Recycling System Analysis for the Vermont Bottle Bill

An Analysis of System Costs and Environmental Impacts of Three Scenarios

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Executive Summary

The Vermont Agency of Natural Resources (ANR), Department of Environmental Conservation (DEC) commissioned the Signalfire Group, a subsidiary of Resource Recycling Systems (RRS), to conduct this study to analyze and compare the costs and benefits – financial and environmental – associated with three models for the management of beverage containers via the "bottle bill" deposit return system and the regular Vermont recycling system. The three models are:

1. Model 1, Existing Bottle Bill: The current Vermont bottle bill and recycling systems.
2. Model 2 (A and B), PRO Bottle Bill: All currently "covered" bottle bill beverage containers, except liquor, are managed by a beverage manufacturer/distributor producer responsibility organization (PRO); a convenience standard is established to increase redemption sites (similar to H.158), sorting by brand at redemption sites is eliminated, and all redemption sites must accept all redeemable containers, not just what they sell. Model 2A relies primarily on bag drop systems, while Model 2B relies on reverse vending machines (RVM).
3. Model 3, Expanded Bottle Bill (EBB) with PRO: Includes all the elements of Model 2 and expands the types of beverages included in the bottle bill deposit program as originally proposed in H.158.

To inform the development of the three models, the project team collected data from various industry subject matter experts and state documents, conducted stakeholder interviews, and gathered information from redemption centers and retailers. This report intends to facilitate discussion about the potential system impacts of various models. The results are based on the best data available, and the most reasonable assumptions; nonetheless they should be viewed as directional, not precise. Table 1 summarizes the key differences applied in the three models.

NOTATION: Given the complexity of the bottle bill system in practice, the following should be considered when interpreting the model results:

1. Model 1 quantifies costs for the VT Bottle Bill system as it currently functions, i.e., without full compliance since it is well established that not all retailers are serving as redemption sites as the law requires. If there were comparable convenience in Model 1 to those levels assumed in Models 2 and 3, the total annual cost of Model 1 would increase by an estimated 20%, surpassing the total cost of Model 2 but not that of Model 3.
2. Model 2 and Model 3 quantify costs associated with increased convenience standards, but they do not include any corresponding impact on **redemption rates** that may result from this change. While one would expect **redemption rates** to increase as a result of increased convenience, the level of increase could not be quantified due to insufficient data available. However, expanded bottle bill systems can increase the beverage container **diversion rate** by capturing more beverage containers from trash/litter in addition to pulling in more containers from the recycling system. RRS found redemption rates increase the most when the deposit increases, as shown with Oregon's experience moving to 10 cents.
3. Brand sorting is eliminated in Model 2 and Model 3. In practice, eliminating brand sorting would be expected to reduce sorting time and by extension, reduce labor costs. In the extensive interviews conducted with redemption centers, there were a wide range of responses with some redemption centers noting potential significant labor savings and some reporting little or none at all. The analysis reflects the average savings projected; it should be noted that when a sensitivity analysis was conducted, it was found that cost impact was highly sensitive to changes in assumptions around labor reduction from elimination of brand sorting.

Table 1: Key differences in Beverage Container Deposit Systems between Models 1, 2 and 3

	MODEL 1	MODEL 2	MODEL 3
Beverage Containers Included in Deposit / Redemption System	Beer, wine coolers, other malt beverages, pre-mixed spirits cocktails, carbonated non-alcoholic beverages including sodas, sparkling waters and juices, and carbonated sports and energy drinks (5 cent deposit). Liquor and spirits (15 cent deposit).		All beverages included, except milk, dairy, plant-based beverages, infant formula, meal replacement drinks, and nonalcoholic cider.
Containers Requiring Brand Sorting at Point of Redemption	18% of containers	None, brand sorting at point of redemption is eliminated.	
Containers in Commingling Agreement	82%[1]	100%[2]	
Handling fee	3.5 cents for commingling; 4 cents for others	No set handling fee. PRO negotiates appropriate compensation for the redemption site which would likely be based on a per container fee[3].	
Convenience Requirements	Retailers are required to take back covered containers of the kind, size, and brand they sell, unless they receive an exemption from the Secretary based on alternate redemption sites that can serve the public need.	• Universal redemption • Minimum of 3 redemption sites per county. • Retailers of 5,000 square feet or more must redeem • Municipalities with populations of 7,000+ must have at least one point of redemption.	
Bottle Bill Management	Distributors/manufacturers "Pickup agent" + Dept. of Liquor & Lottery (DLL for liquor	PRO + DLL (for liquor)	
Number of Redemption Sites	123	170	

1 Redemption Centers that handle more than 250,000 containers per year are required to commingle according to an Agency-approved commingling agreement. Bottle Bill Fact Sheet: Retailers and Redemption Centers. Vermont DEC. (2024, September). https://dec.vermont.gov/sites/dec/files/wmp/SolidWaste/Documents/BottleBillFactSheet-Retailers.pdf. The percentage of containers that are part of the Commingling agreement were provided by Vermont container processors.

2 Given that distributors/manufacturers will need to join and pay the PRO, it is assumed that this would logically go together with electing to being part of the commingling-type agreement.

3 This report does not stipulate a handling fee, which provides the PRO and redemption sites the flexibility for negotiations, which would be useful, for example, in the event of changes in market conditions.

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Comparative Impacts of Bottle Bill Models

For each model, the following were considered:

1. MATERIAL DIVERSION RATES:[5]

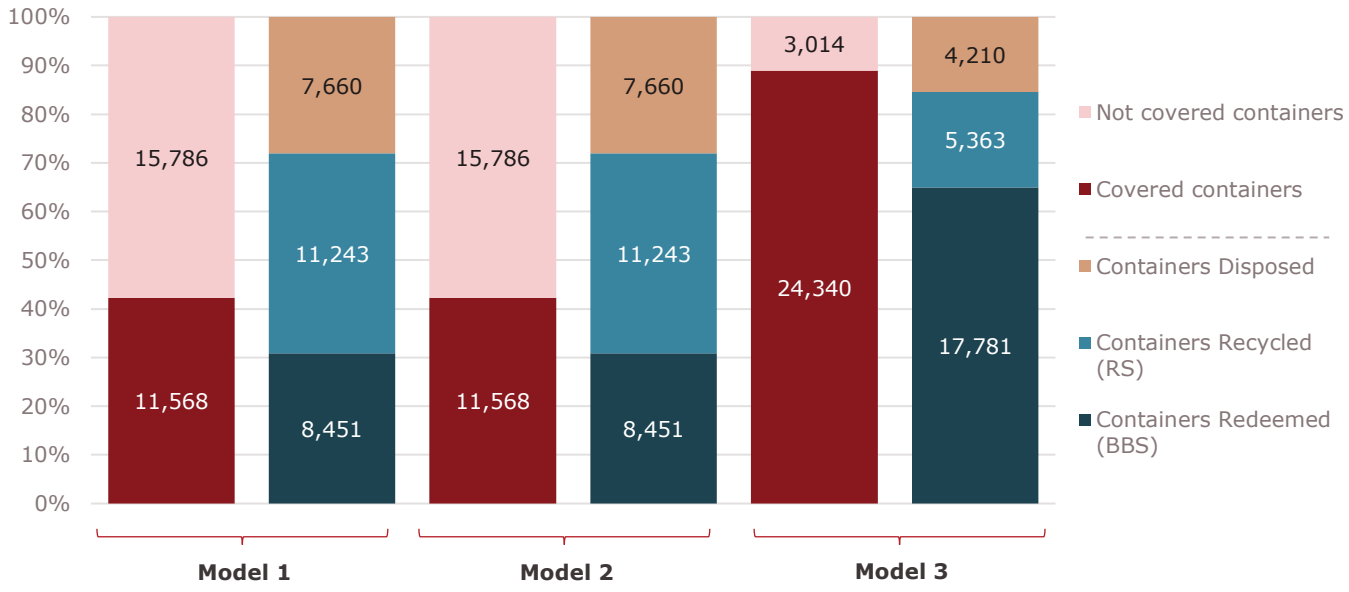
Table 2: Diversion rates for Models 1, 2 and 3.

BEVERAGE CONTAINER DIVERSION RATES		
MODEL 1:	MODEL 2:	MODEL 3:
72%[4]	72%	85%

For Models 1, 2A (Bag Drop), and 2B (RVM), the diversion of beverage containers, through both the recycling system and bottle bill system, remain at current levels (see the blue Notation box above for disclaimers and details about why no redemption rate change is projected in Model 2A and B). For Model 3, overall diversion of beverage containers is estimated to grow from 72% to 85% due to the addition of new types of covered containers to the bottle bill program – primarily #1 PET plastic bottles, wine bottles, hard ciders, juice and tea. In Model 3, more containers are covered by the BB, and more are redeemed, but the redemption rate remains the same. This is summarized in Table 2 and illustrated in Figure 1.

Diversion rates for all beverage containers include estimated collection through the recycling system i.e. mandatory curbside and drop off recycling service and programs, as well as the bottle bill system. They include all beverage containers sold in Vermont made of aluminum, glass, PET plastic, or HDPE plastic and, therefore, include containers not currently covered.

Figure 1: Breakdown of containers by coverage as well as by end destinations (Disposed, Recycled and Redeemed) for Models 1, 2 and 3.



[4] Depending on the assumptions applied and the data used, calculated beverage container diversion rates for the current system, Model 1, could range widely, due to differences in data sources and methodological approaches. While multiple valid methods exist for estimating diversion, this analysis applies the most reasonable and well-supported assumptions to ensure consistency with Vermont's system. Stakeholders reviewed the methodology and resulting estimates to verify their reliability and alignment with real-world conditions. The findings presented represent the most rigorous and defensible assessment of system-wide impacts, based on the best available data.

[5] "Diversion" means the management of solid wastes through methods other than disposal. In this report, diversion of beverage containers includes redemption through the bottle bill and recycling through the recycling system i.e. curbside + drop-off.

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2. COSTS

Costs are described across the three models for both the Bottle Bill System (BBS) and the Recycling System (RS) in three ways: 1) system-level cost, 2) cost allocated to beverage containers, and 3) per container cost. This allows for an analysis of the nuanced cost impact of each system. An Overall System (i.e. weighted BBS + RS) per container cost is also presented to quantify the overall efficiency of the container recycling in Vermont.

Bottle Bill System System-Level Costs and Cost Allocated to Beverage Containers: Model 1 represents the existing system and has a system-level cost similar to that of Model 2A and Model 2B. Costs of Model 2 are reduced with the elimination of brand sorting and redistributed away from redemption sites when managed by the PRO; however, Model 2 also has an increased number of redemption sites to meet convenience requirements. Model 3 has the highest system-level cost to support the increased container throughput due to expansion. For the BBS, which only collects containers, the system-level cost and cost allocated to beverage containers is the same.

Bottle Bill System Per Container Cost: Model 3 is the most cost-efficient on a per container basis, largely due to increased throughput and adoption of a strategic mix of technologies, including bulk RVMs for high-volume redemption centers and a combination of retail redemption RVMs and bag drop options to meet required convenience standards. Should Model 1 meet the same convenience standards required in Model 2 and Model 3, the per container cost is estimated to be $0.059. This is summarized in Table 3.

Table 3: Bottle Bill System-Level Costs and Per Container Costs for Models 1, 2 and 3.

	MODEL 1:	MODEL 2A, Bag Drop:	MODEL 2B, RVM:	MODEL 3, EBB:
BBS SYSTEM-LEVEL COSTS (excluding latent cost of separate trips taken by consumers to redeem)	**$9.4 million**	**$10.5 million**	**$9.2 million**	**$14.0 million**
BS COST PER REDEEMED CONTAINER (excluding latent costs of separate trips taken by consumers to redeem)	**$0.050**[6]	**$0.056**	**$0.049**	**$0.040**

Recycling System System-Level Costs and Cost Allocated to Beverage Containers: Costs from curbside collection and drop-off programs change only slightly with the expansion of covered containers under Model 3 and the expected movement of some beverage containers from curbside and drop-off recycling to redemption sites. Most recycling system costs are fixed – such as trucks and recycling facilities – so they will not decrease when containers are recycled through the deposit program instead of the municipal system. They will incur a slight loss of revenue with this shift, resulting in an overall estimated system cost increase of 2%.

[6] Model 1 costs might be 20% higher if there were full compliance.

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Recycling System Per Container Cost: Models 1 and 2 per container cost are the most cost efficient across both BBS and RS per container costs, while Model 3 is less cost-efficient in the recycling system on a per container basis, largely due to decreased throughput, i.e., more containers collected through the BBS and fewer through the RS.

The Recycling System costs are summarized in *Table 4*.

Table 4: Recycling System-Level Costs, Container Costs and Per Container Costs for Models 1, 2 and 3.

RS SYSTEM-LEVEL COSTS (all recyclables: paper, cardboard, steel and aluminum cans, glass bottles and jars, plastic bottles and jugs, but excluding latent cost of separate trips taken by consumers to redeem)	MODEL 1:	MODEL 2:	MODEL 3:
	$37.95 million	$37.95 million	$38.85 million
RS CONTAINER COSTS[7] (excluding latent cost of separate trips taken by consumers to redeem)	$4.25 million	$4.25 million	$2.20 million
RS COST PER CONTAINER (excluding latent costs of separate trips taken by consumers to redeem)	$0.033	$0.033	$0.045

Overall System[8] **(i.e., Weighted BBS + RS) per container cost:** Model 3 is the most cost-efficient on a per container basis, given the reduction in costs with the elimination of brand sorting, increased efficiencies through technology adoption and management by the PRO, as well as increased overall volume of containers collected. This is summarized in *Table 5*.

Table 5: Overall Cost Per Container for Models 1, 2 and 3.

OVERALL COST PER CONTAINER (excluding latent costs of separate trips taken by consumers to redeem)	MODEL 1:	MODEL 2A, Bag Drop:	MODEL 2B, RVM:	MODEL 3, EBB:
	$0.043[9]	$0.047	$0.043	$0.040

Unclaimed Deposits: Unclaimed deposits reflect a redistribution of funds from consumers who forfeit their deposits to the State. In consideration of financial impact across the system, unclaimed deposits appear as a financial "loss" to consumers and as a financial "gain" to the State, that then funds systems unconnected to the bottle bill. In Model 3, unclaimed deposits increase because the same redemption rates are applied to more beverage types. Since more deposits are received than redeemed for a greater volume of containers, there is a corresponding greater amount of deposits being forfeited and therefore an increase in unclaimed deposits. This is summarized in *Table 6*.

[7] Includes non-bottle bill covered containers. System-level Cost refers to the total cost, including blue bin recycling collection costs for those that use curbside haulers, as well as the costs for the haulers and facilities to collect, sort, store, transport, and process material for sale or shipment to end markets. Container Cost is the cost allocated to beverage containers, which is used to calculate the cost per container, i.e., System-level Cost multiplied by Beverage Container Tons, divided by Total Waste Tons.

[8] "Overall System" refers to the combined system of both the Bottle Bill System (BBS) and the Recycling System (RS).

[9] Model 1 costs would be 20% higher if there were full compliance. The per container rate would be $0.06 i.e. higher than that of Model 2 & 3.

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Table 6: Unclaimed deposits for Models 1, 2 and 3.

UNCLAIMED DEPOSITS	MODEL 1:	MODEL 2:	MODEL 3:
	$3.94 million	$3.94 million	$7.54 million

Distribution of Costs: In Model 1, redemption sites and distributors/manufacturers bear the system cost. In Models 2A/B and 3, the PRO redistributes the cost, ultimately entirely to distributors/manufacturers. Compared to Model 1, the distributors/manufacturers' costs are two times higher in Model 2 and three times higher in Model 3. Given expansion, there is also an increase in unclaimed deposits between Model 1 and 2 compared to Model 3, thereby increasing the cost to consumers who do not redeem. Similarly, expansion causes a cost increase for Municipal Solid Waste (MSW) System Haulers and Processors that collect mandated recyclables including beverage containers. This cost redistribution is illustrated in *Table 7*.

Although represented as a net zero transaction, the decision not to reinvest the unclaimed deposits within the bottle bill systems is a loss of benefits to distributors.

Table 7: Overall Financial Impact by Stakeholder

STAKEHOLDER	MODEL 1	MODEL 2	MODEL 3
Consumers	COST	COST	COST MORE
State (Unclaimed deposits)	GAIN	GAIN	GAIN MORE
Retail redemption	COST	GAIN MORE	GAIN MORE
Redemption centers	COST	GAIN MORE	GAIN MORE
Distributors/Manufacturers	COST	COST MORE	COST MORE
MSW System Haulers and Processors	COST	COST	COST MORE

3. GREENHOUSE GAS EMISSIONS:

Greenhouse gas emissions estimates for beverage containers managed through the bottle bill system and the existing recycling system were developed using EPA's Waste Reduction Model (WARM) and supplemented with additional consumer trip information. Model 2 yields slightly higher environmental benefits than Model 1, primarily due to reduced transportation emissions associated with a higher number of redemption locations. Model 3 provides the most significant environmental benefit (i.e., a greater emission reduction than Models 1 and 2). This 13% greater reduction in emissions is due to increased recovery of materials and reduced contamination in the curbside and drop-off recycling system.

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4. LITTER:

Litter tonnage estimates are expected to be the same for Models 1 and 2, with a slight decrease in Model 3 because of expansion in covered beverages.

The key metrics and impacts, as elaborated above, are summarized in Table 8.

Table 8: Key Metrics and Impacts of Models 1, 2, and 3

METRIC			MODEL 1		MODEL 2A/B[10]		MODEL 3	
1. Resources and Diversion	**BEVERAGE CONTAINERS REDEEMED BY BBS BY MATERIAL TYPE**							
	Tons % by tons	**Cans**	2,064	24%	2,064	24%	2,691	15%
		Glass	5,638	67%	5,638	67%	11,722	66%
		PET	749	9%	749	9%	2,875	16%
		HDPE	0	0%	0	0%	493	3%
		TOTAL	8,451	100%	8,451	100%	17,781	100%
	BEVERAGE CONTAINERS COLLECTED BY RS BY MATERIAL TYPE							
	Tons % by tons	**Cans**	591	5%	591	5%	148	3%
		Glass	9,360	83%	9,360	83%	4,680	87%
		PET	1,110	10%	1,110	10%	444	8%
		HDPE	182	2%	182	2%	91	2%
		TOTAL	11,243	100%	11,243	100%	5,363	100%
	BEVERAGE CONTAINER DIVERSION RATE							
	Overall diversion rate			72%		72%		85%
	% of containers by BBS			43%		43%		76%
	% of containers by RS			57%		57%		24%
2. Costs	**BOTTLE BILL SYSTEM COSTS**							
	BBS system-level cost (exc)		$ 9,366,280		a. $ 10,496,224		$ 14,002,337	
					b. $ 9,221,988			
	# Containers Redeemed		188,324,041		188,324,041		351,011,408	
	Per-container cost (exc)		$ 0.050		a. $ 0.056		$ 0.040	
					b. $ 0.049			
	Annual Separate Trip cost		$ 2,573,108		$ 2,250,684		$ 2,250,684	
	BBS system-level cost (inc)		$ 11,939,388		a. $ 12,746,908		$ 16,253,020	
					b. $ 11,472,672			
	Per-container cost (inc)		$ 0.063		a. $ $0.068		$ 0.046	
					b. $ $0.061			
	Unclaimed Bottle Bill Deposits[11]		$ 3,939,820		$ 3,939,820		$ 7,537,845[12]	

[10] 2A applies Bag Drop technology costs. 2B applies RVM technology costs.

[11] Includes unclaimed deposits retained by DLL.

[12] While redemption rates remain the same (since the deposit amount is unchanged), the expanded coverage results in an absolute higher volume of container deposits being collected, along with a corresponding higher amount of deposits being forfeited when those containers are not redeemed.

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METRIC		MODEL 1	MODEL 2A/B[10]	MODEL 3
	RECYCLING SYSTEM COSTS (CURBSIDE AND DROP-OFF)			
	RS system-level cost; RS container cost (exc)	$ 37,949,369	$ 37,949,369	$ 38,852,556
		$ 4,247,725	$ 4,247,725	$ 2,203,278
	# Containers Collected	127,340,107	127,340,107	49,477,787
	Per-container cost (exc)	$ 0.033	$ 0.033	$ 0.045
	System-level Recycling (& Refuse) Drop off Separate Trip Cost; Drop off Separate Trip Container Cost[13]	$ 4,636,935	$ 4,636,935	$ 4,636,935
		$ 109,025	$ 109,025	$ 52,003
	# Containers Collected	6,298,687	6,298,687	2,447,344
	Per-container cost (inc)	$ 0.051	$ 0.051	$ 0.066
	OVERALL SYSTEM COST (BBS + RS)			
	Per-container cost (exc)	$ 0.043	a. $ 0.047	$ 0.040
			b. $ 0.043	
	Per-container cost (inc)	$ 0.058	a. $ 0.061	$ 0.049
			b. $ 0.057	
3. Greenhouse Gas Emissions	**TONS OF CARBON EQUIVALENT AVOIDED BY LANDFILL ALTERNATIVES**			
	Bottle Bill Metric Ton Carbon Equivalent[14]	(21,134)	(21,134)	(31,108)
	Recycling System Metric Ton Carbon Equivalent[15]	(9,244)	(9,244)	(3,158)
	Net Total Metric Ton Carbon Equivalent (exc)	(30,074)	(30,074)	(34,108)
	Net Total Metric Ton Carbon Equivalent (inc)	(27,631)	(27,924)	(32,011)
4. Litter	**LITTER**			
	All Beverage Container Litter (t)	411	411	322

Key

(t) = tons
(all) = all beverage containers

(exc) = excluding separate trip cost
(inc) = including separate trip cost

[13] System-level Cost refers to the total cost for separate trip to drop-off refuse and recyclables. Drop Off Separate Trip Container Cost is the cost allocated to beverage containers dropped off for recycling. This is used to calculate the cost per container, i.e., System-level Cost multiplied by Recycled Beverage Container Tons via Drop Off, divided by Total Refuse and Recycled Tons Dropped Off.

[14] Excludes impacts from recycling system, refuse, and separate consumer trips,

[15] Excludes impacts from the bottle bill, refuse, and separate consumer trips.

