be scavenged on the street or at the MRF for the nickel value;
    - Give the container to an organization looking to raise money through bottle drives; or
    - Throw the container in the trash.
- The consumer that redeems the container is paid the nickel by the redemption center or retailer, and the redemption center or retailer is paid the deposit plus the handling fee by the distributor.
- The distributor, or a third party agent collects the containers and brings them back to a warehouse for consolidation by material type, and auditing of container counts.
- The containers are sold to a broker/processor/reclaimer for processing to produce a commodity.
- The commodity is sold to an end user.

At each step there is a material flow and an economic cost that must be accounted for. There is also an environmental cost and benefit. Consideration of the environmental costs and benefits significantly expands the system boundaries in that much of the environmental cost (and the environmental benefit of recycling) occurs prior to bottling of the beverage in the container, as recycling reduces the mining and manufacturing impacts of producing a beverage container from virgin materials.

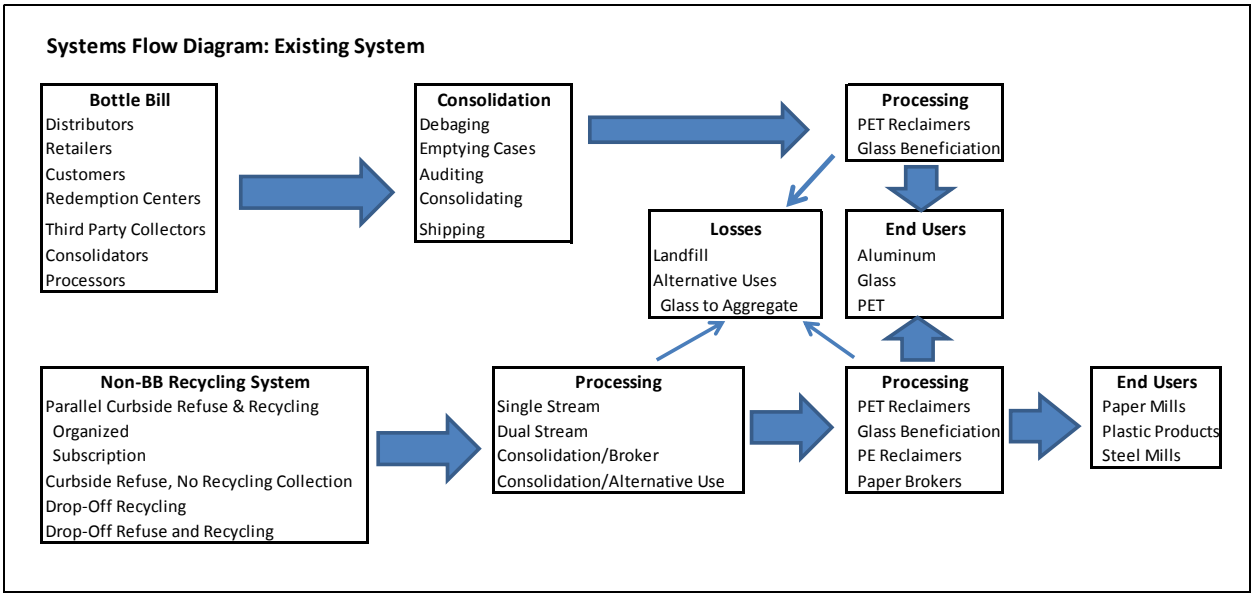
This analysis does not explicitly include economic or material costs outside of the system boundaries described above. However, the analysis incorporates results from the US EPA Waste Reduction Model (WARM) as a surrogate for the environmental costs of mining and manufacturing the container. The WARM model is a life-cycle, greenhouse gas (GHG) accounting tool that assesses energy use and GHG emissions from a systems perspective, from raw materials extraction, processing, manufacturing, transportation, through disposal. WARM calculates and totals GHG emissions of base case and alternative waste management practices—source reduction, recycling,

[51] Some redemption centers offer the consumer six cents instead of five cents, apparently sharing in the 3.5 to 4 cent handling fee the redemption center receives as an incentive to attract the material.

combustion, composting, and landfilling - for a wide range of material types, including those used in beverage containers. Although the WARM Model calculates only GHG emissions, GHGs are a relatively good surrogate for other pollutants. The use of WARM is therefore useful in assessing the relative environmental impacts of the existing bottle bill, an expanded bottle bill, and the single-stream system.

Figure 8 below shows how the bottle bill system fits into the other recycling systems in Vermont.

FIGURE 8. SYSTEMS FLOW DIAGRAM: EXISTING SYSTEM (1)



(1) Note that Aluminum is not listed in the second processing block because it goes directly from first level processing to end users.

SALES AND RETURNS THROUGH VERMONT'S BOTTLE BILL

As requested by ANR and the Project Team for this analysis, Northbridge Environmental Management Consultants (Northbridge), which audits returns under Vermont's commingling agreement, surveyed Vermont distributors and collected and consolidated confidential data on redemption system costs and total sales and returns by beverage container material type (e.g., aluminum, PET, glass) and size for this study. Northbridge reported that roughly 270.4 million carbonated beverage containers were sold in Vermont in 2011.[52] In addition, 3.7 million liquor bottles were reported as sold by the Vermont Department of Liquor Control in FY 2012.[53]

Northbridge developed a standardized reporting template for distributors of carbonated and malt beverages to confidentially report on sales by beverage type and packaging mix (size and packaging material type) for the most recent year. Northbridge compiled confidential producer, vendor, and retailer data with cooperation from Vermont Commingling Group, LLC (representing distributors who participate in the commingling agreement), non-

[52] See *Vermont Bottle Bill Analysis, Prepared to Support Analysis Required Under Act 148*, February 8, 2013 by Northbridge Environmental.
[53] As reported by Vermont Department of Liquor Control for FY 2012.

commingling distributors (Coca-Cola of Northern New England, Nestle Waters North America, Polar Beverages), the Beverage Association of Vermont, the Vermont Wholesale Beverage Association, and the Vermont Grocers Association.

Northbridge stated that sales data for carbonated beverages subject to the current bottle bill included participation from beer wholesalers who accounted for 95.1% of taxable sales of malt beverages in Vermont in 2011 and from companies representing soda and other carbonated sales returned through the commingling program, by Coca-Cola of Northern New England , by Nestle Waters, and by Polar Beverages (who are not in the commingling program) and who together account for at least 91% of the carbonated soft drinks sold. Missing data was reported to be extrapolated based on the reported packaging mixes. Overall the sample of actual Vermont sales data covered an estimated 93% of the beer and soft drink markets.

For noncarbonated beverage sales, companies that sell beverages directly to retailers (direct store delivery or DSD) as well as companies that sell to wholesalers or brokers who then get the products in to stores (through warehouses) were both surveyed. Northbridge reported to sample 100 percent of the DSD companies and 47 percent of warehouse sales. DSD companies cover all store types, including convenience stores, drug stores and big box retailers while private label brands are captured through the broker or warehouse distribution.[54] Since each sales category represents about 50 percent of the market in Vermont, the sample size could be calculated at 73.5 percent from which the results were extrapolated to represent the missing data.

The Container Recycling Institute (CRI) also provided the Project Team with detailed beverage sales data including liquid volume and container estimates by both beverage type (e.g., carbonated non-alcoholic, carbonated alcoholic, non-carbonated non-alcoholic, and non-carbonated alcoholic) and by material type for 2010. The CRI sales estimates were significantly higher than Northbridge reported sales for some beverage container types (especially non-carbonated PET beverages).[55]

While there is some certainty regarding the number of redeemed containers reported in Vermont due to handling fees tracked, and reported scrap material sales, there is less certainty concerning beverage sales in Vermont (other than liquor sales which are tracked by VT Dept. of Liquor Control). This is because outside of the commingling agreement, which allows brands to be commingled when collected for processing under Vermont's bottle bill[56]

[54] Northbridge reported that an 80 percent sample of warehouse distribution (based on market share data) of supermarket sales in Vermont with supermarkets accounting for 59 percent of food store sales in Vermont equating to an overall sample of 47 percent of food store sales for warehouse delivered water and other noncarbonated beverages. Northbridge then reported they inflated warehouse sample data by 1/0.47 to account for private label waters, juices, and other drinks sold by retailers like Wal-Mart, Costco, and major drug chains and by non-participating wholesalers like C&S, Capital Candy, Hibbert & McGee, Pine State Trading, and others. While estimated bottled water sales were lower than an estimated statewide sales estimate derived from Nielsen data, Northbridge points out that Nielsen data were extrapolated from an even smaller sample, but without however, we were not confident that this provided any more reliable estimate.

[55] Using liquid volume (gallons) sold in the absence of Vermont specific package size and mix is not enough information to make accurate estimates of containers sold by material type, which is necessary to estimate tons of beverage container packaging sold and returned under the Vermont bottle bill. Combining regional volume data with U.S. packaging statistics to create per capita state-by-state estimates is a reasonable approach in the absence of any available state-specific data. However the Project Team proceeded under direction of ANR to use State specific data. Northbridge agreed as part of this project to conduct a comprehensive distributors' survey to generate Vermont-specific sales and return estimates.

[56] The commingling agreement allows participating distributors to pay a 3.5 cent per container handling fee instead of 4 cents to redemption centers because the redemption centers can commingle containers by material type and

(but does not include all beverage distributors), there is no mechanism to track sales, as deposits initiated remain with the distributor. Northbridge is responsible for monitoring and auditing the commingling agreement on behalf of the distributors involved. The Project Team understands that costs are then apportioned based on the audited sales data.

Northbridge surveys of Vermont distributors included data on beverage container returns by material type, third party collection costs under the comingling agreement, distributor costs for collection of non-comingled containers (primarily from on-premise accounts), and other costs to distributors associated with handling and administering the Vermont bottle bill program. Northbridge provided the Project Team with this annualized cost, sales and returns information in a consolidated power point format, but then also provided the underlying data to the Project Team under a confidentiality agreement. The Project Team then met with Northbridge to review the underlying data in detail.

The Project Team compared the Northbridge and CRI data presented for the existing Vermont Bottle Bill and for an expanded Bottle Bill (assuming Maine's covered beverages) and tried to bridge the gap between the two data sets by accounting for factors that may have led to a difference in estimates. These factors include: out-of-state purchases of beverages that have the deposit indicia brought into Vermont, primarily along the New Hampshire border[57]; under-reporting of sales by some distributors; over-reporting of returns by some parties; inaccurate conversions of sales volume to container size and type based on regional, rather than Vermont-specific data; and returns of containers not sold in Vermont (from which no deposit was collected).

Under the existing bottle bill, the difference between the two data sets on total containers sold basis was roughly 19 percent. Applying the Northbridge reported number of containers redeemed to their sales estimates yields a return (or redemption) rate of around 90 percent. This rate is in contrast to much lower rates reported in MA, NY and CT where sales and returns have been tracked.[58] Because of the factors listed above, it is plausible that returns reported represent a 75 percent return or redemption rate of beverage containers consumed in Vermont, which is more in line with bordering states with bottle bills.[59] Accounting for all these factors, including out-of-state sales and reporting errors, may be part of the reason why the CRI estimates are different from (and greater than) the Northbridge figures.[60]

Table 23, on the next page, assumes the returns reported represent 75 percent of beverage containers consumed in Vermont (whether they are sold in or out-of-state) and in turn calculates an estimate of total sales.

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not also by brand. Repayment of deposits and handling fees are then paid by participating distributors based on reported sales data as opposed to actual container redemption based on brand counts.

[57] See for example "The Unintended Consequences of Public Policy Choices: The Connecticut River Valley Economy as a Case Study" Northern Economic Consulting, Arthur Woolf, November 2010.

[58] Because escheats are retained by the states of MA, CT and NY, sales and returns are tracked but not published. For example, a return rate of 70.8 percent was reported in MA for FY 2010. A return rate of 66.8 was reported in NY for FY 2007.

[59] Vermont Liquor Control reported a 76% return rate in FY 2012 and 75% for FY 2011.

[60] Other reasons could be that data sources for some of the CRI data such as the Beverage Marketing Institute Data are regional in nature, or rely on applying a standard container size to data on state specific gallons sold.

TABLE 23. USING BEVERAGE CONTAINER RETURNS AND 75% RETURN RATE TO ESTIMATE TOTAL SALES TO VERMONT (CY 2011)

Beverage Containers	Reported Returns (1)	Assumed Return Rate	Estimated Total Sales (2)	Reported Sales (3)	Difference (Additional Containers)(4)	
By Beverage Type:	*(ctrs, in 1,000's)*	*(%)*	*(ctrs, in 1,000's)*	*(ctrs, in 1,000's)*	*(ctrs, in 1,000's)*	*(%)*
Carbonated Soft Drinks	106,535	75%	142,047	124,911	17,136	14%
Beer	135,394	75%	180,526	145,472	35,053	24%
Liquor	2,860	75%	3,814	3,745	69	2%
Total:	**244,790**		**326,386**	**274,128**	**52,258**	**19%**
By Commodity:	*(tons)*	*(%)*	*(tons)*	*(tons)*	*(tons)*	*(%)*
Aluminum	2,206	75%	2,942	2,434	508	21%
Glass	14,285	75%	19,047	15,525	3,522	23%
PET	1,300	75%	1,734	1,650	83	5%
Total:	**17,792**		**23,722**	**19,609**	**4,113**	**21%**

(1) Return data from Vermont Bottle Bill Analysis, Prepared to Support Analysis Required Under Act 148, July, 2013 by Northbridge Environmental.
(2) Sales data estimated based on a 75 percent return rate.
(3) Reported sales from Northbridge Environmental, as above.
(4) Difference between Estimated Total Sales and Reported Sales.

As described below, this difference in reported sales or generation of carbonated and other beverages covered under Vermont's current bottle bill (19% by container count and 21% by weight) is used to estimate beverages that would be covered under an expanded bottle bill.

ESTIMATING SALES AND RETURNS UNDER AN EXPANDED BOTTLE BILL

The Container Recycling Institute (CRI) and Northbridge provided additional input to the Project Team in the development of baseline estimates of sales and returns of beverage containers in Vermont that would be subject to an expanded bottle bill (EBB). Based on the CRI and Northbridge data, the Project Team decided on the following course of action.

First, as shown in Table 23 above, the Northbridge sales data for all beverage containers subject to the *existing bottle bill* was increased by adjusting the existing overall redemption rate from over 85% down to 75%. The 75% redemption rate was acknowledged by stakeholders to be more in line with what other states are experiencing.[61] This accounts for purchases (by Vermonters) of beverages in New Hampshire, reporting errors, and other factors discussed above. This resulted in adjusting up the beverage sales data by roughly 20 percent, bringing aggregate

[61] The Project Team recognizes that assuming a uniform redemption rate for the purpose of estimating out-of-state sales masks differences in the redemption rate across beverage categories and material types. We understand, for example, that beer is redeemed at higher rates than soft drinks in Vermont, and that redemption rates vary by material type with glass being the highest followed by aluminum and then PET.

sales of beverage containers covered by the existing bottle bill close to CRI's estimate (326 versus 331 million containers), though there are still discrepancies by beverage mix and package material type.

Second, the Project Team increased the Northbridge sales estimates for beverages that would be covered under an *expanded bottle bill* by 21 percent to help bridge the gap between the CRI and the Northbridge sales estimates. The results are shown in Table 24.

The adjusted sales estimates significantly reduce the gap between Northbridge and CRI sales estimates with an expanded bottle bill that were included in the initial analysis.[62] Nonetheless, the CRI sales estimate for PET remains 45 percent higher, even after the adjustments presented above. While ideally the gap could have been closed further, two Vermont-specific data sets are inconsistent with a larger increase in sales – the recent statewide Waste Composition Study, and reported 2011 Vermont MRF PET bale sales data.[63]

Because the Waste Composition Study and Vermont MRF sales data do not support significantly increasing sales, and because ANR (as directed by the VT Legislature) has explicitly stated the analysis should be based on Vermont-specific data to the greatest extent possible, the Project Team considers a 21 percent increase to account for the factors described above is a reasonable approach to the analysis that considers both Northbridge and CRI data sets.

Table 24 presents estimated sales and returns (containers and tonnage) for the new beverages that will be included under the Vermont expanded bottle bill. Table 24 was constructed in a similar fashion to Table23, but starts with reported sales of beverages (instead of returns) estimated by Northbridge, adjusts for out-of-state (New Hampshire) sales and other factors using the same overall percentage increase in sales as (19% for containers, 21% for tons), and applies the 75% return rate to estimate returns.

[62] DSM Environmental Services and Tellus Institute, Comparison of System Costs and Materials Recovery Rates: Implementation of Universal Single Stream Recycling With and Without Beverage Container Deposits, Draft Report, Prepared for Vermont Agency of Natural Resources, March 4, 2013.

[63] First, the State of Vermont Waste Composition Study, Final Report, May 2013, details PET beverage container disposal and indicates that 1,400 tons of EBB beverage PET was disposed last year (1,800 tons at the very high end of the confidence interval). Second, reported PET bale sales from Vermont materials processing facilities for 2011 indicate roughly 1,400 tons of all types of PET (including non-beverage PET) generated by Vermont were recycled through MRFs and processing facilities last year. These two sets of data imply that no more than 3,000 tons of beverage-container PET is potentially available to be redeemed through an EBB.

TABLE 24. ESTIMATE OF SALES AND INCREASED AMOUNT OF RETURNS UNDER AN EXPANDED VERMONT BOTTLE BILL

Beverage Containers	Estimated Vermont Sales (1)	Difference (Percent Additional Containers) (2)	Additional Containers (2)	Total Estimated Sales	Return Rate	Estimated Returns (3)
By Beverage Type:	*(ctrs, in 1,000's)*	*(%)*	*(ctrs, in 1,000's)*	*(ctrs, in 1,000's)*	*(%)*	*(ctrs, in 1,000's)*
Non-carbonated, non-alcoholic	109,103	19%	20,799	129,902	75%	97,426
Wine	9,846	19%	1,877	11,723	75%	8,792
Total:	118,949		22,676	141,625		106,219
By Commodity:	*(ctrs)*		*(ctrs)*	*(ctrs)*		
Aluminum	8,503	19%	1,621	10,124	75%	7,593
Glass	14,314	19%	2,729	17,043	75%	12,782
PET	88,393	19%	16,851	105,244	75%	78,933
All Other	7,739	19%	1,475	9,214	75%	6,911
Total:	118,949		22,676	141,625		106,219
By Commodity:	(tons)		(tons)	(tons)		(tons)
Aluminum	181	21%	38	219	75%	164
Glass	7,139	21%	1,498	8,637	75%	6,477
PET	2,400	21%	503	2,903	75%	2,178
All Other	422	21%	88	510	75%	383
Total:	**10,142**		**2,127**	**12,269**		**9,202**

(1) Vermont sales estimates for CY 2011 from Vermont Bottle Bill Analysis, Prepared to Support Analysis Required Under Act 148, July 2013. Northbridge Environmental Management Consultants.

(2) Sales estimates are inflated by 19% for containers (21% by weight) as calculated for carbonated beverages under the existing bottle bill (See Table 23).

(3) Returns estimated to be 75 percent of total estimated sales (in-state and out-of-state).

VI. ENHANCEMENTS TO SYSTEM INFRASTRUCTURE UNDER ACT 148

PARALLEL COLLECTION

Act 148 requires parallel collection of recyclables, refuse, leaf and yard residuals and food residuals at curbside and at all solid waste collection facilities. Parallel collection simply means that haulers that offer collection of refuse must also offer services for collection of mandatory recyclables by 2015, leaf and yard residuals by 2016, and food residuals by 2017. Haulers cannot charge a separate fee for residential mandated recyclables; rather the cost must be embedded in the refuse collection fees. However, they may charge extra for collection of yard waste or food residuals. The same requirement applies to transfer stations, which means that any drop-off or transfer station that only accepts refuse now will be required to accept mandated recyclables, yard waste and food residuals.

These requirements will impact haulers in areas of the state where subscription curbside recycling is uncommon, and especially haulers that are currently not collecting recyclables.[64] The law does not specify that curbside collection of recyclables be offered on the same day as recycling, or that recycling only drop-off facilities also accept drop-off trash. However, as discussed in the Implementation section of this report, parallel collection with refuse and recyclables collected on the same day will increase recovery rates for mandated recyclables compared to refuse collection and recycling collection on different days.

Based on the estimates made for the Base Case system on how households are served (as shown earlier in Table 7), estimates were made to determine how service would change for all Vermont households that currently do not have parallel refuse and recycling collection service. Table 25 (on the next page) presents a *rough estimate* of the number of households that will be impacted by this requirement, and provides some ballpark estimates of the number of households to be served by organized, subscription and drop-off service after Act 148 is fully implemented for recyclables (assumed to be 2015).

As shown in Table 25, it is assumed that roughly 25,000 additional households live in communities where it will be optimal to implement some type of coordinated curbside refuse collection (to match the organized recycling collection)[65], and an additional 2,100 households will need to have organized curbside recycling collection (to match the existing organized refuse collection service). This would result in an estimated 20,500 fewer households with subscription refuse collection in those municipalities. In addition, as estimated 63,100 households would now have curbside recycling collection as part of their subscription curbside refuse collection service. Finally, roughly 4,500 households are assumed to no longer use drop-offs for refuse collection (as they would be living in municipalities where curbside collection is now organized and therefore offered to all, or most households), and roughly 2,700 households will no longer rely on drop-offs for recycling collection.

[64] ANR states that for districts that have had ordinances banning disposal of recyclables and are already managing them, such as Chittenden SWD and Addison County SWMD, the parallel collection requirement will not be burdensome. However, the implementation of these ordinances may not be enough to meet the overall requirement of Act 148 with respect to unit-based pricing and parallel collection.

[65] As with parallel collection of recyclables on the same day of the week, while Act 148 does not require this, the Project Team believes that it will be necessary to maximize mandated recyclables diversion from these households.

TABLE 25. PARALLEL REFUSE AND RECYCLING COLLECTION SERVICE BY TYPE OF SERVICE

HOUSEHOLDS BY SERVICE TYPE UNDER ACT 148		CHANGE FROM BASELINE	
Collection Service Type	Recycling and Refuse *(households)*	Refuse *(households)*	Recycling *(households)*
Organized Curbside			
Chittenden County	17,300	16,100	0
Rest of Vermont	19,600	8,900	2,100
Subtotal, Organized:	**36,900**	**25,000**	**2,100**
Subscription Collection			
Chittenden County			
Curbside	22,800	-16,100	0
Containerized	13,400	0	0
Rest of Vermont			
Curbside	65,600	-4,400	35,700
Exempt Haulers and Fast Trash	14,000	0	8,050
Containerized	21,500	0	19,350
Subtotal, Subscription:	**137,300**	**-20,500**	**63,100**
Drop-off Collection			
Chittenden County	8,300	0	0
Rest of Vermont	87,400	-4,500	-2,700
Subtotal, Drop-off:	**95,700**	-4,500	-2,700
Total Households Served:	**269,900**	0	62,500

Some of the assumptions made in developing these estimates include:

- The City of Burlington would organize refuse collection, joining Westford and parts of Underhill in Chittenden County, so that recycling and refuse collection are provided on the same day, and possibly by the same service provider.
- Hartford, Middlebury and Bristol would also organize refuse collection so that refuse was offered on the same day as recycling, and Vernon and Westminster would add organized recycling collection to their refuse collection so that same day service for both refuse and recycling is provided in all these communities.
- All households on container service (typically, but not always, front load) would have sufficient separate container volume available for recyclables.
- All refuse subscribers in the state would also now have organized recycling offered by their haulers (and embedded in the refuse price). Certain service providers in Bennington County, NE Kingdom, the Upper Valley and south to Windham County, and in parts of Central Vermont would be particularly impacted by this.
- All fast trash haulers will be licensed and required to offer recycling collection along with refuse collection as part of their operating license.
- Households that now have parallel curbside refuse and recycling collection would no longer rely on drop-offs, slightly reducing the number of households using drop-offs. and,
- The Kirby Transfer Station and Mt. Tabor drop-off will need to add recycling.

As a result of all households now having access to recycling in the same manner that they manage refuse, there will be no reason for households to make separate trips to recycle. As a consequence the cost of separate trips for drop-off recycling is eliminated from the Project Team's cost model for these households in 2015. The model does

continue to include separate trip costs for all households who use transfer stations for both refuse and recycling as they incur a cost every time they drive to the facility to drop off refuse, recyclable and/or organics.

Data on commercial refuse and recycling collection are harder to gather and organize, since the commercial sector is served almost exclusively by the private sector with the exception of some small businesses using municipal and district drop-offs. Nonetheless, rough estimates of the volume of commercial refuse and recycling that will be collected by each type of collection (i.e. drop-off, rear and side load through toters referred to as curbside, front load or rear load containerized, or in roll-off containers) are provided to demonstrate the potential impact of Act 148 on the commercial sector.

These are shown below in Table 26, and do not include C&D waste collection. Note that these estimates of ICI recycling tonnages are increased (and refuse decreased), after implementation of Act 148 when compared to Table 10.

TABLE 26. ESTIMATED TONS OF COMMERCIAL REFUSE AND RECYCLING UNDER UNIVERSAL SINGLE STREAM AND ACT 148

TYPE OF COLLECTION	REFUSE		RECYCLING	
	(tons)	*(%)*	*(tons)*	*(%)*
Drop-off	6,200	4%	2,000	3%
Curbside	12,500	9%	21,000	35%
Containerized	104,070	71%	35,730	60%
Roll-offs	24,000	16%	1,000	2%
Total:	**146,770**	**100%**	**59,730**	**100%**

UNIT-BASED PRICING

Act 148 requires municipalities to implement variable-rate pricing (also called Pay-As-You-Throw or Unit Based Pricing) based on volume or weight for municipal solid waste from residential customers by 2015. While Unit Based Pricing (UBP) charges are used at drop-offs throughout Vermont, they are not used in many curbside programs. Since very few municipalities have any type of organized refuse collection, this will need to be accomplished primarily through ordinances requiring that haulers operating in the municipality (or district) implement volume- or weight-based charges.

To effectively drive higher diversion, regulations for haulers would likely need to be established requiring them to provide, and charge escalating rates, for a range of cart sizes (perhaps starting with a 32-gallon or 48-gallon cart). These requirements could be included in licenses for haulers. This is because there is no incentive for a private hauler to implement aggressive UBP without regulations requiring them to because it is inconsistent with their actual cost structure as described below.

While there are many options for pricing carts that incentivize households to reduce waste, they also impact on cost recovery by the private hauler. For example, while small cart sizes incentivize households to significantly reduce refuse set out and maximize recycling and organics diversion, significantly lower price for smaller carts (which are necessary to convince households to use them) reduce the revenue collected by the hauler without significantly reducing hauler costs. This is because it costs almost the same to collect a small cart as it does to

collect a 64-gallon cart (the current standard) since most of the collection cost is “fixed” once the truck is sent out on a route. Therefore the actual system cost savings associated with collecting a small cart versus a 64-gallon cart is only the avoided disposal cost of the waste which is not enough of an incentive for the household to choose the small cart.

The problem confronting haulers and municipalities/districts in Vermont is that 64 gallons of capacity is more than adequate for most households with weekly or bi-weekly refuse collection, even if they do not recycle, or only recycle a small fraction of what they could recycle. Therefore, there is little incentive for these households to increase diversion of recyclables or organics. Reducing the cart size to 32 or 48 gallons begins to restrict the capacity to place all materials in the cart. But, to assure that households maximize diversion, the charge for moving to a 64 gallon cart has to be significantly higher than smaller capacity carts in order to dissuade households from using the 64 gallon carts. As stated above, the hauler would then be pricing collection of the 64 gallon cart above the actual cost to the hauler. This issue will be central to the decisions that ANR and municipalities make with respect to what constitutes true UBP.

Once organics are banned from disposal in 2020, municipalities, districts and private haulers will have to make decisions about how much of total system costs (e.g. refuse collection and disposal, recycling collection and disposal, and any special waste programs) they want to include in the UBP price for refuse. This is because the amount of refuse disposed will be reduced by about 30 percent by the parallel recycling collection system and the ban on organics to landfill. This will not only reduce revenues raised through landfill surcharges but also the revenue from bag- or weight-based user fees at drop-offs, and bag- or cart-based fees charged by haulers. Because revenues raised from disposal surcharges have been a significant source of revenues supporting districts in Vermont, falling disposal quantities will require significant increases in UBP prices to make up the difference. And if the full cost of the waste management system, except for organics, is to be absorbed through the UBP price on refuse, then some type of balancing mechanism will be necessary to account for falling tonnages.

PUBLIC SPACE RECYCLING

Public Space Recycling is a major infrastructure improvement that will need to be made under Act 148, which requires that recycling containers be provided and located in publically owned places (municipal and state) where trash cans are located (except in bathrooms) by 2015. It also requires that the Vermont State House implement a similar program by July 2012.

This is a significant requirement for many municipalities that currently play no role in curbside refuse collection, and therefore have no vehicles (or staff) to utilize for public space recycling collection. As a consequence the Project Team has assumed that this requirement will be carried out primarily through private haulers operating in the municipality as an add-on to their collection contracts for all municipal facilities.

Photo at right:
Public Space Recycling in Rutland downtown
(*Courtesy: Deane Wilson, RSWD*)

While several Vermont cities (e.g., Burlington, Winooski and Rutland) have some degree of public space recycling, the cost to service these containers is not readily available; nor are other data on the average costs of operating a municipal-wide public space recycling program. However, based on the circumstances under which public space recycling is offered, it is reasonable to assume that per ton costs will be greater than for either residential or ICI collection, just as collection costs for public space refuse (litter bins) are typically higher than for residential or ICI collection. This is because of higher labor costs to service containers, lower quantities typically collected per stop, and longer times between stops to service containers (leading to higher costs per ton collected).

For purposes of this analysis public space recycling has been included at an assumed $500 per ton. While this cost may be high on a per ton basis, it has not been applied to a large volume of material so the overall impact on systems costs is relatively minor. However, this is an area where investments are likely necessary to be made over time to fully provide parallel recycling at all litter collection locations, many that are not directly addressed by the Act 148 legislation (see Section XII, Implementation Issues)

VII. ORGANICS MANAGEMENT

ORGANICS REQUIREMENTS UNDER ACT 148

Sub-Section 6605k of Act 148 states:

"It is the policy of the state that food residuals collected under the requirements of this chapter shall be managed according to the following order of priority uses:

- *Reduction in the amount generated at the source;*
- *Diversion for food consumption by humans;*
- *Diversion for agricultural use, including consumption by animals;*
- *Composting, land application, and digestion; and,*
- *Energy recovery."*

Sub-Section 6605k goes on to state:

" A person who produces more than an amount identified under subsection(c) of this section in food residuals and is located within 20 miles of a certified organics management facility that has available capacity and is willing to accept the food residuals shall:

Separate food residuals from other solid waste, provided that a de minimis amount of food residuals may be disposed of in solid waste when a person has established a program to separate food residuals and the program includes a component for the education of program users regarding the need to separate food residuals; and

Arrange for the transfer of food residuals to a location that manages food residuals in a manner consistent with the priority uses established under subdivisions (a) (2)-(5) of this section or shall manage food residuals on site.

- *The following persons shall be subject to the requirements of subsection (b) of this section:*
- *Beginning July 1, 2014, a person whose acts or processes produce more than 104 tons per year of food residuals;*
- *Beginning July 1, 2015, a person whose acts or processes produce more than 52 tons per year of food residuals;*
- *Beginning July 1, 2016, a person whose acts or processes produce more than 26 tons per year of food residuals;*
- *Beginning July 1, 2017, a person whose acts or processes produce more than 18 tons per year of food residuals; and*
- *Beginning July 1, 2020, any person who generates any amount of food residuals."*

The source separation provisions quoted above apply mainly to large, non-household generators until 2020. For that reason, the tonnage and cost analysis are divided into ICI tonnage and residential tonnage, with the assumption that the Act 148 requirement for source separation of food residuals will not apply to residential food residuals until 2020. The impacts on ICI food residuals are presented below based on the phased in requirements, followed by a discussion of residential food and yard residuals.

ORGANICS DIVERSION AND MANAGEMENT

Unlike materials recycling, where Vermont has over 30 years of experience with increasing levels of diversion, Act 148 establishes very aggressive deadlines for diversion of organics. While there are aggressive organics diversion programs in place in a number of large west coast cities (e.g., Seattle, Portland and San Francisco), and there is an on-going program in Massachusetts designed to lead to a ban on ICI organics at disposal facilities, there are no models in the U.S. for statewide implementation of a food residuals ban along the aggressive timelines established in Act 148.

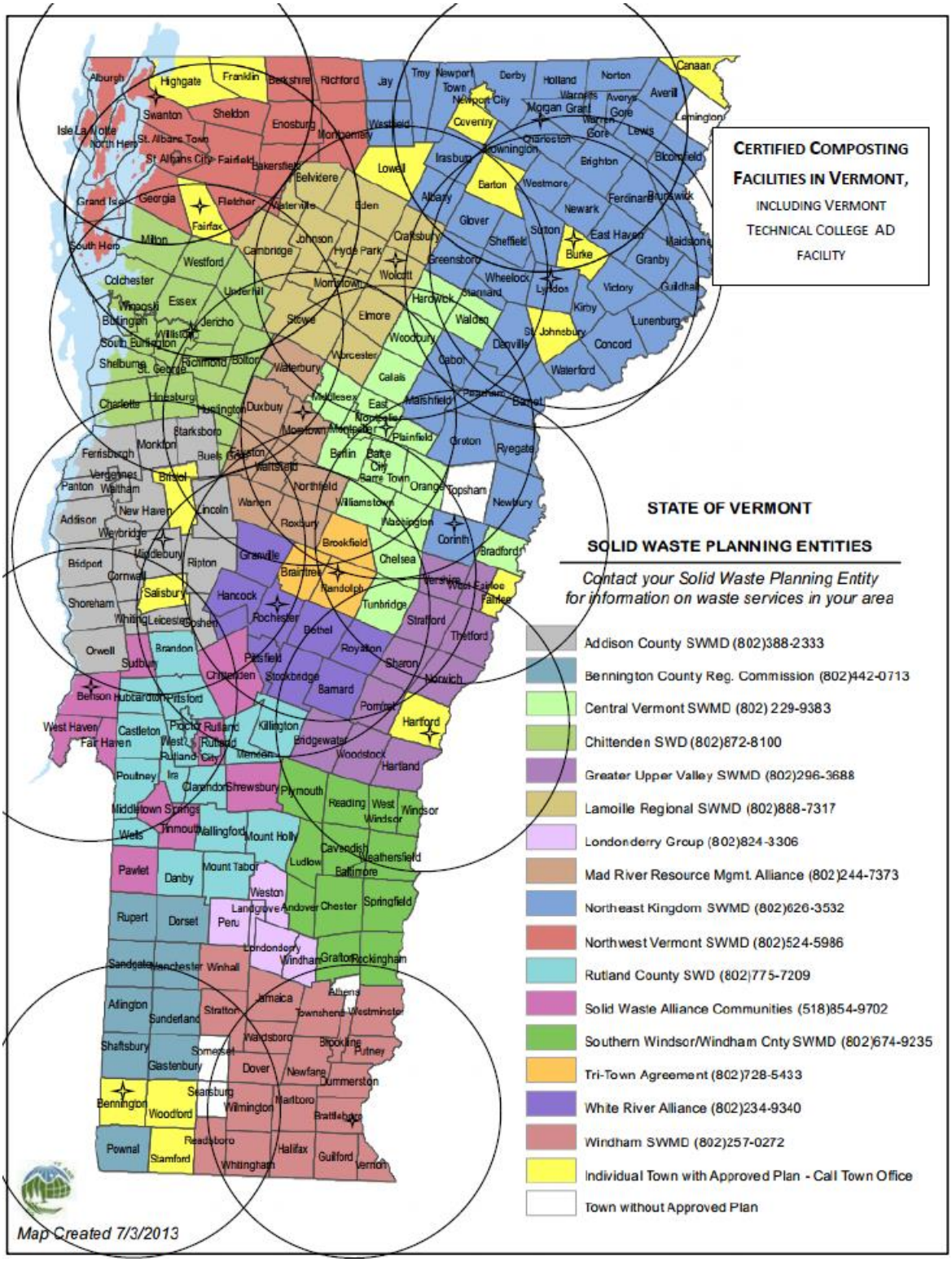
It should be noted that there is one Canadian province with an organics ban, and that there are a wide range of organics management programs in Europe, driven primarily by European Union mandates prohibiting disposal of untreated MSW. The Project Team did not evaluate these programs because most of the Canadian and European organics recycling programs utilize large, centralized in-vessel composting or anaerobic digestion facilities that process hundreds of tons per day of food and yard waste residuals. The scale of these projects (and the associated costs) is likely above the size that could realistically be implemented in Vermont, especially given the ANR's current emphasis on small scale organics management facilities.

Due to the lack of a statewide organics program model, the Project Team has made a series of assumptions about how many tons of organics will be diverted each year as the various provisions of Act 148 are implemented and the associated costs. These diverted tons drive both the collection costs, as well as the costs for the infrastructure necessary to manage these tons.

FOOD RESIDUALS GENERATION AND DIVERSION ASSUMPTIONS

The requirement for large generators to separate food residuals and deliver them to an organics management facility is predicated on a facility willing to accept the food residuals within 20 miles of the generator. This provision of Act 148 makes it difficult to model potential outcomes and costs because of the uncertainties associated with the potential availability and location of sufficient food residuals management facilities over the next seven years (until 2020). Figure 9 illustrates the location of current organics management facilities with a 20 mile radius around each facility (as the "crow flies", not actual road miles which may be longer). It is not clear whether these existing facilities have the capacity to accept all of the ICI food residuals that will be banned from disposal under Act 148. Nor is it clear how many new facilities outside of areas of the state already within 20 miles of an existing facility will come on line to take advantage of this provision. As illustrated by Figure 9, large portions of the state already have organics capacity within 20 miles of most ICI generators. However, Vermont's geography, landscape and road networks are likely to result in much longer driving distances from locations on the perimeter of many of these 20 mile radius zones.

FIGURE 9. CERTIFIED COMPOSTING FACILITIES, AND 20 MILE RADIUS[66]



[66] Not drawn to exact scale.

This report focuses primarily on development of new aerobic composting facilities, although capital costs are also presented for two anaerobic digestion (AD) technologies. While there is significant interest in AD for processing food residuals, it is the Project Team's experience that stand-alone AD facilities will be significantly more expensive to develop than aerobic facilities at the small scale likely to be viable in Vermont. AD facilities are, therefore, less likely to be implemented over the next five to seven years unless there are significant long-term energy subsidies to encourage their development.

However, there currently are 17 farm-based AD facilities operating in Vermont, with one additional facility under construction and several in the planning stages.[67] In addition, a number of wastewater treatment plants in Vermont utilize AD technologies that could potentially accept slurried food residuals. Currently very little commercial or institutional food residuals is processed at these facilities, primarily because food residuals would need to be converted to a slurry, with potential contaminants removed for use in these facilities. There are, however, a number of Vermont farm AD facilities that receive industrial food residuals in liquid form from Vermont ice cream and cheese manufacturers, as well as loads of liquid food residuals from the Boston area, and Maine. As Act 148 is implemented, it is likely that a number of these dairy farm AD facilities will consider the potential energy sales benefits of adding slurried food residuals. According to Michael Raker, adding 10 percent slurried food residuals to an existing manure digester could potentially double the energy output of the facility, with little change in the digestate output.[68]

There are however a number of farm-specific issues that will have to be addressed in order for slurried food waste to be added to existing manure digesters, including:

- the potential impact on bedding quality, because most farm digesters use the resulting substrate as bedding after digestion;
- the potential need to increase the size of the electrical generator and/or additional digester vessel capacity in some cases; and,
- the farm's nutrient management plan to accommodate additional nitrogen and phosphorous for land application of liquid digestate.

As discussed in Appendix C, a collaborative effort from ANR and the Vermont Agency of Agriculture, Farms and Markets (AAFM) will be required to identify and facilitate such capacity expansion on farms.

Assuming that these issues can be addressed, there will also be a need to process food residuals for use in these on-farm digesters. It is the Project Team's opinion that it is unlikely that many dairy farms will be willing to allow the delivery of food residuals in garbage trucks to their farms. Instead, it is more likely that private waste haulers will decide to invest in food residuals processing capacity at transfer stations or other centralized locations. Such facilities would have equipment to remove non-food contaminants, grind food residuals into slurry that could be stored on-site, blended with other materials to optimize the recipe for a specific farm's digester and/or nutrient management plan, and then delivered in large tanker trucks to the farm digesters.

Given the increased gas production at the farm digester, allowing for greater electrical generation, it may be reasonable to assume that farms would pay for such material, although this would be project/farm specific. This model of off-site processing is consistent with the evolution of recycling facilities in Vermont (and across the U.S.) where the recyclables are received at MRF's, separated, cleaned and baled and then shipped to material end users.

[67] Comments received by ANR from Michael Raker, Agricultural Energy Consultants, LLC., August 30, 2013.
[68] Meeting with Michael Raker, October 3, 2013.

Given that 58 percent of all Vermont household waste, and the vast majority of ICI waste is collected by private haulers, this appears to be a potentially viable model going forward to meet the requirements of Act 148, and to fully utilize the large public investment in the energy generation capacity of current on-farm AD facilities. As stated by Michael Raker, *"if one considers the combination of federal (USDA REAP, ARRA, USDS NRCS), state (CEDF, AAFM) and local (GMP RDF) grants that have supported these projects, public 'ownership' far exceeds private ownership."*[69]

There is also an undetermined capacity[70] to process food residuals at wastewater treatment facilities (WWTFs) that have biosolids AD systems. Again, there are technical challenges of processing food residuals into a form acceptable to the WWTFs, and while it will be possible to extract the energy associated with the introduction of food residuals, the resulting "cake" may be of less value for some agricultural uses because it will be mixed with sewage sludge.

As an alternative to low-solids AD, high-solids AD is more like conventional aerobic composting in that food residuals are mixed with a carbonaceous bulking agent, primarily brush and leaves, and loaded into a gas-tight reactor where liquid percolate is flushed through the vessel, creating methane. As with aerobic composting, such high solids AD systems require an equal volume of bulking agent, which may not be readily or economically available in most of Vermont, likely slowing the development (or increasing the operating costs) of both high solids AD facilities and aerobic composting facilities.

Proponents point to the hundreds of AD facilities in Europe processing food residuals. However, most of those facilities were developed with favorable feed-in-tariffs for power sales or other financial incentives for facility developers, something that will be required in Vermont if high-solids AD is to become a long-term solution for organic materials management. The "Cow Power" feed-in-tariff (TiF) program created by the Vermont Legislature in 2009 provides a subsidized price for small (<2.2 MW) methane and other renewable projects and is a step in this direction as is the ambitious Sustainably Priced Energy Enterprise Development (SPEED) program, which incentivizes Vermont utilities to include increasing amounts of renewable resources in their power supply portfolios.

At the current time it is impossible for the Project Team to know with any certainty how the development of new organics processing capacity is going to play out. Instead, the Project Team has simply assumed that in each year leading up to 2020, there will be a 60 percent reduction/diversion rate of food residuals (based on tonnage) from ICI generators potentially impacted by the expansion of the ban in that year (to lower tonnage generators), and that sufficient organics processing capacity will either be available or will be constructed to manage this increased diversion. This assumes potential development of new organics management capacity over this period to achieve compliance with the Act 148 bans.

Then in 2020, when the ban is no longer limited by the 20-mile from organics management facility distance requirement, the Project Team has made the assumption that 60 percent (rounded) of current ICI generation of food residuals will be diverted to food shelves, fed to animals, or delivered to existing and new organics

[69] Ibid, Comments to ANR.
[70] Data had not been compiled by ANR on the capacity of biosolids digesters in Vermont at the time of this report.

management facilities. These facilities might consist of new aerobic or AD facilities, and/or existing farm digesters that construct the capacity to handle food residuals.[71]

In line with the priorities of Act 148 the Project Team has further assumed that there will be a two percent per year reduction in ICI food residual generation requiring off-site disposal every year from 2014 through 2022. This reduction is related to a combination of increased delivery of useable food to food shelves and other food distribution outlets, as well as an effort by ICI generators to reduce food residuals generation as a result of public education programs (funded in the model). Note that while this may seem like it would have a relatively small impact, it results in a cumulative reduction of 18 percent of current ICI food residuals generation by 2022.[72] Given the limited success of attempts to reduce waste generation over the past 30 years, this level of reduction in ICI food residuals generation is ambitious and would be a significant challenge.

For residential waste it is assumed that there will be a two percent per year increase in the amount of back yard composting of residential food residuals from 2014 through 2020. The two percent per year reduction results in a 13 percent cumulative reduction in off-site residential food residuals disposal by 2020.[73] The Project Team believes that one reason for the relatively low quantities of food residuals found in the Waste Composition Study is that many Vermont households already utilize backyard composting for at least a portion of their food residuals.

Finally, the Project Team has assumed that five percent of households choose to use drop-off food residuals recycling options and/or subscribe to separate food residuals curbside collection from 2014 to 2017, moving to 10 percent by 2018. Then, when the ban on organics disposal applies to all organics in 2020 it is assumed that a total of 60 percent of all food residuals are either managed on-site or diverted through new collection programs.

Table 27 summarizes the results of these assumptions on organics disposal in 2022 relative to the base year of 2014. A more detailed table illustrating assumed changes on a year-to-year basis is provided in the next section.[74]

[71] While Act 148 bans organics at landfills, the Project Team believes that a 60 percent diversion rate by 2020 is in fact an extremely aggressive diversion rate and that despite the ban, significant quantities of food residuals and other organics will still be going to landfill in 2020, just as significant quantities of recyclables are still going to landfill after 30 years of efforts to divert them.

[72] The year 2022 was established as the end year for the systems analysis because it represents a two year window after the 2020 organics ban for more complete implementation of the facilities and programs that will be necessary to realize the goal of Act 148.

[73] It is assumed that increased levels of diversion to back yard composting will stop after 2020 because of the availability of new collection alternatives in 2020 for residential organics, and because back yard composting has been available for many years under current solid waste management programs. This is why the reduction is only 13 percent instead of 18 percent for similar levels of reduction for ICI organics. Note that the total reduction is only 13 percent instead of a logical 14 percent because the reduction runs off of the lower total generation each year.

[74] It should be noted here that comments have been received by ANR and by other reviewers that the Project Team's assumptions are too conservative. The Project Team has chosen not to change the assumptions because, as discussed further in the Implementation Section, the requirements of Act 148 establish very short time frames for diversion. The Project Team believes that the history of increasing materials diversion subsequent to Act 78 is analogous to what Vermont is likely to experience with Act 148, and results in more conservative assumptions about diversion than some proponents of Act 148 would like to see.

TABLE 27. ESTIMATED REDUCTIONS IN ORGANICS DISPOSAL BY 2022

Organics	2014 Tons	2022 Tons	% Change Over 2014
ICI Organics			
Food Residuals Disposed	18,592	6,095	***67%***
Reduced		1,608	
Food Rescue		1,592	
New Diversion		10,889	
Yard Waste Disposed	4,818	2,409	***50%***
On-site Disposal		964	
Diverted		1,445	
Compostable Paper Disposed	6,345	3,173	***50%***
Diverted		3,173	
Total ICI Disposed	***29,755***	***11,677***	***61%***
Residential Organics			
Food Residuals Disposed	41,486	18,007	***57%***
On-Site Composting		5,471	
Diverted		18,007	
Yard Waste Disposed	7,913	2,216	***72%***
On-Site Disposal		2,374	
Diverted		3,323	
Compostable Paper Disposed	15,506	7,753	***50%***
Diverted		7,753	
Total Residential Disposed	***64,905***	***27,976***	***57%***
Total Disposed, ICI & Residential	***94,660***	***39,653***	***58%***

ALLOCATION OF ICI FOOD RESIDUALS GENERATION

Several attempts have been made in Vermont to determine the location and number of large food residual generators. These include the Stone Environmental GIS mapping effort, and an incomplete US EPA effort provided to the Project Team by ANR. The Highfields Center for Composting also developed estimates of total food residuals by region in Vermont (see the Center's Strategic Plan for Close the Loop Vermont! campaign), but these estimates are based primarily on the Stone Environmental data and appear to be significantly higher than the estimated ICI organics disposal tonnage determined by the State of Vermont Waste Composition Study. Because the Project Team's scope requires use of available Vermont data, the Waste Composition Study forms the upper limit for estimating potentially available organics in Vermont, and for allocating ICI food residuals generation.

Given the lack of detailed data on large ICI food residuals generators in Vermont, the Project Team used the incomplete US EPA estimates for supermarket and restaurant generation by municipality and by generator size as a very rough way to allocate potential ICI food residuals generators potentially subject to the ban over the period 2014 through 2018. The difference between the US EPA estimate of generation for restaurants and supermarkets (adjusted down by current diversion), and the Waste Composition estimate of total ICI food residuals disposed was then assigned to the other potential ICI generators (see Table28) as a rough approximation of food residuals generation by generator type.

TABLE 28. NUMBER OF ESTABLISHMENTS AND EMPLOYMENT, BY NAICS CODE, POTENTIALLY IMPACTED BY ACT 148 ORGANICS DIVERSION REQUIREMENTS

NAICS	Potential Types of Establishments Generating Food Residuals	Number of Establishments	Total Employees
7221	Full-service restaurants	722	10,524
4451	Grocery stores	363	10,065
6113	Colleges, universities, and professional schools	21	9,413
7222	Limited-service eating places	477	5,272
6111	Elementary and secondary schools	94	3,327
3118	Bakeries and tortilla manufacturing	52	604
4452	Specialty food stores	70	353
72232	Caterers	38	255
42448	Fresh fruit and vegetable merchant wholesalers	6	204
42443	Dairy product (except dried or canned) merchant wholesalers	9	171
42445	Confectionery merchant wholesalers	5	22
7223	Special food services	142	NA
6112	Junior colleges	1	NA
42446	Fish and seafood merchant wholesalers	3	NA
42447	Meat and meat product merchant wholesalers	7	NA
	Total:	**2,010**	**40,210**

The next step was to allocate total disposal to generators by size to reflect the phased in implementation of the ICI food residuals ban depending on annual generation. Again, the Project Team relied on the US EPA generation estimates for restaurants and supermarkets as a *rough* guide to the quantity of food residuals that would be impacted each year (including from large institutional generators). Table 29, at the end of this section on ICI and residential generation lays out assumptions made for each year with respect to diversion.

RESIDENTIAL FOOD RESIDUALS GENERATION

Act 148 does not mandate diversion of residential food residuals until 2020. As such, actual diversion (other than back yard composting) up until 2020 will be driven by solid waste districts and/or the private sector looking to either add organics to existing facilities, or to provide a new diversion opportunity for those households who want to voluntarily divert food residuals. Based on experience with voluntary materials recycling programs it is reasonable to assume that actual diversion of residential food residuals will represent a relatively small portion of the 41,500 (rounded) tons of residential food residuals estimated to be generated in 2014 based on the 2012 Vermont Waste Composition Study. This will likely be the case even though UBP pricing will be implemented during 2015 under Act 148 since the Act does not mandate embedding of the price of organics collection in the price for MSW and recycling collection.

OTHER ORGANICS

YARD RESIDUALS

Act 148 also requires that *"leaf and yard residuals be collected separately from other solid waste and delivered to a location that manages leaf and yard residuals in a manner consistent with the priority uses established under subdivisions 6650k(a)(3)-(5)"* by July 2016.

The Waste Composition Study indicates that relatively small quantities of yard residuals, estimated at 7,900 tons from residential and 4,800 tons from ICI sources, were disposed off-site in 2012. This represents roughly three percent of the residential and ICI waste streams, which could be defined as a "de minimis" amount of yard residuals, even after the ban on disposal goes into effect in 2016. However, there will be times in the spring and fall when yard residuals represent a larger fraction of the waste stream.

It is unlikely that a subscription hauler will be able to offer separate collection of yard residuals at a price that is attractive to most residential or ICI generators, although it is possible that some municipalities with organized curbside collection may add yard waste collection during the spring and fall. As such the Project Team has assumed that most of the banned yard residuals that would typically be collected with MSW by subscription haulers (that is not disposed on-site) will be self-hauled to existing transfer stations and drop-offs with a leaf and yard residuals collection pile. In addition, because leaf and yard residuals will be an important source of carbon for increasing composting of food residuals, it is likely that landscapers and compost operations will be willing to accept leaf and yard residuals at no or low cost. Therefore, for purposes of this analysis it is assumed that from 2016 to 2020 roughly 50 percent of the yard residuals estimated to be disposed of in 2014 will be either disposed on-site or diverted by generators to leaf and yard waste composting operations with a zero tip fee. Hauling is assumed to be self-haul with an estimated 10 mile round trip charged at the IRS mileage rate.

Finally, the Project Team assumed that the other 50 percent of yard residuals will continue to be delivered to transfer stations and landfills mixed with MSW. This will change in 2020 when residential food residuals are banned from disposal. This will create an opportunity to collect curbside yard residuals and food residuals together, with the yard residuals serving as a carbon source for food residuals being composted.[75]

OTHER ORGANICS

There are two other organics categories included in the Waste Composition Study. The first is Fines and Dirt. While it is certainly possible that some portion of this material will be diverted to organics facilities, it is not likely that this category will be actively sought after for management, so it is ignored for purposes of this analysis.

[75] Brattleboro's current food residual program discourages residents from including yard residuals because Brattleboro offers separate collection of yard residuals for two weeks in May and two weeks in November. This is an economic decision since year round co-collection would greatly increase volumes of organics, exceeding capacity of the third compartment in the side loading recycling truck necessary because of dual stream recycling collection. The other issue with co-collection is that once food residuals are added to yard waste, the material must go to a permitted composting facility.

The second category is Other Organics which is defined in the Waste Composition Study as *"**Remainder/Composite Organic** means organic material that cannot be put in any other type or subtype. This type includes items made mostly of organic materials but combined with other materials. Examples include cork, hemp rope, hair, cigarette butts, full vacuum bags, and animal feces."* As with fines and dirt, it is unlikely that significant amounts of this material will be actively sought after by organics management facilities because of contamination issues. Therefore, it is assumed that both fines and dirt and other organics will continue to be disposed of as MSW over the 9 year timeframe of this analysis.

COMPOSTABLE PAPER

The Vermont Waste Composition Study includes a paper category for compostable paper which is defined as "*low grade paper that is not capable of being recycled, as well as food contaminated paper. Examples include paper towels, paper plates, waxed papers and waxed cardboard, and tissues."* This category is likely to be important to commercial scale composting facilities because it will provide a carbon source. As such, it is assumed that as increasing quantities of ICI food residuals are composted between 2014 and 2018, increasing levels of compostable paper – especially waxed cardboard – will be diverted simultaneously. Because it is difficult to determine exactly how large generators will be impacted, an assumption has been made that beginning in 2014, 10 percent of compostable paper from the ICI waste stream will be diverted and that this will increase by an additional 10 percentage points each year after that, culminating at 60 percent in 2020 for ICI waste.[76]

It is further assumed that once residential food residuals are banned in 2020, much of the residential compostable paper will be included with the separate collection/management of residential food residuals. As such, it is assumed that diversion rates for compostable paper will track residential diversion rates for food residuals. This is consistent with Windham County's current experience with voluntary residential and ICI food residuals diversion.

It is important to note that this assumption has several implications. First, the diversion of compostable paper increases the overall diversion of materials from disposal when compared to just diversion of food residuals and yard residuals. Second, the addition of compostable paper also allows for collection of food residuals in conventional compaction trucks, as well as dedicated recycling trucks, because the compostable paper acts to absorb excess moisture available in the food residuals.[77] Third, and most importantly, the compostable paper provides a low cost carbon source, reducing composting costs and the need to purchase carbon, which would likely be required if compostable paper were not allowed in the compost.

Unfortunately, the negative side of allowing compostable paper is that it increases plastic contaminants either contained in the paper, or inadvertently mixed in with the mixed food residuals and paper. This plastic will reduce the value of the resulting compost, as well as its potential use for animal feed and/or grinding for addition to anaerobic digesters. The presence of plastic and inorganic contaminants will also increase the capital and

[76] The Project Team recognizes that some organics management facilities will not be willing to accept waste paper because it will jeopardize their ability to sell compost to organic farms. This is currently the case with facilities serving the Central Vermont Solid Waste Management District.

[77] It is likely that collection of organics will be in a mixture of vehicle types with many haulers opting to collect mixed organics in existing (or newly purchased) garbage compactor trucks because these trucks are versatile and can be used for MSW and recycling as well. However, larger haulers are likely to invest in trucks with rendering bodies which don't leak and don't compact, reducing costs because food residuals by themselves are heavy enough that compaction is not important while liquids leaking from the truck is problematic.

operating costs of composting facilities as they incorporate sorting equipment to remove contaminants, such as de-stoners and air classifiers. Currently, some Vermont food residual compost facilities spend considerable labor time manually sorting out film plastic. The Project Team believes that procedures for preventing such contamination, and for sorting and removal will be an important regulatory and operating cost issue that ANR will have to grapple with as the ban goes fully into effect in 2020.

At the same time, based on many years of experience with operating composting facilities the Project Team recognizes that low-cost sources of carbon are going to be essential and that managing the contaminants through generator education and back-end screening will be less costly than purchasing high-quality carbon. It is also highly likely that it will be necessary to significantly increase tub grinder capacity in Vermont, either through joint purchase or through contracts to grind potential sources of carbon.

Table 29 presents the results of the assumptions presented above on total organic residuals available for diversion beginning in 2014. The totals for ICI and residential organics Off-Site Use/Processing feed into the large systems model to estimate collection and processing costs.

TABLE 29. ESTIMATED PHASE-IN OF ORGANICS BAN ASSOCIATED WITH ACT 148

Source/Type of Organics	Tons from Waste Composition Study	2014	2015	2016	2017	2018	2019	2020	2021	2022
Commercial (ICI) Organics										
Food Residuals	18,592	18,406	18,222	18,040	17,859	17,681	17,504	17,329	17,155	16,984
Food Rescue		184	182	180	179	177	175	173	172	170
New Diversion		2,150	2,785	2,374		1,341		648	-	
Cumulative Diversion		2,334	5,301	7,855	8,034	9,551	9,726	10,547	10,719	10,889
Food Residuals Disposal:		***16,072***	***12,921***	***10,184***	***9,825***	***8,129***	***7,777***	***6,782***	***6,437***	***6,095***
Mixed Yard Waste	4,818	4,818	4,818	4,818	4,818	4,818	4,818	4,818	4,818	4,818
On-site disposal				964	964	964	964	964	964	964
Diverted				1,445	1,445	1,445	1,445	1,445	1,445	1,445
Yard Waste Disposal:		***4,818***	***4,818***	***2,409***	***2,409***	***2,409***	***2,409***	***2,409***	***2,409***	***2,409***
Compostable Paper	6,345	6,345	6,345	6,345	6,345	6,345	6,345	6,345	6,345	6,345
New Diversion		734	950	810		457		221		
Cumulative Diversion		734	1,684	2,494	2,494	2,952	2,952	3,173	3,173	3,173
Compostable Paper Disposal:		***5,612***	***4,661***	***3,851***	***3,851***	***3,394***	***3,394***	***3,173***	***3,173***	***3,173***
Total ICI, Off-Site Use/Processing:		***2,883***	***6,803***	***11,615***	***11,795***	***13,772***	***13,948***	***14,992***	***15,165***	***15,337***
Total ICI Disposed:		**26,502**	**22,400**	**16,444**	**16,085**	**13,932**	**13,580**	**12,363**	**12,019**	**11,677**
Residential Organics										
Food Residuals	41,486	40,656	39,843	39,046	38,265	37,500	36,750	36,015	36,015	36,015
On-site composting		830	813	797	781	765	750	735		
Diverted		2,033	1,992	1,952	1,913	3,750	3,675	18,007	18,007	18,007
Food Residuals Disposal:		***37,794***	***37,038***	***36,297***	***35,571***	***32,985***	***32,325***	***17,272***	***18,007***	***18,007***
Mixed Yard Waste	7,913	7,913	7,913	7,913	7,913	7,913	7,913	7,913	7,913	7,913
On-site disposal			2,374	2,374	2,374	2,374	2,374	2,374	2,374	2,374
Diverted			1,583	1,583	1,583	1,583	1,583	3,165	3,323	3,323
Yard Waste Disposal:		***7,913***	***3,956***	***3,956***	***3,956***	***3,956***	***3,956***	***2,374***	***2,216***	***2,216***
Compostable Paper	15,506	15,506	15,506	15,506	15,506	15,506	15,506	15,506	15,506	15,506
Diverted			775	775	775	1,551	1,551	7,753	7,753	7,753
Compostable Paper Disposal:		***15,506***	***14,731***	***14,731***	***14,731***	***13,955***	***13,955***	***7,753***	***7,753***	***7,753***
Total Residential, Off-Site Use/Processing:		***2,033***	***4,350***	***4,310***	***4,271***	***6,883***	***6,808***	***28,926***	***29,084***	***29,084***
Total Residential Disposed:		**61,212**	**55,725**	**54,984**	**54,258**	**50,896**	**50,237**	**27,399**	**27,976**	**27,976**
Carbon		*734*	*4,042*	*6,297*	*6,297*	*7,530*	*7,530*	*15,536*	*15,694*	*15,694*
Total Off-Site Use/Processing:		***4,916***	***11,153***	***15,925***	***16,066***	***20,655***	***20,756***	***43,917***	***44,249***	***44,420***
Total Disposed:		**87,714**	**78,125**	**71,428**	**70,344**	**64,828**	**63,817**	**39,763**	**39,995**	**39,653**

ORGANICS COLLECTION

As with materials recycling, the largest cost associated with managing source separated organics will be collection costs. This is especially the case because unlike recycling and refuse collection food residuals cannot be stored for two weeks, and many ICI food residual generators will require even more frequent collection. In addition, while it is possible to store food residuals in dumpsters for collection using front loading commercial trucks (the most efficient way to collect much ICI refuse), because of the weight, moisture content, and cleanliness factor, much of the food residuals will have to be collected in rolling carts which tend to be more expensive to service than dumpsters.

The Project Team has used the Total, Off-Site Use/Processing tonnages under ICI organics and Residential organics in Table 29, above, to estimate collection costs. Fortunately, there are two good examples of ICI food residuals collection in Vermont that can be used as a model to estimate costs. The first is the Central Vermont Solid Waste Management District organics collection program. Operated by the District, this program collects from 100 ICI accounts ranging from Stowe to Hardwick and south through the Barre/Montpelier area, delivering organics to three separate composting facilities[78]. All of the food residuals (they do not collect compostable paper) are collected in rolling carts (toters) using either a converted roll-off truck with a lift and wash system, or a box truck. The District maintains accurate records of most of the costs associated with this program, and has provided these costs to the Project Team. They form the basis for the rear loader (assumed to be toter) collection costs.

Triple T Trucking in Brattleboro also has a relatively large route in southern Vermont and in Massachusetts collecting food and compostable paper residuals using dumpsters and a front load compaction truck. Discussions with Triple T Trucking combined with data that DSM has collected on commercial collection costs in the Chittenden District form the basis for cost estimates of collection of ICI food and paper residuals in dumpsters.

Finally, some ICI food residuals will be collected in 30 and 40 cubic yard enclosed roll-offs. Costs for collection of this material (excluding disposal costs) in roll-offs is essentially the same as costs to service a similar roll-off filled with MSW. Thus, there is no additional collection cost, just a shift from the cost of MSW collection to organics collection.

There is no real way of knowing what the breakdown of collection will be between these three collection types (roll-off, rear load, and dumpster/front load). Based on comments received on drafts of this report and discussions with haulers and solid waste districts, the Project Team has assumed that 25 percent of the organics will be collected in roll-offs, 25 percent in dumpsters, and 50 percent in rolling carts serviced by rear-loading compaction trucks and/or trucks with a rendering body on them.

One key to residential food residuals collection costs will be the number of haulers that choose to move to every other week collection of refuse and recycling, with weekly collection of organics by 2020. This is the model that Portland, OR has chosen, and is likely to result in the lowest overall systems costs. It can be done by sending two trucks out each week. One collects food residuals and the other collets recyclables one week and refuse the next. Alternatively, haulers can choose to move to split trucks where food residuals are collected on one side and recycling on the other side one week, and food residuals and refuse the next week. The Project Team has made the assumption that one-third of the curbside collection will move to the split trucks by 2020, and has reduced truck requirements accordingly. However, it is important to note that the significant weight differential between food

[78] Information on CVSWD organics collection provided by Leesa Stewart, General Manager

residuals and recyclables (or dry refuse), as well as the potential for leakage of water from the food residuals to the recyclables side of the truck may limit the ability to collect these materials in split trucks. This will be less of a problem for haulers who encourage the food residuals to be mixed with compostable paper, therefore drying up the food residuals and lightening the organics side of the truck.

ORGANICS PROCESSING CAPACITY

EXISTING COMPOSTING FACILITIES AND PROCESSING CAPACITY

Table 30, on the next page, presents a list of operating state certified composting facilities in Vermont. Of those, 14 are certified to process food residuals, which is designated “CF “in the “Feedstocks Accepted” column.

The column “Permitted Capacity” uses “cubic yards,” “wet tons,” and “dry tons.” Vermont’s annual compost facility reporting form uses a conversion factor for food residuals of 0.45 tons per cubic yard. Since food residuals is about 75% water, it is reasonable to use a conversion rate of 7.5 X 1 dry ton to convert cubic yards to wet tons.

Using those conversions, the total permitted capacity of the 14 facilities for food residuals is approximately 22,000 tons per year. It should be noted here that some of these facilities are not operating at their maximum permitted capacity, and some may require changes to facilities and/or operations in order to operate at their permitted capacity.

Another estimate of existing composting facility capacity was produced by Highfields Center for Composting, which prepared a proprietary list of composting facilities and capacities. As reported in HCC's Close the Loop Strategic Plan:

- *Our evaluation of current composting activities in the state shows there is currently the food- scrap recycling capacity to handle 34,944 tons of food- scraps (22% of CTL 2017 Goal) or 672 tons/week, which represents significant unused capacity, as diversion is currently estimated to be 545 Tons/week (see fig. 7). This is very likely an underestimate as it is not within our capacity at this time to assess small-scale diversion by pig farmers or livestock feeding and anaerobic digestion, which is more common in the food processing/manufacturing sectors.*

- *Examples of medium- scale operations include:*
    - *Highfields Research and Education Facility (20 Tons/week Capacity);*
    - *Vermont Compost Company (2 sites 30 Tons/week Capacity including Chickens); and,*
    - *Grow Compost.*

- Examples of large-scale operations include:
    - *Green Mountain Compost (100 Tons/week Capacity).*

TABLE 30. CERTIFIED COMPOSTING FACILITIES IN VERMONT

	Facility Name	Facility Town	Feedstocks Accepted	Effective Date	Expiration Date	Certification Type
1	Over The Hill Farm	Benson	DA, LY, WG, MN	4/10/2009	3/31/2014	Categorical
2	Wise Worm Compost	Burke	CF, LY, MN, WG	11/24/2009	9/30/2014	Categorical
3	Sandberg Farm - Highfields Ins	Corinth	CF, LY, MN, WG	6/26/2012	none	Small (Registration)
4	Fairmont Farms	East Montpelier	CF, MN, OC	1/14/2008	12/31/2012 recertification under review	Categorical
5	Clokey/Crawford Compost Fac	Fairfax	DA	8/3/2009	6/30/2014	Categorical
6	Greater Upper Valley Solid Waste Management District	Hartford	CF, LY, MN, WG	2/13/2013	none	Small (Registration)
7	Paris Farm	Lyndon	CF, LY, MN, WG	6/10/2011	3/31/2016	Categorical
8	Foster Brothers Farm	Middlebury	CF, LY, MN, WG	2/25/2009	12/31/2013	Categorical
9	Grow Compost of Vermont	Moretown	CF, LY, MN, WG	3/4/2009	12/31/2013	Categorical
10	North Hollow Farm	Rochester	DA, WG, MN	12/18/2009	12/18/2014	Categorical
11	Hudak Farm	Swanton	CF, MN, LY, WG	2/9/2010	12/31/2014	Categorical
12	CSWD Organics Processing Facility	Williston	CF, LY, MN, WG, CP	9/20/2010	6/30/2015	Full
13	TAM Compost Facility	Bennington	CF, LY, MN, WG, CP	1/29/2013	12/31/2017	Medium (Categorical)
14	Windham Solid Waste Management District	Brattleboro	CF, LY, MN, WG,	8/11/2012	none	Small (Registration)
15	Dane Farm	West Charleston	CF, LY, MN, WG,	7/13/2012	none	Small (Registration)
16	Highfields Compost	Wolcott	CF, DA, LY, MN, WG, OC	7/7/2011	6/30/2016	Categorical

TABLE 30 Key to Feedstocks Accepted:

CF = Food Waste
CP = Paper
DA = Dead Animal
MN = Manure
LY = Leaf and yard
OC = Other
WG = Wood Waste

It should be noted that the total permitted capacity from the ANR list of permitted facilities is 22,000 tons per year, and HCC estimates almost 35,000 tons. This difference is due to the fact that ANR does not have access to data from some of the facilities in the HCC list which includes larger industrial generators, such as breweries, that divert their organic materials to animal feed or land application and therefore are not permitted by ANR. In addition, the ANR does not include generators with on-site composting systems such as a number of colleges.

PROJECTED ORGANIC MATERIALS PROCESSING CAPACITY

Using the estimated diversion of organic residuals by 2020 from both the ICI and residential generators, the Project Team estimates that there will be a need for off-site processing of 43,917 tons per year once the Act 148 ban is in full effect in 2020. Of the total, food residuals comprise 28,554 tons, compostable paper 10,926 tons, and mixed yard residuals 4,610 tons. Note that this total off-site capacity is based on the assumptions contained in Table 29 about diversion to food banks, on-site composting, and food waste reduction which are higher priorities of Act 148.

Combining the yard residuals and compostable paper totals 15,536 tons of high carbon materials (except for grass), and 28,554 tons of high nitrogen material (food residuals).