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Introduction and Definitions

DEFINITIONS

All beverage containers	Beverage containers typically accepted for recycling either through curbside recycling, drop-off, or bottle bill redemption. Some beverage containers like cartons and pouches are currently disposed of as trash and are landfilled in Vermont.
All covered beverage containers	Beverage containers covered by Vermont's current bottle bill, including beer, malt beverages, wine coolers, carbonated non-alcoholic beverages, liquor and spirits, and ready-to-drink spirits.
Bottle Bill System (BBS)	The system within Vermont encompassing the handling and processing of containers covered under the state's bottle bill. These containers are collected through redemption sites both manually and by way of sorting technology.
Brand accounting	Brand sorting by collectors or processors to attribute handling costs and/or provide brands with data on their containers redeemed.
Brand sorting	The act of separating beverage containers by brand for redemption and processing to determine brand allocation of system costs. At redemption sites, this is typically done by staff who separate containers into brand-specific bags or gaylords, or through automation in reverse vending machines (RVMs).
Bulk RVM	A type of reverse vending machine (RVM) designed to allow users to deposit large quantities of empty beverage containers (like plastic bottles and cans) at once, rather than inserting them individually. Note: unless specified as "Bulk RVM," the term RVM in this report refers to single-feed RVM.
Certified Redemption Center	A location certified by the state that offers universal redemption (i.e., takes back all covered containers to be processed through the redemption system). Retail-based and standalone redemption sites may be certified redemption centers.
Commingling Agreement	The legislated commingling procedure managed by a central organization and agreed upon by beverage distributors/manufacturers to allocate fees by a means other than by brand sorting of redeemed containers at redemption centers.
Commingling	The sorting of beverage containers at a redemption site by material type and size only for brands that are a part of the commingling agreement, not by beverage brand, in accordance with the requirements of an approved commingling agreement. The Vermont Commingling Group (VCG) manages this agreement in Vermont.
Deposit amount	The amount that is charged to the consumer at the point of purchase and returned to them when the container is redeemed.
Distributors/Manufacturers	Companies that buy beverages from beverage manufacturers and wholesalers, wholesale and then distribute them. The distributors and manufacturers of covered bottle bill beverage containers sold in Vermont are responsible for reimbursing retailers and redemption sites for the deposit and the appropriate handling fee, depending on whether or not they have joined the commingling agreement.
Diversion rate	"Diversion" means the management of solid wastes through methods other than disposal. In this report, diversion of beverage containers includes redemption through the Bottle Bill System (BBS) and recycling through the curbside and drop off Recycling System (RS).

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Handling fee	A set amount paid to the redeemer to compensate for their costs to sort and store covered containers. Under current law, the handling fee is higher for brands not a part of a commingling agreement, because they require additional effort by staff to brand sort.
Liquor Store Redemption	A store or other licensed entity that sells liquor beverages primarily to consumers and that takes back only containers of the kinds, brands, and sizes that it sells (alcoholic and non-alcoholic).
Overall System	The combined system of both the Bottle Bill System (BBS) and the Recycling System (RS).
Producer fee	The sum of the deposit amount and the handling fee for each redeemed container, attributed to brands that distribute/manufacture a covered beverage.
Producer Responsibility Organization (PRO)	A centralized organization that helps distributors/manufacturers meet their regulatory obligations for reclaiming and recycling waste from their products.
Recycling System (RS)	The system within Vermont that encompasses the handling and processing of recyclables collected through curbside (blue bin) collection or drop off services.
Redemption Center	A location that offers universal redemption (i.e., takes back all covered containers to be processed through the redemption system). A retailer may also be a redemption center if they accept all types of beverage containers, not only the containers for the beverages that they sell.
Redemption Rate	The percentage of covered containers redeemed through the Bottle Bill System.
Redemption Site	Any location that takes back containers to be processed through the redemption system using any technology or mechanism, whether accepting all covered containers or just the containers they sell.
Retail Redemption Location	A retail store that takes back only beverage containers of the kinds, brands, and sizes that they sell.
Retail-based vs. standalone redemption site	Retail-based redemption sites are those where redemption services are offered and managed by retailers and their employees. Standalone redemption sites are those that only offer redemption service and do not sell consumer goods.
Retailer	Any store or other licensed entity where containers are sold at the retail level for off-premises consumption. Excludes bars and restaurants that sell beverages for "on-premises consumption."
Reverse Vending Machine (RVM)	Equipment similar in appearance to a vending machine into which consumers insert empty beverage containers that are then scanned to identify if the container meets recycling criteria, the material, and the brand. The machines typically crush the container and return a deposit amount to the consumer.
Universal redemption	Acceptance of all covered beverage containers, with no refusal based on what beverage types, brands, or sizes that are sold.

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BACKGROUND

Vermont implemented its beverage container deposit/redemption program in 1973, often called the "Bottle Bill." Its primary objective was to reduce litter in beer, soda, and alcoholic beverage containers.[16] Since then, it has substantially contributed to the state's recycling efforts. As of 2019, the program was amended to direct unclaimed deposits from non-liquor containers to be kept by the State's Clean Water Fund.[17]

The state currently has 54 redemption centers and 69 retail redemption locations (~123 total sites) that run redemption operations and process bottle bill materials. While the Bottle Bill legislates that all retailers of beverages are required to take back empties for beverage brands that they sell, in practice, this is not strictly enforced. The 123 redemption sites identified in this study are those with active redemption and back-end collection operations as provided by Vermont container processors.

The program currently places a 5-cent deposit on beer, malt beverages, mineral water, mixed wine drinks, soda water, carbonated soft drinks, and ready-to-drink spirits, and a 15-cent deposit on liquor. Beverage distributors/manufacturers must pay handling fees to redemption centers and retailers that redeem and process empty containers. The fee varies based on whether the distributor/manufacturer is part of the Vermont commingling agreement.

Commingling refers to sorting beverage containers by material type and size rather than brand at redemption sites under an approved commingling agreement. Brands that sign on to the comingling agreement pay a lower handling fee to redemption centers and develop a system to account for beverages by distributor, apportioning responsibility through other means. Retailers and redemption centers receive a handling fee of 3.5 cents per container for brands that are part of the agreement and 4 cents for those that are not. This practice, added to Vermont's beverage container redemption law in 2007 and implemented in 2008, was introduced to reduce the complexity and costs of sorting at redemption sites. The Vermont Commingling Group oversees the program, which includes 82% of the beverage containers sold in the state and includes major brands like Coke and Pepsi, national and craft beer brands, and liquor containers managed by the Vermont Department of Liquor Control. The remaining 18% of containers not within the commingling agreement continue to be sorted separately by brand at redemption sites. Those containers flow through TOMRA sorting facilities for further brand accounting and processing. Containers collected through Vermont's Recycling System are processed through the state's Material Recovery Facilities before being sent to end markets.

In 2023, Vermonters achieved a redemption rate of around 72% for containers covered by the Bottle Bill. Of these covered containers, the Container Recycling Institute (CRI) estimates an additional 10% to be captured through the Recycling System.[18] With regard to all beverage containers and not just those covered by the Bottle Bill, this study estimates an overall diversion rate of approximately 72%, including both containers redeemed through the Bottle Bill System as well as those captured through the Recycling System.

[16] Vermont "Bottle Bill". Vermont Agency of Natural Resources Department of Environmental Conservation. (2025, January). https://dec.vermont.gov/waste-management/solid/product-stewardship/bottle-bill

[17] Abandoned beverage container deposits. Department of Taxes. (n.d.). https://tax.vermont.gov/businesses/beverage-deposit

[18] Redemption Rates and Other Features of 10 U.S. State Beverage Container Deposit Programs Prepared by the Container Recycling Institute. (n.d.). https://www.bottlebill.org/images/Allstates/10%20states%20Redemption%20Rates%20080524.pdf

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In 2023, H.158 was introduced by Representative Amy Sheldon and co-sponsored by Representatives Dara Torre, Kristi Morris, Larry Satcowitz, and Seth Bongartz. The bill aimed to expand the scope of beverages subject to the beverage container redemption system to include all drinks in liquid form and intended for human consumption, except for milk, dairy products, plant-based beverages, infant formula, meal replacement drinks, or nonalcoholic cider.[19] Despite being vetoed by the Governor and sustained by the House of Representatives, the discussions surrounding H.158 highlighted the need to revisit and potentially reform Vermont's Bottle Bill to address contemporary environmental and economic considerations.

[19] *Bill as introduced H.158 2023*. Vermont General Assembly. (2023)

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Approach

THE SCENARIOS ASSESSED IN THIS STUDY

Vermont DEC defined and scoped the models within this analysis in the contract agreement between the department and Signalfire Group. Model 1 analyzes the current Bottle Bill System, Model 2 analyzes a PRO-managed Bottle Bill System under convenience requirements stipulated under H.158, without coverage expansion, while Model 3 includes all the elements of Model 2 with coverage expansion. These scenarios are illustrated in Figure 2 and Figure 3.

Figure 2: Illustration of Model 1

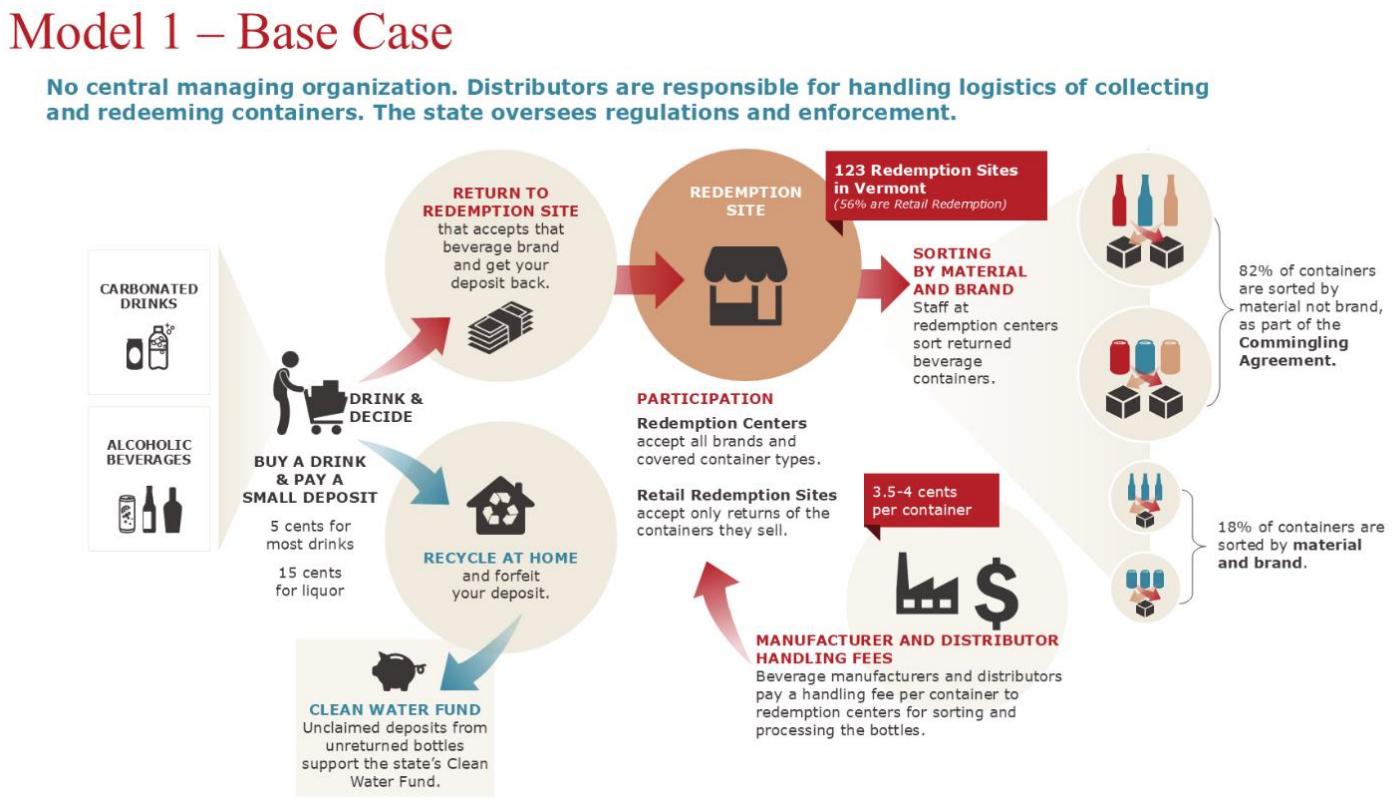

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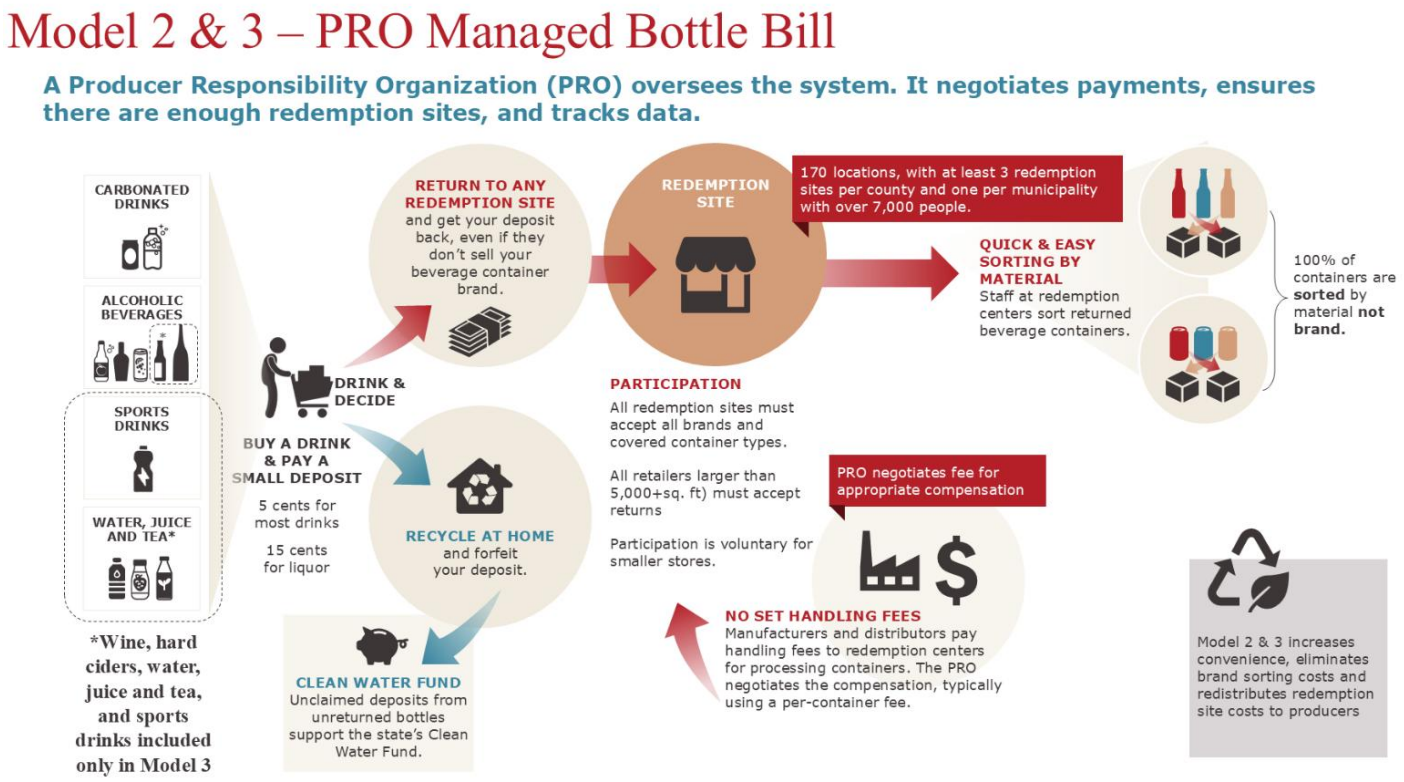
Figure 3: Illustration of Model 2 and 3



METHODOLOGY AND COST MODELING APPROACH

The Signalfire Group's analysis of beverage container management in Vermont was informed by a synthesis of existing literature and supplemented by state-specific studies, independent research, and primary data provided by stakeholders and gathered through interviews.

Data Request and Collection

To obtain relevant information, the Signalfire team submitted a data request to Vermont DEC for all relevant state-specific data and system information to inform the model. Once that was received and reviewed, the team identified gaps in knowledge and data, conducted secondary research on publicly available data, and held stakeholder interviews, ensuring a comprehensive understanding of the system.

Specific datasets and sources used are outlined in the Data Modeling section corresponding to the system element they informed.

Stakeholder Engagement

Stakeholder interviews were conducted throughout the project to inform key model assumptions at the outset and verify the accuracy of modeled data as the project progressed. A broad range of stakeholders were consulted to capture perspectives from those impacted or interested in the current Bottle Bill System, Recycling System and potential future scenarios. The interviewees were chosen with guidance from Vermont DEC and are listed below.

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Stakeholders consulted during this study include:

- Breezeway Consulting LLC, representing the Vermont Commingling Group, LLC
- Casella (MRF operator in Chittenden and Rutland Counties)
- Chittenden Solid Waste District
- Container Recycling Institute (CRI)
- Department of Liquor and Lottery (DLL)
- Green Up Vermont
- TOMRA[20]
- Redemption sites (21 interviews completed across a representative range of locations)
- Vermont Agency of Natural Resources (ANR) Department of Environmental Conservation (DEC)[21]
- Vermont Public Interest Research Group (VPIRG)
- Vermont Retail & Grocers Association

Redemption Site Interviews

Conducting interviews with redemption sites was crucial for gathering primary data to inform the modeling of costs associated with each location type. To ensure a representative sample, sites were chosen that were expected to be a mix of both RVMs and manual sorting (this assumption was confirmed during interviews), spanning a wide range of locations and varying in size from small to large. This list was iterative, based on insights from the initial interviews and with guidance from Vermont DEC. The final interview list included 32 locations, 21 of which responded and were willing to participate in the interview. One location declined participation, and 10 did not respond to outreach efforts.

Of the 21 complete interviews, 15 were conducted with manual redemption sites, 1 with a hybrid redemption site using both RVM and manual sorting, and 5 with locations using only RVMs or other technology. It is important to note that 1 of the 5 RVMs and other technology interviews were conducted with one of the largest retail chains in the state; average costs were obtained for their 15+ stores.

Interview participants were told the general goal of the study and asked between ten and fifteen interview questions. Interview questions are available in Appendix A. Interview answers were then aggregated and grouped by site type for integration into the Model.

Data Modeling

Data obtained through data requests, independent research, and stakeholder interviews was integrated into the various model elements. The pertinent datasets and sources used are listed under each modeled section.

Modeling the Bottle Bill System

To develop the Bottle Bill System (BBS) model, the Signalfire Group engaged in secondary research as well as multiple meetings with the stakeholders listed above to understand Vermont's system. Each model mapped and translated the flow of beverage container material and financial transactions into cost line items and then apportioned those costs by stakeholder group: consumers, retailers,

[20]Primary Vermont container processor
[21]Client that commissioned this study

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redemption centers, DLL, distributors/manufacturers, and the State. Data from various sources were compared, adjusted, and applied to calculate the net annual and per-container cost estimates. Where possible, each cost line item was verified with the relevant primary stakeholder and adjusted as needed.

Key data sources and datasets reviewed and used in BB Model:

a) **Deposit fees**: based on legislation
b) **Number of containers sold**: Vermont Abandoned Beverage Container Deposit (ABD) 2023 Data and DLL 2023 sales data.
c) **Number of containers redeemed**: Vermont ABD Data 2023 redemption data, DLL 2023 redemption data, and 2023 data from Vermont container processor to break down beverage container redemption rates by material type.
d) **Annual cost per store type and throughput**: Adjusted from DSM 2007 study, "The Costs of Beverage Container Redemption in Vermont" ("DSM 2007 study") for increased labor costs and verified through primary data collected from interviews. For RVM redemption sites, primary data from Vermont container processors was used to model monthly costs. Monthly costs per store were multiplied by the respective number of stores and annualized to obtain a total system cost for the retailer redemption sites as well as the redemption centers. A per container rate was calculated by dividing the total cost by the number of containers.
e) **Container throughput per store type**: Primary data from Vermont container processor.
f) **DLL container throughput and collection costs**: 2023 Sales and Redemption data, receipts and interviews with DLL.
g) **Collection and processing costs**: Adjusted from DSM 2007 study, "The Costs of Beverage Container Redemption in Vermont," for increased labor costs and verified through primary data collected from interviews**.**
h) **Material revenue**: Scrap prices based on recyclingmarket.net commodity averages and a Signalfire Group estimated price premium for higher quality deposit material. Adjusted to a per-container rate using processor data on container weights and containers per pound.
i) PRO **cost calculations:** Assumes PRO negotiations with redemption sites to cover their costs and a profit margin (20%). Assumes a PRO Administration fee that reflects 10% of all costs incurred by PRO (i.e. handling fees, redemption site payments and net collection, processing cost as well as material revenue).

Modeling the Recycling System

To develop the Recycling System (RS) Model, the Signalfire Group team referenced the Systems Analysis of the Impact of Act 148 on Solid Waste Management in Vermont Final Report conducted in 2013 ("2013 Systems Analysis Report"). Cost items were adjusted for inflation, particularly for increased labor costs, using state-specific data from the U.S. Bureau of Labor Statistics. Assumptions used to calculate collection and processing costs were verified with primary stakeholders. The most updated and reliable data available was applied in the model, including waste characterization data, recycling rates by collection method, and material type. The cost components and assumptions to derive the cost of the Recycling System may be referenced in Appendix C Table 40.

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Key data sources and datasets reviewed and used in System Model:

a) **Curbside recycling access in Vermont**: 92% of the population has curbside recycling access.[22] Population data from the US 2020 Census.
b) **Drop-off services available to households and estimated tons**: Those without curbside access have access to drop off services; the tons recycled are apportioned consistent with the rates in the 2013 Systems Analysis Report.
c) **Density of areas**: Grouped by county using US 2020 Census household data and square mileage. Number of households served per truck provided by primary collection service providers.
d) **Collection, drop off, and processing costs**: Adjusted from 2013 Systems Analysis Report, verified with primary collection service providers.
e) **Institutional Commercial Industrial (ICI) collection costs**: Adjusted from 2013 Systems Analysis Report, verified with primary collection service providers.
f) **Estimated tons used to apportion cost and calculate per container rate**: 2023 Vermont Waste Composition Study, 2022 Recycling System data from the 2024 Vermont Materials Management Plan and provided by Vermont Agency of Natural Resources. RRS internal data to estimate beverage containers collected through Recycling System. Extrapolated primary data from Vermont container processors.

Separate Trips

For the Bottle Bill System, although by current law all retailers are required to take back the beverages they sell (unless they obtain an exemption from ANR), it is known that not all retailers actively offer redemption services. This and shopping patterns may result in consumers not returning containers to their original point of purchase. Therefore, we consider the financial and environmental costs of consumers' need to take separate trips to redeem containers purchased. To develop the cost of separate trips made by the consumer to redeem containers, the Signalfire Group used GIS mapping of the active redemption sites, retailers and population block groups within Vermont. Travel distances between each population block group, their nearest active redemption site, and a retailer were calculated. The difference between the travel distance from the population block group to the nearest retailer and the travel distance from the population block group to the active redemption site was calculated for all population block groups in Vermont. Where the travel distance from a population block group to their nearest retailer was more than that to their nearest active redemption site, this difference in travel distance was taken to be 0 (i.e., not considered a separate trip). Where the distance from a block group to their active redemption site was greater than the distance to the retailer, it was defined as a separate trip. A separate trip average mileage per redemption center location was then calculated and weighted by population. This was converted to cost using Vermont's 2024 mileage reimbursement rate, which is $0.67/per mile.