As discussed in the technology review contained in Appendix C, this is important to determine because it helps define the mixture of materials that are needed to have a properly operating composting facility. The typical operating assumption is a minimum of two parts carbon (e.g., leaves, paper, wood) to one part nitrogen (food residuals, grass). However, many facilities utilize even higher proportions of carbon in order to minimize odor and leachate.[79]

Based on the statewide estimate of diversion it is clear that there is approximately twice as much food residuals as compostable paper/yard residuals available from diversion of disposed organics. Therefore, at a minimum an additional 40,700 tons carbon will be required by 2020 assuming that most of the organic processing capacity is aerobic composting or high solids AD processing, such as described in Appendix C. It is highly likely that much of this carbon will have to be purchased or produced using tub-grinding of large organic material.

One advantage of low-solids AD systems is that they do not require additional carbon since it is a liquid system. To the extent that off-site processing and slurrying of food residuals can be accomplished for delivery to low solids AD facilities as discussed above, the need for carbon will be significantly reduced.

It should also be noted that the digestate from high-solids AD systems that require additional carbon can be further composted at a composting facility, or land applied to agricultural fields. However, since the high solids material is typically very wet when removed from the vessel (unless there is a drying step), it will have to be further diluted with additional carbon to effectively compost.

The estimate of total organics diverted statewide (Table 29) has then been allocated on a county by county basis for 2020 based solely on county population. While the Project Team understands that many other factors besides population will apply to the ultimate selection of facility locations, this is sufficient for the cost analysis included in the report. Based on this allocation, Table 31 presents the total tons of organics processing capacity that will be required in each county by 2020. The required processing capacity figures assume that the bulk of the organics will be composted as opposed to digested or fed to animals, and reflect the fact that for every ton of food residuals approximately twice as much other carbon material is required. As discussed above, the amount of composting capacity may be significantly reduced using the model of centralized locations for food residuals grinding and cleaning to produce a slurry for use by AD facilities. However, this will not significantly change the number of organics facilities or the capital cost estimate because at this level of analysis these pre-processing facilities for delivery to AD facilities will have capital and operating costs sufficiently similar to composting facilities to not change the overall economic analysis.

It is important to emphasize here that it has taken twenty years to reach the current level of sophistication in recyclable materials separation technology. It will take a number of years to develop similar levels of sophistication for organics processing in Vermont. As such, this report can only provide a very rough estimate of what the capital costs might be, where the facilities might be located, and what type of facilities will ultimately prevail.

[79] For example, as of June 2013, Green Mountain Compost reports that their "current non-horse manure recipe is 3 parts leaves, 1 part wood chips, 1 part food residuals by volume."[79] On a weight basis the recipe is "roughly 35% food, 50% leaves, and 15% wood."

TABLE 31. ALLOCATION OF ORGANICS PROCESSING CAPACITY BY COUNTY, 2020

County	Tons Diverted	Design Capacity	Tons/Day (1)	Tons/Week
Addison	2,570	4,986	17	119
Bennington	2,591	5,027	17	119
Caledonia	2,179	4,227	14	98
Chittenden	10,925	21,194	71	497
Essex	440	854	3	21
Franklin	3,332	6,464	22	154
Grand Isle	482	935	3	21
Lamoille	1,708	3,314	11	77
Orange	2,019	3,917	13	91
Orleans	1,900	3,686	12	84
Rutland	4,302	8,346	28	196
Washington	4,155	8,061	27	189
Windham	3,107	6,028	20	140
Windsor	3,955	7,673	26	182
Total:	**43,666**	**84,712**	**282**	**1,974**

(1) Assumes 300 operating days per year

Using the total annual tonnage of organics projected to be diverted in 2020, plus almost twice as much carbon material such as wood chips and horse bedding, the Project Team estimates that one centralized compost facility will be necessary for each county, with a number of smaller commercial and farm-scale facilities also likely in each county.[80] It is important to emphasize again here that while this report uses centralized composting facilities to estimate costs, facilities for grinding and cleaning of food residuals for delivery to AD facilities can be substituted for some of these composting facilities. There are simply too many unknowns about how these facilities might work and how much they might cost at this time to complete a more detailed and precise economic analysis.

It is also important to note here that for purposes of the cost analysis the Project Team *has assumed that roughly 30 percent of the organics management capacity will be low-technology, on-farm capacity* as is currently employed at most of the Vermont farms permitted by ANR for composting. The remaining organics are assumed to be managed by the more centralized processing capacity. As a consequence, capital costs are 30 percent lower than they would be if all of the facilities organics were managed at centralized facilities.

This is a simplified approach to estimating total capital costs required to meet the organic recycling mandate of Act 148. In reality it may be less costly in some cases to transfer organics to larger facilities, or conversely, there may be several smaller facilities rather than one centralized facility.

[80] Note that this assumption is also consistent with the Highfields Center for Composting, *Close the Loop Vermont! Strategic Plan, 2012 - 2017*.

CENTRALIZED ORGANICS PROCESSING FACILITIES

The Project Team does not believe it is realistic for Vermont to rely primarily on farm-scale composting facilities to handle the large increase in food residuals diversion, for a variety of reasons. First, in Massachusetts, where farm composting systems have been promoted by the state for the past 10 years, only a small percentage of the total needed capacity has been developed by farmers. In fact, a number of farms that started food residuals composting facilities have closed their operations for a variety of reasons, including contamination of the compost, neighbor opposition, high costs of operation, and conflict with the state's Agricultural Preservation Restriction requirements.

Second, some dairy farmers will also be concerned about the impacts of bringing food scraps to their farm.[81] Food residuals that are dumped into a receiving bunker at a dairy farm may have vermin in the load, attract vermin, breed flies, or create wind-blown litter. There are very few dairy farms willing to accept these types of risks if milk production is the primary goal. Also, most dairy farmers do not have the time or expertise to start a new composting business, and many already have an excess of phosphorous from their manure, so they have limited land area that can be used to land apply compost. This is why the Project Team believes that a system that incorporates off-farm cleaning and grinding of food residuals with delivery of a slurry to farms with AD capacity is a much more likely alternative.

A more detailed discussion of farm based anaerobic digestion systems is presented in Appendix C.

Similar to the centralized materials recycling facilities (MRFs) constructed in the 1990s by CSWD and WSWMD, and more recently by Casella in Rutland, the Project Team believes that centralized organics processing facilities will be developed throughout the state over and above the decentralized farm based systems which have been assumed to take 30 percent of the organics. As with the MRFs, a combination of public and private sector arrangements are possible, including:

- Publicly owned and operated;
- Publicly owned and privately operated; and,
- Privately owned and operated.

There are significant challenges to site selection, permitting, development, financing, and operation of this new infrastructure, whether composting, anaerobic digestion, or a combination of technologies. Smaller facilities face much larger costs per ton of capacity to address these challenges than larger facilities. Thus, there will be economies of scale associated with designing larger, and fewer, facilities.

Financing of this new organics processing infrastructure will also be necessary. In addition to private waste management and organics management companies, districts will also likely be developers given their chartered mandates to divert solid waste from disposal. However, public financing in the absence of the availability of grant funding is likely to be a difficult process for a solid waste district given the required approval at town meetings by member communities.

[81] AD systems on dairy farms do take in Fats Oils and Grease in a liquid form that can be pumped directly into the receiving tanks. Integrating solid food residuals to farm digesters will, in most cases have to be accomplished by off-site grinding and slurrying, then transporting the liquid to the farm. This is the model for Agreen Energy's 5 farm project in Massachusetts.

For privately developed facilities seeking conventional bank financing, "put-or-pay" contracts with municipal generators of the source separated organic materials may be required unless the private sector is willing to operate "merchant" facilities and take the full risk of a consistent food residuals supply

Assuming financing can be arranged for centralized facilities, it will take at least 12 to 24 months for design, permitting and construction of a facility, another six months for a new facility to ramp up into full production, with an additional 6 to 12 months to demonstrate that the compost or digestate product can be successfully marketed.

The Project Team has assumed that a range of sizes of organics processing facilities will be developed in Vermont to meet the requirements of Act 148. Using the estimated design capacity for each county as shown in Table 31, the counties can be grouped into four size categories as illustrated in Table 32. Estimated tons capacity per year in 2020 are shown for each county.

TABLE 32. ALLOCATION OF ORGANICS PROCESSING CAPACITY BY SIZE AND COUNTY

25,000 Tons Per Year:	Chittenden County - 21,000 tpy
10,000 Tons Per Year:	Franklin County – 6,500 tpy Rutland County – 8,500 tpy Washington County – 8,000 tpy Windham County – 6,000 tpy Windsor County – 7,700 tpy
5,000 Tons Per Year:	Addison County – 5,000 tpy Bennington County – 5,000 tpy Caledonia County – 4,000 tpy Lamoille County – 3,000 tpy Orange County – 4,000 tpy Orleans County – 3,500 tpy
1,000 Tons Per Year	Essex County – 900 tpy Grand Isle County – 900 tpy

For the largest facility at 25,000 tons per year, the Chittenden District already has a centralized composting facility, Green Mountain Compost (GMC) in Williston. GMC has a design capacity of about 100 tons per week, which is significantly less than the approximately 400 tons per week (21,000 tons per year) that the Project Team projects will be necessary. According to Dan Goosen, GMC facility operator, as of June 2013 GMC was receiving about 3,400 tons per year of food residuals. At a bulk density of 1,400 pounds per cubic yard, that is almost 5,000 cubic yards per year. Goosen estimates that within the current footprint, the facility will be able to handle "an additional 50 to100 percent volume of food residuals."[82] On a weight basis a 100% increase in food residuals processing would be a total of 6,800 tons per year.

[82] Email to Bob Spencer from Dan Goosen, Green Mountain Compost, June 28, 2013.

Therefore, using GMC's current volume recipe of four parts carbon to one part food residuals, there will be less food residual capacity than will be necessary based on projected generation in the CSWD.

In addition to capacity, the expense of obtaining carbon sources to mix with the food residuals must be considered. If food residuals are doubled to 10,000 cubic yards per year, then an additional 40,000 cubic yards per year of carbon will be required, for a total design capacity of 50,000 cubic yards, or approximately 25,000 tons per year at a bulk density of 1,000 pounds per cubic yard.

Based on CSWD's $2.4 million capital cost for its Williston composting facility, if CSWD were to quadruple capacity from 100 tons per week to 400 tons per week (adding about 15,000 tons per year of total materials), they would need to invest approximately $7.2 million by 2020.

The next largest category of facility is 10,000 tons per year of design capacity for five counties with a projected organics generation from 6,000 to 8,300 ton per year. This may be larger than a few of the counties need, but allows for future expansion, and is within the ballpark for costs.

Using compost technology vendor capital costs for a 10,000 ton per year facility, capital costs will range from $1.2 to $2 million for each facility, including up-front processing mixers, biofilter, and screens for final compost product. Land acquisition, site work, engineering and permitting could add another $500,000 for a total of $1.7 to $2.5 million per facility.[83]

The next size compost facility is 5,000 tons per year for six counties generating from 3,300 tons per year to 5,000 tons per year of organic residuals in 2020. Capital costs are estimated to be between $650,000 and $930,000 with land acquisition, site development, engineering and permitting costs of roughly $150,000 to $200,000 for a total capital cost ranging from $800,000 to $1.1 million per facility.

The smallest centralized composting facility has a design capacity of 1,000 tons per year. Capital costs for such small-scale systems can vary significantly depending on site constraints and type of technology selected. HCC's Wolcott site capital costs for their 20 ton per week facility were approximately $260,000, plus $30,000 for engineering design and permitting. Therefore, with that as a model for Vermont, approximately $300,000 of capital cost could be anticipated.[84]

Alternatively, using Green Mountain Compost's Technologies' capital cost for a 20 ton per week containerized composting system, the capital cost would be $160,000 for a four container system, plus another $105,000 for a loader, screen, and permitting for a total of $265,000. If a building enclosure is provided, and leachate collection, which are both highly recommended, costs could increase another $100,000, for a total of $365,000.

Based on these two systems, capital costs for a 1,000 ton-per-year facility are assumed to be approximately $300,000 to $365,000, plus the cost of land and site development work.

[83] The Project Team has a long history of designing, financing, operating and trouble-shooting aerobic composting facilities in New England. As such we believe that it is important to use estimates that may appear to be on the high side rather than be optimistic about the costs to develop this capacity in a sustainable manner.

[84] Capital costs for very small facilities can vary greatly. The estimated capital cost is again on the high side, which the Project Team believes is a more realistic reflection of total sustainable, long-term costs.

Summing the capital costs described above by county results in a total estimated capital cost of $26 million. The Project Team has assumed that roughly one-third of this capacity can be met through animal feeding and use of existing capacity. This leaves roughly $20 million (rounded) in new investment necessary to process the remaining organics estimated to be diverted for off-site processing under the ban by 2020.[85]

[85] A number of comments were received on the draft report that relying on existing AD facilities could significantly reduce this capital cost estimate. While that may be the case the Project Team does not have enough information on what it will cost to prepare food waste at off-site facilities to warrant making this assumption. Clearly the use of off-site food grinding and cleaning for delivery to existing AD facilities requires additional investigation by ANR and the Agricultural Department.

VIII. LOCAL GOVERNANCE EVALUATION

Vermont's Act 78 required municipal responsibility for the management of solid waste generated within their borders. The original 1989 State Solid Waste Plan assumed regional cooperation to develop facilities, direct materials (and recyclables) to these facilities, and control revenues generated. Since that time, most municipalities have joined together as "districts", "alliances", or "groups" or work through agreements to fulfill these responsibilities, including adopting and carrying out activities outlined in their ANR-approved Solid Waste Implementation Plans (SWIP). (See 24 V.S.A. §2202a(c)).

Approved SWIPs demonstrate consistency with the State Solid Waste Plan (now referred to as Materials Management Plan, or MMP) and should help the State reach goals set for materials management. Through developing and implementing the SWIP jointly, member towns and cities should be able to lower costs of reaching these goals, and expand opportunities for materials management services for the population served.

Roughly 88 percent of Vermont's population resides in a community that participates in joint management of materials through a "solid waste planning entity" comprising 10 solid waste districts and 6 alliances or groups. In addition, 18 municipalities (roughly 10 percent of the population) have chosen to act independently and adopt their own SWIP. The balance – five towns with an estimated 3,500 residents - have not adopted a SWIP. Towns without an Agency-approved SWIP cannot operate or dispose of their waste at a Vermont certified solid waste facility or receive ANR solid waste grant funding, and are unlikely to help the state reach materials management goals. Figure 10 right) provides ANR's most recent map (July 2013) of the state's solid waste planning entities.

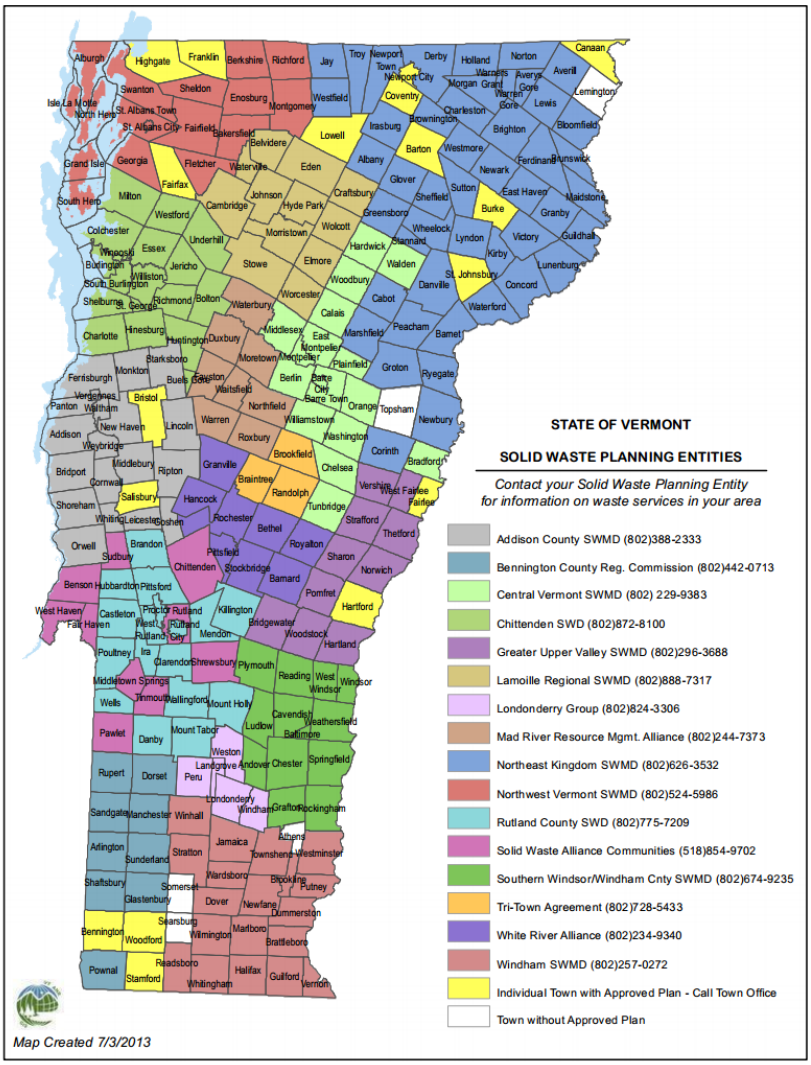


FIGURE 10. VERMONT SOLID WASTE PLANNING ENTITIES

SOLID WASTE MANAGEMENT ENTITIES AND INFRASTRUCTURE

The Project Team analyzed the costs and activities carried out by these solid waste management entities drawing together budgets, facilities data and revenue sources. In addition, the Project Team asked these entities to update an activities matrix originally created by the CSWD (See Appendix B). Table 33 presents demographic and budget information from these entities, and revenues raised through assessments or surcharges on MSW and C&D disposal.

As shown in Table 33, combined budgets total $20.4 million of which $7.8 million (or 38%) is raised through surcharges on waste tip fees or per capita assessments[86]. These entities employ 117 full time equivalent employees (FTE's) working in education and outreach as well as facility operations. In addition, included in some budgets are contractual costs, such as operation of the CSWD MRF which employs additional personnel not counted in Table 33.

TABLE 33. VERMONT SOLID WASTE MANAGEMENT ENTITIES, POPULATION SERVED AND BUDGETS

SW Planning Entity	Number of Municipalities	Population (1)	Households (2)	Percent of Total (%)	Budget (3) ($)	Employees	Assessments ($)	Surcharges ($)	Total Raised (4) ($)	Percent of Total Raised (%)
Chittenden SWD	18	158,681	62,709	28%	$9,255,677	40	$0	$2,908,979	$2,908,979	38%
Central Vermont SWMD	18	51,522	20,609	9%	$849,899	10	$99,838	$915,950	$1,015,788	13%
Rutland County SWD	17	47,005	19,675	8%	$1,435,714	8	$0	$545,960	$545,960	7%
Northwest Vermont SWMD	17	46,668	15,000	8%	$849,390	10	$0	$600,000	$600,000	8%
Northeast Kingdom WMD	48	46,421	17,854	8%	$656,010	9	$40,421	$429,346	$469,767	6%
Windham SWMD	19	37,451	*14,980*	7%	$1,620,174	13	$449,400	$0	$449,400	6%
Addison County SWM District	19	31,170	12,495	6%	$2,373,900	8	$0	$719,171	$719,171	9%
So. Windsor/Windham SWMD	13	31,030	17,837	6%	$176,600	1	$0	$130,000	$130,000	2%
Lamoille Regional SWMD	12	28,000	10,000	5%	$1,099,000	9	$0	$287,750	$287,750	4%
Greater Upper Valley SWMD	10	18,386	8,904	3%	$753,778	3	$232,583	$210,105	$442,688	6%
Bennington RPC	9	17,939	7,748	3%	$50,000	0.5	$36,000	$0	$36,000	0%
Solid Waste Alliance Communities	10	13,817	5,400	2%	$53,845	1	$29,845	$0	$29,845	0%
Mad River RMA	6	13,047	5,325	2%	$96,247	1	$39,468	$0	$39,468	1%
White River Alliance	8	8,400	*3,360*	1%	$1,162,952	3	$0	$77,988	$77,988	1%
Tri-town Agreement	3	7,000	*2,800*	1%						
Londonderry Group	5	4,200	*1,680*	1%	$345,984	2	$175,000	$0	$175,000	2%
Total:	**232**	**560,737**	**226,376**	**100%**	**$20,433,186**	**117**	**$927,555**	**$6,825,249**	**$7,752,804**	100%

(1) Provided by Districts, or estimated using US Census 2010 data (American Community Survey).
(2) Provided by Districts, unless italicized and is estimated at 2.5 persons per household.
(3) Budgets are shown for CY or FY 2012.
(4) Revenues in budget year (CY or FY 2012).

The Project Team inventoried facilities operated by the solid waste management entities, updating the facilities chart created initially by the CSWD and the Vermont Solid Waste Managers' Association. This chart is included in Appendix B. The Project Team cross checked the facilities listed by districts against Vermont certified solid waste facilities using reported quarterly and annual volume data on waste and recycling types (and destinations) to better understand the infrastructure operated by these entities as opposed to that operated by municipalities and private businesses. Table 34, below summarizes this facilities data for the entities listed in Table 33 (with the exception of the Tri-Town Agreement towns, which did not provide information to DSM).

[86] The remaining $12.7 million is raised by operational or program revenues.

As shown in Table 34, solid waste management entities operate three transfer stations, three MRFs (one under contract) and 23 small transfer station/drop-off facilities that offer parallel collection of MSW and recycling[87].

The 23 drop-off facilities primarily serve households, offer MSW and recycling (parallel) collection and do not cater to larger haulers. These facilities collected an average of 636 tons of MSW and C&D, and 263 tons of recycling.[88]

TABLE 34. FACILITIES OPERATED BY VERMONT SOLID WASTE MANAGEMENT ENTITIES FOR MSW, C&D AND RECYCLING AND CY 2011 ANNUAL VOLUMES AND AVERAGE THROUGHPUT (1), (2), (5)

SW Planning Entity	Serves Large Haulers			Public Drop-offs (MSW & Recycling)			Hours and Throughput		
	Transfer Station		MRF	Total Number of Facilities	MSW and C&D Volume	Recyclables Volume	Hours Open per week, All Facilities	MSW/C&D or MRF Throughput	Recycling DO Throughput
	(MSW tons)	(C&D tons)	(tons)	(#)	(tons)	(tons)	(hrs)	(tons/hour)	(tons/hour)
Addison County SWM District	12,779	7,180		0		294	44	8.9	0.13
Bennington RPC				0					
Central Vermont SWMD (3)				0	NA	NA	18		
Chittenden SWD			41,017	7	6,283	3,296	183	18.9 MRF / 0.9 DO	0.46
Greater Upper Valley SWMD (3)				0	NA	NA	38		
Lamoille Regional SWMD				6	3,597	891	135	0.5	0.13
Londonderry Group				1	1,596	280	39	0.8	0.14
Mad River RMA				0					
Northeast Kingdom WMD			1,860	0	NA	NA	47	0.8	
Northwest Vermont SWMD (4)				6	676	486	77	0.2	0.12
Rutland County SWD	23,831	6,353		1		358	48	12.3	0.15
Solid Waste Alliance Com.				0					
So. Windsor/Windham SWMD				0					
White River Alliance	7,140			1		586	30	4.7	0.38
Windham SWMD			5,122	1	1,202	2,104	42	0.6 DO	0.05
Subtotal:	**43,750**	**13,533**	**47,999**	**23**	**13,354**	**8,296**	**700**		

(1) The facility count does not include the 11 unmanned, 24/7 recycling drop-offs (counted in Table 21 below) maintained and serviced by the Windham District, but the volumes collected at these sites is included.

(2) Tonnage data from 2011 ANR permitted facility reports. For facilities that did not report (or are not permitted), DSM either collected data directly from the facility owner/operator or, for very small facilities, estimated volumes based on the population served.

(3) Both CVSWMD and GUVSWMD do have a collection facility for special waste (See Table 24), but not for MSW and traditional blue bin recyclables.

(4) The Northwest Vermont SWMD public drop-off count includes two sites (Fletcher and Bakersfield) where no volume data was available. Including this tonnage would increase the throughput slightly in the NW District.

(5) Note that the Rutland MRF, whose building is owned by the RSWD but leased to a private operator, is not included in these totals.

The annual throughput (using CY 2011 facility reports) and the hours open for each category of facility (Transfer Station for MSW and C&D, MRF or Small Transfer/Drop-off Facility) was analyzed to calculate the average throughput per hour in tons (tph) at each type of facility. Table 34 shows that the CSWD MRF averaged 18.9 tons per hour (tph) as compared to the Windham dual stream MRF which averaged 2.4 tph and the Northeast Kingdom MRF less than 1 tph (note that the Northeast Kingdom facility does not sort material). The Addison County and Rutland Transfer Station processed an average of 8.9 and 12.3 tph of MSW/C&D to transfer for disposal

[87] There are an additional 11 un-manned drop-offs operated by the Windham District.

[88] Windham's 11 unstaffed 24/7 recycling drop-off sites averaged 181 tons per site. Note that Table 34 presents the average tph of the drop-offs but not the MRF which is reported to be 2.4 tph.

respectively, while the smaller Bethel/Royalton transfer station (that services a much higher percentage of small vehicles) handled 4.7 tph.

Looking at the smaller transfer/drop-off facilities that primarily collect residential waste, all averaged less than 1 tph for combined MSW/C&D, with the highest in the CSWD (0.9 tph) and the lowest in the NWSWD (0.2 tph). For recycling at these drop-offs, throughputs ranged from a high at the CSWD facilities of .46 tph to a low of .05 tph at Windham's Convenience Center. This may be the result of the 24/7 drop-off sites throughout the County that collected almost 2,000 tons in 2011.

Table 35 details the additional sites operated or serviced by solid waste management entities, including the number of sites that provide full service collection of all special wastes and collection of food residuals.

TABLE 35. TOTAL FACILITIES SERVICED OR OPERATED BY VERMONT SOLID WASTE MANAGEMENT ENTITIES AND NUMBER OF FACILITIES THAT COLLECT SPECIAL WASTES, HHW AND FOOD RESIDUALS

SW Planning Entity	Number of Facilities							Total Facilities or Drop Sites (#)
	Transfer Station (#)	MRF (#)	MSW/Recycling Drop-off (#)	Special Wastes (1) (#)	Organics Drop-off (2) (#)	Permanent HHW (#)	Recycling Only (3) (#)	
Addison County SWM District	1		0	1	1	1		1
Bennington RPC			0	0				0
Central Vermont SWMD (4)			0	1				1
Chittenden SWD		1	7	8	8	1		10
Greater Upper Valley SWMD (4)			0	1				1
Lamoille Regional SWMD			6	3				6
Londonderry Group			1	1	0			1
Mad River RMA			0	0				0
Northeast Kingdom WMD		1	0	1	1	1	1	1
Northwest Vermont SWMD			6	2	2	1		7
Rutland County SWD	1		1	1	0	1		3
Solid Waste Alliance Com.			0	0				0
So. Windsor/Windham SWMD			0	0				0
White River Alliance	1		1	1				1
Windham SWMD		1	1	1	3		11	13
Total:	**3**	**3**	**23**	**21**	**15**	**5**	**12**	**45**

(1) Special wastes include furniture/bulky waste; construction debris; appliances; scrap metal; books; clothing & textiles; reusable items; tires; plastic grocery bags; clean wood; yard residuals; and, universal or hard to handle wastes such as household and automotive batteries, cell phones and electronics, fluorescent bulbs, motor oil & filters; paint, and propane tanks. Not all facilities collect all materials – see APPENDIX 1 for details.

(2) Organics drop-off is offered at existing MSW/Recycling drop-off facilities except at CSWD which also operates a separate organics composting facility.

(3) These are additional drop-off sites that only accept recyclables (no MSW).

(4) These sites collect a more limited range of materials – see APPENDIX 1 for details.

(5) Note that the Rutland MRF, whose building is owned by the RSWD but leased to a private operator, is not included in these totals.

Of these 26 transfer stations and/or drop-offs, 18 offer collection of a full range of special wastes, two facilities collect a limited range and one facility collects only brush and wood. A total of 14 of the 26 facilities offer collection of food residuals and one facility collects organics only in large quantities and composts on-site. Appendix B provides the detail of which facilities offer what type of collection.

As described in Section IV. Existing Solid Waste Management Infrastructure, a total of five entities operate permanent HHW collection facilities.

BREAKDOWN OF COSTS AND SERVICES

Thirteen of the sixteen solid waste management entities provided the Project Team with budget detail including an allocation of costs by major expense area, as defined by the Project Team. The Project Team asked each entity to take their expenses and revenues and allocate them across the following areas:

- ***Administration*** - Administration, Planning, and Regulatory functions including licensing of haulers and other regulatory efforts, collection of surcharges, accounting functions, District Board meetings, etc.
- ***Education and Outreach*** - School and civic outreach, provision of free or low-cost compost bins, recycling bins, and educational materials, waste reduction outreach to homes and businesses, and all other activities that raise awareness of solid waste and recycling issues. This might include participation in Green Up Day events, providing electronics collection information, answering questions on where people can bring bulky and special wastes, and attending meetings with Select Board and Councils on materials management issues.
- ***HHW and Universal Waste*** – Permanent programs and collection days (revenues should include State HHW grants, pesticide grants and any CEG user fees).
- ***Operations*** - All solid waste and recycling operations (except for universal waste and special waste) including operating transfer stations and drop-offs, collection of materials for reuse or recycling, MRF operations, organics diversion programs (including any collection, processing or marketing composting yard waste, food residuals, etc.), and disposal costs.
- ***Special Wastes*** (excluding HHW and Universal Wastes) – One day collections and costs for managing bulky wastes including furniture, mattresses, tires and appliances, if available separate from Transfer Station and Drop-off Costs.
- ***All Other Costs*** –Catch-all category that included costs for one bottle redemption operation, debt service, annual capital reserve and closure fund contributions, and participation in product stewardship activities.

Using the cost allocations and the budgets provided, the Project Team consolidated the expense and revenue data from the 13 entities reporting to create Table 36.

TABLE 36. MAJOR EXPENSES AND REVENUE SOURCES FOR SOLID WASTE MANAGEMENT ENTITIES (1)

	Expenses	Revenues	Difference
Major Cost Areas	($)	($)	($)
Administration	$2,733,000	$209,000	($2,524,000)
Education and Outreach	$1,008,000	$10,000	($998,000)
HHW and Universal Waste	$1,557,000	$365,000	($1,192,000)
Operations	$12,044,000	$10,845,000	($1,199,000)
Special Wastes (excluding HHW and Universal Wastes)	$1,039,000	$366,000	($673,000)
Misc	$869,000	$181,000	($688,000)
Total:	$19,250,000	$11,976,000	($7,274,000)

TABLE 36 NOTES:

(1) Note that the cost figures in Table 36 do not equal those presented earlier in Table 33, because data for Table 36 was compiled from only 13 of the 15 entities reporting in Table 33 (one entity is listed in Table 33, but did not report any data), and because Tables 33 and 36 used different budget years for some solid waste management entities. For example, ANR provided $411,000 in HHW grants last year of which a portion is reflected in revenues for HHW and Universal Waste above.

(2) All budget years used were between FY 2012 and FY 2014.

(3) Revenues shown are from user fees, including collection and disposal fees, as well as from grants and other sources than disposal fee surcharges and assessments.

As shown in Tables 33 and 36, solid waste entities spent roughly $20 million on various types of solid waste management activities including operating facilities, conducting collections of HHW and special wastes, performing education and outreach and administering their organizations. To finance this, fees were charged for many services. For examples, hauler licensing fees help offset costs of administering licenses and tracking waste flow and disposal. At transfer stations and drop-offs, volume or weight based fees (per bag, per yard, per ton or per item/unit) for MSW, bulky wastes and C&D wastes are set to cover all or part of facility operating costs as well as trucking and disposal costs.

Finally for HHW and Universal Waste Management, annual state HHW and pesticide grants (of which HHW grants totaled $411,000 last year) help to offset a small portion of the costs as does charging conditionally exempt generators disposal fees for using programs and facilities. These revenues do not come close to what is necessary to pay for these programs. In contrast, at the three material recovery facilities owned or operated by the Districts, revenues often meet or exceed operating expenses. Sales of materials are one of the main sources of revenue with some tip charges levied for certain materials, particularly for out-of-district materials or for materials with very low value. It should be noted that revenue sharing is often offered under periods of high material value.

Figures 11 and 12 below graphically show the costs and revenues by major activity carried out by the solid waste management entities, excluding any surcharges, assessments of solid waste management fees.

FIGURE 11.
SWM ENTITY COSTS BY ACTIVITY

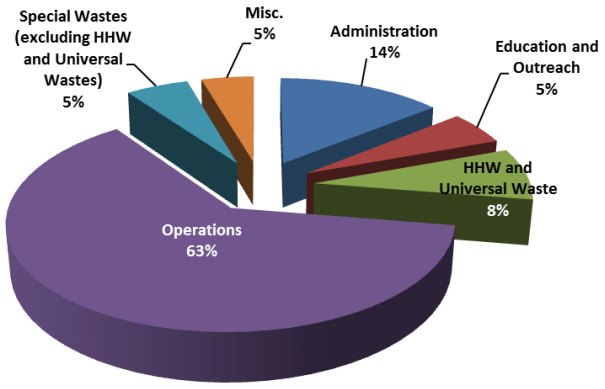
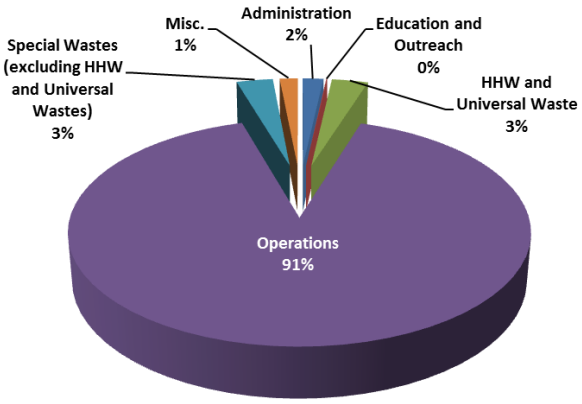
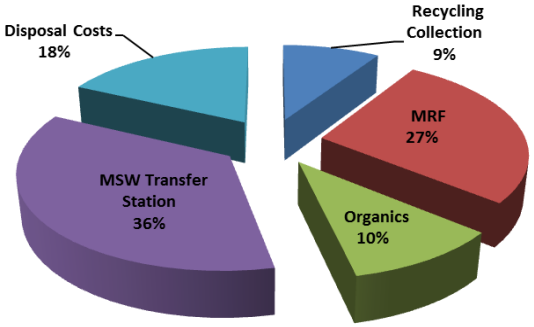


FIGURE 12.
SWM ENTITY REVENUES BY ACTIVITY



Looking more closely at operations, which is the largest cost area for all entities combined, the Project Team roughly categorized costs using budget breakdowns for those entities that did not allocate these costs directly. Figure 13 shows this *rough* breakdown, providing some perspective on the type of facilities that make up these facility operating expenses.