For the Recycling System, the cost of separate trips to drop off refuse and recycling was included where consumers had no access to curbside refuse and recycling services. The Signalfire Group conducted a GIS mapping of the population census block groups to a list of 111 Vermont transfer stations collecting recyclables and estimated that trips from households to transfer stations average 5 miles. This was

[22] State of Recycling, The Present and Future of Residential Recycling in the U.S. The Recycling Partnership. (2024). https://recyclingpartnership.org/wp-content/uploads/dlm_uploads/2024/05/SORR_Methodology-1-1.pdf. This corroborates with the number of households under the Northeast Kingdom Waste Management District that use drop-off services and make up almost 8% of households in VT.

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applied to the number of households assumed to be without curbside access (8%) and assumed that trips were made weekly. The total mileage was then converted to cost using Vermont's 2024 mileage reimbursement rate is $0.67/per mile. Given that the drop-off trip would include refuse and recyclables of all material types, the proportion of tons was used to allocate cost to beverage containers for the calculation of the per container rate.

Key data sources and datasets reviewed and used in Separate Trips:

j) **Mapping**: List of Active Redemption sites in 2024, Liquor store locations in Vermont, Dun & Bradstreet retailers in Vermont, US Census Block Groups in Vermont.

Greenhouse Gas Emissions

Emissions calculations were conducted using the U.S. Environmental Protection Agency's Waste Reduction Model – Version 16, the WARM model. The WARM model evaluates the greenhouse gas emissions throughout the lifecycle of a product or material, including emissions associated with the product's intended end of life management option, the extent to which any carbon sinks are impacted due to the production or disposal of that product, and the extent to which the end-of-life management option recovers energy, therefore reducing overall utility emissions. These assumptions include transportation emissions using data from the National Renewable Energy Laboratory and consider the decreased emissions due to increased recycling and displaced virgin material use.[23]

The average distances from curbside collection points to landfills, curbside collection points to Vermont material recovery facilities, and redemption sites to Vermont sorting facilities were determined using ArcGIS mapping. The distances account for materials likely transferred out of state, as these represent the most conservative distance estimates. Consequently, the transportation distances and, by extension, the associated greenhouse gas emissions may be slightly lower than the values presented below.

Tonnage inputs for the greenhouse gas emissions estimations were derived through Signalfire Group's modeling, conducted in collaboration with industry stakeholders, to understand the current flow of materials through Vermont's systems. The latest state Diversion and Disposal Report supplemented the model to estimate waste tonnages exported from the state.

Bottles from Out-of-State Redeemed in VT

The Signalfire Group interviewed subject matter experts to estimate the proportion of redeemed containers contributed by purchases out-of-state but redeemed in Vermont ("Fraudulent redemption"). The average estimate is 11% of all redeemed containers. While estimated for each model, the potential cost impact was not included in the BB Model Cost or calculation of unclaimed deposits. Redemption center interviews indicated that this varied by proximity to the state border with New Hampshire and seasonally if located in an area visited heavily by tourists. If beverage containers purchased out-of-state and redeemed in VT make up about 11% of redeemed containers, unclaimed deposits may be reduced by about $0.5 Million. This financial impact was not included in the Bottle Bill System Costs given the absence of data that could quantify how this would change between Models 1, 2 and 3.

[23] *Documentation for Greenhouse Gas Emission and Energy Factors Used in the Waste Reduction Model (WARM)*. EPA. (2023, December). https://www.epa.gov/system/files/documents/2023-12/warm-background_v16_dec.pdf

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Key data sources and datasets reviewed and used in Fraudulent redemption:

k) 7.2% fraudulent redemption estimate comes from the Container Recycling Institute (CRI)
l) 15% fraudulent redemption estimate comes from Breezeway Consulting LLC
m) Average = 11%

Elimination of Brand Sorting

Highly varied responses from interviews on the impact of eliminating brand sorting resulted in a large range in terms of the cost impact modeled. Interviewees were asked to estimate the impact of eliminating brand sorting at their facility. The question was asked in various ways including:

- What percentage of your costs are associated with brand sorting?
- How much time would you save if you could avoid brand sorting?
- If brand sorting were eliminated and you were only sorting by material type (i.e., glass, plastic, aluminum), would you need any handling fee? If so, how much per container?

Of the 19 interviewees that responded to the question regarding the impact that eliminating brand sorting would have on their operations, about 60% (11/19 interviewees) indicated that eliminating brand sorting would be helpful and would lower operational costs. Of those that indicated it would be helpful, only three were able to provide quantitative estimates (and could only do so in terms of saved sorting time). The remaining 40% (8/19 interviewees) indicated that eliminating brand sorting would have little to no impact (i.e., 0% reduction in sorting time). Taken as an average, the reduction in sorting time was 14% overall across interviewees.

To translate the reduction in sorting time into a cost impact in the context of the total cost of redemption sites in the system (modeled to be $9,997,559 in the BBS), the following assumptions were made:

- 80% of redemption site cost is labor cost[24]
- Employees spend 75% of their time sorting as opposed to other activities such as cleaning, working the register, loading containers and/or other related retail operations
- Elimination of brand sorting results in a 15% reduction in sorting time[25]

This resulted in an estimated average cost impact of $899,780 (0.5 cents per container). The estimate is consistent with and reflects the existing difference in handling fee (3.5 vs 4 cents) provided for brand-sorted containers as compared to comingled containers.

It should be noted that the cost impact of brand sorting is highly sensitive to the assumptions applied. A sensitivity analysis[26] was conducted on the following 2 variables to illustrate this point:

- Time spent sorting is assumed to be between 50%-100% (i.e. 50%, 75% and 100%)
- Reduction in sorting time is assumed to be between 0%-30% (i.e. 0%, 15% and 30%)

[24] In the DSM 2007 study, surveys indicated labor represents nearly 70% of the cost of redemption. Feedback from interviews as well as modeling based on wage increases over the years suggest this should be closer to 80% currently.
[25] This assumption rounded the 14% to the nearest 5% for ease of presenting the sensitivity analysis.
[26] Sensitivity analysis is a method used to determine how changes in input variables of a model affect its output.

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If it is assumed sorting time is not reduced at all, the overall system cost remains unchanged. On the high end, if employees spend 100% of their time sorting and elimination of brand sorting reduces that time by 30%, the system impact could be as much as $2,399,414 or 7 cents/container.

Figure 4: Cost impact of eliminating brand sorting with the average cost impact highlighted in yellow.

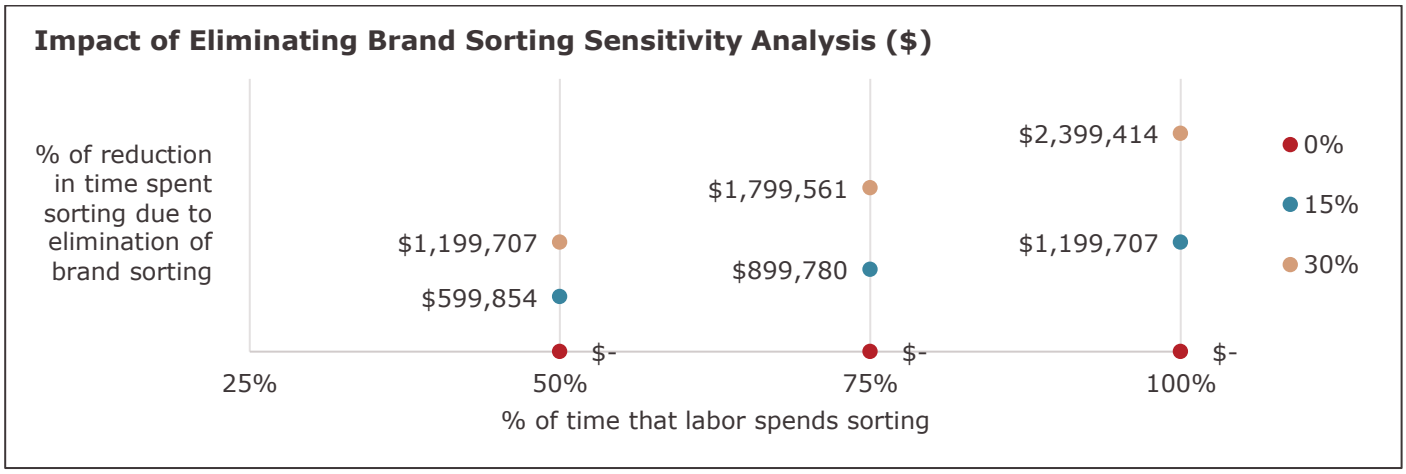

Table 9: Elimination of brand sorting sensitivity analysis details

Impact of eliminating brand sorting sensitivity analysis		TIME LABOR SPENDS SORTING		
		50%	75%	100%
REDUCTION IN TIME SORTING	0%	$ -	$ -	$ -
	15%	$599,854	**$899,780**	$1,199,707
	30%	$1,199,707	$1,799,561	$2,399,414

The average impact (i.e., system cost reduction of $899,780) was selected for analysis elsewhere in this report and is included in Table 13, Table 24, Table 25, and Table 28.

Choice of Technology - Impacts on Redemption Rates and Consumer Engagement

Industry knowledge and consumer preference were used to determine which technology would be the best path forward for Vermont redemption while maintaining the necessary convenience requirements in the Model 2 and 3 Collection Plans. Detailed evaluation of appropriate site-technology mix is described in Appendix B.

Key data sources and datasets reviewed and used in Choice of Technology:

- Signalfire data bank, confirmed by industry experts, was used to determine costs for bag drop sites.
- Primary interviews as well as data from a VT container processor were used to determine costs for RVM sites.
- Redemption site interviews were used to collect consumer preferences and redemption site owner and operator estimation of costs as well as opinions on available technologies.

As noted above, assumptions and calculations throughout the data modeling process were tested and verified with key stakeholders.

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Model 1: Base Case

ELEMENTS OF SYSTEM

Description: The base case models the cost of Vermont's current Bottle Bill System and current curbside and drop off Recycling System. Key elements include:

1. The net cost of the existing Bottle Bill System for covered containers
2. Residential curbside and drop off recycling costs for beverage containers
3. Commercial recycling collection costs (dumpster service, rear load service and drop-off service) for beverage containers
4. Net processing cost for residential recycling of beverage containers
5. Net processing cost for commercial recycling of beverage containers
6. Residential beverage container waste disposal costs for containers in MSW[27]
7. Commercial beverage container waste disposal costs for containers in MSW[28]
8. Separate trips (residential) to drop off or to redeem beverage containers

KEY ASSUMPTIONS AND VARIABLES

- Table 10 presents the distribution of redemption locations in Vermont's Bottle Bill System and the percentage of containers redeemed at each type. Redemption Centers employing manual sorting dominate the system, accounting for 52 locations and redeeming approximately 85% of containers. This highlights the reliance on manual systems within Vermont's infrastructure. Although 47 retailers are equipped with older, single-feed RVMs, these machines handle only 4.5% of redeemed containers. The limited contribution of RVMs may align with reports of consumer frustration due to operational challenges, such as machines being full, broken, or limited to accepting containers sold by that retailer. The manual nature of the system reflects significant reliance on labor, which may influence costs and operational efficiency.

Table 10: Model 1 number of redemption sites and containers redeemed

	REDEMPTION CENTER – MANUAL	REDEMPTION CENTER – RVM	RETAILER – MANUAL	RETAILER – RVM	TOTAL
# of locations	52	2	22	47	123
% of containers redeemed	84.7%	3.1%	7.7%	4.5%	100%

- Table 11 breaks down operational costs for redemption sites based on container throughput and type. These annual costs were derived from adjusting costs reported in the 2007 "The Costs of Beverage Container Redemption in Vermont" report to account for inflation, modelled using primary data from Vermont container processors and were verified through interviews with entities engaged in the redemption system. Specifically, data collected from interviews included wage and hours of employment. Average costs per store type were then computed and checked against modelled costs. Redemption centers with manual operations generally incur higher costs as throughput increases, reflecting the labor-intensive nature of manual sorting, especially for

[27] Even though VT has a landfill ban, waste composition data indicates that some beverage containers are disposed of as waste.
[28] Same as above

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brands outside of the commingling agreement. For example, manual redemption centers with a throughput above 7 million containers annually incur cost of $267,524. On the other hand, RVM operations become more efficient at higher throughputs and exhibit a much lower annual cost of $181,833 to operate high volume redemption centers, likely due to technology advances (bulk RVM instead of single-feed RVM) and better machine utilization. For the retail redemption location operations, RVMs are consistently more cost effective than manual retail redemption locations across throughput levels. Understanding the variation is essential for evaluating system optimization opportunities, such as incentivizing automation or enhancing manual systems' efficiency. This data is combined with the number of each respective type of store identified within the state to obtain the annual cost of redemption location operations.

Table 11: Model 1 Bottle Bill System redemption site annual operational cost by type and container throughput

REDEMPTION VOLUME	REDEMPTION CENTER - MANUAL	REDEMPTION CENTER – WITH RVM	RETAILER-MANUAL	RETAILER WITH RVM
Average annual cost for each type of redemption site modelled	$142,284	$39,562	$46,032	$39,562
<600k[29]	$32,034	$12,122	$33,234	$12,122
>=600k, <1.2M	$46,120	$43,066	$90,617	$43,066
>=1.2M, <3M	$63,100	$66,991	$148,000	$66,991
>=3M, <5M[30]	$105,720	$161,629	$184,400	$161,629
>=5M, <7M	$186,622	$172,794	NA	$172,794
>=7M	$267,524	$181,833	NA	$181,833

- Table 12 provides a breakdown of per-container costs for collection and processing within the Bottle Bill System. The weighted average cost is $0.014 per container, with significant variation between compacted containers processed through RVMs ($0.005) and uncompacted containers managed manually ($0.015). The dominance of manual processing inflates the average cost, indicating that Vermont's reliance on manual systems contributes to higher operational expenses. This table underscores the potential cost savings from increasing the use of compacted systems, though operational constraints and consumer accessibility must be considered.

Table 12: Model 1 Bottle Bill System Collection and Processing Costs

		$/CONTAINER
Department of Liquor and Lottery (DLL)		$0.070
All covered containers	Compacted (RVM) – 7.6%	$0.005
	Uncompacted (Manual) – 92.4%	$0.015
	Weighted Average	$0.014

[29] All units refer to annual redemption volume (# of containers)

[30] For RVMs with throughput higher than 3 million, they are considered high volume RVMs. The costing was modelled using "Bulk RVM" technology assumptions as provided by VT container processor.

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BOTTLE BILL SYSTEM COSTS

Table 13 shows the financial values in the same colors indicate corresponding expenditures for one entity and revenue for another, visually representing the funds transferred between consumers, the state, redemption sites, and distributors/manufacturers.

Table 13: Model 1 Bottle Bill System Costs

CONSUMERS	COST PER CONTAINER ($)	# OF CONTAINERS	TOTAL COST
Deposits paid[31]	($0.050)	257,708,333	($12,885,417)
Deposits returned[32]	$0.050	184,882,584	$9,244,129
Liquor deposits paid[33]	($0.150)	5,431,677	($814,752)
Liquor deposits returned[34]	$0.150	3,441,457	$516,219
Unclaimed Deposits			**($3,939,820)**
Annual Separate Trip Cost	($0.014)	188,324,041	($2,573,108)
STATE	**COST PER CONTAINER ($)**	**# OF CONTAINERS**	**TOTAL COST**
Unclaimed Deposits	$0.053	74,815,969	**$3,939,820**
Unclaimed Deposits not handled by DLL			$3,641,287
Subtotal, DLL			**($59,992)**
DLL deposits collected	$0.150	5,431,677	$814,752
DLL deposits returned	($0.150)	3,441,457	($516,219)
DLL collection cost[35]	($0.07)	3,441,457	($238,074)
DLL handling fees paid[36]	($0.035)	3,441,457	($120,451)
Subtotal, State			**$3,581,295**
RETAIL REDEMPTION	**COST PER CONTAINER ($)**	**# OF CONTAINERS**	**TOTAL COST**
Handling fees received[37]	$0.036	22,996,837	$825,208
Manual retail redemption location costs	($0.12)	14,552,678	($1,800,437)
RVM retail redemption location costs	($0.07)	8,444,159	($569,742)
Subtotal, Retail Redemption Locations			**($1,544,971)**
REDEMPTION CENTERS	**COST PER CONTAINER ($)**	**# OF CONTAINERS**	**TOTAL COST**
Handling fees received[38]	$0.036	165,327,204	$5,932,528
Manual redemption center costs	($0.05)	159,458,736	($7,398,761)
RVM redemption center costs	($0.04)	5,868,468	($228,620)
Subtotal, Redemption Centers			**($1,694,853)**

[31] Based on Vermont ABD 2023 Data

[32] Based on Vermont ABD 2023 Data

[33] Based on 2023 data from DLL

[34] Based on 2023 data from DLL

[35] Based on DLL receipts

[36] Based on DLL receipts and primary data

[37] Calculated per container rate based on 82% containers sold under commingling agreement i.e. 82% 3.5 cents and 18% 4 cents. Total # of containers from Vermont ABD 2023 Data and DLL 2023 Data. Breakdown of container throughput by store type based on primary data from Vermont container processors.

[38] Same as above

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DISTRIBUTORS/MANUFACTURERS	COST PER CONTAINER ($)	# OF CONTAINERS	TOTAL COST
HANDLING FEES			
Commingled	($0.035)	151,603,719	($5,306,130)
Brand Sorted	($0.040)	33,278,865	($1,331,155)
Collection & processing costs	($0.014)	184,882,584	($2,678,070)
MATERIAL REVENUE RECEIVED[39]			
Aluminum Cans	$0.022	132,504,856	$2,979,639
Glass Bottles[40]	$0.008	24,097,930	$183,776
PET Bottles	$0.012	31,721,254	$384,007
Subtotal, Distributors/Manufacturers			**($5,767,931)**
Model 1 Net Costs (excl. separate trips)	**($0.05)**	**188,324,041**	**($9,366,280)**
Model 1 Net Costs (incl. separate trips)	**($0.063)**	**188,324,041**	**($11,939,388)**

Table 13 offers a detailed account of the flow of funds among key stakeholders, including consumers, the state, redemption sites, and distributors/manufacturers. Consumers contribute significantly to dynamics in Model 1, primarily through unclaimed deposits, which totaled $3.94 million from both regular containers and liquor containers. Retail redemption locations and redemption centers collectively face a net loss, reflecting the cost burden of handling and sorting containers. Distributors/manufacturers experience a net cost of $5.61 million after accounting for material revenue.

Accounting for Base Case Convenience Levels

Model 1, the Base Case, quantifies costs for the VT Bottle Bill system as it currently functions. Therefore, the cost analysis reflects the reality that retailers are not in full compliance with serving as redemption sites. Model 1 accounts for 123 redemption sites and has a total annual cost (excluding separate trips) of $9,204,164 and the per container cost excluding separate trips is $0.049. However, if there were comparable convenience in Model 1 to those levels assumed in Models 2 and 3, the number of redemption sites would increase to 170; having additional redemption sites which would increase the total annual cost. With 170 redemption sites, the total annual cost excluding separate trips would be $ 11,063,562 and the per container cost excluding separate trips would be $0.059. This increase in convenience (and compliance) would lead to a cost increase of 20%. When comparing Model 1 with Models 2 and 3, it can be helpful to consider that, as presented in this report, Model 1 does not have the same convenience (i.e., number of redemption sites) and compliance as the other models.

[39] See material revenue in methodology section for material price/ container unless otherwise stated. Vermont container processor data % split for material type x DEC 2023 redemption data. Vermont container processor data assumes 24 containers per case for cans, glass and PET containers.

[40] Assumes $20/ton material value, derived from Signalfire Group and RRS expertise.

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Recycling System Costs

Table 14 presents the system-wide recycling costs for beverage containers not captured by beverage redemption. This includes residential and commercial refuse and recycling and separate trips to drop-offs. The $0.033 net cost of the Recycling System is less than the net Bottle Bill System cost of $0.050 per container for overall Model 1 Bottle Bill System costs.

Table 14: Model 1 Recycling System Costs

	Total Cost[41]	System Total tons	Beverage containers (tons)	Cost allocated to beverage containers ($)[42]	Beverage containers (units)	Cost Per Container ($)
Residential						
Refuse collection and disposal	$54,384,376	202,719	4,108	$1,102,118	123,476,069	$0.010
Recycling collection and processing	$28,064,126	66,108	7,399	$3,141,228	83,794,734	$0.037
ICI						
Refuse collection and disposal	$50,625,232	175,323	3,553	$1,025,824	106,787,320	$0.010
Recycling collection and processing	$9,885,243	34,341	3,844	$1,106,469	43,534,174	$0.025
Separate trips, residential						
Refuse & Recycling drop-off	$4,636,950	23,653	556[43]	$109,025	6,298,687[44]	$0.017
Subtotal, Recycling System excluding Separate Trips	**$37,949,369**	**100,449**	**11,243**	**$4,247,725**	**127,340,107**	**$0.033**
Subtotal, Recycling System including Separate Trips	**$42,586,304**	**100,449**	**11,243**	**$4,356,750**	**127,340,107**	**$0.051**

SEPARATE TRIPS COSTS

The cost of separate trips in the BBS and RS appear in Table 12 and Table 14 and are discussed further here. Separate trip costs were divided between trips consumers took to redemption locations which were attributed to the Bottle Bill System trips total, and consumer trips to their nearest transfer stations which were attributed to the Recycling System trips total.

[41] Refer to Appendix C: System Cost for cost components and calculation assumptions

[42] Cost allocation by beverage container tons / system total tons collected

[43] Total beverage containers recycled

[44] Same as above

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The total mileage for Bottle Bill System redemption separate trips given the current 123 active redemption locations was calculated using GIS mapping to be 3,840,459 miles. This was converted to cost using Vermont's 2024 mileage reimbursement rate is $0.67/per mile to obtain a cost of $2,573,108.

For the Recycling System separate trips, the average distance for households to travel to their nearest transfer stations was found to be 5 miles. Assuming 8% of households use the drop off weekly (92% curbside access), separate trip miles are estimated to be 6,920,800 miles, associated with a cost of $4,636,950. The per container cost is $0.017; this cost is low, given recycled beverage containers make up a relatively low proportion (<0.5%) of materials in the overall refuse and recyclables dropped off in a given trip.

GREENHOUSE GAS EMISSIONS

The following tables present the total metric tons of CO2 equivalents categorized by commodity type, end-of-life pathway, such as recycling, landfilling, or incineration, and the corresponding Vermont waste management system, including the Bottle Bill System, Recycling System, or refuse.

The emissions associated with separate consumer trips to redeem their containers were calculated using a different methodology outside of the WARM model. Though not a comprehensive LCA analysis, this impact analysis utilized a standard passenger vehicle process from the Ecoinvent database, along with an estimated number of separate trip miles traveled by consumers to redemption locations and to drop off locations. The total potential increase in emissions due to these separate trips could be 2,443 $MTCO_2$-eq.[45]

[45] Ecoinvent *Database*. https://ecoinvent.org/database/

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Table 15: Model 1 Material management streams of aluminum, glass, PET, and HDPE beverage containers in/from Vermont, with detailed breakdown of metric tons of CO2 equivalents.

		Recycled (tons)	Landfilled[46] (tons)	Incinerated[47] (tons)	Total MTCE
Bottle Bill System[48]	Aluminum Cans	2,064			(18,830)
	Glass Bottles	5,638			(1,532)
	HDPE Bottles	0			0
	PET Bottles	749			(772)
Subtotal					**(21,134)**
Recycling System[49]	Aluminum Cans	591			(5,396)
	Glass Bottles	9,360			(2,563)
	HDPE Bottles	182			(138)
	PET Bottles	1,110			(1,147)
Subtotal					**(9,244)**
Refuse[50]	Aluminum Cans		1,524	20	49
	Glass Bottles		2,894	38	92
	HDPE Bottles		544	7	30
	PET Bottles		2,595	34	133
Subtotal					**304**
Total					**(30,074)**

[46] Of the 7,557 tons landfilled, 86% (6,511 tons) was landfilled in Vermont, 5% (414 tons) was landfilled in New Hampshire, and 9% (732 tons) was landfilled in New York. The amount landfilled in Massachusetts is negligible.

[47] All incinerated tons are handled out of state in either New York or Massachusetts.

[48] Total containers from Vermont ABD 2023 Data and DLL 2023 Data. Breakdown of container throughput by store type based on primary data from Vermont container processors.

[49] Calculated with reference to 2022 data on the material collected by the Recycling System from the 2024 Vermont Materials Management Plan. Agency of Natural Resources: Vermont Department of Environmental Conservation. (2024). https://dec.vermont.gov/sites/dec/files/wmp/SolidWaste/Documents/DRAFT-2024-MMP.pdf, directly from DEC for aluminum containers, RRS internal data for % of glass beverage containers, American Chemistry Council Resin Review 2023 Edition The Annual Statistical Report of the North American Plastics Industry for % of HDPE beverage containers, CSWD 2018 PET sort data for % of PET beverage containers.

[50] Calculated with reference to 2023 Vermont Waste Composition Study. Agency of Natural Resources: Vermont Department of Environmental Conservation. (2023, May 23). https://dec.vermont.gov/sites/dec/files/wmp/SolidWaste/Documents/2023-VT-Waste-Composition-Study.pdf

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UNCLAIMED DEPOSITS

In Model 1, Vermont's Bottle Bill System allocates unredeemed deposits to two primary funds, reflecting the current structure of deposit management. The calculations below show that $3,641,287 in unredeemed deposits is generated annually from non-liquor containers and $298,553 annually from unredeemed liquor containers.

Unredeemed Deposits = (Covered containers sold – Covered containers redeemed) * Deposit Fee

Unredeemed Deposits = (257,708,333 - 184,882,584)*0.05 + (5,431,677 - 3,441,457)*0.15 = $3,641,287 + $298,553

MATERIAL DESTINATIONS

Table 16 shows the breakdown of the annual volume of containers redeemed through the Bottle Bill System by material type, calculated from primary data from Vermont container processors. Analysis of 5 years of data (2019-2023) shows an increase in the proportion of cans and a decrease in the proportion of glass and PET containers. Given that these trends corroborate with the sentiments of primary stakeholders interviewed, the 2023 breakdown was assessed to be the most representative of the current system.

Table 16: Model 1 Percent of containers redeemed in the existing (2023) Vermont Bottle Bill System by material type

	Units	Units (%)	Tons	Tons (%)
Aluminum Cans	132,504,856	70%	2,064	24%
Glass Bottles	24,097,930	13%	5,638	67%
HDPE Bottles	0	0	0	0
PET Bottles	31,721,254	17%	749	9%
Total	188,324,041	100%	8,451	100%

Correspondingly,
Table 17 shows the breakdown of the annual volume of containers recovered through the Recycling System by material type. To provide for congruence through tables in the report, the same units/ ton material conversion factor Appendix C Table 43 was applied unless otherwise stated.

Table 17: Model 1 Percent of containers recovered (2023) by the Recycling System by material type

	Units	Units (%)	Tons	Tons (%)
Aluminum Cans	37,959,879	30%	591	5%
Glass Bottles	40,008,782	31%	9,360	83%
HDPE Bottles	2,348,476	2%	182	2%
PET Bottles	47,022,969	37%	1,110	10%
Total	127,340,107	100%	11,243	100%

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Bottle Bill System Material Destinations:

- Aluminum: sent to recyclers in AL, KY, TN that produce new can sheet.
- Glass: sent to facilities in NY, VA, NC, IN, FL that use the cullet in the production of new glass containers. Some glass from the Essex facility is also sent to Canada.
- PET: sent to reclaimers in NY and NC, that produce food quality resin for use in new bottle production.

Recycling System Material Destinations:

- Aluminum: sent to metal recyclers in NY and MI that produce new can sheet and a variety of aluminum products like automotive parts.
- Glass: some glass is processed into "processed glass aggregate" and used in place of sand in construction projects, both in state and out of state. Some is sent to out of state glass recycling processors in CT, NC and Canada that process single stream glass, source separated glass, and bottle glass. Companies are cited to have optical sorting capabilities that sort glass by color and thereby could be made into products including new glass containers, fiberglass insulation (or glass wool), flat glass, filtration, abrasives, and road markings.
- HDPE: sent to plastic recyclers in NC, NY, AL and MI.
- PET: sent to plastic recyclers in GA and NC. These bottles are processed to produce flooring, carpet, other products and performance textiles (Vermont Agency of Natural Resources, personal communication, March 12, 2025).

It is worth noting that material collected through the Bottle Bill System, particularly for glass, is more likely to be sent on to a beneficiation facility for recycling. By contrast, some of the glass collected through the Recycling System is processed into glass aggregate and used in place of sand in construction projects. Similarly for PET, material collected through the Bottle Bill System may be recycled back into higher value food grade resin, while that collected through the Recycling System tends to be made into other products like carpet and textiles.

LITTER

The total volume of litter in Model 1 is based on the lbs. per capita formula from a 2009 litter study.[51] This is the most recent data available for per-capita litter generation. In 2009, Greenup Vermont suggested, based on a litter waste composition study finding, that covered and non-covered beverage container material comprises about 10% to 20% of litter by weight.[52] 10% was used for the analysis in Table 18.

[51] 2009 National Visible Litter Survey and Litter Cost Study. Keep America Beautiful, Inc. (2009, September). https://site.extension.uga.edu/kbb/files/2022/10/Keep-American-Beautiful-2009-litter-study.pdf

[52] Waste Composition Study Report for Waste Audit and Data Collection Services of Green Up Day 2009 Waste Samples to the Vermont Department of Environmental Conservation Solid Waste Program. Vermont Department of Environmental Conservation. (2009, July). https://dec.vermont.gov/sites/dec/files/wmp/SolidWaste/Documents/GreenUpDay-2009-Waste-Comp-Study.pdf

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Table 18: Model 1 Litter Tonnages in Vermont, Based on 2009 Green Up Vermont Day Waste Composition Study

For counties with population:	lbs. per capita	# of counties	Sum of population	Tons of litter
<30,000	7.49	4	65,437	245
30,000 or more, up to 100,000	15.47	9	40,9317	3,166
>100,000	8.3	1	168,323	699
Total in VT		14	643,077	4,110
Beverage Container + Bottle Bill litter as a % of overall litter by weight (10%-20%)		10%		411 tons

Data from the 2021 Keep America Beautiful study suggests a composition of 40% cans, 36% PET, and 24% glass by units.[53] Combined with container per pound conversion factors derived from CRI 2021 purchased data for the state of Vermont, the estimated 411 tons of litter was converted to the number of containers by container type.[54] Solving for the units, this resulted in an estimate of 3,859,800 units of containers (i.e., ~1% of all containers sold). When reported by weight, the breakdown of 411 tons is: 6% cans, 7% PET, 1% HDPE, and 86% glass. By weight, glass appears more prevalent due to its high weight per unit.

DIVERSION RATE[55]

The diversion rate for all beverage containers (including both covered Bottle Bill containers and those not covered in the Bottle Bill) was calculated assuming the total tons of containers generated in Vermont includes beverage containers redeemed, recycled, and wasted using the formula below.

All beverage containers = Redeemed through BBS[56] + Recycled through RS[57] + Wasted[58]

[53] Keep America Beautiful. May 2021. 2020 National Litter Study https://kab.org/wp-content/uploads/2021/05/Litter-Study-Summary-Report-May-2021_final_05172021.pdf

[54] CRI 2021 purchased data units/ ton conversion rate for all containers applied: Aluminum (61,530), PET Bottles (46,169), HDPE Bottles (12,909) and Glass bottles (2,623)

[55] "Diversion" means the management of solid wastes through methods other than disposal. In this report, diversion of beverage containers includes redemption through the bottle bill and recycling through the Recycling System i.e. curbside + drop-off.

[56] Total containers from Vermont ABD 2023 Data and DLL 2023 Data. Breakdown of container throughput by store type based on primary data from Vermont container processors.

[57] Calculated with reference to 2022 data on the material collected by the Recycling System from the 2024 Vermont Materials Management Plan. Agency of Natural Resources: Vermont Department of Environmental Conservation. (2024). https://dec.vermont.gov/sites/dec/files/wmp/SolidWaste/Documents/DRAFT-2024-MMP.pdf, directly from DEC for aluminum containers, RRS internal data for % of glass beverage containers, American Chemistry Council Resin Review 2023 Edition The Annual Statistical Report of the North American Plastics Industry for % of HDPE beverage containers, CSWD 2018 PET sort data for % of PET beverage containers.

[58] Calculated with reference to 2023 Vermont Waste Composition Study. Agency of Natural Resources: Vermont Department of Environmental Conservation. (2023, May 23). https://dec.vermont.gov/sites/dec/files/wmp/SolidWaste/Documents/2023-VT-Waste-Composition-Study.pdf

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The diversion rate for all beverage containers calculated for Model 1 may be referenced in Table 19:

Table 19: Model 1 Diversion rate for aluminum, glass, PET, and HDPE beverage containers

	All beverage containers (tons)	Redeemed through BB system (tons)	BB System Diversion rate (%)	Recycling system (tons)	Recycling System Diversion rate (%)	Overall Diversion rate[59] (%)
Aluminum Cans	4,200	2,064	49%	591	14%	63%
Glass Bottles	17,931	5,638	31%	9,360	52%	84%
HDPE Bottles	734	0	0%	182	25%	25%
PET Bottles	4,490	749	17%	1,110	25%	41%
Total	**27,354**	**8,451**	**31%**	**11,243**	**41%**	**72%**

[59] Overall diversion = BB System diversion + Recycling System diversion

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Model 2: PRO Managed Bottle Bill

ELEMENTS OF SYSTEM AND COLLECTION PLAN

Description: Model 2 maintains the same coverage of containers as Model 1. However, all containers, except for liquor, are managed by a beverage manufacturer/distributor producer responsibility organization (PRO). Furthermore, a convenience standard is established to increase redemption sites (similar to H.158), sorting by brand at redemption sites is eliminated, and all redemption sites must accept all redeemable containers, not just what they sell. For technology comparison purposes, this model is presented in 2 forms:

a. **Model 2a: Bag Drop** – relies primarily on bag drop system technology
b. **Model 2b: RVM** – relies on reverse vending machine system technology

Key elements from Model 1 are retained with the following modifications for Model 2, built according to guiding principles provided by the Agency in the RFP and contract for this study:

1. **Mandatory Brand Participation in PRO**: Mandatory participation in a PRO effectively establishes a de facto commingling agreement. It is not economically viable for a brand to pay into the PRO and incur the higher non-commingling handling fee.
2. **Negotiated Payment Structure:** Signalfire assumes that a flexible, negotiated payment between the PRO and redemption centers will replace the current fixed handling fees. The PRO may establish a tiered compensation scheme based on volume.
    a. **Disputes**: Strong performance and convenience requirements for the PRO would drive healthy redemption site negotiations. Disputes could be resolved through a mediation process established by the Agency of Natural Resources.
3. **System Standardization:** Shifting all redemption sites to universal redemption (all redemption sites must accept all beverage containers, not just those they sell) improves consumer convenience. Eliminating brand sorting requirements for redemption sites reduces wait times for consumers and simplifies redemption center operations.
4. **Retail Participation:** Retailers meeting a minimum size criterion (5,000+ sq. ft.) must redeem all covered containers, e.g. universal redemption.
5. **Convenience Standards:** A minimum of three redemption sites per county will be established and at least one for municipalities of 7,000 or more residents.
6. **Advanced Redemption Options:** Application of upgraded technology based on redemption site size, volume, and costs could improve consumer experience and may include bag drop and Reverse Vending Machine (RVM) methods.
7. **Funding and Support for Redemption Centers:** Producer fees, based on sales/supplied quantities, will provide sustained financial support to incentivize modernization where applicable and appropriate.
    a. **Producer Fee:** Basing the producer fee on sales data reduces the need for brand accounting. However, an alternative may be required for fair distribution of costs.
8. **Unclaimed Deposits:** 100% of unclaimed deposits are kept by the State.
9. **Redemption rate:** Based on data from other bottle bill programs and stakeholders' perspectives, redemption rates are assumed to remain the same as in the current Bottle Bill System. [60]

[60] In Oregon, an increase to $.10 was required as a part of expansion law only if the redemption rate did NOT increase after expansion. Given Oregon now uses $.10, it indicates an increase in deposit is required to increase redemption rate.

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KEY ASSUMPTIONS AND VARIABLES

a) All redemption sites are redemption centers for Model 2. By ensuring redemption sites are profitable, the PRO is able to ensure such operations are economically sustainable for all redemption centers.
b) Number of redemption site locations and percent of containers redeemed for Model 2 are summarized in
c)
d) Table 20 and Table 21.
e) Aside from the modeled monthly cost for a redemption center with Bag Drop, monthly redemption site cost assumptions remain the same as Model 1 as summarized in Table 22.
f) For Model 2a. Bag Drop, collection and processing costs were modeled (summarized in
g) Table 23) assuming a new processing plant would be created to debag and sort containers collected through the bag drop. Processing costs could be decreased by leveraging existing infrastructure either by collaborating with in-state facilities to manage handling of bagged containers or building a regional processing plant that could better reap economies of scale. It is also assumed that containers collected through manual redemption centers may flow through the same collection and processing operations.
h) For Model 2b. RVM, collection and processing costs were assumed to be the same as Model 1 as summarized in
i) Table 12.
j) "Bulk RVM" sites refer to high volume RVM sites (more than 3 million annual container throughput). The cost is modelled based on "Bulk RVM" technology which, differs from the single-feed RVM technology.
k)
l) Table 20 and Table 21 present the distribution of redemption sites and the percentage of containers redeemed at each type for Model 2a and 2b respectively. Thirty-three (33) of the largest redemption centers (receiving 79% of container volume) remain unchanged, meaning they maintain manual redemption methods. As for the remaining 137 sites, the model assumes that the PRO would encourage modernization and cost reduction through additional technology.[61]

Table 20: Model 2a: Bag Drop, number of redemption sites and containers redeemed

	Redemption Center - Manual	Redemption Center – Bulk RVM	Redemption Center – Bag Drop	Total
# of locations[62]	31	2	137	170
% of containers redeemed	75%	5%	20%	100%

[61] While feedback from various stakeholders revealed a preference for having both a technology-assisted option as well as a manual option available to consumers, authors recognize the technological investment and retention of existing labor cost would be less cost-efficient. Model 2 therefore retained the assumption that almost 80% of containers continue to be manually sorted while technology is adopted for processing the remaining 20%.

[62] This study assumes the same convenience standards described in H.158 and assumes retailers larger than 5,000 sq. ft will provide redemption services. It estimates there are 147 such retailers in VT, and of these, 14 are part of the high volume 33 redemption centers that remain active (i.e., 133 new retailers will become active redemption sites). Additionally, 4 sites need to be added to fulfill the convenience criteria (3 in Essex County, 1 in Hartford), increasing the total number of redemption sites to 137. The same convenience criteria are applied to Model 2 and Model 3.

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Table 21: Model 2b: RVM, number of redemption sites and containers redeemed

	Redemption Center - Manual	Redemption Center – Bulk RVM	Redemption Center – RVM	Total
# of locations	31	2	137	170
% of containers redeemed	75%	5%	20%	100%

Table 22 presents the operational costs for redemption sites under Model 2. It is worth noting that the cost of operations for a manual redemption increases as throughput increases. This was verified with both primary operators as well as the container processor where labor, as a direct input, increases at an exponential rate as illustrated in

m) Figure 5. At higher volumes, RVM labor costs are about 20-30% lower than manual redemption costs due to labor savings. Bag drop, which requires little to no labor, incurs even lower costs and does not correlate to redemption volume since the volume does not significantly impact bag drop operational system costs.

Table 22: Model 2 Bottle Bill System redemption site annual operational cost by type and container throughput[63]

Redemption Volume	Redemption Center - Manual	Redemption Center – RVM	Redemption Center – Bag drop
Average annual cost for each type of redemption site modelled	$142,284	$39,562	$8,115[64]
<600k[65]	$32,034	$12,122	-
>=600k, <1.2M	$46,120	$43,066	-
>=1.2M, <3M	$63,100	$66,991	-
>=3M, <5M	$105,720	$161,629	-
>=5M, <7M	$186,622	$172,794	-
>=7M	$267,524	$181,833	-

[63] Calculated based on adjusting 2007 DSM study labor cost by inflation as well as adjustment using primary data from interviews.

[64] Modelled cost per store

[65] All units refer to annual redemption volume (# of containers).

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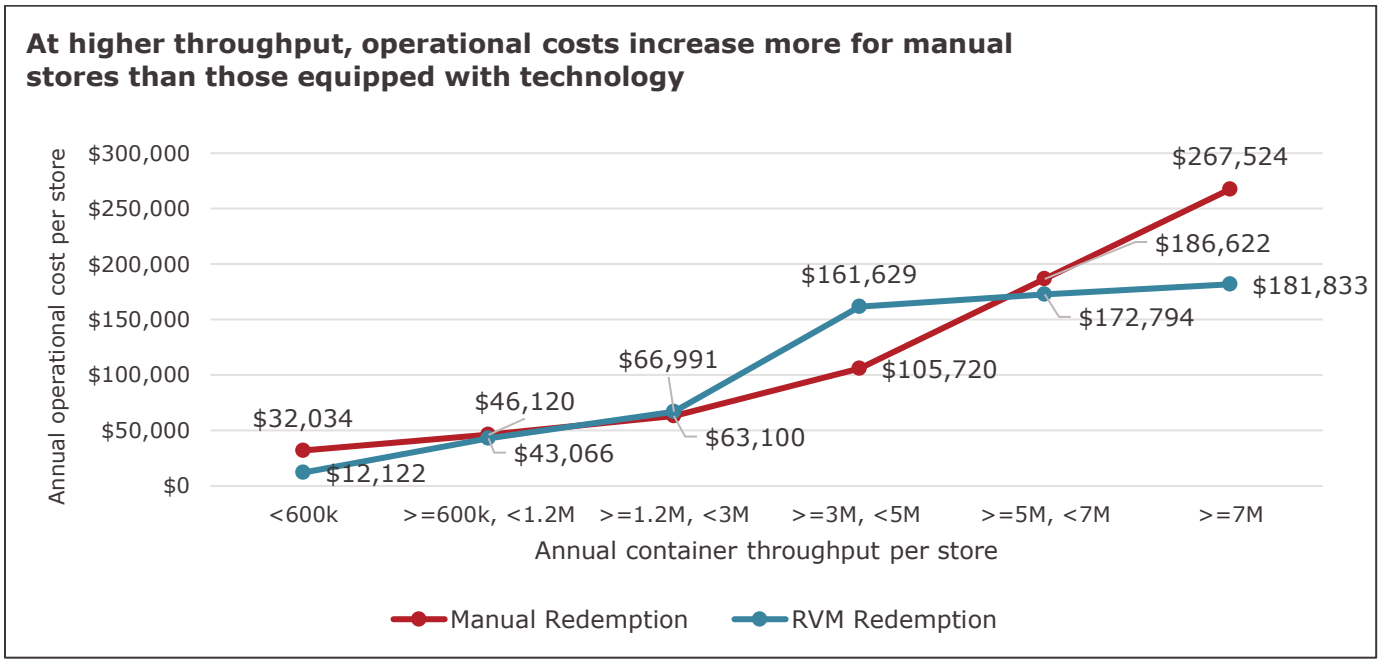
Figure 5: With higher throughput, cost increase for manual operations is exponential while technology options plateau off (better able to reap economies of scale).



n) Table 23 shows the per container cost for a bag drop system when considering capital costs for land, drop station, and kiosk, operating costs such as collection costs, site maintenance, and processing costs, as well as relevant overhead. The inputs into the bag drop cost model are based on primary interviews with technology providers and the Signalfire Group data bank. Where possible, state specific data was used as inputs.[66] The cost of the model is primarily driven by changes in the number of locations and per container cost estimate is affected by per container throughput. The total $0.048 per container cost is relatively high compared to RVM in Model 1's current system due to additional infrastructure and logistics required to collect, de-bag, and account for containers. However, this assumes that Vermont alone must bear the full processing cost of a new system. Reaching economies of scale and leveraging existing facilities in neighboring bottle bill states could reduce costs. Bag drop also offers more operational flexibility and expanded convenience for consumers versus the single-feed RVM units, which Vermonters use little to redeem and often find not operational.

Table 23: Model 2a: Bag Drop, Bottle Bill System collection and processing costs

Collection and Processing Cost		**$/Container**
Bag drop[67]	Capital Cost	$0.019
	Operating Cost	$0.029
	Total Cost	$0.048

[66] This includes population and household data from the 2020 US Census as well as wage data from the State Occupational Employment and Wage Estimates, Vermont by the U.S. Bureau of Labor Statistics.