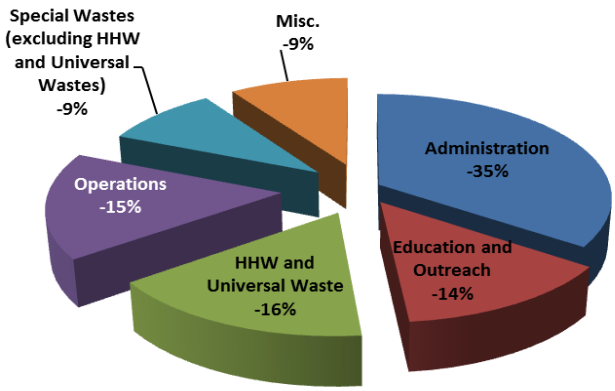
FIGURE 13. ESTIMATED BREAKDOWN OF ANNUAL OPERATIONS COSTS FROM TABLE 36.



As shown in Table 36, revenues collected through user and tip fees, sale of materials, permits and licenses and other charges do not cover all the expenses, leaving over $7 million to be raised from other sources. Surcharges on MSW and C&D disposal and per capita assessments bridge this gap and enable solid waste management entities to perform many services that cannot be covered through user fees.

Figure 14 below shows where these revenue shortfalls are.

FIGURE 14. SWM ENTITY REVENUE SHORTFALL BY MAJOR ACTIVITY



Finally the Project Team analyzed expenses categorized by individual solid waste management entities. Note that Table 37 presents only very rough approximations of costs, and does not necessarily represent approved budgets or actual, full cost allocations. However, these cost data do provide a snapshot of which entities are heavily involved in operations and management of HHW and special wastes as opposed to performing mostly administrative and education and outreach functions. (For a full list of these activities by entity see Appendix B.)

TABLE 37. SOLID WASTE PLANNING ENTITY COSTS ALLOCATED BY MAJOR ACTIVITY

Solid Waste Planning Entity	Administration	*Percent of Budget*	Education and Outreach	*Percent of Budget*	HHW and Universal Waste	*Percent of Budget*	Operations	*Percent of Budget*	Special Wastes	*Percent of Budget*	Other	*Percent of Budget*
	($)	*(%)*	*($)*	*(%)*	*($)*	*(%)*	*($)*	*(%)*	*($)*	*(%)*	*($)*	*(%)*
Addison County SWM District	$175,500	6%	$97,800	4%	$206,100	7%	$1,932,600	70%	$28,200	1%	$314,900	11%
Bennington RPC (1)	$15,000	30%	$25,000	50%	$10,000	20%	$0	0%	$0	0%	$0	0%
Central Vermont SWMD	$344,200	40%	$107,400	13%	$96,700	11%	$287,600	34%	$14,100	2%	$0	0%
Chittenden SWD	$555,600	6%	$497,600	6%	$677,700	8%	$5,962,300	69%	$859,900	10%	$111,300	1%
Greater Upper Valley SWMD (2)	$427,500	64%	$3,200	0%	$33,200	5%	$0	0%	$9,700	1%	$194,100	29%
Lamoille Regional SWMD	$162,700	14%	$79,000	7%	$30,600	3%	$840,000	70%	$11,500	1%	$68,200	6%
Londonderry Group	$9,500	3%	$500	0%	$18,000	5%	$336,000	92%	$0	0%	$0	0%
Mad River RMA	$33,600	35%	$31,500	33%	$28,500	30%	$0	0%	$2,800	3%	$100	0%
Northeast Kingdom WMD	$164,800	27%	$72,000	12%	$79,000	13%	$280,000	47%	$4,000	1%	$0	0%
Northwest Vermont SWMD	$157,200	19%	$69,300	8%	$106,800	13%	$326,000	38%	$72,200	9%	$117,900	14%
Rutland County SWD	$483,000	34%	$6,100	0%	$146,500	10%	$785,700	55%	$14,400	1%	$0	0%
Solid Waste Alliance Com.	$29,800	71%	$0	0%	$12,000	29%	$0	0%	$0	0%	$0	0%
So. Windsor/Windham SWMD	$91,000	54%	$17,000	10%	$62,000	36%	$0	0%	$0	0%	$0	0%
Windham SWMD	$98,400	6%	$26,300	2%	$65,000	4%	$1,294,300	83%	$22,300	1%	$62,000	4%

(1) Bennington's cost allocation was estimated by the Project Team based on limited data provided.
(2) GUVSWMD administration costs include the $90,000 cost (and reimbursement) to investigate waste flows and collect surcharges for other Solid Waste Districts.

As shown in Table 37, five entities (ACSWMD, CSWD, LRSWMD, Londonderry Group and WSWMD) spend around 70 percent or more of their budgets on facility operations. In contrast, five other entities spend nothing on facility operations.

LOCAL GOVERNANCE SUMMARY OF FINDINGS

ANR's approved scope of work specified that the Project Team report on where solid waste management consolidation or reorganization will result in cost savings to the solid waste management system, and in particular report on two areas:

- Identification of entities that are not providing data in a useable or easily referenced format; and,
- Recommend whether solid waste management entity consolidation will lead to more cost effective services.

First, the data maintained and published by most (but not all) solid waste management entities is not particularly helpful for evaluating their individual progress in meeting State Solid Waste Plan or Materials Management Goals. While over 95 percent of the state's population resides in communities with approved SWIPs, there is little or no tracking of progress toward implementation of action items contained in the SWIPs, which are geared toward meeting State Goals. The exception is CSWD, ACSWMD and the NEKSWMD which all calculate a diversion rate annually, tracking all materials diverted in their respective Districts against materials disposed. Other entities do a good job of tracking materials diversion for a wide range of materials, but only for those materials they manage. In addition, solid waste management entities that do not charge a surcharge on disposal, have no idea of how much MSW and C&D is generated for disposal in their regions, making it hard to gauge their progress with waste reduction or diversion.

Some specific needs in regards to data management in most planning regions include:

- More complete tracking of materials diversion within the planning region, particularly of activity outside of drop-offs (and through curbside collection and the commercial sector);

- A better understanding of the role of the private sector, including services offered toward materials diversion and opportunities for partnerships; and

- Development of realistic metrics that can be updated annually to track their performance toward SWIP and State MMP goals.

- More explicit reporting requirements from ANR on HHW quantities and costs would be helpful

For example, the Project Team requested that entities provide an estimate of the tons of printed paper and packaging type materials (fibers, bottles and cans and plastic film and packaging) recycled in their region last year (FY or CY) from the residential and commercial sectors (excluding materials marketed directly from large generators). The Project Team received data back or was able to locate data (on a district website) from only a few districts (CSWD, ACSWD, and NEKSWD) to be able to address this question. Because the private sector plays such a large role in collection of both refuse and recycling in the state, more engagement and tracking of their activity is necessary to work toward SWIP and State goals.

Second, consolidation of some responsibilities of the solid waste planning entities is likely to save money. Looking at the revenue shortfalls identified in Table 36 (a difference of $7.3 million, rounded) and the rough cost allocations shown in Table 37, there is likely to be opportunity to consolidate administrative, education and some areas of operations to free up monies to expand services (operations). For example, reviewing the detailed data in Appendix B on services provided, there may be many areas in which collaboration or consolidation has potential.

For example, websites, brochures, posters, newsletters and news articles are offered to most of the state's population through these entities (See Appendix B) but may be done differently by each entity. Looking at websites alone, there is a fair amount of information that might be created (and updated) once and located on one single statewide website. This includes the educational tools that most entities need and use. This will become even more critical as the aggressive goals of Act 148 are pursued. Since roughly 70 percent of all recyclables collected in the State go through the CSWD and Rutland MRFs (both operated by Casella), the specifications are uniform for all entities delivering material to these MRFs and therefore one site, or set of information could be developed (and referenced or linked on a website) to these specifications.

An even larger cost is administration. Like school districts, small solid waste districts come at a high administrative cost. For those districts that do not collect materials or operate facilities, or have ordinances in place to regulate haulers, consolidation of administrative activities may make a lot of sense. These may include the Greater Upper Valley and Southern Windsor/Windham Counties Districts and the Bennington RPC towns. In addition, the Tri-Town Alliance region (who did not provide any information), and the White River Alliance (who was interviewed and provided budget data), are likely candidates to participate in some regional consolidation, as they do not have administrative and education/outreach staff to track or manage their progress toward waste reduction, making Act 148's goals an even greater challenge for them to meet.

IX. MATERIALS RECOVERY FROM UNIVERSAL SINGLE STREAM WITH AND WITHOUT THE BOTTLE BILL, AND AN EXPANDED BOTTLE BILL

BASELINE MATERIALS RECOVERY

Tables 3 and 23 of this report outline the estimated quantities recycled through the existing recycling infrastructure and Vermont's bottle bill, respectively, and detail the data sources used to make these estimates. Note that so-called "economic recycling," the materials that ICI generators recycle directly through a broker, may not be reported to ANR, and therefore are not included in the current analysis.

The Project Team's estimate of existing material recovery rates for residential and commercial recyclable materials was developed using three primary sources: (1) quantities of Vermont material collected for recycling through existing recycling infrastructure (Table 2) as developed from recycling facility reports submitted to ANR; (2) quantities of material reported as returned through Vermont's Bottle Bill (Table 23); and, (3) Vermont's Waste Composition Study. As summarized in the following equation, dividing the amount of a *specific material recycled* (or group of materials, accounting for losses) by the total amount of the *same material disposed* in the waste stream plus the amount recycled provides the estimated material recovery rate.

Materials Recovery Rate =
(Material Recycled – Losses)/(Material Recycled + Material Disposed)

Note that a materials recovery rate is different from a municipal solid waste recycling or diversion rate. Recycling or diversion rates measure the percent of materials recycled (and/or diverted) divided by *all municipal solid waste disposed* and recycled/diverted. Different jurisdictions calculate recycling or diversion rates quite differently. For example, some recycling or diversion rates include C&D materials along with MSW, while others do not. Also, some jurisdictions include materials used as landfill cover in their diversion rates. And perhaps most controversially, some jurisdictions count materials sent to waste-to-energy incinerators in their diversion rates, while other jurisdictions explicitly prohibit this.

Because of the wide ranges in reported recycling rates, materials recovery rates are a more accurate way to measure the success of recycling programs than recycling rates.

MATERIALS RECYCLED

The Project Team used the most recent materials recycled data that had been fully compiled and vetted by ANR, which is from 2011. Unfortunately the individual facility reports are not consistent in how they report the data. Some report materials received while others report materials sold. Because the Project Team needed to account for losses during processing, all data had to be converted to materials sales to account for loss of contaminants during processing.

The Project Team also needed to account for whether the material was coming from residential or industrial/ commercial/institutional (ICI) sources because the cost analysis for each system requires at least a rough understanding of the underlying infrastructure (see below). The Project Team used the individual facility reports to allocate incoming materials between residential and ICI sources. However, it should be noted that this is an inexact science because no data exist on the actual breakdown of residential versus ICI disposal in Vermont. Ultimately it is

the Project Team's best professional judgment, based on an analysis of the mix of materials delivered to recycling facilities, that 49% of the material recycled in CY 2011 was from residential sources and 51% from ICI sources.

As discussed above in the earlier section on Losses, the Project Team sorted process residue and glass output from the Rutland MRF and requested results for glass and other materials using bale audits from buyers wherever possible. These were incorporated into all the final materials recovery estimates made.

HOW MATERIALS DISPOSED IN VERMONT ARE USED TO ESTIMATE RECOVERY RATES

Some portion of each recyclable material is not captured by the recycling system and ends up in the waste stream. The recently completed Waste Composition Study collected samples of residential waste separate from ICI waste, sorted the samples and developed average values for the percent of each material found in the residential and ICI samples. These average percentages were extrapolated to the total residential and ICI waste tonnages disposed in 2011 to estimate the total tonnage of each recyclable material disposed from residential and ICI sources.[89]

As detailed in the report, 60% of the waste disposed in Vermont is assumed to be generated by residential sources and 40% from ICI sources. Therefore, of the 413,000 (rounded) tons disposed in Vermont in 2011, 248,000 (rounded) were residential tons and 165,000 were ICI tons.

One key area of concern (as discussed in more detail below) is that the calculation of recovery rates for deposit containers based on a comparison of sales data (accounting for out-of-state sales and other factors), recycling tonnage reported to ANR, and the composition of the waste stream indicate very high recovery rates for glass (especially), as well as PET and aluminum under the existing system. If this is the case, then the potential to significantly increase beverage container recovery rates under an expanded bottle bill do not exist.[90]

There are several potential explanations for the computed high recovery rates for the existing system. First, Vermonter's are already doing a relatively good job of recycling beverage containers, both through the existing deposit system and in drop-off and curbside collection programs. This would be consistent with the large investment of both the private sector and the districts in recycling infrastructure and education over the past 20 years.

Second, beverage containers purchased outside of Vermont, but with the deposit indicia are being redeemed in Vermont. This is clearly an issue in Maine where return rates in some southern counties are reported to be well over 100%.

Third, the Waste Composition Study may under-estimate the amount of recyclables in the waste stream – and therefore in the denominator of the recovery rate calculation. While the Waste Composition Study compared Vermont to other states, and found results comparable for most categories, Vermont is undeniably at the lowest end in terms of the number of samples taken and sorted for both residential and ICI waste, leading to any error that may be introduced to have more impact. The Project Team has attempted to account for this by using the high end of the confidence interval for the assumed quantities of bottle bill materials potentially available in the waste stream.

[89] DSM Environmental Services, Inc. and Mid Atlantic Consultants. State of Vermont Waste Composition Study, Final Report, May, 2013. Vermont, Department of Environmental Conservation.

[90] The net result is that additional material diverted under an expanded bottle bill has to come out of existing recycling programs rather than just out of materials disposed.

MATERIALS RECOVERY RATES

Materials recovery rates were estimated for the four systems analyzed, as described in Section II, Methodology:

- ***System 1: Base Case***, which assumes Act 148 was not enacted and all existing programs continue including the bottle bill for carbonated beverage containers and drop-off and curbside collection of the remaining recyclables processed through a combination of single stream, dual stream and source separated facilities.

- ***System 2: Universal Single Stream under Act 148 with no bottle bill*** and reliance solely on an enhanced single stream recycling system with implementation of UBP, public space recycling and universal, parallel access to recycling, all required under Act 148. This should significantly increase household recycling by providing all households who currently do not have parallel access with "free" recycling of all single stream material.

- ***System 3: Universal Single Stream as in System 2 but with the existing bottle bill***, which incorporates the volumes captured under the current bottle bill with the elements of universal single stream, UBP, and public space recycling as described for System 2 above.[91]

- ***System 4: Universal Single Stream as in System 2 but with an expanded bottle bill*** to cover all beverage containers covered by Maine's expanded bottle bill (including water and other carbonated and non-carbonated beverages except dairy products and unprocessed cider) ***.***

In order to estimate materials recovery rates for each material for the Base Case and the other three systems, total generation was estimated for each material by adding the tonnage of material disposed (using the results from the Waste Composition Study) to the tonnage of material recovered (as reported through the bottle bill and reported in the ANR facility reports from curbside and drop-off tonnage (Table 3 and 23). These figures are shown below in Table 38 under the columns "System 1: Baseline". The Recovery Rate for each material is calculated by the tonnage recycled divided by the tonnage generated with generation equal to the sum of tons recycled plus tons disposed (from the Waste Composition Study).

As shown in Table 38, the current materials recovery rate (by weight) is roughly 50 percent for all materials combined for the current ***System 1, Base Case***.

These material recovery rates are different from the state's reported diversion (recycling) rate of 34%, which divides all materials recycled and diverted (e.g., scrap metal, organics and backyard composting, reuse activities, etc.) by the sum of all materials recycled plus all MSW disposed.[92]

[91] Note that the estimate of materials recovery under System 3 is used for System 3(A) because it essentially represents the Base Case with implementation of Act 148.

[92] Recycling rates are notoriously poor ways of measuring success of programs, especially when comparing across states because there is so much variability in what is counted in both the numerator and the denominator. For example, California is often held up as having one of the highest recycling rates in the country, and it may, but there is no way of telling from the reported data, which allows CA municipalities to count sewage sludge and ground C&D used as landfill cover in the recycling rate calculation.

Note that disposal tons for aluminum used beverage containers (UBC), glass and PET include estimated tons disposed of both bottle bill and expanded bottle bill material along with all other aluminum, glass and PET containers, including those used for food and other packaging.[93]

To estimate tons collected for recycling of non-bottle bill material in Systems 2 – 4, generation is multiplied by a recovery rate for each material category (and rounded) to estimate tons recovered. For bottle bill and expanded bottle bill materials, the estimated tons collected are inputs (in tons) from Tables 23 and 24 (and rounded). For Systems 3 and 4, the BB Tons are assumed to be the same volume as used for System 1 (Baseline). For System 4, EBB volumes (from Table 24) are added to the BB volumes and the totals are shown in the column "BB and EBB Tons".

The recovery rates shown in Table 38 are before losses that occur at MRFs, reclaimers, and end users, except for the Base Case system, which represents estimates of materials sold from Vermont and therefore already includes losses incurred at the MRFs, although not at the end user.

It should be recognized that the estimates in Table 38 are made using the best available Vermont-specific data on beverage container and other materials recycling and potentially achievable recovery rates. Because the composition of incoming and outgoing materials at the MRFs and other recycling facilities is not analyzed by MRF operators to report what percentage of each commodity baled is beverage containers (and subject to a BB, EBB or exempt) as opposed to food or other packaging containers, recovery rates for beverage containers outside of the bottle bill cannot be calculated. Instead total recovery rates by material type (including curbside and drop-off and deposit containers) are shown in aggregate.

Table 38 represents the Project Team's best estimates of potential recovery rates under each system given highly performing universal recycling programs in Systems 2-4 and a highly performing EBB program in System 4.

TABLE 38. ESTIMATED RECOVERY RATES BY MATERIAL UNDER EACH SYSTEM

MATERIAL	SYSTEM 1: BASE CASE				SYSTEM 2: USS		SYSTEM 3: USS/BB			SYSTEM 4: USS/BB/EBB		
	Disposed (tons)	Recovery (3) (tons)	Generation (tons)	Recovery Rate (%)	Recovery Rate (%)	USS Tons	Recovery Rate (%)	BB Tons (4)	USS Tons	Recovery Rate (%)	BB and EBB Tons (5)	USS Tons
Aluminum - UBC (1)	870	2,300	3,170	73%	66%	2,080	87%	2,200	560	89%	2,360	460
Glass	5,900	25,300	31,200	81%	61%	19,100	83%	14,300	11,600	84%	20,780	5,400
PET	3,000	2,600	5,600	46%	43%	2,400	48%	1,300	1,400	70%	3,480	450
HDPE	2,000	1,400	3,400	41%	42%	1,425	42%	0	1,425	43%	285	1,175
Other Plastics (2)	7,800	1,500	9,300	16%	24%	2,275	24%	0	2,275	25%	95	2,275
Steel Cans	2,900	1,700	4,600	37%	39%	1,800	39%	0	1,800	39%	0	1,800
Aluminum - Other	210	20	230	9%	22%	50	22%	0	50	22%	0	50
Fibers	73,200	62,100	135,300	46%	68%	91,600	68%	0	91,600	68%	0	91,600
Totals:	**95,880**	**96,920**	**192,800**	**50%**	**63%**	**120,730**	**67%**	**17,800**	**110,710**	**68%**	**27,000**	**103,210**

[93] Glass and PET quantities of beverage containers disposed were taken from the 2012 Waste Composition Study but adjusted up by using the upper end of the confidence interval identified in the Waste Composition Study results to increase disposed volumes of these materials. Without this adjustment, the assumption would have to be that the vast majority of the beverage containers not covered by the bottle bill are already recycled through other facilities. In reality, there is no reason to assume that the high end of the range is any more likely to occur than the lower end of the range, meaning that it is just as likely that the vast majority of beverage containers not covered by the bottle bill are already being recycled.

TABLE 38 NOTES:

(1) Note that recovery rates for Aluminum UBC do not include recovery at scrap metal recycling facilities that do not report to ANR.

(2) Disposed "Other Plastics" include 3-7 bottles, rigid plastics, containers > 1 gallon and thermoforms. Recovery "Other Plastics" as reported by VT DEC.

(3) Recovery under the Base Case includes bottle bill returns and MRF recycling (Table 3).

(4) Bottle Bill tons same as in base case, as shown in Table 23.

(5) EBB tons from Table 24, column "Returns" added to BB tons (Table 23).

As shown in Table 38 above, the overall recovery rate for each system is:

- System 1: Base Case (existing BB, not parallel collection or other elements of Act 148): **50%**
- System 2: Universal Single Stream, No BB: **63%**
- System 3: Universal Single Stream with existing BB: **67%**
- System 4: Universal Single Stream with Expanded BB: **68%**

The Project Team recognizes that material losses both at the MRF and at the reclaimer level reduce the volumes ultimately recovered. These losses are addressed in the series of tables in the next section of the report, and the recovery rates recalculated to reflect losses.

SUMMARY OF FINDINGS, MATERIALS RECOVERY RATE ANALYSIS

There are several critical findings that can be made about the Base Case system which impact on the analysis of future systems under Act 148.

First, the amount of PET captured by the existing bottle bill is almost equal to the amount collected for recycling in the curbside and drop off programs. However, this is not the case for aluminum beverage containers, with over 90% captured by the bottle bill (2,200 of the 2,300 tons reported).

Second, as was discussed in the introduction, fiber (paper) tons dominate the quantities of material collected for recycling outside of the BB. Fiber also dominates the amount of potentially available material remaining in the waste stream.

Third, Vermonters appear to already be diverting very high quantities of glass, both through the BB and through the existing recycling system where 81% of the glass generated was already collected for recycling.[94] After losses, that number is reduced, as shown in the NET RECOVERY figures in Table 39, below. It should be noted that while the Rutland single stream MRF produces a glass product that can be sold to glass beneficiation facilities (Rutland's material is currently shipped to a Strategic Materials facility in Georgia), both the Windham dual stream facility and

[94] Both bottle bill glass and single stream glass that is not used for aggregate goes to glass processing (beneficiation) plants where contaminants (e.g., ceramics, labels, caps and rings, metal and paper) are removed. In most cases the glass pieces are then color sorted if they are greater than 3/8 to 5/8 inch in size and then sold for glass bottle production. Fines and pieces smaller than 3/8 inch which are typically not color sorted can either be sold for fiberglass production, or for non-glass uses. If the smaller pieces are not sold for fiberglass then the glass beneficiation plant may include this material in their loss rate.

the Chittenden single stream MRF sell the majority of their glass for low-end aggregate uses. This may change next year if the Chittenden District upgrades the Chittenden MRF.

Finally, using the 2012 State Waste Composition Study for Base Case data, there is a limit on the quantity of beverage containers disposed that can be diverted from landfills (or WTE facilities) to an EBB. Instead, much of the material captured in an EBB must be diverted from MRFs or other municipal recycling collection. This results in lower recovery of beverage containers through MRFs under System 3 and 4 than through System 2 where there is assumed to be no BB and recovery of beverage containers is only through MRFs and other recycling facilities.

POTENTIALLY ACHIEVABLE MATERIALS RECOVERY RATES

As stated above, Act 148 creates most of the key incentives for achieving high materials recovery rates including:

- Mandatory variable rate pricing (UBP) for residential MSW and recycling with the cost of recycling "embedded" in the cost of MSW, and therefore appearing "free" to the household; and,

- Parallel collection of recyclables – recycling collection in the same way as MSW collection.[95]

In addition, the above recycling collection requirements will expand access to and participation in single stream collection of a wide range of recyclable materials, with the majority of the households in Vermont capable of recycling the same set of materials.

The Project Team has made the assumption that under this set of infrastructure and incentives, households in Vermont can be expected to achieve materials recovery rates averaging 60 percent without a bottle bill – and higher with a BB or an EBB.

ANR requested that the Project Team provide examples of other programs that had achieved these material recovery rates.

Three sets of data are presented. The first is a compilation of material capture rate (or recovery rate) data collected by DSM from various recycling programs around the United States over the past 15 years. Each of these data represent actual on-route collection and sorting of MSW and recycling from representative routes in each of the municipalities represented in Table 39.

As illustrated by Table 39, overall material recovery rates of 60 percent and above have been achieved in a number of municipalities and a number of programs for at least the last 15 years. All of these data are exclusive of bottle bill material; although, obviously the data from Massachusetts and Iowa represent municipalities in BB states.

[95] As discussed in the Implementation section of this report Act 148 simply requires that all haulers that collect refuse offer recycling collection with the cost embedded in the refuse collection invoice. The Project Team has assumed that ANR and/or districts will adopt rules designed to encourage collection on the same day as refuse to reduce confusion and increase recovery rates.

TABLE 39. MATERIAL RECOVERY RATES MEASURED BY DSM (1)

City	Year	Recovery Rate (%)
Boston, Mass		
W. Roxbury	1998	65%
Roslindale		60%
Cambridge, Mass	2003 - 04	
Tuesday		74%
Wednesday		64%
Thursday		38%
Friday		69%
ECICOG (Iowa)	2002	
Cedar Rapids		67%
Iowa City		59%
Marion		77%
Iowa County		89%
Dublin, Ohio	2005	
Dublinshire		67%
Brandonway		59%
Control		77%
Columbus, Ohio		
Split Cart Pilot	2001	76%
Worchester	2002	
Wednesday		49%
Thursday		64%

(1) In each case the recovery rates presented are a sum of the individual material recovery rates.

Second, DSM has worked with the Chittenden Solid Waste District to evaluate the success of their recycling programs.[96] Data compiled by DSM combined with data compiled by Nancy Plunkett of the CSWD indicate that the CSWD had an overall residential materials recovery rate of roughly 62 percent in 2007.

Third, Seattle, which is often held up as one of the highest achieving cities in the U.S. with respect to materials (and organics) recycling conducted MSW and recycling sorting in 2010.[97] Total tonnages of materials found in the waste stream and collected for recycling were calculated based on the waste and recycling composition studies.

[96] *Letter Report, Analysis of Residential Waste Generation and Recovery in the Chittenden Solid Waste District and Opportunities for Increased Recycling,* June 15, 2007, Prepared by DSM Environmental Services, Inc.

[97] *2010 Residential Waste Stream Composition Study, Final Report*, Prepared for Seattle Public Utilities, Prepared by Cascadia Consulting Group; and *2010 Residential Recycling Stream Composition Study, Final Report,* Prepared for Seattle Public Utilities, Prepared by Cascadia Consulting Group.

While data on materials capture (recovery) rates were not reported in these two studies one can sum the quantities of materials found in both studies and develop materials recovery rates as follows:

- Corrugated Containers: 87%
- Newsprint 93%
- Mixed Paper 63%
- Plastic Bottles 63%
- PET 68%
- Rigid Plastic Containers 61%
- Glass[98] 121%
- Aluminum Beverage 66%
- Steel (Tin) Cans 62%

INCORPORATING LOSSES TO ESTIMATE ACTUAL MATERIALS RECOVERY

Tables 40 – 43 take the quantities shown in Table 38 that are assumed to be collected for recycling and apply losses that occur first at the MRF/processing facility and then at the end user or reclaimer facility. Table 40 illustrates the Base Case system (System 1) which has already accounted for losses at the materials recovery facility and reflects estimated materials sold. Note that the losses in these tables are lower than those in the Interim Report because, as directed by ANR, actual losses based on materials audits from the Rutland MRF, as opposed to US averages, are now incorporated. This is referenced in the footnotes to Table 40, and described in more detail in Section 3, Material Losses and shown in Table 4.

[98] Just as the Project Team has struggled with very high glass recycling rates in Vermont, this is clearly an issue in the Seattle waste and recycling composition studies as well.

TABLE 40. SYSTEM 1, BASE CASE, ESTIMATED NET MATERIALS RECOVERY

SYSTEM 1: BASE CASE	COLLECTED AND PROCESSED		LOSSES		NET RECOVERY
Material	Vermont BB (1) *(tons)*	MSW Recycling (2) *(tons)*	Processing Residue (%)	End User Residue (3) (%)	Total *(tons)*
Aluminum - UBC	2,200		Current system assumes volumes reflect materials sold, after losses.	1%	2,180
Glass Beverage	14,300			2%	14,090
PET Beverage	1,300			7%	1,210
Other Plastic and Steel Beverage	0				0
Subtotal, BB:	**17,800**				**17,480**
Subtotal, Fibers:		**62,100**		2%	**60,570**
Aluminum - UBC (4)		100		1%	100
Aluminum - Other (4)		20		1%	20
Glass (5)		11,000		11%	9,790
PET (6) (7)		1,300		7%	1,210
HDPE Plastics (7) (8)		1,400		7%	1,300
Other Plastics (8)		1,500		7%	1,400
Steel Cans		1,700		5%	1,620
Subtotal, Containers:		**17,020**			**15,440**
Total Collection:	**17,800**	**79,120**			
TOTAL RECYCLED:					**93,490**
Percent Lost (9):					**5%**
Recovery Rate:					**48%**

(1) Source: Northbridge Environmental, Vermont Bottle Bill Analysis, July 2013, rounded to indicate estimate.

(2) Source: 2011 VT DEC Solid Waste Facility Reported Volumes adjusted for residue and material losses at MRF, and misreporting of VT material by one processor. Totals are estimated processed recycling volumes sold, and exclude economic recycling activity with the exception of Canusa who reports to VT DEC. Note that numbers shown are rounded to the nearest 100 tons, so may not equal Table 3 exactly.

(3) Losses reflect estimated average residue percentages reported by buyers for materials delivered from Vermont MRFs.

(4) Estimated loss in baled material sold as confirmed by buyers.

(5) Glass Losses Source: Strategic Materials, Mixed Glass - Test Report - Casella MRF's (January 1 – May 6, 2013). Note that subsequent to the draft report Strategic has reported that the loss rate is 13% instead of 11% however they have not provided audit reports to document this change, and the change is insignificant enough to have a minimal impact on this analysis.

(6) Source: E-mail communication with Haycore, who purchases PET from both the CSWD and Casella/Rutland MRFs.

(7) Both CSWD and Rutland MRF positively sort PET and HDPE reducing buyer/reclaimer losses.

(8) Assumed same loss rate for HDPE and Other Plastics as PET.

(9) Loss rate shown accounts for assumed losses associated with sold commingled material, which have already been adjusted in MSW Recycling totals.

The materials at the top of Table 40 focus on beverage containers separate from all other materials in the lower rows. Note that while aluminum cans, glass and PET can be reported as beverage containers under the bottle bill, in a MRF they are simply a commodity (aluminum , PET or glass) and sold without a distinction between bottle bill and other material. Therefore calculating precise recovery of beverage containers occurring outside of a redemption system is not possible.

The tons of materials collected and processed are totaled first before losses occur and again after taking into account losses at the MRF, and at the reclaimer. The total quantity recovered is summed and the ***percent lost*** calculated for the entire system. Finally, the ***recovery rate*** is recalculated for each system taking into account these losses.

Tables 41 – 43 illustrate the impact of losses on Systems 2 – 4 using the estimated tons recovered under each system shown in Table 38.

Note that in Table 41, System 2 (Universal Single Stream with No Bottle Bill), beverage containers that would be covered under a BB (or an EBB) are instead assumed to be collected curbside (or at a drop-off) with other materials that are not subject to the BB (or an EBB). These are shown in the top rows under beverage containers and include materials formerly collected through the BB redemption system.

In System 3 and 4, (Tables 42 and 43) beverage containers recovered in the single stream system are shown separately from material collected through the BB and EBB redemption systems. In System 4 (Table 43), the estimate for beverage containers collected drops to 1,040 tons, since the EBB covers wine bottles, still water and other beverage containers which would divert these materials from MRFs and other municipal recycling programs.

TABLE 41. SYSTEM 2, UNIVERSAL SINGLE STREAM AND NO BOTTLE BILL, ESTIMATED NET MATERIALS RECOVERY

SYSTEM 2: USS	COLLECTED AND PROCESSED	LOSSES		NET RECOVERY
	MSW SS Recycling	Processing Residue (1)	End User Residue (2), (3)	MSW Recycling
Material	*(tons)*	(%)	(%)	*(tons)*
Aluminum Beverage	1,900	17%	1%	1,560
Glass Beverage	11,000	4%	11%	9,400
PET Beverage	1,800	1%	7%	1,660
Other Plastic and Steel Beverage	300	17%	7%	230
Subtotal:	**15,000**			**12,850**
Subtotal, Fibers:	**91,600**	2%	2%	**87,560**
Aluminum - UBC	180	17%	1%	150
Aluminum - Other	50	17%	1%	40
Glass	8,100	4%	11%	6,920
PET	600	1%	7%	550
HDPE Containers	1,200	1%	7%	1,110
Other Plastics	2,200	1%	7%	2,030
Steel Cans	1,800	1%	5%	1,690
Containers:	**14,130**			**12,490**
Total Collection:	**120,730**			
TOTAL RECYCLED:				**112,900**
Percent Lost:				**6%**
Recovery Rate				**59%**

(1) Losses into processing residue at the MRF or processing facility. Note that "Other Plastic and Steel Beverage" losses at MRFs are estimated based on Aluminum UBC losses measured at Vermont MRFs, and shown in the lower portion of the table.

(2) Losses reflect estimated average residue percentages reported by buyers for materials delivered from Vermont MRFs. This includes losses at PET reclaimers.

(3) See previous table for losses detail, which is carried through all tables.

TABLE 42. SYSTEM 3, UNIVERSAL SINGLE STREAM WITH CURRENT BOTTLE BILL, ESTIMATED NET MATERIALS RECOVERY

SYSTEM 3: USS/BB	COLLECTED AND PROCESSED		LOSSES		NET RECOVERY	
	Vermont BB	MSW SS Recycling	Processing Residue (1)	End User Residue (2), (3)	Vermont BB/EBB	MSW SS Recycling
Material	*(tons)*	*(tons)*	(%)	(%)	*(tons)*	*(tons)*
Aluminum Beverage						
BB	2,200			1%	2,180	
MSW SS		400	17%	1%		330
Glass Beverage						
BB	14,300			2%	14,090	
MSW SS		3,500	4%	11%		2,990
PET Beverage						
BB	1,300			7%	1,210	
MSW SS		800	1%	7%		740
Beverage						
BB	0			7%	0	
MSW SS		300	17%	7%		230
Subtotal, BB:	**17,800**	**5,000**			**17,480**	**4,290**
Fibers		**91,600**	2%	2%		**87,560**
Aluminum - UBC		160	17%	1%		130
Aluminum - Other		50	17%	1%		40
Glass		8,100	4%	11%		6,920
PET		600	1%	7%		550
HDPE Plastics		1,200	1%	7%		1,110
Other Plastics		2,200	1%	7%		2,030
Steel Cans		1,800	1%	5%		1,690
Subtotal, Containers:		**14,110**				**12,470**
Total Collection:	**17,800**	**110,710**				
TOTAL RECYCLED:						**121,800**
Percent Lost:						**5%**
Recovery Rate						**63%**

(1) Losses into processing residue at the MRF or processing facility.

(2) Losses reflect estimated average residue percentages reported by buyers for materials delivered from Vermont MRFs.

(3) See previous table for losses detail, which is carried through all tables.

TABLE 43. SYSTEM 4, UNIVERSAL SINGLE STREAM WITH EXPANDED BOTTLE BILL, ESTIMATED NET MATERIALS RECOVERY

SYSTEM 4: USS/BB/EBB	COLLECTED AND PROCESSED		LOSSES		NET RECOVERY	
	Vermont BB/EBB	MSW SS Recycling	Processing Residue (1)	End User Residue (2), (3)	Vermont BB/EBB	MSW SS Recycling
Material	*(tons)*	*(tons)*	(%)	(%)	*(tons)*	*(tons)*
Aluminum Beverage						
EBB	2,360			1%	2,340	
MSW SS		300	17%	1%		250
Glass Beverage						
EBB	20,780			2%	20,470	
MSW SS		600	4%	11%		510
PET Beverage						
EBB	3,480			7%	3,240	
MSW SS		0	1%	7%		0
Other Plastic and Steel Beverage						
EBB	380			7%	350	
MSW SS		300	1%	7%		280
Subtotal, BB:	**27,000**	**1,200**			**26,400**	**1,040**
Fibers		**91,600**	2%	2%		**87,560**
Aluminum - UBC		160	17%	1%		130
Aluminum - Other		50	17%	1%		40
Glass		4,800	4%	11%		4,100
PET		450	1%	7%		410
HDPE Plastics		950	1%	7%		880
Other Plastics		2,200	1%	7%		2,030
Steel Cans		1,800	1%	5%		1,690
Subtotal, Containers:		**10,250**				**9,280**
Total Collection:	**27,000**	**103,050**				
TOTAL RECYCLED:						**124,280**
Percent Lost:						**4%**
Recovery Rate						**64%**

(1) Losses into processing residue at the MRF or processing facility.
(2) Losses reflect estimated average residue percentages reported by buyers for materials delivered from Vermont MRFs.
(3) See previous table for losses detail, which is carried through all tables.

Key assumptions used and findings from Tables 40 - 43 above are:

- Because Vermont recycles glass bottles at a high percentage under the current (Base Case) system, a majority of any increase in glass recycling associated with an EBB has to occur by pulling glass out of the existing recycling system, as not enough is currently available from the disposed waste stream.
- The Project Team assumed a 75% return rate for all PET under the EBB. This is consistent with the return rate for PET under the existing bottle bill but may over-estimate initial PET recovery given the

first year report of a 57% return rate in Connecticut, which expanded its bottle bill to cover bottled water.

- The EBB is estimated to increase tons of PET recovery by 150% (3,930 tons, total before losses). However, 1,200 tons of the 3,930 tons are estimated to come out of the existing recycling system, with the rest diverted from disposal because there aren't enough tons available in Vermont's waste stream based on the Waste Composition Study.
- Similarly, recovery of aluminum is expected to increase under an EBB, but much of this increase is expected to come from MRFs instead of being diverted from disposal, since so little aluminum is found in Vermont's refuse.

Several stakeholders raised concerns during comments on the Interim Report about what the impact of an EBB would be on MRF revenues. Table 44, below provides a rough estimate of material losses and net revenues, after processing costs from MRFs under an EBB. Aluminum values are estimated at $1,600 per ton (80 cents per pound) and PET at $575 per ton. It is interesting to note that so little aluminum is now going to Vermont MRFs, and so little new aluminum would be diverted under an EBB, that the impact of losses under an EBB is assumed to be primarily associated with PET. The losses represented in Table 44 come from bottle bill material that is currently going to Vermont MRFs, not from bottle bill material being disposed.

TABLE 44. ESTIMATED MATERIALS DIVERTED FROM VERMONT MRFS UNDER SYSTEM 4, UNIVERSAL SINGLE STREAM WITH EBB

Lost from MRFs to EBB	Volume	Revenues
Material	(tons)	($)
Aluminum Beverage	-120	-$192,000
Glass Beverage	-5,600	$0
PET Beverage	-1,200	-$692,143
Total:	**-6,920**	**-$884,143**

Conversely, Table 45 presents rough estimates of potential material gains (and estimated revenues) to MRFs under Universal Single Stream without a BB. The increased glass delivery is a net loss to the MRFs, while the increase in aluminum is a significant gain to the MRFs. The change for PET is not as great because not as much PET is currently being diverted through the current BB and PET has a lower commodity value than aluminum.

TABLE 45. MATERIALS ESTIMATED TO BE DIVERTED TO MRFS UNDER SYSTEM 2 (UNIVERSAL SINGLE STREAM, WITH NO BOTTLE BILL)

Gains to MRFs under USS	Volume	Processing Costs	Revenues	Net
Material	(tons)	($)	($)	($)
Aluminum Beverage	1,620	-$113,400	$2,592,000	$2,478,600
Glass Beverage	6,630	-$464,100	$0	-$464,100
PET Beverage	1,270	-$88,900	$732,518	$643,618
Total:	**9,520**	**-$666,400**	**$3,324,518**	**$2,658,118**

X. COST ANALYSIS

Costs were estimated for each component of each of the four Solid Waste Systems and are detailed below. Because the bottle bill or expanded bottle bill are inserted as a separate cost for all systems except System 2, this section begins with a description of how the bottle bill and expanded bottle bill costs were calculated. It is then followed by a description of the major assumptions used to estimate all other costs in the system cost analysis.

ESTIMATED COSTS OF CURRENT BOTTLE BILL AND AN EXPANDED BOTTLE BILL

The cost analysis for the bottle bill is presented in Table 46 at the end of this section[99].

The annual net costs of the bottle bill (BB) and expanded bottle bill (EBB) at the bottom of Table 46 are carried as a single row across the nine years for each of the four systems analyzed (Tables 52 – 55). The BB net cost is carried in the Base Case (System 1), and in System 3, USS plus BB. The Expanded Bottle Bill (EBB) net cost is carried forward in System 4 (USS plus EBB). Each system adjusts for the diversion of materials associated with the BB or EBB, both in terms of materials sales from VT MRFs, and in terms of reduced disposal tons.

EXISTING BOTTLE BILL

As stated in the Section II, above, much of the cost data necessary to analyze the beverage container deposit system are available only to the distributors, or to the third party contractor for the distributors collecting empty containers from redemption centers. While this may be appropriate because ultimately the distributors are financially responsible for the costs of the system, it makes it difficult to independently analyze system costs. This lack of available data is not unique to Vermont. Maine (the only state outside of Hawaii and California with a fully expanded bottle bill incorporating all beverages), for example, faces the same lack of access to data.[100]

Each major cost category presented in Table 46 is summarized below.

STATE ADMINISTRATIVE COSTS

Vermont currently has very low administrative costs, reported at $21,500. This would, of necessity have to change with an Expanded Bottle Bill because there would be so many non-Direct to Store Delivery (DSD) products being sold into the State (see discussion of DSD sales in Section V above). Maine currently carries an administrative and enforcement budget of $250,000. This budget has been reduced proportionately for Vermont, and assumed to be $150,000 for System 4.

[99] Table 46 was presented in the Interim Report as Table 9. It has subsequently been updated to reflect, as best as possible, comments received by stakeholders on the Interim Report.

[100] The Maine Department of Agriculture is responsible for monitoring that state's bottle bill system. A 2007 Department report required by the Maine Legislature states *"In developing a logical response for this report the Department found that its ability to quantify this information was impeded by the lack of appropriate statutory authority. The Department has no legal basis to officially access, audit and verify the information contained in this report. All information was obtained voluntarily from 'initiators of deposit', commingling groups, redemption centers and contracted agents."*

DISTRIBUTORS – SALES AND RETURN DATA

Northbridge is responsible for monitoring and auditing the commingling agreement that many of the distributors have for collection of beverage containers in Vermont.[101] The distributors agreed to contract with Northbridge to collect and consolidate confidential data on sales and returns as well as third party collection costs under the comingling agreement; distributor costs for collection of non-comingled containers (primarily from on-premise accounts); and, other distributor costs associated with handling and administering the program. Northbridge provided the Project Team with this information under a confidentiality agreement. The Project Team then met with Northbridge to review the underlying data in detail, and subsequently revised data based on input from the Container Recycling Institute (CRI). See Sections above titled, *Vermont's Bottle Bill,* and *Estimated Recovery under an Expanded Bottle Bill* for a discussion of the sales and returns data sets and adjustments to the estimates that were made.

RETAILERS

The Project Team received confidential data from one large supermarket chain in Vermont on their costs to redeem containers using Reverse Vending Machines (RVMs). The Project Team also received information from TOMRA, a major vendor of RVMs and service provider for the collection and processing of bottle bill material. Data from this retailer and from TOMRA augmented data from DSM's 2007 handling fee study performed for ANR, which included extensive surveying of redemption centers, and an earlier study for Massachusetts DEP on retail redemption costs. In addition, Northbridge provided confidential data based on their survey of retailers for the distributors.

The Interim Report carried a retailer cost of 5 cents per container for containers redeemed through a reverse vending machine (RVM). TOMRA objected to this cost and stated that the actual cost per container for RVM redemptions was between 1 cent and 1.34 cents. As with third party collection costs, ANR requested that TOMRA and Northbridge provide detailed back-up data to support their estimated costs. Northbridge supplied this backup information to ANR on May 15. TOMRA supplied limited data to ANR on May 31.

A careful review of the Northbridge and TOMRA data indicated that the TOMRA data only covered the actual lease and servicing cost of the RVM machines while the Northbridge data covered all other in-store costs. As stated above, DSM carried out a detailed analysis of retailer RVM costs in Massachusetts in July 1999. This analysis showed that while RVM lease and servicing costs ranged from 1 to 1.5 cents per container, when in-store costs were added to the RVM leasing costs, total costs ranged from 3.4 to 6.8 cents per container for an average of 5.1 cents per container.[102]

While it is certainly possible that RVM lease and servicing costs have come down since 1999, TOMRA has not provided detailed retailer data to dispute the Northbridge survey data. In addition, RVM costs are very scale dependent, with higher volumes significantly lowering per container costs. While the Project Team believes that the 5 cent per container cost is reasonable for the current BB, it has *lowered the cost to 3.4 cents per container* for

[101] The commingling agreement allows participating distributors to pay a 3.5 cent handling fee per container instead of 4 cents to redemption centers because the redemption centers can commingle containers by material type and not also by brand. Repayment of deposits and handling fees are then paid by participating distributors based on reported sales data as opposed to actual container redemption based on brand counts.

[102] *Commonwealth of Massachusetts Bottle Bill Redemption Fee Study,* prepared for MA DEP, Prepared by DSM Environmental Services, Inc., July 1999

the current BB (the low end of DSM's Massachusetts's retailer survey data) for the BB, and has carried 4.1 cents per container for the EBB (a 20 percent increase); because of the significant amount of additional PET which will either require additional retailer time to empty or require shredding in the RVM which will lower the PET values.

CONSUMERS

The Project Team conducted 364 surveys of consumer behavior at redemption centers at eight locations throughout Vermont, including Barre, Rutland, Burlington, and Brattleboro. The Beverage Baron & Redemption located in Barre agreed to work with the Project Team to set up and test the initial survey questions, and to identify additional redemption centers willing to allow surveying. The survey results are provided in Appendix D. The survey was primarily designed to learn whether consumers traveled out of their way to redeem containers, and if so, how far, as well as how often they redeemed containers and how many containers they redeemed each time they visited a redemption center. Any mileage driven out of the consumer's way could be the result of a separate or "special" trip made for the purpose of returning the bottles and cans, or a combined trip on another errand that still required the consumer to drive some distance out of their way to deliver containers to the redemption center.

ANR received a significant number of comments on the Interim Report stating that it was inappropriate to include consumer travel to redeem containers if they went out of their way to do so. However the Project Team believes that in fact it is essential to carry these costs given that Act 148 specifically requires parallel collection of recyclables with MSW in all cases in Vermont. One of the largest problems with the BB or EBB is that it is not a parallel collection system, but instead is an entirely separate system designed to manage one portion of the recyclable materials.

The Project Team has instead attempted to address the comments received about including separate trips by specifically accounting for all separate trips to drop-off and transfer stations incurred to drop off MSW and recyclables in Vermont. This significantly increases the total system cost for System 2 (no BB) because a relatively large portion of Vermont households drive to transfer stations to deliver their MSW and recyclables. As discussed above, these households avoid the cost incurred by private haulers collecting MSW and recyclables, but they incur their own costs instead, and these costs are incorporated in the systems analysis.[103]

The issue of separate trips becomes even more critical when mandatory separation of food residuals is required under Act 148 in 2020, but haulers are not required to embed the cost of separate collection of organics in their refuse and recycling collection invoice. The result will certainly be increased separate trips by residents trying to avoid the cost of separate organics collection. Failure to account for this cost will lead to under-estimation of the true cost of this new requirement in Act 148, and will also ignore the environmental impacts associated with additional trips to drop off locations.

[103] One of the first articles on the role of special trips on total system costs was published jointly by DSM and Porter Ball, then working for the ANR in Resource Recycling Magazine in September 1993. This article demonstrated that it would be cheaper for residents of Cornwall and Orwell in Addison County to contract for roadside collection of refuse and recycling than to drive their recyclables to a drop-off facility. Subsequently DSM has conducted extensive surveying of the behavior of households driving recyclables to drop-offs in Iowa, Ohio, Delaware, and Tennessee. DSM's research on special trip costs in Columbus, OH and Knoxville, TN helped those city councils decide to implement city-wide curbside collection programs for recyclables instead of relying of drop-off recycling facilities.

Because of the controversy surrounding separate trips, the Project Team has included a sensitivity analysis where all special trips (for BB, refuse and organics) are eliminated so that those readers who object to the inclusion of separate trips can see what impact separate trips has on total system costs.

REDEMPTION CENTERS

DSM conducted an extensive analysis of redemption center handling costs for the VT ANR in 2007[104]. This study formed the basis for the current handling fee paid by distributors in Vermont, which is 3.5 cents per container for comingled containers and 4 cents per container for brand and material separated containers. Average costs from the 2007 analysis were updated to 2012 using CPI adjustments to estimate current handling costs for the existing system.

It should be noted here that the 3.5 and 4 cent average masked very large variations in actual handling costs for retailers and redemption centers. Large redemption centers can operate at significantly lower costs per container (which is one reason some redemption centers pay out more than the 5 cent deposit), while smaller redemption centers, small grocery stores, and supermarkets leasing RVM machines may have costs significantly above the average.

The blended handling costs under an EBB have been increased to reflect the large number of lightweight PET containers that redemption centers will have to count and store, as well as the large increase in sorting categories necessary to deal with non-DSD containers[105].

THIRD PARTY COLLECTION

While some distributors collect the majority of their empty containers (e.g., Coca-Cola Bottling Company of Northern New England – CCNE; many distributors contract with a third party to collect their empty containers. Vermont Commingling Group, LLC/TOMRA (TOMRA) is the contractor for most distributors in Vermont. TOMRA enters into separate proprietary contracts with each distributor for third party collection of material. The contracts include the fees for TOMRA services and specify who owns the resulting materials. These contracts are not available to the Project Team, so costs for third part collection must be estimated based on data provided by certain distributors and by TOMRA directly.[106]

The Project Team met with TOMRA at their Essex facility to conduct due diligence on third party collection costs, and to understand where the containers that are collected are sent for processing. TOMRA also submitted verbal comments at the public hearing on the Interim Report disputing the third party collection costs presented in the Interim Report, stating that they were in fact 1 cent per container, not the 1.9 cents per container used in the Interim Report.

[104] *The Costs of Beverage Container Redemption in Vermont*, June 30, 2007, prepared for VT ANR by DSM Environmental Services, Inc.

[105] Because the handling fee is fixed, it has not been increased above 4 cents, although it is likely that an EBB would result in requests for higher handling fees going forward.

[106] According to Northbridge, which collected survey data representing 88 percent of returns: 10.3% of returns went through Reverse Vending Machines (RVM's), some of which are owned by TOMRA, but some of which are owned by retailers and some of which are owned by ENVIPCO; 60.3% were collected under commingling agreements – primarily by TOMRA; 18.6% were collected by company pick-ups; and, the remaining 10.7% were collected by other third parties but assumed to be sorted by TOMRA.

Subsequent to the public hearing ANR sent out a written request to both Northbridge and TOMRA to attempt to reach consensus on third party collection costs. Ultimately Northbridge provided detailed data on their survey results. TOMRA provided limited data to support their contention that the cost was only 1 cent per container. However, the Northbridge survey data provided to the Project Team is significantly more comprehensive than the data provided by TOMRA. More importantly, the TOMRA data only reflects TOMRA collection costs while the Northbridge survey encompasses the remaining 40 percent of containers that are not collected by TOMRA under comingling agreements.

As with redemption center costs, the average masks large variations in actual third party collection contract costs, which are negotiated separately by each distributor and which can include significant variation in who receives what percent of material value. TOMRA has provided limited data to ANR arguing that this cost is higher than what TOMRA receives under its collection contracts. However the Project Team has not been provided any data to independently verify this statement.

Because not all material is collected by TOMRA, and it is likely that distributors incur costs outside of the TOMRA contract the Project Team has *carried a revised third party cost of 1.5 cents per container*. This cost has been increased by 20 percent for the EBB to reflect the impact that collecting lightweight PET bottles will have on collection truck/trailer capacity.

MATERIAL REVENUES

Bottle bill material is typically cleaner than the same material coming out of single stream MRF's because it has not been comingled with food containers and is typically not compacted. As such it typically commands a premium over SS material.

Beverage containers redeemed at redemption centers are either collected directly by TOMRA under a contract with the distributors or, separately by a distributor and eventually transferred to a TOMRA facility. Material collected in the northern part of the state is brought back to TOMRA's warehouse in Essex, VT where ten percent of the bags are audited to assure that redemption centers are paid for accurate counts of containers per bag. The containers are then commingled by material type and consolidated for shipment. PET containers are delivered to PET reclaimers, glass is shipped as mixed color cullet to glass beneficiation facilities, and aluminum is baled and sold to aluminum manufacturers. Material collected in the southern part of the state is transported to TOMRA facilities in Connecticut and New York for consolidation and auditing, and then is shipped to processors in southern New England.

The Project Team visited glass and PET processing facilities accepting bottle bill and single stream materials to learn about rates of contamination associated with both systems and to learn what the price premium for bottle bill materials were over single stream materials. Table 46 assumes that the distributors retain 100 percent of the value of the materials sold, and that PET and aluminum beverage bale prices are higher than for single stream PET and aluminum;[107] further that bottle bill glass is worth $20 per ton when compared to zero for single stream glass.[108]

[107] Comments were received from the CSWD and Casella that the spread between bottle bill aluminum and PET and the single stream aluminum and PET produced in Vermont was less than 10 cents per pound based on the quality of the material coming out of the SS MRFs. Discussions with Haycore, the PET buyer indicate that that is the case, and the aluminum bale quality provided by Casella to the Project Team also indicates that the aluminum

TABLE 46. COSTS OF THE CURRENT BOTTLE BILL AND ESTIMATED COSTS OF EXPANDED BOTTLE BILL

Parties and Cost/Revenue Components	Cost Per Container ($)	BOTTLE BILL		EXPANDED BOTTLE BILL	
		# Containers	Total Cost ($)	# Containers	Total Cost ($)
State Administrative Costs			***($21,500)***		***($150,000)***
Distributors					
Deposits collected	0.05	*270,382,907*	$13,519,145	*383,230,704*	$19,161,535
Deposits redeemed	0.05	*241,948,783*	($12,097,439)	*324,966,302*	($16,248,315)
Deposits collected, wine	0.15			*9,846,154*	$1,476,923
Deposits redeemed, wine	0.15			*7,384,616*	($1,107,692)
Handling fees paid out					
Commingled	0.035	*183,881,075*	($6,435,838)	*217,628,096*	($7,616,983)
Sorted	0.04	*58,067,708*	($2,322,708)	*117,184,360*	($4,687,374)
Collection costs (third party & owı	0.015	*241,948,783*	($3,629,232)	*334,812,456*	($6,026,624)
Materials revenue received					
Aluminum		*146,174,028*	$3,750,899	*153,765,729*	$5,564,228
Plastics		*35,946,008*	$789,228	*107,765,988*	$1,872,642
Glass		*59,809,251*	$332,129	*70,540,336*	$293,790
Liquor Glass				*7,384,616*	$110,831
Sub-Total, Distributors			***($6,093,816)***		***($7,317,871)***
Vermont Liquor Control					
Deposits collected	0.150	*3,745,035*	$561,755	*3,745,035*	$561,755
Deposits paid out	0.150	*2,860,458*	($429,069)	*2,860,458*	($429,069)
Collection Cost	0.078	*2,860,458*	($223,116)	*2,860,458*	($223,116)
Handling fees paid out	0.035	*2,860,458*	($100,116)	*2,860,458*	($100,116)
Materials revenue received	0.000				
Sub-Total, VLC			($190,545)		($190,545)
Retailers/Redemption Centers					
RVM costs	0.034	*24,194,878*	($822,626)	*48,744,945*	($1,657,328)
Manual costs	0.038	*217,753,905*	($8,239,953)	*283,605,972*	($10,647,030)
Handling fees received	0.036	*241,948,783*	$8,758,546	*332,350,917*	$12,304,358
Sub-Total, Retailers			***($304,033)***		***$0***
Consumers					
Deposit paid	0.05	*270,382,907*	($13,519,145)	*383,230,704*	($19,161,535)
Deposits received	0.05	*241,948,783*	$12,097,439	*324,966,302*	$16,248,315
Liquor deposits paid	0.15	*3,745,035*	($561,755)	*13,591,189*	($2,038,678)
Liquor deposits received	0.15	*2,860,458*	$429,069	*10,245,074*	$1,536,761
Sub-Total, Consumers			***($1,554,393)***		***($3,415,137)***
Total :			***($8,164,287)***		***($11,073,553)***
Additional Cost to Consumers					
Separate trips to redeem	0.014	244,809,241	($3,448,633)	335,211,375	($4,722,130)
Total :			($11,612,920)		($15,795,683)

(1) Under "Consumers", Special trips to redeem were counted for bottle redeemers that answered "yes" to the question "Is this a special trip to redeem bottles and cans, or are you combining it with another errand?" or no to the question "If you weren't returning containers today, would you have taken this trip?"

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quality is very good. As such the bale price differential has been dropped to 5 cents per pound from 10 cents per pound to reflect the relatively high quality of the material produced at the Rutland and Chittenden MRF's.

[108] In both cases the value of the glass represents glass FOB the glass beneficiation plant.

BEST MANAGEMENT PRACTICES TO REDUCE BB AND EBB COSTS

One of the Project Team's tasks was to evaluate ways to reduce the costs associated with the BB and EBB. An analysis of Table 46, and a review of other deposit states makes it clear that the easiest way to reduce total costs would be to eliminate the handling fee. Oregon has no handling fee, and a relatively robust container deposit system. Elimination of the handling fee would cut $8.76 million off of the total BB cost of $12.3 million.

Unfortunately, elimination of the handling fee would essentially spell the death knell for most redemption centers in Vermont, would primarily benefit the distributors, and would have a significant negative impact on retailers.

A second best management practice would be to eliminate the counting of containers by brand. This would reduce third party collection costs, but would require a change in the statute to require that all distributors report sales to a state auditing entity who could then allocate costs and revenues based solely on sales. This could also be accomplished through a cooperative if all bottlers/distributors were members and reported verifiable sales data confidentially to the coop.

Elimination of counting of containers would also allow for compaction of containers during collection (as proposed by VPIRG), further reducing third party collection costs. However, to accomplish this it would be necessary to carry out spot audits of bags and boxes at redemption centers rather than back at a central warehouse. This would increase collection costs, and would also result in lower quality materials if glass and PET containers were compacted on the same truck.

COLLECTION SYSTEM COSTS

While Systems 2, 3 and 4 are titled after the collection of recycling and bottle bill materials (because the bottle bill is the sole variable that is changed) each of the three systems required detailed estimates of tons collected and households served for residential refuse, recycling and organics collection as well as detailed estimates of ICI refuse, recycling and organics collection. These assumptions are outlined below.

RESIDENTIAL COLLECTION

Tables 47 (repeated from Table 7) and48 (repeated from Table 25), below present the Project Team's best estimate of the number of households (and corresponding tonnage) using: organized curbside collection now, and under the Act 148 requirement for parallel collection; subscribing for curbside/roadside collection; and, using drop-offs and transfer stations. These estimates form the basis for estimating first year costs (called 2014 in the model) for residential refuse, recycling, and ultimately organics collection.

TABLE 47. ESTIMATED RESIDENTIAL REFUSE AND RECYCLING COLLECTION IN VERMONT UNDER THE BASE CASE (CURRENT) SYSTEM

	CURRENT SYSTEM		ROUGH ESTIMATES			
	Refuse *(HH's)*	Recycling *(HH's)*	Refuse *(tons)*	Recycling *(tons)*	Refuse *(lbs/hh)*	Recycling *(lbs/hh)*
Organized Curbside						
Chittenden County	1,200	17,300	1,200	3,600	2,000	416
Rest of Vermont	10,700	17,500	10,000	3,700	1,869	423
Subtotal, Organized:	**11,900**	**34,800**	11,200	7,300	**1,882**	**420**
Subscription Collection						
Chittenden County						
Curbside	38,900	22,800	35,700	6,000	1,835	526
Containerized	13,400	13,400	9,800	1,800	1,463	269
Rest of Vermont						
Curbside	70,000	29,900	84,987	4,200	2,428	281
Exempt Haulers and Fast Trash	14,000	5,950	14,569	650	2,081	218
Containerized	21,500	2,150	21,854	250	2,033	233
Total Subscription:	**157,800**	**74,200**	166,910	12,900	**2,115**	**348**
Drop-off Collection						
Chittenden County	8,300	8,300	4,800	3,000	1,157	723
Rest of Vermont	91,900	90,100	65,200	15,500	1,419	344
Total Drop-off:	**100,200**	**98,400**	70,000	18,500	**1,397**	**376**
Total Households Served:	**269,900**	**207,400**	**248,110**	**38,100**	**1,839**	**367**
Lack of Parrallel Access	**62,500**					
Percentage of Vermont Households	***30%***					

Table 48 then realigns households beginning in 2015 so that all households in Vermont have parallel access to recycling, which means that all haulers will have to provide parallel collection of recyclables with refuse, and embed the cost in their refuse collection charges. The assumptions made for Table 48 are explained in Section VI of the report and shown in Table 25.

TABLE 48. ESTIMATED RESIDENTIAL REFUSE AND RECYCLING COLLECTION IN VERMONT UNDER THE PARALLEL SERVICE REQUIREMENT OF ACT 148

HOUSEHOLDS BY SERVICE TYPE UNDER ACT 148		CHANGE FROM BASELINE	
Service	**Recycling and Refuse** *(households)*	**Refuse** *(households)*	**Recycling** *(households)*
Organized Curbside			
Chittenden County	17,300	16,100	0
Rest of Vermont	19,600	8,900	2,100
Subtotal, Organized:	**36,900**	25,000	2,100
Subscription Collection			
Chittenden County			
Curbside	22,800	-16,100	0
Containerized	13,400	0	0
Rest of Vermont			
Curbside	65,600	-4,400	35,700
Exempt Haulers and Fast Trash	14,000	0	8,050
Containerized	21,500	0	19,350
Total Subscription:	**137,300**	-20,500	63,100
Drop-off Collection			
Chittenden County	8,300	0	0
Rest of Vermont	87,400	-4,500	-2,700
Total Drop-off:	**95,700**	-4,500	-2,700
Total Households Served:	**269,900**	**0**	**62,500**

The Project Team then estimated the number of collection trucks necessary to serve both organized and subscription households, and multiplied the truck count by total annual, "all-in" per truck costs (exclusive of capital costs). "All-in" costs include all operating and maintenance costs, labor, insurance, taxes and fees, as well as an assumed profit margin per truck.

Curbside subscription household collection costs are based on the assumption that most collection in Vermont is time limited, not tons limited, which increases costs (especially recycling costs) over organized collection costs.

Drop-off collection costs are based on program budgets provided to DSM by the Wethersfield and Hartford transfer stations, as well as data maintained and provided by the Chittenden District. They include facility operational costs, as well as per ton pull costs for moving refuse, recyclables and organics that are not source separated and/or processed on site.

It was assumed that households using drop-offs or transfer stations made a trip roughly every three weeks and that the round trip was roughly 10 miles for a total (rounded) of 200 miles of driving per year to deliver refuse, recycling and, in some cases organics.[109] The trip miles, and cost, at the current IRS rate were allocated to refuse,

[109] It is assumed that before 2020 some households will drive organics to the closest transfer station that has a separate organics drop-off.

recycling and organics depending on the assumption about how many households delivered organics to drop-offs and transfer stations before the 2020 ban on organics to landfill. Households only delivering refuse and recycling were assumed to split the separate trip cost in half. Households delivering all three materials split the cost three ways, and those households under the Base Case who drove exclusively to deliver recycling were charged the entire cost for recycling only.

ICI COLLECTION

A similar effort was made to understand the ICI collection system in Vermont. Recent data from the CSWD gathered by DSM for a separate project were combined with surveys of private haulers in Vermont and the Project Team's best professional estimates to quantify collection activity in Vermont using front-loader (container or dumpster service), roll-off service, or rear load service. These estimates are presented in Tables 49 and 50.

TABLE 49. ESTIMATED ALLOCATION OF CURRENT ICI REFUSE AND RECYCLING COLLECTION IN VERMONT (1)

	REFUSE		RECYCLING	
Commercial Collection	*(tons)*	*(%)*	*(tons)*	*(%)*
Chittenden County				
Drop-off	400		200	
Curbside	4,100		3,175	
Containerized	26,200		9,225	
Roll-offs	10,800		300	
Subtotal:	**41,500**	25%	**12,900**	31%
All Other Vermont				
Drop-off	6,195		1,410	
Curbside	12,390		12,690	
Containerized	86,730		13,400	
Roll-offs	18,585		700	
Subtotal:	**123,900**	75%	28,200	69%
Total:	**165,400**	**100%**	**41,100**	**100%**
	REFUSE		**RECYCLING**	
Type of Collection	*(tons)*	*(%)*	*(tons)*	*(%)*
Drop-off	6,600	4%	1,600	4%
Curbside	16,500	10%	15,900	39%
Containerized	112,900	68%	22,600	55%
Roll-offs	29,400	18%	1,000	2%
Total:	**165,400**	**100%**	**41,100**	**100%**

(1) Percentage of Total Refuse and Total Recycling in CSWD vs. Rest of State, and % of tons by collection method.

TABLE 50. ESTIMATED TONS BY COLLECTION METHOD AND COST PER TON TO COLLECT ICI REFUSE AND RECYCLING BEGINNING IN 2015

	UNIVERSAL SS		SS / BB		SS / EBB		COST PER TON (1)	
TYPE OF COLLECTION	Refuse (tons)	Recycling (tons)	Refuse (tons)	Recycling (tons)	Refuse (tons)	Recycling (tons)	Refuse ($/ton)	Recycling (tons)
Drop-off	6,200	2,000	6,200	2,000	6,200	2,000	**$93**	**$110**
Curbside	12,500	21,000	12,500	20,000	12,500	19,000	**$300**	**$171**
Containerized	104,070	35,730	107,900	32,300	106,960	29,600	**$118**	**$84**
Roll-offs	24,000	1,000	24,000	1,000	24,000	1,000	**$50**	**$20**
Total:	**146,770**	**59,730**	**150,600**	**55,300**	**149,660**	**51,600**		

(1) The cost per ton estimates were developing using data from the CSWD 2011 consoldiated colleciton study, the 2005 State of Vermont pricing study, and interviews with haulers on current truck operating costs (2013).
(2) Cost per ton are exclusive of disposal costs and disposal surcharges (which vary throughout the State).

PROCESSING AND DISPOSAL COSTS

Processing and disposal costs for recycling, refuse, and organics are carried as separate rows in the large systems cost tables. The Project Team has assumed that recycling costs, net of revenues are zero; disposal costs are $70 per ton (exclusive of district surcharges which are carried as district administrative costs), and organics processing costs (exclusive of capital) are $40 per ton. It should be noted that with capital costs added to operating costs for organics management the estimated cost is roughly $50 per ton. The Project Team is aware that current organics processors are charging roughly $35 to $37 per ton. However, the Project Team does not believe that this cost is sustainable, especially in the long run as sources of carbon become difficult to acquire (or more costly), and as more compostable paper, and associated plastic wastes, are composted and require much more highly sophisticated screening equipment.

DISTRICT ADMINISTRATIVE COSTS

District administrative costs are carried in the Base Case as reported in the Local Governance section above. They are assumed to increase in 2015 to accommodate the need to implement UBP and parallel collection, and then are increased another 30 percent in 2019 in anticipation of the ban on organics to landfills which will require a significant public education effort.

The total increase in 2015 is $900,000 statewide, assuming a ten percent increase in administrative costs and a 30 percent increase in education and enforcement costs. Another $1.4 million (rounded) in new District administration and education/enforcement costs are added in 2020 to implement the ban on organics to landfill for both ICI and residential food residuals.

It may seem counter-intuitive to haulers delivering refuse who are paying the district surcharge, but the systems analysis does not reduce district administrative costs with declining refuse tons. While the individual hauler may pay a tipping fee of $90 to $98 per ton for disposal that includes the district surcharge, and therefore save the entire amount for every ton diverted, those district administrative and educational costs remain and must be carried (and paid for) even with the reduce tons. In fact, as discussed above, these district costs will increase with

implementation of the requirements of Act 148, and will need to be covered as part of overall system costs. For this reason, district administration costs are carried as separate rows in the cost analysis.

LITTER COLLECTION COSTS WITH ELIMINATION OF THE BOTTLE BILL

Comments received by ANR during the public review of the Interim Report in March, 2013, included statements that one of the most important benefits to the public associated with beverage container deposits is the positive impact container deposits have on litter, including broken glass bottles. The Project Team examined the data that are often cited in the literature to support the assumption that deposits reduce litter. A complete description of the Project Team's analysis is contained in Appendix E.

The Project Team's general conclusion from all of these studies is that there are no conclusive data that show deposit legislation has or does not have a significant impact on roadside litter. This should not be surprising because a comprehensive review of the literature on litter surveys will illustrate that there is not a uniform way to measure litter (by count, piece size and/or weight), and that factors such as roadside mowing, the frequency of litter collection, the volume of traffic and population, and open container laws all play a large role in litter generation and measurement.[110] Studies controlling for all of these variables, and then controlling for the impact of deposit legislation have simply not occurred.

While deposits likely had some impact on litter when deposit legislation was first passed in most states some 30 years ago, the Project Team has found no data sets to support this conclusion today. As a result, no additional cost has been carried for additional litter collection under System 2 because it is not clear that the BB or EBB does, or will impact litter deposition in Vermont.

CAPITAL COSTS

There will be a need for investment in new trucks and containers associated both with the parallel collection requirement in 2015, and with adoption of the phased in ban on organics to landfill. The Systems Cost models add trucks as necessary to collect the increase in single stream material (and to service all households not currently serviced – estimated at 60,000 households). All trucks are added at an assumed capital cost of $170,000. The Project Team does not know what decisions will be made by the wide range of private haulers serving Vermont. Small haulers may choose to purchase used, small packer trucks at costs significantly lower than $170,000. Conversely, some haulers may choose to purchase large, automated collection trucks that could cost as much as $300,000, and some haulers may choose to purchase split compaction trucks which might cost $200,000 to $220,000. Finally, some haulers may choose to purchase rendering type trucks for organics collection that cost $140,000. Because of the wide range in costs and the uncertainty associated with how the private haulers will

[110] See for example, *Analysis of Beverage Container Redemption System Options to Increase Municipal Recycling in Rhode Island,* Prepared for the Rhode Island Resource Recovery Corporation, Prepared by DSM Environmental Services, Inc., May 2009, p 18 -20.

choose to meet the requirements of Act 148, the Project Team has simply chosen a truck cost somewhere in the middle of the range as a placeholder for the model.