[67] Modeled cost per store

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BOTTLE BILL SYSTEM COSTS

Model 2a: Bag Drop. In the table below, financial values in the same colors indicate corresponding expenditures for one entity and revenue for another, visually representing the transfer of funds between consumers, the state, redemption sites, and distributors/manufacturers.

Table 24 outlines the financial flows for consumers, redemption centers, distributors/manufacturers, and the state under the bag drop model. Consumers' unclaimed deposits are unchanged from Model 1. Redemption centers see a modest net surplus of $1.12 million because of payments from the PRO. Distributors/manufacturers bear most of the system costs at a net cost of $12.16 million due to PRO payments. In the bag drop system, the PRO acts as an intermediary, managing the collection and processing, accounting, vending, and payment distributions for the system. The balanced accounts underscore the central role of the PRO in streamlining financial flows and ensuring redemption centers remain operationally viable.

The overall net system cost for Model 2a is $10.5 million, or $0.056 per container, as compared to Model 1's $0.050 per container.

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Table 24: Model 2a: Bag Drop, Bottle Bill System Cost

Consumers	Cost Per Container ($)	# of Containers	Total Cost
Deposits paid	($0.050)	257,708,333	($12,885,417)
Deposits received	$0.050	184,882,584	$9,244,129
Liquor deposits paid	($0.150)	5,431,677	($814,752)
Liquor deposits received	$0.150	3,441,457	$516,219
Unclaimed Deposits			**($3,939,820)**
Separate trips	($0.012)	188,324,041	($2,250,684)
State	**Cost Per Container**	**# of Containers**	**Total Cost**
Unclaimed Deposits	$0.053	74,815,969	**$3,939,820**
Unclaimed Deposits not handled by DLL			$3,641,287
Subtotal, DLL			**($59,992)**
DLL deposits collected	$0.150	5,431,677	$814,752
DLL deposits returned	($0.150)	3,441,457	($516,219)
DLL collection cost	($0.07)	3,441,457	($238,074)
DLL handling fees paid	($0.035)	3,441,457	($120,451)
Subtotal, State			**$3,581,295**
Redemption Centers	**Cost Per Container ($)**	**# of Containers**	**Total Cost**
Manual redemption center costs	($0.030)	141,255,423	($4,188,170)
RVM redemption center costs	($0.035)	9,113,253	($323,258)
Bag Drop redemption center costs	($0.029)	37,955,365	($1,111,694)
Redemption Center Costs	($0.030)	188,324,041	**($5,623,122)**
Payment from PRO			**$6,747,747**
Subtotal, Redemption Centers			**$1,124,624**
Redemption Sites	**Cost Per Container ($)**	**# of Containers**	**Total Cost**
System impact of eliminating brand sorting	$0.005	188,324,041	$899,780
Distributors/Manufacturers	**Cost Per Container ($)**	**# of Containers**	**Total Cost**
Payments to PRO			
Payment to redemption sites			($6,747,747)
Net collection and processing costs + material revenue			($4,308,711)
PRO Admin costs			($1,105,646)
Subtotal, Distributors/Manufacturers			**($12,162,104)**
PRO	**Cost Per Container ($)**	**# of Containers**	**Total Cost**
Collection & processing costs	($0.042)	184,882,584	($7,856,134)
Materials revenue received			
Aluminum Cans	$0.022	132,504,856	$2,979,639
Glass Bottles	$0.008	24,097,930	$183,776
PET Bottles	$0.012	31,721,254	$384,007
Payment from Distributor/Manufacturer			$12,162,104
Payment to Redemption sites			($6,747,747)
Admin costs			($1,105,646)
Subtotal, PRO			**$0**
Model 2a, Bag Drop Net Costs (excl. separate trips)[68]	**($0.056)**	**188,324,041**	**($10,496,224)**
Model 2a, Bag Drop Net Costs (incl. separate trips)	**($0.068)**	**188,324,041**	**($12,746,908)**

[68] Per container cost based on # of containers redeemed

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Model 2b: RVM. In the table below, financial values in the same colors indicate corresponding expenditures for one entity and revenue for another, visually representing the transfer of funds between consumers, the state, redemption sites, and distributors/manufacturers. Table 25 mirrors the structure of Table 24 but focuses on an RVM-based redemption center approach. In this model, redemption centers handle higher front-end costs ($9.93 million) due to RVM operations, but the PRO's payments ($11.92 million) allow a slight surplus for these centers. The total net system cost is $9.22 million, or $0.049 per container. Due to RVM compaction, the PRO's collection and processing costs are significantly lower than Model 2a.

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Table 25: Model 2b: RVM, Bottle Bill System Cost

Consumers	Cost Per Container ($)	# of Containers	Total Cost
Deposits paid	($0.050)	257,708,333	($12,885,417)
Deposits received	$0.050	184,882,584	$9,244,129
Liquor deposits paid	($0.150)	5,431,677	($814,752)
Liquor deposits received	$0.150	3,441,457	$516,219
Unclaimed Deposits			**($3,939,820)**
Separate trips	($0.012)	188,324,041	($2,250,684)
State	**Cost Per Container**	**# of Containers**	**Total Cost**
Unclaimed Deposits	$0.053	74,815,969	**$3,939,820**
Unclaimed Deposits not handled by DLL			$3,641,287
Subtotal, DLL			**($59,992)**
DLL deposits collected	$0.150	5,431,677	$814,752
DLL deposits returned	($0.150)	3,441,457	($516,219)
DLL collection cost	($0.07)	3,441,457	($238,074)
DLL handling fees paid	($0.035)	3,441,457	($120,451)
Subtotal, State			**$3,581,295**
Redemption Centers	**Cost Per Container ($)**	**# of Containers**	**Total Cost**
Manual redemption center costs	($0.030)	141,255,423	($4,188,170)
RVM redemption center costs	($0.122)	47,068,618	($5,743,204)
Bag Drop redemption center costs	NA	NA	NA
Redemption Center Costs	($0.053)	188,324,041	**($9,931,374)**
Payment from PRO			**$11,917,649**
Subtotal, Redemption Centers			**$1,986,275**
Redemption Sites	**Cost Per Container ($)**	**# of Containers**	**Total Cost**
System impact of eliminating brand sorting	$0.005	188,324,041	$899,780
Distributors/Manufacturers	**Cost Per Container ($)**	**# of Containers**	**Total Cost**
Payments to PRO			
Payment to redemption sites			($11,917,649)
Net collection and processing costs + material revenue			$1,236,269
PRO Admin costs			($1,068,138)
Subtotal, Distributors/Manufacturers			**($11,749,518)**
PRO	**Cost Per Container ($)**	**# of Containers**	**Total Cost**
Collection & processing costs	($0.013)	184,882,584	($2,311,154)
Materials revenue received			
Aluminum Cans	$0.022	132,504,856	$2,979,639
Glass Bottles	$0.008	24,097,930	$183,776
PET Bottles	$0.012	31,721,254	$384,007
Payment from Distributor/Manufacturer			$11,749,518
Payment to Redemption sites			($11,917,649)
Admin costs			($1,068,138)
Subtotal, PRO			**$0**
Model 2b, RVM Net Costs (excl. separate trips)[69]	**($0.049)**	**188,324,041**	**($9,221,988)**
Model 2b, RVM Net Costs (incl. separate trips)	**($0.061)**	**188,324,041**	**($11,472,672)**

[69] Per container cost based on # of containers redeemed

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Comparison of Model 2a. Bag Drop and 2b. RVM

Table 26 highlights the key aspects of the choice of technology in which costs differ. The choice of technology most suitable for Vermont's Bottle Bill System, the pros and cons of each technology, are considered in the Model 2 Collection Plan shared in Appendix B. While Model 2's technology adoption and a PRO that makes front-end redemption locations financially sustainable achieve better consumer and redemption center experience, the overall system cost is similar to that of Model 1.

Table 26: Comparison of Model 2a. vs. Model 2b.

	Model 2a. Bag Drop	Model 2b. RVM	Notes
Technology	Bag Drop	RVM	For comparison purposes. See Model 3 for Hybrid technology mix.
Annual redemption site costs	$5,623,122	$9,931,374	Bag drop has lower front-end redemption site cost
Collection and Processing costs	$7,856,134	$2,311,154	Bag drop has higher back-end processing cost due to the need to debag and sort containers
Overall system cost (Annual)	$10,496,224	$9,221,988	Model outputs differ from other reports that suggest a marginal difference (~$0.3M higher cost) between bag drop BB vs. non-bag drop BB models for the state of Vermont.[70] One reason for this is that this bag drop model assumes a new processing plant rather than leveraging existing infrastructure.[71]
Overall system cost (per container rate)	$0.056	$0.049	

[70] *Northeast: Reimagining the Bottle Bill.* Reloop. (2022). https://bottlebillreimagined.org/wp-content/uploads/2022/03/Reimagining-the-Bottle-Bill-REPORT.pdf

[71] If the processing plant cost is reduced by 60% e.g. if existing infrastructure could be leveraged or processing could be shared with other out of state facilities, the cost would be comparable between bag drop and RVM models.

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Figure 6: Potential cost efficiencies from technology adoption for high volume manual redemption sites (7M+) under Model 2a and 2b.

Bag Drop for High Volume Stores

- Sites with >7M throughput may be incentivized by the PRO to convert from manual to bag drop operations.
  - Number of redemption sites impacted: 6
  - Annual savings per site based on Table 22: $267,524 - $8,115 = $259,409
  - Total savings per year = 6 * $259,409 = $1,556,454
- Given containers remain uncompacted under the bag drop system, the cost of collection and processing remains unchanged from Model 2a in this scenario.
- Total potential savings from bag drop technology adoption at the top 6 of the 33 highest volume sites:
  - Annual BB system cost savings: $1,556,454
  - Impact on BB system per container rate (188,324,041 containers): $0.008/container

Bulk RVM Technology for High Volume Stores

- Sites with >7M throughput may be incentivized by the PRO to convert from manual to bulk RVM operations.
  - Number of redemption sites impacted: 6
  - Annual savings per site based on Table 11: $267,524 - $181,833 = $85,691
  - Total savings per year = 6 * $85,691 = $514,146
- Additionally, given the increase in volume of containers compacted within the system, the cost savings in terms of collection and processing may be calculated as follows:
  - Total containers within system that would be compacted (previously uncompacted when stores were manual): 55,041,381

Per container savings based on

  - Table 12: $0.015 - $0.005 = $0.01
  - Total savings per year = $0.01 * 55,041,381 = $550,414
- Total potential savings from Bulk RVM technology adoption at the top 6 of the 33 highest volume sites:
  - Annual BB system cost savings: $514,146 + $550,414 = $1,064,560
  - Impact on BB system per container rate (188,324,041 containers): $0.006/container

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RECYCLING SYSTEM COSTS

Same as Model 1 system cost. No material change is expected, given that bottle bill coverage does not expand, and the redemption rate is assumed to remain the same.

SEPARATE TRIPS COSTS

The cost of separate trips in the BBS and RS appear in Table 12 and Table 14 and are discussed further here. Separate trip costs were divided between trips consumers took to redemption locations which were attributed to the Bottle Bill System trips total, and consumer trips to their nearest transfer stations which were attributed to the Recycling System trips total.

For Model 2, GIS mapping was used to determine the total mileage for separate trips given the inclusion of all retailers that are 5,000 sq. ft. or larger as redemption sites. The 5,000 sq. ft. or larger retailers were removed from the separate trip calculation used in Model 1 (marked as redemption sites instead). This reduced the separate trip distance to 3,359,229 miles (about 87% of that in Model 1). This reduction corroborates with the more extensive data set of retailers referenced from a private business database studied where 5,000 sq. ft. or larger retailers make up about 13% of retailers in Vermont. This was converted to cost using Vermont's 2024 mileage reimbursement rate is $0.67/per mile to obtain a cost of $2,250,684. It is worth noting Model 2 also requires redemption sites to be universal redemption, making the system more convenient for consumers and consistent with the way other Extended Producer Responsibility (EPR) laws function.

There is no change to the Recycling System separate trips calculation between Model 1 and Model 2.

UNCLAIMED DEPOSITS

There is no change in unclaimed deposits between Model 1 and Model 2.

GREENHOUSE GAS EMISSIONS

The management of containers under Model 2 is the same as under Model 1; therefore, there is no change in material volumes handled. As a result, the greenhouse gas emissions will not change between the two Models. Refer to Table 15 for $MTCO_2$-eq of Model 2.

The high-volume manual redemption centers remain unchanged, and the other redemption sites and retailers can transition to a bag drop or Reverse Vending Machine (RVMs). One anticipated change in emissions of each redemption site stems from the selected equipment, specifically the energy consumption of the RVMs versus manual sorting. Additionally, while there is the potential of reduced transportation related emissions resulting from an increased use of RVMs and greater compaction of materials, it is not clear those reductions would be realized, and therefore they were not reflected in the model.

The emissions associated with separate consumer trips to redeem their containers were calculated using a different methodology outside of the WARM model. Though not a comprehensive LCA analysis, this impact analysis utilized a standard passenger vehicle process from the Ecoinvent database, along with an estimated number of separate trip miles traveled by consumers to redemption locations and to drop off locations. The total potential increase in emissions due to these separate trips could be 2,150

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$MTCO_2$-eq.[72] Since separate trips in Model 2 are predicted to be lower due to more redemption sites and therefore greater consumer convenience, the GHG emissions in Model 2 are lower than Model 1 which is estimated at 2,443 $MTCO_2$-eq.

MATERIAL DESTINATIONS

There is no change in material destinations between Model 1 (Table 16 and Table 17) and Model 2 given the coverage of beverage containers and redemption rates remain unchanged.

LITTER

There is no change in litter between Model 1 (Table 18) and Model 2 given the coverage of beverage containers and redemption rates remain unchanged.

DIVERSION RATE

There is no change in diversion rate between Model 1 (Table 19) and Model 2 given the coverage of beverage containers and redemption rates remain unchanged.

[72] Ecoinvent *Database*. https://ecoinvent.org/database/

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Model 3: PRO Managed, Expanded Bottle Bill

ELEMENTS OF SYSTEM AND COLLECTION PLAN

Description: Model 3, expanded bottle bill (EBB) collection, (further described in Appendix B), maintains all elements of the system as described in Model 2 but with an expansion in the types of beverages included in the bottle bill deposit program as originally proposed in H.158.

1. **Material Scope:** All beverages are covered in Model 3's expanded bottle bill, except for milk, dairy products, plant-based beverages, infant formula, meal replacement drinks, or non-alcoholic cider. As such, water, juice, teas, coffee drinks, sports drinks, and wine are added as covered containers in the redemption system. Liquor is managed by the Department of Liquor and Lottery rather than by the PRO. Expanding the Vermont Bottle Bill System in Model 3 to include more beverage containers in the deposit system will likely divert additional containers from the Recycling System. However, the model still projects that some consumers will choose to recycle through the Recycling System instead of redeeming containers.
2. **Technology Mix:** Model 3 adopts a mix of manual, RVM, and Bag Drop redemption sites (Table 27)

KEY ASSUMPTIONS AND VARIABLES

a) Number of locations and % of containers redeemed for Model 3 is summarized in Table 27.
b) Assumptions for annual costs per site type are assumed to be the same as Model 1 in Table 11.
c) Based on container throughput, relevant collection and processing cost from
d) Table 12 (compacted containers collected through RVM redemption sites) and Table 23 (containers collected through manual and bag drop redemption sites) are applied.
e) The existing redemption rate of 72% was applied to the expanded coverage of containers.
f) Calculation for the total number of covered containers redeemed in Model 3:
    i. Containers redeemed in EBB = Containers redeemed in M1 + Total EBB impact
    ii. Total EBB impact = Impact of EBB on waste + Impact of EBB on recycling system
    iii. Impact of the EBB on waste: Redemption rates by material type as applied to covered containers in Model 1 were applied to EBB waste, on corresponding material type, as estimated in the 2023 Waste Composition study.
    iv. Impact of the EBB on recycling system: Calculations assume a loss of 75% aluminum, 60% PET and 50% glass and 50% for HDPE of containers flowing through MRFs in the base model that would instead be recycled through the Bottle Bill System.[73]
    v. Calculation was done in tons and converted to number of units using conversion factors in Appendix C Table 43 and
    vi. Table 44.
    vii. Total covered beverages redeemed in units = 351,011,408
g) Calculation for the number of liquor containers redeemed and sold in Model 3:
    i. Total Liquor Containers = Liquor containers currently managed by DLL per Model 1 + Wine
    ii. CRI 2021 sales data estimated a total of 8,775,078 units of Spirits (Liquor) and 18,223,636 units of Wine. The total units of liquor sold by DLL in 2023 was 5,431,677. A

[73] This assumption aligns with the Senate Natural Resources Committee on the H.158 Financial Impact for Chittenden Solid Waste District's MRF. Given HDPE loss was not captured in the testimony, the team assumed a loss of 50%.

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proportionate calculation was done to estimate the sales of wine for Model 3 i.e. Wine sold = 5,431,677/ 8,775,078 * 18,223,636 = 11,280,231

iii. The same redemption rate based on DLL data in 2023 was applied to Wine estimated as sold into Vermont, to obtain an estimate for units of Wine containers redeemed i.e. Wine redeemed = 3,441,457/5,431,677 * 11,280,231 = 7,147,043.

iv. Total liquor (lumping liquor and wine since H.158 proposed a deposit of 15 cents on wine a.k.a. vinous beverages) redeemed = Liquor redeemed + Wine redeemed = 3,441,457 + 7,147,043 = 10,588,500

v. Total liquor (lumping liquor and wine since H.158 proposed a deposit of 15 cents on wine, which is the same as spirits/liquor currently carry) sold = Liquor sold + Wine sold = 5,431,677 + 11,280,231 = 16,711,908

h) Calculation for the total number of covered containers sold in Model 3:

i. Total non-liquor containers redeemed = 351,011,408 - 10,588,500 = 340,422,908

ii. Assuming same redemption rate as Model 1 i.e. 72%, Total non-liquor containers sold = 340,422,908 /72% = 472,809,595[74]

i) Table 27 demonstrates the redistribution of redemption efforts under Model 3. This expanded system includes a broader set of covered beverage containers with the same 170 redemption sites as Model 2 to meet convenience requirements. Of the 33 largest existing redemption centers retained, in addition to the 2 existing bulk RVM locations, the top 6 (annual volume >7M) adopt bulk RVM technology (i.e., 25 manual sites and 8 bulk RVM sites). Of the remaining 137 redemption sites, 16 adopt RVM technology (likely single-feed) to fulfill the immediate return of deposit requirement within specific counties. The remaining 121 redemption sites adopt bag drop given it has the lowest front-end store cost. 31% of the containers are compacted before collection and processing, while the rest remain uncompacted (through manual sort and bag drop redemption sites).

Table 27: Model 3 number of redemption sites and containers redeemed

	Redemption Center - Manual	Redemption Center – Bulk RVM	Redemption Center – Bag Drop	Total
# of locations	25	24	121	170
% of containers redeemed[75]	44.7%	27.6%	27.7%	100%

[74] Vermont ABD 2023 Data

[75] Assumes existing covered materials continue to flow through respective large redemption centers with ~35% converting to RVM given technology adoption for the top 6 (~38% including existing 2 RVM sites). Additionally, 50% of newly covered materials under EBB flow to redemption centers and rest flow to retailers with the spread of containers proportional to the number of sites.

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BOTTLE BILL SYSTEM COSTS

In Table 28, financial values in the same colors indicate corresponding expenditures for one entity and revenue for another, visually representing the transfer of funds between consumers, the state, redemption sites, and distributors/manufacturers.

Table 28: Model 3 Bottle Bill System Costs

Consumers	Cost Per Container ($)	# of Containers	Total Cost
Deposits paid[76]	($0.050)	472,809,595	($23,640,480)
Deposits received[77]	$0.050	340,422,908	$17,021,145
Liquor (+wine) deposits paid[78]	($0.150)	16,711,908	($2,506,786)
Liquor (+wine) deposits received[79]	$0.150	10,588,500	$1,588,275
Unclaimed deposits			**($7,537,845)**
Separate trips	($0.006)	351,011,408	($2,250,684)

State	Cost Per Container ($)	# of Containers	Total Cost
Unclaimed Deposits	$0.054	138,510,094	**$7,537,845**
Unclaimed Deposits not handled by DLL			**$7,239,312**
Subtotal, DLL			**($59,992)**
DLL Deposits collected	$0.150	5,431,677	$814,752
DLL Deposits redeemed	($0.150)	3,441,457	($516,219)
DLL Collection cost	($0.07)	3,441,457	($238,074)
DLL Handling fees paid out	($0.035)	3,441,457	($120,451)
Subtotal, State			**$7,179,320**

Redemption Centers	Cost Per Container ($)	# of Containers	Total Cost
Manual redemption center costs	($0.043)	156,742,906	($6,688,095)
RVM redemption center costs	($0.045)	96,877,851	($1,454,660)
Bag Drop redemption center costs	($0.010)	97,390,652	($981,861)
Redemption Center Costs			($12,033,937)
Payment from PRO			$14,440,724
Subtotal, Redemption Centers			**$2,406,787**

Redemption Sites	Cost Per Container ($)	# of Containers	Total Cost
System impact of eliminating brand sorting	$0.005	188,324,041	$899,780

Distributors/Manufacturers	Cost Per Container ($)	# of Containers	Total Cost

[76] See calculation for number of containers in Model 3 Key Assumptions and Variables.
[77] Same as above.
[78] Same as above.
[79] Same as above.

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Payment to PRO			
Payment to redemption sites	$0.035	351,011,408	($14,440,724)
Net collection and processing costs + material revenue			($968,711)
PRO admin costs			($1,540,944)
Subtotal, Distributors/Manufacturers			**($16,950,379)**

PRO	**Cost Per Container ($)**	**# of Containers**	**Total Cost**
Collection & processing costs	($0.019)	347,569,951	($6,480,927)
Materials revenue received			
Aluminum Cans	$0.022	124,094,678	$2,790,519
Glass Bottles	$0.008	40,350,959	$307,726
PET Bottles	$0.012	184,793,396	$2,237,050
HDPE Bottles	$0.100	1,772,375	$176,921
Payment from Distributors/Manufacturers			$16,950,379
Payment to Redemption sites			($14,440,724)
Admin costs			($1,540,944)
Subtotal, PRO			**$0**[80]
Model 3 Net Costs (excl. separate trips)	**($0.040)**	**351,011,408**	**($14,002,337)**
Model 3 Net Costs (incl. separate trips)	**($0.046)**	**351,011,408**	**($16,253,020)**

Table 28 details the most efficient per container cost ($0.04/container) Bottle Bill System, however it is also the most costly Bottle Bill System of the three models with a net system cost of $14 million. The per container efficiency is due to a combination of factors, mainly, the increased container throughput as well as the adoption of technology options that both lowers system costs and allows cost to be spread across a higher volume of containers. To satisfy consumer preferences, manual redemption centers are assumed to continue operating as part of the redemption site mix. Redemption center cost is brought down by the use of bulk RVMs. Collectively, the manual redemption centers and bulk RVMs satisfy the minimum convenience standards of immediate redemption that would have been legislated in H.158. An increase in compacted container throughput at redemption sites (through RVM) also results in approximately $970,000 in collection and processing cost savings, which, at $0.019/container, is much more efficient than that of the bag drop option in Model 2a ($0.042/container) and closer to that of Model 2b's RVM system ($0.013/container).