An attempt has been made in the model to account for the likely change to every other week collection of refuse and recyclables for some households with the addition of organics collection. For purposes of this analysis, it is assumed that beginning in 2020, a third of all households receiving organized and subscription curbside collection will switch to collection of refuse and organics one week and single stream recycling and organics the next week. This partially offsets he additional capital and operation costs associated with separate collection of food residuals and other organics.

It should be noted here that one of the reasons that the total system cost for System 3 (A), which assumes that a number of municipalities and districts don't switch to single stream collection or transfer, is higher than System 3 (which assumes that curbside single stream collection is adopted statewide) is that it will be extremely difficult to co-collect refuse and recycling or organics and recycling if the collection truck has to have two compartments for dual stream recyclables.

It is also assumed that carts will be purchased both for new parallel curbside collection of recyclables and for curbside collection of organics. One and two cubic yard dumpsters are also assumed to be necessary for front loader collection of organics. Finally, it is assumed that 12 new organics transfer compactors located at existing transfer stations will be necessary for organics in 2020.

The only recycling processing capacity necessary is proposed modifications to the Chittenden District MRF (reported to be $1.9 million). There will, however, be significant new organics processing capacity required, as described in Section VII. This capacity is brought on line as the organics ban is implemented and tonnage ramps up.

It is important to reiterate here that the Project Team has assumed that one third of the new processing capacity for off-site organics management will be on-farm and low cost windrow composting at existing drop-offs and transfer stations. That reduces the total capital cost by 30 percent over what it would be if all organics were delivered to central processing facilities.

All capital costs are carried in the year they are constructed or purchased, with the sum of each year's new capital added to previous year's capital costs and reported in the Summary Tables.

SYSTEM COSTS

Table 51 below outlines the critical assumptions used in the system cost model to estimate baseline system costs, and to estimate future costs under the phase in of Act 148. As discussed at the beginning of this report the most important driver of system costs is collection. Two critical sets of assumptions combine to establish collection costs. The first is the route size, and the second is the annual, all-in cost to operate a truck. The Project Team made the assumption, confirmed by interviews with large, medium and small haulers that for most of Vermont the limiting factor to route size is the number of stops that can be made in a typical collection day, rather than the loaded capacity of the truck. This is because of the largely rural nature of much of Vermont which means that the truck drives long distances between stops when compared to urban areas.

As illustrated by Table 51, subscription route sizes range from 800 to 960 households per week. These can be compared to organized collection route sizes of 1,500 to 2,000, illustrating that one way to reduce system-wide costs would be to organize collection routes in additional areas of Vermont.

The second critical collection cost assumption is the all-in cost to own and operate a collection truck over the course of a year. Based on confidential information supplied by large, medium and small haulers the Project Team decided to use a blended average cost of $182,000 per year per truck for rear loading trucks and $240,000 for front load compactor trucks. There are obviously small haulers, who can operate a truck for significantly less than the blended average, but large haulers collect the majority of refuse and recycling in Vermont and they report higher costs than used in the model. It should be noted that these total annual truck costs include labor, fuel, maintenance, insurance, taxes, and all of the overhead and profit associated with running a solid waste collection company.

Other critical points associated with the model are as follows:

- Disposal costs are carried at the actual cost of disposal, exclusive of district surcharges, which are carried instead under district administrative costs.

- All recyclables delivered to single stream MRFs are assumed to be delivered at a net cost of zero which accounts for the tipping fee typically charged less revenue sharing over the year. Because revenue sharing is not assured and depends on market conditions there will be years when material sales is greater than the tipping fee and years when revenues are insufficient to cover tipping fees. Based on costs and revenues over the past five to ten years, the Project Team believes that the assumption of a zero net cost is a reasonable.

- All ICI collection costs are carried in dollars per ton because data are not available from the private haulers to estimate costs in any other way. The dollars per ton costs are net of disposal costs which, as with residential waste, are carried in a separate disposal row.

- It is assumed that once separation of food residuals is mandatory for all generators in 2020 that a number of transfer stations will add transfer capacity for organics for delivery to centralized organics processing facilities.

TABLE 51. CRITICAL ASSUMPTIONS USED TO ESTIMATE BASELINE AND FUTURE SYSTEM COSTS

ASSUMPTIONS	UNIT	DESCRIPTION
Equipment Costs		
Truck, Rear Loader	$ 182,000	Annual Operating Cost
Truck, Front Loader	$ 240,000	Annual Operating Cost
Cart	$ 65	Average Capital Cost, New Cart
Dumpster	$ 350	Average Capital Cost, 4-10 yd. Container
Facility Costs		
Drop-offs		
Refuse, operational	$ 75	Cost per ton of refuse handled to operate facility
Refuse, transfer	$ 18	Cost per ton of refuse transferred from drop-off
Recycling, operational	$ 158	Cost per ton of recycling handled to operate facility
Recycling, revenues	$ 22	Revenues paid, FOB drop-off dock
Organics, operational	$ 30	Baseline Costs, low tech
Organics, transfer	$ 18	Same as refuse
Commercial Collection Costs		
Dumpster Service, Refuse	$ 118	Cost per ton, excluding disposal, to collect from containers 2 - 12 yard
Roll-Off Service, Refuse	$ 30	Cost per ton, excluding disposal to collect roll-offs of MSW, the majority which are compacted
Rear Load Service, Refuse	$ 300	Cost per ton, excluding disposal, to collect MSW in bags, cans or carts
Drop-off Service, Refuse	$ 75	Cost per ton, excluding disposal
Dumpster Service, Recycling	$ 84	
Roll-Off Service, Recycling	$ 40	
Rear Load Service, Recycling	$ 171	
Public Space Recycling	$ 500	
Dumpster Service, Organics	$ 150	Cost per ton, excluding processing, to collect from containers 2 - 12 yard
Roll-Off Service, Organics	$ 30	Cost per ton, excluding processing to collect roll-offs of organic waste, the majority which are compacted
Rear Load Service, Organics	$ 200	Cost per ton, excluding processing, to collect organics in cans or carts
Processing and Disposal (Cost/ton)		
Net Cost, SS Res Recycling Processing	$ -	Cost per ton
Net Cost, SS ICI Recycling Processing	$ -	Cost per ton
Residential Organics Processing	$ 40	Cost per ton
ICI Organics Processing	$ 40	Cost per ton
Residential Refuse Disposal	$ 70	Cost per ton, excluding surcharges
ICI Refuse Disposal	$ 70	Cost per ton, excluding surcharges
Route Sizes, Residential		
Refuse, Organized	1,500	Households Served Per Truck
Refuse, Subscription	800	Households Served Per Truck
Recycling, Organized	2,000	Households Served Per Truck
Recycling, Subscription	960	Households Served Per Truck
Organics, Organized	1,500	Households Served Per Truck
Organics, Subscription	800	Households Served Per Truck
Residential Collection Service	269,900	Total Households Served, adjusted for seasonal use
Refuse, Organized Curbside	11,900	Households Served, baseline
Recycling, Organized Curbside	34,800	Households Served, baseline
Refuse, Subscription Curbside	157,800	Households Served, baseline
Recycling, Subscription Curbside	74,200	Households Served, baseline
Refuse, Drop-off	100,200	Households Served, baseline
Recycling, Drop-off	98,400	Households Served, baseline
Recycling, Drop-off, subscription refu	10,000	Households Served, baseline
Organics, Drop-off	7,500	Households Served, baseline

TABLE 51. CRITICAL ASSUMPTIONS USED TO ESTIMATE BASELINE AND FUTURE SYSTEM COSTS (CONTINUED)

Commercial Collection Service Percent ICI Tons Collected by:	Refuse (%)	Recycling (%)	Organics (%)
Dumpster Service, Refuse	68%	55%	25%
Roll-Off Service, Refuse	18%	2%	25%
Rear Load Service, Refuse	10%	39%	50%
Drop-off Service, Refuse	4%	4%	0%

ASSUMPTIONS	UNIT	DESCRIPTION
Equipment Costs		
ICI Dumpsters (Tons/dumpster)	52	Tons per dumpster/year
ICI Carts (Tons/cart/yr.)	5.2	Tons/cart/year
Drop-Off Transfer Capacity	1000	
Facility Costs		
Organics Facility Capital Cost	$ 20,000,000	Total organics facility capital cost
Drop-offs		
Recycling, operational	$ 120	Reduced cost to handle Single Stream at TS, net of transfer cost
Recycling, revenues	$ -	No revenue sharing with single stream
Organics, operational	$ 45	Increased cost due to investment in odor control, washing, separate area
Organics, transfer	$ 18	Same as refuse
Residential Collection Service		
Refuse, Organized Curbside	36,900	Households Served, Act 148
Recycling, Organized Curbside	36,900	Households Served, Act 148
Refuse, Subscription Curbside	137,300	Households Served, Act 148
Recycling, Subscription Curbside	137,300	Households Served, Act 148
Refuse, Drop-off	95,700	Households Served, Act 148
Recycling, Drop-off	95,700	Households Served, Act 148
Recycling, Drop-off, subscription refuse	0	Households Served, Act 148
District Administration		
Administration	$ 2,958,890	Ten percent increase in costs
Education and Outreach	$ 1,382,550	Thirty percent increase in costs
HHW and Universal Waste	$ 1,271,100	Same as baseline
Operations	$ 1,661,920	Thirty percent increase in costs
Special Wastes	$ 717,300	Same as baseline
Miscellaneous	$ 732,600	Same as baseline

SUMMARY OF SYSTEM COSTS, SYSTEMS 1-4

Table 52, below, presents the Base Case, System 1 costs, including the key assumptions used in all of the tables to illustrate how truck counts and operating costs are allocated for each type of collection in the system. Tables 52 – 55 do not show all of the unit coefficients because they change every year with the ramp up of organics and parallel collection of recyclables and it is impossible to present the entire system model in a coherent table. As such, only the annual costs are presented for each of these systems.

TABLE 52. SYSTEM 1, BASE CASE COSTS

	SYSTEM 1 - BASE CASE	UNITS / COSTS		COSTS BY YEAR								
	STATE-WIDE ANNUAL COSTS	Unit/ Coefficient	Baseline	BASE 2014	2015	2016	2017	2018	2019	2020	2021	2022
RESIDENTIAL COSTS	**RESIDENTIAL**											
	Refuse Collection	Tons	*248,110*									
	Organized Curbside	Households Served	*11,900*									
	HH per truck/Number of trucks	**1500**	*8*									
	Costs (Using $/truck)	Annual Operating Cost	***$ 182,000***	$ 1,443,867	$ 1,443,867	$ 1,443,867	$ 1,443,867	$ 1,443,867	$ 1,443,867	$ 1,443,867	$ 1,443,867	$ 1,443,867
	Subscription Curbside	Households Served	*157,800*									
	HH per truck/Number of trucks	**800**	*197*									
	Costs (Using $/truck)	Annual Operating Cost	***$ 182,000***	$ 35,899,500	$ 35,899,500	$ 35,899,500	$ 35,899,500	$ 35,899,500	$ 35,899,500	$ 35,899,500	$ 35,899,500	$ 35,899,500
	Drop-Off (Self-Haul)	Households Served	*100,200*									
	Tons Collected	Tons	*70,000*									
	Drop-Off Operational Costs	Cost/ton	***$ 75***	$ 5,250,000	$ 5,250,000	$ 5,250,000	$ 5,250,000	$ 5,250,000	$ 5,250,000	$ 5,250,000	$ 5,250,000	$ 5,250,000
	Transfer/Pull costs	Cost/ton	***$ 18***	$ 1,260,000	$ 1,260,000	$ 1,260,000	$ 1,260,000	$ 1,260,000	$ 1,260,000	$ 1,260,000	$ 1,260,000	$ 1,260,000
	Recycling Collection											
	Organized Curbside	Households Served	*34,800*									
	HH per truck/Number of trucks	**2000**	*17*									
	Costs (Using $/truck)	Annual Operating Cost	***$ 182,000***	$ 3,166,800	$ 3,166,800	$ 3,166,800	$ 3,166,800	$ 3,166,800	$ 3,166,800	$ 3,166,800	$ 3,166,800	$ 3,166,800
	Subscription Curbside	Households Served	*74,200*									
	HH per truck/Number of trucks	**960**	*77*									
	Costs (Using $/truck)	Annual Operating Cost	***$ 182,000***	$ 14,067,083	$ 14,067,083	$ 14,067,083	$ 14,067,083	$ 14,067,083	$ 14,067,083	$ 14,067,083	$ 14,067,083	$ 14,067,083
	Drop-Off (Self-Haul)	Households Served	*98,400*									
	Tons Collected	Tons	*18,280*									
	Drop-Off Operational Costs	Cost/ton	***$ 158***	$ 2,923,000	$ 2,923,000	$ 2,923,000	$ 2,923,000	$ 2,923,000	$ 2,923,000	$ 2,923,000	$ 2,923,000	$ 2,923,000
	Revenues from Sale of Recyclables	Revenue/ton	***$ 22***	$ (407,000)	$ (407,000)	$ (407,000)	$ (407,000)	$ (407,000)	$ (407,000)	$ (407,000)	$ (407,000)	$ (407,000)
	Organics Collection											
	Organized Curbside	Households Served	*0*									
	Number of trucks		*0*									
	Cost	$ -										
	Subscription Curbside	Households Served	*900*									
	HH per truck/Number of trucks	**800**	*1*									
	Cost	$ -		$ 55,000	$ 55,000	$ 55,000	$ 55,000	$ 55,000	$ 55,000	$ 55,000	$ 55,000	$ 55,000
	Drop-Off (Self-Haul)	Households Served	*7,500*									
	Tons Collected	Tons	*3,486*									
	Drop-Off Operational Costs	Cost/ton	***$ 30***	$ 122,510	$ 122,510	$ 122,510	$ 122,510	$ 122,510	$ 122,510	$ 122,510	$ 122,510	$ 122,510
	Transfer/Pull costs	Cost/ton	***$ 18***									

TABLE 52. SYSTEM 1, BASE CASE COSTS (CONTINUED)

	SYSTEM 1 - BASE CASE	UNITS / COSTS		COSTS BY YEAR								
	STATE-WIDE ANNUAL COSTS	Unit/ Coefficient	Baseline	BASE 2014	2015	2016	2017	2018	2019	2020	2021	2022
COMMERCIAL /ICI COSTS	**COMMERCIAL**											
	Refuse Collection	Total Tons	*165,400*									
	Dumpster Service: $ Per Ton / Tons	**$ 118**	*112,900*	$ 13,322,200	$ 13,322,200	$ 13,322,200	$ 13,322,200	$ 13,322,200	$ 13,322,200	$ 13,322,200	$ 13,322,200	$ 13,322,200
	Roll-Off Service: $ Per ton / Tons	**$ 30**	*29,400*	$ 882,000	$ 882,000	$ 882,000	$ 882,000	$ 882,000	$ 882,000	$ 882,000	$ 882,000	$ 882,000
	Rear Load Service: $ Per Ton / Tons	**$ 300**	*16,500*	$ 4,950,000	$ 4,950,000	$ 4,950,000	$ 4,950,000	$ 4,950,000	$ 4,950,000	$ 4,950,000	$ 4,950,000	$ 4,950,000
	Drop-off Service : $ Per Ton / Tons	**$ 75**	*6,600*	$ 495,000	$ 495,000	$ 495,000	$ 495,000	$ 495,000	$ 495,000	$ 495,000	$ 495,000	$ 495,000
	Recycling Collection	Tons	*41,100*									
	Dumpster Service: $ Per Ton / Tons	**$ 84**	*22,600*	$ 1,888,909	$ 1,888,909	$ 1,888,909	$ 1,888,909	$ 1,888,909	$ 1,888,909	$ 1,888,909	$ 1,888,909	$ 1,888,909
	Roll-Off Service: $ Per ton / Tons	**$ 40**	*1,000*	$ 40,000	$ 40,000	$ 40,000	$ 40,000	$ 40,000	$ 40,000	$ 40,000	$ 40,000	$ 40,000
	Rear Load Service: $ Per Ton / Tons	**$ 171**	*15,900*	$ 2,718,274	$ 2,718,274	$ 2,718,274	$ 2,718,274	$ 2,718,274	$ 2,718,274	$ 2,718,274	$ 2,718,274	$ 2,718,274
	Drop-off Service : $ Per Ton / Tons	**$ 136**	*1,600*	$ 217,600	$ 217,600	$ 217,600	$ 217,600	$ 217,600	$ 217,600	$ 217,600	$ 217,600	$ 217,600
	Public Space Recycling: $ Per ton / Tons	**$ 500**	-									
	Organics Collection (tons)	8,134	***8,134***									
	Dumpster Service: $ Per Ton / Tons	$ 150	*2,034*	$ 305,025	$ 305,025	$ 305,025	$ 305,025	$ 305,025	$ 305,025	$ 305,025	$ 305,025	$ 305,025
	Roll-Off Service: $ Per ton / Tons	$ 30	*2,034*	$ 61,005	$ 61,005	$ 61,005	$ 61,005	$ 61,005	$ 61,005	$ 61,005	$ 61,005	$ 61,005
	Rear Load Service: $ Per Ton / Tons	$ 200	*4,067*	$ 813,400	$ 813,400	$ 813,400	$ 813,400	$ 813,400	$ 813,400	$ 813,400	$ 813,400	$ 813,400
OTHER COSTS	**BOTTLE BILL (Net Costs)**			$8,164,287	$ 8,164,287	$ 8,164,287	$ 8,164,287	$ 8,164,287	$ 8,164,287	$ 8,164,287	$ 8,164,287	$ 8,164,287
	Processing and Disposal	Cost/Ton	*(tons)*									
	Net Cost, SS Res Recycling Processing	$ -										
	Net Cost, SS ICI Recycling Processing	$ 40										
	Residential Organics Processing	**$ 35**	*3,486*	$ 122,010	$ 122,010	$ 122,010	$ 122,010	$ 122,010	$ 122,010	$ 122,010	$ 122,010	$ 122,010
	ICI Organics Processing	**$ 35**	*8,134*	$ 284,690	$ 284,690	$ 284,690	$ 284,690	$ 284,690	$ 284,690	$ 284,690	$ 284,690	$ 284,690
	Residential Refuse Disposal	$ 70	*248,110*	$ 17,367,700	$ 17,367,700	$ 17,367,700	$ 17,367,700	$ 17,367,700	$ 17,367,700	$ 17,367,700	$ 17,367,700	$ 17,367,700
	ICI Refuse Disposal	$ 70	*165,400*	$ 11,578,000	$ 11,578,000	$ 11,578,000	$ 11,578,000	$ 11,578,000	$ 11,578,000	$ 11,578,000	$ 11,578,000	$ 11,578,000
	Separate Trips, Residential											
	Refuse, Drop-off	Miles/hh/yr	*100*	$ 5,661,300	$ 5,661,300	$ 5,661,300	$ 5,661,300	$ 5,661,300	$ 5,661,300	$ 5,661,300	$ 5,661,300	$ 5,661,300
	Recycling, Drop-off	Miles/hh/yr	*100*	$ 5,559,600	$ 5,559,600	$ 5,559,600	$ 5,559,600	$ 5,559,600	$ 5,559,600	$ 5,559,600	$ 5,559,600	$ 5,559,600
	Recycling, Drop-off, Subscription Refuse	Miles/hh/yr	*200*	$ 1,130,000	$ 1,130,000	$ 1,130,000	$ 1,130,000	$ 1,130,000	$ 1,130,000	$ 1,130,000	$ 1,130,000	$ 1,130,000
	Organics, Drop-off	Miles/hh/yr	*66*	$ 279,675	$ 279,675	$ 279,675	$ 279,675	$ 279,675	$ 279,675	$ 279,675	$ 279,675	$ 279,675
	Beverage Redemption	Cost per container	*$ 0.014*	$ 3,448,633	$ 3,448,633	$ 3,448,633	$ 3,448,633	$ 3,448,633	$ 3,448,633	$ 3,448,633	$ 3,448,633	$ 3,448,633
	District Administration											
	Administration			$ 2,689,900	$ 2,689,900	$ 2,689,900	$ 2,689,900	$ 2,689,900	$ 2,689,900	$ 2,689,900	$ 2,689,900	$ 2,689,900
	Education and Outreach			$ 1,063,500	$ 1,063,500	$ 1,063,500	$ 1,063,500	$ 1,063,500	$ 1,063,500	$ 1,063,500	$ 1,063,500	$ 1,063,500
	HHW and Universal Waste			$ 1,271,100	$ 1,271,100	$ 1,271,100	$ 1,271,100	$ 1,271,100	$ 1,271,100	$ 1,271,100	$ 1,271,100	$ 1,271,100
	Operations			$ 1,278,400	$ 1,278,400	$ 1,278,400	$ 1,278,400	$ 1,278,400	$ 1,278,400	$ 1,278,400	$ 1,278,400	$ 1,278,400
	Special Wastes			$ 717,300	$ 717,300	$ 717,300	$ 717,300	$ 717,300	$ 717,300	$ 717,300	$ 717,300	$ 717,300
	Miscellaneous			$ 732,600	$ 732,600	$ 732,600	$ 732,600	$ 732,600	$ 732,600	$ 732,600	$ 732,600	$ 732,600
	Sub-Total:			***$ 150,822,868***	***$ 150,822,868***	***$ 150,822,868***	***$ 150,822,868***	***$ 150,822,868***	***$ 150,822,868***	***$ 150,822,868***	***$ 150,822,868***	***$ 150,822,868***
												$ 1,357,405,811
	Sub-Total, without Separate Trips:			**$ 134,743,660**	**$ 134,743,660**	**$ 134,743,660**	**$ 134,743,660**	**$ 134,743,660**	**$ 134,743,660**	**$ 134,743,660**	**$ 134,743,660.01**	**$ 134,743,660.01**
												$ 1,212,692,940
CAPITAL	**CAPITAL INVESTMENT**											
	Single Stream Upgrades, CSWD			**$ 1,900,000**								**$ 1,900,000**
	Total, Annual and Capital:											**$ 1,359,305,811**
	Total, without Separate Trips:											**$ 1,214,592,940**

TABLE 53. SYSTEM 2, USS COSTS

	SYSTEM 2 - UNIVERSAL SINGLE STREAM STATE-WIDE ANNUAL COSTS	Unit/ Coefficient	COSTS BY YEAR								
			BASE 2014	2015	2016	2017	2018	2019	2020	2021	2022
RESIDENTIAL COSTS	***RESIDENTIAL***										
	Refuse Collection	Tons									
	Organized Curbside	Households Served									
	HH per truck/Number of trucks	1500									
	Costs (Using $/truck)	$182,000	$ 1,443,867	$ 4,477,200	$ 4,477,200	$ 4,477,200	$ 4,477,200	$ 4,477,200	$ 3,134,040	$ 3,134,040	$ 3,134,040
	Subscription Curbside	Households Served									
	HH per truck/Number of trucks	800									
	Costs (Using $/truck)	$182,000	$ 35,899,500	$ 31,235,750	$ 31,235,750	$ 31,235,750	$ 31,235,750	$ 31,235,750	$ 21,865,025	$ 21,865,025	$ 21,865,025
	Drop-Off (Self-Haul)	Households Served									
	Tons (Declines with increasing organics diversion)										
	Drop-Off Operational Costs (Cost/ton)	$75	$ 5,174,859	$ 5,030,375	$ 5,010,504	$ 4,991,029	$ 4,902,374	$ 4,884,656	$ 4,284,779	$ 4,284,779	$ 4,284,779
	Transfer/Pull costs	$18	$ 1,241,966	$ 1,207,290	$ 1,202,521	$ 1,197,847	$ 1,176,570	$ 1,172,317	$ 1,028,347	$ 1,028,347	$ 1,028,347
	Recycling Collection										
	Organized Curbside	Households Served									
	Number of trucks	2000									
	Costs (Using $/truck)	$182,000	$ 3,166,800	$ 3,357,900	$ 3,357,900	$ 3,357,900	$ 3,357,900	$ 3,357,900	$ 2,350,530	$ 2,350,530	$ 2,350,530
	Subscription Curbside	Households Served									
	HH per truck/Number of trucks	960									
	Costs (Using $/truck)	$182,000	$ 14,067,083	$ 26,029,792	$ 26,029,792	$ 26,029,792	$ 26,029,792	$ 26,029,792	$ 18,220,854	$ 18,220,854	$ 18,220,854
	Drop-Off (Self-Haul)	# HHs									
	Tons Collected	Tons									
	Operational Costs (Cost/ton)	$ 120	$ 2,193,600	$2,772,000	$2,772,000	$2,772,000	$2,772,000	$2,772,000	$2,772,000	$2,772,000	$2,772,000
	Revenues from Sale of Recyclables	$ 22	$ (402,160)								
	Organics Collection (tons)	3,486									
	Organized Curbside	Households Served									
	HH per truck/Number of trucks	1,500									
	Costs (Using $/truck)	$182,000		$ 313,404	$ 313,404	$ 313,404	$ 671,580	$ 671,580	$ 2,686,320	$ 2,686,320	$ 2,686,320
	Subscription Curbside	Households Served									
	Number of trucks	800									
	Costs (Using $/truck)	$182,000	$ 91,000	$ 2,186,503	$ 2,186,503	$ 2,186,503	$ 4,685,363	$ 4,685,363	$ 18,741,450	$ 18,741,450	$ 18,741,450
	Drop-Off (Self-Haul)	# HHs									
	Tons Collected										
	Drop-Off Operational Costs	$ 45	$ 157,513	$ 194,008	$ 193,381	$ 192,766	$ 233,905	$ 232,724	$ 581,074	$ 581,074	$ 581,074
	Transfer/Pull costs	$ 18							$ 232,429	$ 232,429	$ 232,429

TABLE 53. SYSTEM 2, USS COSTS (CONTINUED)

	SYSTEM 2 - UNIVERSAL SINGLE STREAM STATE-WIDE ANNUAL COSTS	Unit/ Coefficient	COSTS BY YEAR BASE 2014	2015	2016	2017	2018	2019	2020	2021	2022
COMMERCIAL /ICI COSTS	***COMMERCIAL REFUSE***										
	Refuse Collection	Total Tons									
	Dumpster Service: Cost per ton / Tons	$ 118	$ 12,171,414	$ 11,841,044	$ 11,361,338	$ 11,332,424	$ 11,158,981	$ 11,130,642	$ 11,032,635	$ 11,032,635	$ 11,032,635
	Roll-Off Service: Cost per ton / Tons	$ 30	$ 805,812	$ 783,940	$ 752,181	$ 750,266	$ 738,783	$ 736,907	$ 730,419	$ 730,419	$ 730,419
	Rear Load Service: Cost per ton / Tons	$ 300	$ 4,522,414	$ 4,399,661	$ 4,221,422	$ 4,210,678	$ 4,146,234	$ 4,135,704	$ 4,099,289	$ 4,099,289	$ 4,099,289
	Drop-off Service : Cost per ton / Tons	$ 75	$ 452,241	$ 439,966	$ 422,142	$ 421,068	$ 414,623	$ 413,570	$ 409,929	$ 409,929	$ 409,929
	Recycling Collection	Tons									
	Dumpster Service: Cost per ton / Tons	$ 84	$ 1,888,909	$ 2,745,123	$ 2,745,123	$ 2,745,123	$ 2,745,123	$ 2,745,123	$ 2,745,123	$ 2,745,123	$ 2,745,123
	Roll-Off Service: Cost per ton / Tons	$ 40	$ 40,000	$ 58,131	$ 58,131	$ 58,131	$ 58,131	$ 58,131	$ 58,131	$ 58,131	$ 58,131
	Rear Load Service: Cost per ton / Tons	$ 171	$ 2,718,274	$ 3,950,426	$ 3,950,426	$ 3,950,426	$ 3,950,426	$ 3,950,426	$ 3,950,426	$ 3,950,426	$ 3,950,426
	Drop-off Service : Cost per ton / Tons	$ 136	$ 217,600	$ 316,235	$ 316,235	$ 316,235	$ 316,235	$ 316,235	$ 316,235	$ 316,235	$ 316,235
	Public Space Recycling: Cost per ton / 200	$ 500		$ 1,000,000	$ 1,000,000	$ 1,000,000	$ 1,000,000	$ 1,000,000	$ 1,000,000	$ 1,000,000	$ 1,000,000
	Organics Collection (tons)	8134									
	Dumpster Service (cost/ton)	$ 150	$ 413,151	$ 560,131	$ 740,571	$ 747,336	$ 821,456	$ 828,087	$ 867,218	$ 867,218	$ 867,218
	Roll-Off Service (cost/ton)	$ 30	$ 82,630	$ 112,026	$ 148,114	$ 149,467	$ 164,291	$ 165,617	$ 173,444	$ 173,444	$ 173,444
	Rear Load Service (cost/ton)	$ 200	$ 1,101,737	$ 1,493,683	$ 1,974,856	$ 1,992,896	$ 2,190,550	$ 2,208,231	$ 2,312,581	$ 2,312,581	$ 2,312,581
OTHER COSTS	**BOTTLE BILL (Net Costs)**		$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -
	Processing and Disposal										
	Net Cost, SS Res Recycling Processing	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -
	Net Cost, SS ICI Recycling Processing	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -
	Residential Organics Processing	$ 40	$ 220,752	$ 313,440	$ 311,846	$ 310,284	$ 414,766	$ 411,766	$ 1,296,463	$ 1,296,463	$ 1,296,463
	ICI Organics Processing	$ 40	$ 440,695	$ 597,473	$ 789,942	$ 797,158	$ 876,220	$ 883,292	$ 925,032	$ 925,032	$ 925,032
	Residential Refuse Disposal	$ 70	$ 16,229,337	$ 15,844,048	$ 15,791,057	$ 15,739,125	$ 15,502,712	$ 15,455,462	$ 13,855,792	$ 13,855,792	$ 13,855,792
	ICI Refuse Disposal	$ 70	$ 10,577,880	$ 10,290,763	$ 9,873,863	$ 9,848,734	$ 9,697,999	$ 9,673,370	$ 9,588,195	$ 9,588,195	$ 9,588,195
	Separate Trips, Residential										
	Refuse, Drop-off	miles/HH/yr	$ 5,661,300	$ 5,407,050	$ 5,407,050	$ 5,407,050	$ 5,407,050	$ 5,407,050	$ 5,407,050	$ 5,407,050	$ 5,407,050
	Recycling, Drop-off	miles/HH/yr	$ 5,559,600	$ 5,018,895	$ 5,018,895	$ 5,018,895	$ 4,478,190	$ 4,478,190	$ 693,255	$ 693,255	$ 693,255
	Recycling, Drop-off, Subscription	mile/HH/yr	$ 1,130,000								
	Organics, Drop-off	mile/HH/yr	$ 423,750	$ 648,846	$ 648,846	$ 648,846	$ 1,297,692	$ 1,297,692	$ 5,839,614	$ 5,839,614	$ 5,839,614
	Beverage Redemption										
	District Administration										
	Administration		$ 2,689,900	$ 2,958,890	$ 2,958,890	$ 2,958,890	$ 2,958,890	$ 2,958,890	$ 3,550,668	$ 3,550,668	$ 3,550,668
	Education and Outreach		$ 1,063,500	$ 1,382,550	$ 1,382,550	$ 1,382,550	$ 1,382,550	$ 1,382,550	$ 1,797,315	$ 1,797,315	$ 1,797,315
	HHW and Universal Wate		$ 1,271,100	$ 1,271,100	$ 1,271,100	$ 1,271,100	$ 1,271,100	$ 1,271,100	$ 1,271,100	$ 1,271,100	$ 1,271,100
	Operations		$ 1,278,400	$ 1,661,920	$ 1,661,920	$ 1,661,920	$ 1,661,920	$ 1,661,920	$ 2,160,496	$ 2,160,496	$ 2,160,496
	Special Wastes		$ 717,300	$ 717,300	$ 717,300	$ 717,300	$ 717,300	$ 717,300	$ 717,300	$ 717,300	$ 717,300
	Miscellaneous		$ 732,600	$ 732,600	$ 732,600	$ 732,600	$ 732,600	$ 732,600	$ 732,600	$ 732,600	$ 732,600
	Sub-Total:		***$ 135,444,325***	***$ 151,349,462***	***$ 151,035,352***	***$ 150,922,693***	***$ 153,646,257***	***$ 153,539,137***	***$ 151,427,158***	***$ 151,427,158***	***$ 151,427,158***
											$ 1,350,218,700
	Sub-Total, without Separate Trips:		**$ 122,669,675**	**$ 140,274,671**	**$ 139,960,561**	**$ 139,847,902**	**$ 142,463,325**	**$ 142,356,205**	**$ 139,487,239**	**$ 139,487,239**	**$ 139,487,239**
											$ 1,246,034,056

TABLE 53. SYSTEM 2, USS COSTS, CAPITAL COSTS

	CAPITAL INVESTMENT	Unit/Coefficient	BASE 2014	2015	2016	2017	2018	2019	2020	2021	2022
CAPITAL COSTS	***Parallel Recycling Collection***										
	New Trucks	$ 170,000		$ 11,701,879							
	Transfer Capacity										
	Carts	$65		$ 4,101,500							
	Organics Collection										
	New Trucks	$ 170,000					$ 2,334,100		$ (5,113,175)		
	ICI Dumpsters (Tons/dumpster)	52	$ 18,539	$ 25,134	$ 33,231	$ 33,534	$ 36,860	$ 37,158	$ 38,914		
	ICI Carts (Tons/cart/yr)	5.2	$ 188,434	$ 183,319	$ 175,893	$ 175,445	$ 172,760	$ 172,321	$ 170,804		
	Residential Carts ($/cart)	$65							$ 5,095,350		
	Drop-Off Transfer Capacity	1,000							$ 968,456		
	Organics Processing										
	Facility Capital Cost	$ 20,000,000	$ 3,900,000	$ 2,000,000	$ 2,000,000		$ 4,000,000		$ 10,000,000		
	Sub-Total, Capital:		**$ 4,106,973**	**$ 18,011,832**	**$ 2,209,123**	**$ 208,979**	**$ 6,543,720**	**$ 209,479**	**$ 11,160,348**		
											$ 42,450,455
	Total, Annual and Capital:										**$ 1,392,669,154**
	Total, without Separate Trips:										**$ 1,288,484,510**

TABLE 54. SYSTEM 3, USS/BB COSTS

	SYSTEM 3 - UNIVERSAL SS, BOTTLE BILL STATE-WIDE ANNUAL COSTS	Unit/ Coefficient	COSTS BY YEAR BASE 2014	2015	2016	2017	2018	2019	2020	2021	2022
RESIDENTIAL COSTS	***RESIDENTIAL***										
	Refuse Collection										
	Organized Curbside										
	HH per truck/Number of trucks	1,500									
	Costs (Using $/truck)	$182,000	$ 1,443,867	$ 4,477,200	$ 4,477,200	$ 4,477,200	$ 4,477,200	$ 4,477,200	$ 3,134,040	$ 3,134,040	$ 3,134,040
	Subscription Curbside	Households Served									
	HH per truck/Number of trucks	800									
	Costs (Using $/truck)	$182,000	$ 35,899,500	$ 31,235,750	$ 31,235,750	$ 31,235,750	$ 31,235,750	$ 31,235,750	$ 21,865,025	$ 21,865,025	$ 21,865,025
	Drop-Off (Self-Haul)	Households Served									
	Tons (Declines with increasing organics diversion)										
	Drop-Off Operational Costs (Cost/ton)	$ 75	$ 5,174,859	$ 5,030,375	$ 5,010,504	$ 4,991,029	$ 4,902,374	$ 4,884,656	$ 4,284,779	$ 4,284,779	$ 4,284,779
	Transfer/Pull costs	$ 18	$ 1,241,966	$ 1,207,290	$ 1,202,521	$ 1,197,847	$ 1,176,570	$ 1,172,317	$ 1,028,347	$ 1,028,347	$ 1,028,347
	Recycling Collection										
	Organized Curbside	Households Served									
	Number of trucks	2,000									
	Costs (Using $/truck)	$182,000	$ 3,166,800	$ 3,357,900	$ 3,357,900	$ 3,357,900	$ 3,357,900	$ 3,357,900	$ 2,350,530	$ 2,350,530	$ 2,350,530
	Subscription Curbside	Households Served									
	HH per truck/Number of trucks	960									
	Costs (Using $/truck)	$182,000	$ 14,067,083	$ 26,029,792	$ 26,029,792	$ 26,029,792	$ 26,029,792	$ 26,029,792	$ 18,220,854	$ 18,220,854	$ 18,220,854
	Drop-Off (Self-Haul)	Households Served									
	Tons Collected										
	Operational Costs (Cost/ton)	$ 120	$ 2,193,600	$ 2,772,000	$ 2,772,000	$ 2,772,000	$ 2,772,000	$ 2,772,000	$ 2,772,000	$ 2,772,000	$ 2,772,000
	Revenues from Sale of Recyclables	$ 22	$ (402,160)								
	Organics Collection (tons)	***3486***									
	Organized Curbside	Households Served									
	HH per truck/Number of trucks	1,500									
	Costs (Using $/truck)	$ 182,000		$ 313,404	$ 313,404	$ 313,404	$ 671,580	$ 671,580	$ 2,686,320	$ 2,686,320	$ 2,686,320
	Subscription Curbside	Households Served									
	Number of trucks	800									
	Costs (Using $/truck)	$ 182,000	$ 91,000	$ 2,186,503	$ 2,186,503	$ 2,186,503	$ 4,685,363	$ 4,685,363	$ 18,741,450	$ 18,741,450	$ 18,741,450
	Drop-Off (Self-Haul)	tons									
	Tons Collected										
	Drop-Off Operational Costs	$ 45	$ 157,513	$ 194,008	$ 193,381	$ 192,766	$ 233,905	$ 232,724	$ 581,074	$ 581,074	$ 581,074
	Transfer/Pull costs	$ 18							$ 232,429	$ 232,429	$ 232,429

TABLE 54. SYSTEM 3, USS/BB COSTS (CONTINUED)

	SYSTEM 3 - UNIVERSAL SS, BOTTLE BILL STATE-WIDE ANNUAL COSTS	Unit/ Coefficient	COSTS BY YEAR BASE 2014	2015	2016	2017	2018	2019	2020	2021	2022
COMMERCIAL /ICI COSTS	***COMMERCIAL REFUSE***										
	Refuse Collection	Total Tons									
	Dumpster Service: Cost per ton / Tons	$ 118	$ 11,955,553	$ 11,625,182	$ 11,145,477	$ 11,116,562	$ 10,943,120	$ 10,914,780	$ 10,816,774	$ 10,816,774	$ 10,816,774
	Roll-Off Service: Cost per ton / Tons	$ 30	$ 791,521	$ 769,648	$ 737,889	$ 735,975	$ 724,492	$ 722,616	$ 716,128	$ 716,128	$ 716,128
	Rear Load Service: Cost per ton / Tons	$ 300	$ 4,442,208	$ 4,319,456	$ 4,141,216	$ 4,130,473	$ 4,066,028	$ 4,055,499	$ 4,019,083	$ 4,019,083	$ 4,019,083
	Drop-off Service : Cost per ton / Tons	$ 75	$ 444,221	$ 431,945.56	$ 414,121.62	$ 413,047.26	$ 406,602.83	$ 405,549.85	$ 401,908.31	$ 401,908	$ 401,908
	Recycling Collection (tons)										
	Dumpster Service: Cost per ton / Tons	$ 84	$ 1,888,909	$ 2,371,477	$ 2,371,477	$ 2,371,477	$ 2,371,477	$ 2,371,477	$ 2,371,477	$ 2,371,477	$ 2,371,477
	Roll-Off Service: Cost per ton / Tons	$ 40	$ 40,000	$ 50,219	$ 50,219	$ 50,219	$ 50,219	$ 50,219	$ 50,219	$ 50,219	$ 50,219
	Rear Load Service: Cost per ton / Tons	$ 171	$ 2,718,274	$ 3,412,724	$ 3,412,724	$ 3,412,724	$ 3,412,724	$ 3,412,724	$ 3,412,724	$ 3,412,724	$ 3,412,724
	Drop-off Service : Cost per ton / Tons	$ 136	$ 217,600	$ 273,191	$ 273,191	$ 273,191	$ 273,191	$ 273,191	$ 273,191	$ 273,191	$ 273,191
	Public Space Recycling: Cost per ton / Tor	$ 500	$ -	$ 1,000,000	$ 1,000,000	$ 1,000,000	$ 1,000,000	$ 1,000,000	$ 1,000,000	$ 1,000,000	$ 1,000,000
	Organics Collection (tons)	***8134***									
	Dumpster Service (cost/ton)	$ 150	$ 413,151	$ 560,131	$ 740,571	$ 747,336	$ 821,456	$ 828,087	$ 867,218	$ 867,218	$ 867,218
	Roll-Off Service (cost/ton)	$ 30	$ 82,630	$ 112,026	$ 148,114	$ 149,467	$ 164,291	$ 165,617	$ 173,444	$ 173,444	$ 173,444
	Rear Load Service (cost/ton)	$ 200	$ 1,101,737	$ 1,493,683	$ 1,974,856	$ 1,992,896	$ 2,190,550	$ 2,208,231	$ 2,312,581	$ 2,312,581	$ 2,312,581
OTHER COSTS	**BOTTLE BILL (Net Costs)**		$ 8,164,288	$ 8,164,288	$ 8,164,288	$ 8,164,288	$ 8,164,288	$ 8,164,288	$ 8,164,288	$ 8,164,288	$ 8,164,288
	Processing and Disposal										
	Net Cost, SS Res Recycling Processing	$ -									
	Net Cost, SS ICI Recycling Processing	$ -									
	Residential Organics Processing	$ 40	$ 220,752	$ 313,440	$ 311,846	$ 310,284	$ 414,766	$ 411,766	$ 1,296,463	$ 1,296,463	$ 1,296,463
	ICI Organics Processing	$ 40	$ 440,695	$ 597,473	$ 789,942	$ 797,158	$ 876,220	$ 883,292	$ 925,032	$ 925,032	$ 925,032
	Residential Refuse Disposal	$ 70	$ 16,068,337	$ 15,683,048	$ 15,630,057	$ 15,578,125	$ 15,341,712	$ 15,294,462	$ 13,694,792	$ 13,694,792	$ 13,694,792
	ICI Refuse Disposal	$ 70	$ 10,390,280	$ 10,103,163	$ 9,686,263	$ 9,661,134	$ 9,510,399	$ 9,485,770	$ 9,400,595	$ 9,400,595	$ 9,400,595
	Separate Trips, Residential										
	Refuse, Drop-off	miles/HH/yr.	$ 5,661,300	$ 5,407,050	$ 5,407,050	$ 5,407,050	$ 5,407,050	$ 5,407,050	$ 5,407,050	$ 5,407,050	$ 5,407,050
	Recycling, Drop-off	miles/HH/yr.	$ 5,559,600	$ 5,018,895	$ 5,018,895	$ 5,018,895	$ 4,478,190	$ 4,478,190	$ 693,255	$ 693,255	$ 693,255
	Recycling, Drop-off, Subscription Refuse	mile/HH/yr.	$ 1,130,000								
	Organics, Drop-off	mile/HH/yr.	$ 423,750	$ 648,846	$ 648,846	$ 648,846	$ 1,297,692	$ 1,297,692	$ 5,839,614	$ 5,839,614	$ 5,839,614
	Beverage Redemption	Cost per container	$ 3,448,633	$ 3,448,633	$ 3,448,633	$ 3,448,633	$ 3,448,633	$ 3,448,633	$ 3,448,633	$ 3,448,633	$ 3,448,633
	District Administration										
	Administration		$ 2,689,900	$ 2,958,890	$ 2,958,890	$ 2,958,890	$ 2,958,890	$ 2,958,890	$ 3,550,668	$ 3,550,668	$ 3,550,668
	Education and Outreach		$ 1,063,500	$ 1,382,550	$ 1,382,550	$ 1,382,550	$ 1,382,550	$ 1,382,550	$ 1,797,315	$ 1,797,315	$ 1,797,315
	HHW and Universal Waste		$ 1,271,100	$ 1,271,100	$ 1,271,100	$ 1,271,100	$ 1,271,100	$ 1,271,100	$ 1,271,100	$ 1,271,100	$ 1,271,100
	Operations		$ 1,278,400	$ 1,661,920	$ 1,661,920	$ 1,661,920	$ 1,661,920	$ 1,661,920	$ 2,160,496	$ 2,160,496	$ 2,160,496
	Special Wastes		$ 717,300	$ 717,300	$ 717,300	$ 717,300	$ 717,300	$ 717,300	$ 717,300	$ 717,300	$ 717,300
	Miscellaneous		$ 732,600	$ 732,600	$ 732,600	$ 732,600	$ 732,600	$ 732,600	$ 732,600	$ 732,600	$ 732,600
	Sub-Total:		***$ 146,390,267***	***$ 161,333,100***	***$ 161,018,990***	***$ 160,906,331***	***$ 163,629,895***	***$ 163,522,775***	***$ 161,410,796***	***$ 161,410,796***	***$ 161,410,796***
											$ 1,441,033,746
	Sub-Total, without Separate Trips:		**$ 130,166,984**	**$ 146,809,676**	**$ 146,495,566**	**$ 146,382,907**	**$ 148,998,330**	**$ 148,891,210**	**$ 146,022,244**	**$ 146,022,244**	**$ 146,022,244**
											$ 1,305,811,407

TABLE 54. SYSTEM 3, USS/BB COSTS, CAPITAL COSTS

	CAPITAL INVESTMENT	Unit/Coefficient	BASE 2014	2015	2016	2017	2018	2019	2020	2021	2022
CAPITAL COSTS	***Parallel Recycling Collection***										
	New Trucks	$ 170,000		$11,701,879							
	Transfer Capacity										
	Carts	$ 65		$4,101,500							
	Organics Collection										
	New Trucks	$ 170,000					$2,334,100		($5,113,175)		
	ICI Dumpsters (tons/dumpster)	52	$ 18,539	$ 25,134	$ 33,231	$ 33,534	$ 36,860	$ 37,158	$ 38,914		
	ICI Carts (tons/cart/yr.)	5.2	$ 185,092	$ 179,977	$ 172,551	$ 172,103	$ 169,418	$ 168,979	$ 167,462		
	Residential Carts	$ 65							$5,095,350		
	Drop-Off Transfer Capacity	1,000							$968,456		
	Organics Processing										
	Facility Capital Cost	$ 20,000,000	$ 3,900,000	$ 2,000,000	$ 2,000,000		$ 4,000,000		$ 10,000,000		
	Sub-Total, Capital:		***$4,103,631***	***$18,008,491***	***$2,205,781***	***$205,637***	***$6,540,378***	***$206,137***	***$11,157,006***	***$0***	***$0***
											$42,427,062
	Total, Annual and Capital:										**$ 1,483,460,808**
	Total, without Separate Trips:										**$ 1,348,238,468**

TABLE 54A. SYSTEM 3 (A), USS/DS/BB COSTS, CAPITAL COSTS

	SYSTEM 3A - STATUS QUO (SS, DS), BOTTLE BILL STATE-WIDE ANNUAL COSTS	Unit/ Coefficient	COSTS BY YEAR 2014	2015	2016	2017	2018	2019	2020	2021	2022
RESIDENTIAL COSTS	***RESIDENTIAL***										
	Refuse Collection	*Tons*									
	Organized Curbside	Households Served									
	HH per truck/Number of trucks	1500									
	Costs (Using $/truck)	$ 182,000	$ 1,443,867	$ 4,477,200	$ 4,477,200	$ 4,477,200	$ 4,477,200	$ 4,477,200	$ 3,357,900	$ 3,357,900	$ 3,357,900
	Subscription Curbside	Households Served									
	HH per truck/Number of trucks	800									
	Costs (Using $/truck)	$ 182,000	$ 35,899,500	$ 31,235,750	$ 31,235,750	$ 31,235,750	$ 31,235,750	$ 31,235,750	$ 23,426,813	$ 23,426,813	$ 23,426,813
	Drop-Off (Self-Haul)	Households Served									
	Tons (Declines with increasing organics diversion)										
	Drop-Off Operational Costs (Cost/ton)	$ 75	$ 5,174,859	$ 5,030,375	$ 5,010,504	$ 4,991,029	$ 4,902,374	$ 4,884,656	$ 4,284,779	$ 4,284,779	$ 4,284,779
	Transfer/Pull costs	$ 18	$ 1,241,966	$ 1,207,290	$ 1,202,521	$ 1,197,847	$ 1,176,570	$ 1,172,317	$ 1,028,347	$ 1,028,347	$ 1,028,347
	Recycling Collection										
	Organized Curbside	Households Served									
	Number of trucks	2000									
	Costs (Using $/truck)	$ 182,000	$ 3,166,800	$ 3,357,900	$ 3,357,900	$ 3,357,900	$ 3,357,900	$ 3,357,900	$ 2,518,425	$ 2,518,425	$ 2,518,425
	Subscription Curbside	Households Served									
	HH per truck/Number of trucks	960									
	Costs (Using $/truck)	$ 182,000	$ 14,067,083	$ 26,029,792	$ 26,029,792	$ 26,029,792	$ 26,029,792	$ 26,029,792	$ 19,522,344	$ 19,522,344	$ 19,522,344
	Drop-Off (Self-Haul)	Households Served									
	Tons Collected										
	Operational Costs (Cost/ton)	$ 158	$ 2,923,000	$ 3,649,800	$ 3,649,800	$ 3,649,800	$ 3,649,800	$ 3,649,800	$ 3,649,800	$ 3,649,800	$ 3,649,800
	Revenues from Sale of Recyclables	$ 22	$ (407,000)	$ (508,200)	$ (508,200)	$ (508,200)	$ (508,200)	$ (508,200)	$ (508,200)	$ (508,200)	$ (508,200)
	Organics Collection (tons)	3,486									
	Organized Curbside	Households Served									
	HH per truck/Number of trucks	1,500									
	Costs (Using $/truck)	$ 182,000		$ 313,404	$ 313,404	$ 313,404	$ 671,580	$ 671,580	$ 2,686,320	$ 2,686,320	$ 2,686,320
	Subscription Curbside	Households Served									
	Number of trucks	800									
	Costs (Using $/truck)	$ 182,000	$ 91,000	$ 2,186,503	$ 2,186,503	$ 2,186,503	$ 4,685,363	$ 4,685,363	$ 18,741,450	$ 18,741,450	$ 18,741,450
	Drop-Off (Self-Haul)	Households Served									
	Tons Collected										
	Drop-Off Operational Costs	$ 45	$ 157,513	$ 194,008	$ 193,381	$ 192,766	$ 233,905	$ 232,724	$ 581,074	$ 581,074	$ 581,074
	Transfer/Pull costs	$ 18							$ 232,429	$ 232,429	$ 232,429

TABLE 54A. SYSTEM 3 (A), USS/DS/BB COSTS, CAPITAL COSTS (CONTINUED)

	SYSTEM 3A - STATUS QUO (SS, DS), BOTTLE BILL STATE-WIDE ANNUAL COSTS	Unit/ Coefficient	COSTS BY YEAR 2014	2015	2016	2017	2018	2019	2020	2021	2022
COMMERCIAL/ICI COSTS	***COMMERCIAL REFUSE***										
	Refuse Collection	Tons									
	Dumpster Service: Cost per ton / Tons	$ 118	$ 11,955,553	$ 2,955,555	$ 11,145,477	$ 11,116,562	$ 10,943,120	$ 10,914,780	$ 10,816,774	$ 10,816,774	$ 10,816,774
	Roll-Off Service: Cost per ton / Tons	$ 30	$ 791,521	$ 769,648	$ 737,889	$ 735,975	$ 724,492	$ 722,616	$ 716,128	$ 716,128	$ 716,128
	Rear Load Service: Cost per ton / Tons	$ 300	$ 4,442,208	$ 4,319,456	$ 4,141,216	$ 4,130,473	$ 4,066,028	$ 4,055,499	$ 4,019,083	$ 4,019,083	$ 4,019,083
	Drop-off Service : Cost per ton / Tons	$ 75	$ 444,221	$ 431,946	$ 414,122	$ 413,047	$ 406,603	$ 405,550	$ 401,908	$ 401,908	$ 401,908
	Recycling Collection	Tons									
	Dumpster Service: Cost per ton / Tons	$ 84	$ 1,888,909	$ 2,541,525	$ 2,541,525	$ 2,541,525	$ 2,541,525	$ 2,541,525	$ 2,541,525	$ 2,541,525	$ 2,541,525
	Roll-Off Service: Cost per ton / Tons	$ 40	$ 40,000	$ 53,820	$ 53,820	$ 53,820	$ 53,820	$ 53,820	$ 53,820	$ 53,820	$ 53,820
	Rear Load Service: Cost per ton / Tons	$ 171	$ 2,718,274	$ 3,657,434	$ 3,657,434	$ 3,657,434	$ 3,657,434	$ 3,657,434	$ 3,657,434	$ 3,657,434	$ 3,657,434
	Drop-off Service : Cost per ton / Tons	$ 136	$ 217,600	$ 292,781	$ 292,781	$ 292,781	$ 292,781	$ 292,781	$ 292,781	$ 292,781	$ 292,781
	Public Space Recycling: Cost per ton / Tons	$ 500	$ -	$ 1,000,000	$ 1,000,000	$ 1,000,000	$ 1,000,000	$ 1,000,000	$ 1,000,000	$ 1,000,000	$ 1,000,000
	Organics Collection (tons)	8134									
	Dumpster Service (cost/ton)	$ 150	$ 413,151	$ 560,131	$ 740,571	$ 747,336	$ 821,456	$ 828,087	$ 867,218	$ 867,218	$ 867,218
	Roll-Off Service (cost/ton)	$ 30	$ 82,630	$ 112,026	$ 148,114	$ 149,467	$ 164,291	$ 165,617	$ 173,444	$ 173,444	$ 173,444
	Rear Load Service (cost/ton)	$ 200	$ 1,101,737	$ 1,493,683	$ 1,974,856	$ 1,992,896	$ 2,190,550	$ 2,208,231	$ 2,312,581	$ 2,312,581	$ 2,312,581
OTHER COSTS	**BOTTLE BILL (Net Costs)**		$ 8,164,287	$ 8,164,287	$ 8,164,287	$ 8,164,287	$ 8,164,287	$ 8,164,287	$ 8,164,287	$ 8,164,287	$ 8,164,287
	Processing and Disposal										
	Net Cost, SS Res Recycling Processing	$ -									
	Net Cost, SS ICI Recycling Processing	$ -									
	Residential Organics Processing	$ 40	$ 220,752	$ 313,440	$ 311,846	$ 310,284	$ 414,766	$ 411,766	$ 1,296,463	$ 1,296,463	$ 1,296,463
	ICI Organics Processing	$ 40	$ 440,695	$ 597,473	$ 789,942	$ 797,158	$ 876,220	$ 883,292	$ 925,032	$ 925,032	$ 925,032
	Residential Refuse Disposal	$ 70	$ 16,068,337	$ 15,683,048	$ 15,630,057	$ 15,578,125	$ 15,341,712	$ 15,294,462	$ 13,694,792	$ 13,694,792	$ 13,694,792
	ICI Refuse Disposal	$ 70	$ 10,390,280	$ 10,103,163	$ 9,686,263	$ 9,661,134	$ 9,510,399	$ 9,485,770	$ 9,400,595	$ 9,400,595	$ 9,400,595
	Separate Trips, Residential										
	Refuse, Drop-off	miles/HH/yr	$ 5,661,300	$ 5,407,050	$ 5,407,050	$ 5,407,050	$ 5,407,050	$ 5,407,050	$ 5,407,050	$ 5,407,050	$ 5,407,050
	Recycling, Drop-off	miles/HH/yr	$ 5,559,600	$ 5,018,895	$ 5,018,895	$ 5,018,895	$ 4,478,190	$ 4,478,190	$ 693,255	$ 693,255	$ 693,255
	Recycling, Drop-off, Subscription Refuse	mile/HH/yr	$ 1,130,000								
	Organics, Drop-off	mile/HH/yr	$ 423,750	$ 648,846	$ 648,846	$ 648,846	$ 1,297,692	$ 1,297,692	$ 5,839,614	$ 5,839,614	$ 5,839,614
	Beverage Redemption	Cost per container	$ 3,448,633	$ 3,448,633	$ 3,448,633	$ 3,448,633	$ 3,448,633	$ 3,448,633	$ 3,448,633	$ 3,448,633	$ 3,448,633
	District Administration										
	Administration		$ 2,689,900	$ 2,958,890	$ 2,958,890	$ 2,958,890	$ 2,958,890	$ 2,958,890	$ 3,550,668	$ 3,550,668	$ 3,550,668
	Education and Outreach		$ 1,063,500	$ 1,382,550	$ 1,382,550	$ 1,382,550	$ 1,382,550	$ 1,382,550	$ 1,797,315	$ 1,797,315	$ 1,797,315
	HHW and Universal Wate		$ 1,271,100	$ 1,271,100	$ 1,271,100	$ 1,271,100	$ 1,271,100	$ 1,271,100	$ 1,271,100	$ 1,271,100	$ 1,271,100
	Operations		$ 1,278,400	$ 1,661,920	$ 1,661,920	$ 1,661,920	$ 1,661,920	$ 1,661,920	$ 2,160,496	$ 2,160,496	$ 2,160,496
	Special Wastes		$ 717,300	$ 717,300	$ 717,300	$ 717,300	$ 717,300	$ 717,300	$ 717,300	$ 717,300	$ 717,300
	Miscellaneous		$ 732,600	$ 732,600	$ 732,600	$ 732,600	$ 732,600	$ 732,600	$ 732,600	$ 732,600	$ 732,600
	Sub-Total:		***$ 147,114,826***	***$ 153,471,021***	***$ 161,826,538***	***$ 161,713,879***	***$ 164,437,443***	***$ 164,330,323***	***$ 165,473,376***	***$ 165,473,376***	***$ 165,473,376***
											$ 1,449,314,157
	Sub-Total, without Separate Trips:		$ 130,891,543	$ 138,947,597	$ 147,303,114	$ 147,190,455	$ 149,805,878	$ 149,698,758	$ 150,084,824	$ 150,084,824	$ 150,084,824
											$ 1,314,091,818

TABLE 54A. SYSTEM 3 (A), CAPITAL COSTS

	CAPITAL INVESTMENT	Unit/Coefficient	BASE 2014	2015	2016	2017	2018	2019	2020	2021	2022
CAPITAL COSTS	***Parallel Recycling Collection***										
	New Trucks	$ 170,000		$ 11,701,879							
	Transfer Capacity										
	Carts	$ 65		$ 4,101,500							
	Organics Collection										
	New Trucks	$ 170,000					$ 2,334,100		$ (2,072,760)		
	ICI Dumpsters (tons/dumpster)	52	$ 18,539	$ 25,134	$ 33,231	$ 33,534	$ 36,860	$ 37,158	$ 38,914		
	ICI Carts (tons/cart/yr)	5.2	$ 185,092	$ 179,977	$ 172,551	$ 172,103	$ 169,418	$ 168,979	$ 167,462		
	Residential Carts	$ 65							$ 5,095,350		
	Drop-Off Transfer Capacity	1000							$ 968,456		
	Organics Processing										
	Facility Capital Cost	$ 20,000,000	$ 3,900,000	$ 2,000,000	$ 2,000,000		$ 4,000,000		$ 10,000,000		
	Sub-Total, Capital:		**$ 4,103,631**	**$ 18,008,491**	**$ 2,205,781**	**$ 205,637**	**$ 6,540,378**	**$ 206,137**	**$ 14,197,421**	$ -	$ -
											$ 45,467,476
	Total, Annual and Capital										**$ 1,494,781,633**
	Total, without Separate Trips:										**$ 1,359,559,294**

TABLE 55. SYSTEM 4, USS/EBB COSTS

	SYSTEM 4 - UNIVERSAL SS, EXPANDED BOTTLE BILL STATE-WIDE ANNUAL COSTS	Unit/ Coefficient	COSTS BY YEAR BASE 2014	2015	2016	2017	2018	2019	2020	2021	2022
RESIDENTIAL COSTS	***RESIDENTIAL***										
	Refuse Collection										
	Organized Curbside										
	HH per truck/Number of trucks	1,500									
	Costs (Using $/truck)	$ 182,000	$ 1,443,867	$ 4,477,200	$ 4,477,200	$ 4,477,200	$ 4,477,200	$ 4,477,200	$ 3,134,040	$ 3,134,040	$ 3,134,040
	Subscription Curbside	Households Served									
	HH per truck/Number of trucks	800									
	Costs (Using $/truck)	$ 182,000	$ 35,899,500	$ 31,235,750	$ 31,235,750	$ 31,235,750	$ 31,235,750	$ 31,235,750	$ 21,865,025	$ 21,865,025	$ 21,865,025
	Drop-Off (Self-Haul)	Households Served									
	Tons (Declines with increasing organics diversion)										
	Drop-Off Operational Costs (Cost/ton)	$ 75	$ 5,174,859	$ 5,030,375	$ 5,010,504	$ 4,991,029	$ 4,902,374	$ 4,884,656	$ 4,284,779	$ 4,284,779	$ 4,284,779
	Transfer/Pull costs	$ 18	$ 1,241,966	$ 1,207,290	$ 1,202,521	$ 1,197,847	$ 1,176,570	$ 1,172,317	$ 1,028,347	$ 1,028,347	$ 1,028,347
	Recycling Collection										
	Organized Curbside	Households Served									
	Number of trucks	2,000									
	Costs (Using $/truck)	$ 182,000	$ 3,166,800	$ 3,357,900	$ 3,357,900	$ 3,357,900	$ 3,357,900	$ 3,357,900	$ 2,350,530	$ 2,350,530	$ 2,350,530
	Subscription Curbside	Households Served									
	HH per truck/Number of trucks	960									
	Costs (Using $/truck)	$ 182,000	$ 14,067,083	$ 26,029,792	$ 26,029,792	$ 26,029,792	$ 26,029,792	$ 26,029,792	$ 18,220,854	$ 18,220,854	$ 18,220,854
	Drop-Off (Self-Haul)	Households Served									
	Tons Collected										
	Operational Costs (Cost/ton)	$ 120	$ 2,193,600	$ 2,772,000	$ 2,772,000	$ 2,772,000	$ 2,772,000	$ 2,772,000	$ 2,772,000	$ 2,772,000	$ 2,772,000
	Revenues from Sale of Recyclables	$ 22	$ (402,160)								
	Organics Collection (tons)	***3486***									
	Organized Curbside	Households Served									
	HH per truck/Number of trucks	1,500									
	Costs (Using $/truck)	$ 182,000		$ 313,404	$ 313,404	$ 313,404	$ 671,580	$ 671,580	$ 2,686,320	$ 2,686,320	$ 2,686,320
	Subscription Curbside	Households Served									
	Number of trucks	800									
	Costs (Using $/truck)	$ 182,000	$ 91,000	$ 2,186,503	$ 2,186,503	$ 2,186,503	$ 4,685,363	$ 4,685,363	$ 18,741,450	$ 18,741,450	$ 18,741,450
	Drop-Off (Self-Haul)	Households Served									
	Tons Collected										
	Drop-Off Operational Costs	$ 45	$ 157,513	$ 194,008	$ 193,381	$ 192,766	$ 233,905	$ 232,724	$ 581,074	$ 581,074	$ 581,074
	Transfer/Pull costs	$ 18							$ 232,429	$ 232,429	$ 232,429

TABLE 55. SYSTEM 4, USS/EBB COSTS (CONTINUED)

	SYSTEM 4 - UNIVERSAL SS, EXPANDED BOTTLE BILL STATE-WIDE ANNUAL COSTS	Unit/ Coefficient	COSTS BY YEAR BASE 2014	2015	2016	2017	2018	2019	2020	2021	2022
COMMERCIAL /ICI COSTS	***COMMERCIAL REFUSE***										
	Refuse Collection	Total Tons									
	Dumpster Service: Cost per ton / Tons	$ 118	$ 11,839,568	$ 11,509,197	$ 11,029,491	$ 11,000,577	$ 10,827,134	$ 10,798,795	$ 10,700,788	$ 10,700,788	$ 10,700,788
	Roll-Off Service: Cost per ton / Tons	$ 30	$ 783,842	$ 761,970	$ 730,211	$ 728,296	$ 716,813	$ 714,937	$ 708,449	$ 708,449	$ 708,449
	Rear Load Service: Cost per ton / Tons	$ 300	$ 4,399,113	$ 4,276,360	$ 4,098,121	$ 4,087,377	$ 4,022,933	$ 4,012,403	$ 3,975,988	$ 3,975,988	$ 3,975,988
	Drop-off Service : Cost per ton / Tons	$ 75	$ 439,911	$ 427,636	$ 409,812	$ 408,738	$ 402,293	$ 401,240	$ 397,599	$ 397,599	$ 397,599
	Recycling Collection (tons)										
	Dumpster Service: Cost per ton / Tons	$ 84	$ 1,888,909	$ 2,371,477	$ 2,371,477	$ 2,371,477	$ 2,371,477	$ 2,371,477	$ 2,371,477	$ 2,371,477	$ 2,371,477
	Roll-Off Service: Cost per ton / Tons	$ 40	$ 40,000	$ 50,219	$ 50,219	$ 50,219	$ 50,219	$ 50,219	$ 50,219	$ 50,219	$ 50,219
	Rear Load Service: Cost per ton / Tons	$ 171	$ 2,718,274	$ 3,412,724	$ 3,412,724	$ 3,412,724	$ 3,412,724	$ 3,412,724	$ 3,412,724	$ 3,412,724	$ 3,412,724
	Drop-off Service : Cost per ton / Tons	$ 136	$ 217,600	$ 273,191	$ 273,191	$ 273,191	$ 273,191	$ 273,191	$ 273,191	$ 273,191	$ 273,191
	Public Space Recycling: Cost per ton / Tons	$ 500	$ -	$ 1,000,000	$ 1,000,000	$ 1,000,000	$ 1,000,000	$ 1,000,000	$ 1,000,000	$ 1,000,000	$ 1,000,000
	Organics Collection (tons)	***8134***									
	Dumpster Service (cost/ton)	$ 150	$ 413,151	$ 560,131	$ 740,571	$ 747,336	$ 821,456	$ 828,087	$ 867,218	$ 867,218	$ 867,218
	Roll-Off Service (cost/ton)	$ 30	$ 82,630	$ 112,026	$ 148,114	$ 149,467	$ 164,291	$ 165,617	$ 173,444	$ 173,444	$ 173,444
	Rear Load Service (cost/ton)	$ 200	$ 1,101,737	$ 1,493,683	$ 1,974,856	$ 1,992,896	$ 2,190,550	$ 2,208,231	$ 2,312,581	$ 2,312,581	$ 2,312,581
OTHER COSTS	**BOTTLE BILL (Net Costs)**		$ 11,073,553	$ 11,073,553	$ 11,073,553	$ 11,073,553	$ 11,073,553	$ 11,073,553	$ 11,073,553	$ 11,073,553	$ 11,073,553
	Processing and Disposal										
	Net Cost, SS Res Recycling Processing	0									
	Net Cost, SS ICI Recycling Processing	0									
	Residential Organics Processing	40	$ 220,752	$ 313,440	$ 311,846	$ 310,284	$ 414,766	$ 411,766	$ 1,296,463	$ 1,296,463	$ 1,296,463
	ICI Organics Processing	40	$ 440,695	$ 597,473	$ 789,942	$ 797,158	$ 876,220	$ 883,292	$ 925,032	$ 925,032	$ 925,032
	Residential Refuse Disposal	70	$ 15,974,537	$ 15,589,248	$ 15,536,257	$ 15,484,325	$ 15,247,912	$ 15,200,662	$ 13,600,992	$ 13,600,992	$ 13,600,992
	ICI Refuse Disposal	70	$ 10,289,480	$ 10,002,363	$ 9,585,463	$ 9,560,334	$ 9,409,599	$ 9,384,970	$ 9,299,795	$ 9,299,795	$ 9,299,795
	Separate Trips, Residential										
	Refuse, Drop-off	miles/HH/yr	$ 5,661,300	$ 5,407,050	$ 5,407,050	$ 5,407,050	$ 5,407,050	$ 5,407,050	$ 5,407,050	$ 5,407,050	$ 5,407,050
	Recycling, Drop-off	miles/HH/yr	$ 5,559,600	$ 5,018,895	$ 5,018,895	$ 5,018,895	$ 4,478,190	$ 4,478,190	$ 693,255	$ 693,255	$ 693,255
	Recycling, Drop-off, Subscription Refuse	mile/HH/yr	$ 1,130,000								
	Organics, Drop-off	mile/HH/yr	$ 423,750	$ 648,846	$ 648,846	$ 648,846	$ 1,297,692	$ 1,297,692	$ 5,839,614	$ 5,839,614	$ 5,839,614
	Beverage Redemption	Cost per container	$ 4,722,130	$ 4,722,130	$ 4,722,130	$ 4,722,130	$ 4,722,130	$ 4,722,130	$ 4,722,130	$ 4,722,130	$ 4,722,130
	District Administration										
	Administration		$ 2,689,900	$ 2,958,890	$ 2,958,890	$ 2,958,890	$ 2,958,890	$ 2,958,890	$ 3,550,668	$ 3,550,668	$ 3,550,668
	Education and Outreach		$ 1,063,500	$ 1,382,550	$ 1,382,550	$ 1,382,550	$ 1,382,550	$ 1,382,550	$ 1,797,315	$ 1,797,315	$ 1,797,315
	HHW and Universal Wate		$ 1,271,100	$ 1,271,100	$ 1,271,100	$ 1,271,100	$ 1,271,100	$ 1,271,100	$ 1,271,100	$ 1,271,100	$ 1,271,100
	Operations		$ 1,278,400	$ 1,661,920	$ 1,661,920	$ 1,661,920	$ 1,661,920	$ 1,661,920	$ 2,160,496	$ 2,160,496	$ 2,160,496
	Special Wastes		$ 717,300	$ 717,300	$ 717,300	$ 717,300	$ 717,300	$ 717,300	$ 717,300	$ 717,300	$ 717,300
	Miscellaneous		$ 732,600	$ 732,600	$ 732,600	$ 732,600	$ 732,600	$ 732,600	$ 732,600	$ 732,600	$ 732,600
	Sub-Total		***$ 150,207,360***	***$ 165,150,193***	***$ 164,836,083***	***$ 164,723,424***	***$ 167,446,988***	***$ 167,339,868***	***$ 165,227,889***	***$ 165,227,889***	***$ 165,227,889***
											$ 1,475,387,582
	Sub-Total, without Separate Trips:		**$ 132,710,580**	**$ 149,353,272**	**$ 149,039,162**	**$ 148,926,503**	**$ 151,541,927**	**$ 151,434,806**	**$ 148,565,840**	**$ 148,565,840**	**$ 148,565,840**
											$ 1,328,703,772

TABLE 55. SYSTEM 4, USS/EBB COSTS, CAPITAL COSTS

	CAPITAL INVESTMENT	Unit/Coefficient	BASE 2014	2015	2016	2017	2018	2019	2020	2021	2022
CAPITAL COSTS	***Parallel Recycling Collection***										
	New Trucks	$ 170,000		$ 11,701,879							
	Transfer Capacity										
	Carts	$ 65		$ 4,101,500							
	Organics Collection										
	New Trucks	$ 170,000					$ 2,334,100		$ (5,113,175)		
	ICI Dumpsters (tons/dumpster)	52	$ 18,539	$ 25,134	$ 33,231	$ 33,534	$ 36,860	$ 37,158	$ 38,914		
	ICI Carts (tons/cart/yr)	5.2	$ 183,296	$ 178,182	$ 170,755	$ 170,307	$ 167,622	$ 167,183	$ 165,666		
	Residential Carts	$ 65							$ 5,095,350		
	Drop-Off Transfer Capacity	1,000							$ 968,456		
	Organics Processing										
	Facility Capital Cost	$ 20,000,000	$ 3,900,000	$ 2,000,000	$ 2,000,000		$ 4,000,000		$ 10,000,000		
	Sub-Total, Capital:		**$ 4,101,835**	**$ 18,006,695**	**$ 2,203,986**	**$ 203,842**	**$ 6,538,582**	**$ 204,341**	**$ 11,155,211**	$ -	$ -
											$ 42,414,492
	Total, Annual and Capital										**$ 1,517,802,074**
	Total, without Separate Trips:										**$ 1,371,118,264**

XI. ENVIRONMENTAL BENEFITS OF ACT 148

While there are a range of environmental benefits, and costs associated with each of the four systems analyzed, identification, measurement and accurate quantification of many of these is beyond the scope of this analysis. However calculation of the Greenhouse Gas (GHG) emissions reductions (or increases) associated with each system (and material) can be accomplished through use of the US EPA Waste Reduction Model (WARM). Because GHG emissions include life-cycle impacts associated with the mining, manufacturing, transport and consumption of goods, and because a number of other pollutants are impacted by similar drivers (especially energy use) the WARM model represents a good surrogate of the environmental benefits and costs of Act 148. Documentation on the methodology and the model, which was last updated in June, 2013, can be found at: http://epa.gov/epawaste/conserve/tools/warm/SWMGHGreport.html

WARM was developed to "help solid waste planners and organizations track and voluntarily report greenhouse gas (GHG) emissions reductions" from different waste management practices. The Microsoft Excel based version was used for this analysis, and enables specific information to be input such as the region, state and methane gas management practices of the disposal facility(s) used. For example, it accounts for the avoided electricity-related emissions in landfilling by assigning the appropriate regional "marginal" electricity grid mix emission factor as well as accounts for factors affecting methane emissions including gas control, energy recovery or flaring, and climate.[111]

The Project Team used WARM to estimate GHG emissions savings from the Base Case (System 1) and from Systems 2, 3 and 4 to compare each against the Base Case. Emissions are shown in metric tons of carbon equivalent (MTCE) for each material category and in energy units (million BTU) and other equivalencies for the aggregated materials impacts. Landfill emissions are held constant for all systems, with the only change in landfill emissions being reductions or additions of specific materials and organics depending on the system.