It is notable that all of the cost for this expanded and improved system under Model 3 is borne by the distributors/manufacturers; their cost is about 3x that of Model 1. Correspondingly, the gain by the state in the form of unclaimed deposits has doubled under Model 3 from Model 1.

[80] Subtotal is $0 because the cost is paid for by Distributors/Manufacturers.

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The PRO's balanced account (similar to Model 2) indicates that the expanded system can achieve financial stability through a more streamlined system, assuming distributors/manufacturers of covered beverage containers fully fund the corresponding cost.

RECYCLING SYSTEM COSTS

Table 29 presents the system-wide recycling costs for beverage containers not captured by beverage redemption. This includes residential and commercial refuse and recycling and separate trips to drop-offs. Most recycling system costs are fixed – such as trucks and recycling facilities – so they will not decrease when containers are recycled through the deposit program instead of the municipal system. However, there is a slight loss of revenue with the shift of some containers currently recycled through the Recycling System being redeemed through the Bottle Bill instead. This is estimated to result in a recycling system cost increase of 2% ($38,852,556 compared to $37,949,369 in Model 1 and 2). The $0.045 per container net cost of the Recycling System is more than the net Bottle Bill System cost of $0.040 per container for Model 3 Bottle Bill System costs, because the recycling system now collects fewer containers than in Model 1 or 2.

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Table 29: Model 3 Recycling System Costs

	Total Cost[81]	System Total tons[82]	Beverage containers (tons)	Cost allocated to beverage containers ($)[83]	Beverage containers (units)	Cost Per Container ($)
Residential						
Refuse collection and disposal	$54,384,376[84]	200,869	2,258	$611,265	77,987,843	$0.010
Recycling collection and processing	$28,658,538[85]	62,238	3,529	$1,625,189	32,562,656	$0.050
ICI						
Refuse collection and disposal	$50,625,232[86]	173,723	1,953	$569,013	67,448,353	$0.010
Recycling collection and processing	$10,194,019[87]	32,330	1,833	$578,090	16,915,131	$0.034
Separate trips, residential						
Refuse & Recycling drop-off	$4,636,935	23,653	265	$52,003	2,447,344	$0.021
Subtotal, Recycling System excluding Separate Trips	**$38,852,556**	**94,569**	**5,363**	**$2,203,278**	**49,477,787**	**$0.045**
Subtotal, Recycling System including Separate Trips	**$43,489,491**	**94,569**	**5,363**	**$2,255,281**	**49,477,787**	**$0.066**

[81] Refer to Appendix C System Cost for cost components and calculation assumptions

[82] Refer to Appendix C EBB Impact on Recycling System and EBB Impact on Waste. Removed EBB impact from System Total tons for Waste and Recyclables at Residential Waste 54% and ICI Waste 46% as well as Residential Recyclables 66% ICI Recyclables 34% respectively.

[83] Cost allocation by beverage container tons / system total tons collected

[84] No change from Model 1 (Table 14).

[85] Refer to Appendix C EBB Impact on Recycling System. Cost from Model 1 + 66%*$903,187.

[86] No change from Model 1 (Table 9)

[87] Refer to Appendix C EBB Impact on Recycling System. Cost from Model 1 + 34%*$903,187.

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SEPARATE TRIPS COSTS

Separate trips were assessed for both the Recycling System and Bottle Bill System. Given identical convenience standards as Model 2, there is no change to the separate trip costs associated with the Bottle Bill System between Model 2 and Model 3. Separate trip costs were divided between trips consumers took to redemption locations which were attributed to the Bottle Bill System trips total, and consumer trips to their nearest transfer stations which were attributed to the Recycling System trips total.

For Model 3's recycling system, the overall allocation of the cost of separate drop-off trips ($4,636,950) is lower given fewer beverage containers would be dropped off (<0.2%). However, the per container rate is higher (increase from $ 0.017 to $0.021) due to the lower throughput of containers collected through recycling drop-off, a decrease from 6,298,687 units to 2,447,344 units, meaning less containers over which costs are spread.

UNCLAIMED DEPOSITS

Pursuant with Bill H.158, the Commissioner of Taxes will deposit funds from the unclaimed deposits according to the following schedule:

> **Year 1:** The first $3 million of unclaimed deposits go into the Clean Water Fund; the Commissioner of Taxes will return any amount above $3 million to the PRO.
> **Year 2:** The first $4 million of unclaimed deposits go into the Clean Water Fund; the Commissioner of Taxes will return any amount above $4 million to the PRO.
> **Year 5:** 50% or $4 million, whichever is greater, of unclaimed deposits go into the Clean Water Fund; the Commission of Taxes will return any remaining amount to the Solid Waste Management Assistance Fund.

Model 3 represents the steady state (Year 5 onwards) of unclaimed deposits. The calculation is as follows:

Unredeemed Deposits = (Covered containers sold – Covered containers redeemed) * Deposit Fee

Unredeemed Deposits = (472,809,595 - 340,422,908) * 0.05 + (16,711,908 - 10,588,500) * 0.15 = $6,619,334 + $918,511 = $7,537,845

Given 50% of $7,537,845 is less than $4,000,000, $4,000,000 would be allocated to the Clean Water Fund and the remaining $3,239,312 would go to the Solid Waste Management Assistance Account. DLL retains $298,533.

GREENHOUSE GAS EMISSIONS

Greenhouse gas emissions under Model 3 differ from Model 1 and 2 due to the expansion under Model 3. Reduction in emissions due to increased diversion is higher at 34,108 metric tons of carbon dioxide equivalents ($MTCO_2$-eq) as compared to 30,074 $MTCO_2$-eq in Model 1 and 2. Furthermore, similar to Model 2, transitioning from manual redemption to RVMs or other redemption technology may lead to changes in energy requirements due to the updated technology and container compaction. This shift could result in increased transportation efficiency, provided routes are optimized accordingly.

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As with Model 1 and 2, Model 3's emissions associated with separate consumer trips to redeem their containers were calculated using a different methodology, outside of the WARM model. Though not a comprehensive LCA analysis, this impact analysis utilized a standard passenger vehicle process from the Ecoinvent database, along with an estimated number of separate trip miles traveled by consumers to redemption locations and to drop off locations. The total potential increase in emissions could be 2,098 $MTCO_2$-eq.

Table 30: Model 3 Material management streams of aluminum, glass, PET, and HDPE beverage containers in/from Vermont, with detailed breakdown of metric tons of CO2 equivalents

		Recycled (tons)	Landfilled[88] (tons)	Incinerated[89] (tons)	Total MTCE
Bottle Bill System[90]	Aluminum Cans	2,691			(24,555)
	Glass Bottles	11,722			(3,210)
	HDPE Bottles	493			(371)
	PET Bottles	2,875			(2,972)
Subtotal					**(31,108)**
Recycling System[91]	Aluminum Cans	148			(1,349)
	Glass Bottles	4,680			(1,281)
	HDPE Bottles	91			(69)
	PET Bottles	444			(459)
Subtotal					**(3,158)**
Refuse[92]	Aluminum Cans		1,343	18	43
	Glass Bottles		1,508	20	48
	HDPE Bottles		148	2	8
	PET Bottles		1,154	15	59
Subtotal					**158**
Total					**(34,108)**

[88] Of the 4,153 tons landfilled, assuming consistent ratios with Model 1, 86% (3,579 tons) would be landfilled in Vermont, 5% (227 tons) would be landfilled in New Hampshire, and 9% (402 tons) would be landfilled in New York. The amount landfilled in Massachusetts is negligible.

[89] All incinerated tons would be handled out of state in either New York or Massachusetts.

[90] Based on 2023 data provided by Vermont container processor

[91] Based on 2022 data directly from DEC and from the *2024 Vermont Materials Management Plan.* Vermont Agency of Natural Resources. (2024, November). https://dec.vermont.gov/sites/dec/files/documents/2024%20Vermont%20Materials%20Management%20Plan.pdf

[92] Based on 2023 Waste Composition Study

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MATERIAL DESTINATIONS

Table 31 shows the breakdown of containers by material type calculated using units and tons. Given the inclusion of non-carbonated water and other beverages, the most significant difference as compared to Model 1 (Table 16) is the increase in PET. It is worth noting that due to the density of the material, the impact of increased PET collection is a lot more significant when rates are calculated using units as compared to when rates are calculated using tons.

Table 31: Model 3 percent of containers redeemed by the expanded Bottle Bill System by material type

	Units	Units (%)	Tons	Tons (%)
Aluminum Cans	172,753,689	49%	2,691	15%
Glass Bottles	50,105,620	14%	11,722	66%
HDPE Bottles	6,358,675	2%	493	3%
PET Bottles	121,793,424	35%	2,875	16%
Total	351,011,408	100%	17,781	100%

Correspondingly, Table 32 shows the breakdown of the annual volume of containers recovered through the Recycling System by material type under expansion. To provide for congruence through tables in the report, the same units/ ton material conversion factor in Appendix C Table 43 and

Table 44 was applied unless otherwise stated.

Table 32: Model 3 Percent of containers recovered from the Recycling System by material type

	Units	Units (%)	Tons	Tons (%)
Aluminum Cans	9,489,970	19%	148	3%
Glass Bottles	20,004,391	40%	4,680	87%
HDPE Bottles	1,174,238	2%	91	2%
PET Bottles	18,809,187	38%	444	8%
Total	49,477,787	100%	5,363	100%

As summarized in Model 1 material destinations for the Bottle Bill System can differ from the Recycling System. Model 3 increases the proportion of containers redeemed through the Bottle Bill System suggesting more containers will be sent onto higher value end markets for recycling.

LITTER

A study in New York based on data from 2008 to 2015 suggested that expansion in their Bottle Bill to include plastic water bottles resulted in a reduction of plastic bottles in litter by about 40%.[93] Assuming Vermont could respond similarly to this Northeastern state, a 40% reduction was applied to modeled litter for all material types, proportionate to the percentage of expansion containers over all container waste. This resulted in a reduction in 89 tons of litter (in weight, 2% Aluminum, 11% PET, 1% HDPE and 85% glass). Thus, litter for Model 3 decreased 22% from Model 1, a decrease from 411 tons in Model 1 to 322 tons in Model 3.

[93] Millette, S. (2025, June). Littered with evidence: Proof that deposit return systems work. Reloop. https://www.reloopplatform.org/resources/littered-with-evidence-proof-that-deposit-return-systems-work/

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DIVERSION RATE

The diversion rate for all beverage containers calculated for Model 3 may be referenced in Table 33 below:

Table 33: Model 3 Diversion rate for aluminum, glass, PET, and HDPE beverage containers

	All beverage containers (tons)	Redeemed through BB system (tons)	BB System Diversion rate (%)	Recycling system (tons)	Recycling System Diversion rate (%)	Overall Diversion rate[94] (%)
Aluminum Cans	4,200	2,691	64%	148	4%	68%
Glass Bottles	17,931	11,722	65%	4,680	26%	91%
HDPE Bottles	734	493	64%	91	12%	80%
PET Bottles	4,490	2,875	67%	444	10%	74%
Total	**27,354**	**17,781**	**65%**	**5,363**	**20%**	**85%**

As compared to Model 1, where 31% (8,451 tons / 27,354 tons) of all containers are diverted through the BBS and 41% (11,243 tons / 27,354 tons) are diverted through the RS, Model 3 has BBS diversion of 65% (17,781 tons / 27,354 tons) of all containers and a lower RS diversion rate of 20% (5,363 tons / 27,354 tons). The lower recovery through the RS is a result of some containers originally recovered through the RS being redeemed through the BBS, given the increase in container coverage. Overall, diversion rate increases from 72% to 85% as some containers that were originally disposed as waste would be redeemed through the BBS.

[94] Overall diversion = BB System diversion + Recycling System diversion

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Comparison and Conclusions

KEY TAKEAWAYS

Model 1

Model 1: Base Case analysis provides an assessment of Vermont's current beverage container management system, evaluating financial, operational, and environmental aspects. The results highlight the high reliance on manual redemption systems, which incur significant labor costs and operational inefficiencies due to brand sorting. Furthermore, automation through RVMs remains underutilized, capturing only a small fraction of returns. Feedback from interviews suggest two main reasons for this: First, a dissatisfaction with the consumer experience of using single-feed RVMs and second, the need to improve the availability of the machines through more robust maintenance regimes. It is possible that aside from choosing to redeem at a manual redemption center, consumers may also choose to recycle the containers through the Recycling System or dispose of their containers instead.

ANR also reports many retailers are not complying with their minimum obligations to redeem what they sell and have not obtained an exemption from the Secretary of the Agency. While legislated to redeem what they sell, compliance with that provision of the law is not highly enforced. The lack of market-based compliance can be explained by the cost analysis, where Model 1 shows the handling fee cannot sustain the cost of redemption operations. This means retailers have no financial incentive to comply. For those that comply, interviewees report that sorting by brand tends to exceed 50 sorts for non-comingling brands, exacerbating the financial strain on redemption sites. It is therefore unsurprising that trend of redemption centers closing, not providing for universal redemption or decertifying their redemption centers has been observed. This negatively impacts consumer convenience given retailers that redeem only what they sell offer limited convenience for consumers.

Greenhouse gas emissions calculations indicate that increasing the volume of recycled containers could reduce emissions more. Notably, though the overall proportion of beverage containers being recycled through the recycling system is higher than through the Bottle Bill System, the Bottle Bill System results in greater reductions in greenhouse gas emissions. This is due to the higher proportion of aluminum material processed through the Bottle Bill System. Greenhouse gas emission reductions through recycling are a meaningful benefit of the Bottle Bill System. Still, separate trip emissions and landfill contributions from non-redeemed containers show opportunities for further optimization. Separate trip costs amount to $2.57 million annually for those using redemption locations and $109,000 annually for those utilizing drop off recycling services. Though these costs vary significantly, it is important to note that less than 0.5% of the total tonnage of recyclables and refuse received through drop-off locations are beverage containers and thus only a very small portion of the separate trip is attributed to them.

Model 2

Model 2: PRO Managed Bottle Bill analysis provided an in-depth evaluation of the potential efficiencies, cost implications, and operational impacts of transitioning to a producer responsibility organization framework for Vermont's Bottle Bill System. The convenience standards stipulated in Bill H.158 are also applied resulting in an increase in redemption locations from 123 sites to 170 sites. The model explores two alternative redemption system designs: Model 2a: Bag Drop and Model 2b: RVM networks. While

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both models seek to modernize the existing system by introducing automation, optimizing financial flows, and standardizing redemption processes, they also introduce new cost structures and operational considerations.

A central component of the PRO-managed system is the shift from a fixed handling fee structure to a negotiated payment framework. This change allows for greater financial flexibility, enabling redemption centers to receive compensation based on performance and volume rather than a standardized rate. Eliminating brand sorting further simplifies redemption site operations, reducing consumer wait times and labor-intensive sorting costs.

The financial implications of the PRO model with the elimination of brand sorting and adoption of technology reveal a potential for increased cost efficiency. Under Model 2a: Bag Drop higher processing costs associated with building a new, dedicated facility to debag and sort collected containers results in a total system cost higher than that of Model 2b, which benefits from compacted materials transport and lower per-container processing costs. Should Model 2a adopt a less conservative assumption such as leveraging an existing facility or sharing the facility with a neighboring state, the total system cost could be comparable to Model 2b. It is worth noting that Model 2 (a and b) has higher convenience standards (more redemption centers) than Model 1. If there were comparable convenience in Model 1 to those levels assumed in Model 2, the total annual cost of Model 1 would increase by an estimated 20%, surpassing the total cost of both Model 2a and Model 2b.

The redistribution of financial responsibility under the PRO model is another notable point. The PRO functions as an intermediary, managing fund distribution and ensuring redemption site financial sustainability. In this way, transitioning to a PRO-manage system could offer financial sustainability while modernizing redemption operations. However, it should be recognized that distributors/manufacturers will need to assume a larger share of the system funding, particularly in covering collection, processing, and handling costs.

Environmentally, Model 2 is projected to have a similar impact as Model 1 since the material flows, diversion rates, and redemption rates remain unchanged. Greenhouse gas emissions associated with beverage container management remain the same, with potential emissions reductions contingent upon route optimization in transportation logistics (e.g., crushing containers reduces transportation emissions). Due to the increased number of redemption locations, separate trip costs are also reduced. GIS mapping estimates that total mileage for separate trips drops from 3.84 million miles to 3.36 million miles, a 14% reduction from Model 1. This results in a corresponding decrease in consumer transportation costs and emissions (approximately 300 metric tons of CO_2 equivalent reduction compared to Model 1).

While Model 2a and Model 2b describe possible cost-competitive alternatives to the existing system, the ultimate choice is balancing front-end redemption site costs with back-end processing expenditures. Bag drop is the more cost-effective option for upfront site costs and provides a better consumer experience; however, it has higher processing costs than the RVM option since containers still need sorting at an aggregation facility. RVM options often require more time by the consumer to feed in containers into a machine manually but have the advantage of recording brand data that are useful in

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allocating costs and offer the benefit of crushing containers to improve transportation efficiency potentially reducing costs and greenhouse gas emissions from this system.

Overall, the findings suggest that transitioning to a PRO-managed system could maintain Vermont's high redemption rates while reducing costs overall, and more equitably distributing system costs across stakeholders.

Model 3

Model 3: PRO Managed, Expanded Bottle Bill evaluates the financial, operational, and environmental implications of broadening Vermont's Bottle Bill System to include additional beverage types. It maintains all aspects of Model 2 and adopts a mix of redemption site operations including manual, RVMs and Bag Drop. The findings indicate that while the expanded system results in higher overall costs, it achieves greater environmental and GHG benefits by increasing the diversion rate, and within the BB system, the per-container cost efficiency improves due to increased throughput and reliance on automation and centralized processing.

A key structural change in Model 3 is the expansion of covered beverage containers to incorporate water, wine, juice, tea, coffee drinks, sports drinks, and other non-dairy beverages. This shift increases the number of containers redeemed from 188 million in Model 1 to 351 million in Model 3. Model 3 also assumes that the 6 largest existing redemption centers adopt bulk RVMs (on top of the existing 2), while 16 new redemption sites integrate RVM technology, allowing for the immediate return of deposits to consumers. The remaining new redemption sites adopt bag drop systems to minimize operational costs.

The financial analysis in Model 3 shows that the expanded system achieves cost efficiencies through increased economies of scale and strategic deployment of technology but is overall more expensive in total than Model 1 or 2 as more containers and redemption sites are a part of this system. Per container cost efficiency is primarily driven by higher container throughput, reduced manual sorting, and transportation efficiencies due to increased compaction rates. These cost savings come at the expense of distributors/manufacturers whose contributions in Model 3 are three times that of Model 1.

Under the framework established in H.158, unclaimed deposits are allocated according to a structured schedule defined in the bill, with an increasing portion directed to the Clean Water Fund over time. In the steady-state model after year 5 of the bill's proposed phased in, 50% of unclaimed deposits (or $4 million, whichever is greater) are allocated to the Clean Water Fund, while the remainder is directed to the Solid Waste Management Assistance Account. The total unclaimed deposit amount under Model 3 is $7.54 million—significantly higher than in Model 1 or Model 2 due to the increased volume of covered containers. Directing the unclaimed deposits to state accounts instead of allowing those resources to stay in the BB system presents a missed opportunity to reinvest in the system in a way that could secure continued system improvements and financial benefits for distributors/manufacturers and, ultimately, consumers. State oversight of these funds would help discourage a manufacturer/distributor PRO from reducing consumer redemption convenience in order to generate greater unclaimed deposit funding. In the ideal system, every deposit would be redeemed and returned to the consumer resulting in no unclaimed deposits.

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Model 3 results in a substantial increase in the diversion of materials from landfills results in notably greater reductions in greenhouse gas emissions. The emissions associated with separate trip costs remains the same as Model 2.

Model 3 expansion is also expected to impact litter by as much as 22%, a decrease from 411 tons in Model 1 to 322 tons in Model 3. However, it should be noted that stakeholder interviews suggest the relationship between deposit legislation and litter rates are not strictly causal. It is the authors' opinion that more prominent societal and behavioral factors drive littering behaviors rather than deposit incentives alone.

Overall Financial and Environmental Impact Comparison

In Model 1, the cost analysis revealed that the Bottle Bill System operates less cost efficiently than the Recycling System, at a higher cost per container rate. With expansion, Model 3's cost analysis shows the opposite where the Bottle Bill System per container rate is lower than that of the Recycling System, primarily due to the increased volume of containers in the expanded Bottle Bill System that costs are spread across. To understand the overall impact, the weighted average per container rate was calculated for comparison in Table 34. Model 3 has the lowest overall per container rate and is therefore the most efficient financially overall, when Models are compared solely on a per container basis.

Table 34: Weighted per container rate calculations for the overall system (BBS + RS) and environmental impact

Excludes latent costs of separate trips taken by consumers to redeem	MODEL 1	MODEL 2A, Bag Drop	MODEL 2B, RVM	MODEL 3, EBB:
BB per container rate (exc)	0.050	$0.056	$0.049	$0.040
RS per container rate (exc)	$0.033	$0.033		$0.045
Overall cost per container (BBS + RS)[95]	**$0.043**	**$0.047**	**$0.043**	**$0.040**

Key: (exc) = excluding separate trip cost
(inc) = including separate trip cost

Regarding environmental impacts, it is worth noting that respective material destinations suggest higher value end uses for the Bottle Bill System, and consequently the per container cost for material collected through the Bottle Bill System is higher than the Recycling System in Model 1 and Model 2. Even though, in the existing system, the diversion rate via the Recycling System is proportionately higher than the Bottle Bill System, the majority (9,360 tons or 83%) of this diverted material is glass; glass may become "processed glass aggregate" and used in place of sand in construction projects or sent to out of state glass recycling processors. The overall environmental impact is summarized in

[95] Weighted average is calculated using the number of containers processed through the BBS and RS. For Model 1 and 2 the BBS processes 188,324,041 containers while the RS processes 127,340,107 containers (total 315,664,148). The weighted average of the overall cost per container for Model 1 is calculated as BBS 0.05*188,324,041/315,664,148 + 0.033*127,340,107 /315,664,148 = $0.0431. For Model 3, the BBS processes 351,011,408 containers while the RS processes 49,477,787 containers (total 400,489,195). The weighted average of the overall cost per container is calculated as BBS 0.04*351,011,408 /400,489,195 + 0.045*49,477,787 / 400,489,195 = $0.0405.