Note that as of August 2010, the WARM model includes a more comprehensive analysis of composting food residuals and yard waste. Landfill emissions are now calculated from organics based on a first-order decay rate to better measure when emissions are generated as opposed to only calculating the lifetime methane emissions. In addition, landfill gas capture and recovery systems are modeled with a time element, and assume systems are phased in. These two new elements enables the model to estimate the amount of methane being generated at a particular time and the amount of methane being captured at that time, which most affects food residuals and grass emissions factors. Finally, the new emission factor takes into account the higher soil carbon sequestration capacity for compost-improved soil as well as the GHG emissions involved in composting machinery and transportation. However, the updated model still does not include an emission factor for other compostable materials, like non-recyclable paper***. Therefore the GHG emissions value of including compostable paper into compost, which is included in our analysis of diversion, could not be calculated and is not included in total emissions reductions.***

WARM also does not include GHG emissions reductions associated with using compost, such as water conservation and changes in fertilizer use. But it also does not differentiate between the potential for varying emissions from different compost sites, which is a function of the technology used and the efficiency of operations. For example, a poorly operated compost facility that goes anaerobic can be a significant generator of methane while a well

[111] Source US EPA, See: http://epa.gov/epawaste/conserve/tools/warm/index.html

operated compost facility will not be. Therefore, actual emissions from composting sites could vary greatly and the Project Team does not represent that these are included in the emissions estimates shown below.

TABLE 56. WARM MODEL RESULTS (IN MTCE'S) FOR ALL SYSTEMS

Commodity	Recycled *(tons)*	Landfilled *(tons)*	Composted *(tons)*	Total MTCE *(MTCE)*	*Change from Base*
System 1/Base Case: GHG Emissions					
Aluminum Cans	2,300	460	NA	(5,568)	NA
Steel Cans	1,620	70	NA	(793)	NA
Glass	23,880	1,200	NA	(1,769)	NA
HDPE	1,300	53	NA	(302)	NA
PET	2,420	1,230	NA	(713)	NA
Food Scraps	NA	29,631	0	3,009	NA
Yard Trimmings	NA	8,000	0	(669)	NA
Mixed Paper	60,570	26,990	NA	(62,852)	NA
Mixed Plastics	1,400	788	NA	(363)	NA
Total GHG Emissions (MTCE), Base Case:				**(70,019)**	NA
System 2: GHG Emissions (MTCE)					
Aluminum Cans	1,750	1,010	NA	(4,228)	*1,340*
Steel Cans	1,690	0	NA	(829)	*(35)*
Glass	16,320	8,760	NA	(1,106)	*662*
HDPE	1,283	0	NA	(298)	*4*
PET	2,210	1,440	NA	(647)	*66*
Food Scraps	NA	0	29,631	(1575)	*(4584)*
Yard Trimmings	NA	0	8,000	(425)	*244*
Mixed Paper	87,560	0	NA	(83,906)	*(21,054)*
Mixed Plastics	2,088	100	NA	(555)	*(192)*
Total GHG Emissions (MTCE), System 2:				**(93,568)**	***(23,549)***
System 3: GHG Emissions (MTCE)					
Aluminum Cans	2,680	80	NA	(6,494)	*(926)*
Steel Cans	1,690	0	NA	(829)	*(35)*
Glass	24,000	1,080	NA	(1,779)	*(11)*
HDPE	1,283	70	NA	(298)	*4*
PET	2,500	1,150	NA	(738)	*(25)*
Food Scraps	NA	0	29,613	(1574)	*-4583*
Yard Trimmings	NA	0	8,000	(425)	*244*
Mixed Paper	87,560	0	NA	(83,906)	*(21,054)*
Mixed Plastics	2,088	100	NA	(555)	*(192)*
Total GHG Emissions (MTCE), System 3:				**(96,597)**	***(26,578)***
System 4: GHG Emissions (MTCE)					
Aluminum Cans	2,760	0	0	(6,689)	*(1,121)*
Steel Cans	1,690	0	0	(829)	*(35)*
Glass	25,080	0	0	(1,874)	*(105)*
HDPE	1,353	0	0	(315)	*(13)*
PET	3,650	0	0	(1,099)	*(386)*
Food Scraps	NA	0	29,613	(1,574)	*(4,583)*
Yard Trimmings	NA	0	8,000	(425)	*244*
Mixed Paper	87,560	0	0	(83,906)	*(21,054)*
Mixed Plastics	2,188	0	0	(583)	*(220)*
Total GHG Emissions (MTCE), System 4:				**(97,293)**	***(27,273)***

TABLE 57. WARM MODEL RESULTS, EQUIVALENCIES OF SAVINGS

Equivalencies	System 2	System 3	System 4
Total Change in Energy Use (million BTU):	(435,109)	(608,016)	(668,517)
This is equivalent to conserving:			
Households' Annual Energy Consumption	3,870	5,408	5,946
Barrels of Oil	74,890	104,650	115,063
Gallons of Gasoline	3,480,869	4,864,129	5,348,137
Removing annual emissions from:			
Passenger Vehicles	16,931	19,107	19,607
Gallons of Gasoline	9,680,109	10,924,326	11,210,327
Railway Cars of Coal	470	531	544

XII. ACT 148 IMPLEMENTATION ISSUES

Act 148 specifies a number of key changes to solid waste management in Vermont designed to improve diversion of materials and organics from landfill disposal. Many solid waste professionals (but not all) consider the following key provisions of Act 148 as the most likely to lead to the highest diversion rates achievable:

- Parallel collection of recyclables and MSW for all households assumed to begin in 2015;
- Variable rate pricing (referred to as Unit Based Pricing in this report) of solid waste with recycling embedded in the cost of refuse collection (i.e. free collection of recyclables);
- Disposal ban on leaf and yard residuals at landfills in 2016;
- Implementation of public space recycling throughout Vermont; and finally,
- A disposal ban on food residuals to landfill by 2020, with a phased in requirement for large generators of food residuals to begin separating their food scraps as early as 2014.

The success of Act 148 will depend on how each of these provisions is implemented over time. The following five stakeholder groups will all play key roles:

- Agency of Natural Resources;
- Solid waste districts. alliances and municipalities;
- Private haulers;
- Owners and developers of organics management facilities, including existing farms; and,
- Business and household generators of waste, recyclables and organics.

Presented below is a discussion of important decisions that must be made by each of the stakeholder groups associated with key provisions of Act 148 as listed above, as well as a discussion of the related implementation issues.

MANDATED SEPARATE COLLECTION OF RECYCLABLES FOR ALL HOUSEHOLDS

Section 4, Subsection 6605 of Act 148 states, "*Solid Waste Management Facility Certification* : *A facility certified under this section that offers the collection of solid waste shall: (i) Beginning in July 1, 2014, collect mandated recyclables separate from other solid waste and deliver mandated recyclables to a facility maintained and operated for the management and recycling of mandated recyclables…(ii) A facility certified under this section that offers the collection of solid waste shall not charge a separate fee for the collection of mandated recyclables."*

There are two primary implementation issues associated with this provision:

- Enforcement of mandated separate collection of recyclables; and,
- Parallel access to collection of recycling and refuse.

ENFORCEMENT OF MANDATED SEPARATE COLLECTION

Enforcement of mandated separation of recyclables is relatively easy at transfer stations and drop-off facilities if municipalities and/or solid waste districts are willing to enforce at the point of transfer/disposal, provide recycling drop-off adjacent to the transfer/disposal location at no cost, and are prepared to adopt and enforce ordinances requiring separation. Enforcement of subscription collection (representing 58 percent of all households) will be more difficult. This is because haulers who do not require separation, or provide limited collection of recyclables (see below) will be able to charge a lower price for collection than those who strictly enforce. This lack of a level playing field for all haulers will be an important issue for municipalities, districts, private haulers and ANR unless there is enforcement at the point of transfer or disposal.

There is no language in Act 148 pertaining to enforcement of the separation mandate.. While UBP will provide an economic incentive for some households to separate (depending on how aggressive UBP is implemented) it is likely that enforcement at the point of transfer or disposal will ultimately be necessary to fully (and successfully) implement this provision of Act 148. For this reason, it will be necessary for ANR to either adopt regulations concerning mandated inspections at transfer and disposal locations (as the Massachusetts Department of Environmental Protection has learned) or ANR will need to make it a requirement of District SWIPs that enforcement occur at these locations. However since the vast majority of refuse is transferred through or directly disposed at private facilities, districts would then need to play an enforcement role at those facilities.

In all cases, any regulation is going to have to define "de minimis" levels as opposed to enforcement for loads containing over some level of mandated recyclables. This is necessary because even high performing programs will only result in recovery rates of mandated recyclables of 60 to 65 percent.

This issue will become much more difficult in 2020 when organics are banned from disposal. Unlike recyclables, where haulers are required to "embed" the cost of recycling collection in the refuse collection charge, haulers will be allowed to charge extra to collect organics. Experience with subscription collection of recyclables, where households are required to pay extra for separate collection of recyclables, suggests that no more than 15 percent of households will be willing to pay extra for separate collection of organics.[112] This means that VT ANR also will have to adopt regulations enforcing organics bans at the point of transfer or disposal in order to meet the 60 percent organics diversion rate used in this analysis.

PARALLEL ACCESS

For purposes of this analysis the Project Team has assumed that private haulers collecting refuse will offer parallel access to recyclables and refuse collection. While Act 148 is silent on whether this means that private haulers must offer collection of recyclables on the same day as refuse, the Project Team feels strongly that the ANR and solid waste districts should require same day collection of recyclables and refuse to households wherever feasible to

[112] Three examples of subscription collection of recyclables at a price of roughly $4 extra per month were Columbus, OH, Knoxville, TN, and Indianapolis, IN. In each case less than 15 percent of households were willing to pay an additional $4 per month for separate collection of recyclables. Our best estimate is that separate collection of organics is likely to cost around $7 to $9 per household per month. At this cost, it is likely that an even lower percentage of households will voluntarily sign up for separate collection of organics.

increase the amount of material collected for recycling and to reduce confusion about recycling collection days. Offering recycling collection on separate days or on a reduced schedule when compared to refuse collection will result in lower materials recovery rates than are estimated in this analysis.[113]

This is not an issue for drop-off or transfer station based refuse collection because it is assumed that all drop-offs and transfer stations that offer refuse collection will also be required to provide facilities for the drop-off of recycling at the same locations and times. It does mean, however, that a private hauler providing refuse collection cannot claim that they are providing recycling collection through a drop-off or transfer station if they are collecting refuse at the curb/roadside.

UNIT BASED PRICING

Section 11. 24 VSA, Subsection 2202(a) requires, *"(d) By no later than July 1, 2015, a municipality shall implement a variable rate pricing system that charges for the collection of municipal solid waste for disposal based on the volume or weight of the waste collected."* Variable rate or unit based pricing is the second of the three legged stool necessary to drive high diversion rates for materials, and a key factor in increasing organics diversion. A wide range of unit based pricing (UBP) programs exist throughout the United States. Many have been very successful in reducing waste disposal and increasing diversion, but others do not provide a sufficient economic incentive to change household behavior. Because of the mixed success of these programs, it will be necessary for ANR to provide specific guidance on what UBP programs will be considered acceptable under Act 148. Key issues include:

- *Payment only for excess refuse* – Any UBP program which allows a household to set out 64 gallons of refuse (a typical rolling cart size), or two bags of refuse per collection day at no charge with payment only for refuse set out above this maximum volume will have minimal impact on behavior because most households generate less than 64 gallons of refuse per week, and will not be impacted by this restriction.

- *UBP for disposal costs only* – Based on Vermont's 2012 waste composition study, the average Vermont household generates roughly 1,835 pounds or refuse per year. If the average disposal cost including State and district surcharges is $95 per ton, each pound of waste disposed costs 4.8 cents. Under an UBP program based solely on disposal costs, the average household would pay $1.68 per week for waste disposal (35 pounds at 4.8 cents). Spread over two bags, the households would pay 84 cents per bag, which in the Project Team's experience is not high enough to induce households to change their behavior. Bag charges must be in the $2.50 to $3.00 per bag range to have the desired impact. For this reason, true UBP requires collection and recycling costs be included in the per bag charge for there to be an effective economic incentive to reduce waste and divert materials and organics. This price will be sufficient to increase materials diversion, but may not be sufficient to increase organics diversion if the average household must pay an additional $7 per household per month more for separate organics collection.

[113] For example, DSM recently completed a recovery rate analysis for a New England city which collects waste and recycling weekly on the same day of the week in some neighborhoods, but collects waste two or three times per week with only one recycling collection day in some areas. Overall recovery rates for recyclables were measured at over 66 percent in the area of the City with same day collection of refuse and recycling as compared to 50 and 58 percent in areas with two refuse collections per week (and one recycling collection), and 41 percent in areas with three refuse collections per week and one recycling collection.

- *Marginal cost pricing by waste haulers* – There is very little incentive for private waste collection companies to adopt aggressive UBP prices because almost all of the cost associated with collecting waste is fixed on the collection route. This is especially the case in Vermont where stops, not tons, are the limiting factor in collection in most regions. For this reason, to create a level playing field, and to achieve true UBP pricing that will influence household behavior, it will be necessary for either ANR or the districts to mandate UBP schemes that all haulers operating in a district must operate within.

- *Use of carts* – As stated above, a pricing scheme that provides one 64 gallon cart of capacity at a fixed cost, with additional charges above 64 gallons does not provide adequate economic incentive to divert material for diversion. If carts are to be used serious consideration must be given to reducing the base cart size to either 48 gallons, or preferably 35 gallons, with 64 gallon carts priced at double that of the smaller cart.

- *Adoption of ordinances* – Act 148 states that *"a municipality shall implement a variable rate pricing system…"* In most cases this will require adoption of an ordinance regulating all haulers within the municipality as well as any transfer stations and drop-off locations. The ordinance will have to address the issues discussed above, and will have to provide for effective enforcement of the ordinance. While it is likely that active solid waste districts will adopt district-wide ordinances, and will then fund enforcement; there are a number of districts and consortiums, especially in the southern part of Vermont that currently do not have the institutional capacity to adopt or enforce a district-wide ordinance. This is a critical issue that ANR will have to address as ANR moves forward with implementation of Act 148. In many cases municipalities will not have the capacity or desire to adopt and enforce ordinances requiring UBP, especially if the municipality is served by multiple subscription haulers.

DISPOSAL BAN ON LEAF AND YARD WASTE

Just as with mandating separation of recyclables, this ban will require enforcement at the transfer or disposal facility site and ANR will need to establish regulations concerning how it will be regulated and enforced. ANR will also need to issue permits for new yard waste processing locations, which the Project Team expects will be a combination of municipal/district facilities and private facilities. Based on the State of Delaware experience with a similar ban, private facilities will primarily be developed by landscape companies, as opposed to waste hauling companies.

One important issue will be the extent to which separate leaf and yard waste collections are carried out with bulk collections versus bagged collections. In the case of bagged collections, the use of "bio-degradable" bags will require attention by both the operators of composting sites and ANR to assure that any plastic is actually degrading in the composting process and not ending up as a contaminant.

PUBLIC SPACE RECYCLING

Act 148 states that *"Beginning July 1, 2015, when a container or containers in a public building or on a public land are provided to the public for use for solid waste destined for disposal, an equal number of containers shall be provided for the collection of mandated recyclables."* The following issues will need to be addressed by ANR and the Districts/municipalities to fully implement public space recycling.

- Act 148 only discusses public space recycling in public spaces. However, convenience stores and gas stations which are private spaces used by the public have the potential to generate significant quantities of recyclables and should be included in district and SWIP plans for future recycling opportunities.

- Public space recycling containers can be expensive. It is not unusual to spend between $500 and $1,200 per container for durable and permanent public space containers that are secured, vandal resistant, and aesthetically pleasing[114]. Funding for these containers will have to be found from some source other than municipal and state general fund budgets if municipalities and state agencies are to implement this requirement of Act 148.

- Users of public space recycling containers typically take only several seconds to decide whether a material should go in the recycling or litter bin. ANR should consider regulations that require a standard color and messaging for bins and/or lids for all public space recycling containers in Vermont. The color that is most universal is blue, reserving green for future organics containers.

- Collection of public space containers can be potentially costly depending on the location of the containers and the current arrangement for collection of the litter bins. For example, if municipal parks crews are collecting litter, they may not be equipped to collect recycling requiring either a separate trip to each container or the need for a split truck. If the litter containers are collected by a private hauler, then it may be necessary for the public entity to amend their existing contract with the private hauler to collect the new recycling container material.

- Contamination can be a significant issue unless there is proper signage and policing of the recycling bins. Again, a state-wide effort to create a uniform color, uniform messaging and a uniform list of acceptable materials, coupled with a state-wide educational effort can help reduce contamination and increase participation.

SOURCE SEPARATION OF ORGANICS

The requirement to source separate food residuals and deliver them to an organics processing facility raises the most important implementation issues, in part because Vermont is the first state in the United States to require all generators of food residuals (residential and ICI) to separate food residuals for delivery to an organics

[114] Playing fields and other temporary public spaces can use low cost recycling containers, but permanent public space recycling will require much more expensive containers.

management facility by 2020. As such there are many issues to address that will require work by all of the stakeholders over the next several years.

The key implementation issues are summarized below.

ENFORCMENT OF SOURCE SEPARATION

Organics collection, especially at the residential level, will cost significantly more than collection of the material as refuse. Because haulers are not required to embed the cost of organics collection in their refuse collection price, many generators will opt to not separate organics unless they are forced to. This is especially critical in 2020 when household food residuals will require source separation.

As estimated through this study, 58 percent of households subscribe to refuse collection at the curb or roadside. The Project Team's data over the past 20 years on the behavior of households that are either required to separately drive their recycling to conveniently located drop-off recycling locations or to pay extra for subscription collection of recycling concludes that only 7 to 15 percent of households typically chose to drive to drop-off locations to recycle or pay for subscription collection over and above their refuse collection cost. There is no reason to expect that household behavior will be any different for organics collection unless there are mandatory ordinances requiring and enforcing organics separation.

It is unreasonable to assume that private haulers will voluntarily enforce mandatory separation because they risk losing customers to haulers who are more lenient. Haulers must have a level playing field of enforcement which can only occur if there are inspections of refuse loads at the point of transfer or disposal, and if ANR is prepared to adopt regulations concerning load inspections. There is no other feasible way to reach high diversion rates for organics because the economics do not yet sustain diversion of organics, even at lower tipping fees (at organics processing facilities) because of the high collection cost, especially for residential organics.

FUNDING OF NEW CAPITAL COSTS

This analysis assumes that roughly 30 percent of food residuals not managed on-site (back yard composting), or reduced (food banks) can be delivered to low cost farm operations. The remaining 70 percent will require construction of new composting facilities and/or front end grinding and contaminant removal for delivery to anaerobic digesters. The Project Team estimates that these facilities will require an investment of at least $20 million. One option for raising funds to pay for this investment is to increase the state per ton franchise fee. For example, doubling the fee from $6 to $12 per ton could raise roughly $2.5 million annually at current disposal rates, which is about one-half of what would be necessary to fund the new truck and processing needs. The amount raised will decline as additional recyclables are diverted; and will decline even further as organics are diverted. However, with disposal fees in surrounding states falling since 2008, and spot market rates at roughly $50 to $60 per ton, and District surcharges added, Vermont's disposal fees could be double those in neighboring states providing a significant incentive for leakage from Vermont.

CARBON CONSTRAINTS

As discussed in the body of the report, the Project Team believes that finding adequate sources of carbon will be difficult if composting is the preferred alternative for managing organics. If this occurs there will be a desire to include a "free" source of carbon which is dirty paper not suitable for recycling. This will add the potential for increased contamination by other materials, especially plastics, which will increase operating costs and/or reduce the value of the final product.

GENERAL IMPLEMENTATION ISSUES

Act 148 imposes significant changes in solid waste management in Vermont, many that will require outreach, implementation support and enforcement at the State level. These costs are accounted for in the assumed increase in District Administrative, Outreach and Operations costs although are more likely to be implemented and effective, at the statewide level as discussed below.

EQUALIZED PROGRAMS AND ENFORCEMENT ACROSS VERMONT

Currently there are large variations in how Act 78 has been implemented across Vermont. While some districts are actively involved in materials diversion programs, other areas of Vermont have very limited programs, relying instead on the private sector to provide refuse collection, and in some cases recycling collection. These regions have a hands-off approach to solid waste management that is unlikely to change unless ANR decides to equally enforce the provisions of the new Act 148. This may require changes in the way that ANR enforces SWIPs, or that ANR actively enforce standards for programs across all municipalities and districts. Without these changes it is unlikely that Vermont will meet the materials and organics diversion levels that are feasible under Act 148.

CONSOLIDATION OF SOLID WASTE ADMINISTRATION

Act 148 establishes state-wide standards for provision of recyclables collection by all haulers with the cost embedded in the refuse fee, adoption of UBP, and the banning of recyclables and organics from disposal. Because roughly 70 percent of all recyclables go to two single stream MRFs with the same materials accepted, and Act 148 requirements are uniform across the State, consideration should be given to a careful analysis of the potential to consolidate district administration and recycling education across the state. This would have the benefits of reducing system-wide administration costs, leveling the playing field for all generators and haulers, and providing consistent messaging across all of Vermont with respect to materials and public space recycling and new organics diversion requirements.

States of similar size such as Delaware and Rhode Island have a single implementation entity responsible for managing a number of programs (and materials) that are managed by a broad range of districts, municipalities and consortiums in Vermont. An analysis of these states could provide insights into the feasibility of consolidating solid waste administrative functions and other activities in Vermont.

DATA COLLECTION AND ANALYSIS

A very large part of the effort associated with this report was collecting, compiling *and analyzing* the data necessary to complete the report. These data are available from both districts and ANR but none of these entities

have compiled them in a standardized way that makes them useful on a state-wide basis. Given the emphasis on data collection and analysis contained in the implementation plan for Act 78, and the large amount of quarterly report data provided to ANR over the years by districts and the private sector; the lack of coherent data compilation and analysis available from ANR for this report is discouraging. Because you cannot manage what you cannot measure, the success of Act 148 will depend in part on the collection, ***compilation and analysis*** of specific and standardized performance data for MSW, recyclables, organics, C&D materials and special wastes. This will either require a fully funded and staffed group at ANR which is not subject to budget cuts and does not have regulatory responsibilities, or the creation of a new entity with the capacity to request data and to synthesize and analyze the data on a timely manner.

One important change which would both reduce the regulatory burden on districts and the private sector and the compilation burden on ANR would be to reduce reporting from quarterly to annual. The Project Team is not aware of any valid analytical reason for requiring quarterly reports.

BROAD BASED FUNDING SOURCE

There has been huge interest, both in-state and from out-of-state interests, associated with the bottle bill, which represents roughly 1 to 2 percent of the total material generated in Vermont. There has been virtually no discussion of the large amount of other packaging materials (roughly 100,000 tons in 2012) which are growing ever larger each year in Vermont's waste stream – much of which is either not recyclable at the current time (e.g., residential film plastics), or potentially recyclable with new investments in collection and sorting technologies.

The addition of a food residuals ban will add an entirely new source of material which will require new resources to manage. As currently structured, these new costs will be borne entirely by households and businesses in Vermont who already face high solid waste management costs relative to other, more densely populated areas of the U.S. Consideration should be given to a broad based fee that covers the full range of packaging and food residuals generated in Vermont, and which could be used to invest in the management and capital necessary to truly move Vermont to a sustainable materials management system.

It is highly unlikely that sustainable materials management can be funded entirely on the backs of municipal property taxes, landfill surcharges and unit based prices. The failure to include the large producers of packaging and food products not impacted by the bottle bill leaves out an essential component of any attempt to internalize sustainable materials management in Vermont.

XIII. SUMMARY OF FINDINGS

Act 148 has the potential to raise materials recovery rates to between 63 and 68 percent , and to divert roughly 60 percent of the food residuals, yard residuals and compostable papers for composting, animal feed, and energy (through anaerobic digestion). This increased diversion comes with concomitant reductions in GHG emissions of roughly 23,500 to 27,300 metric tons carbon equivalent per year over the existing system once Act 148 is fully implemented

However, to achieve the highest recovery rates and the greatest environmental benefits, Vermonters will have to spend more than they are currently spending on solid waste management. As illustrated by Table 58, while System 2, with Universal Single Stream recycling and no bottle bill has the lowest overall system-wide cost over the nine year analysis period, this system still results in an estimated increase of $7.8 million per year in new costs, exclusive of separate trips which have been eliminated from all systems in Table 58. Increasing diversion above the levels projected in System 2 through the use of deposits on beverage containers increases annual costs by another $5 to $10 million per year.

Adding separate trips to each system increases the cost of the Base Case and reduces the added cost of implementing System 2, but still results in increased costs for all new systems when compared to the Base Case.

TABLE 58. SUMMARY OF MATERIALS RECOVERY, GHG EMISSIONS, AND SYSTEM COSTS ASSOCIATED WITH IMPLEMENTATION OF ACT 148, *WITHOUT SEPARATE TRIPS*

SYSTEMS EVALUATION	SYSTEM 1	SYSTEM 2	SYSTEM 3	SYSTEM 3A	SYSTEM 4
Metrics	Base Case, No Act 148	Act 148, Universal Single Stream, No BB	Act 148, USS, BB	Base Case With Act 148,BB	Act 148, USS, EBB
Diversion, in Tons (2022)					
Materials					
Plastic	5,120	5,580	5,870	5,753	7,190
Aluminum	2,300	1,750	2,680	2,626	2,760
Glass	23,880	16,320	24,000	23,520	25,080
Fiber	60,570	87,560	87,560	85,809	87,560
Steel Cans	1,620	1,690	1,690	1,656	1,690
Organics	0	48,098	48,098	48,098	48,098
Total:	93,490	160,998	169,898	167,462	172,378
Percent Increase over Base:	***na***	72%	82%	79%	84%
GHG Emissions Reductions					
Total, in Metric Tons Carbon Equivalent:	(70,019)	(93,568)	(96,597)	(96,000)	(97,293)
Percent Decrease over Base:	***na***	34%	38%	37%	39%
Sum of Annual System Costs (2014 - 2022)					
Operating	$ 1,212,692,940	$ 1,246,034,056	$ 1,305,811,407	$ 1,314,091,818	$ 1,328,703,772
Capital	$ 1,900,000	$ 42,450,455	$ 42,427,062	$ 45,467,476	$ 42,414,492
Total	***$ 1,214,592,940***	***$ 1,288,484,510***	***$ 1,348,238,468***	***$ 1,359,559,294***	***$ 1,371,118,264***
Change in Total System Cost over Base:	***na***	***$ 73,891,570***	***$ 133,645,528***	***$ 144,966,354***	***$ 156,525,324***
Percent Change from Base:	***na***	5%	10%	11%	12%
Unit Costs (2022)					
Average Per HH Monthly Cost	$ 28.33	$ 31.29	$ 33.01	$ 34.38	$ 33.61
Percent Change from Base:	***na***	10%	17%	21%	19%
Average Per Ton Cost, ICI	$ 202	$ 206	$ 221	$ 220	$ 225
Percent Change from Base:	***na***	2%	9%	9%	12%

TABLE 59. SUMMARY OF MATERIALS RECOVERY, GHG EMISSIONS, AND SYSTEM COSTS ASSOCIATED WITH IMPLEMENTATION OF ACT 148, *WITH SEPARATE TRIPS*

SYSTEMS EVALUATION	SYSTEM 1	SYSTEM 2	SYSTEM 3	SYSTEM 3A	SYSTEM 4
Metrics	Base Case, No Act 148	Act 148, Universal Single Stream, No BB	Act 148, USS, BB	Base Case With Act 148,BB	Act 148, USS, EBB
Diversion, in Tons (2022)					
Materials					
Plastic	5,120	5,580	5,870	5,753	7,190
Aluminum	2,300	1,750	2,680	2,626	2,760
Glass	23,880	16,320	24,000	23,520	25,080
Fiber	60,570	87,560	87,560	85,809	87,560
Steel Cans	1,620	1,690	1,690	1,656	1,690
Organics	0	48,098	48,098	48,098	48,098
Total:	93,490	160,998	169,898	167,462	172,378
Percent Increase over Base:	***na***	72%	82%	79%	84%
GHG Emissions Reductions					
Total, in Metric Tons Carbon Equivalent:	(70,019)	(93,568)	(96,597)	(96,000)	(97,293)
Percent Decrease over Base:	***na***	34%	38%	37%	39%
Sum of Annual System Costs (2014 - 2022)					
Operating	$ 1,357,405,811	$ 1,350,218,700	$ 1,441,033,746	$ 1,449,314,157	$ 1,475,387,582
Capital	$ 1,900,000	$ 42,450,455	$ 42,427,062	$ 45,467,476	$ 42,414,492
Total	***$ 1,359,305,811***	***$ 1,392,669,154***	***$ 1,483,460,808***	***$ 1,494,781,633***	***$ 1,517,802,074***
Change in Total System Cost over Base:	***na***	***$ 33,363,344***	***$ 124,154,997***	***$ 135,475,823***	***$ 158,496,264***
Percent Change from Base:	***na***	2%	9%	10%	12%
Unit Costs (2022)					
Average Per HH Monthly Cost	$ 33.29	$ 34.98	$ 36.70	$ 38.07	$ 37.30
Percent Change from Base:	***na***	5%	10%	14%	12%
Average Per Ton Cost, ICI	$ 202	$ 206	$ 221	$ 220	$ 225
Percent Change from Base:	***na***	2%	9%	9%	12%

While it is likely that private haulers and the public sector can devise ways to reduce the overall implementation costs of implementing Act 148, especially by reducing refuse collection frequency and adding split truck capacities, it will take significant experimentation throughout Vermont to achieve savings while continuing to implement Act 148.

As stated in the report, while it is not necessary for areas of Vermont that have not switched to single stream collection to do so in 2015, it is likely that switching to single stream collection in 2020 will allow for reduced costs, as illustrated by the higher costs associated with System 3 (A) above.

Key areas that could reduce the costs estimated in this report include:

- ***Consolidation of districts and alliances*** – Especially once there is a state-wide requirement for parallel collection of recyclables which should allow for a single recycling message and enforcement state-wide.

- ***Reduction or elimination of the bottle bill handling fee*** – The largest single cost associated with the BB and or EBB is the 3.5 or 4 cent handling fee. Reducing the handling fee to 1 cent, or eliminating it would significantly reduce bottle bill costs, but at a great impact to existing redemption centers and retailers.

- ***Organization of collection*** – Subscription collection with multiple haulers operating in the same area has been shown to be more costly than organized collection. Organizing collection is one way to reduce

overall system costs, especially as Vermont moves to residential organics collection. For example, if average route sizes were to double, the impact on system costs would be a reduction of roughly $20 million on an annual basis which would be sufficient to cover much of the cost increase associated with implementation of Act 148. However, this change would disrupt the existing private hauling sector in Vermont in ways that need substantial additional analysis to determine.

- ***Increase implementation of every other week collection of refuse and recycling*** with implementation of the residential organics to landfill ban.

- ***Implementation of more on-farm organics diversion programs than envisioned in this report*** – this will require a significant effort by the Department of Agriculture and ANR to develop rules that protect health and the environment while fostering greater use of organics on existing and new farms in Vermont. One area of significant potential is the ability to add slurried food residuals to existing on-farm AD facilities through off-farm processing of the food residuals and delivery of cleaned and slurried food residuals to participating farms.