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Table 35. Model 3 also has the most favorable environmental impact in terms of greatest $MTCO_2$-eq avoided.

Table 35: Comparison of environmental benefits

		MODEL 1	MODEL 2	MODEL 3
$MTCO_2$-eq Avoided	**BBS**	(21,134)	(21,134)	(31,108)
	RS	(9,244)	(9,244)	(3,158)
$MTCO_2$-eq associated with Separate Consumer Trips	**BBS**	2,344	2,050	2,050
	RS	99	99	47
Net Total $MTCO_2$-eq (exc)		(30,074)	(30,074)	(34,108)
Net Total $MTCO_2$-eq (inc)		**(27,631)**	**(27,924)**	**(32,011)**

Key: (exc) = excluding separate trip cost
(inc) = including separate trip cost

CONCLUSION

By modeling Vermont's current system of managing beverage containers, along with other scenarios of interest to the State, this report provides quantitative comparisons that may be useful for weighing the impacts of potential policy changes. Modernizing the Bottle Bill System by incorporating a PRO and expanding redemption technologies have notable economic benefits. The greatest environmental benefits are realized when the bottle bill coverage is expanded to include a broader suite of beverages. The reported analyses and metrics on cost, material flows, and environmental impacts are intended to support evidence-based policy decisions.

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Appendix A

REDEMPTION SITE INTERVIEW QUESTIONS

1. Is the 3.5 cents commingling/4 cent non-commingling handling fee sufficient to cover the costs of redemption? If not, what would be sufficient to cover all your sorting, staffing costs, and storage costs associated with collecting and redeeming beverage containers?
2. Could you share your approximate profit margin?
3. What percentage of your costs are associated with brand sorting? How much time would you save if you could avoid brand sorting?
4. What is your daily/weekly/monthly/yearly container throughput?
5. How common do you think out-of-state redemption is at your location (e.g. fraud)?
6. If there were a bottle bill expansion with brand sorting eliminated, would your facility be able to handle an increased volume?
    a. If yes, how much additional capacity could your facility handle?
    b. If not, how much would it cost to update your facility for increased capacity?
7. If you received more containers, how would this impact your revenue, costs, and profit margin and why?
8. Can you describe your operation?
9. What type of sorting do you use (manual, hybrid, or automatic)?
    a. If automatic, what equipment is used?
10. How many full-time and part-time staff work in your facility? How much of their time is spent on tasks related to bottle redemption? What are their typical tasks?
11. What are the typical staff wages?
12. What is the square footage of your facility?
13. If you had to do it all over again and set up a redemption site from scratch, what would you do differently?

In follow up interviews, some interviewees were asked their thoughts on preliminary model outputs to gauge opinions, clarifications were made from the first interview on labor hours and tasks, and the following additional questions were asked:

14. What is the average amount of containers brought in by customers?
15. General sentiments and commentary were encouraged about a potential PRO contract negotiation with redemption centers in lieu of a handling fee under a PRO managed system.

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Appendix B
Bottle Bill Collection Plan: Model 2

This collection plan for Model 2 outlines a new strategic approach for expanding and optimizing redemption locations to increase convenience and accessibility while preserving the interests of existing redemption centers. The following sections describe the methods and criteria used to determine new site placements, balance stakeholder concerns, and employ effective technologies in alignment with the needs of the collection network. Model 2 assumptions and guiding principles may be referenced in the main report.

The Model 2 collection plan integrates the need for enhanced consumer convenience with the operational realities of Vermont's existing redemption infrastructure. By adopting a Producer Responsibility Organization (PRO) framework, the plan leverages current facilities and incorporates modernized collection practices to ensure equitable access to redemption services across the state.

Existing redemption sites serve as the foundation of the new system, with modernization efforts aimed at supporting redemption sites in meeting capacity and efficiency. New redemption locations are introduced where geographic gaps or regulatory requirements necessitate additional coverage. These adjustments are designed to maintain balance within the system, encouraging consumer participation while fostering operations stability for current facilities.

Increasing convenience through additional redemption locations has the potential for uneven distribution of container volumes in counties where additional "competition" for container volumes is introduced. The use of container take-back technologies, such as reverse vending machines (RVMs) or bag-drop systems, is intended to mitigate these impacts. Sites that invest in modernization are expected to adapt more successfully to the evolving system, maintaining or growing their share of total volume processes. Sites choosing not to modernize may experience challenges but are not precluded from continued participation. The precise impact, if any, on redemption sites' volume due to modernization remains uncertain but is expected to ease the barriers to redemption participation for both consumers and retailers. Data from other US Bottle Bill programs does not indicate that an increase in convenience will increase redemption rates.[96]

A core consideration in the plan is balancing enhancing convenience for consumers and addressing concerns from current redemption locations regarding increased competition. Model 2 criteria attempted to address these concerns equitably under realistic PRO governance; Signalfire evaluated these criteria through cost modeling, stakeholder interviews, and PRO design experience.

[96] In Oregon, an increase to $.10 was required as a part of expansion law only if the redemption rate did NOT increase after expansion and management by OBRC. That experience (Oregon now uses $.10) would indicate that increase in deposit is required to increase redemption rate.

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CONVENIENCE STANDARDS

Model 2's collection plan outlines the following convenience criteria as aligned with that of Model 3, which is based on that discussed as part of H.158:

Convenience Criterion 1: H.158 requires the PRO to provide a minimum of 3 redemption locations per county offering an immediate return of the deposit. Based on the criterion alone, there are 2 counties, Essex and Grand Isle, that need additional redemption sites. For Essex County, two new redemption centers would need to be constructed to meet the minimum requirement. The location of these two new redemption centers would be within a reasonable distance of the most densely populated areas of the county, not yet served by a redemption center. This means these new locations would be close to the Essex borders with Caledonia and Orleans, where other accessible redemption centers exist for these populations. As such, an exemption is advised for this county. For Grand Isle, contracts with 2 retailers with property space equal to or greater than 5,000 sq. ft are proposed. These arrangements use retail-based and standalone facilities to create a comprehensive network while minimizing operational disruptions.

Modernizing existing sites includes the elimination of brand sorting, allowing redemption sites to process all container types more efficiently. This simplification aligns with the plan's emphasis on universal redemption, reducing customer wait times and operational bottlenecks for retail staff. This also encourages continued participation from existing redemption sites, which may find improved operational efficiencies through technologies like bag drop and RVM attractive and reduces the need for a PRO to site new redemption locations to meet the minimum requirements.

Convenience Criterion 2: H.158 requires the PRO to ensure that municipalities with populations of 7,000 or more residents have at least one redemption site that offers immediate return of deposit. All municipalities with 7,000 or more residents meet this criterion except for Hartford in Windsor County as seen in Table 36.

The grocery store Orange Food Workshop does not offer redemption services in Hartford. And, since this grocer is not 5,000 sq. ft or more, the PRO cannot require their participation (as indicated in criterion 3). However, the PRO can attempt to bring this retailer into the redemption network to take advantage of existing infrastructure. Otherwise, the PRO will have to construct a new redemption center in Hartford.

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Table 36: Population count and number of existing redemption sites by county

County	Municipality	Population (2020)	Number of Existing Redemption Sites
Addison	Middlebury	9152	2
Bennington	Bennington	15333	5
Caledonia	St. Johnsbury	7364	2
Chittenden	Burlington	44743	3
Chittenden	Colchester	17524	3
Chittenden	Essex	22094	1
Chittenden	Milton	10723	3
Chittenden	Shelburne	7717	1
Chittenden	South Burlington	20292	1
Chittenden	Williston	10103	1
Chittenden	Winooski	7997	1
Rutland	Rutland	15807	4
Washington	Barre (city)	8491	1
Washington	Barre (town)	7923	1
Washington	Montpelier	8074	2
Windham	Brattleboro	12184	3
Windsor	Hartford	10686	Need 1 in Hartford
Windsor	Springfield	9062	2

Convenience Criterion 3: H.158 stipulates that only retailers of 5,000 sq. ft or more must redeem at least the containers of the kinds, brands, and sizes they sell. However, Model 2 assumes universal redemption for these retailers, making them all redemption centers. In Vermont, 147 retailers operate in spaces of 5,000 sq. ft. or more. Signalfire assumes all of these sites will need to be redemption centers under Model 2.

Collectively, meeting the 3 criteria results in 170 total redemption centers in Model 2 as summarized by county in Table 37. Of the existing top 33 high-volume redemption centers, 14 also meet the 5,000 sq. ft. threshold and are expected to continue operating under the current model. This leaves 133 additional large-format retailers (147 total minus 14 existing) that would need to initiate redemption services. In addition, 4 new sites identified under criteria 1 and 2 must be included.

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Table 37: Top 33 sites processing 80% of existing containers redeemed, 133 retailers with operations equal to or larger than 5,000sqft and 4 additional sites required to meet all convenience criteria, broken down by county.

County	Top, High-Volume Redemption Centers	Retailers >= 5,000sqft Required to Start Redemption	Additional Sites Required to Meet Convenience Criteria	Total
Chittenden	6	27	0	33
Franklin	3	10	0	13
Rutland	4	14	0	18
Orleans	2	9	0	11
Washington	3	15	0	18
Bennington	4	11	0	15
Windsor	2	15	1	17
Caledonia	2	8	0	10
Addison	3	5	0	8
Windham	1	7	0	8
Lamoille	1	4	0	5
Orange	2	6	0	8
Essex	0	0	3	3
Grand Isle	0	3	0	3
	33	**133**	**4**	**170**

Only 51 (35%) of the 147 retailers of 5,000+ sq. ft or more currently offer beverage container redemption services; 96 (65%) do not offer any redemption service. Signalfire assumes that the 51 existing redemption sites will continue operating under the PRO contract. To facilitate the transition, the PRO should engage in contractual agreements that align handling fees with operational realities, allowing redemption center profit margins that ensure that the underlying redemption businesses are healthy. The PRO must work with the remaining 96 retailers of 5,000 sq. ft or more to implement redemption services. Modernization of the system, technology, customer and staff experience, and negotiations on compensation should be sufficiently designed to encourage participation from these larger retailers.

Initially, the PRO may contract according to a tiered system for costs and provisions for modernization that provide a 20% profit margin for retailers and other redeemers that offer redemption services. These measures aim to make redemption sites' participation economically viable while enhancing consumers' convenience. By leveraging these incentives, the PRO can improve the redemption network. Retailers who decline to participate face no penalty but may naturally see reduced competitiveness in serving customers who value convenience and a fast return experience from improved efficiency. Several redemption centers mentioned that they can provide a better customer service experience and run a more profitable operation by using manual sortation, and would not want to

> "Even some people that have 30 to 40 containers will drive past RVMs at grocery stores to get (to their location) because they don't like them (RVMs)."
>
> - VT Redemption Site

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switch to an RVM for fear that it would drive current redemption down. One location noted that because of this consumer preference for manual sorting, they are certain "even some people that have 30 to 40 containers will drive past RVMs at grocery stores to get (to their location) because they don't like them (RVMs)." Another indicated that prior to their location switching to RVMs, they would receive "full truck loads (of containers) coming from large rental units" however, they don't receive those anymore "because no one wants to feed them (containers) into a machine one at a time".

GEOGRAPHIC SITING

With convenience standards in mind, both those proposed by the State and those expected by customers and retail staff, the plan considers the optimal mix of redemption center locations. Under Model 2, there is a recommended distribution of 170 redemption locations across Vermont to meet the established convenience criteria. This distribution reflects the state's population density and container deposit volumes, prioritizing coverage in both urban and rural areas. As seen in Table 37, Vermont's most populous counties—Chittenden, Washington, and Rutland—will host the highest number of redemption sites, with 33, 18, and 18 locations, respectively. Geographical sitings are also illustrated in Figure 7.

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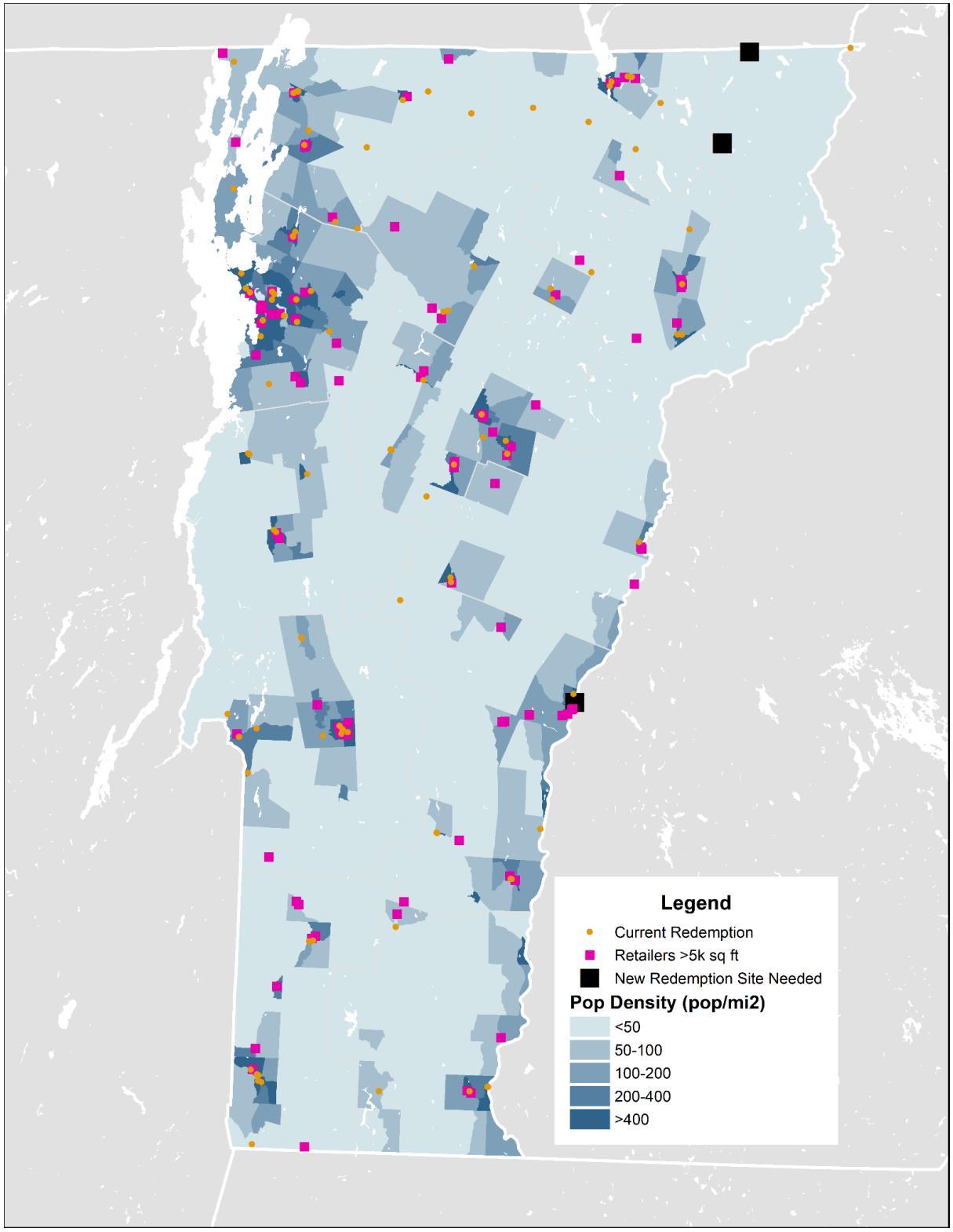
Figure 7: Total 170 sites - top 33 sites processing 80% of existing containers redeemed, 133 retailers with operations equal to or larger than 5,000sqft and 4 additional sites required to meet convenience criteria



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While Signalfire believes this to be a realistic proposition, active retailers maintaining operations under a contractual agreement with the PRO that aligns handling fees with operational realities, we acknowledge that limited data on retailer preference to stay open or to shut down redemption services limit Signalfire's ability to predict closures and the associated costs. Under the agreement, the PRO and redemption sites will negotiate fees and pathways toward modernization so that redemption sites can offer universal redemption and still cover operation costs.

> "It feels like a lot of work for redemption centers to prove their worth"
>
> - VT Redemption Site

Through redemption site interviews Signalfire did hear of concern and uncertainty when asked about owners' and operators' opinions on a negotiation with the PRO. Acknowledging that not all of the details of a negotiation plan are worked out, one redemption site said that "it feels like a lot of work for redemption centers to prove their worth" and that the additional auditing that would be necessary would be cumbersome. Another location said it seemed like "an odd way of doing things", as a center that's doing things more efficiently might end up getting paid less than a location that is just inefficient at what they do.

COLLECTION METHODS, TECHNOLOGICAL CONSIDERATIONS, AND COST

Moving to universal redemption and eliminating brand sorting requirements will streamline redemption processes by reducing operational complexity, shortening processing times, and reducing labor costs. This is applied to all 170 redemption sites. Liquor containers will continue to be managed by DLL and remain unchanged from Model 1.

Modernization and cost reduction will be encouraged. Where advanced technology helps achieve these goals, the PRO should support an approach to help centers adopt advanced technology. Interviews with Bree Dietly and redemption center operators suggest that the large, high-volume redemption centers have succeeded in developing proficient and efficient manual redemption operations often preferred by "professional" redeemers over RVM technologies. These top 33 redemption centers, which manage about 80% of Vermont's redeemed container volume, will continue without change under Model 2's PRO system. Presently, 2 of the 33 redemption centers are high volume (more than 3 million annual throughput) RVM sites. Bulk RVM technology, as opposed to single-feed RVM technology, is assumed for these two sites. The remaining 137 redemption sites will have the opportunity for technology upgrades as part of negotiated costs with the PRO. Signalfire evaluated the cost of providing these 137 redemption sites with various technology solutions to reduce operational frustrations. Bag drop and RVM (single feed for throughput less than 3 million annual containers) stand out as the recommended "PRO-preferred solution"; RRS considered the financial impact should each site be provided the same technology option for standardization across the system in Model 2a: Bag Drop and Model 2b: RVM as summarized in Table 38.

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Table 38: Redemption center technology applied for Model 2

County	Top, High-Volume Manual Redemption Centers	Top, High-Volume or "Bulk" RVM Redemption Centers	Redemption Center with either Bag Drop or RVM Technology	Total
Chittenden	6	0	27	33
Franklin	3	0	10	13
Rutland	3	1	14	18
Orleans	2	0	9	11
Washington	3	0	15	18
Bennington	4	0	11	15
Windsor	2	0	15	17
Caledonia	2	0	8	10
Addison	3	0	5	8
Windham	1	0	7	8
Lamoille	0	1	4	5
Orange	2	0	6	8
Essex	0	0	3	3
Grand Isle	0	0	3	3
	31	**2**	**137**	**170**

The PRO-preferred solutions consider the per-container costs and data inputs, including the physical size of each redemption site (square footage), container throughput, population, and site suitability.

In determining a per-container cost for a site's labor, building cost, and other operating costs, Signalfire considered the type of technology used at the redemption site, the sorting method, and the process for aggregating sorted materials. Each site's monthly container throughput provides a basis for calculating operational efficiency, while labor costs are included to cover both standard operations and any additional labor requirements unique to the site's technology setup.

Following stakeholder sentiments and the considerations mentioned above, Signalfire suggests that smaller retailers transition to either bag drop or RVM technologies with leasing terms arranged between the PRO and technology provider. Both bag drop and RVM provide opportunities for streamlining operations and improving customer experience, yet they result in different cost burden allocations.

Bag Drop vs. Single-Feed RVMs: Bag drop offers significant customer convenience and experience advantages, such as reducing drop-off wait times to a few minutes and reducing the need to feed in containers one by one. Offering a more seamless bottle deposit, this technology has the potential to improve customer experience for those who view the current system as inconvenient and laborious. However, bag drop does not offer immediate cash returns, which may discourage some customers who rely on the income from this system. The uncrushed nature of containers also results in higher transportation costs due to inefficient use of space. Conversely, despite the automation, RVMs are notorious for breaking down, long waiting times for high-traffic areas, and troublesome customer experiences. Their need for ongoing maintenance burdens staff-strapped retailers and can strain the

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budgets of smaller redemption sites. However, RVMs provide immediate deposit refunds, brand accounting assistance, and compact containers for reduced storage and transportation costs.

Interviews with stakeholders provided insight into the operational efficiencies and challenges experienced with providing redemption services and the use of various technologies, including the fact that eliminating brand sorting does not necessarily mean increasing redemption sites' capacity to manage higher volumes. Several redemption locations, already constrained by limited space, indicated that their facilities could not handle an increased volume of containers from an expansion of covered containers, even with the elimination of brand sorting. These insights inform the PRO's consideration for system arrangements.

Retail redemption sites, often smaller or larger retailers with staff that float between retail and redemption tasks, have distinct labor needs, different from redemption centers with highly trained redemption staff. Small sites like convenience stores typically handle lower volumes of redeemed containers and rely on manual processes, often performed by shared staff labor. For some small independent retailers, redemption is part of their core values and customer service strategy. For many small chains and chain convenience stores with a centralized corporate structure, redemption services are often considered based on regulation, operational costs, and (in)efficiencies. In contrast, larger redemption centers deal with significantly larger volumes, frequently catering to "professional redeemers" who process containers in bulk for profit. These sites require dedicated labor or advanced systems, such as automated counting and sorting machines, to manage the influx efficiently. Labor at larger redemption centers is often specialized to ensure compliance with regulations, proper sorting, and fast customer services, as delays or inefficiencies can frustrate both professional redeemers and casual customers; in some instances, professional redeemers express greater satisfaction with the manual sorting by these specialized employees over the experiences of an RVM.

Shifting smaller retailer redemption sites to standardized technology like bag drop or upgraded RVMs offers advantages to reduce the operation strain experienced by these sites. For small redemption sites, bag drop systems reduce labor demands and centralize sorting and counting at a centralized facility rather than on-site. This approach is particularly well-suited for "dump culture," where customers drop off large volumes at once rather than more frequent, lower-volume trips. Bag drop systems also appeal to casual customers who value convenience and are less concerned about immediate payouts. If bag drop is not economically viable, upgraded RVMs can serve as a similar improvement to the system.

Equally, maintaining manual operations at larger redemption sites accommodates the needs of high-volume "professional" redeemers who prioritize speed, efficiency, and immediate payout. Manual systems at these locations provide high-speed sorting staff and direct customer payouts based on container counts, which often bypass the long lines typically seen at RVMs due to container-by-container depositing or equipment malfunctions. Some large redemption centers, like Morrisville Beverage, even implement dual lines for different customer types with the option for manual or RVM returns during busy times.

The chosen solution and, respectively, a redemption site's choice in modernization will influence the consumer experience. Redemption sites offering better consumer experiences are expected to outperform competing or redundant redemption sites.

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REDEMPTION BEHAVIOR AND IMPACT ON REDEMPTION RATES

The parameters and technologies introduced under Model 2, such as universal redemption, elimination of brand sorting, and the adoption of advanced technologies like bag drop and upgraded RVMs, are intended to improve operational efficiency and consumer convenience. Despite this, research and data from other bottle bill programs do not suggest that convenience improvements alone drive substantial changes in consumer redemption behavior. Most consumers who already participate in the redemption system are motivated by the deposit value rather than system efficiencies or ease of use. For consumers who do not currently redeem their containers, barriers such as lack of interest, low perceived value of the deposit, and established disposal habits often outweigh the benefits of technological improvements or increased convenience.

While operational enhancements may improve consumers' experience, reduce wait times, and streamline processes at redemption centers, these factors are not expected to meaningfully alter redemption rates or overall redeemed container volumes. As such, the impact of Model 2 will primarily be felt in system efficiencies and cost optimization rather than a measurable increase in redeemed containers.

Bottle Bill Collection Plan: Model 3

This collection plan for Model 3 outlines the approach for corresponding to an Expanded Bottle Bill as outlined in Bill H.158 of 2023. Model 3 assumptions and guiding principles may be referenced in the main report. They are, essentially, the same as Model 2 but with a higher throughput of containers being processed by the system because of increased container coverage.

Like Model 2, under Model 3's specifications, all brands are required to join the PRO. Accordingly, the system under the PRO will proceed as a de facto mandatory commingling group. This removes the requirement for redemption sites to brand sort, which RRS considers to essentially remove the $0.05 handling fee for non-commingled containers and pays redemption centers the commingling fee of $0.035 per container handled. The PRO, instead, will manage and bear the cost for brand accounting and auditing redeemed containers against brand sales data. Under Model 3, redemption sites may still modernize or adopt new technologies based on market conditions.

CONVENIENCE STANDARDS

The same convenience standards applied in Model 2 are applied in Model 3.

GEOGRAPHIC SITING

The same geographic sitings applied in Model 2 are applied in Model 3.

COLLECTION METHODS, TECHNOLOGICAL CONSIDERATIONS, AND COST

Like Model 2, the network in Model 3 includes 33 large, existing high-throughput redemption centers, which currently handle approximately 80% of Vermont's container deposit volume. As described in Table 27, in addition to the 2 existing bulk RVM locations, the top 6 (annual volume >7M) will also adopt bulk RVM technology (i.e., 25 manual sites and 8 bulk RVM sites). Of the remaining 137 redemption sites, 16 adopt RVM technology to fulfill the immediate return of deposit requirement within Windsor, Caledonia, Windham, Lamoille, Orange, Essex, and Grand Isle as well as cities with >7000

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population within Chittenden. For most of these municipalities, the need can be met by integrating new retailers with over 5,000 square feet into the system. These retailers, newly brought into the redemption network, will expand coverage and support convenient consumer access. The remaining 121 redemption sites adopt bag drop given that strategy has the lowest front-end store cost. The breakdown by county is summarized in Table 39.

Table 39: Redemption center technology applied for Model 3

County	Top, High-Volume Manual Redemption Centers	Top, High-Volume or "Bulk" RVM Redemption Centers	Redemption Center Technology mix		Total
			RVM	Bag Drop	
Chittenden	5	1	2	25	33
Franklin	2	1	0	10	13
Rutland	3	1	0	14	18
Orleans	2	0	1	8	11
Washington	2	1	0	15	18
Bennington	4	0	0	11	15
Windsor	1	1	1	14	17
Caledonia	1	1	1	7	10
Addison	3	0	0	5	8
Windham	0	1	2	5	8
Lamoille	0	1	2	2	5
Orange	2	0	1	5	8
Essex	0	0	3	0	3
Grand Isle	0	0	3	0	3
	25	8	16	121	170

Modernizing existing sites includes the elimination of brand sorting, allowing redemption sites to process all container types more efficiently. While this does not mandate universal redemption at every location, it effectively transitions Retailer Redemption sites into universal redemption centers. Retailers are no longer required to sort containers they do not sell, as the PRO will oversee container commingling and compensate retailers for handling increased volumes. This shift reduces labor demands, improves processing speed, and provides consumers with a seamless redemption experience.

The commingling agreement plays a pivotal role in simplifying operations, as it eliminates the need for redemption sites to separate containers by brand. Instead, the PRO will manage the auditing process, ensuring deposit reimbursements and handling fees are equitably distributed among participating brands. This system reduces administrative burdens for redemption sites and guarantees that financial accountability is maintained across the network. Additionally, the PRO will conduct regular audits to verify volumes and ensure compliance, addressing discrepancies in container sales data for brands that lack accurate reporting mechanisms.

The expansion of covered beverages under Model 3 introduces new challenges and opportunities for volume management. By including containers such as water bottles and other nonalcoholic drinks,

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redemption sites may see an increase in throughput, which may, in turn, necessitate adjustments to operational processes, including storage, sorting, and transport logistics.

With increased container volumes and the integration of more advanced technologies, redemption sites also stand to benefit from economies of scale. Higher throughput enables sites to spread fixed costs, such as labor and equipment maintenance, across a larger volume of containers, effectively lowering per-container costs.
Retailers not designated as immediate return-of-deposit sites may find technologies such as bag drop systems attractive solutions. Both bag drop and RVM technologies offer operational efficiencies by automating container intake; RVMs also compact containers, reducing the labor required for manual sorting, and improving space utilization. Bag drop systems, in particular, provide flexibility for consumers and redemption sites alike, while RVMs enhance convenience through automated, immediate deposit returns.

REDEMPTION BEHAVIOR AND IMPACT ON REDEMPTION RATES

Under Model 3, the expansion of covered beverages to include items like water bottles and other non-alcoholic drinks is expected to lead to an increase in Vermont's overall redemption rate. By adding these highly recognized materials to the system, the Model 3 framework incentivizes consumers to redeem more containers during regular redemption activities,

Importantly, this anticipated increase in the redemption rate is not expected to result from a significant shift in consumer behavior but rather from the expansion of the covered container list. Consumers who already participate in the redemption system will now have more types of containers to return, which will naturally raise the total number of redeemed containers. However, the same behavior patterns—such as the frequency of redemption trips and overall participation rates—are assumed to remain consistent. For example, individuals who previously redeemed their soda and beer containers will now bring water bottles and similar items in addition, increasing the system’s throughput without requiring a change in consumer habits. It is expected that the primary driver of improved redemption rates in Model 3 would be the structural change in the program's coverage, rather than a behavioral shift among consumers.

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Additional Maps (Model 1)

Figure 8, Figure 9 and Figure 10 provide visuals of the current active redemption sites in context of retailers with an operational area of at least 5000 square feet, liquor stores as well as Vermont's population density by county.

Figure 8: Current 100 Redemption Sites in Vermont

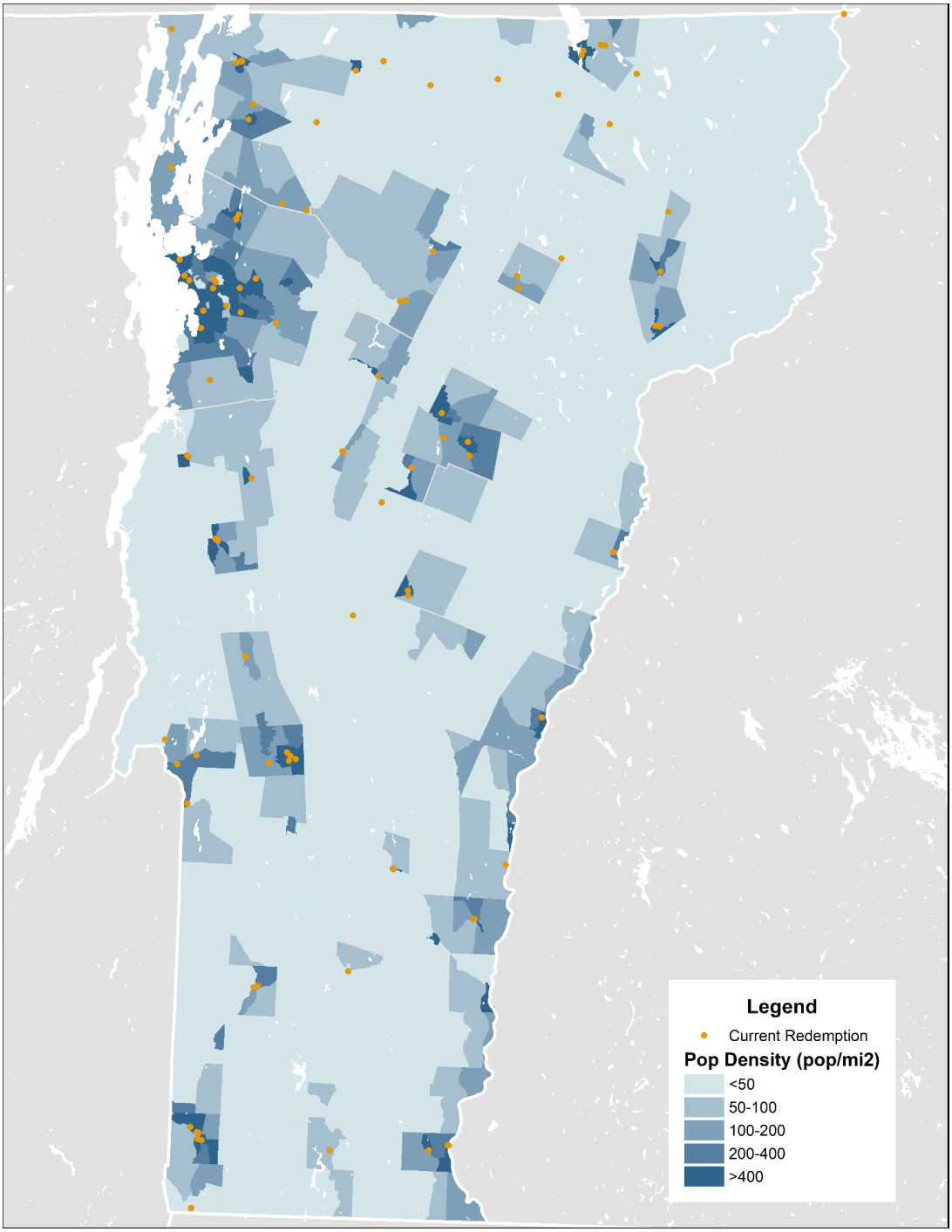

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Figure 9: 100 Current Redemption Sites and 147 Retailers over 5,000 sq ft (including 51 Current Redemption Sites) in Vermont

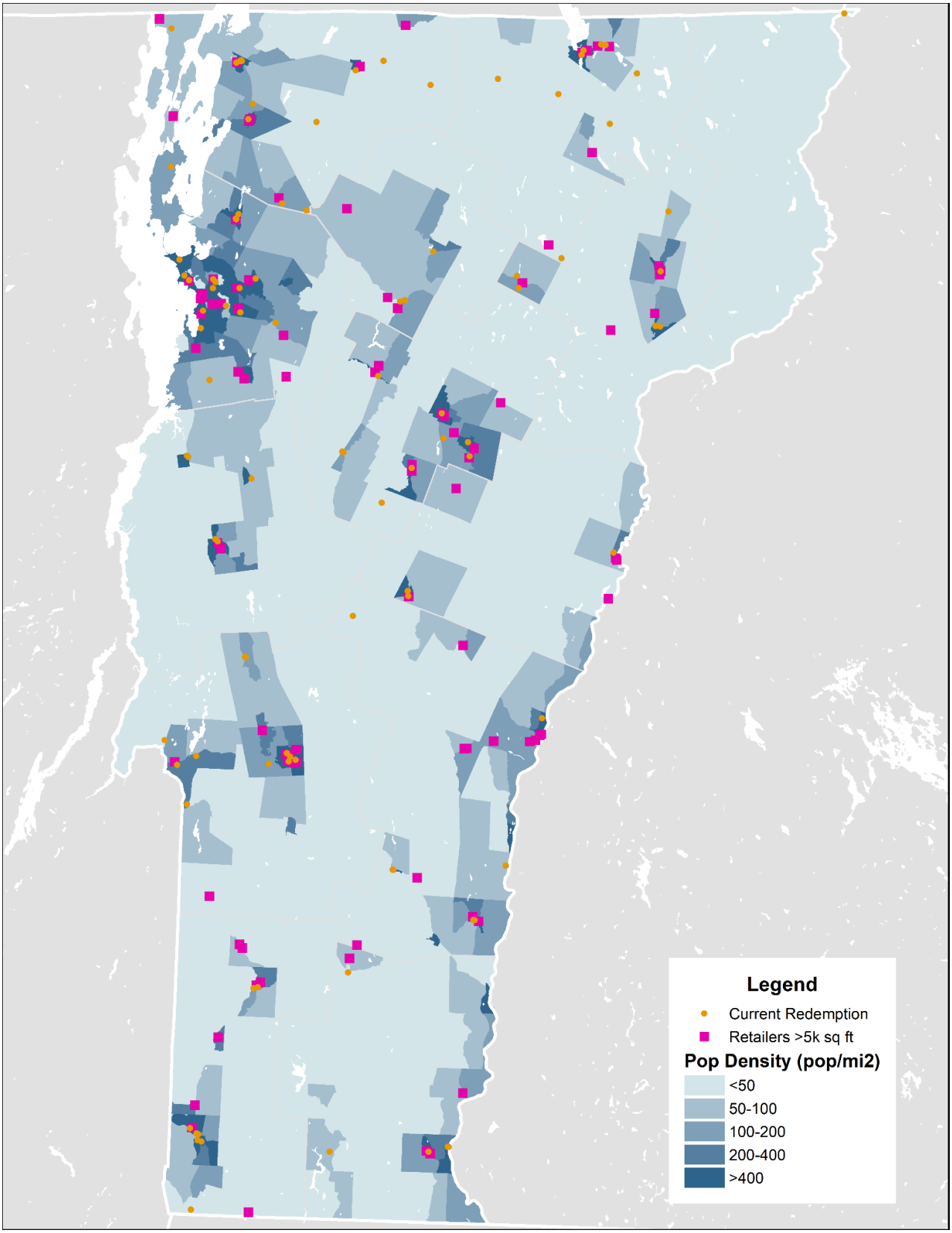

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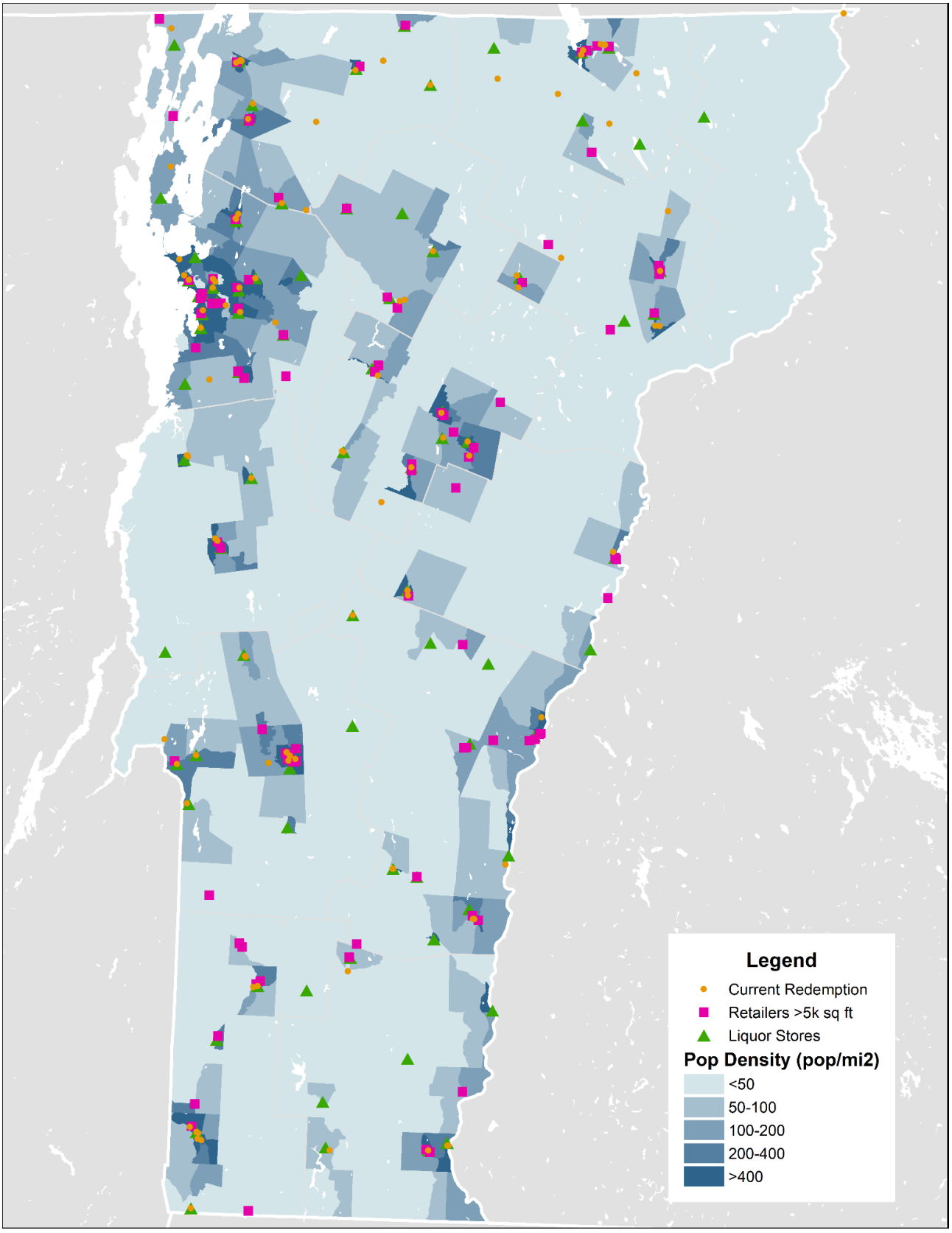
Figure 10: 100 Current Redemption Sites, 147 Retailers over 5,000 sq ft (including 51 Current Redemption Sites), and 82 Liquor Stores (including 11 Current Redemption Sites) in Vermont



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Appendix C

SYSTEM COST

Table 40 summarizes the assumptions used to derive the Recycling System costs. These numbers were modeled after the 2013 Systems Analysis on Solid Waste Management for VT with adjustments for wage inflation, using data from the 2022 Diversion and Disposal Report for VT as well as verified through primary interviews with waste haulers and processors in VT.

Table 40: Recycling System cost breakdown

	Description	Unit/ Coefficient	Baseline	System Cost Estimate
	Refuse Collection		202,719	**$54,384,376**
RESIDENTIAL COSTS	Curbside access	Households Served	307,573	
	High Density	Households Served	67,238	
	HH per truck/Number of trucks	950	10	
	Costs (Using $/truck)	Annual Operating Cost	246,400	$2,491,352
	Med/ Low Density	Households Served	240,334	
	HH per truck/Number of trucks	375	92	
	Costs (Using $/truck)	Annual Operating Cost	246,400	$22,559,385
	Drop-Off (Self-Haul)	Households Served	26,745	
	Tons Collected via Drop-off	Tons	18,684	
	Drop-Off Operational Costs	Cost/ton	128	$2,382,266
	Transfer/Pull costs	Cost/ton	32	$597,902
	Residential Refuse Disposal	Cost/ton	130	$26,353,470
	Recycling Collection		66,108	**$28,064,126**
	Curbside access	Households Served	307,573	
	High Density	Households Served	67,238	
	HH per truck/Number of trucks	950	10	
	Costs (Using $/truck)	Annual Operating Cost	246,400	$2,491,352
	Med/ Low Density	Households Served	240,334	
	HH per truck/Number of trucks	375	92	
	Costs (Using $/truck)	Annual Operating Cost	246,400	$22,559,385
	Drop-Off (Self-Haul)	Households Served	26,745	
	Tons Collected via Drop-off	Tons	4,969	
	Drop-Off Operational Costs	Cost/ton	128	$633,492
	Revenues from Sale of Recyclables	Revenue/ton	98	-6,445,554
	Net Cost, SS Res Recycling Processing	Cost/ton	134	$8,825,450
COMMERCIAL /ICI COSTS	**Refuse Collection**		**175,323**	**$50,625,232**
	Dumpster Service: $ Per Ton / Tons	130	145,544	$18,920,703
	Rear Load Service: $ Per Ton / Tons	338	21,271	$7,178,897
	Drop-off Service: $ Per Ton / Tons	204	8,508	$1,733,642
	ICI Refuse Disposal	130	175,323	$22,791,990
	Recycling Collection		**34,341**	**$9,885,243**
	Dumpster Service: $ Per Ton / Tons	109	19,354	$2,109,608
	Rear Load Service: $ Per Ton / Tons	217	13,616	$2,954,770
	Drop-off Service: $ Per Ton / Tons	173	1,370	$236,361
	Net Cost, SS Res Recycling Processing	134	34,341	$4,584,505

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EBB Impact on Recycling System

Table 41 summarizes the price assumptions for materials recycled. The same assumptions used for the BBS were applied to the RS for Aluminum and PET. HDPE assumes mix of natural and colored based on RRS internal data. Glass is assumed to be $0/ ton for RS vs. $20/ ton for the BBS.

Table 41: Material price assumptions used to calculate impact of expansion on MRF revenue

Reduction in MRF revenue	Aluminum Cans	PET Bottles	HDPE Bottles	Glass Bottles	Total
Average $/ton - Single Stream Collection	$1,384	$323	$820	$0	-
Tons removed from MRF	443	666	91	4,680	5,881
Financial Impact	$613,605	$214,984	$74,599	$0	$903,187

EBB IMPACT ON WASTE

Table 42 is based on the 2023 Waste Composition Study done for the state of VT. Material redemption rates from Model 1 were applied to estimated EBB waste respectively.

Table 42: EBB tons removed from waste broken down by material type

	Aluminum Cans	PET Bottles	HDPE Bottles	Glass Bottles	Total
Tons removed from Waste	183	1,460	402	1,404	3,450

UNITS TO WEIGHT CONVERSION FACTORS

Table 43 and Table 44 provide the assumptions used to convert units to weight in the model, unless otherwise specified in the report.

Table 43: Units to weight conversion factors based on 2023 Vermont Container Processor Redemption data

	Aluminum	Glass	PET	HDPE
Containers per pound (CPP)	32.10	2.14	21.18	NA
Containers per ton	64,197	4,274	42,356	NA

Table 44: Units to weight conversion factors based on CRI 2021 data

	HDPE Bottles
Containers per ton	12,909
Containers per pound	6.45

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